BEFORE THE MARYLAND DEPARTMENT OF THE ENVIRONMENT
WATER AND SCIENCE ADMINISTRATION

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Clean Water Act Section 401 Certification *
Conowingo Hydroelectric Project
FERC Project No. P-405 *
MDE WSA Application No. 17-WQC-02
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RECONSIDERATION ORDER

WHEREAS, pursuant to its authority under Section 401 of the federal Clean Water Act, Title 9, Subtitle 3 of the Environment Article, Annotated Code of Maryland, and COMAR 26.08.02.10, the Maryland Department of the Environment ("MDE" or the "Department") granted to Constellation Energy Generation, LLC[1] ("Constellation") on April 27, 2018, a water quality certification with conditions (the "Certification") in response to Constellation's application, submitted on May 17, 2017 (WSA 17-WQC-02), for the Conowingo Hydroelectric Project, which is undergoing relicensing through the Federal Energy Regulatory Commission ("FERC"), FERC Project Number P-405;

WHEREAS, the Certification and COMAR 26.08.02.10F(4) provide that any person aggrieved by the Department's decision to issue the Certification may appeal such decision by submitting a request for reconsideration within 30 days of the decision;

WHEREAS, on May 25, 2018, Constellation submitted to MDE a document styled Protective Petition for Reconsideration and Administrative Appeal, which requested

[1] Constellation was formerly known as Exelon Generation Company, LLC.

reconsideration and administrative appeal of the Certification (the "Constellation Administrative Proceeding");

WHEREAS, on June 8, 2018, the Stewards of the Lower Susquehanna, d/b/a Lower Susquehanna Riverkeeper Association, and Waterkeepers Chesapeake (the "Waterkeepers" and, together with Constellation, the "Parties") submitted to MDE a document styled Administrative Appeal of Final Decision to Issue Clean Water Act Section 401 Certification For the Conowingo Hydroelectric Project, which also requested reconsideration and administrative appeal of the Certification (the "Waterkeepers Administrative Proceeding," and together with the Constellation Administrative Proceeding, the "Reconsideration");

WHEREAS, by letter dated August 30, 2018, MDE notified both Constellation and Waterkeepers that Reconsideration was under review by MDE, and offered the parties an opportunity to appear before MDE and make presentations in support of Reconsideration. MDE also offered the parties an opportunity to submit any documents and additional information either party wished MDE to consider in making a determination on the Reconsideration;

WHEREAS, on October 19, 2018, MDE convened a meeting at its offices at 1800 Washington Boulevard, Baltimore, Maryland 21230, and both Constellation and the Waterkeepers appeared before MDE and presented in support of their positions on Reconsideration. MDE thereafter offered the parties an additional opportunity to submit written information;

WHEREAS, in separate litigation instituted by Constellation against MDE to challenge the Certification[2], the Appellate Court of Maryland ordered the parties to alternative dispute

[2] Constellation initiated an action in the Maryland state courts by filing a Complaint for Declaratory and Injunctive Relief, and in the Alternative, Petition for Judicial Review and Complaint for Mandamus, in the Circuit Court for Baltimore City, Case No. 24-C-18-003410.

resolution, and Constellation and MDE entered into a confidential mediation agreement on March 21, 2019;

WHEREAS, as a result of alternative dispute resolution before the Appellate Court of Maryland, on October 29, 2019, MDE and Constellation entered into a comprehensive Conowingo Dam Water Quality Settlement Agreement (the "2019 Settlement"), in which each agreed to jointly submit to FERC an offer of settlement with proposed license articles, pursuant to which, if FERC approved the offer of settlement and incorporated all of the proposed license articles into a new FERC license without modification, the State of Maryland would conditionally waive its rights to grant a water quality certification with or without conditions in connection with the FERC license, and Constellation would dismiss all litigation regarding the Certification;

WHEREAS, on or about March 19, 2021, FERC issued an "Order Issuing New License" for the Project, which license incorporated the proposed license articles of the 2019 Settlement Agreement without material change (the "2021 License"), and because FERC found the conditional waiver to be effective the Reconsideration were deemed moot;

WHEREAS, on or about December 20, 2022, in a petition for review of the 2019 License filed by the Waterkeepers, styled as *Waterkeepers Chesapeake, et al. v. FERC*, No. 21-1139 ("2021 License Appeal"), the U.S. Court of Appeals for the D.C. Circuit issued a decision vacating the 2021 License, and concluding that MDE's conditional waiver was ineffective and that the administrative of the Certification that was interrupted by the 2019 Settlement must continue;

WHEREAS, as a result of the 2021 License Appeal, Reconsideration of the Certification has resumed, and MDE must make a decision on Reconsideration to invalidate the Certification, affirm the Certification, or revise the Certification;

WHEREAS, MDE solicited supplemental briefings from the Parties with respect to the Certification, and, to facilitate resolution of Reconsideration, MDE and the Parties entered into confidential mediation on April 1, 2024, through FERC's Dispute Resolution Service;

WHEREAS, as a result of mediation, MDE and the Parties entered into a new, comprehensive Conowingo Dam Water Quality Settlement Agreement, dated September 26, 2025, which supersedes the 2019 Settlement and in which the Parties acknowledge and agree that MDE would revise the Certification with conditions; and

WHEREAS, pursuant to its authority under Title 9, Subtitle 3 of the Environment Article, Annotated Code of Maryland and COMAR 26.08.02.10F(4), the Department is rendering this Order in determination of Reconsideration.

NOW THEREFORE, upon Reconsideration, and review of all other information, material, and arguments presented in support of Reconsideration as set forth above or otherwise considered by the Department, the Department HEREBY REVISES the Certification with conditions, as evidenced by the Revised Water Quality Certification attached as Exhibit A (the "Revised Certification") to this Order. The Revised Certification is incorporated herein by reference into and is a part of this Order.

October 2, 2025
Date

D. Lee Currey, Director
Water and Science Administration

Approved as to form and legal sufficiency
this 2 day of October, 2025

Jonathan E.C. May
Assistant Attorney General

STATE OF MARYLAND
DEPARTMENT OF THE ENVIRONMENT
WATER AND SCIENCE ADMINISTRATION

WATER QUALITY CERTIFICATION (Revised)
17-WQC-02 (R1)

ISSUANCE DATE:	**April 27, 2018**
REVISED ISSUANCE DATE:	**October 2, 2025**
CERTIFICATION HOLDER:	**Constellation Energy Generation, LLC (formerly Exelon Generation Company, LLC)**
PROJECT LOCATION:	**Conowingo Hydroelectric Project/FERC Project No. P-405 Susquehanna River, at river mile 10 in Maryland, spanning the river between Cecil and Harford Counties, Maryland. The lowermost six miles of the Project's reservoir lie within Maryland, while the remaining eight miles extend into York and Lancaster counties, Pennsylvania**

UNDER AUTHORITY OF SECTION 401 OF THE FEDERAL WATER POLLUTION CONTROL ACT AND ITS AMENDMENTS AND IN ACCORDANCE WITH §9-313 THROUGH §9-323, INCLUSIVE, OF THE ENVIRONMENT ARTICLE, ANNOTATED CODE OF MARYLAND, THE WATER AND SCIENCE ADMINISTRATION ("ADMINISTRATION") HAS DETERMINED THAT THE REGULATED ACTIVITY DESCRIBED IN THE REQUEST FOR CERTIFICATION OF THE CONOWINGO HYDROELECTRIC PROJECT/FERC PROJECT P-405 WILL NOT VIOLATE MARYLAND'S WATER QUALITY STANDARDS IF CONDUCTED IN ACCORDANCE WITH THE TERMS AND CONDITIONS OF THIS CERTIFICATION.

THIS CERTIFICATION IS HEREBY GRANTED WITH CONDITIONS. THIS CERTIFICATION DOES NOT RELIEVE THE APPLICANT OF RESPONSIBILITY FOR OBTAINING ANY OTHER APPROVALS, LICENSES, OR PERMITS IN ACCORDANCE WITH FEDERAL, STATE, OR LOCAL REQUIREMENTS. A COPY OF THIS REQUIRED CERTIFICATION HAS BEEN SENT TO THE FEDERAL ENERGY REGULATORY COMMISSION (FERC). THE CERTIFICATION HOLDER SHALL COMPLY WITH THE CONDITIONS LISTED BELOW:

PROJECT DESCRIPTION

Tracking Number: 201762332 Agency Interest Number: 2063

The Project is a peaking hydroelectric facility that includes: (1) the Dam, (2) a spillway, (3) the Reservoir, (4) an intake and powerhouse, (5) the West Fish Lift and the East Fish Lift, and (6) an Eel passage facility on the west side, all of which are located on the River approximately 10 miles north of the River's confluence with the Chesapeake Bay.

The West Fish Lift, adjacent to the Dam's right abutment, and the newer East Fish Lift, located near the midpoint of the Dam, are used primarily to assist in the passage of Shad, Herring, and other migratory fish during the March-June migration season. The Reservoir serves as the lower reservoir for Muddy Run. It also serves as the source of cooling water for Peach Bottom and the York Energy Center. The Reservoir is also a public water supply source, with the City of Baltimore and Chester Water Authority (in Pennsylvania) having permitted withdrawals of 250 million gallons per day and 30 million gallons a day, respectively. The powerhouse is integrated with the Dam. There are 13 turbine-generator units, associated draft tubes, and transformer bays. Water flowing through the turbines is discharged via the draft tubes into the Tailrace.

This Water Quality Certification (Certification) is issued under authority of Section 401 of the Federal Water Pollution Control Act and its Amendments, Title 9, Subtitle 3 of the Environment Article, and Code of Maryland Regulations (COMAR) 26.08.02.10. The Maryland Department of the Environment (Department) has determined from a review of the request application file, and upon subsequent administrative reconsideration, that the project activities described above will not violate Maryland's water quality standards, provided that the following conditions are satisfied. A Public Notice for the Certification request was issued on July 10, 2017, and a Public Hearing for the Certification request was held on Tuesday, December 5, 2017 at the Harford Community College in Bel Air, Maryland. The Department issued an initial decision on the Certification request on April 27, 2018. After administrative reconsideration requested by the Certification Holder, Lower Susquehanna Riverkeeper Association and Waterkeepers Chesapeake, the Department is issuing this Revised Certification as the Department's final decision on Reconsideration.

DEFINITIONS

In addition to terms defined elsewhere in this Certification, the following terms have the following meaning when used in this Certification and the Attachments hereto:

"Anadromous" means migratory fish that spawn in freshwater rivers but spend most of their life in the ocean.

"Application" means that certain Application for a Maryland Water Quality Certification for the Conowingo Hydroelectric Project submitted to the Department by the Certification Holder with respect to the Project on May 17, 2017, as amended, supplemented, or modified.

"Aquatic Invasive Species" means Northern Snakehead (*Channa argus*), Flathead Catfish *(Pylodictis olivaris*), and Blue Catfish (*Ictalurus furcatus*) or other species identified as detrimental to the ecosystem and non-native through this Certification.

"Authorization" means any applicable license, permit, approval, consent, exemption, or authorization from a federal, State, or local governmental authority.

"Bay" means the Chesapeake Bay and its tidal tributaries.

"cfs" means cubic feet per second.

"CPI" means the Consumer Price Index for All Urban Consumers (CPI-U; U.S. City Average; all items, not seasonally adjusted; 1982-84=100 reference base) published from time to time by the U.S. Bureau of Labor Statistics. Any amounts in this Certification adjusted for inflation in accordance with the CPI shall be based on the cumulative change in CPI.

"Dam" means the Conowingo Dam, as described in Section 1.1 of the FERC Application.

"Maryland DNR" means the Maryland Department of Natural Resources.

"DO" means dissolved oxygen.

"DOI" means the United States Department of the Interior.

"DOI Modified Prescription for Fishways" means the USFWS Modified Prescription for Fishways for the Conowingo Hydroelectric Project (Project, Conowingo, and Conowingo Project), FERC P-405, pursuant to Section 18 of the Federal Power Act (FPA) dated June 8, 2016.

"Downstream fish passage efficiency" means the percentage of the fish that approach the upstream side of the Project and survive as they pass the Project.

"Eel" means American eel (*Anguilla rostrata*).

"East Fish Lift" or "EFL" means the east fish lift at the Project.

"Environment Article" means the Environment Article of the Annotated Code of Maryland.

"FERC" means the Federal Energy Regulatory Commission.

"FERC Application" means that certain Application for New License for Major Water Power Project-Existing Dam submitted to FERC by the Certification Holder with respect to the Project on or about August 9, 2012, as amended, supplemented, or modified.

"Fish Lift" means an elevator-like structure with a Hopper used to convey fish from the Tailwaters to the headpond of high dams or in connection with Trap and Transport operations.

"Herring" means, interchangeably and collectively, alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*).

"Holtwood" means the Holtwood Hydroelectric Project, FERC Project Number 1881.

"Hopper" means the structural part of the fish lift used to hold fish as they are transported from the Tailwaters to the headpond.

"Laws" means applicable laws, statutes, regulations, rules, administrative orders, and judicial orders.

"Marietta Gage" means the water stage gage located on the River approximately one mile downstream of Marietta, Pennsylvania, USGS station #01576000.

"Muddy Run" means the Muddy Run Pumped Storage Project, FERC Project Number 2355.

"New License" means the new license for the Project requested in the FERC Application.

"NMFS" means the National Marine Fisheries Service.

"Payment Operative Date" means the date 30 days after the following, whichever is later: (1) the times to file any challenges to the FERC-issued New License or any component thereof (including this Revised Water Quality Certification) have expired, and no challenges have been filed; or (2) consideration of any filed challenges to the FERC-issued New License or any component thereof has been concluded with no opportunities for further review and the New License and all components thereof have been affirmed.

"Peach Bottom" means the Peach Bottom Atomic Power Station.

"Project" means the Conowingo Hydroelectric Project, FERC Project Number 405, including all Project lands, the powerhouse, and the spillway.

"Reservoir" means the water impounded by the Dam, which is sometimes referred to as the Conowingo Pond or Conowingo Pool.

"River" means the Susquehanna River.

"SAV" means submerged aquatic vegetation.

"Secretary" means the Secretary of the Environment of the State of Maryland, and any successor thereto.

"Safe Harbor" means the Safe Harbor Hydroelectric Project, FERC Project Number 1025.

"Sediment Management Plan" or "SDMP" means the Certification Holder's Sediment Management Plan dated August 2012, included in the FERC Application, revised September 2021, and incorporated herein by reference.

"Shad" means American shad (*Alosa sapidissima*).

"Shoreline Management Plan" or "SMP" means the Certification Holder's Shoreline Management Plan

dated August 2012, included in the Application and in Volume 3 of the FERC Application, and as revised September 2021, which is incorporated herein by reference.

"SRAFRC" means the Susquehanna River Anadromous Fish Restoration Cooperative.

"SRMFAIS Collaborative" means the Susquehanna River Migratory Fish and Aquatic Invasive Species Collaborative consisting of U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, Susquehanna River Basin Commission, Pennsylvania Fish and Boat Commission, Maryland Department of Natural Resources, New York State Department of Environmental Conservation, the owners and operators of each of the lower Susquehanna River hydroelectric dams (Conowingo, Holtwood, Safe Harbor, and York Haven), and the Susquehanna River Anadromous Fish Restoration Cooperative formed to address management of aquatic invasive species in the Susquehanna River watershed.

"Station 643" means monitoring station 643, located approximately 0.6 miles downstream of the Dam for instream monitoring of dissolved oxygen under the Project's Maryland State Discharge Permit No. 19DP0491 MD, NPDES Permit No. MD0002518 (December 2021).

"Sturgeon" means Atlantic and shortnose sturgeon (*Acipenser brevirostrum*, *Acipenser oxyrinchus oxyrinchus*).

"Tailrace" means the area downstream of the Dam that is in the hydraulic influence of Project operations.

"Tailwaters" means the Tailrace, extending to the downstream tip of Rowland Island.

"Target Efficiency" means the upstream and downstream passage criteria that are the basis of the DOI 2016 Modified Prescription for Fishways Pursuant to Section 18 of the Federal Power Act and the requirements of this Certification.

"Term" means the term of the New License.

"TMDL" means a calculation for an impaired water body of the maximum amount of a pollutant the water body can receive and still meet applicable water quality standards in accordance with federal Clean Water Act requirements pursuant to COMAR 26.08.11.03B(49).

"Trap and Transport" means fish that are collected at a downstream project and loaded in a tank truck and transported and released into some location upstream of that project.

"Upstream Eel Migration Season" begins on May 1 or whenever River temperatures are 14 degrees Celsius, whichever is earlier, and runs until November 1 or when the fall mean daily River temperature below Conowingo Dam is 14 degrees Celsius or less for three consecutive days, whichever is earlier. River temperatures shall be based on daily monitoring of water temperatures at 11 am at Station 643, or another location agreed upon by the Certification Holder and MDE.

"Upstream Fish Passage Efficiency" means the percentage of the fish present in the Tailwaters that successfully move through the fish lift and continue upstream migrations; e.g., the percentage of fish that start at point B (downstream end of Rowland Island in the case of the Dam) and passes point E in the diagram set forth in Attachment A of this Certification.

"USFWS" means the United States Fish and Wildlife Service.

"Volitional Passage" means fish passage from the Tailwaters to the headpond.

"West Fish Lift" or "WFL" means the west fish lift at the Project.

"WQS" means applicable Maryland water quality criteria and standards set forth in COMAR 26.08.01 and COMAR 26.08.02.

The Certification Holder shall comply with the following conditions:

SPECIAL CONDITIONS

1) Compliance with WQS

a) The Certification Holder shall meet all applicable WQS associated with the operations of and discharge from the Project as set forth in the conditions of this Certification. Except as specifically set forth herein, this Certification does not authorize the discharge of any pollutants. The Certification Holder shall not discharge any waste or wastewater from the Project, unless it is specifically authorized by MDE. This Certification does not authorize any work to occur in waters of the State, including any dredging or the construction or placing of any physical structures, facilities, fill, or debris or the undertaking of related activities in any waters of the State. The Certification Holder shall comply with any other permit or authorization required by law, including all water quality-related performance standards and conditions required by such other permit or authorization.

2) Operational Flow Regime

a) The Certification Holder shall operate the Project in accordance with the following operational flow regime ("Interim Flow Regime") beginning at the time of issuance of the New License and ending not later than the third anniversary of the issuance of the New License.

Interim Flow Regime	
Date	**Minimum Flow***
September 15 - March 31	3,500 cfs or natural inflow, whichever is less
April 1 – 30	10,000 cfs or natural inflow, whichever is less
May 1 - June 15	7,500 cfs or natural inflow, whichever is less
June 16 - September 14	5,000 cfs or natural inflow, whichever is less

*Natural inflow must be measured at the Marietta Gage.

b) The Certification Holder shall operate the Project in accordance with the following operational flow regime ("Year 4 Flow Regime"), which shall begin no later than the third anniversary of the issuance of the New License, unless modified under Condition 2 (f), (h) through (k), or (o) herein:

Year 4 Flow Regime				
Date	**Minimum Flow***	**Down-Ramping Rate**	**Up-Ramping Rate**	**Maximum Flow****
January 1 –31	5,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	None	None
February 1– 29	5,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	None	None
March 1 –15	11,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	None
March 16 –31	11,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	None
April 1 –30	17,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	None
May 1 – 31	17,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	75,000 cfs
June 1 – 15	11,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	75,000 cfs

Year 4 Flow Regime				
Date	**Minimum Flow***	**Down-Ramping Rate**	**Up-Ramping Rate**	**Maximum Flow****
June 16 –30	5,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	75,000 cfs
July 1 – 31	5,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	79,000 cfs
August 1 –31	5,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	79,000 cfs
September 1 – 30	5,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	79,000 cfs
October 1 – 31	5,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	Up to 40,000 cfs/hour	None
November 1 – 30	5,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	None	None
December 1 – 31	5,000 cfs or natural inflow, whichever is less	Up to 12,000 cfs/hour if Conowingo Discharge is less than 30,000 cfs	None	None

*Natural inflow must be measured at the Marietta Gage.

**Maximum flow restrictions only apply when the natural inflow is less than 86,000 cfs.

c) The Year 4 Flow Regime may not be modified or deviated from other than as described in (f), (h) through (k), or (o) herein. For the purposes of requesting a modification to the Year 4 Flow Regime by the Certification Holder, the Certification Holder shall conduct an "Alternative Flow Regime Study" for MDE's review and approval.

i) An "Alternative Flow Regime Study" or "AFRS" means a study that demonstrates that the benefits to the aquatic system of a modified flow regime proposed by the Certification Holder are equal to or exceed the Year 4 Flow Regime. The AFRS shall be subject to independent external technical and scientific peer review and submitted by the Certification Holder to MDE for review and approval. The peer review shall consist of at least three qualified and independent technical experts or scientists with

specialties in the appropriate scientific or technical disciplines and approved in writing by MDE prior to initiation of any peer review.

ii) For purposes of this Operational Flow Regime Condition, "benefits to the aquatic system" shall include, at a minimum, consideration of measurable improvements in the following, as applicable: (a) the modeled, estimated or projected percentage of Shad and Herring successfully entering the fish lifts within three days of their entry into the Tailrace; (b) the modeled, estimated or projected condition of downstream aquatic life, as evidenced by a modeled, estimated or projected reduction in the number of fish strandings; (c) the modeled, estimated or projected habitat, abundance, and composition of macroinvertebrates and freshwater mussels; and (d) the modeled, estimated or projected presence and composition of SAV within the segment of the River between the Project and the head of tide.

d) For each AFRS, the Certification Holder shall develop a study design with the objective of analyzing one or more component parts of the Year 4 Flow Regime or another flow regime to determine whether such component parts provide sufficient benefits to the aquatic system. The Certification Holder shall subject the study designs to the peer review and incorporate any consensus recommendations into the study design as a result of that process.

e) The Certification Holder shall provide MDE, for review and approval, each final study design with the results of the peer review prior to initiating the AFRS. Upon MDE approval the AFRS shall be filed with FERC.

f) If the AFRS and the results of peer review determine that a modified flow regime is likely to provide equal or greater benefits to the aquatic system compared to the unmodified Year 4 Flow Regime, the Certification Holder may submit to MDE for review and approval a modified flow regime and implementation schedule along with the final AFRS and results of the peer review. The Certification Holder shall submit the results of any completed AFRS including the results of peer review to MDE for evaluation a minimum of 12 months prior to requesting a modification. Upon MDE approval the modified flow regime and implementation schedule, including the final AFRS and results of the peer review shall be filed with FERC.

g) The Certification Holder shall submit a report to MDE on the seventh anniversary after the issuance of the New License and every five years thereafter on developments in new technology that will provide a measurable reduction in the peaking generation at the Project which are technologically and economically feasible to implement at the Project at the time of the report. Technologically and economically feasible for Condition 2 (g) means that new technology exists that could be implemented to

provide a measurable reduction in the peaking generation at the Project without causing a reduction in the pre-tax present value of the combined revenues of the Project and Muddy Run.

h) If compliance with the Interim Flow Regime, the Year 4 Flow Regime, or an approved modified flow regime, as the case may be (each, "Applicable Flow Requirements"), would cause the Certification Holder to violate or breach any Law, any Authorization, including the Nuclear Regulatory Commission license for the Peach Bottom Atomic Power Station, the FERC license for the Muddy Run Pumped Storage Project No. 2355 ("Muddy Run Project"), any agreement with the City of Baltimore or other governmental entity, or any tariff or other requirement of the PJM Interconnection Regional Transmission Organization or their assigns, the Certification Holder may deviate from the prescribed flows to the least degree necessary in order to avoid such violation or breach.

i) If compliance with any of the Applicable Flow Requirements would cause the Certification Holder to violate any agreement in effect as of September 1, 2025, with the Chester Water Authority, Old Dominion Electric Cooperative, or the York Energy Center, the Certification Holder may deviate from the Applicable Flow Requirements to the least degree necessary in order to avoid such violation or breach.

j) If compliance with any of the Applicable Flow Requirements would cause or exacerbate flooding or a similar public safety hazard, the Certification Holder may deviate from the Applicable Flow Requirements to the least degree necessary in order to avoid such flooding or public safety hazard.

k) Not including the authorized deviations in Conditions 2(h), (i), and (j) of this Certification, the Certification Holder shall have the flexibility to deviate from the up-ramping, down-ramping and maximum flow restrictions according to the following limits during each month:

   i) January, February: eight total permitted hours of deviation per month;

   ii) March, April, May, and that portion of June during which the East Fish Lift (EFL) is in operation: no deviations allowed;

   iii) June after EFL operation has ceased: eight total permitted hours of deviation per month of which no more than 50% will be allocated to down-ramping and up-ramping;

   iv) July, August: 26 total permitted hours of deviation per month of which no more than 50% will be allocated to down-ramping and up-ramping;

   v) September: 32 total permitted hours of deviation per month of which no more than 50% will be allocated to down-ramping and up-ramping;

vi) October: 14 total permitted hours of deviation per month; and

vii) November, December: eight total permitted hours of deviation per month.

When the Certification Holder deviates from the down-ramping or up-ramping restrictions of the Applicable Flow Requirements, the amount of time applied against the limits set forth above is two hours per event, regardless of the actual amount of time it takes the Certification Holder to complete the down-ramping or up-ramping event. Minimum flow releases may be temporarily modified if required by operating emergencies beyond the control of the Certification Holder, and for short periods upon mutual agreement among the Certification Holder and MDE. Upon agreement, the Certification Holder shall notify FERC. The Certification Holder must maintain complete and accurate records of all deviations that occur pursuant to this section.

l) For authorized deviations in Conditions 2(h), (i), and (j) of this Certification and unplanned deviations, the Certification Holder must file a report with MDE and FERC as soon as possible, but no later than 14 days after the onset of the incident. The report must describe the incident, including: (1) the cause, (2) the duration and magnitude, (3) any pertinent operational and/or monitoring data, (4) a timeline of the incident and the Certification Holder's response, (5) any adverse environmental effects, (6) documentation that MDE and USFWS were notified and any comments received, or, affirmation that no comments were received, and (7) any measures to be implemented to prevent similar incidents in the future.

m) For the authorized deviations in Conditions 2(k) of this Certification, the Certification Holder must file a report with MDE and FERC by July 31 for the authorized deviations from January 1st through June 30th. The report must describe the deviation, including: (1) the duration, timeline and magnitude, (2) any pertinent operational and/or monitoring data, and (3) any adverse environmental effects.

n) No later than March 1 of each year, the Certification Holder shall provide an annual report to MDE and FERC of all authorized deviations in Conditions 2(h), (i), (j) and (k) of this Certification and unplanned deviations from the Applicable Flow Requirements that occurred during the previous calendar year. The annual report shall include, at a minimum, reason for the deviation, description of the hourly flows provided during the deviation period, the duration of the hourly flows under these circumstances, and any observed adverse impacts to aquatic life (e.g., fish kills, additional observed delays in migratory fish reaching the fish lifts, etc.).

o) The Year 4 Flow Regime also may be modified in accordance with the following:

i) Within six months after publication of the final FERC license or any license amendment for Holtwood or Safe Harbor indicating that the flow

requirements at Holtwood or Safe Harbor have changed or will change, the Certification Holder shall deliver a report (an "Improved Minimum Flow Report") to MDE, portions of which involving the assessment of "Detrimental Economic Impact" as described below may be designated as confidential, stating (1) whether or not the changed flow requirements at Holtwood or Safe Harbor will permit the achievement of greater minimum flows at the Dam than the minimum flows set forth in the Year 4 Flow Regime or any other approved Modified Flow Regime; (2) the greatest increase in minimum flows at the Dam that will result in benefits to the aquatic system under the Condition 2(c)(ii) criteria without causing a Detrimental Economic Impact (defined below) (the "Improved Minimum Flows"); and (3) the operational and cost impacts of implementing the Improved Minimum Flows, if any. The Improved Minimum Flow Report shall be based upon publicly available energy price forecasts and discount rates, and, subject to Condition 21(a) of this Revised Certification, the Certification Holder shall provide sufficient supporting documentation to explain the Improved Minimum Flows Proposal.

ii) A "Detrimental Economic Impact" shall be deemed to exist if the Modified Present Value is less than the Unmodified Present Value. "Unmodified Present Value" means a good faith projection, based on publicly available energy price forecasts and discount rates, of the pre-tax present value of combined energy revenues that Conowingo and Muddy Run would expect to receive through the remainder of the Term of the New License (excluding any annual extensions) if no modification was made to the Year 4 Flow Regime. "Modified Present Value" means, with respect to any potential change in the Year 4 Flow Regime, a good faith projection, based on publicly available energy price forecasts and discount rates, of the pre-tax present value of combined energy revenues that Conowingo and Muddy Run would expect to receive through the remainder of the Term of the New License (excluding any annual extensions).

iii) Within six months (unless a new timeframe is otherwise agreed upon) after receiving an Improved Minimum Flow Report that proposes Improved Minimum Flows, MDE agrees to notify the Certification Holder that it either approves or does not approve the proposed Improved Minimum Flows. If MDE approves the proposed Improved Minimum Flows, the Certification Holder shall submit a proposed modified flow regime and implementation schedule to MDE requesting a modification of the Revised WQC and a modification request to FERC. After modification

of the Revised WQC and approval by FERC, the Certification Holder shall operate in accordance with the modified flow regime approved by MDE and FERC and with any required modification to the FERC License within the specified timeframe.

3) Minimum Stream Flow Operational Plan

a) The Certification Holder shall within 6 months following issuance of the New License submit a Minimum Stream Flow Operational Plan ("MSFOP"), governing operations under the Interim Flow Regime set forth in Condition 2(a) of this Revised Certification, to MDE for review and approval, so that MDE may ensure that the MSFOP is consistent with Condition 2(a) and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Minimum Stream Flow Operational Plan dated March 18, 2022, attached hereto as Attachment B. The Certification Holder shall implement and comply with the MSFOP as approved by MDE and as thereafter submitted to and approved by FERC. The MSFOP as approved by MDE and FERC shall be made part of this Certification.

b) No less than 24 months prior to the effective date of the Year 4 Flow Regime set forth in Condition 2(b) of this Revised Certification, the Certification Holder shall submit a revised MSFOP ("Revised MSFOP") governing operations under the Year 4 Flow Regime. The Revised MSFOP, and any subsequent modifications proposed by the Certification Holder, must be submitted to MDE for review and approval before it is submitted to FERC, so that MDE may ensure that the Revised MSFOP is consistent with the Year 4 Flow Regime set forth in Conditions 2(b) and 2(h) through 2(k) of this Revised Certification. Upon MDE approval the Revised MSFOP shall be filed with FERC for its approval.

c) The Revised MSFOP will include at a minimum:

i) a detailed description of how the Project will comply with the minimum flow, ramping rate, and maximum flow requirements of the New License, as well as Conowingo reservoir level restrictions specified in the New License;

ii) a description of the mechanisms and structures (e.g., type and exact locations of all flow and reservoir elevation monitoring equipment and gages) to be used for maintaining compliance with operational requirements, and procedures for maintaining and calibrating monitoring equipment; and

iii) standard operating procedures to be implemented during routine

maintenance, including a schedule of routine maintenance, and procedures to be implemented during conditions outside of normal operation, including during emergency conditions such as unscheduled facility shutdowns and maintenance.

d) The Certification Holder shall implement and comply with the Revised MSFOP and any subsequent modifications, upon approval by FERC. Upon approval the Revised MSFOP, and any subsequent modifications proposed by the Certification Holder and approved by FERC and MDE, shall be attached and made part of this Certification.

e) The Certification Holder shall submit an annual report to MDE by March 1 of each year detailing the implementation of the MSFOP or Revised MSFOP, including any deviations from the MSFOP or Revised MSFOP and processes to prevent those deviations in the future.

4) Monitoring Stream Flows in the Tailrace

a) The Certification Holder shall complete a study regarding the feasibility of redesigning, installing, and maintaining best available real-time flow telemetry at the United States Geological Survey (USGS) flow gage in the project tailrace (No. 01578310) ("Tail Race Gage Study") or otherwise downstream of the spillway channel within one year of issuance of the New License. The Tail Race Gage Study shall include consultation with USGS and MDE and will be sited to capture total flow from the Project. The Tail Race Gage Study findings shall be reported to MDE within sixty (60) days of study completion.

b) If the Certification Holder, following consultation with MDE and USGS, concludes in the Tail Race Gage Study that it is feasible to do so, the Certification Holder shall submit to the USGS and MDE, for review and approval, a plan for the redesign, installation, and maintenance of best available real-time flow telemetry at the stream gage in the Tailrace (USGS Station Gage #01578310) ("Tailrace Gage Plan") or comparable area that captures the total flow from the Project within one hundred eighty (180) days after completing the Tail Race Gage Study. The Tailrace Gage Plan shall include:

i) an implementation schedule;

ii) documentation of consultation;

iii) copies of recommendations on the completed Tail Race Gage Plan; and

iv) specific descriptions of how any comments are accommodated by the Tail

Race Gage Plan.

c) The Certification Holder shall implement and comply with the Tailrace Gage Plan upon approval. Upon approval the Tailrace Gage Plan, and any subsequent modifications proposed by the Certification Holder and approved by FERC, USGS, and MDE, shall be made part of this Certification.

d) The Tailrace Gage Plan shall include a provision requiring the Certification Holder to submit monitoring results from any new Tailrace Gage annually, by March 1 of the following year, to MDE. These results shall be included in the MSFOP or Revised MSFOP annual report.

5) Fish Passage

a) As specified in Condition 5 of the Certification, the Certification Holder shall take actions designed to advance the goals that the Project ultimately be able to allow up to 5,000,000 Shad and 12,000,000 Herring that approach the Project to pass the Dam each year during the Term.

b) The Certification Holder shall implement and comply with all provisions of the DOI Modified Prescription for Fishways, dated June 8, 2016, unless MDE, in conjunction with USFWS and FERC, agrees that an existing obligation in the Prescription may be removed or lessened. (Attachment C)

c) The Certification Holder shall within 6 months following issuance of the New License submit a Fishway Effectiveness Monitoring Plan ("FEMP") to MDE for review and approval, so that MDE may ensure that the FEMP is consistent with Condition 5 of this Revised Certification and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Fishway Effectiveness Monitoring Plan dated September 2021, attached hereto as Attachment D. The Certification Holder shall implement and comply with the FEMP as approved by MDE and as thereafter submitted to and approved by FERC. The FEMP as approved by MDE and FERC shall be made part of this Certification.

d) The Certification Holder shall include MDE and Maryland DNR in annual discussions with USFWS and other SRAFRC entities regarding modifications to the FEMP. The Certification Holder shall submit to MDE any proposed modifications to the approved FEMP for review and approval prior to submission to FERC, so that MDE may ensure that the revised FEMP remains consistent with Condition 5 of this Certification. Upon approval of a revised FEMP by FERC, the Certification Holder shall implement and comply with the approved revised FEMP. Any modifications to the FEMP proposed by the Certification Holder and approved by FERC and MDE

shall be attached and made part of this Certification.

e) The Certification Holder shall within 6 months following issuance of the New License submit a Fishway Operations and Maintenance Plan ("FOMP") to MDE for review and approval, so that MDE may ensure that the FOMP is consistent with Condition 5 of this Revised Certification and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Fishway Operations and Maintenance Plan dated January 31, 2023, attached hereto as Attachment E. The Certification Holder shall implement and comply with the FOMP as approved by MDE and as thereafter submitted to and approved by FERC. The FOMP as approved by MDE and FERC shall be made part of this Certification.

f) The Certification Holder shall include MDE and Maryland DNR in annual discussions with USFWS and other SRAFRC entities regarding modifications to the FOMP. The Certification Holder shall submit to MDE any proposed modifications to the approved FOMP for review and approval prior to submission to FERC, so that MDE may ensure that the revised FOMP remains consistent with Condition 5 of this Certification. Upon approval of a revised FOMP by FERC, the Certification Holder shall implement and comply with the approved revised FOMP. Any modifications to the FOMP proposed by the Certification Holder and approved by FERC and MDE shall be attached and made part of this Certification.

g) The Certification Holder shall design new fishway(s) to ensure operation under River flows in the range of 6,330 cfs to 143,000 cfs. The Certification Holder shall not be required to operate the fishway(s) at flows greater than 113,000 cfs unless data available at the time demonstrates that operation of fishways at flows greater than 113,000 cfs is necessary to achieve the Target Efficiency.

h) The fishways shall be designed with sufficient freeboard (or other protection) to minimize damage from River flows of up to the 50-year return interval.

i) The Certification Holder shall provide written documentation to MDE that all fish lift operational personnel have reviewed and understand the FOMP, and it shall be signed by the operations manager of the Project. Copies of the approved FOMP and any modifications shall be provided to MDE on an annual basis.

j) The Certification Holder shall complete work on the development of design plans to modify the East Fish Lift ("EFL Modification Plan") to satisfy obligations set forth in the DOI Modified Prescription for Fishways and Condition 5 of this Certification. The completion of the design plans shall be conducted in consultation with MDE and

USFWS.[1] The 90% design plans shall be submitted to MDE and USFWS for review and approval within 6 months of the date of issuance of the New License, prior to their submission to FERC for approval. The Certification Holder shall complete the physical improvements to the EFL as provided in a schedule for completion of the work approved by MDE, USFWS and FERC, provided timely issuance of all applicable Authorizations. The EFL Modification Plan and any subsequent approved modifications proposed by the Certification Holder and approved by FERC, USFWS, and MDE shall become a part of the Certification.

k) The Certification Holder shall visually quantify, for each fish lift hopper, the fullness of each lift during operation of the East and West Fish Lifts. The Certification Holder shall report to MDE on the fifth anniversary of the New License, and every five years thereafter, on research into whether technology has become available to quantify the bucket "fullness" of each fish lift hopper and the costs associated with installation and maintenance of such technology.

l) The Certification Holder shall provide an annual report to MDE by January 31 of each year regarding implementation of the FOMP.

m) The Certification Holder shall record in a database during the fish passage season the data collected for the annual FOMP report and provide MDE and Maryland DNR open access to the database in addition to the annual report. Data shall be entered into the database no later than one week after collection.

n) For the modifications to existing fish lifts described herein, the Certification Holder shall minimize interruption of the fish lift operations and, to the extent possible, fish lift operation interruptions shall not be scheduled during the upstream fish migration period.

6) <u>Lower River Fisheries Survey</u>

a) The Certification Holder shall submit to MDE for review and approval a plan for surveying fish ("<u>Lower River Fisheries</u> <u>Survey Plan</u>") specifically targeting the State-threatened Chesapeake Logperch (*Percina bimaculata)* ("Logperch") at least 90 days prior to conducting the initial survey identified in (6)(b)(i). Upon approval by MDE, in consultation with Maryland DNR, the Certification Holder shall implement and comply with the Lower River Fisheries Survey Plan. The Lower River Fisheries Survey Plan and any subsequent modifications proposed by the Certification Holder and approved by FERC and MDE, shall be attached and made part of this

[1] As of the date of this Certification, the 30% and 60% design plans have been submitted to MDE and USFWS, which have reviewed and provided comments on the plans.

Certification.

b) The Lower River Fisheries Survey Plan shall include:

i) a schedule for one survey to be conducted on or before the fourth anniversary of the issuance of the New License, and once during years 10, 20, 30 and 40 after license issuance;

ii) surveying fish in Reaches 1, 2, and 3, Figure 3.1-1 of RSP 3.10 (Attachment F) beginning June 15th and ending September 30th in the years they occur;

iii) surveys to be conducted by benthic electrical trawls, with an equal number of trawls and total button time as found in RSP 3.10; and

iv) collection of data including species, abundance, and effort (i.e., trawl seconds, number of trawls, number of trawls with Logperch detected).

c) The Certification Holder shall, no later than December 31 of each year that the fisheries survey was conducted, submit a report to MDE including:

i) summary of the survey effort completed; and

ii) all data collected for the survey year provided as a MS Excel file.

7) Fish Stranding Minimization

a) The Certification Holder shall within 6 months following issuance of the New License submit a Fish Kill Notification Plan to MDE for review and approval, so that MDE may ensure that the Fish Kill Notification Plan is consistent with, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Fish Kill Notification Plan dated March 2022, attached hereto as Attachment G. The Certification Holder shall implement and comply with the Fish Kill Notification Plan as approved by MDE and as thereafter submitted to and approved by FERC. The Fish Kill Notification Plan as approved by MDE and FERC shall be made part of this Certification.

b) To mitigate the effect of fish strandings, the Certification Holder shall:

i) implement and maintain downramping restrictions as required by Condition 2(b) of this Certification; and

ii) make payments into Maryland DNR Special Fund 0326 as follows. The

Certification Holder shall pay Fifty-Thousand Dollars ($50,000) on the sixth anniversary of the issuance of the New License, so long as that date occurs after the Payment Operative Date. The Certification Holder shall pay an additional Fifty-Thousand Dollars ($50,000) on each anniversary of the issuance of the New License after the sixth anniversary, adjusted for inflation based on CPI, so long as those dates occur after the Payment Operative Date. If any of the above anniversary dates occur before the Payment Operative Date, the Certification Holder shall make those payments 60 days after the Payment Operative Date, so that a total of 45 payments will be made over the term of the New License.

c) Within 24 months of issuance of the New License, the Certification Holder shall submit to MDE for review and approval a plan for surveying stranded fish in the River below the Dam ("Fish Stranding Survey Plan"). Upon approval by MDE, in consultation with Maryland DNR, the Certification Holder shall implement and comply with the Fish Stranding Survey Plan, attached and made part of this Certification. The Fish Stranding Survey Plan shall include the following survey periods and information:

i) surveys to be conducted consecutively during winter, spring, summer, and fall seasons, if and to the extent such surveys may be conducted in accordance with the Certification Holder's safety protocols, for a one-year period, which shall commence in the winter season following the first anniversary of the implementation of the Year 4 Flow Regime so that, if a survey cannot be conducted that winter season, a winter survey then may be conducted following the fall season survey, allowing a single four-season consecutive survey to be completed as part of the survey period;

ii) accurate data records and estimates of the total number of fish stranded and dead in that seasonally and annually, including species and size class, to the extent possible given water clarity and visual observation survey methods;

iii) collection of air and water temperature and DO measurements;

iv) Project operating data at the Dam before and after all survey events; and

v) provisions for consultation with MDE and Maryland DNR to determine a potential alternative survey period different from that identified in Condition 7(d)(i) that results in the same data collection opportunities, unless waived by MDE during consultation, if the survey periods in Condition 7(d)(i) are interrupted due to inclement weather, or other

circumstances approved by MDE upon consultation.

d) The Certification Holder shall submit a report six months after completion of the Fish Stranding Survey ("Fish Stranding Survey Report"). The Fish Stranding Survey Report shall include:

i) data and estimates of the total number of fish stranded and dead in each season of the survey and annually, including species and size class, to the extent possible given water clarity and visual observation survey methods;

ii) estimates of the number of avian predators present at the times of the survey;

iii) air and water temperature and DO measurements collected during each survey event; and

iv) Project operating data during each survey conducted, including the number of hydro-peaking events each season.

e) The Certification Holder shall submit the results of the Fish Stranding Survey described in Condition 7(d) above to MDE and Maryland DNR within 90 days of completion of the survey, as an MS Excel file.

8) Eel Passage

a) The Certification Holder shall within 12 months following issuance of the New License submit an American Eel Passage and Restoration Plan ("EPRP") to MDE for review and approval, so that MDE may ensure that the EPRP is consistent with Condition 8 of this Revised Certification and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) American Eel Passage and Restoration Plan dated September 2021, attached hereto as Attachment H. The Certification Holder shall implement and comply with the EPRP as approved by MDE and as thereafter submitted to and approved by FERC. The EPRP as approved by MDE and FERC shall be made part of this Certification.

b) The Certification Holder shall take actions to achieve a minimum annual survival rate of 95% for juvenile Eels during processes for collection, holding, and transportation. If these survival rates are not met in a given year, the Certification Holder shall consult with MDE, Maryland DNR, USFWS, and the Eel Passage Advisory Group ("EPAG"), review the reasons that the 95% survival rates were not achieved and, if necessary, develop revisions to the EPRP designed to increase survival rates to be implemented prior to the start of the Eel passage season in the following year.

c) The Certification Holder shall maintain the upstream Eel passage trap and transport

program required by Section 12.6.1 of the DOI Modified Prescription for Fishways, and shall extend that trap and transport program for Eels through 2035, provided that USFWS agrees that volitional passage for Eels need not commence in 2031, with volitional passage to commence instead in 2036. For purposes of this Certification, volitional passage can be satisfied by trapping and transporting Eels into the Reservoir.

d) The Certification Holder shall make an annual payment of $100,000 to Maryland DNR Special Fund 0326, unless otherwise directed by MDE, with the amount adjusted for inflation based on CPI, beginning on July 1, 2036 and continuing on each anniversary of that date throughout the remainder of the Term of the New License, for the purpose of the restoration and enhancement of Eels.

e) The Certification Holder shall continue to provide MDE and USFWS access to the Conowingo Eel collection facilities ("ECFs") consistent with Condition 21(g) (Right of Entry) for as long as any Eel ramp is operational.

f) The Certification Holder shall consult with MDE annually by December 1 regarding that year's Eel passage results from all operational ECFs and consult with MDE regarding Eel collection for the following year and any proposed modifications to the EPRP.

g) The Certification Holder shall ensure that all ECF components, including the Eel ramp, collection, overflow, and holding tanks, as well as the associated water lines are installed and tested according to the EPRP on or before April 30 of each year, in accordance with input received during consultation from the previous year with MDE per Condition (8)(f), during EPAG. If any component is not in working order or any element of the process for Eel passage is delayed, the Certification Holder shall notify MDE and Maryland DNR within 24 hours after testing identifies equipment failure. The Certification Holder shall provide a plan and schedule for necessary corrective actions to MDE for review and approval.

h) The Certification Holder shall operate all ECFs at Conowingo Dam as required herein annually during the Upstream Eel Migration Season.

i) The Certification Holder shall operate the ECFs continuously (24 hours per day, seven days per week to the extent feasible) during each Upstream Eel Migration Season throughout the Term, regardless of whether the ECFs are operated as a trap and transport or a volitional fishway.

j) The Certification Holder shall ensure all collection tanks have continuous temperature, DO, and water flow monitoring devices with appropriate alarms if monitoring parameters fall below acceptable levels. Upon observation, the

Certification Holder shall remove, enumerate, and report dead Eels. The collection tank shall be designed and operated to hold Eels at densities not exceeding ten elvers per liter unless otherwise agreed to by the Certification Holder, MDE, Maryland DNR, USFWS, and FERC. When the collection tank density is ten elvers per liter more than three times during a season, collection tank capacity will be increased if deemed necessary by MDE and approved by FERC. The Certification Holder shall provide daily reports on collection activities to MDE and the Maryland DNR.

k) If the number of Eels attempting to migrate within an ECF exceeds the maximum capacity of Eels per unit of ramp area, the Certification Holder shall redesign and construct the ECF to reduce crowding.

l) The Certification Holder's transport of juvenile Eels upstream shall occur as necessary based on the capacity of holding tank(s) at the ECFs. No Eels shall be held longer than one week. The holding tank(s) shall have continuous temperature, DO, and flow monitoring devices with alarms that sound in a daily staffed location if levels of any of these parameters are outside of limits as established in the approved EPRP.

m) The Certification Holder shall transport Eels from the holding tank(s) to a vehicle equipped with an insulated transport container(s) that shall be covered and aerated. The transport vehicle(s) shall be designed and operated to hold Eels at densities not exceeding ten elvers per liter unless otherwise permitted by MDE in writing. Each transport vehicle shall have an automatically engaging backup pump and an alarm that sounds in the cab of the vehicle. The transport vehicle shall have continuous temperature and DO monitoring devices with alarms that sound in the vehicle cab if levels of any parameter are outside established limits.

n) Eels shall be transported to appropriate release locations and released on the same day of removal from holding. Upon observation, dead Eels shall be removed, enumerated, and shall be included in the annual Eel report required by the EPRP.

o) The Certification Holder shall twice yearly assess the numbers and density of Eels using the ECFs during periods when use is anticipated to be high (e.g., increases in discharge or turbidity) to determine if capacity is exceeded or if density or other conditions result in fallback or an inability of Eels to ascend the ramp. The results of said assessments shall be included in the annual Eel report required by the EPRP.

p) The Certification Holder shall report to MDE on the first anniversary of the New License issuance, and every ten years thereafter, on technology available to assess the overall efficiency of upstream passage, including the success rate of Eels reaching the ramps and/or each of the ramp's passage efficiencies, and the costs associated with such technology. If the Certification Holder's report recommends a technology as

feasible and cost-effective for assessing overall Eel passage and/or ramp passage efficiencies at the ECFs, the Certification Holder shall submit to MDE and Maryland DNR for review and approval a plan for evaluating the overall Eel passage and/or ramp passage efficiencies at the ECFs ("Upstream ECF Efficiency Study Plan"). Upon approval of the Upstream ECF Efficiency Study Plan, the Certification Holder shall implement and comply with the plan, attached and made part of this Certification.

q) As required by the DOI Modified Prescription for Fishways and as included in the FEMP, the Certification Holder shall submit a plan, including an implementation schedule, to conduct a silver Eel downstream survival study (the "Downstream Survival Plan") and submit the Downstream Survival Plan to MDE and Maryland DNR for review and consultation prior to submission to FERC. Upon FERC approval of the Downstream Survival Plan, the Certification Holder shall implement and comply with the Downstream Survival Plan and any FERC-approved subsequent modification, attached and made part of this Certification.

r) The Certification Holder shall utilize stocking locations for collected Eels as determined annually with the Eel Passage Advisory Group ("EPAG"), which includes MDE, the Maryland DNR, the Pennsylvania Department of Environmental Protection (Pennsylvania DEP), Pennsylvania Fish and Boat Commission (Pennsylvania FBC), the Susquehanna River Basin Commission, and the USFWS, as described in the Muddy Run license. The Certification Holder shall implement and comply with the annual Eel Stocking Plan developed through consultation with the EPAG.

9) Freshwater Mussel Restoration

a) The Certification Holder, beginning within sixty (60) days after the Payment Operative Date and annually thereafter throughout the term of the New License, shall make payments to MDE to mitigate adverse impacts to freshwater mussels, including Eastern elliptio (*Elliptio complanata*), as a result of Project operations and discharges impacting the Reservoir and the River. The payments will be deposited into the Maryland Clean Water Fund, unless otherwise directed by MDE, for the purpose of aiding restoration of freshwater mussels in accordance with the payment schedule set forth in Table I. The payments in Table I shall be adjusted for inflation, based on CPI, with the base payment set as of the date of issuance of the New License. The first payment shall be due 60 days after the Payment Operative Date and adjusted based on CPI; additional payments (also adjusted based on CPI) shall be made on the Payment Operative Date if necessary so that the number of payments made on the Payment Operative Date equals the number of full years since issuance of the New License; and subsequent payments (adjusted based on CPI) shall be made annually thereafter

on the anniversary date of the Payment Operative Date until a total of 30 payments are made.

Freshwater Mussel Restoration TABLE I	
Year	Payment (Annual)
1	$3,000,000
2	$3,070,000
3-30	$350,000

10) Aquatic Invasive Species

a) If the Certification Holder, as well as other parties, enter into a voluntary agreement regarding aquatic invasive species ("AIS") through the Susquehanna River Migratory Fish and Aquatic Invasive Species Collaborative, the provisions of that agreement ("SRMFAIS Collaborative Agreement") shall replace Condition 10 (b-k) in this Certification upon the effective date of that agreement and following the submission of the agreement to FERC and FERC's approval of the agreement. The Certification Holder shall implement and comply with any such SRMFAIS Collaborative Agreement to which it and other parties have agreed, and any subsequent modifications proposed by the Certification Holder and approved by FERC shall be made part of this Certification.

b) The Certification Holder shall participate in a meeting on or before December 15 annually with MDE, Maryland DNR, Pennsylvania DEP, Pennsylvania FBC, USFWS, and other state resource agencies as appropriate, to consult regarding whether the defined list of AIS should be expanded or changed. If the majority of participants in each annual meeting determine that the defined list of AIS should be expanded or changed, the Certification Holder shall comply as is reasonably practicable. In the event the list of AIS is expanded or changed, the obligations and limitations set forth in Conditions 10 (a) through 10 (l) including the required processes and financial obligations remain unchanged.

c) The Certification Holder shall follow the provisions of the DOI Modified Prescription for Fishways for the first five fish passage seasons following issuance of the New License. If USFWS and FERC agree to suspend the provisions of the DOI Modified Prescription for Fishways and the New License regarding the volitional passage operations of the East Fish Lift (EFL), in an effort to prevent the passage of AIS into

the Reservoir, to whatever extent the Certification Holder thereafter operates the EFL and West Fish Lift (WFL) in trap and transport mode during any of the first five fish passage seasons noted above, the Certification Holder shall segregate and tender to Maryland DNR for disposal all AIS captured at the EFL and WFL.

d) The obligations in Condition 10(c) shall be satisfied when the Certification Holder expends Two-Hundred Thousand Dollars ($200,000) in incremental costs as provided for in this Condition 10(d). The Two-Hundred Thousand Dollars ($200,000) shall be adjusted for inflation, based on CPI, with the base amount set as of the date of issuance of the New License. The Certification Holder shall track the commercially reasonable incremental costs associated with segregating and tendering AIS to Maryland DNR, or their agent, which are costs beyond what the Certification Holder would incur if it operated the EFL and WFL in accordance with the provisions of the DOI Modified Prescription for Fishways. The Certification Holder shall provide monthly expenditure reports on these incremental costs to MDE and Maryland DNR within 10 days after the close of each calendar month during fish passage season. The Certification Holder shall provide MDE and Maryland DNR with thirty (30) days' notice of the date on which the Certification Holder anticipates it will reach the threshold of Two-Hundred Thousand Dollars ($200,000) in incremental costs described above.

e) As soon as the Certification Holder determines that Two-Hundred Thousand Dollars ($200,000) will be expended prior to the end of the fish passage season per Condition 10(d) in connection with costs associated with segregating and tendering AIS to Maryland DNR, or their agent, and operating the EFL and WFL in trap and transport mode, the Certification Holder shall immediately seek approval from FERC to cease operations of the WFL and to direct all remaining funds to continued trap and transport operation of the EFL only, to prevent volitional passage of AIS. If the Certification Holder expends less than Two-Hundred Thousand Dollars ($200,000) in a given fish passage season on the EFL and WFL, the Certification Holder shall make a payment of the remaining funds up to Two-Hundred Thousand Dollars ($200,000), as adjusted for inflation, based on CPI, to the Maryland Clean Water Fund to support research into means to better identify, segregate, and remove AIS in connection with fish lift operations.

f) Once the Certification Holder has expended Two-Hundred Thousand Dollars ($200,000) in incremental costs and as adjusted for inflation, based on CPI, as noted in Condition 10 (d), the Certification Holder may operate the EFL and WFL in accordance with the provisions of the DOI Modified Prescription for Fishways. Passage of AIS in connection with volitional operation of the EFL into the Reservoir is permitted, and the Certification Holder is authorized to return AIS captured in the EFL and WFL to the Susquehanna River below the Dam, unless:

i) The Certification Holder has successfully petitioned FERC, following a request to do so by MDE, in consultation with Maryland DNR, USFWS, Pennsylvania DEP, and Pennsylvania Fish and Boat Commission, to suspend operations at the EFL and WFL for the remainder of the season;

ii) MDE agrees to extend credit to the Certification Holder from the payment obligations set forth in Condition 9 or Condition 12 of this Certification for any incremental costs as described above that exceed Two-Hundred Thousand Dollars ($200,000), as adjusted for inflation, based on CPI;

iii) MDE or Maryland DNR otherwise provides funds to the Certification Holder to pay the incremental costs as described above that exceed Two-Hundred Thousand Dollars ($200,000), as adjusted for inflation, based on CPI; or

iv) Condition 10 is superseded by an agreement reached by the SRMFAIS Collaborative per Condition 10 (a).

g) For the remainder of the New License starting in the sixth fish passage year after the New License is issued the same conditions as set forth in Condition 10 (d-f) shall apply, except that wherever the dollar figure Two-Hundred Thousand Dollars ($200,000) appears, it shall be replaced by $66,000, as adjusted for inflation, based on CPI.

h) If at any time during the effective period of the New License, technological advancements are developed and implemented by the Certification Holder upon approval by FERC, which replace existing AIS management processes (i.e., manual sorting and retaining AIS), the Certification Holder's incremental cost obligation shall be reduced from the amounts in Condition 10 (d) through Condition 10 (h) as agreed by the Certification Holder, MDE, and Maryland DNR.

i) The Certification Holder shall, within sixty (60) days of an executed modification of the DOI Modified Prescription for Fishways to eliminate the Zone of Passage obligations and upon approval by FERC, pay One Million Dollars ($1,000,000) into Maryland DNR Special Fund 0326, unless otherwise directed by MDE, for the purpose of supporting research into means to better identify, segregate, and remove AIS in connection with fish lift operations.

j) With regard to tendering captured AIS to Maryland DNR, or their agent, the Certification Holder shall place all aquatic invasive fish species in a Maryland DNR-provided refrigeration unit for disposal. Maryland DNR or their agent, or USFWS, shall be responsible for disposing of the AIS and the costs thereof. If refrigeration space at the Project for storage of aquatic invasive species becomes limited, the

Certification Holder shall notify MDE, Maryland DNR or their agent, and USFWS to ensure timely action.

k) The Certification Holder shall notify Maryland DNR, Pennsylvania DEP, Pennsylvania FBC, and USFWS within 24 hours, or on an alternative schedule agreed upon by all parties in writing, if an aquatic invasive species is captured and removed in the WFL, captured and removed in the EFL, or passed from the East Fish Lift into Conowingo Reservoir. Notifications must include:

   i) the species name and number of specimens observed or collected;

   ii) the disposition of the aquatic invasive species observed or collected;

   iii) the approximate size of aquatic invasive species observed or collected;

   iv) the date and time of passage; and

   v) the estimated flow through the Conowingo Dam at time of passage.

l) The Certification Holder shall annually obtain a Maryland DNR Scientific Collection Permit for project operations. The Certification Holder shall implement and comply with the conditions of that permit.

11) <u>Dissolved Oxygen (DO) in the River Downstream of the Dam as Measured at Station 643</u>

a) The Certification Holder shall continue DO enhancement at the project using the existing turbine venting systems on units 1 through 7 and the aerating runners on units 2 and 5.

b) The Certification Holder shall implement and comply with the obligations for monitoring DO at Station 643 located approximately 0.6 miles downstream of the power station in accordance with the requirements of the Project's Maryland State Discharge Permit No. 19DP0491 MD, NPDES Permit No. MD0002518, as may be renewed or extended consistent with the procedures set forth under Maryland law and regulations (<u>"Discharge Permit"</u>).

c) The Certification Holder shall implement and comply with the Fish Kill Notification Plan as set forth in Condition 7(a).

d) If at any time during the New License term, the Project does not have a Discharge Permit in place, the Certification Holder shall submit to MDE for review and approval a plan and schedule for monitoring DO at Station 643 ("<u>643 Monitoring Plan</u>"). Upon approval of the 643 Monitoring Plan by MDE, the Certification Holder shall implement and comply with the Plan, and any subsequent modifications

proposed by the Certification Holder and approved by FERC and MDE, attached and made part of this Certification. The 643 Monitoring Plan shall provide for continuous monitoring of DO levels in the Tailrace at Station 643 from May 1st through October 31st of each year. If monitoring conducted under the 643 Monitoring Plan identifies DO levels below the applicable minimum as defined in COMAR 26.08.02.03-3A (2), the Certification Holder shall, within 30 days, notify MDE of the exceedance in writing.

12) <u>Water Quality Mitigation Payment</u>

a) The Certification Holder shall, beginning within sixty (60) days after the Payment Operative Date and annually thereafter throughout the term of the New License, make payments to MDE in accordance with the payment set forth in Table II below for mitigation of water quality impacts from the discharges and operation at the Dam. The payments will be deposited into the Maryland Clean Water Fund for the purpose of implementing water quality and resiliency improvement projects designed to benefit the Susquehanna River and the Chesapeake Bay, unless otherwise directed by MDE. The payments in Table II shall be adjusted for inflation, based on CPI, with the base payment set as of the date of issuance of the New License. The first payment shall be due 60 days after the Payment Operative Date and adjusted based on CPI; additional payments (also adjusted based on CPI) shall be made on the Payment Operative Date if necessary so that the number of payments made on the Payment Operative Date equals the number of full years since issuance of the New License; and subsequent payments (adjusted based on CPI) shall be made annually thereafter on the anniversary date of the Payment Operative Date until a total of 50 payments are made.

Water Quality Mitigation Payment Table II	
Year	Payment (Annual)
1-5	$1,215,000
6-25	$1,515,000
26-29	$800,000
30-50	$900,000

13) Dissolved Oxygen and Chlorophyll-A Levels in the Reservoir

a) The Certification Holder shall within 9 months following issuance of the New License submit a Chlorophyll-A Monitoring Plan to MDE for review and approval, so that MDE may ensure that the Chlorophyll-A Monitoring Plan is consistent with Condition 13 of this Revised Certification and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Chlorophyll-A Monitoring Plan dated March 2023, attached hereto as Attachment I. The Certification Holder shall implement and comply with the Chlorophyll-A Monitoring Plan as approved by MDE and as thereafter submitted to and approved by FERC. The Chlorophyll-A Monitoring Plan as approved by MDE and FERC shall be made part of this Certification.

b) The Chlorophyll-A Monitoring Plan shall provide for the collection of an additional two (2) years of data on Chlorophyll-A and DO levels in the Maryland portion of the Reservoir in accordance with Condition 13 (c).

c) The Chlorophyll-A Monitoring Plan shall include at a minimum the following:

i) a sampling Quality Assurance Project Plan ("QAPP") that is consistent with MDE's "Quality Assurance Project Plan for Lake Nutrient Monitoring for Integrated Report Assessment and Total Maximum Daily Load Development" dated February 26, 2025 (Attachment J) and that includes procedures consistent with MDE's Tier III data quality collection criteria, MDE's assessment methodology, *Guidelines for Interpreting Dissolved Oxygen and Chlorophyll a Criteria in Maryland Seasonally Stratified Water-Supply Reservoirs (Feb. 2012)* and Environmental Protection Agency (EPA) documents *Quality Assurance Project Plan Standard (2023)* and *Region 3 QAPP Standard Template Final* (Attachment K);

ii) The Certification Holder shall consult with MDE at least 90 days prior to submitting the QAPP to MDE for review and approval on any specific laboratory procedures or data quality procedures that differ from those specified in MDE's "Quality Assurance Project Plan for Lake Nutrient Monitoring for Integrated Report Assessment and Total Maximum Daily Load Development" dated February 26, 2025, specifically the MDE Standard Operating Procedures referenced in the appendices;

iii) sampling locations consisting of the following eight stations in the table below as included in the Revised Chlorophyll-A Monitoring Plan dated March 2023 Chlorophyll-A Monitoring Plan (March 2023); and

Chlorophyll-A Monitoring Plan (March 2023)			
Station ID	**Latitude**	**Longitude**	**Description**
XLG0091	39.667000	-76.182700	Mid-Channel. Close to Conowingo Dam.
XLG0880	39.680600	-76.201400	Mid-Channel. Across from Conowingo Creek.
XLG2166	39.702400	-76.224300	Mid-Channel. Across from Broad Creek.
Conowingo-1	39.659940	-76.176750	New station, nearest dam (at least 400 yards upstream of the dam for safety).
Conowingo-2	39.686350	-76.215320	New station, upstream of Glen Cove Marina.
Conowingo-3	39.711750	-76.239780	New station, west side of Conowingo Reservoir, upstream of Broad Creek confluence.
Conowingo-4	39.698280	-76.210160	New station, east side of Conowingo Reservoir, upstream of Conowingo Creek.
Conowingo-5	39.720510	-76.232880	Mid-Channel. Just below the MD/PA border.

iv) frequency of monitoring to include:

a) sampling from April of the first year of the additional two-year study period through October of the second year of the additional two-year study period, with frequency of sampling per month as set forth below;

b) monthly sampling from November to March, subject to the consultation requirements stated in 13(c)(ii) and provided that, in all instances, sampling need only occur if it can be conducted in accordance with the Project's safety protocols given River conditions;

c) bimonthly (twice per month) sampling from April through October, during each year of the additional two-year study period; and

d) provisions for consultation with MDE to determine an alternative monitoring frequency or schedule for the periods identified in

Condition 13(c)(iv)(a-b), unless waived by MDE during consultation, if the sampling periods are interrupted due to inclement weather, or other circumstances approved by MDE upon consultation.

v) sampling parameters to include:

a) Field parameters:

i) measurements of physical parameters including pH, salinity, temperature, DO, and conductivity will be collected as profiles at multiple depths *in situ* using a multiparameter water quality instrument at each sampling site.

ii) both a turbidity measurement and Secchi disc depth will be recorded at each location.

b) Laboratory parameters:

i) Chlorophyll-A. Surface grab samples for Chlorophyll-A will be collected at each sampling location by boat during daylight hours (between 9:00 AM and 3:00 PM).

ii) Nutrients: NO2 (nitrite), NO3 (nitrate), P (phosphorus), NH4 (ammonium), Total Dissolved Nitrogen, Total Dissolved Phosphorus.

iii) collection and analysis as specified in the approved QAPP.

d) The Certification Holder shall provide MDE with:

i) annual reports of all measured field and lab parameters, and dates and locations of monitoring in the Maryland portion of the Reservoir by December 31 of the year in which the monitoring occurred;

ii) a final report that analyzes and presents the results of all measured field and lab parameter monitoring submitted by June 30 of the year after the final year of monitoring; and

iii) an attachment to the final report that includes the two years of data required by this Certification in the MDE-provided MS Excel data template (Attachment L) to enable independent analysis and a summary of the data collected for the two years of sampling conducted in accordance

with this Certification and the 3 years of data collected in accordance with the Certification Holder's previously submitted Chlorophyll-A Monitoring Plan dated November 2021 and Revised Chlorophyll-A Monitoring Plan dated March 2023.

e) The Certification Holder shall not be required to expend more than Fifty-Five Thousand Dollars ($55,000) per year to complete the monitoring and reporting obligations in Condition 13, which shall be adjusted annually for inflation based on CPI, in connection with the costs of implementing the Updated Revised Chlorophyll-A Monitoring Plan and any associated annual reporting. If the Certification Holder is unable to perform all the requirements under Condition 13, they shall be required to furnish, to MDE, a detailed estimate that provides the itemized costs of this sampling effort. MDE will then determine, in consultation with the Certification Holder, which portions of the sampling plan will not be completed.

14) Trash and Debris

a) The Certification Holder shall within 6 months following issuance of the New License submit a Debris Management Plan to MDE for review and approval, so that MDE may ensure that the Debris Management Plan is consistent with Condition 14 of this Revised Certification and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Debris Management Plan, Revision dated October 2021, attached hereto as Attachment M. The Certification Holder shall implement and comply with the Debris Management Plan as approved by MDE and as thereafter submitted to and approved by FERC. The Debris Management Plan as approved by MDE and FERC shall be made part of this Certification.

b) The Debris Management Plan shall include:

i) a description of the debris management program, including:

1) debris management goals;

2) a description of debris management methods;

3) timeframes for when debris will be collected and the frequency of removal operations;

4) specific size criteria for target floating debris;

5) a description of best management practices for the storage of the debris materials at Hopkins Cove and other Certification Holder-owned lands

within the Project boundary; and

6) procedures for removal of stored debris, and procedures for tracking debris storage and removal.

ii) a provision for a public hotline for boaters to link directly to the Certification Holder to report areas of hazardous debris;

iii) a provision to employ clamming or any other equally or more effective measures to remove 450 loads of trash and debris per year, in the Reservoir and as accumulated at the Dam as the first order of priority, unless there is an insufficient amount of trash and debris accumulated at the Dam or in the Reservoir to make it reasonably practicable to remove 450 loads. A "load" consists of the maximum volume of trash and debris that can be safely transported in a standard 20-cubic yard dumpster;

iv) a provision for prioritizing removal of trash and debris directly behind the Dam and for responding to any complaint from a marina operator or a public boat ramp monitor, such as the Maryland DNR;

v) a provision requiring trash and debris removal to begin each calendar year before Memorial Day;

vi) a provision to monitor and record the duration of the trash and debris removal events (number of hours), and the amount of debris and trash removed and subsequently disposed of during each clamming/trash and debris removal event (in cubic yards) and submit the data to MDE in the annual report required in Condition 14 (b) (xiii) of this section;

vii) a provision for temporary storage of trash and debris prior to final disposal or recycling;

viii) provisions for sorting, recycling and disposal of trash and debris. Non-organic debris shall be disposed of through a licensed vendor, and any hazardous material shall be disposed of pursuant to the appropriate safety provisions and regulations;

ix) a provision requiring the Certification Holder to promptly respond to any complaint from a marina operator or a public boat ramp monitor, such as Maryland DNR, regarding accumulated trash and debris at Project facilities that interfere with recreational uses in the Reservoir by removing to the extent reasonably practicable and safe any such debris interfering with recreational activities between Memorial Day and November 15. The

Certification Holder must maintain, for review by MDE staff, records of complaints filed (name, date, location, nature of the trash and/or debris at issue and amount) and corrective actions taken (date, time, description of action, and amount of trash and/or debris removed). The Certification Holder will also provide a public hotline for boaters to link directly to the Certification Holder to report hazardous debris. The Certification Holder will provide the public with the Conowingo Visitor Center phone number via its website and recreation site kiosks;

x) a provision to sponsor at least two annual community-based cleanups of Conowingo Reservoir, tributaries upstream of the Project that feed Conowingo Reservoir, and/or the Susquehanna River and tributaries downstream of the Project, which may be in coordination with Lower Susquehanna Riverkeeper Association and Waterkeepers Chesapeake. The Certification Holder must advertise each event, provide all needed supplies, and be responsible for the disposal of the materials collected.

xi) a provision specifying that, after any storm event which results in trash and debris blocking water supply intakes in the Susquehanna River downstream of the Conowingo Dam, within the Project boundary, the Certification Holder must ensure that blockage is removed as soon as it is safe to enter the water;

xii) a provision for hurricanes, tropical storms, and tropical depressions, as these events as defined by the National Weather Service for the Atlantic Basin create challenges to the safe passage of flows in excess of plant capacity and debris management from sources upstream of Conowingo Dam. In such instances, the Certification Holder shall conduct event-specific assessments of the risk of a major flow event and update the assessment daily. The Certification Holder would evaluate the debris present in conjunction with the risk assessment to determine whether pre-storm debris removal can be conducted safely and notify MDE accordingly; and

xiii) a provision for an annual report to be filed with MDE by April 1 throughout the Term, summarizing the previous year's debris removal efforts in accordance with this Certification, including the amount and types of trash and debris managed, hotline calls, action items and outcomes.

c) The Certification Holder is not required to remove more than 450 loads of trash and debris in any year, excluding the debris removed as required in Condition 14 (b)(x).

d) The Certification Holder shall submit any proposed further modification to the Debris Management Plan to MDE for review and approval, prior to submission to FERC, so that MDE may ensure that further modification remains consistent with Condition 14 of this Certification. The Certification Holder shall implement and comply with any subsequent approved modified Debris Management Plan.

e) The Certification Holder shall report once every seven years, as a supplement to its annual report for that year as required by Condition 14 (b) (xiii), on research into alternative or innovative practices to support removal of trash and debris, and for any reliable and feasible practices that it recommends to pursue, and provide an analysis of and costs associated with installation, operation and maintenance of any such recommended practices. The Certification Holder may seek any necessary state and federal approvals to install such technology, when recommended to be feasible based on the report.

15) Sediment Management Plan

a) The Certification Holder shall within 12 months following issuance of the New License submit a Sediment Management Plan to MDE for review and approval, so that MDE may ensure that the Sediment Management Plan is consistent with Condition 15 of this Revised Certification and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Sediment Management Plan dated August 2012 and Revised September 2021, attached hereto as Attachment N. The Certification Holder shall implement and comply with the Sediment Management Plan as approved by MDE and as thereafter submitted to and approved by FERC. The Sediment Management Plan as approved by MDE and FERC shall be made part of this Certification.

b) The Certification Holder shall conduct a bathymetric survey of Conowingo Reservoir every five years to monitor sediment transport and depositional patterns within the Reservoir beginning the first year upon issuance of the New License. The results of each bathymetric survey must include an analysis of any change in sediment deposition or scour in the Reservoir from the previous survey(s), including the 2011 survey, so that any changes in sediment depositional or scour patterns in the Reservoir over time since the 2011 survey can be monitored.

c) The Certification Holder shall submit to MDE each bathymetric survey within six months of completion in the annual reporting year it is due for completion.

16) Shoreline Management Plan

a) The Certification Holder shall within 12 months following issuance of the New License submit a Shoreline Management Plan ("SMP") to MDE for review and approval, so that MDE may ensure that the SMP is consistent with Condition 16 of this Revised Certification and, to the extent relevant and applicable, the Project's previously submitted Shoreline Management Plan dated August 31, 2012, revised September 2021, attached hereto as Attachment O. The Certification Holder shall implement and comply with the SMP as approved by MDE and as thereafter submitted to and approved by FERC. The SMP as approved by MDE and FERC shall be made part of this Certification.

b) The SMP shall be reviewed and updated every ten years from the date of the last approval.

c) The Certification Holder shall submit to MDE any modifications to the SMP for review and approval prior to submission to FERC, so that MDE may ensure that the proposed revised SMP remains consistent with Condition 16 of this Certification. Upon approval of a revised SMP by FERC, the Certification Holder shall implement and comply with the approved revised Shoreline Management Plan.

d) Non-Project use of Project Land. If the Certification Holder intends to make any non-Project use of any Project land, or receives any request from a third party for non-Project use of any Project land, the Certification Holder shall:

   i) prepare, or require the third-party requester to prepare, a written assessment of the impacts on water quality of the proposed use;

   ii) provide this assessment to MDE for MDE's review to determine whether the proposed use is consistent with water quality standards; and

   iii) consult with MDE regarding the proposed use.

e) Shoreline Vegetation Management. If the Certification Holder intends to make any modifications to the shoreline vegetation for viewshed maintenance, development, or recreation access within the Project boundary, the Certification Holder shall:

   i) prepare a written assessment of the impacts to water quality from the proposed modifications;

   ii) provide this assessment to MDE for a review and determination regarding whether the proposed modifications are consistent with water quality standards; and

iii) not undertake any such modifications until MDE notifies the Certification Holder in writing that it has no objections to such proposed use.

f) Sensitive Natural Resources Protection Overlay and Policies. The Certification Holder shall consult with MDE regarding any proposed modification of an existing use of Project lands in cases where such use may affect any sensitive aquatic resources identified by the Certification Holder in the "sensitive resources overlays" included in the SMP.

17) Bog Turtle (*Glyptemys muhlenbergii*) Protection Plan

a) The Certification Holder shall within 6 months following issuance of the New License submit a Bog Turtle Protection Plan to MDE for review and approval, so that MDE may ensure that the Bog Turtle Protection Plan is consistent with Condition 17 of this Revised Certification and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Bog Turtle Protection Plan dated July 2022, attached hereto as Attachment P.[2] The Certification Holder shall implement and comply with the Bog Turtle Protection Plan as approved by MDE and as thereafter submitted to and approved by FERC. The Bog Turtle Protection Plan as approved by MDE and FERC shall be made part of this Certification.

b) The Certification Holder shall maintain a Bog Turtle Protection Plan that requires the protection and enhancement of the bog turtle population associated with Project lands, including at a minimum:

i) a map of the wetland(s) documented to support bog turtles, and a record of bog turtle sightings in and around the wetland(s) within the project boundary;

ii) the restriction of mowing in the wetland(s) documented to support bog turtles;

iii) invasive plant and woody plant control, particularly reed canary grass (*Phalaris arundinacea*), in the areas around the wetland(s) documented to support bog turtles;

iv) limits on public access to the wetland(s) documented to support bog turtles without advertising the reason; and

[2] This protection plan is being withheld from attachments as privileged information because it contains confidential information regarding a federally and state-protected species and should not be released to the public.

v) a provision stating that, before any ground-disturbing work begins on Project lands, the Certification Holder must review the USFWS Chesapeake Bay Field Office and Pennsylvania Field Office websites, and coordinate with Maryland DNR for any updates to the bog turtle management guidelines.

18) Northern Map Turtle (*Graptemys geographica*) Protection Plan

a) The Certification Holder shall within 12 months following issuance of the New License submit a Northern Map Turtle Protection Plan to MDE for review and approval, so that MDE may ensure that the Northern Map Turtle Protection Plan is consistent with Condition 18 of this Revised Certification and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Northern Map Turtle Protection Plan dated March 2022, attached hereto as Attachment Q.[3] The Certification Holder shall implement and comply with the Northern Map Turtle Protection Plan as approved by MDE and as thereafter submitted to and approved by FERC. The Northern Map Turtle Protection Plan as approved by MDE and FERC shall be made part of this Certification.

b) The Certification Holder shall maintain a Northern Map Turtle Protection Plan ("Map Turtle Plan") that requires the protection and enhancement of the northern map turtle population associated with Project lands, including at a minimum:

i) annual monitoring of the northern map turtle population at the project for ten consecutive years, followed by population monitoring every five years;

ii) a study to determine the amount of artificial basking habitat needed over the normal range of generation flows to support current and future populations of northern map turtles within the Reservoir and all areas of the Susquehanna River downstream of the Conowingo Dam within the Project boundary affected by generation flows;

iii) a study to determine the proper locations for deployment of artificial basking platforms;

iv) nest management and protection measures;

v) annual monitoring of the use and success of both the mitigation and protection measures; and

[3] This protection plan is being withheld from attachments as privileged information because it contains confidential information regarding a federally and state-protected species and should not be released to the public.

vi) an assessment of the northern map turtle's response to changes in operating practices at the project that are required by this Certification or the New License.

19) Waterfowl Nesting Protection Plan

a) The Certification Holder shall within 6 months following issuance of the New License submit a Waterfowl Nesting Protection Plan to MDE for review and approval, so that MDE may ensure that the Waterfowl Nesting Protection Plan is consistent with Condition 19 of this Revised Certification and, to the extent relevant and applicable, the previously submitted Conowingo Hydroelectric Project (FERC Project No. 405) Waterfowl Nesting Protection Plan dated March 2022, attached hereto as Attachment R.[4] The Certification Holder shall implement and comply with the Waterfowl Nesting Protection Plan as approved by MDE and as thereafter submitted to and approved by FERC. The Waterfowl Nesting Protection Plan as approved by MDE and FERC shall be made part of this Certification.

b) The Certification Holder shall maintain a Waterfowl Nesting Protection Plan that includes, at a minimum:

i) a provision to verify specific Project-related effects on nesting waterfowl, such as Project-related water level fluctuations during the nesting season;

ii) a provision to verify which species of nesting waterfowl (as well as the black-crowned night-heron (*Nycticorax nycticorax*), a wading bird species) are affected by the Project, if any;

iii) a provision to describe appropriate protection or mitigation measures, if new Project-related effects are identified; and

iv) a provision for an assessment of the impacts of such protection and mitigation measures on water quality.

20) Sturgeon Protection Plan

a) Within 12 months following issuance of the New License (or sooner, if required by a federal governmental agency) the Certification Holder shall submit to MDE and Maryland DNR for review and MDE's approval a Sturgeon Protection Plan, so that MDE may ensure that the Sturgeon Protection Plan is consistent with Condition 20 of this Revised Certification. The Certification Holder shall implement and comply with

[4] This protection plan is being withheld from attachments as privileged information because it contains confidential information regarding a federally and state-protected species and should not be released to the public.

the Sturgeon Protection Plan as approved by MDE, and as thereafter submitted to and approved by FERC and NMFS, the Sturgeon Protection Plan, and any subsequent modifications proposed by the Certification Holder and approved by FERC, NMFS and MDE, shall be attached hereto and made part of this Certification.

b) The Sturgeon Plan shall include:

i) provisions to monitor and report to Maryland DNR stranded sturgeon in the River within Project boundaries within 48 hours;

ii) procedures for trapping, handling, and safely returning sturgeon lifted at any fish lift to the Tailrace; and

iii) monitoring of water quality in any tanks used to hold sturgeon.

21) GENERAL CONDITIONS

a) Confidentiality

i) The Certification Holder may request in writing, at the time of submission of any document pursuant to this Certification, that confidential information, including but not limited to confidential business information, not be disclosed. Any such information shall be clearly marked as confidential. MDE will withhold information clearly marked as confidential to the extent permitted by law, including the Maryland Public Information Act. In the event MDE receives a request for disclosure of such information under the Maryland Public Information Act or other applicable law, MDE shall notify the Certification Holder no less than ten (10) days prior to disclosure if MDE determines it is required to disclose such information.

b) Web Portal

i) The Certification Holder shall maintain at all times during the Term a web site or page ("Web Portal") specifically designed to provide the public with access to the non-confidential information required to be produced to MDE by this Water Quality Certification. The Certification Holder shall:

1) provide all data and final reports, including monitoring results, collected or developed pursuant to any Plan required by this Certification to MDE in electronic format;

2) make all such non-confidential data and final reports publicly available on a Web Portal;

3) make all final Plans required by this Certification publicly available on a Web Portal contemporaneously with submission thereof to MDE; and

4) make all final approved Plans publicly available on the Web Portal.

ii) The Certification Holder shall post any non-confidential annual reports required for submission to MDE under this Certification on the Web Portal contemporaneously with the submission of the report to MDE.

c) <u>Plans</u>

i) Where MDE has the right under this Certification to approve a Plan specified in this Certification, MDE may approve such Plan, in whole or in part, or decline to approve it and provide written comments to the extent necessary to ensure that the Plan meets the elements required in this Certification. MDE may also request additional information to the extent necessary to evaluate the completeness of the Plan in meeting the elements required in this Certification. The Certification Holder shall consult with MDE at least 30 days prior to submission of any such Plan about the subject matter thereof. To be effective, any approval by MDE hereunder must be provided in writing.

ii) MDE may solicit public comments and may hold, or require the Certification Holder to hold, one or more public informational meetings with respect to any Plan for which MDE approval is required. MDE may consult and share relevant information with and may require the Certification Holder to consult and share relevant information with, other governmental entities or third parties having particular expertise in connection with the review, implementation, and/or oversight of any such Plan, including Maryland DNR, USFWS, NMFS, the Susquehanna River Basin Commission and the Eel Passage Advisory Group. In connection with each Plan for which MDE approval is required, the Certification Holder shall provide MDE with:

1) documentation regarding consultation with other governmental entities and third parties;

2) an explanation of how the proposed Plan addresses comments or recommendations from governmental entities or third parties; and

3) an explanation of why any such comments or recommendations are

not addressed in the proposed Plan.

iii) Upon approval by MDE in writing and, to the extent applicable, by other resource agencies and FERC, the Plan shall be incorporated into this Certification, and the Certification Holder shall comply with the Plan as approved. In the event a Plan modifies a prior-approved Plan, the most recent version of the Plan is incorporated into this Certification and shall govern.

iv) In the event of MDE's disapproval, in whole or in part, of any Plan, MDE shall specify any deficiencies in writing to the Certification Holder. The Certification Holder shall respond to the deficiencies within 30 days from receipt of disapproval by MDE unless MDE grants an extension. Upon consideration of the Certification Holder's response, MDE may approve the Plan, in whole or in part, or decline to approve it.

v) If the Certification Holder takes exception to all or part of MDE's disapproval of any Plan for which MDE approval is required, representatives of MDE and the Certification Holder shall confer in person or virtually in an attempt to resolve any disagreement. If a resolution is reached, that resolution shall be in writing and signed by representatives of each party. In the event that resolution is not reached within 15 days, or such reasonable extension of time as determined by MDE, MDE shall issue a final decision disapproving of the Plan in whole or in part. The Certification Holder may challenge any final decision by MDE in connection with any Plan in accordance with applicable State Law. The Certification Holder shall have the right to file any Plan with FERC as may be required to comply with the New License or applicable Law; provided, if MDE has not yet approved a Plan for which MDE approval is required in accordance with this Certification, the Certification Holder shall (i) first exhaust all opportunities to seek extensions of time for the filing of such Plan with FERC, as necessary to enable the Parties to fully comply with this Certification; and (ii) clearly state in any such filing with FERC that MDE has not yet approved the Plan.

vi) The Certification Holder shall submit notification of MDE approval of any Plan required by this Certification to be approved by MDE to FERC as a means of demonstrating compliance with the terms of this Certification and as appropriate to comply with the FERC License.

d) <u>Other Authorizations</u>

i) This Certification does not relieve the Certification Holder of the

responsibility to obtain any other authorizations or approvals related to the Project that are required by Law, or to comply with all conditions of such authorizations or approvals.

e) <u>Construction and Interpretation</u>

i) All references herein to Conditions or Attachments are references to Conditions of or Attachments to this Certification, unless otherwise indicated. All Attachments to this Certification are deemed to be incorporated by reference and made a part of this Certification. All documents incorporated by reference into this Certification that are not attached hereto are qualified by the provisions, requirements and conditions of this Certification. Whenever the words "include," "includes," or "including" are used in this Certification, they shall be deemed to be followed by the words "without limitation." All references herein to temperatures are expressed in degrees Celsius, unless otherwise noted. All references herein to "days" are calendar days unless otherwise noted. All references herein to governmental entities are to such governmental entities and any successor(s) thereto.

f) <u>Record Keeping</u>

i) All records and information resulting from the monitoring, sampling, record keeping, inspection, and reporting activities required by this Certification shall be retained for fifteen years. For any measurements or sampling taken to satisfy the requirements of this Certification, the Certification Holder shall record:

1) the exact place, date, and time of sampling or measurement;

2) the person(s) who performed the sampling or measurement;

3) the dates and times the analyses were performed;

4) the person(s) who performed the analyses;

5) the analytical techniques or methods used; and

6) the results of all required analyses. The sampling and analytical methods used shall conform to procedures for the analysis of pollutants as identified in 40 CFR Part 136 – "Guidelines Establishing Test Procedures for the Analysis of Pollutants" unless otherwise specified by MDE in writing in an approved Plan.

g) Right of Entry

i) In addition to any other right of entry provided for by law, MDE, or its authorized representatives, shall have the right to enter at reasonable times the premises or property that is the subject of the Certification (including the Reservoir and all land within Project boundaries) or where any records are required to be kept under the provisions, requirements, and conditions of this Certification.

ii) Upon arrival, MDE, or its authorized representatives, shall provide reasonable notice to the Certification Holder or its representatives of the purpose of the visit and any activities that may be conducted.

iii) This right of entry shall include the right to:

1) access and copy, at reasonable times, any records that are required to be kept under the provisions, requirements, and conditions of this Certification;

2) inspect, at reasonable times, any monitoring equipment or monitoring method required in this Certification;

3) inspect, at reasonable times, any discharge facilities subject to this Certification;

4) conduct sampling, at reasonable times, of any discharge or of the water column in the River or Reservoir;

5) take soil or sediment borings or core samples, at reasonable times, and with the provision of at least 45 days notice to the Certification Holder to ensure non-interference with buried cables and Project operations and the existence of appropriate safety and other protocols, in the bed of the River or the Reservoir, unless an emergency exists and notice requirements need to be shortened in coordination with the Certification Holder; and

6) take photographs.

h) Duty to Provide Information

i) The Certification Holder shall submit to MDE all information requested by MDE that is required, within the time frame reasonably stipulated by

MDE, to determine compliance with this Certification. The Certification Holder shall also submit to MDE, upon request, copies of any records required to be kept by this Certification.

i) Property Rights

i) The issuance of this Certification does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor does it authorize any infringement of federal, State, or local Laws.

j) Notice/Reporting of Noncompliance

i) Unless MDE provides different instructions in writing from time to time, any notice or other submission due to MDE under this Certification shall be provided in writing to:

Program Manager
Wetlands and Waterways Protection Program
Maryland Department of the Environment
Water and Science Administration
1800 Washington Boulevard
Baltimore, Maryland 21230

For any violations of the provisions, requirements, or conditions of this Certification, the Certification Holder shall promptly notify MDE by telephone within 24 hours of discovery of the violation, at 410-537-3510. In addition, within seven days, the Certification Holder shall provide MDE with the following information in writing (which may be delivered via email):

1) a description of the noncompliance, including the date, time, location, and estimated discharge volume (if applicable), and impact on receiving water;

2) the cause of the noncompliance, to the extent known;

3) the anticipated time the cause of the noncompliance is expected to continue, or, if the condition has been corrected, the duration of the period of the noncompliance;

4) steps taken by the Certification Holder to eliminate or correct the violation; and

5) steps planned or implemented by the Certification Holder to prevent the recurrence of the noncompliance.

k) No Waivers

i) MDE's failure to enforce any provision, requirement, or condition of this Certification shall not constitute a waiver of MDE's right to enforce any such provision, requirement, or condition, or otherwise relieve the Certification Holder from compliance with any obligations imposed by this Certification.

l) Transfer

i) The Certification Holder shall notify MDE in writing upon transferring property ownership or responsibility for compliance with these conditions to another person. The new owner/operator shall request in writing the transfer of this Certification to its name.

m) Severability

i) The provisions of this Certification are severable. If any provision of this Certification is held invalid for any reason, the remaining provisions shall remain in full force and effect.

n) Term

i) This Certification is valid for the Project identified herein and the associated federal permit or license for the Conowingo Hydroelectric Project (FERC Project P-405) until such time that it expires.

CERTIFICATION APPROVED:

D. Lee Currey, Director
Water and Science Administration

Statements of Necessity
Attachments

cc: WSA Inspection & Compliance Program

STATEMENTS OF NECESSITY AND CITATIONS

1. Statement of Necessity for Special Conditions 1-20: These conditions are necessary to ensure that water quality standards are met.

Citations: Federal and state laws which authorize this condition include but are not limited to: 33 U.S.C. § 1341(a), (b), & (d); 33 U.S.C. § 1251(b); 33 U.S.C. § 1370; Md. Ann. Code, Env. Article, Title 1, Subtitles 3 and 4; Md. Ann. Code, Env. Article, Title 5, Subtitles 5 and 9; Md. Ann. Code, Env. Article, Title 9, Subtitle 3; Md. Ann. Code, Env. Article, Title 16; COMAR 26.08; 26.17.04; COMAR 26.23; COMAR 26.23.02.06; COMAR 26.08.02.02B; COMAR 26.08.02.03 and COMAR 26.08.02.03-3; 26.08.02.03B(1)(b)

2. Statement of Necessity for Special Conditions 2, 3, and 5(a): These conditions are necessary to ensure that discharges will meet water quality standards for growth and propagation of fish, other aquatic life, and wildlife.

Citations: COMAR 26.08.02.02B; 26.08.02.03; COMAR 26.08.02.03-3; 26.08.02.03B(1)(b); 26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a)

3. Statement of Necessity for Special Conditions 2(c), 2(d), 2(f), 2 (g), 2(k), 2(l), 2(m), 2(o), 3, 4, 5(a), 5(b), 5 (c), 5 (d), 5(e), 5(f), 5 (g), 5(h), 5(i), 5(j), 5(k), 5(n), 5(m), 6(a), 6(b), 7, 8(r), 8(q), 10(a), 10(j), 10(k), 10(l), 11(c), 11(d), 16(f), 16(g), 17(a), 17(b),18(a), 19(a), 19(b), and 20 : These conditions are necessary to ensure that water quality standards for growth and propagation of fish, other aquatic life, and wildlife are met.

Citations: COMAR 26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a)

4. Statement of Necessity for Special Conditions 2(h), 2(i), 2(j): These conditions are necessary to ensure compliance with other federal and state laws to ensure water quality standards are met.

Citations: Federal and state laws which authorize this condition include but are not limited to: 33 U.S.C. § 1341(a), (b), & (d); 33 U.S.C. § 1251(b); 33 U.S.C. § 1370; Md. Ann. Code, Env. Article, Title 1, Subtitles 3 and 4; Md. Ann. Code, Env. Article, Title 5, Subtitles 5 and 9; Md. Ann. Code, Env. Article, Title 9, Subtitle 3; Md. Ann. Code, Env. Article, Title 16.

5. Statement of Necessity for Special Conditions 2(g), 2(l), 2(m), 2(n), 2(o), 3(e), 4(c), 4(d), 5(k), 5(l), 6(c), 7(a), 7(b), 7(c), 7(d), 7(e), 8(d), 8(o), 8(p), 9(a), 10 (c), 10 (d), 10(e), 10 (f), 10(g), 10(h), 10(i), 11(d), 12(a), 13(d), 13(e),14(e), 15(c), 15(d,) 16(b), 20(b): These conditions are necessary to ensure that approved management, monitoring, and equipment plans, implemented by the Certification Holder for discharges meet water quality standards and water quality standards for the growth and propagation of fish, other aquatic life, and wildlife are met.

Citations: COMAR 26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a); 26.08.02.03; 26.08.02.03A; 26.08.02.03B(1)(b); 26.08.02.03-3; 26.08.02.03C-1(1); 26.08.02.03-3C(8)(b); 26.08.02.03-3C(10); 26.08.02.03-3C-1(1); 26.08.02.03-3A(5); 26.08.02.03-3B(1); 26.08.02.03-3C-1(1); 26.08.02.03-3C(5)

6. Statements of Necessity for Special Conditions 5(n), 8(a), 8(b), 8(c), 8(e), 8(g), 8(h), 8(i), 8(j), 8(k), 8(l), 8(m), 8(q), 8(r): These conditions are necessary to meet water quality standards as follows:

a) to ensure that discharges will be conducted in a manner which meets water quality standards;
b) to meet water quality standards for growth and propagation of fish, other aquatic life, and wildlife; and
c) to meet water quality standards for support of estuarine and marine aquatic life and shellfish harvest.

Citations: COMAR 26.08.02.02-1; 26.08.02.03B(1)(b); 26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a); 26.08.02.02B(3)(a); 26.08.02.02B(4)(a)

7. Statement of Necessity for Special Conditions 4(a), 4(b), 4(c), 8(o), 8(p), 11(b), 13(a), 13(b), 13(c), 13(d), 13(e), 14(a), 14(b), 14(d), 14(e), 15(c), 15(d), 16(d), 16(e), 20(b), 21(b): These conditions are necessary to ensure that approved management, monitoring, and equipment plans, implemented by the Certification Holder ensure discharges comply with water quality standards for the growth and propagation of fish, other aquatic life, and wildlife and numeric criteria of water quality standards are met.

Citations: COMAR 26.08.02.03B(1)(b); 26.08.02.03-3C(10); 26.08.02.03-3C-1(1);26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a); 26.08.02.03B(2)(a); 26.08.02.03B(2)(d); 26.08.02.03B(2)(e); 26,08.02.02B(1)(a); 26.08.02.02B(1)(b); 26.08.02.03-3A(5); 26.08.02.03-3B(1); 26.08.02.03-3C-1(1); 26.08.02.03-3C(5)

8. Statement of Necessity for Special Condition 11(a), 11(c), 11(d): These conditions are necessary to ensure that water quality standards for the growth and propagation of fish, other aquatic life, and wildlife are met, and numeric criteria of water quality standards are met.

Citations: 26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a); 26.08.02.03-3A(2); 26.08.02.03-3B(1); 26.08.02.03-3C-1(1); 26.08.02.03-3C(8)(b)

9. Statement of Necessity for Special Conditions 13(a), 13(b), 13(c), 13(d), 13(e): These conditions are necessary to ensure that water quality standards for the growth and propagation of fish, other aquatic life, and wildlife are met, and numeric criteria of water quality standards are met.

Citations: 26.08.02.03-3C(10); 26.08.02.03-3C-1(1); 26.08.02.03-3H

10. Statement of Necessity for Special Conditions 14(a), 14(b), 14(c), 14(d), 14(e): These conditions are necessary to address trash and debris accumulation in Conowingo Pond to meet water quality standards.

Citations: COMAR 26.08.02.03B(2)(a); 26.08.02.03B(2)(d); 26.08.02.03B(2)(e); 26,08.02.02B(1)(a); 26.08.02.02B(1)(b)

11. Statement of Necessity for Special Conditions 16(a), 16(b), 16(c), 16(d), 16(e), 16(f): These conditions are necessary to ensure use of any project lands and discharges from those uses will meet water quality standards for growth and propagation of fish, other aquatic life, and wildlife.

Citations: COMAR 26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a); 26.08.02.03B(2)(a); 26.08.02.03B(2)(d); 26.08.02.03B(2)(e)26,08.02.02B(1)(a); 26.08.02.02B(1)(b); 26.08.02.03-3A(5); 26.08.02.03-3B(1); 26.08.02.03-3C-1(1); 26.08.02.03-3C(5)

12. Statement of Necessity for Special Condition 16(d): These conditions are necessary to ensure use of any project lands and discharges from those uses will meet water quality standards for growth and propagation of fish, other aquatic life, and wildlife.

Citations: COMAR 26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a); 26.08.02.03B(2)(a); 26.08.02.03B(2)(d); 26.08.02.03B(2)(e); 26,08.02.02B(1)(a); 26.08.02.02B(1)(b); 26.08.02.03-3A(5); 26.08.02.03-3B(1); 26.08.02.03-3C-1(1); 26.08.02.03-3C(5)

13. Statements of Necessity for Special Conditions 2(h), 2(i), 2(j), 2(k), 2(l), 2(m), 2(n), 2(o), 2(p), 3(b), 3(c), 3(d), 4(c), 5(n), 6(a), 8(a), 8(b), 8(f), 8(g),10(a), 10(b),10(c),10(h), 11(d), 14(b), 14(d), 14(e), 15(a),15(b), 15(d),16(b), 16(c), 16(e), 17(b), 18(b): These conditions are necessary to ensure that Project operations and discharges do not interfere

with water quality standards for growth and propagation of fish, other aquatic life, or wildlife.

Citations: COMAR 26.08.02.03-3; 26.08.02.03B; 26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a); 26.08.02.03; 26.08.02.03B(2)(a); 26.08.02.03B(2)(d); 26,08.02.02B(1)(a); 26.08.02.02B(1)(b); 26.08.02.03-3A(5); 26.08.02.03-3B(1); 26.08.02.03-3C-1(1); 26.08.02.03-3C(5)

14. Statement of Necessity for Special Conditions 4(b), 4(c), 5(d), 5(f), 5(m), 5(j), 5(n), 5(k), 6(a), 8, 10(a), 10(b), 10(c), 11(c), 11(d), 13(a), 13(b), 14(a), 14(b), 15(a), 15(c), 16(a), 17(a), 17(b), 18(a), 18(b), 19(a), 19(b), 20(a), 20(b): MDE-approved management, monitoring, and equipment plans, implemented by the Certification Holder, ensure discharges comply with water quality standards for the growth and propagation of fish, other aquatic life, and wildlife.

Citations: COMAR 26.08.02.02B(1)(d); 26.08.02.03B(2)(e); 26.08.02.02B(4)(a); 26.08.02.02B(2)(a); 26.08.02.03-3A(5); 26.08.02.03-3B(1); 26.08.02.03-3C-1(1); 26.08.02.03-3C(5); 26.08.02.03B(2)(a); 26.08.02.03B(2)(d); 26.08.02.03B(2)(e); 26,08.02.02B(1)(a); 26.08.02.02B(1)(b)

15. Statement of Necessity for Special Condition 1, 5(h), 8(e), 10(l) and General Condition 21: These conditions are necessary to ensure review of required reports and data, which are used to evaluate compliance with the Certification and determine whether operations and discharges meet water quality standards. They address unique discharge circumstances and long-term retention of operational data to verify ongoing compliance with water quality standards.

Citations: Md. Ann. Code, Env. Article, Title 1, Subtitles 3 and 4; Md. Ann. Code, Env. Article, Title 5, Subtitles 5 and 9; Md. Ann. Code, Env. Article, Title 9, Subtitle 3; Md. Ann. Code, Env. Article, Title 16; COMAR 26.08; 26.17.04; COMAR 26.23; COMAR 26.23.02.06

List of Attachments

Attachment Code	Section/Topic of WQC	Condition
A	Fish Passage Diagram (Definitions-Upstream Fish Passage Efficiency	Definitions
B	Minimum Stream Flow Operational Plan ("MSFOP") dated March 18, 2022	3(a)
C	DOI Modified Prescription for Fishways, dated June 8, 2016	5(b)
D	Conowingo Hydroelectric Project (FERC Project No. 405) Fishway Effectiveness Monitoring Plan ("FEMP") dated September 2021	5(c)
E	Conowingo Hydroelectric Project (FERC Project No. 405) Fishway Operations and Maintenance Plan ("FOMP") dated January 2023	5(e)
F	Conowingo Hydroelectric Project (FERC Project No. 405) Final Study Report Maryland Darter Survey Revised Study Plan ("RSP 3.10") dated August 2012	6(b)(ii)
G	Conowingo Hydroelectric Project (FERC Project No. 405) Fish Kill Notification Plan dated March 2022	7(a) and 11(c)
H	Conowingo Hydroelectric Project (FERC Project No. 405), American Eel Passage and Restoration Plan ("EPRP"), dated September 2021	8 (a)
I	Conowingo Hydroelectric Project (FERC Project No. 405) Project's previously-filed Chlorophyll-A Monitoring Plan dated March 2023	13(a)
J	Quality Assurance Project Plan for Lake Nutrient Monitoring for Integrated Report Assessment and Total Maximum Daily Load Development dated February 26, 2025	13(c)(i)
K	EPA Region 3 QAPP Standard Template Final	13(d)(iii)
L	MDE-provided MS Excel data template	13(d)(iii)

List of Attachments

M	Conowingo Hydroelectric Project (FERC Project No. 405), Debris Management Plan, Revision ("Debris Management Plan"), dated October 2021	14(a)
N	Conowingo Hydroelectric Project (FERC Project No. 405) Sediment Management Plan, dated August 2012 and Revised September 2021	15(a)
O	Conowingo Hydroelectric Project (FERC Project No. 405) Shoreline Management Plan ("SMP") dated August 31, 2012, revised September 2021	16(a)
P	Conowingo Hydroelectric Project (FERC Project No. 405) Revised Bog Turtle Protection Plan dated July 2022[1]	17(a)
Q	Conowingo Hydroelectric Project (FERC Project No. 405) Northern Map Turtle Protection Plan dated March 2022[2]	18(a)
R	Conowingo Hydroelectric Project (FERC Project No. 405) Waterfowl Nesting Protection Plan dated March 2022[3]	19(a)

[1] This protection plan is being withheld from attachments as privileged information because it contains confidential information regarding a federally and state-protected species and should not be released to the public

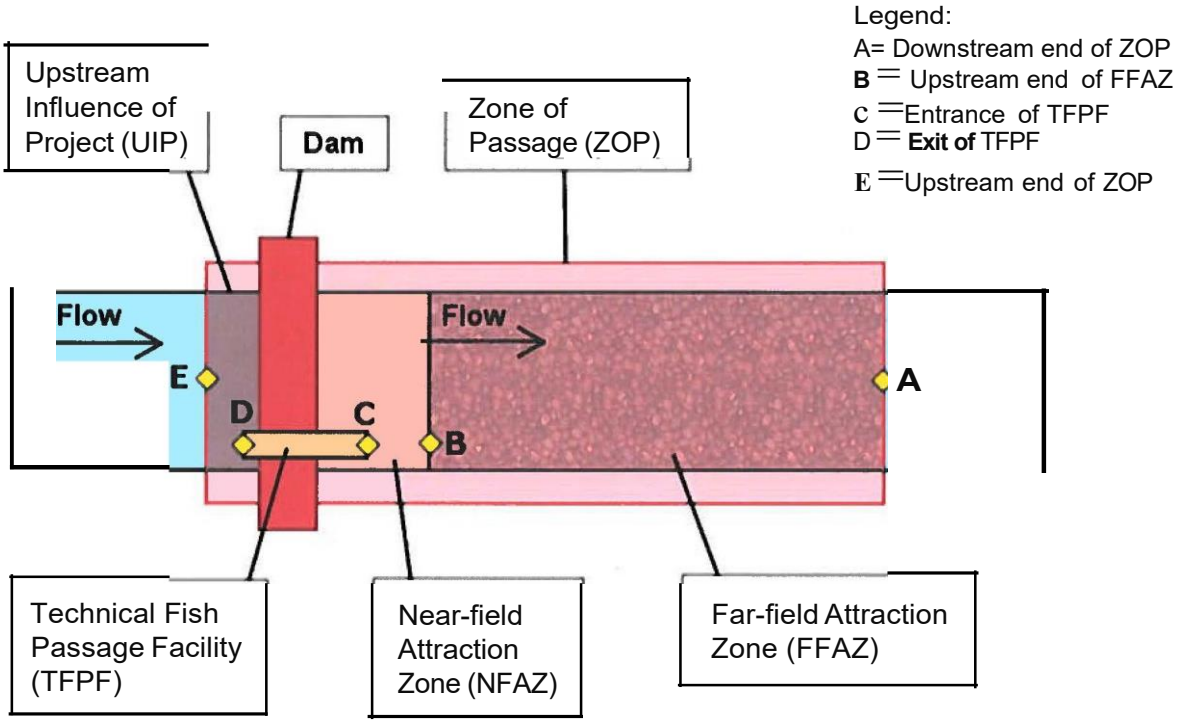
[2] This protection plan is being withheld from attachments as privileged information because it contains confidential information regarding a federally and state-protected species and should not be released to the public.

[3] This protection plan is being withheld from attachments as privileged information because it contains confidential information regarding a federally and state-protected species and should not be released to the public

Attachment A

Fish Passage Diagram

Diagram of Fish Passage
Definitions



Attachment B

Minimum Stream Flow Operational Plan

("MSFOP")

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CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NUMBER 405

MINIMUM STREAM FLOW OPERATION PLAN

Prepared for:

Constellation.

Prepared by:

GOMEZ AND SULLIVAN ENGINEERS

March 2022

Document Accession #: 20220318-5159 Filed Date: 03/18/2022

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LIST OF ABBREVIATIONS

cfs	cubic feet per second
Commission	Federal Energy Regulatory Commission
Constellation	Constellation Energy Generation, LLC (formerly known as Exelon Generation Company, LLC)
CRO	control room operator
DCS	Distributed Control System
EFL	East Fish Lift
FERC	Federal Energy Regulatory Commission
FWS	United States Fish and Wildlife Service
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MW	megawatt
NGVD 29	National Geodetic Vertical Datum of 1929
PADEP	Pennsylvania Department of Environmental Protection
PFBC	Pennsylvania Fish and Boat Commission
PJM	Pennsylvania Jersey Maryland Interconnection
Port Ops	Constellation's Portfolio Operations Group
Project	Conowingo Hydroelectric Project
RM	River Mile
RTO	regional transmission organization
SRBC	Susquehanna River Basin Commission
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey

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1 INTRODUCTION

The Conowingo Hydroelectric Project (Project) is a 570.15 megawatt (MW) hydroelectric project located at the Conowingo Dam on the Susquehanna River in Harford and Cecil counties, Maryland. The Project is owned and operated by Constellation Energy Generation, LLC (formerly known as Exelon Generation Company, LLC (Constellation)).

A new Federal Energy Regulatory Commission (FERC or Commission) license for the Project was issued on March 19, 2021, with a term of 50 years and an effective date of March 1, 2021 (FERC, 2019). Under Article 408 of the new FERC License, Constellation is required to develop a Minimum Stream Flow Operation Plan.

Specifically, Article 408 of the License states:

> *Within one year of license issuance, the licensee must file with the Commission for approval, a minimum stream flow operation plan that describes how the licensee will document compliance with the minimum flow releases required by this license, to be initiated beginning 4 years from the date of license issuance. The plan must include the following:*
>
> *a) A detailed description of how the project will comply with the minimum flow, ramping rate, and maximum flow requirements of the license as well as Conowingo reservoir level restrictions specified in Article 406, including procedures for sequencing turbine start-up and operation for seasonal and daily operation;*
>
> *b) A description of the mechanisms and structures (i.e., type and exact locations of all flow and reservoir elevation monitoring equipment and gates) to be used for maintaining compliance with operational requirements, and procedures for maintaining and calibrating monitoring equipment;*
>
> *c) Standard operating procedures to be implemented during routine maintenance, including a schedule of routine maintenance, and procedures to be implemented during conditions outside of normal operation, including during emergency conditions such as unscheduled facility shutdowns and maintenance;*
>
> *d) A provision to file with the Commission, after consultation with MDE, a minimum flow and operation compliance report by March 1, annually, detailing implementation of the plan, including any deviations in minimum flows (planned and unplanned deviations, including those authorized pursuant to paragraphs c-f of Article 407) ramping rates, maximum flows, and pond levels that occurred during the previous calendar year; and*
>
> *e) An implementation schedule.*
>
> *The plan must be developed after consultation with MDE. The licensee must include with the plan documentation of consultation, copies of recommendations on the completed plan after it has been prepared and provided to MDE, and specific descriptions of how MDE's comments are accommodated by the plan. The licensee must provide a minimum of 30 days for MDE to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a*

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> *recommendation, the filing must include the licensee's reasons, based on project-specific information.*
>
> *The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.*

This plan addresses near-term filing requirements to comply with the minimum flow, ramping rate, and maximum flow requirements of the license as well as Conowingo reservoir level restrictions specified in Articles 406 and 407. Per Article 409 of the License, Constellation is also currently conducting a study, in consultation with MDE, regarding the feasibility of redesigning, installing, and maintaining best available real-time flow telemetry at the USGS flow gage in the Project tailrace. This tailrace gage feasibility study is interrelated with many of the monitoring provisions contained in this plan, particularly as it relates to methods to monitor minimum flow releases and ramping rates at the Project. Given this, Constellation will review this plan at the conclusion of the tailrace gage feasibility study (March 2023) and update this plan as needed to reflect any proposed changes to the operation compliance monitoring program that result.

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2 PROJECT DESCRIPTION

2.1 Susquehanna River Basin

The Project is located at River Mile (RM) 10 on the Susquehanna River. The Susquehanna River is the largest tributary to the Chesapeake Bay at approximately 444 miles long. It begins near Cooperstown, New York at Otsego Lake and flows into the Chesapeake Bay at Havre de Grace, Maryland. The Susquehanna River basin, which drains approximately 27,510 square miles in New York, Pennsylvania, and Maryland, encompasses 43% of the Chesapeake Bay's drainage area and provides approximately 50% of the total freshwater inflow to the bay. Major tributaries of the Susquehanna River include the Juniata River, Conodoguinet Creek, Conewago Creek, the Conestoga River, and Swatara Creek. The Susquehanna River becomes tidally influenced approximately 3.5 miles downstream of Conowingo Dam.

There are five hydroelectric projects on the lower Susquehanna River. The most upstream of these projects is the York Haven Hydroelectric Project (FERC Project No. 1888) at RM 55, followed by the Safe Harbor Hydroelectric Project (FERC Project No. 1025) at RM 33, the Holtwood Hydroelectric Project (FERC Project No. 1881) at RM 25, and the Muddy Run Pumped Storage Project (FERC Project No. 2355) at RM 22. The Conowingo Hydroelectric Project is the most downstream project.

2.2 Project Works

Conowingo Dam is a concrete gravity structure with a maximum height of approximately 94 feet and a total length of 4,648 feet. The dam consists of four distinct sections from east to west: (1) a 1,190-foot-long non-overflow gravity section with an elevation of 115.7 feet (east abutment); (2) an ogee shaped spillway, the major portion of which is 2,250 feet long, and the minor portion of which is 135 feet long; (3) an intake-powerhouse section which is 946 feet long; and (4) a 127-foot-long non-overflow gravity section (west abutment). 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 support US Highway Route No. 1, which passes over the top of the Conowingo Dam. Flow over the spillway section is controlled by 50 Stoney-type crest gates and two regulating gates.

The Project has eleven (11) turbine-generator units and two (2) house (station service) units. Seven turbine-generator units (Units 1 through 7) and the two (2) house units are completely enclosed within the powerhouse, while the other four turbine-generator units (Units 8 through 11) are outside the powerhouse. Units 1 through 7 are Francis-type single runner hydraulic turbines and Units 8 through 11 are mixed-flow Kaplan-type hydraulic turbines. Table 2.2-1 includes a summary of turbine characteristics at the Project including rated head/capacity and hydraulic capacity in cubic feet per second (cfs).

2.3 Impoundment

Conowingo Dam impounds Conowingo Pond, an approximately 8,500-acre, 14-mile-long reservoir. Conowingo Pond has a gross storage capacity of 310,000 acre-feet at the normal full pool elevation of 109.2 feet National Geodetic Vertical Datum of 1929 (NGVD 29). The Project is operated as a peaking facility that uses reservoir storage to generate during periods of high electricity demand. Article 406 of the FERC License requires Constellation to maintain elevations between 101.2 feet NGVD 29 and 110.2 feet NGVD 29, with a minimum elevation of 107.2 feet NGVD 29 on weekends between Memorial Day and Labor Day, to meet recreational needs.

Table 2.2-1: Summary of Turbine Characteristics

Unit	Type	Rated Head (feet)	Rated Capacity (MW)	Max. Hydraulic Capacity (cfs)	Min. Hydraulic Capacity (cfs)
1	Francis	89	45.0	6,749	4,200
2	Francis	89	40.5	6,320	2,000
3	Francis	89	47.7	6,749	4,200
4	Francis	89	47.7	6,749	4,200
5	Francis	89	36.0	6,320	2,000
6	Francis	89	47.7	6,749	4,200
7	Francis	89	47.7	6,749	4,200
8	Mixed-Flow Kaplan	86	63.75	9,352	7,500
9	Mixed-Flow Kaplan	86	63.75	9,727	7,800
10	Mixed-Flow Kaplan	86	63.75	9,727	7,800
11	Mixed-Flow Kaplan	86	63.75	9,727	7,800
House #1	Francis	89	1.425	247	210
House #2	Francis	89	1.425	247	210

3 OPERATING REQUIREMENTS UNDER NEW LICENSE

The following articles describe the flow management conditions required by the FERC license.

Article 406 of the License states (FERC, 2019):

> *Upon license issuance, the licensee must operate the project with a normal range of operation for Conowingo Pond between elevations 101.2 feet National Geodetic Vertical Datum of 1929 (NGVD 29) and 110.2 feet NGVD 29, with a minimum elevation of 107.2 feet NGVD 29 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 (Pennsylvania DEP), and the Maryland Department of the Environment (MDE). If pond levels are so modified, the licensee must notify the Commission, in writing, as soon as possible, but no later than 14 days after each such incident. In addition, the licensee must implement the following requirements with regard to planned and unplanned (emergency) changes in water surface elevation requirements of this article.*
>
> *Planned Deviations:*
>
> *Impoundment elevations may be temporarily modified if required by operating emergencies beyond the control of the licensee, or for short periods, up to three weeks, after mutual agreement among the licensee, Pennsylvania DEP, and the MDE. The licensee must file a report with the Commission as soon as possible, but no later than 14 calendar days after the onset of the planned deviation. Each report must include: (1) the reasons for the deviation and whether operations were modified; (2) the duration and magnitude of the deviation; (3) any environmental effects; and (4) documentation of consultation with Pennsylvania DEP and MDE. For planned deviations exceeding three weeks, the licensee must file an application for a temporary amendment of lake levels and receive Commission approval prior to implementation.*
>
> *Unplanned Deviation, more than three hours or resulting in environmental effects:*
>
> *If the licensee deviates from the impoundment elevation requirements, the licensee must file a report of each incident with the Commission. For any deviation that lasts longer than three hours or results in environmental effects, the licensee must file a report as soon as possible, but no later than 14 calendar days after each such incident. The report must include: (1) the cause of the event; (2) the duration and magnitude of the deviation; (3) any pertinent operational and/or monitoring data; (4) a timeline of the incident and the license's response; (5) any comments or correspondence received from Pennsylvania DEP and MDE, or confirmation that no comments were received from the consulted agencies; (6) documentation of any observed environmental effects; and (7) a description of measures implemented to prevent similar deviations in the future.*
>
> *Unplanned Deviations lasting three hours or less with no environmental effects:*
>
> *For deviations lasting three hours or less that do not result in environment effects, the licensee must file an annual report with the Commission, by March 1 of the year*

following the reporting year, describing each incident up to one month prior to the reporting date, including: (1) the cause of the event; (2) the duration and magnitude of the deviation; (3) any pertinent operational and/or monitoring data; (4) a timeline of the incident and the license's response; (5) any comments or correspondence received from Pennsylvania DEP and MDE, or confirmation that no comments were received from the listed agencies; and (6) a description of measures implemented to prevent similar deviations in the future.

Article 407 of the License states (FERC, 2019):

Upon license issuance, the licensee must operate the project in accordance with the following operational flow regime:

Date	***Minimum Flow***
September 15 – March 31	*3,500 cfs or natural inflow, whichever is less*
April 1 – 30	*10,000 cfs or natural inflow, whichever is less*
May 1 – June 15	*7,500 cfs or natural inflow, whichever is less*
June 16 – September 14	*5,000 cfs or natural inflow, whichever is less*

Beginning four years from the date of issuance of this license, the licensee must provide minimum flow and maximum flow releases and ramping rate limitations as described below:

Date	***Minimum Flow***	***Down-ramping Rate***	***Up-ramping Rate***	***Maximum Flow***
January 1–31	*4,000 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs*	*None*	*None*
February 1–28	*4,000 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs*	*None*	*None*
March 1–15	*13,100 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs*	*Up to 40,000 cfs/hour*	*None*
March 16–31	*18,200 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*Up to 40,000 cfs/hour*	*None*
April 1–30	*18,200 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*Up to 40,000 cfs/hour*	*None*
May 1–31	*18,200 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*Up to 40,000 cfs/hour*	*75,000 cfs*
June 1–15	*10,000 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*Up to 40,000 cfs/hour*	*75,000 cfs*

Date	*Minimum Flow*	*Down-ramping Rate*	*Up-ramping Rate*	*Maximum Flow*
June 16–30	*7,500 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*Up to 40,000 cfs/hour*	*75,000 cfs*
July 1–31	*5,500 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*Up to 40,000 cfs/hour*	*79,000 cfs*
August 1–31	*4,000 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*Up to 40,000 cfs/hour*	*79,000 cfs*
September 1–30	*4,000 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*Up to 40,000 cfs/hour*	*79,000 cfs*
October 1–31	*4,000 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*Up to 40,000 cfs/hour*	*None*
November 1–30	*4,000 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*None*	*None*
December 1–31	*4,000 cfs or natural inflow, whichever is less*	*Up to 12,000 cfs/hour if Conowingo discharge is less than 30,000 cfs.*	*None*	*None*

a) Natural inflow must be measured at the Marietta U.S. Geological Survey gage (No. 01576000).

b) Maximum flow restrictions must only apply when the natural flow is less than 86,000 cfs.

c) If compliance with the prescribed flows would cause the licensee to violate or breach any law, any applicable license, permit, approval, consent, exemption or authorization from a federal, state, or local governmental authority, including the Nuclear Regulatory Commission license for the Peach Bottom Atomic Power Station, the license for the Muddy Run Pumped Storage Project No. 2355 (Muddy Run Project), any agreement with the City of Baltimore or other governmental entity, or any tariff or other requirement of the PJM Interconnection Regional Transmission Organization or their assigns, the licensee may deviate from the prescribed flows to the least degree necessary in order to avoid such violation or breach.

d) If compliance with the prescribed flows would cause the licensee to violate any agreement in effect as of September 1, 2019, with the Chester Water Authority, Old Dominion Electric Cooperative, or the York Energy Center, the licensee may deviate from the prescribed flows to the least degree necessary in order to avoid such violation or breach.

e) If compliance with the prescribed flows would cause or exacerbate flooding or a similar public safety hazard, the licensee may deviate from the prescribed flows to the least degree necessary in order to avoid such flooding or public safety hazard.

f) Not including the authorized deviations in sections (c), (d), and (e) of this license article, the licensee shall have the flexibility to deviate from the up-ramping, down-ramping and maximum flow restrictions according to the following limits during each month:

- *January, February: 8 total permitted hours of deviation per month;*
- *March, April, May, and that portion of June during which the East Fish Lift (EFL) is in operation: no deviations allowed;*
- *June after EFL operation has ceased: 8 total permitted hours of deviation per month of which no more than 50% will be allocated to down-ramping and up-ramping;*
- *July, August: 26 total permitted hours of deviation per month of which no more than 50% will be allocated to down-ramping and up-ramping;*
- *September: 32 total permitted hours of deviation per month of which no more than 50% will be allocated to down-ramping and up-ramping;*
- *October: 14 total permitted hours of deviation per month; and*
- *November, December: 8 total permitted hours of deviation per month.*

When the licensee deviates from the down-ramping or up-ramping restrictions of the operational flow regime, the amount of time applied against the limits set forth above is two hours per event, regardless of the actual amount of time it takes the licensee to complete the down-ramping or up-ramping event. 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 Maryland Department of the Environment. The licensee must maintain complete and accurate records of all deviations that occur pursuant to this section.

<u>Unplanned Deviations</u>

For unplanned deviations, the licensee must file a report with the Commission as soon as possible, but no later than 14 days after the onset of the incident. Each report must describe the incident, including: (1) the cause, (2) the duration and magnitude,(3) any pertinent operational and/or monitoring data, (4) a timeline of the incident and the licensee's response, (5) any environmental effects, (6) documentation that MDE and FWS were notified and any comments received, or, affirmation that no comments were received, and (7) any measures to be implemented to prevent similar incidents in the future.

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4 OPERATIONS MONITORING PLAN

Conowingo Station is managed according to a set of operating guidelines, which are maintained and periodically updated by Constellation. The operating guidelines include extensive, and sensitive, details regarding communication protocols, responsibilities, action levels, unit operations, and gate operations. The management of pond levels, downstream discharge, emergency conditions (including unit trips and ice jams), and maintenance activities are all covered by these operating guidelines. The following sections summarize the items covered by the operating guidelines.

4.1 Operations Management Overview

The Project will operate in a peaking mode, as scheduled through coordination between PJM Interconnection, LLC (PJM)[1] and Constellation's Portfolio Operations Group (Port Ops)[2] considering river flows, peak demand hours, Muddy Run Pumped Storage Project operations, and other parameters. Schedules are typically issued daily before 10 AM with a four-day outlook. However, the schedules are revised multiple times throughout the day to accommodate changing river and market conditions. The schedule consists of a generation setpoint for the Project and is manually dispatched by phone call from Port Ops to the control room operator (CRO) at the Project. The CRO determines how many units to put into or remove from service to match the generation setpoint, ensuring that all impoundment level, downstream flow, and any other requirements will be met as part of the change. If the CRO identifies an issue with meeting any requirements[3], the CRO and Port Ops will coordinate to resolve the issue. Once all issues are resolved, the CRO fills out a sheet documenting the current and proposed unit settings and gets approval from the control room shift manager prior to making any changes to the number of units started or stopped. The CRO then manually starts or stops the required units to meet the generation setpoint, ensuring that all required public safety measures (e.g., sirens, beacons, visually verifying tailrace conditions) are followed. During normal operations, the units are in Gate Control mode with a wicket gate setpoint of 80%. However, the CRO may select a different wicket gate setpoint if needed to meet minimum flow requirements, increase flow due to imminent spill conditions, address mechanical issues with a unit, or resolve other situations. Throughout unit operation, the CRO monitors water levels, flows, and other metrics to ensure compliance with all Project requirements.

Under normal operations, the Project first utilizes four of the small units (Units 1 through 7), then the four large units (Units 8 through 11), before using the remaining three small units (Units 1 through 7). During high flow conditions, crest gates are utilized once all units are operating to pass flow downstream for the purpose of water level management. These gates cannot be throttled and are thus either opened or closed. There is no set order for the use of crest gates, as the order is rotated to ensure continued operability of all gates. PJM, Port Ops, and the Project are staffed 24 hours a day, 7 days a week to ensure operational changes deviate from License requirements to the least degree necessary due to emergency conditions, including unscheduled facility shutdowns and maintenance.

[1] PJM is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of 13 states and the District of Columbia.
[2] Port Ops is the group within Constellation that markets and sells power.
[3] PJM and Port Ops are expected to create schedules that comply with all FERC License requirements, but it is ultimately the responsibility of the CRO to ensure compliance.

4.2 Operations Monitoring Equipment and Methods

A Distributed Control System (DCS) is used by the CRO to monitor and adjust Project operations. The DCS monitors instantaneous headwater and tailwater levels, generation for each unit, regulating and crest gate openings, wicket gate setting, unit and gate discharge, and other ancillary Project operating data. Data is not archived on a set interval, but rather a new archive value is recorded for a given parameter when the difference between the current archive value the current actual value meets or exceeds a pre-defined percent change in magnitude[4]. When the DCS generates a report at a specified interval, the reported values are linearly interpolated between the archived data points.

Impoundment water levels are monitored by two separate pressure sensors located in a single stilling well on the headworks near Unit 1. The average reading from these two sensors is recorded as the headwater level for the Project. Tailrace water levels are monitored by two separate pressure sensors in stilling wells near Unit 1 and Unit 8[5]. The average reading from these two sensors is recorded as the tailwater level for the Project. The difference between the headwater and tailwater levels is recorded as the net head for the Project. Each unit is equipped with a MW transducer to monitor its generation output.

Flow through each unit, including the House Units, is computed by the DCS using the net head and that unit's current generation output as inputs to a polynomial equation based on the turbine performance curves for that unit. Tables of flow through each unit for a given net head and MW output are provided in Appendix A. The CRO manually sets the regulating and crest gates as either opened or closed in the DCS, once station personnel have reported a gate change. The flow through each open gate is computed by the DCS based on the impoundment water level and a discharge rating curve. Gate discharge rating curves are provided in Appendix A. Total Project discharge is then calculated by adding flow from all units and gates[6].

4.3 Operations Monitoring Compliance

4.3.1 Impoundments Levels

Constellation will utilize the pressure sensors located on the headworks and described in Section 4.2 to monitor and record real-time impoundment levels, which will be recorded electronically by the DCS system and archived and output at a 15-minute time interval for Constellation's record of compliance with the requirements of the FERC license.

4.3.2 Minimum and Maximum Flows

Minimum and maximum flow requirements vary depending on the natural inflow, which is to be measured at the Marietta USGS gage (Gage No. 01576000). Constellation will monitor the natural inflow and generation at the Project continuously via the DCS. Turbine outflow will be calculated automatically from the generation output readings (MW) and the net head (difference between impoundment and tailrace water level transducer readings) as described in Section 4.2 and using the turbine performance curves for each unit (Appendix A). Flow through the other Project components including over the spillway will be determined by reading and recording gate settings and pond level and calculating flow based on the engineering curves for each component (Appendix A). The calculated turbine and spillway outflows will

[4] The percent change applied to the headwater gages equates to approximately 0.46 feet, while the percent change applied to the generating units varies between approximately 70 cfs and 110 cfs, depending on the unit.
[5] The sensor near Unit 8 shares a stilling well with the United States Geological Survey (USGS) pressure sensor associated with Gage Number 01578310 (Susquehanna River at Conowingo, MD).
[6] The DCS does not currently track flows through Regulating Gate 1, as this gate is throttled (i.e., not just open or closed) to supply controlled flows for East Fish Lift (EFL) operations.

be recorded electronically by the DCS system and archived and output at a 15-minute time interval for Constellation's record of compliance with the minimum and maximum flow requirements of the FERC license.

4.3.3 Ramping Rates

Compliance with up and down ramping requirements will be monitored continuously via the DCS using the turbine outflow calculations as described Section 4.3.2. The calculated turbine outflows will be recorded electronically by the DCS system and archived and output at a 15-minute time interval to determine Constellation's record of compliance with the up and down ramping requirements of the FERC license.

4.4 Procedures for Monitoring Equipment Maintenance and Calibration

During each quarter of the year, the headwater and tailwater pressure sensor readings are compared against a visual reading of the staff gage located in the Project's forebay and tailrace, and, if necessary, these water level recorders are calibrated. During each unit outage, the wicket gate position transmitters and MW transducers are inspected, and, if necessary, these measurement devices are calibrated. As previously stated, there is no set order for the use of crest gates, as the order is rotated to ensure continued operability of all gates. All crest and regulating gates are operated annually.

4.5 Routine Maintenance

Periodic turbine shutdowns will occur as necessary to perform maintenance activities. Under these circumstances, Constellation will maintain the impoundment levels, minimum flows, maximum flows, and ramping rates as described in Section 4.3 through the remaining operable turbine units and/or over the spillway as available or appropriate, in accordance with the operating guidelines.

During planned maintenance activities or other conditions where temporary changes to the required impoundment levels, minimum and maximum flows, or ramping rates are necessary, Constellation will consult with the Susquehanna River Basin Commission (SRBC), Maryland Department of Environment (MDE), Maryland Department of Natural Resources (MDNR), Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Fish and Boat Commission (PFBC), and U.S. Fish and Wildlife Service (USFWS).

4.6 Unscheduled Facility Shutdowns and Maintenance

The minimum and maximum flows as well as ramping rates can be maintained by several different combinations of the seven small units (Units 1 through 7), or the four large units (Units 8 through 11). The generating unit(s) may occasionally trip unexpectedly (i.e., line fault, equipment failure, etc.). Under these circumstances, Constellation will maintain the impoundment levels, minimum and maximum flows, and ramping rates through the remaining unit(s) or over the spillway as available or appropriate, in accordance with the operating guidelines.

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5 REPORTING AND NOTIFICATION OF DEVIATIONS

The procedures, outlined in Section 4.0 of this document, are designed to allow the Project to operate such that it would not deviate from the water level and flow constraints described in the Project's FERC License Articles 406 and 407, respectively. However, these articles allow for different authorized deviations in water level and flow requirements, as well as limited discretionary deviations in flow requirements. Alarms are programmed in the DCS to notify the CRO should a deviation occur. The CRO will be responsible for maintaining a log of all deviations. The CRO will first categorize the deviation, as this will determine the reporting requirements associated with the deviation. Table 5-1 outlines the deviation types and associated required report type(s), while Table 5-2 outlines the minimum data log requirements for each deviation type.

5.1.1 Operation Compliance Annual Report

Annual reports will be drafted by January 15th following each calendar year of operation describing all deviation events occurring the previous calendar year. These drafts will be provided to MDE for a 30-day consultation period, after which the reports will be finalized and filed with the Commission by March 1st.

5.1.2 Operation Compliance Event Reports

Planned Deviations:

As required by Article 406 of the License, Constellation will consult with PADEP and the MDE in advance of a planned deviation from impoundment elevation requirements due to operating emergencies beyond the control of the licensee, or for short periods, up to three weeks. After concurrence from these resource agencies, Constellation will file a report with the Commission as soon as possible, but no later than 14 calendar days after the onset of the planned deviation. Each report must include: (1) the reasons for the deviation and whether operations were modified; (2) the duration and magnitude of the deviation; (3) any environmental effects; and (4) documentation of consultation with Pennsylvania DEP and MDE. For planned deviations exceeding three weeks, the licensee must file an application for a temporary amendment of lake levels and receive Commission approval prior to implementation.

Unplanned Deviations:

As required by Article 406 of the License, for any unplanned deviation from impoundment level requirements that lasts longer than 3 hours or results in visible environmental effects, Constellation will notify FERC as soon as possible, but no later than 14 days of any such deviations from impoundment elevation requirements. The report will contain, to the extent possible, (1) the cause of the event; (2) the duration and magnitude of the deviation; (3) any pertinent operational and/or monitoring data; (4) a timeline of the incident and the license's response; (5) any comments or correspondence received from PADEP and MDE, or confirmation that no comments were received from the consulted agencies; (6) documentation of any observed environmental effects; and (7) a description of measures implemented to prevent similar deviations in the future.

As required by Article 406 of the License, for unplanned deviations lasting 3 hours or less that do not result in visible environmental effects, Constellation will file an annual report to the Commission, by March 1, describing each incident up to one month prior to the reporting date, including: (1) the cause of the event; (2) the duration and magnitude of the deviation; (3) any pertinent operational and/or monitoring data; (4) a timeline of the incident and the license's response; (5) any comments or correspondence received from

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Pennsylvania DEP and MDE, or confirmation that no comments were received from the listed agencies; and (6) a description of measures implemented to prevent similar deviations in the future.

As required by Article 407 of the License, for unplanned deviations from minimum flows, Constellation will file a report with the Commission as soon as possible, but no later than 14 days after the onset of the incident. Each report must describe the incident, including: (1) the cause, (2) the duration and magnitude,(3) any pertinent operational and/or monitoring data, (4) a timeline of the incident and the licensee's response, (5) any environmental effects, (6) documentation that MDE and USFWS were notified and any comments received, or, affirmation that no comments were received, and (7) any measures to be implemented to prevent similar incidents in the future.

Table 5-1: Summary of Deviation and Report Types

Deviation Type	Deviation Description	Reporting Type	
		Event Report	Annual Report
406-A	Planned Deviations pursuant to Article 406	X	X
406-B	Unplanned Deviations lasting more than three hours or resulting in environmental effects pursuant to Article 406	X	X
406-C	Unplanned Deviations lasting less than three hours with no environmental effects pursuant to Article 406		X
407-A	Unplanned Deviations pursuant to Article 407 sections (c), (d), and (e)	X	X
407-B	Planned Deviations pursuant to Article 407 section (f)		X

Table 5-2: Summary of Minimum Data Log Requirements

Deviation Reporting Information	Deviation Type				
	406-A	406-B	406-C	407-A	407-B
Cause	X	X	X	X	
Duration	X	X	X	X	X[4]
Magnitude	X	X	X	X	X
Environmental Effects	X	X		X	
Agency Correspondence	X[1]	X[2]	X[2]	X[3]	X[5]
Pertinent Operational/Monitoring Data		X	X	X	X
Timeline and Response		X	X	X	
Changes to Prevent Future Deviations		X	X	X	

Notes:
1. Pennsylvania DEP and MDE approval required in advance of implementing all planned water level deviations. FERC approval must be obtained prior to implementing water level deviations planned to last longer than three weeks.
2. Comments/correspondence, or confirmation that no comments were received, from Pennsylvania DEP and MDE must be included.
3. Documentation of MDE and FWS notification and either comments received or affirmation that no comments were received must be included.
4. The duration applied to deviations from down-ramping and up-ramping restrictions will be two hours per event, regardless of the actual amount of time it takes the licensee to complete the down-ramping or up-ramping event.
5. Temporary modifications to minimum flow requirements due to operating emergencies require prior approval from MDE.

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6 AGENCY CONSULTATION

A draft of this plan was provided to MDE on February 14, 2022. MDE responded on March 16, 2022 that they had no comments on the draft Minimum Stream Flow Operation Plan. Appendix B includes, a copy of the draft plan transmittal letter, and a copy of the response from MDE.

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7 REFERENCES

FERC. (2019, March 19). *Order Issuing New License re Exelon Generation Company, LLC under P-405.* Retrieved from Federal Energy Regulatory Commision eLibrary: https://elibrary.ferc.gov/eLibrary/search

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APPENDIX A. UNIT AND GATE DISCHARGE RATING CURVES

Table A-1: Unit Discharge Rating Curves for 75 feet of Net Head

Generation (MW)	Discharge (cfs) under 75 feet of Net Head										
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11
0	1,821	1,759	1,801	1,801	1,759	1,821	1,801	2,686	2,692	2,692	2,692
5	1,870	1,759	1,843	1,843	1,759	1,870	1,843	3,142	3,160	3,160	3,160
10	2,558	2,290	2,590	2,590	2,290	2,558	2,590	3,751	3,785	3,785	3,785
15	3,189	2,895	3,256	3,256	2,895	3,189	3,256	4,360	4,409	4,409	4,409
20	3,878	3,526	3,976	3,976	3,526	3,878	3,976	4,970	5,033	5,033	5,033
25	4,598	4,279	4,713	4,713	4,279	4,598	4,713	5,579	5,658	5,658	5,658
30	5,279	5,048	5,386	5,386	5,048	5,279	5,386	6,188	6,282	6,282	6,282
35	5,923	6,629	6,300	6,300	6,629	5,923	6,300	6,797	6,907	6,907	6,907
40	7,115	6,629	7,146	7,146	6,629	7,115	7,146	7,406	7,531	7,531	7,531
45	7,407	6,629	7,146	7,146	6,629	7,407	7,146	8,014	8,137	8,137	8,137
50	7,407	6,629	7,146	7,146	6,629	7,407	7,146	8,599	8,691	8,691	8,691
55								10,163	9,903	9,903	9,903
60								10,163	9,903	9,903	9,903
65								10,163	9,903	9,903	9,903
70								10,163	9,903	9,903	9,903
75								10,163	9,903	9,903	9,903

Table A-2: Unit Discharge Rating Curves for 80 feet of Net Head

Generation (MW)	Discharge (cfs) under 80 feet of Net Head										
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11
0	1,838	1,772	1,863	1,863	1,772	1,838	1,863	2,686	2,692	2,692	2,692
5	1,879	1,772	1,872	1,872	1,772	1,879	1,872	3,142	3,160	3,160	3,160
10	2,536	2,261	2,488	2,488	2,261	2,536	2,488	3,751	3,785	3,785	3,785
15	3,158	2,873	3,126	3,126	2,873	3,158	3,126	4,360	4,409	4,409	4,409
20	3,832	3,489	3,761	3,761	3,489	3,832	3,761	4,970	5,033	5,033	5,033
25	4,541	4,213	4,467	4,467	4,213	4,541	4,467	5,579	5,658	5,658	5,658
30	5,214	4,966	5,143	5,143	4,966	5,214	5,143	6,188	6,282	6,282	6,282
35	5,851	6,324	5,807	5,807	6,324	5,851	5,807	6,797	6,907	6,907	6,907
40	6,951	6,676	6,903	6,903	6,676	6,951	6,903	7,406	7,531	7,531	7,531
45	7,365	6,676	7,340	7,340	6,676	7,365	7,340	8,014	8,137	8,137	8,137
50	7,459	6,676	7,340	7,340	6,676	7,459	7,340	8,599	8,691	8,691	8,691
55								10,163	9,903	9,903	9,903
60								10,163	9,903	9,903	9,903
65								10,163	9,903	9,903	9,903
70								10,163	9,903	9,903	9,903
75								10,163	9,903	9,903	9,903

Table A-3: Unit Discharge Rating Curves for 85 feet of Net Head

Generation (MW)	Discharge (cfs) under 85 feet of Net Head										
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11
0	1,906	1,828	1,927	1,927	1,828	1,906	1,927	2,703	2,709	2,709	2,709
5	1,916	1,828	1,927	1,927	1,828	1,916	1,927	3,134	3,143	3,143	3,143
10	2,451	2,155	2,389	2,389	2,155	2,451	2,389	3,708	3,721	3,721	3,721
15	3,034	2,769	3,008	3,008	2,769	3,034	3,008	4,282	4,299	4,299	4,299
20	3,646	3,368	3,590	3,590	3,368	3,646	3,590	4,856	4,877	4,877	4,877
25	4,314	3,982	4,241	4,241	3,982	4,314	4,241	5,430	5,455	5,455	5,455
30	4,957	4,681	4,898	4,898	4,681	4,957	4,898	6,004	6,033	6,033	6,033
35	5,565	5,488	5,480	5,480	5,488	5,565	5,480	6,578	6,611	6,611	6,611
40	6,293	6,862	6,264	6,264	6,862	6,293	6,264	7,152	7,189	7,189	7,189
45	7,197	6,862	7,515	7,515	6,862	7,197	7,515	7,725	7,764	7,764	7,764
50	7,668	6,862	7,542	7,542	6,862	7,668	7,542	8,288	8,323	8,323	8,323
55								8,843	8,985	8,985	8,985
60								10,316	9,882	9,882	9,882
65								10,316	10,064	10,064	10,064
70								10,316	10,064	10,064	10,064
75								10,316	10,064	10,064	10,064

Table A-4: Unit Discharge Rating Curves for 90 feet of Net Head

Generation (MW)	Discharge (cfs) under 90 feet of Net Head										
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11
0	1,974	1,890	1,983	1,983	1,890	1,974	1,983	2,720	2,689	2,689	2,689
5	1,974	1,890	1,983	1,983	1,890	1,974	1,983	3,120	3,094	3,094	3,094
10	2,367	2,063	2,306	2,306	2,063	2,367	2,306	3,653	3,634	3,634	3,634
15	2,929	2,667	2,918	2,918	2,667	2,929	2,918	4,186	4,174	4,174	4,174
20	3,487	3,256	3,478	3,478	3,256	3,487	3,478	4,719	4,714	4,714	4,714
25	4,121	3,833	4,056	4,056	3,833	4,121	4,056	5,252	5,254	5,254	5,254
30	4,731	4,442	4,656	4,656	4,442	4,731	4,656	5,785	5,794	5,794	5,794
35	5,303	5,095	5,242	5,242	5,095	5,303	5,242	6,318	6,333	6,333	6,333
40	5,877	6,206	5,795	5,795	6,206	5,877	5,795	6,852	6,874	6,874	6,874
45	6,658	7,040	6,854	6,854	7,040	6,658	6,854	7,385	7,414	7,414	7,414
50	7,838	7,040	7,741	7,741	7,838	7,741	7,915	7,954	7,954	7,954	7,954
55								8,431	8,475	8,475	8,475
60								8,965	8,993	8,993	8,993
65								10,498	10,232	10,232	10,232
70								10,498	10,232	10,232	10,232
75								10,498	10,232	10,232	10,232

Table A-5: Unit Discharge Rating Curves for 95 feet of Net Head

Generation (MW)	Discharge (cfs) under 95 feet of Net Head										
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11
0	2,012	1,948	2,035	2,035	1,948	2,012	2,035	2,708	2,692	2,692	2,692
5	2,012	1,948	2,035	2,035	1,948	2,012	2,035	3,083	3,072	3,072	3,072
10	2,321	2,007	2,231	2,231	2,007	2,321	2,231	3,582	3,577	3,577	3,577
15	2,879	2,571	2,828	2,828	2,571	2,879	2,828	4,081	4,083	4,083	4,083
20	3,419	3,147	3,379	3,379	3,147	3,419	3,379	4,580	4,588	4,588	4,588
25	4,016	3,694	3,919	3,919	3,694	4,016	3,919	5,080	5,094	5,094	5,094
30	4,613	4,252	4,472	4,472	4,252	4,613	4,472	5,579	5,600	5,600	5,600
35	5,178	4,841	5,026	5,026	4,841	5,178	5,026	6,078	6,105	6,105	6,105
40	5,732	5,625	5,556	5,556	5,625	5,732	5,556	6,577	6,611	6,611	6,611
45	6,376	6,827	6,262	6,262	6,827	6,376	6,262	7,077	7,116	7,116	7,116
50	7,532	7,212	7,474	7,474	7,212	7,532	7,474	7,576	7,622	7,622	7,622
55								8,075	8,128	8,128	8,128
60								8,564	8,618	8,618	8,618
65								9,220	9,245	9,245	9,245
70								10,678	10,395	10,395	10,395
75								10,678	10,395	10,395	10,395

Table A-6: Gate Discharge Rating Curves

Reservoir Level (ft, NGVD29)	Discharge (cfs)		
	Per Regulating Gate (n=2)	Per Crest Gate (n=50)	All Gates
101.0	275	7,354	368,260
101.5	408	7,787	390,181
102.0	561	8,232	412,699
102.5	735	8,687	435,813
103.0	928	9,146	459,164
103.5	1,138	9,611	482,823
104.0	1,367	10,086	507,019
104.5	1,612	10,570	531,747
105.0	1,870	11,061	556,791
105.5	2,144	11,558	582,197
106.0	2,435	12,065	608,108
106.5	2,745	12,581	634,524
107.0	3,063	13,107	661,475
107.5	3,391	13,643	688,952
108.0	3,734	14,189	716,930
108.5	4,091	14,745	745,410
109.0	4,455	15,298	773,831
109.5	4,823	15,853	802,318
110.0	5,508	16,417	831,849
110.5	5,741	16,988	860,884

Document Accession #: 20220318-5159 Filed Date: 03/18/2022

APPENDIX B. AGENCY COMMENTS

From: David Seaborn -MDE- <david.seaborn@maryland.gov>
Sent: Wednesday, March 16, 2022 3:54 PM
To: Erin Redding <eredding@gomezandsullivan.com>
Cc: Denise Keehner, MDE <denise.keehner@maryland.gov>; Heather Nelson, MDE <hnelson@maryland.gov>; Danucalov, Andrea H:(Exelon Power) <Andrea.Danucalov@constellation.com>; Kirk Smith <ksmith@gomezandsullivan.com>; David Frazier <dfrazier@gomezandsullivan.com>
Subject: EXTERNAL EMAIL -Re: Constellation Conowingo Minimum Stream Flow Operation Plan

CAUTION: This email originated from outside of GSE. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Andrea and Kirk,

Maryland (MDE coordinating with MDNR) does not have any comments on the Constellation's draft Minimum Stream Flow Operation Plan.

Thank you,

David Seaborn

On Thu, Mar 10, 2022 at 12:28 PM Erin Redding <eredding@gomezandsullivan.com> wrote:

Hello,

Thank you to everyone who is reviewing Constellation's Minimum Stream Flow Operation Plan Draft sent on February 14. Please submit any comments to Andrea Danucalov and Kirk Smith by March 16, 2021.

Thank you,

Erin Redding (she/her)

Certified Senior Ecologist, ESA

Gomez and Sullivan Engineers, D.P.C.

1961 Wehrle Dr.

Suite 12

Williamsville, NY 14221
eredding@gomezandsullivan.com

Please note, I do not work on Wednesdays.

GOMEZ AND SULLIVAN ENGINEERS

From: Erin Redding
Sent: Monday, February 14, 2022 4:48 PM
To: David Seaborn. MDE <david.seaborn@maryland.gov>; Denise Keehner, MDE <denise.keehner@maryland.gov>; Heather Nelson, MDE <hnelson@maryland.gov>
Cc: Andrea Danucalov <andrea.danucalov@constellation.com>; Kirk Smith <ksmith@gomezandsullivan.com>; David Frazier <dfrazier@gomezandsullivan.com>
Subject: Constellation Conowingo Minimum Stream Flow Operation Plan

Hello,

Constellation has prepared the attached Minimum Stream Flow Operation Plan Draft in accordance with Conowingo Hydroelectric Project Federal Energy Commission License Article 408. Please review this plan and provide any comments to Andrea Danucalov and Kirk Smith by March 16, 2021.

Sincerely,

Erin Redding (she/her)

Certified Senior Ecologist, ESA

Gomez and Sullivan Engineers, D.P.C.

1961 Wehrle Dr.

Suite 12

Williamsville, NY 14221
eredding@gomezandsullivan.com

Please note, I do not work on Wednesdays.

GOMEZ AND SULLIVAN ENGINEERS

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CHANGING Maryland FOR THE BETTER

Document Content(s)

MSFOP_FERC_Cover_Letter.pdf.....1
Conowingo_Minimum_Stream_Flow_Operation_Plan.pdf 2

Attachment C

DOI Modified Prescription for Fishways

United States Department of the Interior

FISH AND WILDLIFE SERVICE
300 Westgate Center Drive
Hadley, MA 01035-9589

JUN - 7 2016

In Reply Refer To:
FWS/R5/ES-ERR/063194

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Conowingo Hydroelectric Project, Federal Energy Regulatory Commission (FERC No. P- 405) Modified Prescription for Fishways

Dear Secretary Bose:

This correspondence contains the U.S. Department of the Interior's (Department) Modified Prescription for Fishways Pursuant to Section 18 of the Federal Power Act (Modified Prescription) for the Federal Energy Regulatory Commission Project No. 405 Conowingo Hydroelectric Project. This Modified Prescription is being filed in compliance with the Department's regulations at 43 CFR Part 45. All hearing requests and alternatives submitted to the Department have been withdrawn within the specified deadlines. Pursuant to the Department's regulations and the U.S. Fish and Wildlife Service's delegation of authority, we are now electronically filing our Modified Prescription for the above referenced Project.

Sincerely,

Wendi Weber
Regional Director

cc: Service List

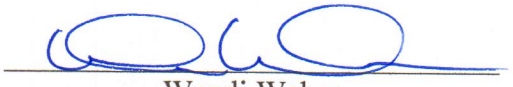
ATTACHMENT A

BEFORE THE
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Exelon Corporation, Applicant	)	Conowingo Hydroelectric Project
	)	FERC No. 405

UNITED STATES DEPARTMENT OF THE INTERIOR
DECISION DOCUMENT AND
MODIFIED PRESCRIPTION FOR FISHWAYS
PURSUANT TO SECTION 18 OF THE FEDERAL POWER ACT

Submitted this 8th day of June, 2016
by:



Wendi Weber
Regional Director
U.S. Fish and Wildlife Service
United States Department of the Interior

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UNITED STATES DEPARTMENT OF THE INTERIOR

DECISION DOCUMENT

MODIFIED PRESCRIPTION FOR FISHWAYS

PURSUANT TO SECTION 18 OF THE FEDERAL POWER ACT

1. Introduction

The United States Department of the Interior (Department) through the U.S. Fish and Wildlife Service (Service) hereby submits its Modified Prescription for Fishways for the Conowingo Hydroelectric Project (Project, Conowingo, and Conowingo Project), FERC P-405, pursuant to Section 18 of the Federal Power Act (FPA). The Department is filing this Modified Prescription with the Federal Energy Regulatory Commission (Commission or FERC) with those portions of its supporting administrative record not already filed with the Commission under 43 C.F.R. part 45.

2. Administrative Process,

This Modified Prescription is the product of a process that began formally with the Department's response to the Commission's Ready for Environmental Analysis (REA) Notice on January 31, proposed to reserve her authority to prescribe fishways during the term of the license, presented several possible alternatives, and announced that if the Department subsequently amended that proposal to include measures in addition to the reservation of authority, the Service would provide the right to a trial-type hearing and accept proposals for alternatives at that time. The Department also made recommendations to the Commission under FPA Section 10(j), including a recommendation that the Commission include fishway terms consistent with the Department's Alternative G. On August 7, 2015, the Department withdrew that 10(j) recommendation, filed an Amended Preliminary Prescription proposing to require the construction, operation, and maintenance of fishways under Section 18 of the Federal Power Act, and providing time and opportunity for public comment and requests for trial-type hearing or formal presentation of alternatives under the 2005 Energy Policy Act and the Department's implementing regulations at 43 C.F.R. part 45. In response to that filing, on September 11, 2015, the license applicant, Exelon Generation Company, filed a request for Trial-Type Hearing and a proposed Alternative. American Rivers, the Chesapeake Bay Conservancy, and The Conservation Fund subsequently

intervened in the trial-type hearing process. This Modified Prescription for Fishways reflects the terms of a settlement agreement reached with the license applicant, Exelon Corporation, filed with the Commission on May 13, 2016, and is the conclusion of the Department's decision-making process.

3. Project Works

The Conowingo Hydroelectric Project (Figure 1) is located in Maryland on the Susquehanna River at river mile (RM) 10 with a total upstream drainage area of 27,500 square miles. Conowingo Dam is located in Maryland connecting Cecil and Harford Counties, as is the lowermost 6 miles of the Project impoundment (Conowingo Pond). The upper 8 miles of Conowingo Pond are located in Pennsylvania, within York and Lancaster Counties. Construction of the Project was completed in 1928, and consists of a main dam, a spillway, Conowingo Pond, an intake and powerhouse, two fish lifts constructed in 1972 (West Fish Lift) and 1991 (East Fish Lift), and other appurtenant facilities (Exelon 2012a, pp. A-2; E-79).

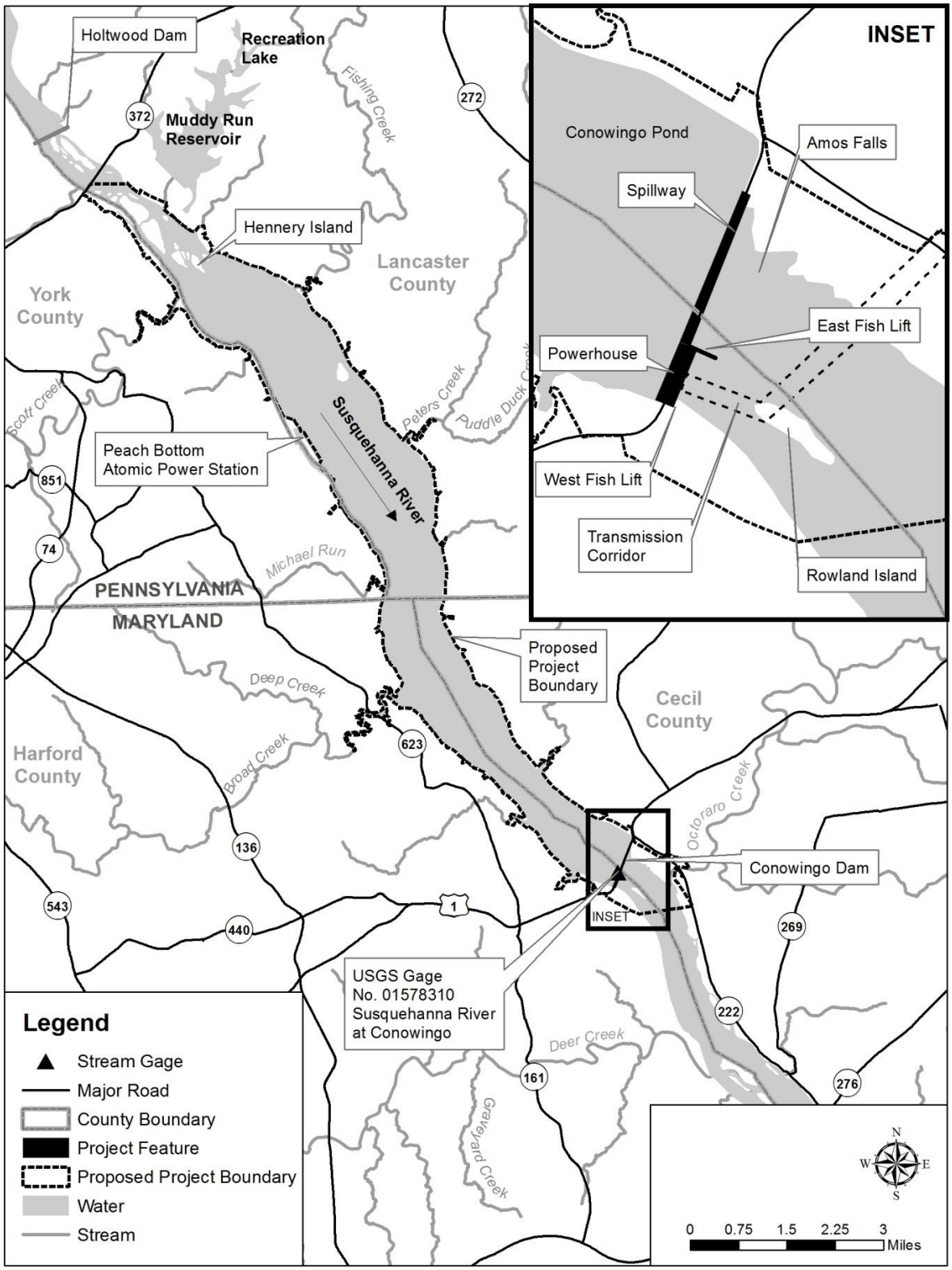

Figure 1. Conowingo Dam Project Area (FERC 2015, p. 37).

The Conowingo Dam is a concrete gravity dam with a maximum height of approximately 94 feet and a total length of 4,648 feet. The dam consists of four distinct sections from east to west: a 1,190-foot long non-overflow gravity section with an elevation of 115.7 feet; an ogee-shaped spillway, the major portion of which is 2,250 feet long with a crest elevation of 86.7 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. 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 US Highway Route 1, which passes over the top of Conowingo Dam. During the original construction, the entire dam was erected upon a solid rock formation of granite and diorite (Exelon 2012a, p. A-2).

In 1978, to increase the dam's capacity and upgrade the structure to meet stability requirements, the dam was anchored into the bedrock foundation by a post-tensioned anchorage system consisting of stranded wire tendons installed in holes drilled through the structure and continuing into the foundation rock. A total of 537 tendons were installed across the non-overflow, spillway and powerhouse intake monoliths (Exelon 2012a, p. A-2).

Flow over the Conowingo Dam ogee spillway sections is controlled by 50 stony-type crest gates with crest elevations of 86.7 feet and two regulating gates with crest elevations of 99.2 feet. Each of the crest gates is 22.5 feet high by 38 feet wide and has a collective discharge capacity of approximately 16,000 cfs at a reservoir elevation of 109.2 feet (Exelon 2012a, p. A-2).

The intakes for each turbine are individually protected by seven trash racks; five are made entirely of steel (clear spacing of 5.375 inches) and two are steel-framed with wood racks (clear spacing of 4.75 inches; Table 1). The top two racks are constructed of wood due to frazzle ice accumulations on the steel sections. The racks were previously cleaned by a stationary crane. However, a multi-purpose gantry crane was installed in 2007 and is now used as a trash rake (Exelon 2012a, p. A-4).

Table 1. Turbine intake structure characteristics at Conowingo Hydroelectric Project (Exelon 2012a, p. A-7).

Site Characteristic		Units 1-11 (Francis and Kaplan Units)	2 House Units
Intake Elevations	Top (ft.)	69.2	41.5
	Bottom (ft.)	11.2	25.7
Unit Intake Width (ft.)		23 per bay, 2 bays per unit	23
Unit Intake Area (sq. ft.)		1334 per bay, 2 bays per unit	361 1 bay for both units
Trash Rack Bars	Thickness (in)	0.625	0.5
	Height (in)	24	24
	Clear Spacing (in)	5.375	1.5

The first seven turbine/generating units (1-7) are completely enclosed within the powerhouse, while the last four units (8-11) are an outdoor type of construction thereby eliminating a superstructure in this area (Table 2). For Units 1-7, a 27-foot diameter butterfly valve is installed at the entrance to the scroll case. These valves are operated by oil pressure cylinders which are opened from a central oil pressure system, but are rarely used. Dewatering is performed by placement of headgates and stoplogs. The main power station superstructure enclosing Units 1-7 includes the generator room and the electrical bay. The electrical bay is located between the generator room and the powerhouse headworks and consists of the 13.8-kilovolt (kV) bus and switching equipment. Compartments for step-up transformers are located on the roof of the electrical bay, together with the station service control room and the main control room, from which windows afford a direct view of the generator room. For Units 8-11, there are no valves within the intake; unit dewatering is performed by placement of headgates and stoplogs. Generator circuit breakers and electrical equipment are located in a two-story structure between the generator area and the headworks. The main step-up transformers are located on the roof of

this structure (Exelon 2012a, p. A-4). Total hydroelectric station hydraulic discharge capacity for the Project is 86,000 cfs (Exelon 2012a, p. B-7).

Table 2. Turbine characteristics at the Conowingo Hydroelectric Project (Exelon 2012a, p. A-9).

Unit	Type	Rated Head (ft.)	Runner Speed (rpm)	Rated Output (hp)	Approx. Rated Discharge (cfs)
1	Francis	89	81.8	64,500	6,749
2	Francis	89	81.8	54,000	6,320
3	Francis	89	81.8	64,500	6,749
4	Francis	89	81.8	64,500	6,749
5	Francis	89	81.8	54,000	6,320
6	Francis	89	81.8	64,500	6,749
7	Francis	89	81.8	64,500	6,749
8	Mixed-Flow Kaplan	86	120	85,000	9,352
9	Mixed-Flow Kaplan	86	120	85,000	9,727
10	Mixed-Flow Kaplan	86	120	85,000	9,727
11	Mixed-Flow Kaplan	86	120	85,000	9,727
House #1	Francis	89	360	1,900	247
House #2	Francis	89	360	1,900	247

4. Resource Description

4.1 Susquehanna River

The Susquehanna River forms in upstate New York and west-central Pennsylvania and runs 444 miles from its headwaters in New York to the river mouth at Havre de Grace, Maryland (Figure 2). The Susquehanna River is the largest river that resides wholly within the United States that drains into the Atlantic Ocean, having a drainage area of over 27,500 square miles. It is the largest tributary to the Chesapeake Bay, providing 50 percent of the Bay's freshwater (SRBC 2013a, entire).

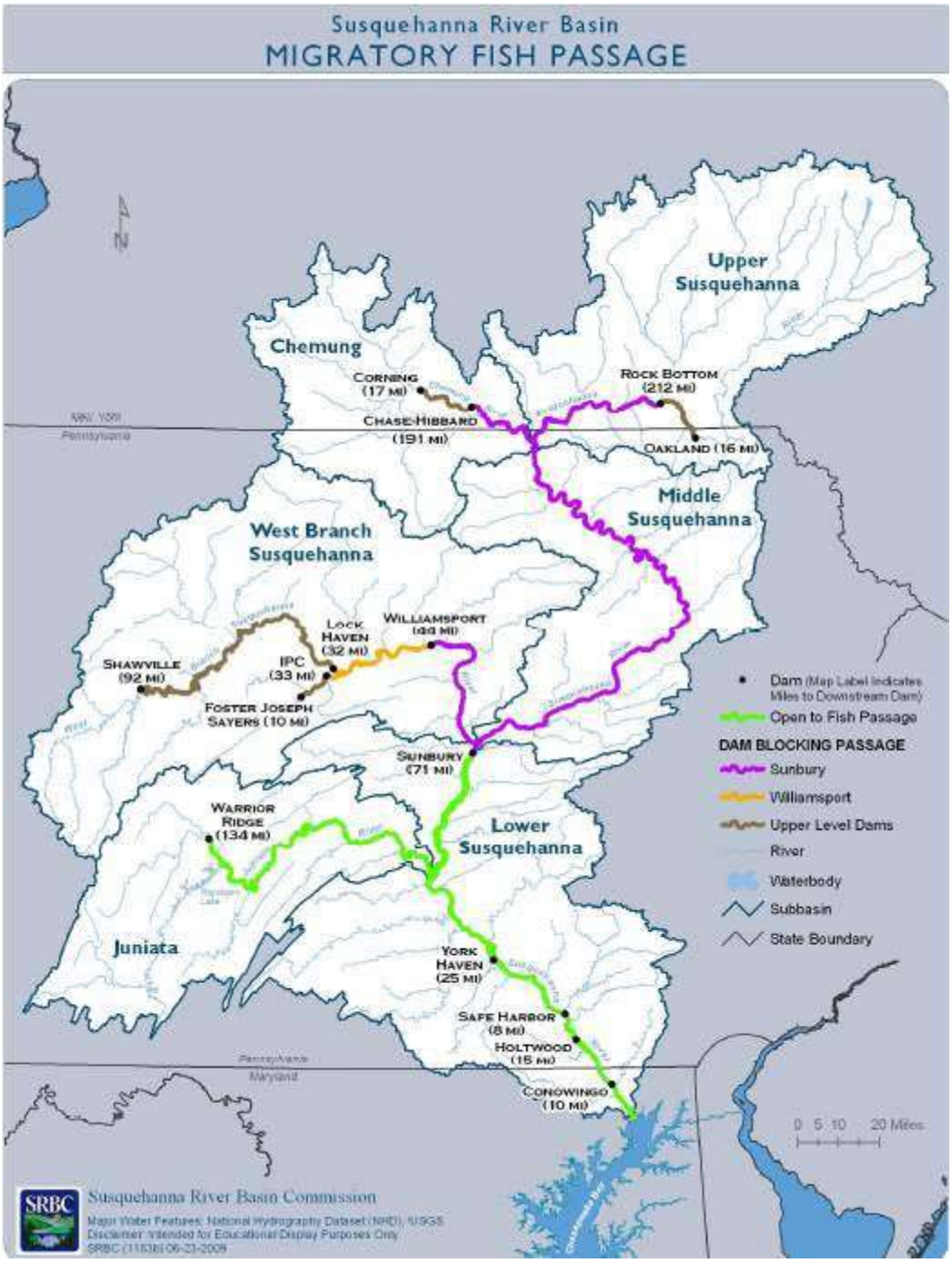

Figure 2. The Susquehanna River Basin, including locations of lower mainstem hydroelectric dams (SRAFRC 2010, p. 66).

4.1.1 History of Dam Construction on the Susquehanna River

Initial dam construction on the mainstem and large tributaries of the Susquehanna River began in the 1830s to feed the Susquehanna Canal system. Dams were located at Duncan's Island and

Columbia on the mainstem, as well as at Nanticoke on the North Branch and North Island on the Juniata River. The canal dams completely blocked migratory fish in some years, but allowed passage in others, particularly when the dams were damaged by ice flows. In 1866, fishways were required to be constructed at the dams, but ultimately were ineffective. By the end of the century, the canal system was abandoned, and breaks in the Columbia Dam on the lower mainstem re-opened a large portion of the river to migratory fish, with numbers rebounding until the early 1900s (SRAFRC 2010, p. 11).

At the turn of the 20th century, the lower mainstem of the Susquehanna River began to be developed to facilitate energy production. The size of this watershed and consistently large volume of water made the lower Susquehanna River an attractive reach for waterpower development, and for fossil and nuclear power plants that require large volumes of water for cooling. The generation capacity of all power projects on the lower Susquehanna River is over 8,000 MW (Table 3), including five hydroelectric, two atomic (nuclear), and one fossil (coal) generation plant (Figure 2).

Table 3. Energy development on the lower Susquehanna River in order of construction.

Project	**Capacity in 2013 (MW)**	**Year Building Started**	**Present ownership interest (100 percent unless stated otherwise)**
York Haven Hydro Project	19.6[a]	1901[a]	Cube Hydro Partners, LLC
Holtwood Hydro Project	234[b]	1905	Talen Energy
Conowingo Hydro Project	573[c]	1926[c]	Exelon
Safe Harbor Hydro Project	417.5[d]	1930[d]	Brookfield Renewable Energy Group
Brunner Island Power Plant	1490[e]	~1958[f]	Talen Energy
Muddy Run Pump Storage	1070[g]	1964[g]	Exelon
Three Mile Island Nuclear Plant	852[h]	1968[h]	Exelon – Unit 1
Peach Bottom Atomic Power Sta.	2490[i]	~1966	Exelon (50 percent) Public Service Enterprise Group Power (50 percent)
Wildcat Point (Proposed)	1000[j]	2014[k]	Old Dominion Electric Cooperative
Total Megawatts	8146.1		

a YHPC 2012. Exhibit A. p. 1.
b *https://www.pplenergyplus.com/large-business/products-and-services/renewable-energy/hydro* (accessed May 18, 2015)
c Exelon 2012a, pp. B-4, C-2.
d http://www.shwpc.com/facts_figures.html (accessed May 18, 2015)
e *http://www.pplweb.com/ppl-generation/ppl-brunner-island/ppl-brunnerisland-plant-fact-sheet.aspx* (accessed January 12, 2014)
f Construction start estimated; commercial operation began in 1961 according to reference at "e"

g Exelon 2012b, pp. A-5, C-2.
h *http://www.exeloncorp.com/assets/energy/powerplants/docs/TMI/fact_tmi.pdf* (accessed May 19, 2015)
i *http://www.exeloncorp.com/assets/energy/powerplants/docs/Peach_Bottom/Fact_PeachBottom.pdf (*accessed May 19, 2015)
j *http://www.odec.com/generation-transmission/future-generation* (accessed May 19, 2015)
k *http://wildcatpoint.com/news* (accessed May 19, 2015)

Construction of the lower mainstem hydroelectric dams began in 1901with the York Haven Dam at river mile (RM) 55. The York Haven Dam is a relatively low dam (9 – 18 feet high), which is operated as a run-of-river facility (FERC 2015, p. 32). The York Haven Hydroelectric Project is owned by Cube Hydro Partners, LLC, and is regulated by the FERC (FERC Project # 1888). The York Haven Hydroelectric Project was issued a 40-year license by FERC in December 2015.

The Holtwood Dam at RM 25 was the first of the high dams on the river, completed in 1910 and standing 55 feet high. During original construction, the Project included a fish ladder and a sluiceway to facilitate fish passage, but they were ineffective in passing American shad (SRAFRC 2010, p. 12). The Holtwood Hydroelectric Project is owned by PPL-Holtwood and is regulated by the FERC (FERC Project # 1881). The Holtwood Hydroelectric Project recently underwent redevelopment to increase generating capacity starting in 2010, and will be up for relicensing with FERC in 2030.

The Conowingo Dam at RM 10 was completed in 1928 and had no fish passage facilities included with initial construction (SRAFRC 2010, p. 12). Additional details on the Conowingo Dam are provided in Section 3.

The Safe Harbor Dam at RM 33 was completed in 1931. That dam is 75 feet high and did not have fish passage facilities installed during the original construction (SRAFRC 2010, p. 12). The Safe Harbor Hydroelectric Project is owned by Brookfield Renewable Energy Group and is regulated by the FERC (FERC Project #1025). The Safe Harbor Hydroelectric Project will be up for relicensing with FERC in 2030.

Muddy Run Pumped Storage Project (MRPSP) at RM 22 was constructed in 1966. This is a pumped storage facility on the eastern bank of Conowingo Pond that has the capacity to

withdraw water up to 28,000 cfs from the Susquehanna River into a 198-acre power reservoir (pond) (Exelon 2012b, pp. A-6, A-7). The Project can discharge 32,000 cfs (Exelon 2012b, p. A-6). The MRPSP is owned by Exelon Corporation and is regulated by FERC (FERC Project # 2355). The MRPSP was issued a 40-year license by FERC in December 2015.

4.2 Migratory Fish of the Susquehanna River Basin

Historically, the Susquehanna River was accessible via the Chesapeake Bay to several species of sea-run migratory fish from the Mid-Atlantic coast. Migratory fish generally can be classified as either "anadromous" or "catadromous." Adult anadromous fish live in the ocean and migrate to freshwater rivers to spawn. Juvenile anadromous fish stay in freshwater habitats for several months or more before they return to the ocean and grow to maturity. Catadromy is the reverse of anadromy. Catadromous fish spend a large portion of their life in freshwater systems and migrate to the ocean to spawn. Juvenile catadromous fish migrate from the ocean to estuarine and freshwater systems to grow to maturity. Of the sea-run migratory fish present in the Susquehanna River, striped bass (*Morone saxatilis*), Atlantic sturgeon (*Acipenser oxyrinchus*), shortnose sturgeon (*A. brevirostrum*), sea lamprey (*Petromyzon marinus*), American shad (*Alosa sapidissima*), hickory shad (*A. mediocris*), alewife (*A. pseudoharengus*), and blueback herring (*A. aestivalis*) are anadromous and the American eel (*Anguilla rostrata*) is catadromous (SRAFRC 2010, p. 5; Li et al. 2014, p. 614).

Although the lower Susquehanna River continues to support several species of sea-run migratory fish, this document focuses on the American shad, river herring (collective term for alewife and blueback herring) and American eel, all of which historically used a substantial portion of the watershed for spawning and nursery habitat (SRAFRC 2010, pp. 7-10). Before the construction of the mainstem dams, these species ascended the Susquehanna River several hundred miles upstream into the West and North Branches (SRAFRC 2010, p. 7). Construction of canal dams on the Susquehanna River in the mid-1800s restricted access to historic spawning grounds for American shad and river herring, but the construction of the four large, hydroelectric dams on the lower mainstem river in the early 1900s eliminated access to nearly all of the spawning habitat and nursery habitat in the Susquehanna River (Dittman et al. 2009, p. 17; SRAFRC 2010, p. 12).

4.2.1 American Shad and River Herring

American shad and river herring are schooling fish that spend the majority of their life in the ocean but ascend their natal Atlantic coast freshwater rivers to spawn in the spring (Fay et al., 1983, p. 5; MacKenzie et al. 1985, pp. 5-6). Juveniles remain in freshwater rivers until fall before migrating back to sea, where they will remain until reaching maturity (Fay et al., 1983, p. 9; MacKenzie et al. 1985, p. 5). American shad typically take 3 to 6 years to mature and river herring take 3 years, with repeat spawning occurring in both species (Fay et al., 1983, p. 5; MacKenzie et al. 1985, pp. 4-5).

Anadromous species such as American shad and river herring are important links in the food chains for freshwater and ocean ecosystems. In freshwater, adults bring nutrients from the marine environment into the freshwater reaches of Atlantic coast tributaries (Garman and Macko 1998, p. 277). In addition, juvenile American shad and river herring can be important seasonal prey items for riverine predatory fish, such as largemouth bass (*Micropterus salmoides*) and smallmouth bass (*M. dolomieu*) (Yako et al. 1998, p. 77; Hanson and Curry 2005, p. 361). As part of the Atlantic coastal food chain, juvenile and adult American shad and river herring consume zooplankton and serve as prey for popular commercial and recreational fish, such as striped bass, fish-eating birds and aquatic mammals (ASMFC 2009, p. 14).

American shad and river herring historically supported substantial river fisheries along the Atlantic coast and played an important role in the history and economy of the Susquehanna River (SRAFRC 2010, pp. 6–9). Their annual spring runs supported one of the oldest fisheries in the United States with spawning areas for American shad occurring as far inland as Binghamton, New York, 318 miles from the river mouth (SRAFRC 2010, p. 7).

Native Americans along the Susquehanna River relied on fish as a substantial component of their diet and caught American shad in large quantities long before European colonists arrived in North America. In the latter half of the 18th century, colonists from Connecticut settled in the Wyoming Valley (Scranton/Wilkes-Barre area) and established commercial and subsistence fisheries for American shad. American shad were a dietary staple and an integral part of the local economy. The fisheries in the North Branch (Susquehanna River upstream of its

confluence with the West Branch at Northumberland, Pennsylvania) were economically valuable and abundant. Historical seine hauls near Northumberland would regularly catch at least 300 shad, some hauls taking 3,000 to 5,000. Nearly 10,000 shad were taken in a single haul at the Fish Island site. The annual commercial value of the North Branch shad fisheries in 1881 was estimated at $12,000[1] with an estimated catch of 150,000 fish. Commercial fisheries were also reported from the West Branch Susquehanna River and from the Juniata River. In addition, many American shad seine fisheries occurred on the lower Susquehanna in Pennsylvania and Maryland during the early decades of the 1800s (SRAFRC 2010, pp. 7-8). Fisheries continued in the river through the early 1900s with Pennsylvania reporting landings from 200,000 – 400,000 pounds annually. After 1910, these landings declined by two-thirds, concurrent with the initial construction of the mainstem dams and use of pound nets to intercept fish in the upper Chesapeake Bay (SRAFRC 2010, pp. 8, 12).

Less is known about historical abundance and use of the Susquehanna River by river herring, but historical accounts indicate they were abundant. While river herring may have spawned far upriver (i.e. Binghamton, New York), the river herring fishery on the Susquehanna River was largely confined to the lower river. Indications of large river herring runs may be found in Pennsylvania State Fishery Reports from around 1900. The reports indicate that many thousands of river herring were harvested, and that the fishery in the Susquehanna River far surpassed the fishery in the Delaware River (SRAFRC 2010, p. 8).

4.2.2 American Eel

American eels along the Atlantic coast of North America are panmictic, meaning that the entire coastal population spawns in one location in the ocean and young are distributed randomly along coastal currents until they reach estuaries and coastal rivers (i.e. they do not necessarily return to the river of their parent's origin; ASMFC 2012a, p. 6). Once young American eels reach the coast, they begin upstream migrations of varying distances. Some American eels will remain in estuaries until they reach maturity, which may occur as early as 3 to 5 years of age. Other young American eels will migrate upstream into freshwater rivers, some traveling hundreds of miles

[1] Referenced in 1881 dollars, would be equivalent to $290,000 in 2014 dollars (http://www.westegg.com/inflation/ last accessed June 1, 2015). Throughout the following discussion, dollar figures are given in the number of dollars spent in the years mentioned, not adjusted to 2014 dollars.

upstream and taking several years to complete the migration. Age at maturity in freshwater areas is highly variable, but it is not uncommon for American eels to be 15 years or older before reaching maturity in far upstream reaches of coastal rivers (ASMFC 2012a, p. 11). American eels in freshwater areas tend to be larger than their estuarine counterparts. In addition, far upstream freshwater reaches of rivers produce only female eels, which are much larger and more fecund than those found in estuaries (ASMFC 2012a, pp. 10, 14). Once American eels reach maturity, they begin their downstream migrations in rivers and estuaries. Maturity typically occurs during late summer through winter, although spring migration has been documented (ASMFC 2012a, p. 132; Eyler 2014, p. 38). American eels spawn in the Sargasso Sea in late winter and early spring and once spawning is completed, the adults die.

American eels play a valuable role in the freshwater river ecosystem, comprising more than 35 percent of the fish biomass in some freshwater streams (Odgen 1970, p. 54). As young eels, they migrate upstream in rivers in large schools and serve as a food source for predatory fish and birds. As American eels grow, especially in freshwater reaches, they begin feeding on aquatic insects, crayfish, and small fish (ASMFC 2012a, pp. 14-15). American eels are also an important host species for successful freshwater mussel reproduction (Lellis et al. 2013, p. 75) and the loss of American eels from freshwater habitats has been linked to reduced mussel populations in Susquehanna River tributaries (Minkkinen et al. 2014, entire). Freshwater mussels, as filter feeders, have the potential to reduce suspended solids and dissolved nutrients from a river system (Vaughn 2010, p. 28; Atkinson et al. 2013, entire).

American eels were once abundant throughout the Susquehanna River, historically reaching the headwaters of the Susquehanna River and tributaries (Dittman et al. 2009, pp. 15-17; SRAFRC 2010, p. 9). Native Americans historically fished and consumed American eels from watersheds as far upstream as Otsego Lake in Cooperstown, New York (Dittman et al. 2009, p. 15). A commercial fishery centered on American eels also occurred in the Susquehanna River basin during the late 1800s and early 1900s (SRAFRC 2010, p. 9). Landings of American eel from the Susquehanna River averaged 150,000 pounds per year from 1909–1912 (SRAFRC 2010, p. 10). Construction of the mainstem dams in the early 1900s precluded juvenile eels from accessing the majority of the Susquehanna River basin and eventually eliminated the in-river fishery upstream

of Conowingo Dam (Dittman et al. 2009, p. 19; SRAFRC 2010, p. 12).

4.2.3 Impacts of Dams on Fish Migrations

Migratory fish have evolved to require specific conditions in river systems and the relatively recent alteration to many river systems by the construction of dams and other impacts has negatively affected migratory fish populations. Dams can impact both upstream and downstream fish migration in river systems (Limburg and Waldman 2009, pp 961). Dams not only block or impede fish migration, but also alter the hydrology and aquatic habitat in the river. Upstream of dams, where water flow is slowed, lake-like conditions, rather than riverine ones, prevail. Water flow downstream of dams, particularly at peaking hydroelectric projects, can be significantly altered (Limburg and Waldman 2009, p. 961) with drastic changes in water depth and velocity occurring over short time periods. Depending on the severity and location of blockages and changes to hydrology, migratory fish populations can be severely reduced or extirpated due to dam impacts (Limburg and Waldman 2009, p. 960).

4.2.3.1 Environmental Factors Associated with Fish Migrations

Migratory fish respond to environmental stimuli (e.g., light, temperature, day length, visual cues, sound, flow) to determine when and to what extent to migrate upstream or downstream (Loesch 1987, p. 90; MacKenzie et al. 1985, p. 5; Eyler 2014, p. 63). Primary cues for upstream migration of American shad, river herring, and American eels are freshwater flow and water temperature (Leggett and Whitney 1972, p. 659; Welsh and Liller 2013, p. 483; Ristroph et al. 2015, p. 1). When appropriate conditions exist, fish swim upstream against the current to reach spawning and juvenile rearing habitat (Walburg and Nichols 1967, p. 4; Welsh and Liller 2013, p. 483). In addition to environmental stimuli, the physiological condition of fish (e.g., sexual maturation) elicits a response to begin the spawning migration (Northcote 1998, p.5). For anadromous fish, the spawning migration is a result of fish seeking freshwater spawning habitat typically within their natal watershed (Walburg and Nichols 1967, p. 4; Loesch 1987, p. 89). For catadromous fish, the spawning migration culminates in the maturing fish, which entered a stream as juveniles to live and grow, leaving the freshwater watershed to spawn in the ocean (ASMFC 2012a, p. 10).

4.2.3.2 Impacts to Upstream Migration

American shad and river herring migrate upstream as adults and American eels migrate upstream as juveniles. The different species of fish have different swimming capabilities, with juvenile American eels having slower relative swimming speeds when compared to the adult American shad and river herring (Bell 1991, pp. 6.3–6.4). High water velocities, created by both natural flood flows and project related discharge may prevent fish from successfully migrating upstream to and past fishways in a timely manner (Haro et al. 2004, p. 1590). Conversely, both naturally occurring and project induced slow water velocities may not elicit an upstream migratory response (Bailey et al. 2004, p. 306), resulting in fish staying in downstream areas that may not be suitable or sufficiently sized spawning or nursery habitat.

4.2.3.3 Impacts to Downstream Migration

For downstream migration, fish respond to river flow and migrate past dams via different routes, including over dam spillways, down bypass channels, and through hydroelectric turbines (Kynard and O'Leary 1993, p. 785; Castro-Santos and Haro 2003, p. 994; Jansen et al. 2007, p. 1442). At hydroelectric dams, large volumes of water can direct out-migrating fish into potential hazards while they attempt to pass the project. Fish may be injured or killed via entrainment through a turbine, discharge through a gate with no adequate plunge pool, impingement on screens and racks, and trauma due to changes in barometric pressure (barotrauma). Mortality caused by passing downstream through turbines at hydroelectric projects can vary greatly depending on species, size, and life stage (adult or juvenile) of fish (e.g., 12 percent mortality for American shad, Heisey et al. 2008, pp. 7-8; 100 percent mortality for American eel, Carr and Whoriskey 2008, p. 393), as well as on turbine design, including turbine flow, tip speed, rotational speed, number of blades/buckets, blade spacing, and runner diameter (Franke et al. 1997; Section 4, p. 6). Also, barotrauma, such as the expansion and rupture of a fish's swim bladder, can cause mortality even if the fish is not injured by a strike from turbine blades (Brown et al. 2014, entire).

4.3 Migratory Fish Restoration Efforts on the Susquehanna River

4.3.1 Early Efforts by State and Federal Resource Agencies

Fish passage efforts in the Susquehanna River began as early as 1866, when the Pennsylvania Legislature passed an act requiring fish passage facilities to be constructed at dams. The fishways constructed in the latter part of the 1800s were largely ineffective in passing migratory fish, but enough fish passed by way of temporary dam breaches caused by ice damage to create optimism for the success of fish passage measures (SRAFRC 2010, p. 11).

The Holtwood Dam, the first of the high dams constructed on the river, had a primitive fish passage device that failed to pass American shad. When Conowingo Dam was being built in the mid-1920s, U. S. Commissioner of Fisheries O'Malley advised the Federal Power Commission (FPC) that "none of the fishways now constructed would be useful in assisting eels or fishes to pass over a dam 100 feet high" and "it is very doubtful that shad would ascend a fishway of any description or any height" (Joint State Government Commission 1949; pg. 42). Thus, with completion of the Conowingo Project in 1928, the Susquehanna River was closed to runs of migratory fishes (St. Pierre 2002, p. 1).

Technology in fishway design improved, and by the 1940s successful passage of American shad was demonstrated at Bonneville Dam on the Columbia River. With the urging of sportsmen, the Pennsylvania Fish Commission (PFC) and the Joint State Government Commission requested that the 1947 Session of the General Assembly of Pennsylvania ask the Congress of the United States to fund studies regarding the biological and engineering feasibility of constructing fish passage facilities at Susquehanna River dams. In response to a Congressional request on this matter, the Service offered several recommendations to Pennsylvania. These included development of an interstate agreement with Maryland to regulate the fisheries, stocking of tagged adult American shad upstream of dams, and assessment of mortality of adult and juvenile American shad passing through turbines (St. Pierre 2002, p. 1).

Pursuant to a bill passed by the 81st Congress, the Service initiated a 6-year study of American shad fisheries of the Atlantic coast in March, 1950. In 1951, the Pennsylvania Legislature passed Bill No. 68 which authorized the PFC to make a comprehensive study of the migratory habits of

American shad, including the stocking and tagging of American shad upstream and downstream of Safe Harbor Dam. The Service was asked to cooperate and provided a project leader to oversee the effort (St. Pierre 2002, p. 2).

Results of this 1952 study led to a more detailed Susquehanna Fishery Study in 1957-1960, sponsored by Philadelphia Electric Company (PECO). The purpose of this $75,000 effort was to determine the desirability and feasibility of passing American shad and other migratory fishes at Conowingo Dam. The Advisory Committee guiding this study was represented by Maryland Department of Research and Education, PFC, and PECO, and technical support was provided by fishery experts from the U. S. and Canada. Based on results from this study, the Advisory Committee concluded that fish passage at Conowingo Dam would not be expected to substantially increase the numbers of American shad or other migratory fish in the Susquehanna River, assuming fish passage was not provided at the remaining upstream mainstem dams (Whitney et al., 1961, p. 2; St. Pierre 2002, p. 2).

Simultaneous with the Susquehanna Fishery Study, a “grass roots” coalition in Pennsylvania was pressuring the U. S. Commissioner of Fisheries and the Secretary of the Interior to petition the FPC to require fish passage at Susquehanna River dams. Though the state PFC and organized sportsmen groups were supportive, this effort was largely sustained by Basse Beck, a newspaperman with the Sunbury Daily Item and spokesman for the Susquehanna Economic Development Association. In response to Beck's insistence, and with support and advice from the Service, the PFC hired consultants to conduct engineering and biological studies of proposed fish passage at dams on the Susquehanna River (St. Pierre 2002, p. 2).

The consultants concluded that development of fish passage facilities at Susquehanna River dams was feasible, and that if properly designed and built, they would pass American shad and American eels which approached the dams. However, the authors recommended that prior to construction of major facilities, a step-wise restoration program should be undertaken. This would include an evaluation of “the present and future suitability of the river to support runs of migratory fishes” and, “trapping of adult fish at Conowingo Dam and transporting them by tank

truck to the area upstream of dams for propagation" (Bell and Holmes 1962, pg. 5; St. Pierre 2002, p. 2).

In October, 1962, the PFC again petitioned the Secretary of the Interior to ask the FPC to require fish passage at Conowingo Dam. In view of recommendations in the PFC report, however, the Commissioner of the Fish and Wildlife Service directed the drafting of a study proposal to resolve the question of suitability of the river to support American shad (St. Pierre 2002, p. 3).

On February 8, 1963, representatives of the Service, PFC, and the Maryland Board of Natural Resources initiated development of a 3-year study, funded by the utility companies and conducted by a team led by Service biologist Frank Carlson. The New York Department of Environmental Conservation (NYSDEC) was also a partner in this effort. Oversight and policy decisions were provided by the four-member Administrative Committee for Susquehanna Shad Studies and each agency contributed staff to a Technical Committee assigned to work directly with Carlson (St. Pierre 2002, p. 3).

The suitability study was conducted between 1963 and 1966 at a cost of about $196,000. Based on study findings, the Administrative Committee concluded that about 350 miles of the mainstem Susquehanna River and major tributaries provided suitable habitat for American shad spawning and juvenile development. However, the Administrative Committee also recognized that "there is not sufficient information to permit decision as to whether or not adult shad with a strong urge to migrate upstream are available, whether or not the designed fishways would in fact attract fish, or whether or not adults would move efficiently upstream through the reservoirs" (Administrative Committee 1968, p. 3; St. Pierre 2002, p. 3).

In an effort to move ahead in responding to concerns expressed by the Administrative Committee, representatives from Pennsylvania, Maryland, and New York met with the Service in Washington, D. C. on May 6, 1969. A cooperative state-federal partnership was established with objectives of restocking the upper basin with American shad eggs and encouraging PECO to build a trap and lift at Conowingo Dam. This group named itself the Susquehanna Shad

Advisory Committee (SSAC) and established a technical subcommittee to provide scientific guidance (St. Pierre 2002, p. 4).

Throughout 1969 and early 1970, the SSAC met eight times with utility representatives. On September 29, 1970, a 5-year settlement agreement was reached with the utility companies whereby upstream licensees agreed to fund a program to collect and stock up to 50 million American shad eggs each year, and PECO agreed to build an experimental fish collecting device at the west side of Conowingo Dam. This device was largely designed by Service engineers and built by Arundel Corporation. Initially budgeted at $500,000, by the time the completed facility became operational in spring, 1972, it had actually cost over $1,000,000 (Settlement Agreement 1970, p. 3; St. Pierre 2002, p. 4).

The Conowingo trap was an effective device, collecting an average of over 1 million fish per year. During the period 1972–1976, in addition to collecting over 650 American shad, the facility captured nearly 875,000 blueback herring, 177,000 alewives, 1,300 hickory shad, and 380,000 American eels (Robbins 1972, pp. 9-10; Foote and Robbins 1973, pp. 7, 15, 19; Buchanan and Robbins 1974, pp 6, 12, 16; Buchanan 1975, pp. 13-14; Kotkas & McGhan 1976, pp. 7, 18). Numbers of this magnitude for these species have rarely been equaled since. American shad culture studies were conducted by the PFC, Service, and Maryland Department of Natural Resources (MDNR) during 1974–1976. It was determined that intensive culture and release of larval American shad would greatly enhance probability of future adult returns, as opposed to continued egg plants. A dedicated American shad hatchery was built with utility funding on PFC property (Van Dyke) along the Juniata River near Thompsontown, Pennsylvania in 1976 (St. Pierre 2002, p. 4).

Also in 1976, SSAC reorganized by adding voting representation from the National Marine Fisheries Service (NMFS) and the hydroelectric project owners (one vote for PECO and one for the three upstream licensees). This seven-member group was renamed Susquehanna River Anadromous Fish Restoration Committee (SRAFRC) in recognition that all migratory fish were targets of restoration in the program. The 5-year agreement from 1970 was annually extended during 1976 through 1980 (Settlement Agreement 1970, p. 3; St. Pierre 2002, p. 5).

Long-term operating licenses for the Susquehanna River hydroelectric projects were scheduled for renewal in different years, complicating resource agency efforts to condition individual licenses to include provisions for fish passage. The Department successfully petitioned the Federal Energy Regulatory Commission (FERC - formerly Federal Power Commission) to combine relicensing for the four projects. Pending receipt of comments from interested agencies on the subject of American shad restoration and fish passage, FERC issued and renewed one-year licenses to each project during 1976–1979 (St. Pierre 2002, p. 5).

In 1979, the Service established a Susquehanna River coordinator position in Harrisburg, Pennsylvania and a Strategic Plan for Restoration of Diadromous Fishes to the Susquehanna River was developed and adopted by state and federal resource agencies. Components of this plan were also included in the Susquehanna River Basin Commission's (SRBC) Comprehensive Plan for management of the basin (St. Pierre 2002, p. 5).

4.3.2 FERC Licensing Process in the 1980s and 1990s

Ultimately, no agreement over fishways was reached and FERC issued long-term licenses for the Projects in August 1980. Issues related to American shad restoration, fish passage, and flow requirements were set aside for hearing. Seven organizations intervened, including the Department, PFC, MDNR, SRBC, Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Federation of Sportsmen’s Clubs, and the Upper Chesapeake Watershed Association. The Department provided a lead counsel role (St. Pierre 2002, p. 5).

Following a year of discovery and preparation of testimony, hearings were conducted before a FERC hearing officer in Washington D.C. between October, 1981 and February, 1982. This first phase hearing (Docket EL80-38) was restricted to American shad restoration requirements with flow issues being deferred. Over 10,000 pages of testimony and hearing record were developed. Parties were again urged to negotiate a settlement rather than rely on the hearing officer and FERC to dictate restoration conditions (St. Pierre 2002, pp. 5-6).

As part of their license renewal, owners of the Safe Harbor Project sought to expand the powerhouse by adding five large new units. The PFC and SRBC threatened to delay such expansion through legal actions since the American shad restoration questions remained unresolved. To avoid such delays, Safe Harbor Water Power Corporation (owned by Baltimore Gas and Electric and Pennsylvania Power and Light) settled the matter in an agreement which provided $750,000 for SRAFRC-approved restoration activities during 1981–1985 (Settlement Agreement 1981, p. 4; St. Pierre 2002, p. 6).

With FERC failing to take any action on the hearing record and funding from the 1981 settlement with Safe Harbor being exhausted within 4 years, negotiations continued between interveners and three upstream licensees. Finally, in December, 1984 a long-term settlement was reached (Table 4; Settlement Agreement 1984). This agreement provided, among other things, $3,700,000 over the 10-year period 1985–1994 to fund SRAFRC-approved studies related to American shad restoration. Licensees also agreed to resolve outstanding issues related to design and construction of fish passage facilities at Holtwood, Safe Harbor, and York Haven projects once PECO agreed to construct passage facilities at Conowingo Dam. SRAFRC was expanded to include representatives from each of the upstream licensees and the SRBC, and NMFS assumed a liaison role to the committee. FERC approved this settlement in April, 1985 (St. Pierre 2002, p. 6).

Separate settlement talks continued sporadically with PECO. To show commitment to the restoration effort, PECO continued to fund trap and transport operations at the Conowingo fish lift throughout the early 1980s. In addition to the fish passage issue, resource agency interveners pressed FERC for establishment of continuous minimum flows from the Conowingo Project to avoid fish kills and to improve habitat conditions downstream of the dam (St. Pierre 2002, p. 6).

Table 4. Settlement agreements addressing fish passage issues at the Susquehanna River lower mainstem hydropower projects.

Year	Parties	Projects	Primary Topics
1970	• Pennsylvania Power & Light Company • Philadelphia Electric Power Company • The Susquehanna Power Company • Metropolitan Edison Company • Safe Harbor Water Power Corporation • U.S. Fish & Wildlife Service • Pennsylvania Fish Commission • Maryland Department of Natural Resources • New York Department of Environmental Conservation	• Conowingo • Holtwood • Safe Harbor • York Haven	• PP&L to construct an experimental fish trapping device to be operated for 5 years at Conowingo Dam (operating by 1971) • Trap and transport operations to be conducted by PEPCO and SPCO • PP&L, SHWPC, and MetEd will collect and stock 50 million fertilized American shad eggs into the Susquehanna River for 5 years
1981	• Pennsylvania Power & Light Company • Safe Harbor Water Power Corporation • Pennsylvania Fish Commission • Susquehanna River Basin Commission	• Holtwood • Safe Harbor	• Requires minimum flow releases, lake level elevations, and water quality to be maintained at the Safe Harbor hydroelectric project • Licensees to pay $750,000 to SRAFRC for fish restoration activities • Licensees will construct fish passage facilities at the Safe Harbor and Holtwood hydroelectric projects at a future date
1984	• Pennsylvania Power & Light Company • Safe Harbor Water Power Corporation • York Haven Power Company • U.S. Fish & Wildlife Service • Pennsylvania Fish Commission • Susquehanna River Basin Commission • Maryland Department of Natural Resources • Pennsylvania Department of Environmental Resources • Upper Chesapeake Watershed Association • Pennsylvania Federation of Sportsmen's Clubs	• Holtwood • Safe Harbor • York Haven	• Resolves issues with fish passage for 1980 re-licensing for Holtwood, Safe Harbor and York Haven hydroelectric projects • Upstream licensees will contribute a total of $3.7 million from 1985 to 1995 toward studies and restoration efforts (including trap and truck and hatchery efforts) to determine if anadromous fish can be restored to the Susquehanna River

Table 4. Continued.

Year	Parties	Projects	Primary Topics
1988	• Philadelphia Electric Power Company • The Susquehanna Power Company • U.S. Fish & Wildlife Service • Pennsylvania Fish Commission • Susquehanna River Basin Commission • Maryland Department of Natural Resources • Pennsylvania Department of Environmental Resources • Upper Chesapeake Watershed Association • Pennsylvania Federation of Sportsmen's Clubs	• Conowingo	• Resolves issues with fish passage for 1980 re-licensing for the Conowingo hydroelectric project • Established seasonal minimum flows and dissolved oxygen criterion for the area downstream of Conowingo Dam • Conduct survival studies of juvenile American shad at Conowingo Dam • Installation of fish passage at Conowingo Dam capable of passing fish directly into Conowingo Pond • Continue to fund upstream trap and transport for American shad until the new upstream fish passage facility is operational • Establishment of the Susquehanna River Technical Committee to provide guidance for fish passage evaluation and modifications
1993	• Pennsylvania Power & Light Company • Safe Harbor Water Power Corporation • York Haven Power Company • U.S. Fish & Wildlife Service • Pennsylvania Fish & Boat Commission • Susquehanna River Basin Commission • Maryland Department of Natural Resources • Pennsylvania Department of Environmental Resources • Upper Chesapeake Watershed Association • Pennsylvania Federation of Sportsmen's Clubs	• Holtwood • Safe Harbor • York Haven	• Install spillway and powerhouse fish lifts at Holtwood Dam by 1997 • Install fish lift on west side of Safe Harbor Dam powerhouse by 1997 • Install a fish lift at the York Haven Dam powerhouse by 2000 • Establishment of Fish Passage Technical Advisory Committees at each project • Continue to fund egg collection and hatchery operations as well as upstream trap and transport of American shad from Conowingo Dam until installation of fish passage facilities is completed • Monitoring of upstream migration and downstream migration and survival at each project

Table 4. Continued.

Year	Parties	Projects	Primary Topics
1997	• York Haven Power Company • Pennsylvania Department of Environmental Protection • Pennsylvania Fish & Boat Commission • Maryland Department of Natural Resources • U.S. Fish & Wildlife Service • Susquehanna River Basin Commission	• York Haven	• Modification of the 1993 agreement for fish passage (change location and type of fishway) • Install fish ladder on the East Channel Dam by 2000 (capacity of 500,000 American shad equivalents annually) • Provide attraction flow to the fishway and minimize spill at the main dam during low flow periods to facilitate fish passage • Conduct studies to evaluate upstream American shad passage
2014	• York Haven Power Company, LLC • U.S. Fish & Wildlife Service • Pennsylvania Fish & Boat Commission • Maryland Department of Natural Resources • Susquehanna River Basin Commission	• York Haven	• Construction of nature-like fishway by 2021 • Operation of sluice gate for downstream passage of juvenile American shad • Studies to monitor upstream and downstream migration and survival of American shad • Contribute $75,000 toward downstream American eel study and monitor passage at York Haven Dam
2015	• Exelon Generation Co., LLC • U.S. Fish & Wildlife Service	• Muddy Run	• Contribute $75,000 toward downstream American eel study and monitor passage at the Muddy Run Pumped Storage Facility • Design American shad trap and truck facility at Conowingo Dam • Monitoring radio telemetered fish passing their facility as part of studies being conducted by other facilities

A FERC hearing was held in 1984 on the flow issue. The hearing officer was persuaded by the Licensee's plan for a multi-year biological assessment under different test flow regimes to determine what, if any, continuous release was needed. However, the full Commission reversed this decision in 1987 in favor of interveners, requiring an analysis technique designed and used by the Service called Instream Flow Incremental Methodology. FERC also required design and construction of an interim $4,000,000 trap and lift at the east end of the Conowingo powerhouse to supplement American shad collections at the existing west bank facility. A new committee called the Susquehanna River Technical Committee was established to oversee all flow and fish passage issues at Conowingo. Members included PECO, Service, PFC, MDNR, and SRBC with FERC serving as liaison (St. Pierre 2002, p. 7).

In light of this decision, PECO approached MDNR to work out a final solution on all issues related to continuous flows, water quality improvements in the Conowingo discharge and fish passage. A comprehensive settlement was reached with all interveners by the end of 1988 (Table 4; Settlement Agreement 1988). This included a minimum release schedule of up to 15,000 cfs during spring months, tapering to 5,000 cfs during summer and 3,500 cfs during winter months with a 3-year test of the need to continue winter releases. PECO also agreed to add turbine venting and, if needed, oxygen injection to meet Maryland's dissolved oxygen standard of 5 ppm in the Conowingo discharge (St. Pierre 2002, p. 7). Finally, rather than building another interim trapping device as suggested by FERC, PECO chose to construct a fish lift at the east end of the powerhouse capable of handling 750,000 American shad and 5 million river herring. This facility was designed to accommodate twice this capacity with future addition of a second lift hopper (Reid and Priest 1989, p. 2; MDNR 1988, p.1). The addition of the second hopper at the East Fish Lift (EFL) as well as a rebuild of the West Fish Lift (WFL) to make a lift structure was to be implemented once the capacity was reached at the EFL (Reid and Priest 1989, entire). With FERC approval of the settlement, the EFL was built in 1990 at a cost of $12,000,000 and began operation in April, 1991. This commitment for upstream fish passage at Conowingo triggered action in the upstream licensees' 1984 agreement whereby they were now required to initiate design of passage facilities for the upstream hydroelectric projects (St. Pierre 2002, p. 7).

The new EFL initially served as a collection facility for interim trap and transport operations until upstream fish passage facilities were constructed at the remaining mainstem dams. Annual costs associated with trap and transport of American shad and river herring from Conowingo Dam were covered by the three upstream hydroelectric dam owners/operators as a component of their 1984 agreement with the resource agencies (SRAFRC 2010, p. 15). Upstream licensees were responsible for trapping and transporting adult American shad to spawning waters upstream of York Haven until their fish passage facilities were operational.

On October 1, 1992, licensees of the three upstream hydroelectric projects met with intervener resource agencies and private groups and reached an Agreement in Principle to design, model-test, construct, and operate fish passage facilities at Holtwood, Safe Harbor, and York Haven dams. Target dates for commencement of operations were April 1, 1997 for Holtwood and Safe Harbor fish lifts. The York Haven passage facility (ultimately a vertical slot fish ladder) was to be operational within 3 years thereafter. A settlement agreement with these provisions was signed in Harrisburg on June 1, 1993 (Table 4; Settlement Agreement 1993, entire; St. Pierre 2002, p. 8).

In 1997, resource agencies and York Haven Power Company (YHPC) owner General Public Utilities-Genco reached a further agreement regarding fish passage at York Haven Dam. This agreement amended the 1993 settlement to allow for construction of a fish ladder with flow augmentation gates and an open weir at the hydroelectric project's East Channel Dam, rather than the powerhouse fish lift originally agreed to in the 1993 settlement agreement (Table 4; Settlement Agreement 1997, entire)

Holtwood and Safe Harbor completed their fish lifts in time for the 1997 spring spawning run. Total cost for this construction was $38,000,000. In spring 2000, York Haven completed their $9,000,000 fish ladder at the East Channel (Red Hill) dam at Three Mile Island. These actions provided limited migratory fish access to about 200 miles of the Susquehanna River up to Sunbury, Pennsylvania and the entire Juniata River to the Warrior Ridge and Raystown dams (St. Pierre 2002, p. 8).

SRAFRC and the utilities had devoted considerable resources during the 1980s and 1990s to address downstream passage concerns at the hydroelectric projects. Radio-telemetry was used extensively to monitor behavior and movements of adult and juvenile American shad at hydroelectric projects (St. Pierre 2002, p. 8). In addition to fish propagation research and studies directed at discrimination between hatchery and wild produced American shad, SRAFRC funded numerous special studies including adult American shad stress analysis and hormone-induced spawning, effects of net pen confinement prior to release, and influence of hydroelectric project operations on adult and juvenile migrations (St. Pierre 2002, p. 8).

4.3.2.1 American Shad Trap and Transport

Trap and transport efforts at Conowingo Dam began in 1972 with the first operation of the WFL. However, due to low catches over the first decade, the first American shad were not transported from the WFL to upstream of the York Haven Dam until 1982 (Table 5). During the early 1980s, catch of American shad at Conowingo Dam improved modestly from earlier years, increasing to a record 2,039 fish in 1982 before falling to 167 by 1984. In an effort to increase the number of spawning American shad in the river upstream of dams, SRAFRC initiated collection and transfer of pre-spawned adult fish from the Connecticut and Hudson Rivers. From 1981 through 1987, a total of about 25,000 live American shad were stocked into the North Branch upstream from the four lower Susquehanna River hydroelectric dams from these sources. From 1985 through 1990, American shad catches at the WFL increased steadily from 1,546 to 15,719 fish (Table 5).

In 1991, the EFL became operational and both lifts were utilized to collect adult American shad for upstream transport. American shad returns to Conowingo continued to increase with both fish lifts operating. Maryland's American shad population estimate for the upper Chesapeake Bay increased steadily from 8,000 in 1984 to 140,000 in 1991 and a corresponding record of 27,227 American shad were collected in the fish lifts in 1991. The number of American shad trapped in the lifts further improved to 32,330 fish by 1994 and almost doubled the next year to over 61,000 fish. A modern record 102,000 river herring were also trapped at Conowingo that year, and the upper Bay American shad population estimate reached 339,000 (St. Pierre 2002, p. 7).

During the trap and transport program from 1982 to 2000, over 230,000 adult American shad, collected at Conowingo Dam, were stocked upstream of the four lower Susquehanna River hydroelectric dams (SRAFRC 2010, p. 18). Transport activities continued through 2000 funded by the hydroelectric dam owners as directed in the 1984 and 1993 settlement agreements. The trap and transport program was terminated once the final fish passage facility at York Haven Dam was completed and upstream migratory access was provided via four fish passage facilities to historical Susquehanna River spawning habitat for American shad.

4.3.2.2 American Shad Hatchery Stocking Efforts

From 1971 through 1977, about 222 million shad eggs were collected and stocked in hatching boxes at numerous mainstem and tributary sites in the lower and mid-Susquehanna Basin (Table 5). Initial egg collections were from the Susquehanna Flats (downstream of Conowingo Dam), but after 1972, other sources from the East Coast and the West Coast rivers were also used. After 1977, direct egg stocking was discontinued and all available eggs were utilized for hatchery culture at the Van Dyke facility (SRAFRC 2010, p. 17).

From 1976 through 2000, nearly 163 million cultured American shad fry were stocked in the Susquehanna River upstream of the four lower hydroelectric dams. Most American shad eggs for the Susquehanna River restoration program during the 1980s came from the Columbia River (Oregon), and the Pamunkey River (Virginia). Throughout the 1990s, the primary sources of American shad eggs were the Hudson and Delaware Rivers (SRAFRC 2010, pp. 17-18). Hatchery production during 1984–2000 averaged 8.4 million shad fry annually (Table 5). Based on microstructure and chemical marks on otoliths, it was shown that hatchery fish comprised 70–85 percent of adult shad returns to Conowingo during 1989–1996 (St. Pierre 2002, pp. 7–8).

Although the trap and transport efforts ended in 2000 with the opening of the fish ladder at York Haven Dam, stocking of hatchery-reared American shad fry has occurred annually in the Susquehanna River to the present date.

Table 5. Summary of American shad egg, fry, and adult stocking activities in the Susquehanna River upstream of dams, 1971–2000 (SRAFRC 2010, Table 1).

Year	Eggs Planted (millions)	Hatchery Fry Stocked (millions)	WFL/EFL Adult Catch	Adults Transported Upstream
1971	8.4	-	-	-
1972	7.1	-	182	116
1973	58.6	-	65	-
1974	50	-	121	-
1975	33.2	-	87	-
1976	54	0.78	82	-
1977	11	1.04	165	-
1978	-	2.13	54	-
1979	-	0.66	50	-
1980	-	3.53	139	-
1981	-	2.05	328	-
1982	-	5.06	2,039	800
1983	-	4.15	413	64
1984	-	12.03	167	0
1985	-	6.34	1,546	967
1986	-	9.97	5,195	4,172
1987	-	5.26	7,667	7,202
1988	-	6.53	5,146	4,736
1989	-	13.53	8,218	6,469
1990	-	5.71	15,719	15,075
1991	-	7.27	27,227	24,662
1992	-	3.06	25,721	15,674
1993	-	6.62	13,546	11,717
1994	-	6.56	32,330	28,681
1995	-	10	61,650	56,370
1996	-	7.47	37,512	33,825
1997	-	8.04	103,945	10,528
1998	-	11.76	46,481	4,593
1999	-	13.50	79,370	5,508
2000	-	9.79	163,330	1,351
Totals	**222.30**	**162.84**	**638,495**	**232,394**

4.3.3 Status of Current Restoration Efforts and Fish Passage at Lower Mainstem Hydroelectric Facilities

4.3.3.1 Fish Passage at York Haven Dam

The fish ladder constructed on the York Haven Project's East Channel Dam in 2000 was designed to pass 0.5 million American shad (Settlement Agreement 1997, pp. 2-3). The fish ladder was constructed according to the Service's design specifications and has had some success in passing American shad, although observed passage efficiency at that Project has been generally low (14 percent of the American shad passing Safe Harbor Dam from 2000–2014; USFWS 2015a, p 2.). One potential reason for low fish passage at York Haven Dam is that some spawning habitat is available for American shad downstream of the York Haven Dam and upstream of Safe Harbor Dam. Fish that are successfully spawning downstream of York Haven Dam may have no biological motivation to pass upstream (Kleinschmidt 2006, p. 9). The low passage efficiency may also be the result of fish having difficulty finding the entrance of the fish passage facility. A radio-telemetry study on American shad conducted in 2005 indicated that relatively few American shad approached the York Haven Dam at the location of the current fish passage facility in the east channel (Kleinschmidt 2006, p. 10).

To remedy the fish passage issues with the current fish ladder at York Haven Dam, a nature-like fishway will be completed in 2021 on the main dam (Table 4; Settlement Agreement 2014, p. 16). The Project owner will also be required to meet the upstream passage efficiency criterion for adult American shad of 75 percent that pass the downstream project (Safe Harbor) and downstream survival criteria of 85 percent for American eel, 80 percent for adult American shad and river herring, and 95 percent for juvenile American shad and river herring. The Project owner will be conducting upstream passage efficiency studies for American shad, and downstream survival studies for American shad, river herring, and American eel at their project in the coming years (Settlement Agreement 2014, pp. 18–33).

4.3.3.2 Fish Passage at Safe Harbor Dam

A fish lift was installed in 1997 and designed to pass 3.75 million alosines (Settlement Agreement 1993, p. 12). The Safe Harbor Project fish lift is designed and currently operating in accordance with the design criteria within the 1993 settlement. The Safe Harbor Project is

similar in size and generating capacity to the Conowingo Dam and has demonstrated high upstream fish passage efficiency with its fish lift compared to other projects on the Susquehanna River, passing a cumulative total of over 288,000 American shad as well as many other species (Normandeau Associates 2014a, p. 3). The long-term average efficiency (1997–2014) for American shad passing the Safe Harbor Dam is 76 percent of those fish that were passed at the Holtwood Dam with a daily passage rate of 31 percent per day (USFWS 2015b, pp. 6–7).

4.3.3.3 Fish Passage at Holtwood Dam

The Holtwood Dam Project currently operates two fish lifts for upstream passage of migratory fish. The fish lifts were originally installed at the Holtwood Dam in 1997 and designed to pass 2.7 million shad and 10 million river herring (USFWS 2009, p. 3). Since their construction, the fish lifts have not achieved the attraction flow specified in the original fishway design and the Project has a malfunctioning entrance gate on the spillway side. The entrance to Gate C was damaged shortly after installation and has been inoperable since that time. Due to failure of the sacrificial flashboards that often occurs during the annual spring freshet there is considerable discharge to the spillway that attracts fish to the area of the inoperable fishway entrance and many fish fail to pass. In addition, when full attraction flow was supplied to the fishway entrances via flow through the exit flume, eddy currents were created in the exit flume that blocked fish exiting the fish passage facility (USFWS 2009, p. 15; USFWS 2014a, entire). Starting in 2010, the Project owner began redeveloping the Holtwood Project, including additional generating capacity as well as improvements to the existing fish passage facilities and operations. As part of the Prescription for Fishways, the Department required the Project owner to implement fish passage improvements including modifications to the existing fish lift. In addition, the Project owner was required to re-route discharge, conduct channel modifications, increase attraction flow, and install a spill control system to enhance the zone of passage up to the fishway entrances (USFWS 2009, p. 26). As part of the Water Quality Certification for the project, the PADEP also required the Holtwood Project to meet upstream passage efficiency criteria for American shad. The Project must pass 75 percent of American shad that pass the Conowingo Project and 50 percent of the American shad must pass the Holtwood Project in 5 days (PADEP 2009, p. 15).

Long-term fish passage efficiency at the Holtwood Project, as measured by the proportion of fish that successfully passed the downstream Conowingo Dam, has been low, averaging 32 percent from 1997–2014 (USFWS 2015a, p. 2). As of spring 2015, not all of the upgrades to the fishway had been completed; however, the Holtwood project reached 63 percent upstream passage efficiency for American shad during the 2015 season[2]. The project owner intends to complete the remaining construction to improve fish passage at the Holtwood Dam by 2016, and will be conducting studies to validate that passage efficiency standards are being met and identify any issues that need to be addressed to continue to improve efficiency (Holtwood 2014, p. 9).

4.3.3.4 Fish Passage at Muddy Run Pumped Storage Project

In addition to the lower mainstem dams, the Muddy Run Pumped Storage Project (MRPSP), also impacts migrations of anadromous fish. The Project is also operated by Exelon Generation Corp., the Licensee for the Conowingo Project. Although the MRPSP does not include a dam that spans the Susquehanna River, the Project withdraws and discharges water daily from the Conowingo Pond. The pumping capacity at MRPSP is large enough to cause local reversal of the river flow in the mainstem of the Susquehanna during periods of low inflow from upstream of the Project (USFWS 2013a, p. 11). The MRPSP has documented impacts of both causing delay and entraining migrating American shad and American eel into the storage pond associated with pumping and discharge operations during both upstream and downstream migration periods (USFWS 2013a entire; USFWS 2013b, entire). Under the new license issued by FERC in 2015, the Project owner will be required to conduct studies to ensure that the operation of the MRPSP is meeting the same upstream and downstream passage efficiency criteria for migratory fish as was established at the York Haven Dam (Settlement Agreement 2015, pp. 37-41).

4.3.3.5 Fish Passage at Conowingo Dam

As noted in Section 4.3.1, the experimental WFL began operation at Conowingo Dam in 1972. It was initially designed as a trapping facility and cannot pass migrating fish directly over the dam and into Conowingo Pond. The EFL at Conowingo Dam was originally designed to pass up to 1.5 million American shad and 10 million river herring based on the installation of two hoppers (buckets) at the lift (MDNR 1988, pp.1). However, a 1989 docket (EL80-38-003) filed

[2] Data from http://fishandboat.com/shad_susq.htm last accessed June 26, 2015.

with FERC signed by PECO and the parties of the 1988 settlement agreement, including the Service, stated that the EFL would initially be constructed with only one of the two hoppers from the original design with a resulting capacity of 0.75 million American shad (Reid and Priest 1989, p. 2). The addition of the second hopper at the EFL, as well as a rebuild of the WFL so that it could pass fish directly into Conowingo Pond, was to be implemented once the capacity was reached at the EFL (Reid and Priest 1989, entire). Neither the second hopper at the EFL nor the rebuild of the WLF have been implemented. The EFL passed more than 193,000 American shad in the peak year of 2001, but passage numbers have declined steadily since then, with the current lowest passage on record of 8,341 American shad in 2015[3]. Fish passage efficiency at the Conowingo Project has been relatively poor and the Project is limited by the capacity of the current EFL. For a thorough discussion of current fish passage at the Conowingo Dam, refer to Section 8 of this document.

4.3.3.6 SRAFRC Agency Efforts Supporting Migratory Fish Restoration

As part of each settlement agreement with the hydroelectric dam owners/operators for fish passage installation (Conowingo in 1988; Holtwood and Safe Harbor in 1993; and York Haven in 1997), separate fish passage technical advisory committees were developed. These advisory committees are comprised of resource agency members of the Pennsylvania Fish and Boat Commission (PFBC), MDNR and the Service, and the affected hydroelectric dam owners/operators (Settlement Agreement 1988, p. 12; Settlement Agreement 1993, p. 5). These committees meet annually, or as needed, to discuss and agree on operational matters needed to provide safe, timely, and effective upstream and downstream fish passage at the dams.

With the development of the advisory committees, the dam owners/operators ceased participation in the SRAFRC. Because of the change in membership of the SRAFRC (no longer including industry representatives), the name of the interagency restoration group changed again in 1995, dropping the word "Committee" in favor of "Cooperative" thus retaining the acronym SRAFRC. An organizational charter was developed and signed by six resource agencies, including NMFS and SRBC (SRAFRC 1995, entire). The charter defined the roles of the Policy and Technical committees and the Service program coordinator. The charter was renewed in

[3] Data from http://fishandboat.com/shad_susq.htm last accessed June 26, 2015.

2014 where NMFS was removed as a signatory to the SRAFRC, with the current membership consisting of the Service, PFBC, MDNR, NYSDEC, and SRBC. The Policy and Technical committees continue to meet annually or more frequently as needed (SRAFRC 2014, entire). SRAFRC continues to be an active supporter of American shad and other migratory fish restoration in the Susquehanna River.

American shad hatchery stocking efforts continue to occur in the Susquehanna Basin, and have been conducted using resource agency (primarily PFBC) funds since 2001 (SRAFRC 2013a, p. 142). The stocking program consists of egg collection of spawning fish primarily from the Potomac River since 2006 (SRAFRC 2013a, p. 168). Eggs are also collected from tank spawning at the WFL (SRAFRC 2013a, p. 168). Exelon provides an operator for the WFL operations but PFBC and MDNR currently fund the egg collection and biological sampling at that location (SRAFRC 2013a, p. 32). PFBC rears the American shad at the Van Dyke hatchery and then releases them to locations in the Susquehanna River Basin during the summer (SRAFRC 2013a, p. 162). An average of 5 million American shad fry have been stocked in the Susquehanna River annually from 2001 to 2012 (SRAFRC 2013a, p. 172). PFBC assesses the success of both hatchery stocking and natural production of American shad in the river upstream of York Haven Dam (SRAFRC 2013a, pp. 194-195). PFBC also evaluates adult American shad from the WFL to determine the percentage of returns that are hatchery versus wild origin to assess the success of the hatchery stocking program (SRAFRC 2013a, p. 215).

MDNR conducts sampling efforts downstream of Conowingo Dam to assess the population of adult and juvenile American shad and juvenile river herring. For the adult population assessment, American shad are captured and tagged in the tailrace of Conowingo Dam and the population size is determined using mark-recapture estimates (SRAFRC 2013a, pp. 272-296). Juvenile American shad and river herring assessments are conducted using seine surveys in the upper Chesapeake Bay and lower Susquehanna River (downstream of Conowingo Dam; Durell and Weedon 2011[4]).

[4] Durell, E.Q., and Weedon, C. 2011. Striped Bass Seine Survey Juvenile Index Web Page. http://dnr2.maryland.gov/fisheries/Pages/juvenile-index/index.aspx. Maryland Department of Natural Resources, Fisheries Service.

The PFBC, MDNR, and NYSDEC also work with other resource agencies, non-profit groups, and private individuals to improve access to upstream habitats through dam removals and providing fish passage within the Susquehanna River basin (Nicholas, no date, entire; NYSDEC, no date, entire). In addition, SRBC, PADEP, and other agencies are working to improve water quality and manage water usage throughout the basin (PADEP, no date, entire; SRBC 2013b, entire).

4.3.4 American Eel Restoration Efforts on the Susquehanna River

American eel restoration efforts in the Susquehanna River began as early as the 1930s. The PFBC conducted a trap and transport program that collected over 17 million juvenile eels downstream of Conowingo Dam and stocked them into the Susquehanna River Basin between 1936 and 1980 (SRAFRC 2010, p. 84). The WFL at Conowingo Dam collected a high of over 126,000 American eels in 1974 (Buchanan and Robins 1974, p. 5), but collections have declined dramatically in recent years, and fewer than 20 eels are captured annually in the EFL since it became operational in 1991 (SRAFRC 2013, p. 14; Normandeau Associates 2013, Table 1; Normandeau Associates 2014b, Table 1).

Fish lifts at the four lower mainstem dams were not designed to pass eels and have passed few American eels in recent years. However juvenile American eels are still abundant in the tailrace of Conowingo Dam. In 2008, the Service initiated an experimental trap and transport program at Conowingo Dam. This program has captured a cumulative total of more than 700,000 juvenile American eels from 2008 through 2014 and released them at various locations throughout the Susquehanna River Basin (SRAFRC 2013, p. 14; Minkkinen and Park 2014, p. 2). A portion of these American eels have been stocked in areas where freshwater mussels occur to promote successful reproduction of the eastern elliptio mussel (*Elliptio complanata*) (Minkkinen et al. 2014, entire).

As part of the Pennsylvania Water Quality Certification for the MRPSP, Exelon will provide $20,000 annually to the Service to support collection and stocking activities until a permanent collection facility is constructed on the west shore of Conowingo Dam (PADEP 2014, Appendix 1, p. 5). Exelon will also construct permanent American eel collection facilities on the eastern

shore (by 2018) and western shore (by 2017) of the Susquehanna River downstream of Conowingo Dam. Exelon will trap and transport American eels to upstream areas as designated by PADEP (2014, Appendix 1, p. 16). Trap and transport, funded by Exelon, will continue through 2030, with the project being switched to volitional passage after that date (PADEP 2014, Appendix 1, p. 15).

4.4 Current Status and Management of Migratory Fish Populations

4.4.1 Management Authority for Migratory Fish Stocks in the Susquehanna River

4.4.1.1 Atlantic States Marine Fisheries Commission

The Atlantic States Marine Fisheries Commission (ASMFC) was formed by the 15 Atlantic coast states in 1942 in recognition that fish do not adhere to political boundaries. The ASMFC is a deliberative body, promoting cooperation and coordination among the member states as they implement their relative responsibilities under state law for protecting the public's interest in marine, estuarine, and anadromous fisheries within their respective jurisdictions. The ASMFC serves as a forum for the states to collectively address fisheries issues under the premise that as a group, using a cooperative approach, they can achieve more than they could as individuals. Fishery Management Plans (FMPs) are developed within the ASMFC under the authority of the Atlantic Coastal Fisheries Cooperative Management Act of 1993 (ACFCMA). States that do not comply with the requirements in the FMPs are subject to have their respective fisheries closed by the Secretary of Commerce (Section 5106 (c)).

The ASMFC's mission is to promote the better utilization of the marine, shell, and anadromous fishery resources of the Atlantic seaboard through the development of a joint program for the promotion and protection of such resources, and by the prevention of physical waste of the fisheries from any cause. The ASMFC's jurisdiction, through the member states, extends from the shoreline to 3 miles out, and all coastal states have their own laws and fisheries agencies to manage fisheries within 3 miles of their coasts. The ASMFC does not promote a particular state, jurisdiction, or a stakeholder sector.

4.4.1.2 Fishery Management Councils

Responsibility for compatible fisheries management action in the Exclusive Economic Zone

(EEZ), the sea area from 3 to 200 miles from shore, lies with the Secretary of Commerce and is conducted through Fishery Management Councils (FMCs). These FMCs were created when Congress passed Public Law 94-265, the Magnuson Fishery Conservation and Management Act of 1976 (also known as Magnuson-Stevens Act). The law created a system of regional fisheries management that was designed to allow regional, participatory governance by knowledgeable people with a stake in fishery management. Although the FMCs work primarily on off-shore fisheries, each federal FMC "...shall comment on and make recommendations to the Secretary and any Federal or State agency concerning any such activity that, in the view of the Council, is likely to substantially affect the habitat, including essential fish habitat, of an anadromous fishery resource under its authority" (from Magnuson-Stevens Fishery Conservation and Management Act, Section 305, P.L. 104-297, (b) FISH HABITAT (3)(B)).

Two FMCs address issues related to American shad and river herring of the Susquehanna River; the Mid-Atlantic Fishery Management Council (MAFMC) and the New England Fishery Management Council (NEFMC). The regional FMCs develops fishery management plans and recommends management measures for the EEZ off the east coast of the United States. The councils recommend fishery management measures to the Secretary of Commerce through NMFS. The decisions made by the councils are not final until they are approved or partially approved by the Secretary of Commerce through NMFS.

Incidental catch of blueback herring, alewife, American shad, and hickory shad occur in the New England and Mid-Atlantic FMC fisheries. In the Mid-Atlantic FMC, an Amendment was passed to monitor river herring and American shad bycatch in the FMC's managed mackerel fishery (MAFMC 2014, entire). The New England FMC has established catch "caps" or limits by area for river herring and American shad as bycatch in the Atlantic herring fishery (NEFMC 2013, entire).

4.4.1.3 Susquehanna River Anadromous Fish Restoration Cooperative

The SRAFRC is an organization comprised of fishery agencies from the three basin states, the SRBC, and the federal government working together to restore self-sustaining migratory fishery resources and their habitats in the Susquehanna River Basin. This cooperative activity

recognizes the need for a unified approach to planning, management, stock enhancement, and evaluation of inter-jurisdictional fishery resources and its purposes are: (1) to provide a forum for information exchange; (2) to plan and implement migratory fishery stock rebuilding programs; (3) to coordinate research activities aimed at collection of scientific data necessary to effect and assess the fishery restoration program; (4) to establish and maintain a comprehensive database and to report on progress; and, (5) to coordinate agencies involvement with construction, operation, and evaluation of passage facilities at dams in the Susquehanna River Basin.

The current Susquehanna River Anadromous Fish Restoration Cooperative Member Agencies include:

Maryland Department of Natural Resources
New York State Department of Environmental Conservation
Pennsylvania Fish and Boat Commission
Susquehanna River Basin Commission
United States Fish and Wildlife Service

The Service serves as the Chair for both the Policy Committee and Technical Committee. Although SRAFRC members cooperatively manage fisheries and restoration efforts within the Susquehanna River Basin, SRAFRC is not a regulating body and legal authority for management lies within the respective jurisdictions of the member agencies.

4.4.2 American Shad

The status of American shad along the Atlantic coast is summarized by the ASMFC in Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (ASMFC 2010, entire) and the most recent American Shad Stock Assessment (ASMFC 2007, Volume I, entire). Historically, American shad, hickory shad, alewife, and blueback herring (collectively termed alosines) were an extremely important fishery resource and supported many successful commercial fisheries along the Atlantic coast of the United States and Canada. Coast-wide landings of American shad at the turn of the 20th century were approximately 50 million pounds. However, by 1980 the landings decreased dramatically to 3.8 million pounds. Total landings of river herring varied from 40 to 65 million pounds from 1950 to 1970, then declined steadily

thereafter to less than 12 million pounds by 1980 (ASMFC 2010, pp. 1–2). These dramatic declines in commercial landings suggested that a coordinated management action would be required to restore alosine stocks to their former levels of abundance. Therefore, in 1981 ASMFC members recommended the preparation of a cooperative Interstate Fishery Management Plan (FMP) for American shad and river herring. The initial FMP was completed in 1985 and recommended management measures that focused primarily on regulating fishing exploitation and enhancing stock restoration efforts (ASMFC 2010, p. 2).

Despite these efforts, alosine stocks continued to decline. In 1994, ASMFC determined that the original FMP was no longer adequate for protecting and restoring remaining American shad and river herring stocks. It concluded that the declines may have been the result of overharvest by in-river and ocean-intercept fisheries; excessive striped bass predation; biotic and abiotic environmental changes; and loss of essential spawning and nursery habitat due to water quality degradation and blockages of spawning reaches by dams and other impediments (ASMFC 2010, p. 2). A coast-wide assessment was completed in 1998 and Amendment 1 to the FMP was adopted in 1999, and additional addenda were added in 2000 and 2002. Amendment 1 and subsequent addenda focused on directed fishing mortality and established benchmarks in hopes of rebuilding the stocks (ASMFC 2010, p. 2). This approach defined ASMFC's American shad management until the adoption of Amendment 3 in 2010.

A stock assessment conducted in 2007 found that coast-wide American shad stocks were at all-time low levels and did not appear to be recovering to acceptable levels. Commercial landings declined to 574,306 pounds in 2005, a reduction of approximately 85 percent since 1980 (ASMFC 2007, Volume I, p. 49). The primary causes for continued stock declines were attributed to a combination of excessive total mortality, habitat loss and degradation, and migration and habitat access impediments including dams (ASMFC 2010, p. 3).

In response to the 2007 stock assessment, ASMFC adopted Amendment 3 to the FMP in 2010. Amendment 3 recommended the use of total mortality rates (rather than just fishing mortality rates) to assess the status of American shad populations and their potential for population growth (ASMFC 2010, pp.15). This was a change from management under Amendment 1 because it

was recognized that besides fishing mortality, American shad stocks are subjected to several other sources of human-induced mortality including fish passage mortality at dams and water development projects (ASMFC 2010, p. 16).

For American shad, ASMFC selected total mortality rates that would preserve 30 percent of the biomass of the female spawning stock that would otherwise be available if there were no human-induced mortality. When total mortality rates exceed this threshold, states should take action to reduce total mortality. When reducing mortality, the priority would be to reduce mortality from inadequate passage at dams and/or bycatch (versus directed fishing efforts) since these losses are avoidable and do not benefit society (ASMFC 2010, p. 15).

Amendment 3 also required the states which continue to have commercial fisheries to file sustainability plans or their fisheries would be closed (ASMFC 2010, p. 31). A sustainability plan for the Susquehanna River has not been developed because no commercial fisheries exist in the river. Finally, Amendment 3 recommended states and jurisdictions develop habitat plans for American shad to reduce or mitigate the impact of dams and other obstructions, water quality, and contamination (ASMFC 2010, p. 42-45). Recommendations for fish passage included that states should work with the Service and the NMFS to: identify hydropower dams that impede fish migration and target them for appropriate recommendations during FERC relicensing; prioritize barriers in need of fish passage based on ecological criteria; develop new technologies to improve fish passage efficiency; design passage facilities that work under all water levels; and implement measures to pass fish via routes with the best survival (ASFMC 2010, p. 35-37). To fulfill the ASMFC recommendation for the development of a habitat restoration plan, state and federal partners within SRAFRC submitted a Susquehanna River Habitat Plan for American shad and river herring to the ASMFC (PFBC 2014, entire). This plan cites barriers to fish migration and poor water quality conditions as the most significant threats to American shad restoration to the Susquehanna River and requires the same passage efficiency criteria and restoration goals as the 2010 Migratory Fish Management and Restoration Plan for the Susquehanna River Basin.

4.4.2.1 Mid-Atlantic Region American Shad Status

Although there has been an overall coast-wide decline in American shad stocks, the 2007

ASMFC stock assessment found much variation in river population trends along the coast. However, there were regional trends with rivers in close geographic proximity showing similar trends in juvenile production (ASMFC 2007, Volume I, p. 153). When assessing the status of the Susquehanna River and attempting to give context to these trends, it is useful to compare it to other large rivers that are also located in the Mid-Atlantic region such as the Delaware River and the Potomac River.

4.4.2.1.1 The Susquehanna River American Shad

As described earlier, the Susquehanna River once supported large numbers of American shad, but stocks have been severely impacted by human activities, including construction of dams. Following efforts by resource agencies dating to the 1950s, the American shad stock improved slowly as a result of trap and transport efforts, fry stocking, and providing fish passage at the lower mainstem dams. American shad passage on the Susquehanna River increased from 1997 through 2001, with a peak of over 190,000 American shad passing Conowingo Dam and 16,000 passing York Haven Dam in 2001 (Figure 3). However, since 2001, adult numbers have decreased, due to a variety of potential contributing factors including: low numbers of spawning fish accessing quality upstream habitat as a result of poor fish passage efficiency and cessation of the trap and transport program; low hatchery production in recent years that reduced juvenile recruitment; ocean and Chesapeake Bay mortality; and increased predation (SRAFRC 2010, pp. 28-30). Only 8,341 American shad were counted at the EFL, with 43 of them ultimately passing York Haven Dam in 2015. 2015 was the lowest American shad passage season at Conowingo Dam since 1997 (Figure 3).

The decline over the past decade in adult American shad passing the Conowingo Dam fish lifts coincides with declines in the population observed downstream of the Conowingo Dam tailrace. MDNR conducted population estimates based on recapture of marked American shad and on results from a “surplus production” model in the tailrace area from 1986 to 2013. The adult population reached a peak from 1999 through 2007; however since 2009, the population of American shad downstream of Conowingo Dam has been as low as it had been before any fishway passage facilities were installed on the Susquehanna River (MDNR 2013, pp. 6–21). Also, catch-per-unit-effort (fish per boat hour) from the Conowingo Dam tailrace showed similar trends (MDNR 2013, pp. 6-21).

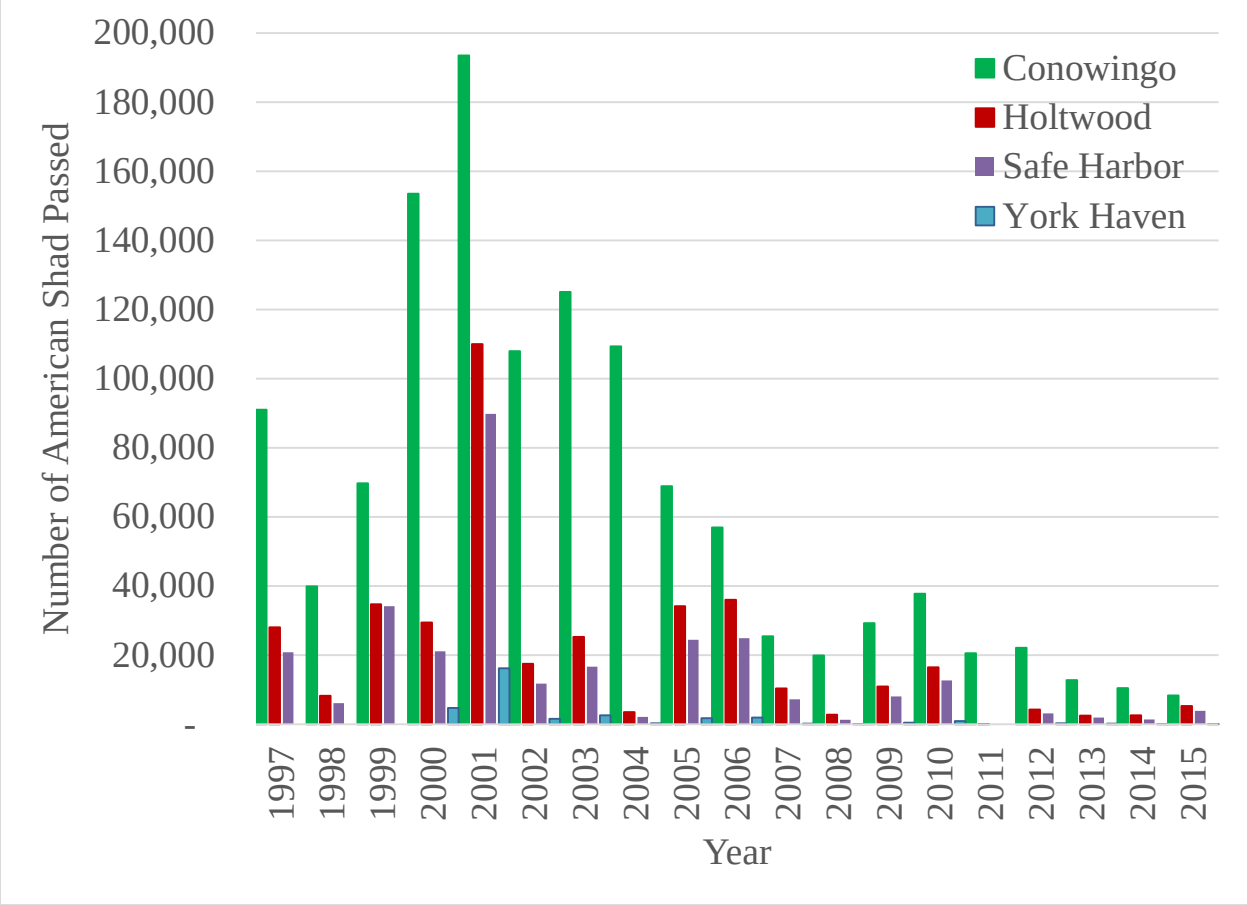

Figure 3. Number of American shad passed via fish passage facilities at the 4 lower mainstem dams on the Susquehanna River[5].

The American shad population in the Susquehanna River has been heavily supplemented by hatchery stocking efforts. In 2014, 45 percent of returning adult American shad was of hatchery origin, with the long-term average being 57 percent of hatchery origin (PFBC 2014, p. 9–10). The reduced hatchery releases in the past decade are likely contributing to declining population numbers downstream of Conowingo Dam compared to the late 1990s through early 2000s when much larger numbers of American shad fry were being released in the river (SRAFRC 2013a, p. 172).

The Susquehanna River has not supported a commercial fishery for American shad since the fishery was closed by MDNR in 1980 (ASMFC 2007, Volume I, p. 110). A small recreational

[5] Data from http://fishandboat.com/shad_susq.htm last accessed June 26, 2015.

catch-and-release fishery managed by MDNR still occurs in the tailrace of Conowingo Dam. The American shad fishery has been lost from the Pennsylvania and New York portions of the river for decades, which has resulted in the loss of economic and cultural benefits, and recreational opportunities, which were part of the historical shad fishery in those states.

4.4.2.1.2 The Delaware River American Shad

In the late 1890s, the Delaware River had the largest annual commercial American shad harvest of any river on the Atlantic coast, with estimates ranging up to 19 million pounds (approximately 5 million fish assuming 3.71 pounds per fish, see Table 8) in a given year (ASMFC 2007, Volume II, p. 302). The harvest began to decline rapidly in the early 1900s due to water pollution, overfishing, and dams on major tributaries of the Delaware River that blocked access to quality spawning habitat (ASMFC 2007, Volume II, p. 302). Despite more restrictive fishery regulations and a massive program of artificial propagation and stocking of shad fry in the late 1800s, the American shad fishery eventually collapsed under the combined pressures. By the 1940s, the Delaware River commercial American shad fisheries were mainly on the lower reaches of the river.

The Delaware River stock of American shad increased from the 1960s through the 1980s, likely as a result of improving water quality and the passage of the Clean Water Act in 1972, but it declined again in the1990s for unknown reasons and remains at low levels compared to the 1980s (ASMFC 2007, Volume II, p. 302). Two indices of abundance of American shad in the Delaware River are the Lewis haul seine fishery survey (conducted at RM 149) and the Smithfield Beach survey (conducted at RM 218). The catch-per-unit-effort (fish/haul) in the Lewis haul seine fishery in the lower Delaware River had a peak in 1989 with a 52.20 fish/haul, but declined in the 1990s and from 2000 to 2013, averaged 4.7 fish/haul per year. However, recent above average catches occurred in 2010 (12.31 fish/haul) and 2013 (11.61 fish/haul) (DRBFWMC 2014, p. 41). The 1996-2013 catch-per-unit-effort in the Smithfield Beach survey averaged 0.87 fish/foot hours of gillnet deployed, but also has been above this average in recent years (2010-2013) (DRBFWMC 2014, p. 44). These indices suggest a possible leveling off in the downward trend of the American shad population in the Delaware River, although populations are still at relatively low levels.

Conversely, the total number of American shad passed at the Conowingo Dam has generally been declining since 2001 (USFWS 2015a, p. 3). A major difference between the Delaware and Susquehanna Rivers is the presence of large mainstem dams on the Susquehanna River which are absent on the Delaware River. The dams on the Susquehanna River preclude fish from reaching quality spawning and rearing habitat, whereas in the Delaware River, American shad have unimpeded access to a large portion of their historical spawning and rearing habitat. The continued inaccessibility to spawning and rearing habitat in the Susquehanna River is a likely reason for the continued population decline on this river.

4.4.2.1.3 The Potomac River American Shad

Among Chesapeake Bay stocks of American shad, the Potomac River population shows the most promising signs of recovery. The gill net index, the pound net index, and the juvenile abundance index from the Potomac River used in the 2007 ASMFC stock assessment (ASMFC 2007, Volume III, Figure 11.15 and Tables 11.7 and 11.16) depict increasing trends in relative abundance. Age structure has broadened (ASMFC 2007, Volume III, p. 146) and the mean age has increased, which indicates increasing adult survival, increasing repeat spawners, and likely increasing total egg deposition. Estimates of total mortality declined from 2002 to 2005 and met management goals (ASMFC 2007, Volume III, p. 149) indicating that mortality levels should not preclude population growth.

The American shad population in Potomac River is increasing and we infer that the Susquehanna River population trend should be similar to the Potomac River since both are major Chesapeake Bay tributaries and fish migrating between their respective riverine and marine habitats would experience similar natural mortality. However, Potomac River American shad have access to suitable spawning and rearing habitat for 30 miles of undammed mainstem river with a fish ladder at Little Falls dam providing access to the final 10 miles of historic spawning habitat (ASMFC 2007, Volume III, p. 135). In the Susquehanna River, access to nearly all spawning habitat is substantially blocked by mainstem dams.

4.4.3 River Herring

The most recent coast-wide stock assessment for river herring was completed by ASMFC in 2012. The stock assessment concluded that the status of the coast-wide complex of river herring stocks on the Atlantic coast was depleted to near historic low abundance. A depleted status indicates that there was evidence for declines in abundance due to a number of factors (e.g. over fishing, bycatch in other fisheries, habitat degradation, migratory barriers), but the relative importance of these factors in reducing river herring stocks could not be determined (ASMFC 2012b Volume I, p. 58). There were contradictory trends in river herring abundance among individual stocks, with some increasing, some decreasing, and some fluctuating without trend, but fisheries-independent surveys that showed declines tended to be from areas south of Long Island (ASMFC 2012b Volume I, p. 55). Differences in abundance trends may be due to differences among rivers in fish passage efficiency or differences in management practices such as transport of adult fish into ponds upstream of dams as is commonly done in Maine rivers (ASMFC 2012b Volume I, p. 55).

On August 5, 2011, the NMFS received a petition from the Natural Resources Defense Council requesting the listing of river herring under the Endangered Species Act (ESA) as threatened throughout all or a significant portion of their range (NRDC 2011, entire). In response to this petition, the Status Review Team conducted another coast-wide assessment of river herring stocks along the Atlantic coast (NEFSC 2013, entire). Although listing under the ESA was determined not to be warranted, the conclusions of the Status Review Team indicated that many populations of both species are depleted and their abundance is well below historical levels (NEFSC 2013, p. 10). The range-wide abundance of alewife significantly increased from 1976 – 2012, but abundance of blueback herring neither significantly increased nor decreased over this time period (NEFSC 2013, p. 7). However, when examined on a regional basis, the Mid-Atlantic stock complex of alewife was stable while Mid-Atlantic stock complex of blueback herring was significantly decreasing, indicating the Mid-Atlantic is an area of concern for blueback herring conservation (NEFSC 2013, p. 9).

The ASMFC and NMFS have taken management actions to conserve river herring coast-wide. Under Amendment 2 to the Interstate Fishery Management Plan for Shad and River Herring

(River Herring Management), states which intend to have fisheries for river herring must have an approved Sustainable Fishery Management Plan (ASMFC 2009, pp 92 – 93); otherwise their fisheries would be closed by January 1, 2012. Currently, the sates of Maine, New Hampshire, New York, North Carolina, and South Carolina have approved plans (http://www.asmfc.org/species/shad-river-herring; accessed April 27, 2015). When NMFS announced listing under the ESA was not warranted, it also announced that it would be working with the ASMFC on a strategy to develop a long-term and dynamic conservation plan with the goal of addressing high priority data gaps for river herring (78 FR 48994 (8/12/13)).

4.4.3.1 Mid-Atlantic Region River Herring Status

There are a few indices of abundance from surveys conducted by resource agencies for river herring in the Mid-Atlantic region that have been used to assess population status and trends. These indices of abundance show much annual variation, but in general show declining populations.

The MDNR has been generating an index of juvenile river herring abundance from annual seine sampling within the Chesapeake Bay since 1954. Baywide juvenile indices for alewife were generally greatest during the 1960s, but then declined to their lowest levels in the 1980s. Since then, indices of abundance have increased but are highly variable without consistent trends since 1996 (ASMFC 2012c Volume II, Figure 13.8, p. 441). Likewise blueback herring juvenile indices were lowest in the 1980s, followed by an increase during mid 1990s but have also been highly variable without consistent trends since the late 1990s (ASMFC 2012c Volume II, Figure 13.12, pp.443).

The Washington D.C. Department of the Environment has conducted electrofishing surveys for adult spawning stock and beach seining for juvenile river herring in the Potomac River. Catch rates of adult river herring from electrofishing showed a steep decline for both alewife and blueback herring from the late 1990s to the early 2000s followed by a period of fluctuation at low levels through 2010 (ASMFC 2012c Volume II, p. 476). Catch rates of juvenile alewife from the beach seining survey also showed a dramatic decline from the early 1990s until 2010. However, juvenile blueback herring have showed a cyclical pattern with relatively high

abundance in the late 1990s followed by a decrease by the mid-2000s and another increase in late 2000s (ASMFC 2012c Volume II, p. 476).

The Delaware Department of Natural Resources and Environmental Control conducts two trawl surveys in the Delaware Bay for fisheries assessment. The 30-foot bottom trawl is used to assess adult river herring and the 16-foot otter trawl is used to assess juvenile river herring. The 30-foot bottom trawl showed an increase in alewife abundance occurred from 1996–1998. After 1998, alewife relative abundance decreased and has remained at low levels since 2002. Blueback herring varied without trend throughout the 1990s prior to good year classes in 1999 and 2000, but then trended downward from 2001 to 2003 and has remained at depressed levels without trend since 2003 (ASMFC 2012c Volume II, pp 384). The annual abundance index from the 16-foot otter trawl showed young-of-the-year (YOY) alewife in the Delaware River and Bay varied without trend throughout the time series with peak years in 1996, 2000, 2003, and 2007. The age-1 alewife index declined since the highest value was reached in 1997. The YOY index for blueback herring increased slightly from 1990 through 2003, but substantial declines were noted since then (ASMFC 2012c Volume II, pp 386). These trends in abundance indices suggest the river herring population has declined in the Delaware Bay and Delaware River over the last decade.

4.4.3.2 Susquehanna River Herring

Declining trends in river herring populations observed throughout the Mid-Atlantic region have also been seen in the fish lifts at Conowingo Dam (Table 6). The numbers of river herring passing Conowingo Dam by the EFL have shown substantial annual variation, but in general, have greatly declined over the last decade. The highest number passing occurred in 2001 with 292,379, but since 2003 the number passing has dramatically declined and has remained less than 1,000 passing each year. In 2014, 25 blueback herring and 111 alewife passed Conowingo Dam (Normandeau Associates 2014b, p. 3). St. Pierre (1981, p. 36) estimated the run size in the 1890s at 10 to 40 million fish based on historical records of commercial catch of river herring at that time. Thus, contemporary numbers of river herring accessing habitat upstream of Conowingo Dam are a small fraction of what once occurred in the river.

Table 6. Counts of river herring passed at the Conowingo Dam East Fish Lift (1991-2014). Data were obtained from SRAFRC (2013a, p. 10) unless otherwise noted.

Year	Blueback Herring	Alewife	Total
1991	13,149	323	13,472
1992	261	3	264
1993	4,574	0	4,574
1994	248	5	253
1995	4,004	170	4,174
1996	261	3	264
1997	242,815	63	242,878
1998	700	6	706
1999	13,625	14	13,639
2000	14,963	2	14,965
2001	284,921	7,458	292,379
2002	2,037	74	2,111
2003	530	21	551
2004	101	89	190
2005	4	0	4
2006	0	0	0
2007	460	429	889
2008	1	4	5
2009	71	160	231
2010	4	1	5
2011	17	2	19
2012	25	27	52
2013[1]	7	0	7
2014[2]	25	111	136

[1]Data Source: Normandeau Associates (2013, p. 3)
[2]Data Source: Normandeau Associates (2014b, p. 3)

4.4.4 American Eel

Declines in American eel populations have been observed across their Atlantic coast range (Haro et al. 2000, entire) and can be attributed to a combination of causes such as historical overfishing, habitat loss, food web alterations, predation, turbine passage mortality, environmental changes, toxins and contaminants, and disease (ASMFC 2012a, p. 100). American eel are managed coast-wide by the ASMFC through an Interstate Fishery Management Plan which is followed by all Atlantic coast states (ASMFC 2000, entire and subsequent addenda). Addendum II to the Fishery Management Plan, issued by ASMFC in 2008, specifically requests provisions for upstream passage and downstream protection measures for American eel during FERC hydroelectric dam relicensing efforts as a management strategy to

protect the coast-wide population of American eels (ASMFC 2008, p. 5). In 2012, ASMFC completed a coast-wide stock assessment for American eels and determined that the population of American eel is depleted and their abundance is well below historical levels (ASMFC 2012a, p. 15). The American Eel Management Board (state directors) addressed coast-wide population declines in October 2014, by establishing a quota for yellow (immature) eels and glass (juvenile) eels, and restricting licenses for the silver (mature) eel fishery (ASMFC 2014, entire). Currently there is no commercial harvest of American eels allowed in the Pennsylvania or New York portions of the Susquehanna River (ASMFC 2014, p. 13).

In 2004, the Service was petitioned to list American eel under the ESA, but ultimately determined that listing was not warranted (72 FR 4967 (2/2/07)). The Service determined that although the population of American eel had declined and had been extirpated from some areas, it was still widely distributed throughout its historic range and not in immediate threat of extinction (72 FR at 4995). In 2010, the Council for Endangered Species Act Reliability petitioned the Service to re-consider listing the American eel under the ESA based on new information (CESAR 2010, entire). The 2010 petition suggested that American eel was currently threatened with extinction due to the present or threatened destruction, modification, or curtailment of its habitat or range, overutilization for commercial and recreational purposes, disease and possibly predation, the inadequacy of existing regulatory mechanisms, as well as global warming, and anthropogenic factors related to electric generation by hydroelectric projects and the spread of swim bladder parasites from ship ballast water (CESAR 2010, p. 16). In 2015, the Service completed the status review and determined that listing was not warranted at this time and that the American eel remains widely distributed throughout its native range (80 FR 60834 (10/8/2015)).

4.4.4.1 Mid-Atlantic Region American Eel

American eel are relatively abundant in the Mid-Atlantic region and support a commercial fishery. From 2010 to 2013, 70 percent of the 1 million pound coast-wide annual commercial fishery harvest of American eel came from the Chesapeake Bay and tributaries (ASMFC 2014, p. 10, with no commercial harvest upstream of Conowingo Dam). The eel population in the Mid-Atlantic region is not evaluated separately from the coast-wide population. The coast-wide

population was considered depleted in the 2012 ASMFC Stock Assessment. The 2012 ASMFC Stock Assessment used data available through 2010 and continued sampling since that time has shown no trend in juvenile recruitment (YOY) through 2013, indicating that the American eel population is not increasing or decreasing in abundance in since 2001 (ASMFC 2014, p. 8).

4.4.4.2 Susquehanna River American Eel

There is no current formal assessment for American eel abundance available for the Susquehanna River. Based on collections by the Service at Conowingo Dam since 2006, juvenile eels (elvers) continue to arrive at the dam in large numbers through the summer (Minkkinen and Park 2014, p. 9). Stocking efforts since 2008 have resulted in American eels being distributed throughout the watershed, with high densities observed at stocking location in studies conducted by resource agencies (Minkkinen and Park 2014, pp. 3, 11).

Service research studies on stocked American eels have found that they grow quickly and are maturing at relatively young ages. American eels are successfully maturing and migrating out of the Susquehanna River, with the first collections of adult eels occurring in 2013 (Minkkinen et al. 2014, entire). Downstream migrating adult American eels were collected in the fall months from the strainers located at Peach Bottom Atomic Power Station (on Conowingo Pond) and at Safe Harbor Dam.

The Service has identified previously stocked American eels with the parasitic stage of juvenile freshwater mussels attached to the eels' gills being found in Susquehanna River tributaries (Minkkinen et al. 2012, p 8). In the Susquehanna River, the American eel is the most effective fish host for successful reproduction of the freshwater elliptio mussel (Lellis et al. 2013, p 75). Preliminary results of field studies indicate that juvenile mussels were much more abundant after American eel stocking than before stocking (Minkkinen et al. 2014, entire). A greater abundance of American eels is expected to result in a greater abundance of mussels, which in turn, may improve water quality in the Susquehanna River and Chesapeake Bay.

5. Comprehensive Plans and Objectives

To address the decline of migratory fish in the Susquehanna River, SRAFRC developed the 2010

Migratory Fish Management and Restoration Plan (2010 SRAFRC Plan) for diadromous fish species in the Susquehanna River (SRAFRC 2010, entire). The 2010 SRAFRC Plan established restoration goals for migratory fish in the Susquehanna River. The restoration goals are based on the completion of a series of management actions, including development of fish passage efficiency criteria for the lower mainstem hydroelectric dams (SRAFRC 2010, pp. 35-55). The 2010 SRAFRC Plan was peer reviewed by a panel of experts, released in draft form for public comment, and all comments were addressed in an appendix to the plan (SRAFRC 2010, pp. 105-124). An addendum to the 2010 SRAFRC Plan was developed and approved by the SRAFRC Policy Committee in 2013. The 2013 addendum specifically addresses American eel restoration to the Susquehanna River basin (SRAFRC 2013, entire).

Following final approval by the SRAFRC Policy Committee, the 2010 SRAFRC Plan was filed with FERC and approved as a comprehensive plan. Pursuant to FPA Section 10(a)(2)(A)(16 U.S.C. 803(a)(2)(A)), and FERC Order No. 481-A, FERC determined that the 2010 SRAFRC Plan and the 2013 SRAFRC Plan satisfied the three statutory criteria to be recognized as comprehensive plans: that the plan is comprehensive for one or more beneficial uses of a waterway; the plan relies on specific standards, data, and methodologies; and the plan is filed with the Commission.

5.1 Published Plans

A number of published state, federal, and regional fishery plans contain management goals that pertain to the Susquehanna River. These comprehensive plans are recognized by the Federal Energy Regulatory Commission's Licensing Process:

Atlantic States Marine Fisheries Commission. 1998. Amendment 1 to the Interstate Fishery Management Plan for Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*). Fishery Management Report No. 31. July 1998. 43pp.

Atlantic States Marine Fisheries Commission. 1998. Interstate fishery management plan for Atlantic striped bass. Fishery Management Report No. 34. January 1998.

Atlantic States Marine Fisheries Commission. 1999. Amendment 1 to the Interstate Fishery Management Plan for shad and river herring. Fishery Management Report No. 35. April 1999. 77pp.

Atlantic States Marine Fisheries Commission. 2000. Interstate fishery management plan for American Eel. Fishery Management Report No. 36 of the Atlantic States Marine Fisheries Commission. 79pp.

Atlantic States Marine Fisheries Commission. 2000. Technical Addendum 1 to Amendment 1 of the Interstate Fishery Management Plan for shad and river herring. February 9, 2000. 6pp.

Atlantic States Marine Fisheries Commission. 2009. Amendment 2 to the Interstate Fishery Management Plan for shad and river herring, Arlington, Virginia. May 2009.

Atlantic States Marine Fisheries Commission. 2010. Amendment 3 to the Interstate Fishery Management Plan for shad and river herring, Arlington, Virginia. February 2010.

Chesapeake Bay Program. 2000. Migratory Fish Restoration and Passage on the Susquehanna River. January 2000.

Chesapeake Bay Program. 2004. Restoring Fish Passages throughout the Chesapeake Bay Watershed. February 2004.

Chesapeake Bay Program. 2004. Shad and the Chesapeake Bay. February 2004.

Chesapeake Bay Program. 2005. Fish Passage Goals. January 2005.

National Marine Fisheries Service. 1998. Final Recovery Plan for the Shortnose Sturgeon (*Acipenser brevirostrum*). Prepared by the Shortnose Sturgeon Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland. December 1998. 104pp.

National Park Service. 1982. The nationwide rivers inventory. Department of the Interior, Washington, D.C. January 1982.

Policy Committee of the Susquehanna River Anadromous Fish Restoration Committee (SRAFRC). 2002. Alosid management and restoration plan for the Susquehanna River Basin.

Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC). 2010. Migratory fish management and restoration plan for the Susquehanna River Basin. 124pp.

Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC). 2013. Susquehanna River Basin American eel restoration plan: addendum to the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) 2010 migratory fish management and restoration plan for the Susquehanna River Basin. 18pp.

Susquehanna River Basin Commission. 1987. Comprehensive plan for management and development of the water resources of the Susquehanna River Basin. Harrisburg, Pennsylvania. June 1987. 153pp. and appendices.

5.2 Restoration Objectives

5.2.1 American Shad and River Herring

The Service supports goals and objectives in the 2010 SRAFRC Plan as a framework to restore important migratory fish resources to the Susquehanna River Basin.

The goal of the 2010 SRAFRC Plan relating to American shad and river herring 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.*

The steps to achieve this goal are partitioned into five objectives, each with a series of tasks. The tasks include a brief description along with timelines, costs, potential sources of funding and an assessment of task status. Brief overviews of the five objectives are:

A. Restore access to historic habitats for juvenile and adult migratory fish. This objective calls for development of passage plans and performance measures to achieve specified minimum passage efficiency for American shad, American eel, and other migratory fish species at major basin dams.

B. Maintain or improve existing migratory fish habitat. This objective focuses on essential habitat issues by inventorying blockages and assessing the impact of fish passage impediments through active involvement of SRAFRC in watershed project reviews while supporting monitoring and improving water quality.

C. Enhance migratory fish spawning stock biomass and maximize juvenile recruitment. This objective includes a variety of tasks designed to directly or indirectly improve migratory fish stocks in the Susquehanna River. Tasks focus on improving current techniques for artificial augmentation of American shad stocks, developing new techniques for augmenting river herring and American eel populations, restoring non-alosine migratory fish, improving upstream and downstream migration, improving spawning and rearing habitat, and improving regulatory framework restricting harvest of migratory fish.

D. Evaluate the migratory fish restoration effort and adjust programs or processes as needed. This objective stresses the importance of data dissemination and analysis. Tasks will include collecting baseline data essential to monitor restoration progress while researching and experimenting with technologies to improve survival, reproduction and spawning biomass.

E. Ensure cooperation among all restoration partners while generating support for the

restoration of migratory fish among the general public and potential funding sources. This objective stresses the importance of a watershed approach to restoration and emphasizes the need to include coastal states and ocean waters.

The SRAFRC, through its Policy and Technical Committees, member agencies and partners, will rely on this plan as the foundation of its restoration activities while also recognizing that changes in fish stocks, threats, and management techniques will require flexibility and adaptation (SRAFRC 2010, p. 6).

To restore access to historical habitat for juvenile and adult migratory fish in the Susquehanna River (objective A), the SRAFRC has established upstream and downstream passage efficiency criteria for the lower mainstem dams on the river. The upstream criteria for American shad are 75 percent of the fish passing the next downstream dam or 85 percent of the fish that enter a hydroelectric project's tailwaters (SRAFRC 2010, p. 35). For Conowingo Dam, the criterion of 85 percent of the American shad that enter the project's tailwaters is applicable because there are no other dams downstream of Conowingo Dam from which to measure the 75 percent standard. Although SRAFRC established population restoration objectives for river herring in the 2010 SRAFRC Plan, they did not establish an upstream passage efficiency criterion for river herring. For downstream passage, the 2010 SRAFRC Plan calls for 80 percent survival for adult, and 95 percent survival for juvenile American shad and river herring (SRAFRC 2010, p. 36-37).

The Service typically expects that all fish attempting to pass a dam will be allowed to pass when it issues fishway passage prescriptions. Nonetheless, in the case of the Susquehanna River dams on the lower mainstem, in this instance, the Service supports the criteria established in the 2010 SRAFRC Plan, accepting, based on the available scientific evidence, the premise that establishing upstream and downstream passage efficiency criteria at less than 100 percent will still allow for achievement of restoration goals for target species (USFWS 2015c, entire).

5.2.2 American Eel

The Service supports goals and objectives of the 2013 addendum to 2010 SRAFRC Plan specific to American eel restoration efforts in the Susquehanna River Basin (SRAFRC 2013).

The goal for American eel restoration 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, 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 larvae (glochidia) of the freshwater mussel, *Elliptio complanata* (SRAFRC 2013, p. 5).

The goal will be achieved through ensuring upstream passage for American eels throughout the Susquehanna River basin, increasing survival and escapement of American eels passing barriers and hydroelectric facilities during their downstream spawning migration, evaluating efforts to reintroduce American eels throughout the Susquehanna River basin, documenting the influences of American eel on freshwater mussel populations, and increasing public awareness, appreciation and knowledge of American eels.

Specifically, the 2010 SRAFRC Plan states that upstream passage plans will need to be developed and implemented at FERC-licensed dams to ensure adequate passage of American eels. The 2013 SRAFRC Plan addendum suggests that a trap and transport program may be most effective for American eel restoration efforts in the basin, by eliminating the cumulative upstream passage inefficiencies as a result of passing multiple mainstem dams. In addition to the restoration plan recommending a trap and transport program for American eel, the Muddy Run Pumped Storage Facility's Water Quality Certification through the Pennsylvania Department of Environmental Protection also requires that American eels be collected at Conowingo Dam or some other location and transported upstream as part of the license conditions for that facility (PADEP 2014, p. 13, Appendix 1), supporting the recommendations of the 2010 SRAFRC Plan and its 2013 addendum.

6. Actions Necessary to Accomplish Restoration Objectives

The low numbers of diadromous fish species (American shad, river herring, and American eel) currently within the Susquehanna River watershed are the result of cumulative effects of multiple factors including predation, poor fish passage effectiveness, turbine mortality, poor environmental conditions in some years, and bycatch in offshore commercial fisheries (SRAFRC

2010, p. 28). The factors of poor passage effectiveness and turbine mortality are directly related to hydropower development and operations on the river. If restoration of diadromous species is to be successful, all hydropower operations have a role in ensuring that their cumulative impacts are minimized to the extent that they are not preventing population growth of diadromous fish species.

6.1 Population Goals for Restoration

The restoration goal for American shad on the Susquehanna River is 2 million adult American shad spawning upstream of York Haven Dam (SRAFRC 2010). This restoration goal was based on the wetted area of the river and an assumed density of adult American shad. The 2010 SRAFRC plan states "These computations used an area-density estimate of 48 American shad per acre for the mainstem up to Sunbury and the entire Juniata River up to present day blockages" (SRAFRC 2010, p. 34). The assumed density of 48 adult American shad per acre was derived by St. Pierre (1979 (rev. 1981), pp. 33-34).

In St. Pierre's original estimation of the number of American shad that the river could support, he included the area of the "…mainstem to Clarks Ferry and the Juniata to Lewistown" which he estimated to have approximately 38,000 acres of habitat. With an assumed density of 48 adult shad per acre, the population in this area was expected to be 1.8 million American shad. St. Pierre also indicated that the density of shad could range from 25 to 142 per acre and thus his estimate of the number of shad that could be supported in the mainstem to Clarks Ferry and the Juniata to Lewistown could range from approximately 950,000 to 5.4 million (St. Pierre 1979 (rev. 1981), pp. 33-34).

The Service further examined the potential population of American shad that could be supported by the amount of habitat in the Susquehanna River under a range of densities of adult American shad and areas of interest. Area of reaches within the river was estimated via a GIS using NHDPlus data (http://www.horizon-systems.com/NHDPlus/NHDPlusV1_home.php) which is more accurate than the methods available at the time St. Pierre drafted the 1979 report.

Table 7 shows the area of various river reaches and the corresponding number of adult American

Shad that could be expected under assumed densities ranging from 25 – 142 per acre (St. Pierre 1979 (rev. 1981), p. 33). The West Branch of the Susquehanna River is included as this tributary also contains suitable habitat for American shad from its confluence upstream to Lock Haven (Kocovsky et al. 2008, p. 907; Kocovsky et al. 2009, pp. 113–114). The area upstream of Lock Haven is polluted with acid mine drainage from bituminous coal mines and is not included. In total, the number of American shad that the Susquehanna River could support in the absence of passage barriers ranges from approximately 2.0 to 11.6 million depending on the assumed density of adult shad. In the area described by St. Pierre (1979 (rev. 1981)), 1.1 to 6.1 million shad would be expected. In the area described in the 2010 SRAFRC plan, 723,000 to 4.1 million shad would be expected. Finally, in the area from York Haven Dam upstream to Binghamton, New York, including the Juniata River and the West Branch as far as Lock Haven, 1.0 to 5.8 million shad would be expected. The current restoration goal of 2 million adult American shad spawning upstream of York Haven Dam falls within the range of estimates based on available spawning habitat in the Susquehanna River.

Table 7. Area-density estimates of the number of American shad that could be supported by the Susquehanna River. Acres of habitat in each river reach were derived from NHDPlus data.

River Reach	Acres	Shad (25/acre)	Shad (48/acre)	Shad (142/acre)
Mouth to Conowingo	4,312	107,789	206,955	612,242
Conowingo to York Haven	23,429	329,632	632,893	1,872,310
York Haven to Clarks Ferry	12,591	314,776	604,370	1,787,928
Clarks Ferry to Sunbury	13,515	337,864	648,698	1,919,066
Sunbury to Binghamton, NY	18,653	466,335	895,363	2,648,781
Juniata River to Lewistown	2,658	66,454	127,592	377,460
Juniata River from Lewistown to Upstream Blockages	144	3,605	6,922	20,476
West Branch to Lock Haven	6,435	160,880	308,889	913,796
Total	81,737	2,043,425	3,923,376	11,606,654
St. Pierre's estimate[1]	42,990	1,074,742	2,063,505	6,104,534
2010 SRAFRC Plan Goal[2]	28,908	722,699	1,387,582	4,104,930
York Haven to Binghamton, NY[3]	41,126	1,028,154	1,974,056	5,839,916

[1]Includes habitat in the reaches of the mouth to Conowingo, Conowingo to York Haven, York Haven to Clarks Ferry, and the Juniata River to Lewistown.
[2]Includes habitat in the reaches of: York Haven to Clarks Ferry, Clarks Ferry to Sunbury, and the entire length of the Juniata River to upstream blockages.
[3]Includes habitat in the reaches from York Haven upstream to Binghamton, NY, Juniata River to upstream blockages, and the West Branch to Lock Haven.

6.2 Fish Passage Efficiency

6.2.1 American Shad

The 2010 SRAFRC management plan calls for each of the four lower river hydroelectric dams to pass upstream 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 (SRAFRC 2010, p. 35). Also, downstream passage should ensure at least 80 percent survival for adult alosines (American shad and river herring) and 95 percent survival for juvenile alosines (SRAFRC 2010, p. 36)

The expected growth of the American shad population in the Susquehanna River under the passage efficiency criteria specified in the 2010 SRAFRC management plan was evaluated by

the Service through simulations of an American shad population model (USFWS 2015c, entire). This population model was developed by Normandeau Associates Inc. and details on the model structure are described in Exelon 2012c (entire). Briefly, this model simulates American shad upstream passage efficiency and downstream passage survival at each of the five hydroelectric facilities on the Susquehanna River. As simulated American shad encounter Conowingo Dam, a proportion of them are passed upstream, and the number of American shad passing successive hydroelectric facilities (Muddy Run, Holtwood, Safe Harbor, and York Haven in an upstream direction) is reduced during upstream passage at those facilities. Those that eventually pass York Haven Dam will spawn. The model allows for some spawning between Safe Harbor and York Haven as there is some suitable spawning habitat in this stretch of river. The model can be adjusted with assumptions of sex ratio, age structure for virgin and repeat spawning females, and a net reproductive rate which is the future recruitment per spawning female and includes fecundity and survival from egg to virgin spawner. Annual stocking and trap and transport operations can also be simulated. The model runs on an annual time step and a starting population can be specified.

The Service used this model to simulate American shad population growth under scenarios of current low upstream fish passage efficiency, increasing fish passage efficiency at each dam to 50 percent as a level suggested by FERC in its Final Environmental Impact Statement for hydropower licenses based on observations from the Columbia River (FERC 2015, p. 177), and increasing fish passage efficiency to levels specified in the 2010 SRAFRC plan. Under each of these scenarios, simulations were run with and without stocking larval American shad and trap and transport operations to determine the sensitivity of population growth over a 50-year license term to these supplementation techniques. The current upstream fish passage efficiency was estimated from counts of American shad passed at all dams from 1997 – 2014 (http://fishandboat.com/shad_susq.htm) using a ratio estimator (USFWS 2015c, p. 5). Upstream passage efficiency at Holtwood Dam, Safe Harbor, and York Haven Dams was 32, 76, and 14 percent, respectively. Upstream passage efficiency at Conowingo Dam was 37 percent which was the average measured through radio telemetry studies conducted at the dam in 2010 and 2012 (Exelon 2011a p. 15; 2012d, p. 16). The model results showed that under current low fish passage efficiency, the population would decline in the absence of stocking larval shad or trap

and transport operations. Model results were corroborated by the observed American shad population decline in the Susquehanna River since 2001, coinciding with the cessation of the trap and transport program, reduction in hatchery stocking, and low fish passage efficiencies at three lower mainstem dams.

When passage efficiency increased to 50 percent, the population only grew if stocking larval American shad or trap and transport continued for the entire 50-year license term and still only reached 9 percent of the restoration goal. Restoration of 2 million adult American shad upstream of York Haven Dam was only possible within a 50-year license term if upstream passage efficiency was increased to the levels specified in the 2010 SRAFRC plan (USFWS 2015c, pp. 5-6). Stocking and trap and transport shortened the time to reach restoration when upstream passage efficiency equaled levels specified in the 2010 SRAFRC plan, but did not result in restoration if upstream passage efficiency was reduced from the SRAFRC specified efficiencies. The results from this modeling effort demonstrated that levels of upstream passage efficiency specified in the 2010 SRAFRC management plan are appropriate for restoration to occur and that restoration of American shad in the Susquehanna River cannot occur if these levels of upstream passage efficiency are not achieved at all projects.

6.2.2 River Herring

There were no upstream passage efficiency goals specified for river herring in the 2010 SRAFRC management plan and a population model for river herring in the Susquehanna River currently does not exist to gain insight as to what appropriate levels of fish passage should be for restoration to occur. However, fish passage efficiency needs to be sufficient to reach the population target of 5 million river herring upstream of York Haven Dam (SRAFRC 2010, p. 5). The 2010 SRAFRC management plan does specify that downstream passage for adult and juvenile alosines (which includes river herring) at the four lower river hydroelectric dams should be 80 and 95 percent survival at each facility, respectively (SRAFRC 2010, p. 36).

6.2.3 American Eel

The 2013 addendum to 2010 SRAFRC Plan has a goal that every American eel that approaches Conowingo Dam is passed upstream into the Susquehanna River basin. For downstream

migrating silver eels, the 2010 SRAFRC Plan calls for 85 percent survival at each hydroelectric project on the river (SRAFRC 2010, p. 37; SRAFRC 2013 p. 7).

Sweka et al. (2014, entire) developed an egg-per-recruit model for American eels in the Susquehanna River to evaluate the effects of upstream and downstream passage on the reproductive output of eels in the basin. The egg-per-recruit model estimated the total number of eggs expected to be produced per individual eel encountering Conowingo Dam during its upstream migration. The model assumed different life histories for American eels that passed upstream of the dams on the Susquehanna River compared to those that remained downstream of Conowingo Dam. Those that passed upstream had a greater probability of becoming female, a longer time until maturity, and experienced lower natural mortality compared to those that remained downstream of Conowingo Dam (Sweka et al. 2014, p. 767). Upon maturity and downstream migration, silver eels that were located upstream of the dams experienced mortality at each of four dams and the MRPSP as opposed to silver eels which spent their entire freshwater life downstream of Conowingo Dam. The model showed that if any eels are passed upstream, downstream passage survival at each of the five hydroelectric projects on the river must be 80 percent or greater (33 percent cumulative survival over all five hydroelectric projects); otherwise the total reproductive output from the river would be less than what would be expected by not passing any eels upstream (Sweka et al. 2014, pp. 770 – 771). These modeling efforts support the SRAFRC goal of 85 percent survival at each hydroelectric project (SRAFRC 2010, p. 37; SRAFRC 2013 p. 7) as that goal promotes some growth of the American eel population compared to the threshold value of 80 percent determined by Sweka et al. (2014, p. 770).

6.3 Rate of Fish Passage for American Shad

Migratory delay is an important component of fish passage that must be addressed for anadromous fish to successfully complete their life cycle. Migratory delay is the decreased rate of upstream (or downstream) movement that occurs when migrating fish encounter a barrier. American shad and river herring must travel upstream at a rate that allows them to reach suitable spawning habitat and successfully spawn within the optimal seasonal spawning window. Further, timing of spawning (Olney et al. 2001, p. 892) and survival of juvenile life stages (Crecco and Savoy 1985, p. 1645; Leach and Houde 1999, p. 768) of American shad are

physiologically linked to water temperature. If fish are delayed in reaching the suitable spawning habitat, they are more likely to encounter late spring water temperatures higher than those conducive to optimum spawning and survival of larval shad. Optimal spawning temperatures range from 57 ° – 70 ° F (Walburg and Nichols 1967, p. 7) and optimal temperatures for larval survival range from 59 ° – 79 ° F (Leach and Houde 1999, p. 781).

Water temperature at York Haven Dam reaches the upper end of the optimal range for American shad spawning by June 1 (Figure 4) in an average year. Fish passing York Haven Dam after this date likely encounter water temperatures greater than the optimal for spawning. The timing of American shad migration each season varies at Conowingo Dam depending on environmental conditions. Fifty percent of the seasonal run passes the project by dates ranging from April 27th to May 20th (USFWS 2015b, p. 7) with a median date of May 7th. The American shad passing Conowingo Dam have experienced a median delay of 5 days, thus we could expect that 50 percent of the shad run arrives at Conowingo Dam by May 2nd. If each dam imposed a 5-day delay for upstream migrating shad, 50 percent of the fish that migrate to York Haven Dam would be expected to pass the dam by May 22nd, leaving only one additional week for the remaining 50 percent of the run to pass the project while optimal temperatures are available. In addition, this estimate does not incorporate travel times between dams, which would further increase time required to reach spawning habitat upstream of York Haven Dam, resulting in less than half of the American shad passing York Haven Dam before temperatures exceeded the optimum range for spawning. Thus, it is important to minimize the delay fish experience at each dam so that spawning is not compromised by elevated temperature by the time shad arrive in habitat that is physically suitable for spawning.

Delays in upstream migration also result in the expenditure of additional energy in reaching the spawning grounds as fish attempt to navigate past a dam (Leggett et al. 2004, entire). The use of more energy per distance traveled can result in a decrease in the total migration distance once energy stores are depleted to a point where upstream migration ceases (Castro-Santos and Letcher 2010, p. 816). When excessive energy is expended in the upstream migration, not only can spawning be compromised, but also post-spawning survival can be reduced if energy stores are depleted to the point where fish suffer mortality before escapement to the ocean following

spawning (Castro-Santos and Letcher 2010, entire). This is especially significant considering that American shad and river herring in the Mid-Atlantic region can spawn multiple times over their lifetime (ASMFC 2007, Volume I, p. 24). The impact of delay was also noted by the FERC (2004, p. 5) when it stated "Upstream-migrating fish may be delayed for hours or days searching for passage at a dam before finding the fish passage facility entrance. This delay could reduce the fitness of spawning adults or the upstream extent of their migration."

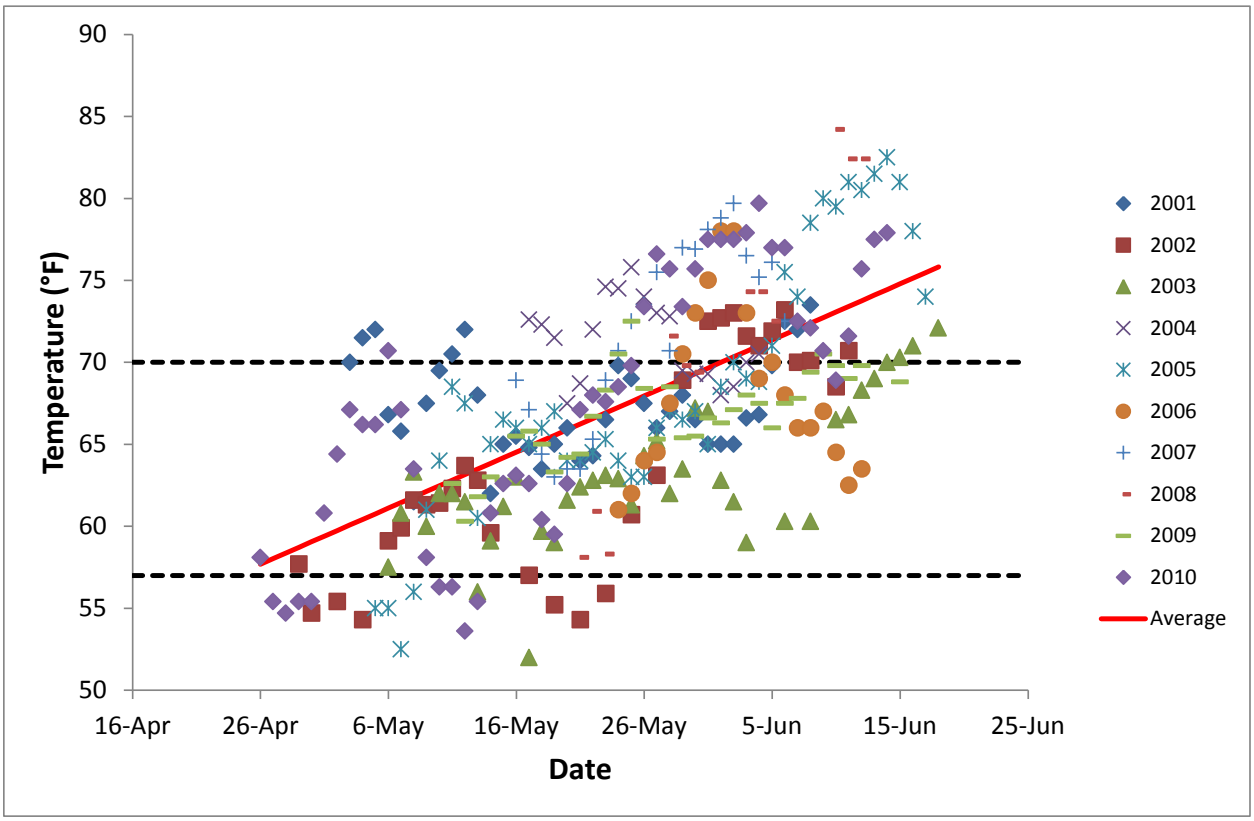

Figure 4: Water temperatures at York Haven Dam (2001 – 2010). The dashed horizontal lines represent bounds on the optimal temperature for American shad spawning and the red line represents average temperature on a given date. The average temperature reaches the upper bound of the optimal range on June 1.

The overall percentage of American shad passing Conowingo Dam is a function of the number of fish entering the tailrace of the dam each day throughout the fish passage season and the rate of passage (percentage of the population available to pass which actually do pass per day). If the rate of passage is low, then the amount of time fish are delayed increases. Also, the overall

percentage of the American shad population that passes the dam decreases because fewer fish are able to pass the dam within the duration of the annual spawning run of shad which lasts 5 to 10 weeks each spring. Thus, in order to have a relatively high overall percentage passing (e.g. 85 percent) during the annual spawning run, the rate of passage must also be high. The 85 percent passage efficiency criterion at Conowingo Dam is consistent with passage efficiency goals specified in the 2010 SRAFRC management plan (SRAFRC 2010, p. 35) and was shown to result in restoration within the time period of a license term (USFWS 2015c, pp. 5-6). Finally, the passage rate that would be associated with achieving 85 percent passage efficiency has been shown to be achievable within the Susquehanna River (See Section 6.4).

6.4 Feasibility of Meeting Passage Efficiency Criteria

The Service's and SRAFRC's criterion for upstream passage efficiency of American shad has been demonstrated to be achievable within the Susquehanna River. In an analysis of fish passage at Safe Harbor Dam, counts of American shad passing Holtwood and Safe Harbor Dams were used to estimate passage rates at Safe Harbor Dam (USFWS 2015b, entire). A survivorship-type model was used to estimate the rate of passage that resulted in the observed number of fish passing Safe Harbor Dam on each day over the 1997 – 2014 fish passage seasons. The median estimated passage rate at Safe Harbor Dam was approximately 32 percent per day (which is equivalent to approximately 80 percent in 4 days). When this passage rate is applied to the proportion of the American shad run arriving at Conowingo Dam each day throughout the fish passage season, a median level of 83 percent (90th percentile range: 44.8 to 97.9 percent) of the shad entering the tailwaters of Conowingo Dam are expected to pass by the end of the run (USFWS 2015b, p. 7). Thus, the SRAFRC goal of 85 percent passage efficiency is expected to be achieved approximately 50 percent of the time at Conowingo Dam if American shad can pass at the same rate as they do at Safe Harbor Dam.

Other hydroelectric dam owners on the Susquehanna River have agreed to improvements of fish passage facilities in efforts to achieve fish passage goals specified by SRAFRC. The owners of both Holtwood and York Haven Dams are currently implementing fish passage improvements and are required to achieve upstream and downstream fish passage goals established in the 2010 SRAFRC management plan. In addition, the MRPSP will be conducting post-licensing studies

to ensure that project meets the SRAFRC upstream and downstream passage criteria.
As previously stated, all hydropower facilities have a role in ensuring that their cumulative impacts are minimized so that they do not prevent population growth of diadromous fish species in the Susquehanna River. Demonstration that SRAFRC fish passage efficiency goals can be achieved at Safe Harbor Dam combined with fish passage improvements at Holtwood and York Haven Dams in efforts to meet SRAFRC fish passage goals will lead to a greater likelihood of fish restoration. However, improvements at Conowingo Dam to increase fish passage efficiency are also needed if restoration of migratory fish to the Susquehanna River is to proceed.

7. Existing Passage Facilities at Conowingo Dam

7.1 Upstream Passage – Fish Lifts

The Conowingo Dam Project includes two fish lift facilities.

7.1.1 East Fish Lift

The EFL is located on the east side of the powerhouse near the spillway. It was constructed in 1991. The EFL was designed to serve dual functions: 1) to obtain fish for the trap and transport program, and 2) to provide for passage of fish directly over the Conowingo Dam. Since 1997, the Licensee has used the EFL to pass all captured fish directly over the dam, and the trap and transport program was discontinued in 2000 from this facility (Exelon 2011b, pp. 11-12).

The EFL has had no substantial upgrades or changes to its structure since 1991 (Exelon 2011b, p. 10). The main drive motors and associated drive mechanisms were initially disassembled and lubricated after each season to extend life of the motors; however, this maintenance was terminated in 2000 (Exelon 2011b, p. 10). The EFL is in need of preventative maintenance to include sand blasting and painting of the steel structure with rust inhibitive paint. The concrete structure appears to be intact with no major spalling or discernable cracks. There is minor spalling at the location of a few of the railing anchors that should be addressed in the near term. The hopper has surface rust on the exterior steel and should have the existing rust removed and be painted with a rust inhibitive paint (Exelon 2011b, p. 10).

In addition to the lack of recent maintenance to the current EFL structure, there are additional problems with the structure that preclude it from being operated as originally designed (Exelon 2011b, pp.10). Fish passage attraction flow intended to discharge through entrance gate A is drowned every time adjacent Kaplan units are generating (Unit Nos. 8, 9, 10, and 11). For this reason, entrance gate A is normally operated in the closed position whenever the Kaplan units are scheduled to generate, making this entrance gate unavailable for fish passage (Exelon 2011b, pp.10).

7.1.2 West Fish Lift

The WFL is located on the west side of the powerhouse on the bank of the river. It began operation in 1972. It was designed as a trapping facility and cannot pass migrating fish directly over the dam and into Conowingo Pond. It was used through 1996 to obtain fish for the trap and transport program to move fish past the lower Susquehanna River dams and into spawning and rearing habitat upstream. The Licensee currently operates the WFL as a fish trapping, sorting, and egg collection facility for American shad restoration. The Licensee provides an operator for the WFL, and State of Maryland and the Commonwealth of Pennsylvania fund contractors who conduct restoration efforts from that facility.

The WFL has had no substantial upgrades or changes to its structure or operation (Exelon 2011b, p. 4). The WFL is in need of preventative maintenance, which includes replacement of crowder motors, sand blasting, and painting of the steel structure with rust inhibitive paint. The concrete structure appears to be intact with no major spalling or discernable cracks. The weir gate motors are in good condition and are not used as frequently as the crowder gate motors during lifting operations. The hopper has surface rust on the exterior steel and should have the existing rust removed and be painted with a rust inhibitive paint (Exelon 2011b, p. 4).

During a fishway inspection in May 2013 (USFWS 2013c, entire), Service fish passage engineers found the following salient issues at the WFL: the hopper maintains less water than the Service criterion of 0.1 cubic feet per pound of fish; the transfer between the hopper and the holding tank poses a high risk for fish injury; and hydraulic conditions within the fishway channel (e.g., eddies) result in misdirection of the fish and fish passage delays.

7.2 Downstream Fish Passage

There are no existing downstream fish passage facilities or measures at the Project. All fish migrating downstream through the Project must navigate through turbines or any open spill gates to reach the Project tailwaters.

8. Fish Passage Effectiveness at Conowingo Hydroelectric Project

8.1 Existing Upstream Fish Passage Efficiency

8.1.1 Upstream Fish Passage Efficiency for American Shad

The EFL is used for direct passage of migratory fish upstream over the dam into Conowingo Pond, and it is the passage facility where fish passage efficiencies have been recently evaluated. The Licensee conducted a radio telemetry study to determine the current passage efficiency of the EFL. The 2-year study found that in 2010 and 2012 only 45 percent and 26 percent of American shad that reached the tailwaters of the Project (as defined by the downstream end of Rowland Island), were able to successfully pass upstream through the fishway; no other species were evaluated (Exelon 2011a, p. 15; Exelon 2012d, p. 16). In addition to the overall low passage efficiencies, American shad that did eventually pass experienced significant migratory delays downstream of the dam. Data from these studies indicated that American shad that did pass were delayed a median of 5.24 days from the time they were initially located in the tailwaters of Conowingo Dam until they eventually passed (Exelon 2011a, Exelon 2012d). Those studies found only 24 percent and 5 percent (2010 and 2012 studies respectively) of the radio tagged American shad passed the Project within a 4-day timeframe (USFWS 2015e, entire) which is much lower than what has been demonstrated as being possible at other Susquehanna River fish lifts (USFWS 2015b, p. 7).

Current passage efficiency at Conowingo Dam is well below levels required for restoration of American shad populations in the Susquehanna River. Mitigation efforts in the forms of stocking larval American shad and trap and transport efforts can have beneficial effects on the Susquehanna River American shad population. However, population growth and timely achievement of restoration goals will still be limited, and if these mitigation efforts cease, the population would once again decline due to insufficient recruitment of juvenile fish from the

Susquehanna River (see Section 6.2.1). Therefore, the Service requires an increase in both the overall passage efficiency and rate of passage through the Project area.

8.1.2 Upstream Fish Passage Efficiency for River Herring

No upstream fish passage efficiency studies have been conducted on river herring at Conowingo Dam. However, river herring have slower swimming speeds than American shad (Bell 1991, p. 6.3). The entrance gate(s) at the EFL are operated to maintain water velocities of 3 to 8 feet per second (fps) (SRAFRC 1993 pp. 1-4). Water velocities higher than 5 fps exceed the sustained swimming speed for river herring (Bell 1991, p. 6.3). The high water velocity at the entrance gates may preclude herring from successfully entering the EFL and being passed upstream (USFWS 2014b, p. 2). Reduced water velocities at entrance gates may be necessary to efficiently pass river herring at this Project.

8.1.3 Upstream Fish Passage Efficiency for American Eel

Juvenile American eels have migrated to the base of Conowingo Dam in large numbers for decades (SRAFRC 2013, pp. 13-14). Although very few American eels have been passed upstream via the fish lifts at Conowingo Dam, resource agencies have conducted intermittent stocking programs to provide limited access to upstream habitat in the Susquehanna River basin for American eels (SRAFRC 2013, pp. 13–14). American eels require different fish passage structures than do other migratory fish (ASMFC 2013, p. 1). Currently there are no permanent American eel passage facilities or measures in place at any of the Susquehanna River hydroelectric projects to facilitate upstream or downstream eel passage. To restore access to the Susquehanna River watershed for American eels, the Service will require installation of upstream eel passage facilities to be provided at Susquehanna River hydroelectric projects.

8.2 Condition of Existing East Fish Lift Structure, Design, and Operation

Low overall migratory passage efficiency and substantial delays at Conowingo Dam can be attributed to several factors associated with the existing EFL structure and operation.

8.2.1 Preventative Maintenance

Preventative maintenance of the EFL at the Conowingo Dam has not been conducted since 2000 (Exelon 2011b, p. 10), and equipment failures have occurred during critical periods of the annual migratory fish passage season (SRAFRC 2013a, Table 3; Normandeau Associates 2014b, p. 4).

Preventative maintenance of the fish lift as well as having common replacement parts on-hand is necessary to ensure the fish passage facility will function properly, or can be quickly repaired and put back into service during the fish passage season.

8.2.2 Current Fish Passage Design Flows

EFL operators at the Project informed Service engineers inspecting the EFL in 2012 that the existing EFL cannot operate when river flows are higher than 113,000 cfs. Based on Service fish passage criteria, the upper range of the fish passage design flows at the Conowingo Project is a river flow of 143,000 cfs (USFWS 2012a, p. 10). Shutting down fish passage operations during river flows that are less than fish passage design flows can result in unwarranted delays and/or unsuccessful passage for migratory fish that would be otherwise naturally motivated to move upstream during higher river flow conditions.

8.2.3 Attraction Flow and Turbine Boils

The Service's fish passage engineers inspected the EFL structure and operation in May of 2012 and 2014 (USFWS 2012b, pp. 1-2; USFWS 2014b, pp. 1–2), and identified that attraction flow is only one-third of the 900 cfs for which this facility was designed (USFWS 2014b, pp. 1–2). The EFL attraction water is fed through the western-most spillway bay immediately upstream of the fishway. Most of this attraction flow is passed down the ogee crest and into the stilling basin (energy dissipation pool) located at the base of the dam just upstream of the EFL hopper. The drop between the top of the ogee crest and the stilling basin is approximately 85 feet. Water falling this distance has high velocity and considerable energy that needs to be dissipated prior to use for fishway attraction flows. The original design for the EFL of 900 cfs of attraction flow is necessary to achieve preferred hydraulic conditions (e.g., water velocities) at the fishway entrances and inside the fish lift (MDNR 1988, p. 2). The License Applicant informed the Service that it currently operates the EFL with only 300 cfs mainly because the size of the

existing stilling basin at the base of the dam is insufficient to dissipate enough energy from the falling water, resulting in unwanted air bubbles in the fish passage flow that deter fish movement upstream. This lower flow also produces inadequate attraction flow velocities within the channel of the fish lift that may be a factor in fish retreating back downstream (fall back) after locating and entering the lift (Exelon 2011a 15-16; Exelon 2012d p. 14; USFWS 2014b, pp. 1-2). In one instance, the Service verbally requested the EFL operators to run the EFL with 900 cfs so that they could observe the hydraulic issues and the excessive air bubbles described by the License Applicant. The License Applicant declined the Service's request, stating that the physical structure of the EFL could suffer structural and mechanical damages from running 900 cfs, despite the fact that the fish lift should have originally been designed to pass this amount of flow (Exelon staff, personal communication, Conowingo Fish Passage Technical Advisory Committee Meeting, March 30, 2015).

To ensure the hydraulic cue created by a technical fish passage facility is discernible, the Service's recommended amount of attraction flow is expressed as a percentage of the sum of other competing flows (e.g., discharge from turbines) (USFWS 2013d, p. 2). The current Service design standard for attraction flow to a fishway requires at least 3 to 5 percent of the total station hydraulic capacity (i.e. 86,000 cfs; Exelon 2012a, p. B-7) to be emanating from the entrance(s) of the fishway, and that the hydraulically connected crowder/hopper system (e.g., internal channels, crowder area, and exit flume) maintain velocities that will not preclude entrance into the fishway for target fish species (USFWS 2012a, p. 11; USFWS 2013d, p. 2). In the case of Conowingo Dam's EFL, the current standard would require 2,580 to 4,300 cfs to be used for attraction flow at the EFL for successful fish passage. The current attraction flow of 300 cfs represents only 0.35 percent of the total station hydraulic capacity.

8.2.4 Zone of Passage and Project Operations

Fish lifts and ladders are long established fish passage technologies for allowing fish to pass over dams and other height barriers. Successful use of these technical fish passes depends on fish finding the fish passage facility entrance, entering the fish passage facility, and then using the lift or ladder to successfully pass the barrier. However, getting fish up to and entering the facility often presents the greater challenge. Accordingly, numerous conceptual models have been

developed to describe the regions influenced by the hydroelectric project beyond the fish lift (ladder) entrance and exit. Castro-Santos and Perry (2012, p. 430) and Castro-Santos (2012, p. 77) partition this area into three regions: an approach zone, an entry zone, and a passage zone; the former two regions describing areas in front of the fish passage facility entrance, the latter zone characterized by movement within the lift, ladder or other fish passage facility. Johnson and Dauble (2006, p. 221) further partition the area in front of the entrance into approach, discovery, and decision zones. Similar terms partitioning the region downstream of the project into far-field and near-field attraction zones are used in common practice. The Service uses the comprehensive term, zone of passage (ZOP), to collectively describe these regions and has successfully incorporated this concept into other fishway prescriptions (e.g., Holyoke Project – FERC 2005, p. 5; Holtwood Project – USFWS 2009, p. 14).

Formally, the ZOP is the contiguous region of sufficient lateral, longitudinal, and vertical extent in which adequate hydraulic and environmental conditions are maintained to provide a route of passage through a stream reach influenced by a dam, hydroelectric project, or other barrier. For upstream passage, the ZOP encompasses a far-field attraction zone, a near-field attraction zone, the technical fish passage facility, and the impoundment. As illustrated in Figure 5, successful passage requires a migrating fish to enter the ZOP at "A" and promptly exit at "E" before continuing on its way upstream (without falling back downstream). Figure 5 also shows the distinction between the umbrella term "fishway" and a component part, such as the technical fish passage facility (e.g., fish lift). The ZOP is recognized as part of the fishway and this definition is in keeping with 16 U.S.C. § 811 (see details in USFWS 2014c).

An effective ZOP must maintain hydraulic and environmental conditions necessary for successful passage. Flow velocity, key among these conditions, must be high enough to trigger a rheotactic response in upstream-migrating fish and low enough to facilitate movement for even the weakest-swimming target species. Additionally, the spatial and temporal persistence of these conditions must not introduce unacceptable fatigue in the target species. On the lower Susquehanna River, river herring represent the weakest-swimming anadromous target species. Based on published biological criteria, methodologies for estimating sustained speed, and associated fatigue times (Bell 1991, p. 6.3; Bain and Stevenson 1999, pp. 146-147; Haro et al.

2004, p. 1595; Maine DOT 2008, p. 18), the Service recommends that a ZOP for upstream passage generally maintain instantaneous velocities between 1 and 3 feet per second 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). To ensure passage is provided for the entire anadromous target population, these hydraulic conditions must be maintained over the range of flows or project discharges that could be experienced during any fish passage season.

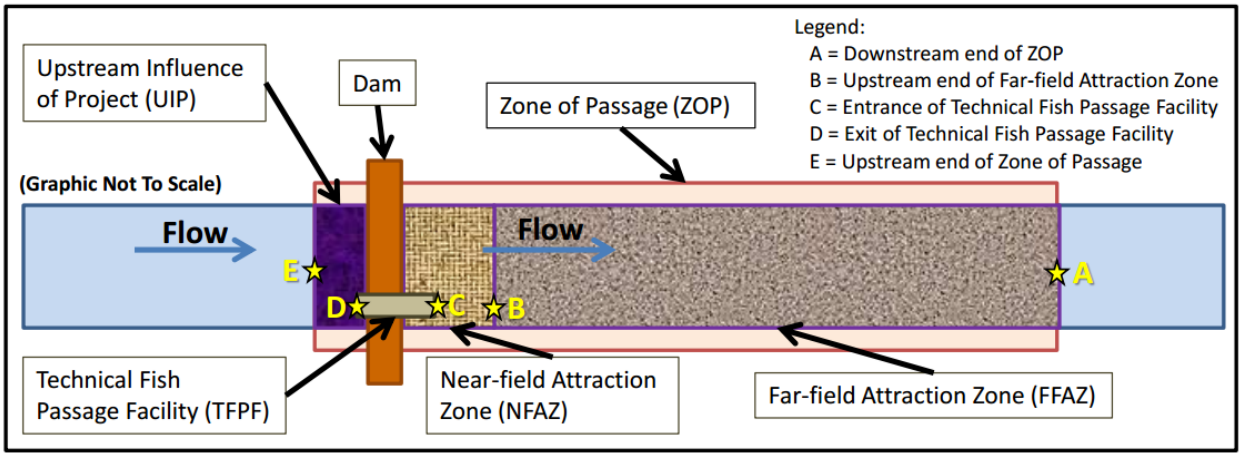

Figure 5: Diagram to illustrate fish passage definitions.

At the Conowingo Project, recent hydraulic modeling has demonstrated the persistence of hydraulic conditions that exceed the abilities of river herring. The model, developed using River 2D software (http://www.river2d.ualberta.ca), indicates that powerhouse discharges in excess of 40,000 cfs create depth-averaged velocities in the tailrace that exceed the 1 to 3 feet per second criterion. These high velocities persist along both sides of Rowland Island (Figure 6; Exelon 2012e, p. 43), for a linear distance greater than river herring are capable of covering while sprinting (i.e., anaerobic burst swim speed). As such, they create a potential barrier to upstream movement. The 30-year flow duration curve indicates that flows exceeded 40,000 cfs for 50 percent of the time during the upstream migration season (USFWS 2012a, p. 28). While the 1 to 3 feet per second criterion was met when flows dropped below 10,000 cfs, occurring only 10 percent of the time during the upstream migration season (USFWS 2012a, p. 28). These conditions demonstrate the inadequacy, on a persistent seasonal basis, of the ZOP in the tailrace downstream of the lift entrances. 3D modeling or actual flow data might demonstrate that a ZOP does exist over the full range of generation scenarios, but that information is unavailable, and the

best information and modeling available indicates that this is a problem that should be remedied. Various in-stream structures including bendway weirs, jetties, rock weirs, and flow training (partitioning) walls have proven effective in reducing bankside velocities to levels consistent with Service criteria. Use of such structures in the tailrace to create a persistent ZOP could mitigate these adverse hydraulic conditions over the range of fish passage design flows experienced during the fish passage season.

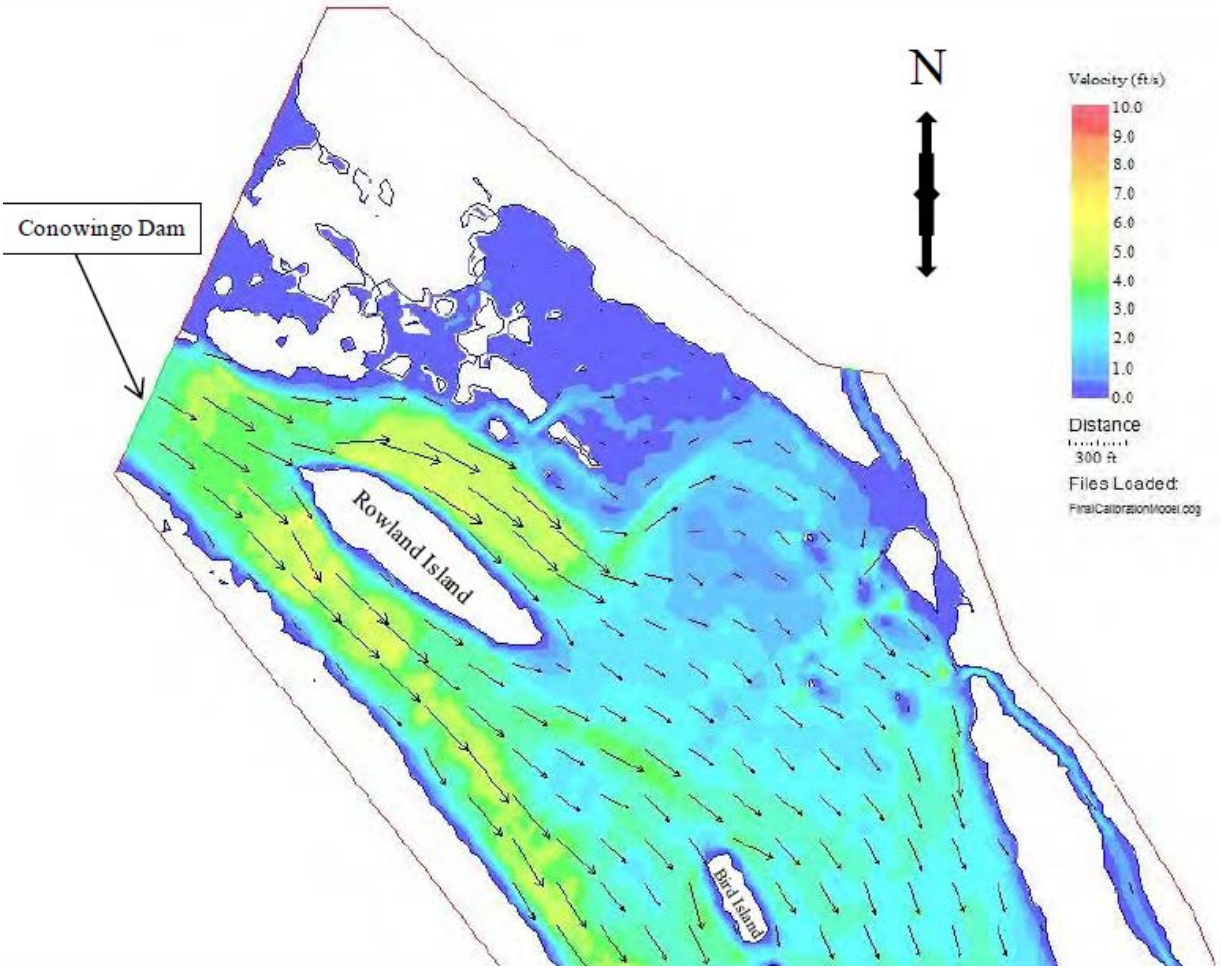

Figure 6. Water velocity in the Susquehanna River in the vicinity of Rowland Island and Bird Island as determined by River 2D Model for 40,000 cfs discharge from Conowingo Dam (Figure 4.2-7: from Exelon 2012e, p. 43).

On a daily and hourly time scale, project operations can also influence the availability of a ZOP for migratory fish. At the Conowingo Project, generation and turbine discharge fluctuate on a daily basis to meet energy demands (i.e. peaking); this cycle creates periods of high project

discharge during fish lift operations (Figure 7). During these daily high discharge periods, water velocity in the tailrace may exceed the sustained swimming speeds of some or all target species. Under such circumstances, normal upstream migration is delayed until conditions change. This demonstrates that even during periods of low project (river) inflow, generation and unit operations can negatively impact the adequacy of the ZOP throughout the tailrace. Modulating tailrace conditions through adjustments to hourly and daily unit operations to provide an adequate ZOP may mitigate this negative impact.

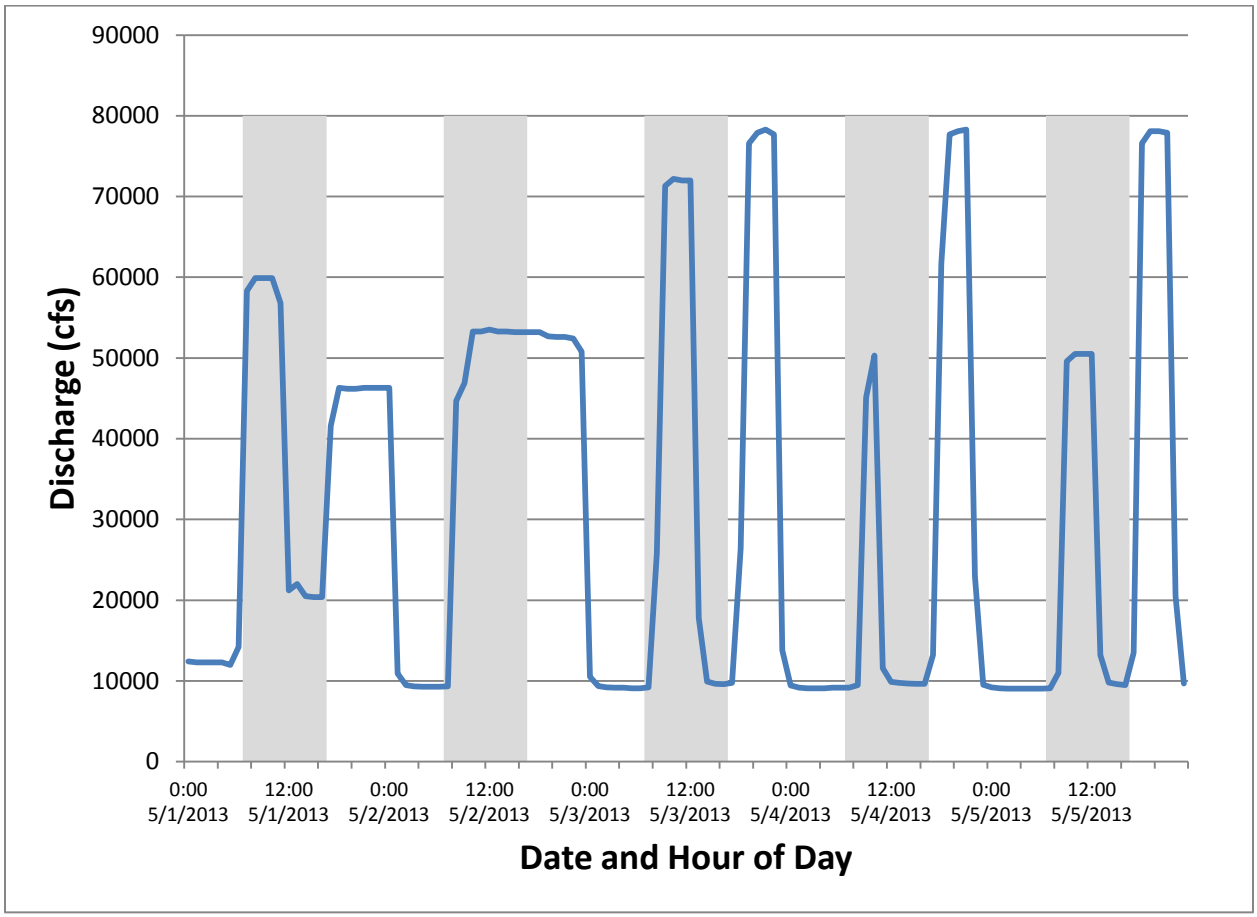

Figure 7. Hydrograph of river discharge downstream of Conowingo Dam during the spring migration season. Data acquired from USGS Gauge Station 01578310. Grey bars indicate hours of fish passage operation (07:00-16:00 daily).

The influence of the Project on the ZOP can also be highly localized. The ZOP properly extends upstream through the tailrace to the fish lift entrances (and beyond). Successful technical fish

passes (e.g., fish lifts) create hydraulic cues that attract fish to one or more entrances in the presence of the competing powerhouse discharges or other false-attraction flows (USFWS 2013d, p. 1). At Conowingo, the current limits on attraction flow discharged from the existing EFL cannot adequately attract upstream migrants to the fish lift entrance while the large Kaplan units are generating. In addition, discharge from the Kaplan units adjacent to the EFL actually creates a localized (high) velocity barrier that inhibits or prevents fish from accessing the EFL entrance(s). Telemetry studies conducted in 2010 and 2012 indicated that of the American shad detected in the tailwaters, only 73 percent and 44 percent, respectively, were able to successfully enter the EFL (Exelon 2011a, p. 15; Exelon 2012d, p. 16). In previous, unsuccessful attempts to mitigate the impacts of the Kaplan discharge, entrance gates A and/or B were frequently closed to fish passage (SRAFRC 2000, pp. 1-3). This further reduced the effectiveness of the facility. The Service concludes that the existing EFL entrances are ineffective at attracting fish, and the ZOP in the vicinity of the Kaplan discharge is inadequate. The aforementioned in-stream structures (e.g., rock weirs) may be used to selectively create continuous, passable routes to the fish lift entrances within the larger tailrace region.

Safe, timely, and effective fish passage at the Conowingo Project is precluded by seasonal, daily, and localized inadequacies in the ZOP which inhibit and prevent access to the existing fish lift entrances for target migratory fish species in the Susquehanna River. The Service recommends or requires measures to avoid or minimize delays in fish migration, particularly since migration events are often time sensitive. The holistic definition of the ZOP and the documented biological criteria provide a scientifically justified framework for the design of measures and in-stream structures to improve passage at the Project.

8.2.5 Capacity of the Existing East Fish Lift

Service fish passage engineering reviews and site inspections have determined that the existing EFL has insufficient lift capacity for passing all the fish attempting passage at the Project (USFWS 2012a, p. 15; USFWS 2012b, p. 13; USFWS 2015d, entire). Fish lift capacity is a measure of the quantity of fish (in pounds per unit of time) that the facility is designed to safely convey, upstream or downstream. The fish lift(s) capacity should be designed so that the available fish of *all species* attempting to pass the project, including American shad, river

herring, and other fish species in the tailrace can be passed upstream in a safe, timely, and effective manner (USFWS 2013e, p. 2).

The timing of when fish arrive during the spawning run is not uniform and is typically highly compressed (the peak of the seasonal run happens during just a few days). The seasonal run of fish can be described as normally distributed (i.e. bell curve), where the crest of the distribution is defined as the peak day of the run during the spawning season. Service experience indicates that for American shad approximately 5 percent to 15 percent of their seasonal run passes during the peak day, depending on the size of the total seasonal run. At Conowingo Dam from 1997 to 2014, 7.3 to 29 percent of total seasonal run passed on the peak day for the respective year. The annual SRAFRC reports show that the average for all years (1997–2014) was 12.8 percent of American shad passing on the peak day (SRAFRC 1998, pp. 1-18 – 1-19; SRAFRC 1999, pp. 1-15 – 1-16; SRAFRC 2000, pp. 1-16 – 1-17; SRAFRC 2001, pp. 1-15 – 1-16; SRAFRC 2002, pp. 1-12 – 1-13; SRAFRC 2003, pp. 1-14 – 1-15; SRAFRC 2004, pp. 1-12 – 1-13; SRAFRC 2005, pp. 1-13 – 1-14; SRAFRC 2006, pp. 1-13 – 1-14; SRAFRC 2008, pp. 16-18; SRAFRC 2011, pp. 11-12; Normandeau Associates 2008, Table 2; Normandeau Associates 2009, Table 2; Normandeau Associates 2010, Table 2; SRAFRC 2012, p. 19; SRAFRC 2013, pp. 23-24; Normandeau Associates 2013, Table 2; Normandeau Associates 2014b, Table 2).

Even on this peak day, the fish do not move uniformly throughout the day. Service experience indicates that approximately 15 percent of the American shad pass on the peak day of passage during the peak hour of that day. For this reason, the designed capacity of a technical fish passage facility (e.g., fish lift) is considered to be a function of the biomass load needed to be passed during the peak hour of the peak day of the seasonal run. The biomass capacity for a fish lift is then defined as the mechanical ability for its hopper, and its holding pool (fish crowding area), to move fish in a single hour. The mechanical capacity for a lift to pass fish in a single hour is a function of the volume of water in the hopper, the volume of water in the holding pool, the volume of water required per fish, and the time the hopper/elevator takes to complete a full lifting cycle as designed (USFWS 2013f, entire; USFWS 2015d, entire).

The Service's standard for American shad weight used in fish passage capacity designs is 4 pounds per fish in order to meet the biological requirements (oxygen) per unit volume for safe passage. This standard has been used for over 30 years on Atlantic coast fish passage projects. Fish passage design is not developed for the "average" size fish, but rather must be more conservative in approach to accommodate larger individuals within the population. Regional data from American shad in both the Susquehanna River Flats and the Delaware River support the use of the 4-pound design criterion when accommodating larger fish that occur in the system (Table 8). Using the Delaware River shad data as a comparison to the Susquehanna River data is appropriate because the Delaware River is geographically close. The population demographics should be similar in the 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 is 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 8).

Table 8. American shad weight used 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 MDNR, Susquehanna Flats surveys from 2009 to 2013

[2]Data from the USFWS Delaware River Coordinator, unpublished data on the Upper Delaware River American shad collections from 2009 to 2013

[3]Data from the USFWS Delaware River Coordinator, Delaware River Lewis Haul Seine Fishery from 1997 to 2006

In addition to American shad, capacity must be provided for river herring passage. River herring are smaller than American shad and their weight is calculated at 0.5 pounds per individual when determining requirements for hopper capacity.

Riverine fish also use or should have access to the fish lift structures at Conowingo Dam. Gizzard shad are a riverine migratory species whose population has increased substantially in the

lower Susquehanna River in recent years. Gizzard shad readily use the fish lifts on the mainstem dams in large numbers, with the EFL passage exceeding 1 million individuals annually since 2011 (Figure 8; SRAFRC 2013a, p. 7). Because gizzard shad migrate over a similar time period as American shad (Normandeau Associates 2014b, Table 1), the Service's capacity calculations assume that the peak of the run for both fish species will overlap. This overlapping of the peak of the run has an impact on the daily capacity required at the Project. Gizzard shad are generally larger than river herring but slightly smaller than American shad. Based on collections from the current WFL, gizzard shad weigh an average of 1.2 pounds (Ray Bleistine, Normandeau Associates, personal communication, February 20, 2015).

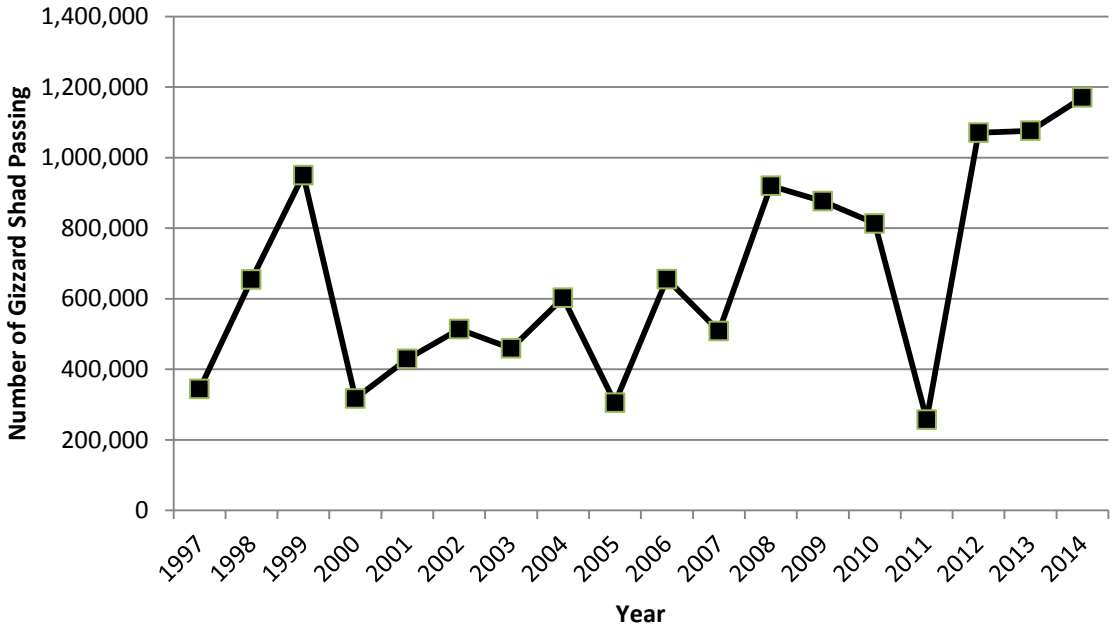

Figure 8: Number of gizzard shad passing Conowingo Dam by the East Fish Lift from 1997 to 2014 (SRAFRC 2013a, p. 11; Normandeau Associates 2013, p. 2; Normandeau Associates 2014b, p. 2). Note: EFL operations were terminated prior to the end of the migratory fish passage season in 2011.

Service's calculations demonstrate that the current 3,300-gallon hopper (Exelon 2011b, p. 11) operating at the EFL provides safe capacity to pass approximately 1.3 million pounds of fish in a single season (USFWS 2015d, entire). Using the Service standard weight of 4 pounds per American shad and assuming that only American shad used the EFL, the capacity would be

325,000 American shad during a single passage season. The actual Service calculated capacity of the current EFL is half of the License Applicant's stated design capacity (750,000 American shad; Exelon 2011b, p. i). Although the lift has never passed 325,000 American shad, it has still been operating at its lifting capacity in recent years due to the large numbers of upstream migrating gizzard shad using the lift.

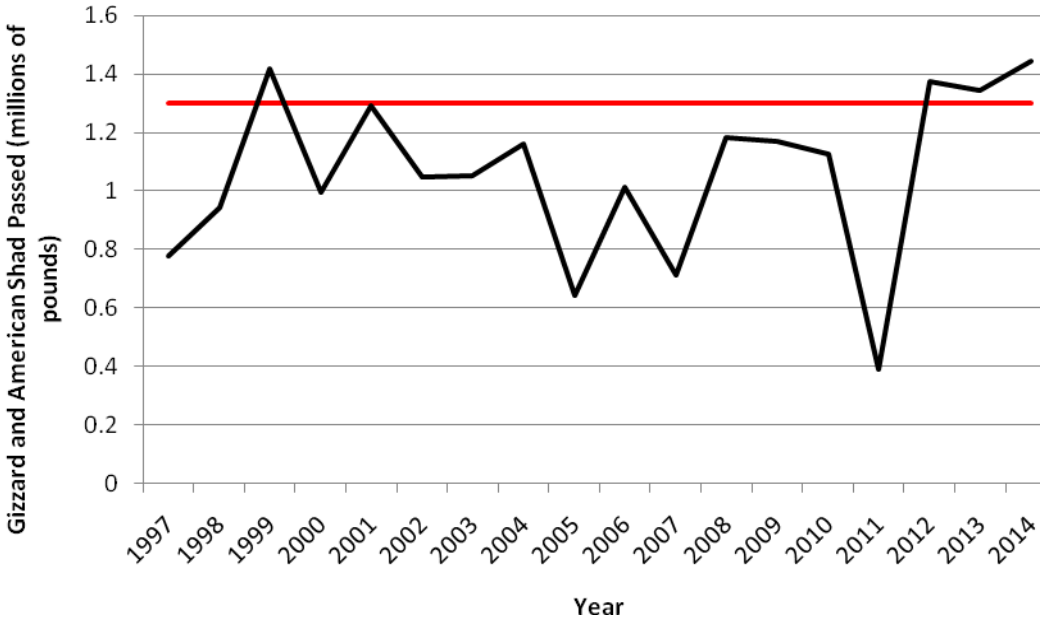

Figure 9: Pounds of gizzard shad and American shad passing Conowingo Dam by the East Fish Lift from 1997 to 2014 (SRAFRC 2013a, p. 11; Normandeau Associates 2013, p. 2; Normandeau Associates 2014b, p. 2). The red line indicates the Service calculated maximum capacity for the existing EFL. Note: EFL operations were terminated prior to the end of the migratory fish passage season in 2011 and this graphic does not include other fish species passing during the same time period which would add additional fish weight to these capacity calculations.

The current EFL hopper capacity is approximately 1.08 million gizzard shad, assuming the lift held exclusively gizzard shad (at 1.2 pounds per fish). Considering that all migratory species, including American shad, river herring, gizzard shad and other resident species that must utilize the currently available fish lift, the existing EFL structure has reached its lift capacity and has been operating at or exceeding safe capacity for at least 3 years (Figure 9). Since current capacity of the EFL has already been exceeded at the Project when considering passage of only

two species, the Service concludes that additional lift capacity is necessary to have safe, timely, and effective fish passage at the Conowingo Dam to pass all migratory species at the Project.

The EFL hopper has been documented to be operating near or over its safe fish lifting capacity for several years and is a likely contributor to the low American shad passage efficiency at Conowingo Dam (Exelon 2011a, p. 15; Exelon 2012d, p. 16). Of the American shad which entered the EFL during the 2010 and 2012 telemetry studies, only 60.6 percent were eventually passed upstream [40 out of 65 in 2010 (Exelon 2011a, p. 15); 17 out of 19 in 2012 (Exelon 2012d, p. 4)]. Crowding by large numbers of gizzard shad attempting to utilize the lift may be one reason why American shad enter the lift but do not pass successfully. Although there is no assessment of efficiency of the current EFL for gizzard shad passage, the EFL is operated in a manner to reduce gizzard shad passage by operating the fishway entrance gates to create high flow velocities at the entrances (EFL operators, personal communication, May 7, 2015, during Service fish lift inspection). Since gizzard shad are smaller than American shad and are expected to be less capable swimmers by comparison (Williamson and Nelson 1985, p. 7; Bell 1991, p. 6.4), the higher velocities are expected to exclude gizzard shad from the fishway. Gizzard shad passage efficiency is likely less than American shad; therefore, the high passage numbers could indicate a possible downstream population size of several million gizzard shad. Although the Service is not establishing an upstream passage efficiency criterion for gizzard shad, we expect the Project to pass all migratory fish species upstream in a safe, timely, and effective manner.

In addition, the EFL has passed few river herring in recent years. Evidence suggests that although river herring have not been passed in large numbers in the EFL in recent years, they are present in the tailrace (MDNR, Genine Lipkey, personal communication, 2015) and crowding due to the abundance of gizzard shad, in addition to ZOP issues, could be contributing factors for why river herring are not effectively passed by the EFL. Additional fish passage capacity would address the over-crowding issue as well as provide American shad and river herring greater opportunity to access and pass through the fish lift.

The need for greater capacity was envisioned in 1989 as part of the previous settlement agreement that made provisions for increasing lift capacity when current capacity was exceeded

(Reid and Priest 1989, p. 5). The 1989 settlement agreement stated that once fish passage capacity was reached (as measured in the number of American shad that were passed) at the EFL, a new WFL facility, with the ability to pass fish directly into Conowingo Pond, would be constructed at Conowingo Dam. However, the terms of the settlement agreement were based on the number of American shad that were passed upstream and did not take into account the large numbers of other species using the fish lifts that would overwhelm the lifting capacity and reduce capacity for American shad. Based on the Service's calculations of capacity, the EFL has been operating at lifting capacity for several years based on total fish biomass being passed upstream, and will therefore not be able to support any increase in American shad passage and population growth. Implementation of additional fish passage capacity at Conowingo Dam is necessary to adequately address current and future passage of all fish in the Project tailrace attempting to migrate upstream.

8.2.6 Fish Stranding and Project Operations

Rapid down-ramping of turbines results in fish stranding at the Project (Exelon 2012f, entire). Fish stranding in the bypass channel is a concern as evidenced by the discovery of migratory fish in the spillway during pre-licensing studies (Exelon 2012f, entire) and as reported by fishery resources staff (Hendricks 2009, entire). Stranded fish may survive in some cases if they locate residual pools of water to reside in until the Project begins discharging generation flows again at levels high enough to wet the bypass channel. These strandings cause migratory delay and could result in migratory fish suffering mortality from the stranding event, which would reduce the overall Project passage efficiency. Pre-licensing studies indicate that 108 American shad were identified as stranded during 4 separate surveys, with 43 percent of those individuals suffering mortality (Exelon 2012f, p. 9). The pre-licensing studies likely underestimated stranding and mortality as many predatory and scavenging birds at the dam may have removed fish from the study area prior to the survey counts of stranded fish. A resource agency staff member witnessed mortality of fish, primarily gizzard shad, in the bypass channel as a result of rapid decreases in water elevation in the tailrace (Hendricks 2009, entire). The License Applicant also acknowledges that "current peaking operations of the Project would continue to have impacts relative to fish stranding in the Conowingo Dam spillway" (Exelon 2012a, p. E-156). Fish stranding could be reduced by limiting down-ramping operations and/or providing low flow

channels linking isolated pools with a clear egress route provided to the main channel of the river downstream of the Project.

8.3 Existing Downstream Fish Passage Efficiency

8.3.1 Downstream Passage for American Shad

A study of downstream migrating juvenile American shad was conducted by Normandeau Associates Inc. for Exelon (RSP 3.2) to estimate the survival of fish passing through a Francis unit. Francis Unit 5 was selected for study because it was believed to represent a worst case scenario for juvenile shad passage (Exelon 2012g, p. 3). A total of 148 treatment fish and 78 control fish were released for the study. Treatment fish were released so that they would pass through Francis Unit 5 and control fish were released into the tailwaters of the dam. All fish were fitted with HI-Z Tags (balloon tags) which would inflate some time period after release, float tagged fish to the water surface, and allow boat crews to recover study fish for examination and assessment of turbine entrainment impacts (Exelon 2012g, pp 5). A statistical technique was used to estimate survival of treatment fish passing through a Francis unit by adjusting for mortality observed in control fish. The survival of juvenile American shad through Francis Unit 5 was 89.9 percent with 90 percent confidence intervals ranging from 84.1 to 95.7 percent (Exelon 2012g, p. 11). Based on the results of this study, there is insufficient evidence to conclude that downstream survival of juvenile American shad through the Conowingo Project was less than the 95 percent criterion specified by SRAFRC (2010, p. 36).

A similar turbine survival study for adult American shad was conducted through Francis Unit 2 and Kaplan Unit 8 at the Project. A total of 100 (Francis) and 101 (Kaplan) HI-Z tagged fish were passed through turbines and an additional 120 control fish were released downstream of the project (Exelon 2012h, p. 6). The 48-hour survival rate of recaptured fish was 88.3 percent (90 percent confidence interval from 77.8 to 98.8 percent) for Unit 2 and 84.1 percent (90 percent confidence interval from 74.2 to 94.0 percent) for Unit 8 (Exelon 2012h, p. 12). Based on the results of this study, there is insufficient evidence to conclude that downstream survival of adult American shad through the Conowingo Project was less than the 80 percent criterion specified by SRAFRC (2010, p. 36).

In addition to the turbine survival study for adult American shad, the radio-telemetry studies provide additional insight into downstream passage for post-spawned American shad at the project. At the end of the radio telemetry study aimed to evaluate upstream passage of adult shad in 2010, 23 American shad that successfully passed upstream of Conowingo Dam ultimately passed downstream through the turbine units at the Project. Fifteen of those passing downstream via the turbines were believed to be alive at their last detection while signals from the other eight shad were stationary and were considered dead (Exelon 2011a, pp 21). From these observations, an estimated 65 percent (15 out of 23) of the adult shad survived downstream passage at Conowingo Dam. Given the small sample size used in this estimate, 90 percent confidence intervals would range from 46.0 to 80.9 percent (see Fleiss 1981, p. 14 for method used to estimate confidence intervals). Based on the telemetry data, we cannot conclude that downstream passage survival of adult American shad at Conowingo Dam is meeting the criterion of 80 percent specified in the 2010 SRAFRC management plan (SRAFRC 2010, p. 36).

8.3.2 Downstream Passage for River Herring

No studies were conducted on downstream migrations of either adult or juvenile river herring at Conowingo Dam. There are no estimates of juvenile river herring survival at similarly sized projects, but a study on a smaller hydroelectric project found juvenile blueback herring survival to be 96 percent (Mathur et al. 1996, p. 159). Based on similar behavior of river herring and American shad, juvenile river herring survival could be similar to the reported juvenile American shad survival through the Conowingo Project. No information is available on adult river herring survival through other hydroelectric projects and assessment at this Project is needed to determine if adult survival is meeting the criterion of 80 percent specified in the 2010 SRAFRC management plan (SRAFRC 2010, p. 36).

8.3.3 Downstream Passage for American Eel

The Service conducted a study to evaluate potential impacts of the Project on downstream migrating American eel (USFWS 2012c, entire). Adult American eels were tagged as part of a study conducted by Exelon at MRPSP in 2011 (Exelon 2012i, entire) and the Service deployed telemetry monitoring equipment in Conowingo Pond and several miles downstream of Conowingo Dam at Havre De Grace, Maryland. Nearly 90 percent of the available American

eels for the study passed the downstream monitoring location, although the physical condition of those fish was not evaluated after passing the dam. The average time from release at the MRPSP project to arrival at the monitoring station at Havre De Grace was 6.8 days, with a range from 1.2 to 32 days. Most American eels (80 percent) migrated downstream from the MRPSP within 13 days of being released (USFWS 2012c, p. 2).

8.4 Summary

Migratory fish populations on the Susquehanna River have been impacted by the multiple hydroelectric projects located on the lower river, most directly by limiting access to historical spawning and rearing habitat. The Conowingo Dam is the first dam on the river encountered by upstream migratory fish and it precludes access to historical spawning habitat in the Susquehanna River for American shad and river herring and nearly the entire Susquehanna basin for juvenile American eels. The lower 10 RM downstream of Conowingo Dam does not provide sufficient habitat area or quality for reproduction and growth of migratory fish required to increase population size and meet management goals in the SRAFRC plan.

Resource agencies have been working with the owners and operators at the remaining 4 hydroelectric projects in the lower river to improve fish passage. The Conowingo Project needs to be more efficient and effective with regards to fish passage in order for the benefits of improved fish passage efforts at the upstream hydroelectric projects to be fully realized. The number of American shad and river herring successfully passing the Conowingo Project is currently at the lowest level since fish passage was implemented in the 1990s, down from a high of nearly 200,000 American shad passing Conowingo Dam in 2001 to less than 10,000 passing Conowingo Dam in 2015 (Figure 3). The inadequate upstream passage efficiency and insufficient fish lift capacity must be addressed to realize restoration of migratory fish to the Susquehanna River Basin as established in the SRAFRC Plan.

9. Engineering Alternatives Considered

The Service examined several alternatives for improving fish passage at the Conowingo Project. The alternatives considered included 2 proposals from the License Applicant, the proposal from FERC's EIS, 8 alternatives generated by the Service, and an alternative that was developed as

part of a Settlement Agreement with the License Applicant. For the Service generated alternatives, a matrix for selection and comparison purposes was developed (USFWS 2013g, entire). They are based on existing fish passage facilities found acceptable for passing large numbers of American shad in big rivers (>1,000 square mile drainage area). The Service has determined that migratory delay resulting in poor passage efficiency and insufficient fish lift capacity are critical issues to overcome at the Conowingo Project. Alternatives were developed with the objective of improving fish passage efficiency and capacity. As discussed further below, the Service adopts herein the alternative reflecting the terms of the settlement agreement, and rejects each of the alternatives.

9.1 Service's Amended Preliminary Prescription: New West Fish Lift at License Issuance and East Lift Modifications

The Service filed an Amended Preliminary Prescription for Fishways in August 2015 (USFWS 2015g, attachment A, pp. 97-129). The Amended Preliminary Prescription focused on requiring new construction as well as modifications to the existing fish passage structures at the Project in order to achieve 85 percent passage efficiency for American shad. This alternative included a complete rebuild of the West Fish Lift immediately upon license issuance, which included two 6,500-gallon hoppers, 3 to 5 percent of Project hydraulic capacity to be used for attraction, and modifications to the ZOP so that fish could reach the fish lift in a safe, timely, and effective manner over the full range of fish passage design flows. The alternative also included a series of modifications to the project through time, based on results of efficiency testing, to improve fish passage efficiency at the project to meet the 85 percent passage criterion for American shad. Initially, the EFL structure was required to improve attraction flow from the current 300 cfs to 900 cfs. Future modifications that may have been implemented if fish passage efficiency was less than 85 percent included modifications to the EFL including modifying entrance gates A & B, constructing a new entrance D, replacing the single 3,300-gallon hopper with two 6,500-gallon hoppers, and constructing an auxiliary water supply. Other modifications at the Project to improve fish passage would include modifications to unit operations and modifications to the ZOP.

Although this proposal has the capacity and passage efficiency to achieve restoration of

American shad during the proposed license term, population growth would initially be slow as few fish would be reaching the primary spawning grounds upstream of York Haven Dam due to the inefficiencies in upstream passage at the three upstream projects (Holtwood, Safe Harbor, and York Haven dams). This alternative does not include a trap and transport program that would provide an initial increase in the number of American shad reaching the spawning grounds by bypassing the other facilities on the river. Other than the timing of Project modifications and the addition of the trap and transport program, the components of the Modified Prescription for Fishways are essentially the same as those in this alternative. The Service concludes that as long as the upstream passage efficiency at the project is achieved, the addition of trap and transport provides an additional benefit to population growth of American shad and river herring during the early years of the license term (USFWS 2016).

9.2 Proposal by License Applicant in License Application: Status Quo and Modifications to Turbine Operations (first on, first off)

The alternative proposed by the License Applicant (Exelon 2012a (E-149 to E-153) states that no significant changes to the existing fish passage facilities are warranted. The License Applicant proposes to study different combinations of generating units in order to enhance fish passage effectiveness, presumably to increase fish attraction to the fishway entrances. It proposes no increase in capacity at either of the fish lifts, no modifications or additional entrances to the fish lifts, and no stream channel modifications in the tailrace to provide an adequate zone of passage to the fish lift entrances.

The biomass of fish currently attempting to pass upstream via the existing 3,300-gallon hopper at the EFL exceeds its capacity for safe upstream passage. In order to allow the Susquehanna River American shad and river herring populations to grow, additional lift capacity is needed. The Service concludes that the License Applicant's proposed alternative does not address the issues identified with poor attraction to the fishway entrances and it will fall short of achieving 85 percent passage efficiency. The results of the two radio-telemetry studies do not indicate any correlation existed between a particular configuration of turbine operation and passage efficiency. Therefore, studying alternative turbine operation scenarios alone will not address the fish passage problems documented at the Project. Existing data also indicates that tagged fish

may be approaching the Project closer to the west bank of the tailwaters, away from the discharge of the Kaplan-type turbine units (i.e., Units 8, 9, 10, and 11), and away from the location of the existing EFL entrances (Exelon 2011c).

The Service concludes that, in addition to increases in lift capacity, additional fish passage facility entrances that provide fish attraction and passage access at various locations within the tailwaters offers the best opportunity to increase passage efficiency and reduce migratory delays. In terms of fish passage conditions at the tailrace, the results from hydraulic modeling identified potential problems with the ability of all target species to move through high flow velocity locations in the tailrace.

9.3 Proposal by FERC (EIS): West Fish Lift and East Fish Lift Upgrades, Additional Hopper at the East Fish Lift, Restart the Trap and Transport Program

The alternative presented by FERC staff in their FEIS (FERC 2015, pp. 63-64) proposes the replacement of the outdated hopper at the WFL with a new 1,500-gallon hopper. It also recommends an additional 3,300-gallon hopper to be added to the EFL that would be located immediately behind the existing hopper. It would require the Licensee to reestablish the trap and transport program that was suspended back in the year 2000. FERC's alternative also requires mechanical and electrical upgrades at both fish lifts, increasing the attraction flow at the EFL to the original design of 900 cfs, and changes to entrances A and B if deemed beneficial to fish passage.

Although FERC's alternative represents an improvement from current conditions, it does not explain how fishway capacity will track and serve a restored American shad population. The Service concludes that the proposed FERC modifications will not achieve full restoration of American shad in the Susquehanna River within the anticipated license term (i.e., next 50 years; see section 6.2.1). The FERC alternative is very similar to the License Applicant's alternative (section 9.3) and reasons for rejection of this alternative are the same as in the previous section.

9.4 Proposals by the Service

9.4.1 Engineering Alternative A: East Fish Lift, Half Collection Gallery and Kaplan Modifications

Engineering Alternative A is defined by the following upgrades to the EFL in order to increase the number of fish that can be passed (hereafter termed passage capacity). Upgrades in this alternative include reductions in the lift cycle time, construction of a second, larger hopper designed to operate simultaneously with the existing 3,300-gallon hopper, additional entrances provided by a half collection gallery that would span the horizontal length of the area in front of the Kaplan units (eastern half of the powerhouse), and modifications to the discharge of all Kaplan units (allowing for a more attractive entrance signal).

Service calculations demonstrate that a new 6,500-gallon hopper in addition to the current 3,300-gallon hopper, while providing sufficient capacity for the current gizzard shad and American shad needs at the Project (assuming 1.2 million gizzard shad and 40,000 American shad passing annually), would not support even moderate growth of migratory fish populations. The Service also foresees that this alternative will not achieve 85 percent passage efficiency (of the available American shad located in the tailwaters) mainly because this alternative does little to address current issues with attraction efficiency. Existing data indicate that fish might be approaching the Project closer to the west bank of the tailwaters, away from the discharge of the Kaplan units and the proposed half collection gallery (Exelon 2011c). Modifications to the Kaplans' discharge could only be considered as an experimental approach because these types of modifications have not been tested at other projects in the Northeast.

9.4.2 Engineering Alternative B: East Fish Lift, Full Collection Gallery and No Kaplan Modifications

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 larger 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 that spans the horizontal length of the entire powerhouse to minimize delay. Additional entrance locations provided by the full collection gallery are considered in this

alternative for the purpose of enhancing attractive entrance signals and improving passage efficiency. The additional entrance locations minimize the problem of turbine turbulence which will result in attraction and passage of more fish.

This alternative has similar deficiencies as Engineering Alternative A. In addition, the lengthened collection gallery is still limited by the insufficient lift capacity which is the main cause for rejection of this alternative.

9.4.3 Engineering Alternative C: East Fish Lock and Half Collection 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. 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 lock uses water to elevate the fish up into the exit channel at the top of the dam. 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 puts 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 to the existing entrance channel would still be needed. The Service also concludes that this alternative will not achieve 85 percent passage efficiency (of the available American shad located in the tailwaters) for the same reasons cited in Engineering Alternative A.

9.4.4 Engineering Alternative D: East Fish Lift, Half Collection Gallery, Kaplan Modification and Sorting

Engineering Alternative D upgrades the EFL to increase fish passage capacity via reductions in the lift cycle time as well as the addition of a second larger hopper designed to operate simultaneously with the existing one. Additional entrance locations would be provided through addition of the half collection gallery, accompanied by modifications to the discharge of the Kaplan units (producing a more attractive fish lift entrance signal) to enhance passage efficiency.

Before raising the lift, gizzard shad would be sorted out of the hopper and returned to the tailwaters. Gizzard shad entering the EFL hopper have been documented utilizing a large portion of the fish lifting capacity, making it unavailable for target species. Removing these non-target fish from the hopper would result in an increase in the overall net capacity for American shad and river herring and improve passage efficiency for target species.

A difference this alternative has relative to A, B, and C is the element of sorting out of non-target fish species. The Service concludes that the handling associated with fish sorting places additional stress on migratory fish which are in spawning condition and is best avoided. Modifications to the Kaplan unit discharge and fish sorting are considered experimental approaches. The difficulty with effectively discerning a gizzard shad from an American shad lies in the strong similarities between these two species. They share almost identical migration periods, the average size of migrants is not so different as to make sorting easy, and their swimming speed capabilities are relatively comparable. Sorting out gizzard shad could also result in removal of other target species, including river herring. In addition, recycling of gizzard shad back into the tailwaters will exacerbate crowding issues and could negatively impact fish passage efficiency for target species.

9.4.5 Engineering Alternative E: Complete West Fish Lift with Two 6,500-gallon Hoppers

Engineering Alternative E proposes a new and complete WFL to provide full upstream passage for all migratory fish. The newly renovated WFL would also include two 6,500-gallon hoppers to increase capacity and a trap and transport facility to monitor migratory fish and enhance upstream restoration efforts. The EFL would be decommissioned soon after the construction of the WFL.

The results of the radio telemetry studies for upstream passage of American shad at Conowingo (Exelon 2011a, p. 15; Exelon 2012d, p. 16) indicate that providing upstream passage on only one side of the 800-foot-wide tailrace likely will not achieve passage efficiency for American shad at the required criterion of 85 percent. Even if the WFL alone does achieve efficiency criteria and the American shad population increases, two hoppers with separate crowding pools should be expected to reach maximum capacity (i.e., 9 million pounds of fish) within the first half of the

license term (see Section 12.1.3.3 for discussion on capacity calculations).

9.4.6 Engineering Alternative F: Kaplan Draft Tubes Extension, East Fish Lift, Half Collection Gallery and Complete West Fish Lift with Two 6,500-gallon Hoppers

Engineering Alternative F proposes upgrades to the EFL to increase fish passage capacity. This would be accomplished via reductions in the lift cycle time as well as addition of a second larger hopper designed to operate simultaneously with the existing one. Additional entrance locations would be provided by the half collection gallery to enhance fish passage efficiency. The Kaplan draft tubes extension would move the current turbulent boil (which confuses fish and prevents them from finding the EFL entrance) downstream and away from the EFL entrances in an attempt to make the fish passage attraction jet from the fish lift entrance more discernible, thus improving the ability of fish to find the entrance. The complete WFL would provide upstream passage to fish approaching the dam on the western side of the powerhouse. The newly renovated WFL would also include two 6,500-gallon hoppers and a trap and transport facility.

The main cause for rejection of this alternative is the expected high cost and experimental nature of the extension of the Kaplan draft tubes.

9.4.7 Engineering Alternative G: East Fish Lift Entrances Relocation, Half Collection Gallery and Complete West Fish Lift with Two 6,500-gallon Hoppers

Engineering Alternative G provides upgrades to the EFL and also would increase its 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 would be relocated to avoid the boil in front of the Kaplan units which currently renders them ineffective and/or inoperable (Figure 10, USFWS 2013h). Entrance A's attraction jet is effectively drowned out by the discharge of the Kaplans, and relocation of entrance A would be designed to address this problem. Access to entrance A would be available along the catwalk, through the area behind the piers (similar to the configuration at the Safe Harbor Project fishway). Additional entrance locations provided by the half collection gallery are proposed in this alternative for the purpose of enhancing passage efficiency. A new and complete WFL would provide upstream passage for migratory fish migrating to the western side of the

powerhouse. The newly renovated WFL would also include a trap and transport facility.

The simultaneous implementation of all of these measures might result in some infrastructure investments that may be premature or excessive for meeting fish passage efficiency and population restoration goals, particularly during the early stages of restoration. A phased approach to the implementation of fish passage solutions, with periodic studies between phases, would contribute crucial information on the effectiveness of each solution; and it would allow the Licensee and resource agencies the ability to diagnose any salient and unresolved issues and address them accordingly.

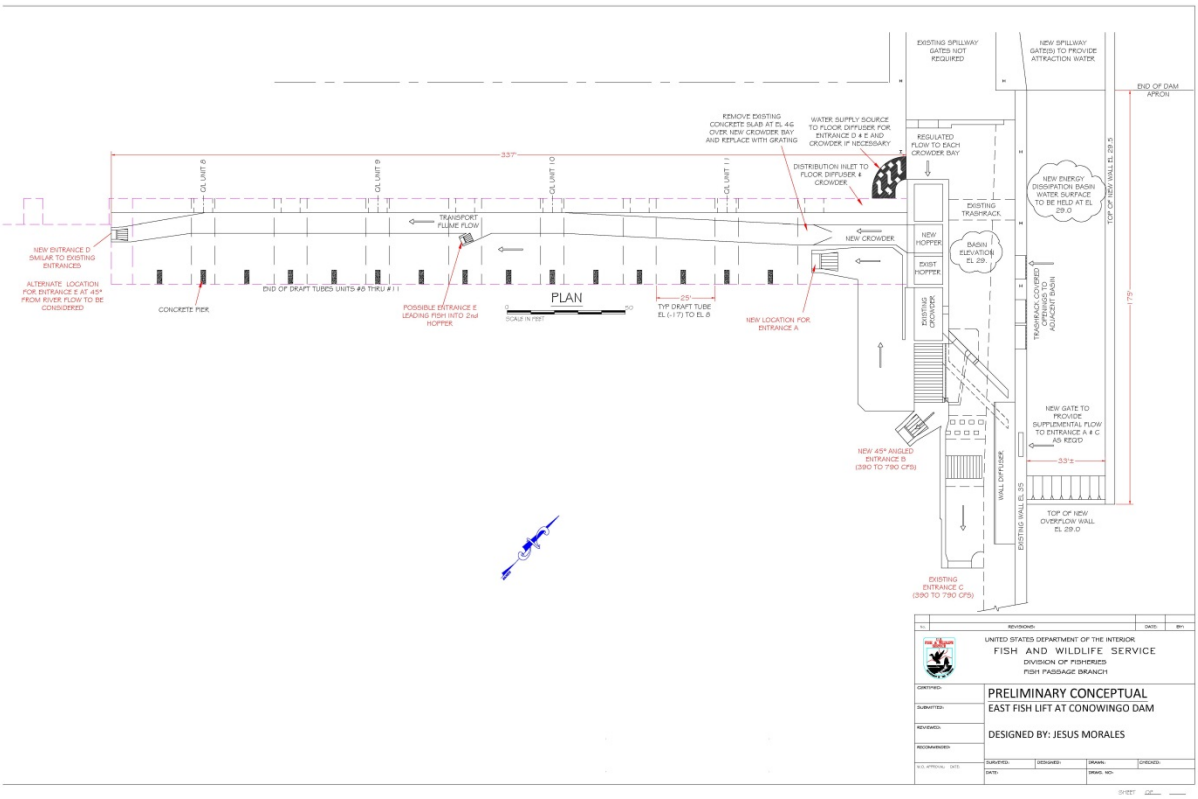

Figure 10. Service conceptual drawing of the proposed modifications at the East Fish Lift.

9.5 Settlement Agreement: Phased East Fish Lift and West Fish Lift Improvements with a Trap and Transport Program

The Settlement Agreement includes a phased approach to implementing fish passage measures on both the east and west sides of Conowingo Dam. The components of this alternative initially include modification to the EFL facility by increasing attraction flows to 900 cfs, replacing the current 3,300-gallon hopper with two 6,500-gallon hoppers, and constructing a ZOP to the EFL and WFL. Both the EFL and WFL structures would be modified to facilitate a trap and transport program that would take 80 percent of the American shad and river herring collected at the EFL and WFL and transport them upstream of York Haven Dam, with a maximum of 100,000 of each species to be transported each year. The project will be required to meet an 85 percent upstream passage efficiency criterion for American shad and periodic testing will ensure that the criterion is being met. In the event that passage efficiency is less than 85 percent, there are a suite of structural and operational modifications that can be made to improve fish passage efficiency. Modifications include improvements to the ZOP, turbine operational modifications, modifying or constructing new entrances at the EFL, adding an auxiliary water supply to the EFL, and construction of a new West Fish Lift with trap and transport capability and associated zone of passage. The Service developed a plan that describes the components, as well as the phasing and triggers for the construction of each component of this alternative in more detail in Section 12.

The Service concludes that this alternative will achieve safe, timely, and effective upstream anadromous fish passage at Conowingo Dam. The Modified Prescription combines the high passage efficiencies required by the Preliminary Prescription, and offers a credit program toward the required upstream passage efficiency for implementing a trap and transport program, which will also benefit early restoration efforts by getting more adult American shad into suitable spawning habitat earlier in the license term. Similar to the Preliminary Prescription, the Modified Prescription follows an adaptive approach to construct or implement fish passage improvements as they are needed through the license term to track changes in fish populations. This adaptive approach assures that high passage efficiencies will be maintained through the license term. The Service also concludes that this alternative will achieve restoration or 2 million American shad upstream of York Haven Dam earlier in the license term compared to the Preliminary Prescription or other alternatives considered because of the addition of the trap and transport program that will get target species to the spawning grounds in higher numbers earlier in the license term (Figure 11).

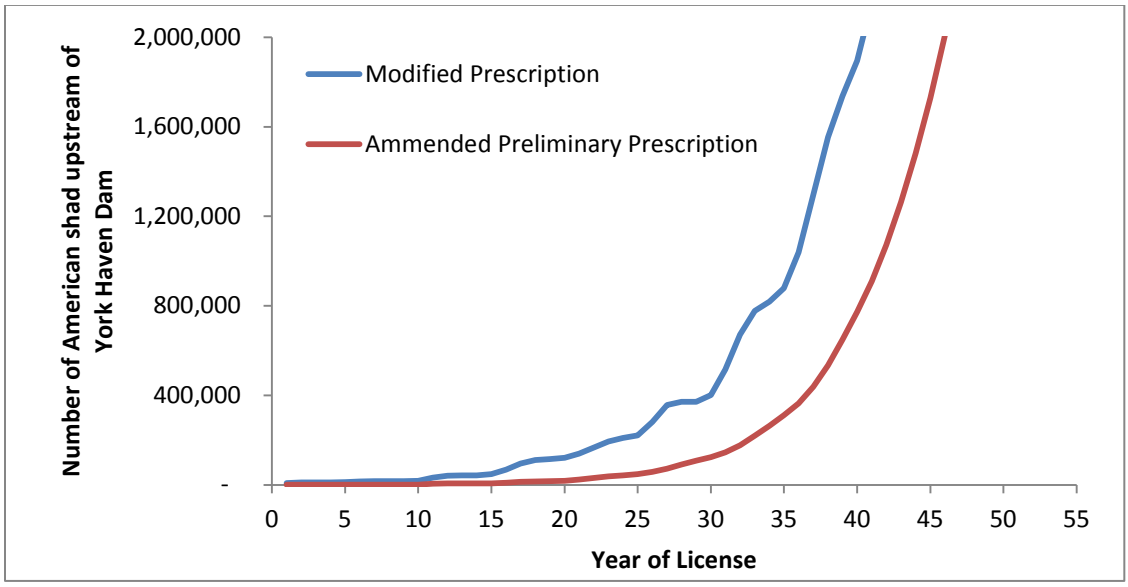

Figure 11. Comparison of the rates of restoration American shad between the Amended Preliminary Prescription and the Modified Prescription (see USFWS 2016).

10. 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 a Licensee at its own expense of …such fishways as may be prescribed by the Secretary of the Interior or the Secretary of Commerce, as appropriate.

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 will 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.

11. Reservation of Authority to Prescribe Fishways

In order to allow for the timely implementation of fishways, including effectiveness measures, the Secretary of the Department reserves her authority to prescribe fishways during the term of the license and requires that the following condition be included in any license(s) the Commission 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 Interior's Modified Prescription for Fishways at the Conowingo Hydroelectric Project.

12. Modified Prescription for Fishways

12.1 Design Criteria

12.1.1 Design Populations

12.1.1.1 American Shad

The goal for this fishway prescription is to ultimately be able to pass up to 5 million American shad annually in order to maintain self-sustaining populations of 2 million American shad annually migrating to and reproducing in the Susquehanna River upstream of York Haven Dam

and in suitable tributaries.

12.1.1.2 River Herring

The goal for this fishway prescription is to ultimately be able to pass up to 12 million river herring annually in order to maintain self-sustaining populations of 5 million river herring annually migrating to and reproducing in the Susquehanna River upstream of York Haven Dam and in suitable tributaries.

12.1.1.3 American Eel

The Licensee shall construct, operate, and maintain fishway(s) at Conowingo Dam sufficient to pass upstream migrating eels that arrive to the Project into the mainstem of the Susquehanna River upstream of York Haven Dam.

12.1.2 Design Capacity

Capacity is determined by a given weight of fish transferred over a given period of time. Capacity calculations take into consideration all species of fish using a fish passage facility; e.g., fish lift(s), and their corresponding weights, and proportional availability.

12.1.2.1 Initial Capacity

Considering that American shad passage efficiency has been measured to be as low as 25 percent (Exelon 2012d, p. 26), and the Project has passed an average of 1.1 million gizzard shad per season from 2012 - 2014 (SRAFRC 2013a, p. 7; Normandeau Associates 2013, p. 3; Normandeau Associates 2014b, p. 3), the Service estimates that as many as 4.4 million gizzard shad could potentially be in the tailrace annually attempting to move upstream. Based on the estimated biomass of gizzard shad attempting to pass upstream at the current time (4.4 million gizzard shad = 5.3 million pounds of fish) as well as allowing additional capacity for growth of American shad and river herring populations, the Service estimates a fish lift biomass capacity of at least 7 million pounds of fish per season needs to be provided immediately after license issuance. Two 6,500-gallon hoppers sharing the same holding pool, with a cycle time of 15 minutes, provides capacity to move 7 million pounds of fish in a single season (assuming a peak day run of 5 percent of the seasonal run, a peak hour run of 15 percent of the peak day and

hopper minimum water volume of 0.1 cubic feet per pound of fish). Based on projected numbers of a successful American shad restoration using the population model, a fish lift capacity of 7 million pounds of fish should provide safe passage at the Conowingo Project for approximately half of a fifty (50) year license term (assuming that the gizzard shad population does not grow larger than 4.4 million fish). For details on calculating fish lift capacity, refer to Appendix A.

12.1.2.2 Final Potential Capacity

The Service anticipates that restored populations of American shad and river herring may require passage capacity for up to 5 million American shad and 12 million river herring as well as other species at the Project. American shad and river herring would require 26 million pounds of hopper capacity in addition to the potential 5 million pounds that may be required by riverine species. However, the fishway prescription does not require construction of sufficient capacity to pass this number immediately; rather, capacity is added only as populations grow enough to impede efficiency in the event that fishway capacity becomes a bottleneck to future population growth. This fishway prescription incorporates a fish passage efficiency target and measures to assess fish passage efficiency throughout the term of the license in order to test for future conditions that would require corrective actions contained in this prescription. This fishway prescription includes measures providing for an ultimate fishway capacity of up to 18 million pounds per season (four 6,500-gallon hoppers with separate holding pools). The Department recognizes the potential lack of capacity for this current fishway prescription during the later years of American shad and river herring restoration, and may exercise its reservation of authority to address this issue at a later date if fishway capacity appears to be a limiting factor to population restoration, as reflected in declining upstream fish passage efficiency due to lack of fishway capacity.

12.1.3 Design Flows

The Licensee shall design new fishway(s) to ensure operation under river flows in the range of 6,330 cfs to 143,000 cfs. However, the Licensee shall not be required to operate the fishway(s) at flows greater than 113,000 cfs unless data available at the time demonstrates that operation of fishways at flows greater than 113,000 cfs is necessary to achieve the target efficiency. Furthermore, the fishways shall be designed with sufficient freeboard (or other protection) to minimize damage from river flows of up to the 50-year return interval.

12.2 Efficiency Criteria

The Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC 2010, 2013) and the Service (USFWS 2015b) have established upstream and downstream passage efficiency criteria for the Susquehanna River basin that are the basis for this Prescription for Fishways. The Service defines upstream fish passage efficiency as the proportion of the fish in the Project tailwaters that successfully move through the fishway and continue upstream migrations, calculated as a percentage. Downstream fish passage efficiency is the proportion of the fish that approach the upstream side of the Project and survive unharmed as they pass the Project and continue downstream migrations. Definitions for fish passage terms used in this document are provided in Section 14. Where no numeric efficiency criteria were set, the Service's goal is to minimize Project impacts to migratory fish populations, with a goal of 100 percent passage and the understanding that no project is likely to fully achieve that goal despite application of the best available technology. Where the Service has information or modeling indicating that restoration may be achieved with less than 100 percent passage, the Service has been able to adopt numeric targets that will achieve restoration, and measures to reach those targets.

12.2.1 Criteria for Upstream American Shad Passage Efficiency[6]

The Licensee shall operate the Project to achieve the upstream passage efficiency criterion of

[6] FWS has agreed to meet with the Licensee in 2043 if the upstream hydroelectric projects are not meeting their target passage efficiencies consistently by then, to discuss the passage efficiency criterion for American shad at the Conowingo project based on then available data. The Service may consider adjusting the passage efficiency criterion at that time.

passing 85 percent of all adult American shad that enter the Project tailwaters ("Target Efficiency"). The tailwaters of the project are defined as extending to the downstream tip of Rowland Island.

The Licensee can receive additional credit toward achieving the upstream passage efficiency criterion for adult American shad by trapping at Conowingo and transporting American shad to upstream of York Haven Dam and thus avoiding upstream passage impediments at the intervening hydroelectric projects on the Susquehanna River (see Section 12.7.2.1).

12.2.2 Criteria for Downstream American Shad Passage Efficiency

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of at least 80 percent of the adult American shad moving downstream past the Project.

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of at least 95 percent of the juvenile American shad moving downstream past the Project.

12.2.3 Criteria for Upstream River Herring Passage Efficiency

In accordance with sections 12.5 and 12.6, the Licensee shall operate the Project to minimize the impact of the Project on upstream migration for adult river herring that approach the Project tailwaters.

Numerical criteria for upstream river herring passage efficiency may be developed in the future when additional information about Susquehanna River herring populations becomes available. Any needed change in fishway requirements resulting from such new targets is not provided for in this Prescription, and would be the subject of independent administrative processes.

12.2.4 Criteria for Downstream River Herring Passage Efficiency

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of at least 80 percent of the adult river herring moving downstream past the Project.

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of

at least 95 percent of the juvenile river herring moving downstream past the Project.

12.2.5 Criteria for Upstream American Eel Passage Efficiency

The Licensee shall operate the Project to minimize the impact of the Project on upstream migration for juvenile American eel that approach the Project tailwaters.

Numerical criteria for upstream American eel passage efficiency may be developed in the future when additional information about the Susquehanna River American eel population becomes available. Any needed change in fishway requirements resulting from such new targets is not provided for in this Prescription, and would be the subject of independent administrative processes.

12.2.6 Criteria for Downstream American Eel Passage Efficiency

The Licensee shall operate the Project to achieve the downstream survival efficiency criterion of at least 85 percent of the adult (i.e., silver) American eel moving downstream past the Project.

12.3 Seasonal Implementation of Fish Passage

The Licensee shall operate a fishway for upstream passage of anadromous fish daily during the American shad and river herring upstream *Migration Period* (Table 9). The Licensee shall operate the fish lift(s) daily during the upstream *Migration Period*, and begin releasing attraction flows at least one hour prior to the start of daily lift operations. The fish lift(s) will operate at the following times during the *Migration Period*: (1) in March, from 7 a.m. to 7 p.m.; (2) in April, from 6:30 a.m. to 7.30 p.m.; and (3) in May and June from 6:00 a.m. to 8:00 p.m.

The Licensee shall provide attraction flow and operate fish passage facilities for continuous upstream American eel passage (i.e. 24 hours per day) during the entire upstream *Migration Period* (Table 9).

The Licensee shall ensure prior to the start of the *Migration Periods* that all mechanical elements of the fishway(s) are working properly. The Licensee shall repair, maintain, and test fishway(s) as necessary in advance of the migration period, in accordance with the *Fishway Operation and*

Maintenance Plan (FOMP) so as to begin operations when required. The Licensee shall maintain and operate fishways to maximize fish passage effectiveness throughout the upstream and downstream *Migration Periods* (Table 9).

Table 9. Upstream and downstream *Migration Periods* for species covered in this Modified Prescription for Fishways.

Species	**Upstream Migration Period[1]**	**Downstream Migration Period[1]**
American shad	Starting when river temperature reaches 50 ^{o} F, until river temperatures rise above 72 ^{o} F for four consecutive days, but ending no earlier than June 1, and no later than June 15[2]	July 1 through November 15 (juv.) May 1 through July 1, as long as river temperature is above 65 ^{o} F[2] (adult)

Species	**Upstream Migration Period[1]**	**Downstream Migration Period[1]**
Alewife and blueback herring	Starting when river temperature reaches 48 ^{o} F for three consecutive days and no earlier than March 1, until river temperatures rise above 72 ^{o} F for four consecutive days, but ending no earlier than June 15[2,3,4]	June 15 through October 14 (juv.) April 15 through July 1 (adult)
American eel	May 1 through September 15[5]	September 15–February 15, whenever river temperature is above 37 ^{o} F for 4 consecutive days[2,6]

[1] Subject to notice and comment, 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. At any time during the new license term, Licensee may submit new information to the Department in support of a request to change the migration periods. In the event the Department seeks to require downstream passage by means other than through the units, the downstream migration periods automatically will be reviewed jointly by the

Department, other fishery agencies, and the Licensee.

[2] Water temperatures shall be monitored once daily at 11 a.m. at Monitoring Station 643 (Shure's Landing) or some other location agreed upon by the Licensee and the Service.

[3] This migration period is based on alewife migration timing from other tributaries to the Chesapeake Bay (Sutherland 2000, p. 9; Eyler et al. 2002, p. 59; Slacum et al. 2003, p. 13).

[4] The Service recognizes that, because of factors outside of the Licensee's control, safety considerations may preclude the Licensee's personnel from performing duties necessary to commence fish passage measures at Conowingo by the commencement date. When such conditions arise, the Licensee shall notify the Service and the Service and the Licensee shall consult regarding the anticipated schedule for commencing such measures.

[5] This initial operational period is based on preliminary data on American eel migration at Conowingo Dam (Minkkinen and Park 2014, Figure 4).

[6] This initial operational period is based on preliminary data on American eel migration timing from other tributaries to the Chesapeake Bay (Eyler 2014, pp. 44-46). Results from the "Downstream American Eel Effectiveness Monitoring" (Section 12.7.5) shall be used to further refine this migration period.

12.4 Fishway Operation and Maintenance Plan

The Licensee shall develop and submit a Fishway Operation and Maintenance Plan (FOMP) to the Service, FERC, and resource agencies (states of Maryland and Pennsylvania, Susquehanna River Basin Commission, and National Marine Fisheries Service) for review and approval by the Service. The Licensee shall keep the FOMP updated on an annual basis, to reflect any changes in fishway operation and maintenance planned for the year. If the Service requests a modification of the FOMP, the Licensee shall respond to the requested modification within 30 days of the request by filing a written response with the Service and serving a copy of the response on FERC and the resource agencies.[7] Any modifications to the FOMP by the Licensee shall require approval by the Service and, if necessary, FERC prior to implementation.

The FOMP shall include:

- Schedules for routine maintenance, pre-season testing, and the procedures for routine fishway operations, including seasonal and daily periods of operation, and associated dam and powerhouse operational measures needed for proper fishway operation;

[7] Requested modifications to the FOMP will not include changes to turbine operations. Any modifications to turbine operations shall be implemented only pursuant to Section 12.5.4.

- Details of how the Project shall be operated during the migration season to provide for adequate fish passage conditions, including:
    - pre-season preparation and testing;
    - sequence of turbine start-up and operation under various flow regimes to enhance fishway operation and effectiveness;
    - debris management at the fishway entrance, guidance channels, and the exit;
    - plant operations to provide near- and far-field attraction flows required for the fishway zone of passage in the tailrace;
- Trap and transport logistics plan and design plans for west and east fish lift modifications needed for trap and transport, including provisions for planning trap and transport logistics so as to avoid, to the extent possible, trapping a population unrepresentative of the migrating population as a whole.
- Trap and transport logistics plan for American eel;[8]
- Standard operating procedures for monitoring and enumerating fish passage by species, including the American eel passage facilities;
- Standard operating procedures for collecting biological samples from target species to assess restoration efforts;
- Standard operating procedures for monitoring and reporting operations that affect fish passage;
- Standard operating procedures in case of emergencies and Project outages to first, avoid, and second, minimize, potential negative impacts on fishway operations and the effectiveness of upstream and downstream passage for target species; and
- Plans for post-season maintenance, protection, and winterizing the fish lifts and eel passage facilities.

The Licensee shall provide written documentation to the Service, FERC, and resource agencies that all fishway operational personnel have reviewed and understand the FOMP and it shall be signed by the operations manager of the Project. Copies of the approved FOMP and any modifications shall be provided to the Service, FERC, and resource agencies on an annual basis.

[8] The Licensee can incorporate by reference American eel plans and logistics developed pursuant to the Eel Passage Advisory Group.

By December 31 of each year, the Licensee shall provide an annual report to the Service, FERC, and resource agencies detailing: the implementation of the FOMP, including any deviations from the FOMP and a process to prevent those deviations in the future; any proposed modifications to the FOMP, 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; and operational data for both fishways and the Project to allow the Parties to examine correlations between particular operational patterns and successful or unsuccessful fishway operation, and to confirm, once an operational regime with known effectiveness is settled upon, that the Project continues to operate under that regime. The Service understands that details of operation constitute confidential business information, and agrees to protect them from disclosure as such to the extent it is able to do so by law.

The annual report shall also include:

- Description of routine maintenance as well as repairs made to the fishways or eel passage facilities during the previous fish passage season;
- Average daily flows at the Marietta gauging station;
- Daily water temperature and dissolved oxygen readings[9] in the fish lift and tailwater areas;
- Hourly individual turbine unit operations and discharge, hourly total discharge from the powerhouse, hourly discharge over the spillway, and hourly passage counts of all fish species at each hopper;
- Daily counts of American eel collected at each facility;
- Thirty-minute recordings of total flow discharging from behind the hopper, total flow discharging from the attraction water supply diffuser, water surface elevation immediately upstream from the entrance gates, water surface elevation at the tailwaters, elevation to the crest of the entrance weir gates, and any irregularities such as the identification of a visible boil in the zone over the floor diffusers;

[9] The Licensee shall provide dissolved oxygen readings, commencing each year when the Project's NPDES permit requires annual data collection to begin, through the end of the upstream migration period.

- Number of fish by species trapped and transported, including date, time, and location of release;
- Weekly collection of a subsample of biological information from passing adult American shad and river herring consisting of sex ratio, spawning condition, length, weight, and age.

In addition to the annual report, the data for daily flows, water quality, project operations, fishway operations and fish passage as described above shall be recorded in a database during the fish passage season and the Service shall be provided open access to that database. Data shall be entered into the database no later than one week after collection.

These data shall be used to assess impacts of river conditions and hydropower operations on successful fish passage through the lifts, with the goal of achieving a better diagnosis of potential fish passage issues at the Project. The operational data will not provide the Service with an independent basis to require modifications and improvements beyond those that may be implemented through the process described below.

By January 31 of each year, the Licensee shall meet with the Service and the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) to discuss the FOMP (and FEMP – See Section 12.7.1). This meeting shall occur no later than January 31 of each year unless the Licensee and the resource agencies agree on a different date. At this annual meeting the Licensee shall discuss with the Service and SRAFRC the fish passage results from the previous year, review regulatory requirements for fish lift and eel passage operations, and discuss any upcoming modification or testing the Licensee shall conduct during the upcoming season.

12.5 Sequencing of Upstream Fish Passage Construction and Implementation

Timely construction, operation, and maintenance of fishways are necessary to ensure their effectiveness and to achieve restoration goals. Therefore, the Licensee shall (1) notify, and (2) obtain approval from the Service and FERC for any extension of time to comply with conditions the Department prescribes.

12.5.1 Trap and Transport of American Shad and River Herring

The Licensee has agreed to and will trap and transport American shad and river herring to areas upstream of York Haven Dam annually. The number of American shad and river herring trapped and transported annually will be up to 80 percent of the number of each species captured in the fish lifts up to a maximum of 100,000 of each species annually. Trap and transport operations shall continue until the Licensee can achieve a measured 85 percent upstream passage efficiency for American shad at the Project without reliance on the trap and truck credit provided for in Section 12.7.2.1.

12.5.2 Initial Construction

Unless otherwise stated, the Licensee shall implement the items defined in Section 12.6.1 "*Initial Construction Items*" within 3 years following license issuance. Construction shall be conducted in a way as to allow for trap and transport operations as well as volitional passage at the EFL to continue uninterrupted during this time period.

12.5.3 Operation in the First Passage Season after License Issuance

Within 1 year of license issuance, trap and transport operations from the EFL and WFL shall begin. A total of 80 percent of the run, up to 100,000 American shad and 100,000 river herring per year shall be trapped and transported to the mainstem Susquehanna River upstream of York Haven.

12.5.4 Efficiency Testing and Triggering of Subsequent Modifications

In the 5th year after license issuance, the Licensee shall begin the "*Initial Efficiency Test*" of fish passage at the Project. The Licensee shall conduct the *Initial Efficiency Test* as defined in Section 12.7.2 in order to evaluate passage performance relative to upstream efficiency criteria for American shad and river herring as described in Section 12.2. In the 5th year after license issuance, the Licensee shall also assess mortality of American shad during the trap and transport process.

If at the end of the *Initial Efficiency Test*, the combined results of the three-year study (the combination of measured efficiency of the *Initial Efficiency Test* and the *Trap and Transport*

Credit resulting in an *Adjusted Efficiency*) meet the *Target Efficiency* of 85 percent for upstream passage of American shad, the Licensee shall operate the Project using the FOMP implemented during the *Initial Efficiency Test*. The Licensee shall then conduct a two-year "*Periodic Efficiency Test"* as defined in Section 12.7.2 in every 5th year thereafter to ensure that the upstream-prescribed efficiency criterion continues to be met through the term of the license.[10]

If at the end of the *Initial Efficiency Test* or after any *Periodic Efficiency Test* thereafter during the license term, or after any subsequent "*Post-Modification Efficiency Test*" as defined in Section 12.7.2, the study results indicate that the Licensee is not meeting the required *Adjusted Efficiency*, the Licensee shall conduct an evaluation of the radio telemetry data and any other data available to the Service and/or the Licensee to determine if the passage inadequacy is related to fishway attraction or fish lift capacity. Concurrent with the submission of the final report from an efficiency study, the Licensee shall propose a course of action most likely to achieve the *Target Efficiency*. Both the Service and the Licensee have agreed on a tiered list of options and the types of either attraction or capacity problems which the tiers may address. If the reason for not achieving the *Target Efficiency* is insufficient fishway attraction, then the Licensee shall follow the actions in Section 12.6.2. If the reason for not achieving the *Target Efficiency* is lack of fish lift capacity, then the Licensee shall follow the actions in Section 12.6.3. In the event that both fishway attraction and fish lift capacity are limiting factors to achieving the *Target Efficiency*, the Licensee shall address items listed under both sections 12.6.2 and 12.6.3, but only to the extent both attraction and capacity measures are necessary to achieve the required *Target Efficiency*. The list of measures in sections 12.6.2 and 12.6.3 is not exclusive and does not preclude either party from identifying and proposing other measures commensurate with the required level of improvement and corresponding tier. The Service shall react to the Licensee's proposal for improving fish passage efficiency within 90 days of receipt. It may:

A. Say nothing, in which case the Licensee shall proceed with its proposed course of action;
B. Agree affirmatively with the Licensee's proposed course of action, in which case the Licensee shall proceed;
C. Propose a different option, not on the tiered list of options, which the Licensee shall

[10] At the Licensee's election, and with Service concurrence, the Periodic Efficiency Test may be extended an additional 1 year. Only after the efficiency tests are completed will the Licensee be required to propose, as may be necessary, a course of action to achieve the Target Efficiency.

proceed with if it agrees;

D. Require, instead, that the Licensee implement an option or options from the appropriate (or lower numbered) tier to address each problem. The Service will choose that option(s) it deems most likely to achieve the *Target Efficiency*. The Service may select an option from a higher-numbered tier only if all options from an appropriate or lower-numbered tier have been implemented. If two or more options appear equally likely to achieve the efficiency criterion, the Service will present the Licensee with the choice, and the Licensee may proceed with whichever it prefers. The Service shall explain, in writing, its reasons for finding that its choice(s) is more likely than the Licensee's to lead to the desired passage efficiency. The Licensee shall then proceed with the selected course of action.

12.5.5 General construction requirements.

All functional (i.e., 30 percent, 60 percent, and 90 percent) and final design plans, operation and maintenance plans, construction schedules, and hydraulic model studies for the new fishways or modifications to existing fishways described herein shall be developed in consultation with the Service and submitted to the Service and FERC for approval. The planning and design process for structures shall generally include CFD modeling prior to construction and post-construction shakedown and testing to confirm modeling.

12.6 Fish **Passage Facilities**

12.6.1 Initial Construction Items

East Fish Lift Modifications – The Licensee shall modify the EFL facility to provide 900 cfs attraction flow to the EFL. Modifications to the EFL facility will include replacing spillway gates A & B, replacing the crowder system, addressing structural vibration issues, replacing diffuser gates A and B, replacing the control system, and upgrading the electrical system to allow for a 15 minute lift cycle.

Replace the current 3,300-gallon hopper with two 6,500-gallon hoppers at the EFL

The Licensee shall remove the current hopper and install two 6,500-gallon hoppers within the

existing superstructure of the EFL. One hopper will replace the current 3,300-gallon hopper and the second hopper will be located immediately upstream from the current location of the existing EFL hopper (see Figure 10). Access to both hoppers will be provided by the current entrance gates (A, B, and C) and the hoppers will share the same holding pool.

Trap and Transport Facilities at the EFL

The Licensee shall reduce cycle time at each hopper at the EFL to be able to lift fish four times per hour and complete modifications to the EFL structure to allow for trapping and sorting fish at the EFL facility and transporting them to the western side of the dam to a truck for transport upstream. Modifications to the EFL shall include two new sorting tanks; a loading tank; and a hy-rail truck and forklift, or functionally similar equipment, to facilitate movement of American shad from sorting tanks at the EFL to the west shore. These improvements shall be accomplished without losing a season of the passage provided by the EFL.

Trap and Transport Facilities at the WFL

WFL modifications shall be made to facilitate trap and transport including: decreasing lift cycle time by replacing the crowder linkage system and raising the elevation of the sorting tank(s), and providing a mechanism to allow for direct sluicing of fish into tanks mounted on the transport vehicle. These initial improvements shall be accomplished without losing a season of the passage provided by the EFL or trap and transport from the WFL.

Provide a Zone of Passage (ZOP) to the Fish Passage Facilities

The Licensee shall construct and maintain structures, to provide American shad and river herring a ZOP (i.e., route of passage) as described in this section.

In advance of any ZOP development and/or construction, the Service and Licensee will review CFD modeling results from the tailrace. The Licensee shall run the model under a predetermined number of structures arrangements (e.g., different angles, different spacing between the weirs, different weir slopes). In consultation with the Service, the Licensee shall choose to construct the configuration of structures that provides the most conducive hydraulic conditions for fish passage of river herring. The area to be considered for potential ZOP improvements includes

approximately 2,500 feet on the west bank and 3,500 feet on the east side of Rowland Island. Based on CFD modeling results that analyze discharge velocities and turbulence, the Licensee shall provide stone weirs, and/or other suitable alternatives or measures that provide a contiguous zone of passage (ZOP) from the southern tip of Rowland Island to one or both of the lifts. The Licensee shall install up to ten stone weirs, with the option of considering other configurations for structures, so long as the total cost does not exceed the cost estimated for up to ten weirs.[11] Model results will guide the placement and formation of these structures to provide for the hydraulic conditions necessary for the weakest swimmers (river herring) to reach the lifts. Specifically, the ZOP must be designed to maintain instantaneous velocities below 3 feet per second, separated only by brief regions of higher velocity that river herring may traverse in seconds at burst speeds up to 6 feet per second, over the full range of operational flows for the EFL, and in all generation scenarios.

After ZOP construction is completed, the Licensee shall assess the ZOP for upstream migrating river herring under the full range of the current fish passage design flows (i.e., up to 113,000 cfs of river flow).

Eel Passage – Eastern Location – The Licensee shall, consistent with the Eel Passage Plan established by Muddy Run license, evaluate potential trapping locations for American eel on the east side of Conowingo Dam including Octoraro Creek starting in May of the first calendar year after license issuance or immediately if license issuance occurs during the upstream American eel migration period. The plan and schedule for implementation of temporary and permanent eel passage facilities and other design criteria shall follow requirements established by the Muddy Run license and be approved by the Service and FERC following consultation with the Licensee and the respective resource agencies. The Licensee shall operate any temporary or permanent eel passage facility continuously (24 hours per day, 7 days per week) during the American eel Upstream Migration Period and shall submit proposed stocking locations for collected American eels to the Service and resource agencies for review and approval by the Service prior to beginning such measures.

[11] The estimated cost of ten weirs plus a contingency of 30% is no more than $2.3 million in 2016 dollars.

Eel Passage – Western Location

The Licensee shall conduct a trap and transport operation for American eels at the west side of Conowingo Dam beginning immediately after license issuance. The eel passage facility shall be designed to provide volitional passage for American eels no later than 2031, and will be sited taking into consideration the potential for a new West Fish Lift. [12]

Design criteria shall follow the components described in the Muddy Run license. The Licensee shall conduct trap and transport of American eels until 2030, and will implement volitional American eel passage starting in the 2031 season. The Licensee shall operate the eel passage facility continuously (24 hours per day, 7 days per week) during the American eel upstream Migration Period. The Licensee shall submit proposed stocking locations for collected American eels to the Service and resource agencies for review and approval by the Service prior to beginning trap and transport of American eels.

12.6.2 Improving Attraction Efficiency

Included is a list of physical and operational modifications to the Project intended to address observed deficiencies in fishway attraction efficiency. The tiered process for improving attraction efficiency is based on passage efficiency during the most recent efficiency test. The items included in the different tiers were developed to be commensurate with the degree of shortfall from the *Target Efficiency*. If, based on the *Adjusted Efficiency* of the current test, all appropriate options from the corresponding tier, including any option proposed by the Licensee and approved by the Service, have been exhausted, the items from the next highest numbered tier may be required, regardless of the current project passage efficiency. More than one item from a tier may be completed at one time depending on the degree of the *Adjusted Efficiency* shortfall.

[12] Consistent with the Eel Passage Plan established by the Muddy Run license, construction of the volitional passage facility will eliminate the Licensee's obligation to participate in the trap and transport program once the volitional upstream eel passage facility is operational. However, if the upstream eel trap and transport and periodic evaluation program continues beyond 2030, the Licensee will continue to provide access to the Conowingo eel collection facilities for as long as the program continues. The Licensee, however, shall bear no cost responsibility for the trap and transport and periodic evaluation program until 2046, at which time cost responsibility shall be shared among all participants in the program.

12.6.2.1 Improving Attraction Efficiency – Tier I (*Adjusted Efficiency 70*%-85%)

In the year following any failure by the Licensee to reach the *Target Efficiency* due to inadequate fishway attraction, the Licensee shall implement one or more of the modifications to Project operations and facilities described in this section.

Correct any Technical Operational Problems and/or Implement Internal Modifications

The Licensee shall correct any technical operational problems that may have been detected during the fish passage season and/or implement internal modifications to the West and/or East fish lift (e.g., energy dissipation, hydraulic attraction).

Implementation of preferential turbine operating schemes

The Licensee shall develop a turbine operation scheme that can range from simply first on/last off to modification of specific Francis and Kaplan unit operation to ensure that fish are able to successfully locate and access the fish lift entrances.

12.6.2.2 Improving Attraction Efficiency – Tier II (*Adjusted Efficiency* 55%-69%)

Within 2 years following any failure to meet the *Target Efficiency* due to inadequate attraction to the fishway, the Licensee may implement either one of the modifications to the Project facilities described in this section to reach upstream passage efficiency.[13]

Relocate EFL Entrances A & B

If the CFD modeling results indicate modifications to Entrances A & B will improve guidance to and accessibility of the lift entrances, then the Licensee shall extend the entrance channel at entrance A with two 45-degree turns in the fish passage facility channel, so as to discharge into the area behind the catwalk piers and upstream from the Kaplan turbine discharge/boil. The attraction flow should be effective along the catwalk and through the space between the piers (Figure 10, USFWS 2013h). The Licensee shall also modify the existing entrance B so that the

[13] The Service may require relocation of Entrances A&B and, if the *Adjusted Efficiency* continues to be between 55%-69%, Entrance D at a later point, but then, per Tier III (and consistent with the "not before" dates), may only require the AWS, not the WFL. Alternatively, the Service may require the relocation of Entrance A&B, and in subsequent cycles proceed to choose the WFL (again, consistent with the "not before" dates) if (a) the *Adjusted Efficiency* is below 55% and Entrance D has not been constructed or (b) the *Adjusted Efficiency* is between 55%-69% and the Service determines that Entrance D is not likely to achieve the efficiency criterion.

centerline of the discharge plume will be at a 45-degree angle to the river flow.

Construct a new Entrance D with a separate crowder and holding pool

The Licensee shall build a new additional entrance, Entrance D, with a separate crowder and holding pool (Figure 10). The hopper will be accessed from the new entrance and through a proposed collection gallery that will span the full length of the Kaplan turbine section of the powerhouse. Entrance D and the collection gallery are intended to provide access to the EFL from the Francis turbine section of the powerhouse. The new collection gallery will be located against and along the powerhouse wall. This improvement will not be required by the Service to be operational before year 15 of the license.

12.6.2.3 Improving Attraction Efficiency -Tier III (*Adjusted Efficiency* less than 55%)

Following any failure by the Licensee to reach upstream passage efficiency due to inadequate fishway attraction, the Licensee may implement one or more of the modifications to Project operations and facilities described in this section.

Construct an Auxiliary Water Supply at the EFL

The Licensee shall construct a new AWS stilling basin and system so the energy from up to 4,300 cfs can be dissipated and incorporated into effective attraction flows emanating from the multiple fish lift entrances. This improvement will not be required by the Service to be operational before year 25 of the license.

WFL Construction

Licensee shall construct a new WFL (as described below, in parts 1-5) in the west corner of the powerhouse tailrace. The Licensee shall operate the new WFL as a tailwater to headpond fish lift with a collection facility for fish sampling that, at the Licensee's option, could be used as a fish trap and transport facility. This improvement will not be required by the Service for reasons of attraction efficiency to be operational before year 25 of the license, and only if neither Entrance D nor the EFL AWS stilling basin and system have been constructed. If the Service requires construction of the WFL for reasons of attraction efficiency, it has agreed not to subsequently require the EFL AWS stilling basin and system under this Prescription.

WFL Construction – Part 1

The Licensee shall construct a facility that provides the capability of enumerating fish passage by species, allows for the collection of and holding of fish for biological sampling, and that can also be used for trapping and transporting American shad and available river herring per year, with the potential for captured fish to be transported upstream of the York Haven Dam.

WFL Construction – Part 2

The Licensee shall install two 6,500-gallon hoppers, with separate crowders, in the new WFL, capable of operating simultaneously.

WFL Construction – Part 3

The Licensee shall construct the WFL to have the ability to provide up to 5 percent of hydraulic capacity of the Project (or up to 4,300 cfs) for attraction flow to the fishway entrance(s). During the design phase and during preconstruction, the Licensee shall conduct computational fluid dynamics (CFD) modeling and other supporting analysis to develop appropriate fish lift entrance attraction flows, velocities, and hydraulic conditions. The Licensee shall operate the WFL to provide attraction flow of at least 2,600 cfs (3 percent of hydraulic capacity of the Project) during the Upstream Migration Period for American shad and river herring. With the goal of improving fish passage efficiency at the WFL following initial start-up of the new WFL, the Service may require the lift operator to modify operation of the fish lift, the allocation of flows through its Auxiliary Water System (AWS), and/or the total amount of flow being supplied to the WFL (up to a maximum of 4,300 cfs or 5 percent of the Project hydraulic capacity).

WFL Construction – Part 4

The Licensee shall design and construct an AWS that meets Service criteria for energy dissipation of the attraction flow while maintaining water quality standards.

WFL Construction – Part 5

The Licensee shall conduct an assessment of the ZOP downstream of the WFL to ensure that it continues to be passable over the range of flows in which the WFL is operational.

12.6.3 Improving Fish Lift Capacity

Included is a list of physical and operational modifications to the Project intended to address possible deficiencies in fish lift capacity. The tiered process for improving capacity is based on passage efficiency during the most recent efficiency test. The items included in the different tiers were developed to be commensurate with the degree of missing the required 85 percent passage efficiency criterion. If, based on the *Adjusted Efficiency* of the current test, all options from the corresponding tier have been exhausted; the items from the next highest numbered tier may be required, regardless of the current project passage efficiency. Implementation of modifications in the capacity tiers is independent of the implementation of similar items used to improve attraction efficiency in section 12.6.2. Both attraction and capacity improvements can be required simultaneously if deemed appropriate from the most recent study results, but only to the extent both improvements are needed to meet the *Target Efficiency*.

12.6.3.1 Improving Fish Lift Capacity - Tier I (Adjusted Efficiency 70% – 85%)

Within 2 years following any failure by the Licensee to reach upstream passage efficiency due to inadequate fishway capacity, the Licensee shall implement the modification to Project facilities described in this section.

Construct a new Entrance D with a separate crowder and holding pool

The Licensee shall build a new additional entrance, Entrance D, with a separate crowder and holding pool (Figure 10). The new hopper will be accessed from the new entrance and through a proposed collection gallery that will span the full length of the Kaplan turbine section of the powerhouse. Entrance D and the collection gallery are intended to provide access to the EFL from the Francis turbine section of the powerhouse. The new collection gallery will be located against and along the powerhouse wall. This improvement will not be required by the Service under this Prescription to be operational before year 15 of the license.

12.6.3.2 Improving Fish Lift Capacity - Tier II (*Adjusted Efficiency* less than 70%)

Within 3 years following any failure by the Licensee to reach upstream passage efficiency due to inadequate fishway capacity, the Licensee shall implement the modifications to Project facilities

described in this section.

WFL Construction

The Licensee shall construct a new WFL (as described in section 12.6.2.3) in the west corner of the powerhouse tailrace. The Licensee will operate the new WFL as a tailwater to headpond fish lift with a collection facility for fish sampling that, at the Licensee's option, could be used as a fish trap and transport facility. This improvement will not be required by the Service under this Prescription to be operational for reasons of capacity before year 25 of the license.

12.7 Fish Passage Effectiveness Monitoring

Efficiency testing of both upstream and downstream fish passage, and determining mortality rates of American shad when using trap and transport are critical to evaluating the success of fish passage structures and operations, diagnosing problems, and determining both when modifications are needed and what modifications are likely to be effective. These measures are essential to ensuring the effectiveness of fishways over the term of the license, particularly in cases where the increasing size of fish populations as a result of improved upstream passage may also lower upstream fish passage efficiencies due to migrating fish crowding and exceeding daily or annual lift capacity, thus keeping some fish from successfully passing the project and limiting net effectiveness.

12.7.1 Fishway Effectiveness Monitoring Plan

The Licensee shall develop a Fishway Effectiveness Monitoring Plan (FEMP) in consultation and with the approval of the Service, and will submit the FEMP to the FERC for approval within 6 months of license issuance. The FEMP will contain the plans for the studies described in Sections 12.7.2 through 12.7.5. If the Service requests a modification of the FEMP, the Licensee shall file a written response with the Service within 30 days and send a copy of the response to FERC and resource agencies. Any modifications to the FEMP by the Licensee will require approval by the Service and, if necessary, FERC prior to implementation.

The Licensee shall submit yearly interim study reports to the Service and FERC following the conclusion of each study year. The interim and final reports for upstream passage studies will be

submitted to the Service by December 31st of each study year. The interim and final reports for downstream passage studies will be submitted to the Service by August 1 following each study year. The final study report will include results for each life stage and type of study conducted with a determination of the Licensee's success or failure in achieving the passage efficiency criteria established in Section 12.2. In conjunction with submitting the final study report(s), the Licensee shall also provide electronic copies of all data collected from studies to the Service.

The Licensee shall meet with the Service and the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) to discuss the FEMP and FOMP. This meeting will occur no later than January 31 each year unless the Licensee and the Service agree on a different date. At this annual meeting the Licensee shall discuss with the Service and SRAFRC the fish passage results from the previous year, review regulatory requirements for fish lift and eel passage operations, and discuss any upcoming modification or testing the Licensee proposes for the upcoming fish passage season.

12.7.2 Initial Efficiency Test, Post-Modification Efficiency Tests, and Periodic Efficiency Tests for Upstream Passage of American Shad and River Herring

The *Initial Efficiency Test* and any *Post-Modification Efficiency Tests* will consist of a three-year fish tagging and monitoring study of American shad and river herring using radio telemetry, or other best tracking technology. The *Periodic Efficiency Tests* will consist of a two-year American shad tagging study using the same techniques unless the Licensee elects, with Service concurrence, to conduct an additional one year of study. The *Initial Efficiency Test* will begin in the 5th passage season after license issuance. The *Post-Modification Efficiency Test* will begin in the first fish passage season immediately following any required modification implemented from the tiers. The *Periodic Efficiency Test* will be conducted on every 5th year after a previous study determines that the *Adjusted Efficienc*y of the project is achieving 85 percent passage efficiency for American shad. Early Periodic Efficiency Tests may be delayed by up to two years to coincide with the schedule for tests at Muddy Run agreed upon in the 2015 Settlement Agreement between the Service and the Licensee.

These studies will use sufficient numbers of test fish to account for drop-back and other fish loss.

These fish will be collected from a downstream location, and be representative of the migrating population as a whole. Specific details of the telemetry studies such as sample sizes, collection of and release location of tagged American shad and river herring, arrangement of telemetry receivers, and appropriate statistical analyses shall be developed by the Licensee in conjunction with the Service and other resource agencies. The Licensee shall submit final study plans to the Service and FERC for review and approval prior to initiating any study.

12.7.2.1 Trap and Transport Credit for American Shad

The Licensee will receive additional credit toward the upstream passage efficiency criterion for adult American shad that are trapped and transported upstream of York Haven Dam. The Service will recognize the benefits to the species by giving credit towards the calculation of whether the efficiency criterion for upstream shad passage is met, due to the value to restoration of avoiding the passage of impediments at the upstream hydroelectric projects.

Details of the credit toward the efficiency criterion are provided in Appendix B. Part of the calculation of the credit toward efficiency criterion requires an estimate of the mortality associated with trap and transport operations. In the 4th year after license issuance, the Licensee shall work with the Service and other resource agencies to develop a one-year study to estimate the mortality of fish which are trapped and transported to areas upstream of York Haven Dam. Such a study will include assessment of immediate mortality (mortality occurring during transport) as well as delayed mortality (mortality occurring during some time period after release). The results of the study will be used to modify, as necessary, the mortality input utilized in the trap and truck credit. The Service's proposed methodology for this study is included in Appendix C; however the Licensee and the Service have not agreed upon a final methodology and final study design is expected to take place post-licensing.

12.7.3 Upstream American Eel Effectiveness Testing

Unless the Service and the Licensee agree that no effective technology is available to enable such testing, the Licensee shall conduct an upstream efficiency study on juvenile American eel at the WFL facility in the year immediately following license issuance. The study will determine the American eel upstream passage efficiency of the eelway throughout the upstream migration

season. The study will consist of two components, including determining attraction efficiency to the facility and passage efficiency of the facility once an eel enters the structure. Efficiency studies will be repeated following any modifications to the operation or physical structure to evaluate the relative success of the modifications. The Licensee shall provide an annual report on the efficiency study to the Service by December 31 of the study year.

12.7.4 Downstream Adult and Juvenile American Shad and River Herring Effectiveness Testing

The Licensee shall conduct downstream passage effectiveness studies of American shad and river herring in 2027 in coordination with the Service. As part of the Conowingo FEMP for downstream passage, the Licensee will evaluate both juvenile and adult life stages using a study protocol developed cooperatively with the Service to include a Conowingo Pond route of passage study. A route of passage study will be conducted to determine the routes chosen by downstream migrating fish through the Project under various generation conditions to determine if there are preferred routes of passage at the dam. The route of passage study will be conducted for 2 years to account for inter-annual variation in flow conditions. The Licensee will have the option to extend the route of passage study for an additional year.

In addition to the route of passage study, a one year separate and discrete passage study for both adult and juvenile American shad and river herring shall be conducted to estimate survival through the Kaplan and Francis turbines under best gate efficiency. This study will commence in 2027. The effects of barotrauma during turbine passage will be included as part of the turbine survival studies for all life stages when possible. Results of the studies will be used to determine through-Project survival (i.e. via spill, Francis turbines, Kaplan turbines, etc.), and immediate and latent mortality for each route to achieve the passage criteria.

In the event the Licensee is unable to achieve the efficiency criteria for survival based on the results of the downstream studies, the Department may exercise its reservation of authority to address the issue.

12.7.5 Downstream American Eel Effectiveness Monitoring

The Licensee shall conduct or participate in two separate studies on downstream migrating American eel in the Susquehanna River. The studies can be done concurrently or separately, and will be conducted in conjunction with the American eel downstream studies undertaken by the Licensee of the Muddy Run Hydroelectric Project. The Licensee shall initiate studies when the Service determines that sufficient numbers of downstream migrants can be collected in the upper watershed to conduct a valid study.

First, the Licensee shall participate in a basin-wide study coordinated by the Service to determine timing of downstream migration of American eels in the Susquehanna River (see USFWS 2014d). To complete this study, the Licensee shall contribute $75,000 to the Service to collect and tag fish for use in the basin-wide study. Radio telemetry monitoring will be conducted by the Licensee year-round for 3 consecutive years.[14]

In addition to the basin-wide migration timing study, the Licensee will conduct a study at Conowingo Dam to determine migratory delay, route of downstream passage (i.e. via spill, Francis turbines, Kaplan turbines, etc.), and immediate and latent mortality for each route. If a sufficient number of tagged fish encounter the Project, a route of passage study can be done concurrently with the basin-wide downstream migration study using the same tagged eels assuming appropriate tag technology is available to assess latent mortality of those fish during the study.

In the event the Licensee is unable to achieve the efficiency criterion for survival based on the results of the downstream studies, the Department may exercise its reservation of authority to address the issue.

12.8 Fishway Inspections

The Licensee shall provide Service personnel and other Service-designated representatives, timely access to the fish passage facilities at the Project and to pertinent Project operational

[14] Mobile tracking and data analysis for this study will be the responsibility of the Service. Annually, the Service will share with the Licensee all data collected as part of the basin-wide study.

records for the purpose of inspecting the fishways to determine compliance with the Fishway Prescription.

13. Pre-License Actions Agreed to by the Licensee

13.1. Items to be completed in 2016 - 2017

The License Applicant has agreed to develop and finalize a detailed logistics plan and operating protocol for trap and transport of American shad and river herring from both the EFL and WFL. The Logistics plan will address near-term operations, as well as logistics necessary to support the collection and transport of up to 80 percent of the American shad and river herring passing the project with a maximum transport of 100,000 American shad and 100,000 river herring annually. This plan will be completed by December 31, 2017.

The License Applicant has agreed to develop detailed computational fluid dynamics (CFD) models of the zones of passage, in consultation with the Service, to the EFL and WFL to assess the ability of fish to reach them.

The License Applicant has agreed to develop its initial FOMP (as described in Section 12.4) and submit to the Service by September 30, 2017.

13.2. Items to be completed in 2017 - 2018

The License Applicant has agreed to finalize design plans for initial fishway improvement and improvements to facilitate the trap and transport program.

14. Scientific Names

Alewife *(Alosa pseudoharengus)*
American eel *(Anguilla rostrata)*
American shad *(Alosa sapidissima)*
Atlantic sturgeon (*Acipenser oxyrinchus)*
Blueback herring *(Alosa aestivalis)*
Gizzard shad (*Dorosoma cepedianum*)
Hickory shad *(Alosa mediocris)*

Largemouth bass *(Micropterus salmoides)*

Sea lamprey *(Petromyzon marinus)*

Shortnose sturgeon *(Acipenser brevirostrum)*

Smallmouth bass *(Micropterus dolomieu)*

Striped bass (*Morone saxatilis*)

15. Definition of Technical Terms

Adjusted Efficiency– The calculated fish passage efficiency that accounts for the biological benefit of fish trapped and transported from the project to areas upstream of other mainstem dams. This calculated efficiency gives credit towards efficiency targets for the number of fish that are trapped and transported.

Alosines – collective term for American shad, blueback herring and alewife

Anadromous – migratory fish that spawn in freshwater rivers but spend most of their life in the ocean

Attraction Efficiency – The proportion of the migrating population that successfully passes a designated downstream point at the Project (i.e. the downstream end of Rowland Island), and successfully enters the fish lift

Barotrauma – trauma due to changes in barometric pressure such as the expansion and rupture of a fish's swim bladder

Biomass – pounds of fish

Catadromous – migratory fish that spawn in the ocean but spend most of their life in freshwater

Diadromous – includes both anadromous and catadromous migratory fish

Downstream Fish Passage Efficiency – the percentage of the fish that approach the upstream side of the Project and survive unharmed as they pass the Project and continue downstream migrations

Effective Passage – the combination of fish passage facilities and project operations that provide conditions where fish can approach and move past a barrier with little or no impact to their migration. Effectiveness may include both qualitative and quantitative components; however, a different term, efficiency, is typically reserved for quantitative evaluations of effectiveness.

Entrainment – fish passage via a particular structure, usually referring to directing fish passage through turbines or into downstream fish passage facilities

Fecund – more fertile, having more eggs

Fish Ladder – an engineered ramp-like structure, typically constructed of concrete and/or metal, used to provide upstream fish passage

Fish Lift – an elevator-like structure with a hopper used to convey fish from the tailwaters to the headpond of high dams

Fish Passage Facility – the physical structure of the fishway used to convey fish upstream; with the term being synonymous with "fish lift" at this Project

Fishway – shall have the definition provided in P.L. 102-486, § 1701(b) (1992)

Headpond – the body of water located on the upstream side of the dam

Hopper – the structural part of the fish lift used to hold fish as they are transported from the tailwaters to the head pond

Impingement – to trap fish against a structure, usually referring to intake screens

Nature-Like Fishway – a ramp-like structure, typically constructed of natural materials (rocks, logs), used to provide upstream fish passage

Panmictic – of one spawning population with no genetic differentiation between geographic areas

Peaking – a hydro-electric facility that rarely spills water has the ability to store water and release on demand for power generation, typically having the ability to significantly impact flows downstream of the project

Repeat Spawning – ability to spawn over multiple years

Run-of-River – a hydro-electric facility that has limited (if any) ability to store water, with water typically flowing over the crest of the dam at all times

Safe Passage – the movement of fish through the zone of passage that does not result in any unacceptable stress, incremental injury, or death of the fish.

Self-Sustaining - Ability to maintain migratory fish populations at the level of their restoration goal without supplementation from trap and transport or hatchery products.

Tailrace – the area downstream of the dam that is in the hydraulic influence of Project operations

Tailwaters – the area downstream of Conowingo Dam located between the dam and the downstream end of Rowland Island

Timely Passage – the successful movement through the zone of passage that proceeds without a delay that would impact the natural behavior patterns or life history requirements of a fish

Trap and Transport – fish that are collected at a downstream project and loaded in a tank truck and transported and released into some location upstream of that project

Upstream Fish Passage Efficiency – the percentage of the fish present in the Project tailwaters that successfully move through the fish lift and continue upstream migrations; e.g. the proportion of fish that start at point B (downstream end of Rowland Island in the case of Conowingo Dam) and passes point E in Figure 5

Volitional Passage – a fish passage facility that allows fish to swim unimpeded from the tailwaters to the headpond; fish lifts are not considered volitional passage because the fish rely on the operation of the lifts in order to pass upstream into the headpond

Zone of Passage (ZOP) – The contiguous area of sufficient lateral, longitudinal, and vertical extent in which adequate hydraulic and environmental conditions are maintained to provide a route of passage through a stream reach influenced by a dam (or stream barrier); e.g. the area between point A and point E in Figure 5.

16. Acronyms and Abbreviations

2010 SRAFRC Plan - Susquehanna River Anadromous Fish Restoration Cooperative's Migratory Fish Management and Restoration Plan for the Susquehanna River Basin

ACFCMA - Atlantic Coastal Fisheries Cooperative Management Act of 1993

ASMFC – Atlantic States Marine Fisheries Commission

AWS – Auxiliary Water System

cfs – cubic feet per second

Commission – Federal Energy Regulatory Commission

Department – U.S. Department of the Interior

DO – dissolved oxygen

EEZ - Exclusive Economic Zone

EFL – East Fish Lift

ESA – Endangered Species Act

FEMP – Fishway Effectiveness Monitoring Plan

FERC – Federal Energy Regulatory Commission (formerly FPC)

FMC - Fishery Management Council

FMP – Fishery Management Plan

FOMP – Fishway Operation and Maintenance Plan

FPA – Federal Power Act

FPC – Federal Power Commission

fps – feet per second

ft^3 – cubic feet

hr - hour

lbf – pounds of fish

MDNR – Maryland Department of Natural Resources

min - minute

MRPSP – Muddy Run Pumped Storage Project

NYSDEC – New York Department of Environmental Conservation

NMFS – National Marine Fisheries Service

PADEP – Pennsylvania Department of Environmental Protection

PECO – Philadelphia Electric Company

PFBC – Pennsylvania Fish and Boat Commission (formerly PFC)

PFC – Pennsylvania Fish Commission

PPL – Philadelphia Power & Light Company

ppm – parts per million

Project – Conowingo Hydroelectric Project

REA – Ready for Environmental Analysis

Resource agencies - states of Maryland and Pennsylvania, Susquehanna River Basin Commission, and National Marine Fisheries Service

River herring – alewife and blueback herring

RM – river mile

(see repeat, below)Service – U.S. Fish and Wildlife Service

SHWPC – Safe Harbor Water Power Corporation

SRAFRC – Susquehanna River Anadromous Fish Restoration Cooperative (formerly Committee)

SRBC – Susquehanna River Basin Commission

SSAC – Susquehanna Shad Advisory Committee

WFL – West Fish Lift

YHPC – York Haven Power Company

YOY – young-of-year (juvenile fish)

ZOP – zone of passage

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Appendix A. Calculation of Fishway Capacity for a 6,500-Gallon Hopper

Biological Parameters		
	λ_m= 0.052 (season/day)	Season-to-Day run compression coefficient; empirically determined designed parameter
	β=0.15 (day/hr)	Hour-to-Day run compression coefficient; empirically determined design parameter
	T=15 min	Lift cycle time (recommended)
Hopper Size		
	Vol_H=868.9ft^3	Estimate of proposed hopper volume (6,500 gallons)
	V_{fH}=0.1 (ft^3/lbf)	Volume required per fish-pound; USFWS criterion; for lift times greater than 15 minutes, a 30 percent increase in V_{fH} is recommended
Allowable peak biological loadings		
Flb_h= (Vol_H/v_{fH}*T)	Flb_h= 34,756 lbf/hr	Allowable loading of fish in pounds per peak hour
Flb_d=Flb_h/ β	Flb_d= 231,706 lbf/day	Allowable loading of fish in pounds during the peak day
Flb_s = Flb_d/ λ_m	Flb_s= 4,455,897 lbf/season	Allowable loading of fish in pounds during an entire season

Appendix B. Calculating Trap and Transport Credit

Credit Towards an Overall Efficiency Criterion (85 percent of the fish entering the Conowingo Tailrace)

For a given number of shad trapped and transported we can estimate the number that would need to pass Conowingo Dam via the fish lift to result in the same number of spawners upstream of York Haven Dam. This number is termed "lift equivalents" (L_e) and is calculated as:

[1] $$L_e = (\sum_{i=1}^{n} TT_i) \cdot (1 - TT_m)/D$$

Where TT_i is the number trapped and transported each year during a single or multi-year study to measure passage efficiency, and TT_m is the mortality associated with trapping and transporting shad. Harris and Hightower (2011) estimated mortality of trapped and transported shad in the Roanoke River to be 15 percent. However, SRAFRC (1997) gave estimates of mortality for holding shad prior to trap and transport, mortality during the transport, and delayed mortality following release. When all these factors are considered, the overall mortality associated with trap and transport operations was 6 percent, which was used in this model. The denominator (*D*) in equation [1] will be calculated using the maximum efficiency of each of the two upstream dams with the highest passage efficiency over the three year study and the average of these efficiencies. For example, if the highest efficiencies of Holtwood, Safe Harbor, and York Haven Dams over the three year study were 0.60, 0.78, and 0.50, respectively, then the denominator would be calculated as $D = 0.60 \cdot 0.78 \cdot \left(\frac{0.60+0.78}{2}\right) = 0.3229$. It was assumed that other than the mortality associated with trap and transport operations, no other negative impacts on their fitness occurred compared to shad that would migrate via multiple fish passage facilities to areas upstream of York Haven Dam.

The L_e can be added to the observed number that were lifted past Conowingo Dam during the study period to arrive at an adjusted total number that are passed via the fish lift (L_a).

[2] $$L_a = L_e + \sum_{i=1}^{n} L_i$$

where L_i is the observed number lifted in each year.

During a radio telemetry study at Conowingo Dam, an estimate of passage efficiency will be made and given the total number of shad actually passed (lifted and released into Conowingo Pond + trapped and transported upstream), an estimate of the total number of shad downstream of Conowingo Dam during all years of the study can be made.

[3] $N = (\sum_{i=1}^{n} P_i)/E_o$

where P_i is the total number passed each year and E_o is the estimated passage efficiency during the study. Equation [3] also assumes that no mortality is suffered while attempting to pass Conowingo Dam.

The variance of N can be estimated by the delta method using the estimated variance of E_o.

[4] $Var(N) = [Var(E_o)/E_o^4] \cdot (\sum_{i=1}^{n} P_i)^2$

The adjusted passage efficiency is then the adjusted number that are lifted during the study divided by the total number of shad downstream of Conowingo Dam during all years of the study.

[5] $E_a = L_a/N$

The associated variance from the delta method is:

[6] $Var(E_a) = [Var(N)/N^4] \cdot L_a^2$

The 95 percent confidence interval for $E_a$can be approximated as:

[7] $95\%\ C.I. \approx 1.96 \cdot \sqrt{Var(E_a)}$

If the upper 95% confidence limit is greater than or equal to the efficiency criterion, then the criterion is considered to be met.

Appendix C. Service's Proposed Methodology for Trap and Transport Mortality Study

To assess the mortality associated with trap and transport (T&T) of American shad collected at Conowingo Dam and transported to areas upstream of York Haven Dam, a study design similar to that of Millard et al. (2005) will be employed. This study will have both a treatment (T&Ted shad) and a control group (shad not T&Ted). The purpose of having both a treatment and a control group is to evaluate both the immediate and delayed mortality associated with T&T operations while controlling for mortality associated with handling stress while carrying out the study.

Control groups will consist of shad that are caught in the lifts at Conowingo Dam, sorted from non-target species, and rather than being loaded into a truck and transported upstream, they will be released to a large holding tank located at Conowingo Dam (size to be determined) and monitored for 72 hours post-release.

Treatment groups will consist of shad that are caught in the lifts at Conowingo Dam, sorted from non-target species, loaded into a truck, and driven around in the truck for a length of time equivalent to the trip duration to areas upstream of York Haven Dam. After simulating transport, the shad will be placed into a holding tank located at Conowingo Dam and monitored for 72 hours post-release.

Experimental tanks for both treatment and control groups will be located at Conowingo Dam in order to eliminate any confounding effects of differences in water temperature/chemistry between treatment and control groups and to isolate the effects of transport. Experimental tanks will be set up with flow through conditions using water pumped from the tailrace of Conowingo Dam.

Each week throughout the fish passage season, a truck load's worth of fish (exact number yet to be determined) will be used in both treatment and control groups. Thus, the experiment will be temporally replicated for 4 – 8 weeks depending on the duration of the spawning run in a given year. This will allow assessment of mortality over the range of water temperatures experienced by shad throughout the season.

During the 72 hour monitoring period, dead shad will be removed from the tank as soon as they are noticed. Mortality will be quantified as the number of dead shad divided by the number of shad that entered either the treatment or control group. Mortality in the treatment group will include all shad that died during the entire process from loading them into the truck to those found dead at the end of the 72 hour monitoring period.

Statistical Analysis

It will be assumed that total mortality of the treatment group consists of two components: 1) mortality associated with transport and release of the shad; and 2) mortality associated with experimental handling of the shad. Thus, total mortality of the treatment group = T&T mortality + handling mortality. The control group would only experience mortality associated with experimental handling. The instantaneous handling mortality rate (m_h) will be estimated from the control group as

$$M_h = -ln(S_c)$$

where S_c is the survival of the control group over all replicates throughout the season. The instantaneous total mortality in the treatment group will be estimated as

$$M_t = -ln(S_t)$$

where S_t is the survival of the treatment group over all replicates throughout the season. The conditional mortality associated with trap and transport (conditioned on handling mortality) is

$$u_{TT} = A - \left[\frac{A \cdot M_h}{-ln(1-A)}\right]$$

where A is the fraction of fish that die from all causes (1-S_t). This equation is based on the traditional fisheries expression $u = A \cdot F/Z$ where u = the expectation of death from fishing, A = total mortality rate from all causes, F = the instantaneous fishing mortality rate, and Z = the total instantaneous mortality rate. Estimation of the conditional mortality associated with trap and transport (u_{TT}) according the above equation is preferred because it account for the probability that the two sources of mortality, trap and transport stress and handling stress, occur simultaneously over the monitoring period (Millard et al. 2005).

Literature Cited

Millard, M.J., J.W. Mohler, A. Kahnle, and A. Cosman. 2005. Mortality associated with catch-and-release angling of striped bass in the Hudson River. North American Journal of Fisheries Management. 25: 1533-1541.

Attachment D

Conowingo Hydroelectric Project
(FERC Project No. 405)

Fishway Effectiveness Monitoring Plan
("FEMP")

CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NUMBER 405

FISHWAY EFFECTIVENESS MONITORING PLAN

Prepared for:

Exelon.

Prepared by:

Normandeau Associates, Inc.

GOMEZ AND SULLIVAN ENGINEERS

September 2021

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Appendix A. Calculating Adjusted Efficiency with Trap and Transport Credit

Appendix B. Resource Agency Consultation Records, Comments, and Responsiveness Matrix

LIST OF ABBREVIATIONS

Conowingo Project, Project	Conowingo Hydroelectric Project
CWECF	Conowingo West Eel Collection Facility
EFL	East Fish Lift
EPAG	Eel Passage Advisory Group
Exelon	Exelon Generation Company, LLC
FEMP	Fishway Effectiveness Monitoring Plan
FERC	Federal Energy Regulatory Commission
MDE	Maryland Department of the Environment
PADEP	Pennsylvania Department of Environmental Protection
USFWS, the Service	United States Fish and Wildlife Service
WFL	West Fish Lift

1 INTRODUCTION

Exelon Generation Company, LLC (Exelon) is the licensee for the 570.15-megawatt Conowingo Hydroelectric Project (Conowingo Project or Project) (Federal Energy Regulatory Commission (FERC) Project No. 405). The Project is located on the Susquehanna River in Pennsylvania and Maryland. Conowingo Dam is located at river mile 10 in Maryland connecting Cecil and Harford counties, as is the lowermost six miles of the Project reservoir, Conowingo Pond. The remaining eight miles of Conowingo Pond are located in Pennsylvania, within York and Lancaster counties.

Exelon filed a Final License Application with FERC on August 30, 2012. Subsequent to filing the Final License Application, Exelon reached a negotiated resolution of fish passage issues at the Project with the United States Fish and Wildlife Service (USFWS). The negotiated agreement between Exelon and the USFWS are reflected in the U.S. Department of the Interior Modified Fishway Prescription for the Conowingo Hydroelectric Project No. 405 (filed June 8, 2016) and has been incorporated into the Project's FERC License issued March 19, 2021 as Appendix 1. As discussed herein, the new FERC License requires Exelon to, among other things, prepare a Fishway Effectiveness Monitoring Plan (FEMP).

This FEMP outlines the process and schedule by which passage effectiveness of American Shad (*Alosa sapidissima*), river herring (collectively, *Alosa aestivalis* and *Alosa pseudoharengus*), and American Eel (*Anguilla rostrata*) will be evaluated over the term of the new license at the Project.

1.1 Project Fish Passage Facilities

The Project contains two fish lifts located at Conowingo Dam, known as the West Fish Lift (WFL) and East Fish Lift (EFL) (Figure 1.1-1). The primary purpose of both lifts is to support trap and transport and volitional passage of American Shad and river herring, though other species use the lifts as well. As part of the FERC License, Exelon will implement substantial modifications to the existing fish lift facilities, along with a tiered approach to future improvements if passage effectiveness is not deemed sufficient based on various studies outlined in this FEMP.

Additionally, the Conowingo West Eel Collection Facility (CWECF) is operated at the Project in the vicinity of the WFL. The facility is designed to capture American Eel for subsequent transport to upstream release locations. The Conowingo East Eel Collection Facility will be constructed in the EFL stilling basin after required modifications to the EFL are complete. As part of both the Conowingo FERC license and consistent with the Muddy Run Pumped Storage Project FERC license, Exelon is evaluating potential locations for an additional eel collection facility on the east side of Conowingo Dam.

1.2 Regulatory Background

The Project's FERC License Article 401 *Commission Approval, Reporting, and Filing of Amendments* also refers to the FEMP as follows:

> *a) Requirement to File Plans for Commission Approval*
>
> *Various conditions of this license found in U.S. Department of the Interior's (Interior's) section 18 prescription (Appendix 1) require the licensee to prepare plans in consultation with other entities for approval by Interior (U.S. Fish and Wildlife Service [FWS]) and*

implement specific measures without prior Commission approval. Each such plan must also be submitted to the Commission for approval. These plans are listed below.

Interior Condition[a]	***Description***	***Due Date***
12.4	*Fishway Operation and Maintenance Plan Updates*	*January 31, annually*
12.7.1	*Fishway Effectiveness Monitoring Plan*	*Within 6 months of license issuance*

a. The conditions shown in this table were filed by Interior on June 8, 2016, and are attached to the license order as Appendix 1.

b. Exelon filed an Initial Fishway Operation and Maintenance Plan on September 29, 2017, and an updated plan on February 2, 2021. The plan is required by Article 413.

The licensee must include with each plan filed with the Commission documentation that the licensee has received approval from FWS, as appropriate.

The Commission reserves the right to make changes to any plan submitted. Upon Commission approval, a plan will become a requirement of the license, and the licensee must implement the plan or changes in project operation or facilities, including any changes required by the Commission.

b) Requirement to File Reports

Certain conditions found in Interior's section 18 prescription (Appendix 1) require the licensee to file reports with other entities. Because these reports relate to compliance with the requirements of this license, each such report must also be submitted to the Commission. These reports are listed in the following table:

Interior Condition[a]	***Description***	***Due Date***
12.7.1	*Upstream Fishway Effectiveness Monitoring Report*	*By December 31, annually[b]*
12.7.1	*Downstream Fishway Effectiveness Monitoring Report*	*By August 31, annually[b]*
12.7.3	*Upstream American Eel Effectiveness Testing Report*	*By December 31, annually[b]*

a. The conditions shown in this table were filed by Interior on June 8, 2016, and are attached to this order as Appendix 1.

b. As defined in condition 12.5.4 of Interior's section 18 prescription, fish passage efficiency testing will begin in the fifth year after license issuance.

The licensee must submit to the Commission documentation of any consultation, and copies of any comments and recommendations made by any consulted entity in connection with each report. The Commission reserves the right to require changes to project operation or facilities based on information contained in the report and any other available information.

c) Requirement to File Amendment Applications

Certain conditions of Interior's section 18 prescription (Appendix 1) contemplate unspecified long-term changes to project operation or facilities based on the results of studies or monitoring. Such changes may not be implemented until the licensee has filed an application to amend the license and the Commission has approved the application. In any amendment request, the licensee must identify related project requirements and request corresponding amendments or extensions of time as needed to maintain consistency among requirements.

The Project's FERC License, Appendix I, Section 12.7.1 outlines the development of a FEMP. This section states:

The Licensee shall develop a Fishway Effectiveness Monitoring Plan (FEMP) in consultation and with the approval of the Service, and will submit the FEMP to the FERC for approval within 6 months of license issuance. The FEMP will contain the plans for the studies described in Sections 12.7.2 through 12.7.5. If the Service requests a modification of the FEMP, the Licensee shall file a written response with the Service within 30 days and send a copy of the response to FERC and resource agencies. Any modifications to the FEMP by the Licensee will require approval by the Service and, if necessary, FERC prior to implementation.

The section also outlines the reporting and consultation requirements for this FEMP and associated studies as:

The Licensee shall submit yearly interim study reports to the Service and FERC following the conclusion of each study year. The interim and final reports for upstream passage studies will be submitted to the Service by December 31st of each study year. The interim and final reports for downstream passage studies will be submitted to the Service by August 1 following each study year. The final study report will include results for each life stage and type of study conducted with a determination of the Licensee's success or failure in achieving the passage efficiency criteria established in Section 12.2. In conjunction with submitting the final study report(s), the Licensee shall also provide electronic copies of all data collected from studies to the Service.

1.3 Passage Criteria

The License establishes upstream and downstream passage efficiency criteria for the Project (Table 1.3-1). The License defines upstream fish passage efficiency as the proportion of the fish in the Project tailwaters that successfully move through the fishway and continue upstream migrations, calculated as a percentage. The Project tailwaters at Conowingo are defined as the area downstream of Conowingo Dam located between the dam and the downstream end of Rowland Island. Upstream passage will be deemed successful for, 1: fish that are passed into Conowingo Pond by the Conowingo East fish lift exit trough and move upstream, and 2: fish that enter a fish lift are placed into a transport tank, and are successfully transported upstream of Conowingo Dam.

Downstream fish survival efficiency is the proportion of the fish that approach the upstream side of the Project and survive as they pass the Project and continue downstream migrations. The License incorporates USFWS numeric targets.

Table 1.3-1: Fish Passage and Survival Efficiency Criteria for the Conowingo Project

Species	Life Stage	Passage	Numeric Criteria
American Shad	Adult	Upstream	85% Adjusted Efficiency[1]
	Adult	Downstream	80% Survival Efficiency
	Juvenile	Downstream	95% Survival Efficiency
River Herring	Adult	Upstream	Not Developed
	Adult	Downstream	80% Survival Efficiency
	Juvenile	Downstream	95% Survival Efficiency
American Eel	Juvenile	Upstream	Not Developed
	Adult	Downstream	85% Survival Efficiency

1.4 Monitoring Schedule

The general monitoring schedule is outlined in Table 1.4-1.[2] Additional details regarding monitoring schedules are described under the studies for each species in their respective sections of this document. The License requires that proposed amendments to the schedule be submitted in writing to the USFWS, for subsequent approval by the USFWS and FERC.

[1] Adjusted Efficiency is the calculated fish passage efficiency that accounts for the biological benefit of fish trapped and transported from the Conowingo Project to areas upstream of other main stem dams. This calculated efficiency gives credit towards efficiency targets for the number of fish that are trapped and transported. Formulae for calculating Adjusted Efficiency were developed by USFWS and are included in Appendix B of the FERC License Appendix 1 and are presented in this report as Appendix A.

[2] Exelon will communicate regularly with resource agencies regarding the monitoring schedule and any necessary revisions.

Table 1.4-1: Fish Passage Effectiveness Monitoring Study Schedule

Species	Life Stage	Direction	Purpose	Timing	Duration
American Shad	Adult	Upstream	Trap and Transport Mortality Study	4th year after license issuance	1 year
	Adult	Upstream	Initial Efficiency Test	5th passage season after license issuance	3 years
	Adult	Upstream	Post-Modification Efficiency Tests	1st passage season immediately following modifications	3 years
	Adult	Upstream	Periodic Efficiency Tests	Every 5th year after a previous study determines project adjusted efficiency ≥ 85%	2 years[3]
	Adult	Downstream	Route Selection	2027	2 years
	Adult	Downstream	Survival	2027	1 year
	Juvenile	Downstream	Route Selection	2027	2 years
	Juvenile	Downstream	Survival	2027	1 year
River Herring	Adult	Upstream	Initial Efficiency Test	5th passage season after license issuance	3 years
	Adult	Upstream	Post-Modification Efficiency Tests	1st passage season immediately following modifications	3 years
	Adult	Downstream	Route Selection	2027	2 years
	Adult	Downstream	Survival	2027	1 year
	Juvenile	Downstream	Route Selection	2027	2 years
	Juvenile	Downstream	Survival	2027	1 year
American Eel	Juvenile	Upstream	Upstream Effectiveness Testing	1st year after license issuance, and/or after any modifications to the operation or physical structure[4]	1 year

[3] The Periodic Efficiency Tests will consist of a two-year American Shad tagging study, unless Exelon elects, with USFWS concurrence, to conduct an additional one year of study.

[4] The USFWS and Exelon have agreed that no effective technology is available to enable such testing; Exelon will reconsider conducting an upstream efficiency study on juvenile American eel at the west-side eel facility if appropriate technology becomes available.

Species	Life Stage	Direction	Purpose	Timing	Duration
	Adult	Downstream	Basin-Wide Monitoring and Funds	When USFWS determines that sufficient numbers of downstream migrants are present in the upper watershed (2021)	3 years
	Adult	Downstream	Route Selection, Delay, and Mortality	When USFWS determines that sufficient numbers of downstream migrants are present in the upper watershed (Start date no earlier than 2022 and no later than 2024)	To be determined[5]

[5] The duration of the route selection, delay, and mortality study is to be determined in consultation with the Eel Passage Advisory Group (EPAG) as outlined in Section 4.3.

EXELON GENERATION COMPANY, LLC

N

CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405
Fishway Effectiveness Monitoring Plan

0 500 1,000 2,000
Feet

Figure 1.1-1:
Project Overview

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2 ANNUAL MEETING

Exelon will meet with the USFWS and the Susquehanna River Anadromous Fish Restoration Cooperative annually to discuss this FEMP, along with the Fishway Operation and Maintenance Plan. This Annual Meeting will occur no later than January 31 each year unless Exelon and the USFWS agree on a different date. The purpose of the meeting will be to discuss the fish passage results from the previous year, review regulatory requirements for fish lift and American Eel passage operations, and discuss any upcoming modification or testing Exelon proposes for the upcoming fish passage season.

3 UPSTREAM PASSAGE

3.1 American Shad Trap and Transport Mortality Study

3.1.1 Background

Exelon will trap American Shad at the Conowingo Project and transport them to areas upstream, providing increased access to spawning habitats upstream of York Haven Dam. The USFWS recognizes the benefits of the trap and transport program and will give credit towards the calculation of the efficiency criterion for upstream passage of shad at the Conowingo Project. This credit calculation requires an estimate of mortality associated with the trap and transport program.

3.1.2 Regulatory Article Text

The Project's FERC License, Appendix 1, Section 12.7.2.1 outlines requirements for evaluation of mortality associated with trap and transport operations for American Shad at the Conowingo Project. The article states:

> *In the 4th year after license issuance, the Licensee shall work with the Service and other resource agencies to develop a one-year study to estimate the mortality of fish which are trapped and transported to areas upstream of York Haven Dam. Such a study will include assessment of immediate mortality (mortality occurring during transport) as well as delayed mortality (mortality occurring during some time period after release). The results of the study will be used to modify, as necessary, the mortality input utilized in the trap and truck credit. The Service's proposed methodology for this study is included in Appendix C; however the Licensee and the Service have not agreed upon a final methodology and final study design is expected to take place post-licensing.*

3.1.3 Methods and Study Plan Development

To assess trap and transport mortality of adult American Shad collected at Conowingo Dam and transported upstream, a treatment and control study, similar to that of Millard *et al*. (2005) is proposed, as requested by the USFWS. The study will incorporate treatment groups and associated control groups that control for mortality associated with handling stress, with replicates occurring each week of the spawning run (4 to 8 weeks, depending on the length of the season).

Exelon will submit a study plan in draft form to the USFWS and other resources agencies in the fourth year after license issuance. The details of the study plan will be presented at a meeting with the agencies, where Exelon and the agencies will come to an agreement on the final methodology. Based on the comments received and agreements reached at the meeting, the study plan will be modified by Exelon and submitted to FERC for approval within six months of study initiation.

3.1.4 Monitoring Schedule

The trap and transport mortality study plan development will be completed by March 2025. The study will then begin in 2026, and the study duration will span the length of the upstream passage season of American Shad that year.

3.1.5 Reporting and Consultation

Exelon will submit the final study reports to the USFWS, the other members of the Eel Passage Advisory Group (EPAG), and the Maryland Department of the Environment (MDE), as well as FERC by December 31 of the study year (2026). Results will be discussed with the agencies at the subsequent Annual Meeting as described in Section 2. Electronic copies of all data collected from this study will be provided to the USFWS.

3.2 American Shad Passage Efficiency Testing

3.2.1 Background

The License target efficiency for upstream passage of adult American Shad at the Project is 85% of the individuals that enter the Project tailwaters by passing the downstream tip of Rowland Island. Additionally, credit toward achieving this passage efficiency can be applied by trapping fish at the Project and transporting them upstream of York Haven Dam.

Exelon has agreed to make substantial changes to the facility at the Project to improve passage of American Shad and other species, along with implementation of a trap and transport program. Upstream passage for adult shad at the Project will be evaluated as outlined in this plan, per the regulatory requirements.

3.2.2 Regulatory Article Text

The Project's FERC License, Appendix 1, Section 12.7.2 outlines requirements for the Initial Efficiency Test, Post-Modification Efficiency Tests, and Periodic Efficiency Tests for Upstream Passage of American Shad and river herring. The section states:

> *The Initial Efficiency Test and any Post-Modification Efficiency Tests will consist of a three-year fish tagging and monitoring study of American Shad and river herring using radio telemetry, or other best tracking technology. The Periodic Efficiency Tests will consist of a two-year American Shad tagging study using the same techniques unless the Licensee elects, with Service concurrence, to conduct an additional one year of study. The Initial Efficiency Test will begin in the 5th passage season after license issuance. The Post-Modification Efficiency Test will begin in the first fish passage season immediately following any required modification implemented from the tiers. The Periodic Efficiency Test will be conducted on every 5th year after a previous study determines that the Adjusted Efficiency of the project is achieving 85 percent passage efficiency for American Shad. Early Periodic Efficiency Tests may be delayed by up to two years to coincide with the schedule for tests at Muddy Run agreed upon in the 2015 Settlement Agreement between the Service and the Licensee.*
>
> *These studies will use sufficient numbers of test fish to account for drop-back and other fish loss. These fish will be collected from a downstream location, and be representative of the migrating population as a whole. Specific details of the telemetry studies such as sample sizes, collection of and release location of tagged American Shad and river herring, arrangement of telemetry receivers, and appropriate statistical analyses shall be developed by the Licensee in conjunction with the Service and other resource agencies. The Licensee shall submit final study plans to the Service and FERC for review and approval prior to initiating any study.*

3.2.3 Methods and Study Plan Development

Upstream passage of adult American Shad will be evaluated each study period using tagged shad captured from the Susquehanna River downstream of the Project. Details of the study, including sample sizes, collection methods, release location, arrangement of telemetry receivers, and statistical analyses will be developed in a study plan, which will be submitted in draft form to the USFWS and other resources agencies. The details of the study plan will be presented at a meeting with the agencies, where Exelon and the agencies will come to an agreement on the number and types of tags, along with receiver locations. Based on the comments received and agreements reached at the meeting, the study plan will be modified by Exelon and submitted to FERC for approval within six months of study initiation.

3.2.4 Monitoring Schedule

Monitoring of upstream passage for adult American Shad at the Project will follow an adaptive approach, with the purpose of monitoring varying depending on whether passage at the Project meets the passage criteria requirements and whether modifications to fish passage are necessary (Figure 3.2.4-1). The respective timelines for each is described in each of their respective subsections below.

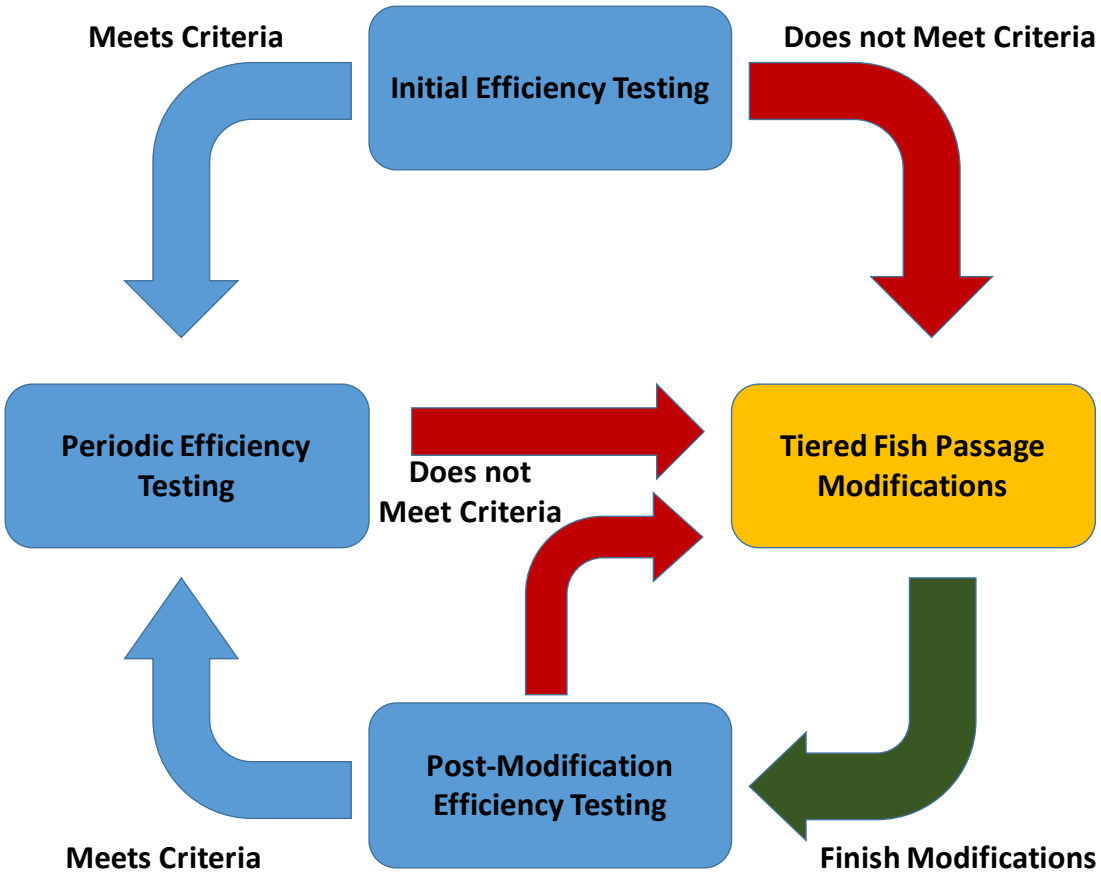

Figure 3.2.4-1: General Process of the Adaptive Efficiency Testing Schedule for American Shad

3.2.4.1 Initial Efficiency Testing

The License requires Exelon to implement substantial modifications to the existing fish passage facilities within three years of license issuance. Initial efficiency testing of the improved fishways will begin during the fifth passage season after license issuance and will consist of three passage seasons of monitoring.

3.2.4.2 Periodic Efficiency Testing

If the Project achieves 85% upstream passage efficiency of adult American Shad, including the Trap and Transport Credit adjustment[6], Exelon will continue to operate the facilities without further modification and will perform periodic efficiency testing starting on the fifth passage season after initial efficiency testing is completed (2033)[7]. Each periodic test will incorporate two consecutive passage seasons of monitoring.[8] Periodic tests will be initiated every fifth passage season after the previous periodic efficiency test or any post-modification efficiency tests determine that passage at the Project meets the upstream passage criteria.

3.2.4.3 Post-Modification Efficiency Testing

Post-modification efficiency testing will commence during the first passage season following any required modification to fish passage implemented at the Project. Each post-modification efficiency test will incorporate three passage seasons. If the Project achieves the adjusted 85% upstream passage efficiency of adult American Shad, then periodic efficiency testing will be initiated. If passage based on post-modification efficiency tests does not meet the criteria, then additional modifications will be completed based on the tiered agreement between Exelon and the USFWS, which would then be followed by additional post-modification testing.

3.2.5 Reporting and Consultation

Exelon will submit interim and final study reports to the USFWS, the other members of EPAG, and MDE, as well as FERC by December 31 following the conclusion of each study year. Results will be discussed with the agencies at the subsequent Annual Meeting as described in Section 2. Electronic copies of all data collected from these studies will be provided to the USFWS.

3.3 River Herring Passage Efficiency Testing

3.3.1 Background

No numeric criteria have been developed for upstream migrating adult river herring to date. However, Exelon has agreed to make substantial changes to the facility at the Project, which is anticipated to improve

[6] Per the FERC License, Appendix 1, Section 12.7.2.1, Exelon Licensee will receive additional credit toward the upstream passage efficiency criterion for adult American Shad that are trapped and transported upstream of York Haven Dam. This credit recognizes the benefits to the species by giving credit towards the calculation of whether the efficiency criterion for upstream shad passage is met, due to the value to restoration of avoiding the passage of impediments at the upstream hydroelectric projects.

[7] Early periodic efficiency tests may be delayed by up to two years to coincide with the schedule for tests at Muddy Run agreed upon in the 2015 Settlement Agreement between the Service and Exelon.

[8] The Periodic Efficiency Tests will consist of a two-year American Shad tagging study, unless Exelon elects, with USFWS concurrence, to conduct an additional one year of study.

passage of river herring. Upstream passage for river herring at the Project will be evaluated as outlined in this plan, per the applicable License requirements.

3.3.2 Regulatory Article Text

The Project's FERC License, Appendix 1, Section 12.7.2 outlines requirements for the Initial Efficiency Test, Post-Modification Efficiency Tests, and Periodic Efficiency Tests for Upstream Passage of American Shad and river herring. The article states:

> *The Initial Efficiency Test and any Post-Modification Efficiency Tests will consist of a three-year fish tagging and monitoring study of American Shad and river herring using radio telemetry, or other best tracking technology. The Periodic Efficiency Tests will consist of a two-year American Shad tagging study using the same techniques unless the Licensee elects, with Service concurrence, to conduct an additional one year of study. The Initial Efficiency Test will begin in the 5th passage season after license issuance. The Post-Modification Efficiency Test will begin in the first fish passage season immediately following any required modification implemented from the tiers. The Periodic Efficiency Test will be conducted on every 5th year after a previous study determines that the Adjusted Efficiency of the project is achieving 85 percent passage efficiency for American Shad. Early Periodic Efficiency Tests may be delayed by up to two years to coincide with the schedule for tests at Muddy Run agreed upon in the 2015 Settlement Agreement between the Service and the Licensee.*
>
> *These studies will use sufficient numbers of test fish to account for drop-back and other fish loss. These fish will be collected from a downstream location, and be representative of the migrating population as a whole. Specific details of the telemetry studies such as sample sizes, collection of and release location of tagged American Shad and river herring, arrangement of telemetry receivers, and appropriate statistical analyses shall be developed by the Licensee in conjunction with the Service and other resource agencies. The Licensee shall submit final study plans to the Service and FERC for review and approval prior to initiating any study.*

3.3.3 Methods and Study Plan Development

Upstream passage of adult river herring will be evaluated each study period using tagged herring captured from the Susquehanna River downstream of the Project. Details of the study, including sample sizes, collection methods, release location, arrangement of telemetry receivers, and statistical analyses will be developed in a study plan, which will be submitted in draft form to the USFWS and other resources agencies in the year preceding study initiation. The details of the study plan will be presented at a meeting with the agencies, where Exelon and the agencies will come to an agreement on the number and types of tags, along with receiver locations. Based on the comments received and agreements reached at the meeting, the study plan will be modified by Exelon and submitted to FERC for approval within six months of study initiation.

3.3.4 Monitoring Schedule

Monitoring of upstream passage for adult river herring at the Project will follow an adaptive approach, with the purpose of monitoring varying depending on whether passage at the Project meets the passage criteria requirements and whether modifications to fish passage are necessary. The respective timelines for each purpose of monitoring is described in each of their respective subsections below.

3.3.4.1 Initial Efficiency Testing

Exelon will be implementing substantial modifications to the existing fish passage facilities within three years of license issuance (2024). Initial efficiency testing of the improved fishways will begin during the fifth passage season (2026) after license issuance and will consist of three passage seasons of monitoring.

3.3.4.2 Post-Modification Efficiency Testing

Post-modification efficiency testing will commence during the first passage season following any required modification to fish passage implemented at the Project. Each post-modification efficiency test will incorporate three passage seasons. If passage based on post-modification efficiency tests is not deemed sufficient, then additional modifications will be completed based on the tiered agreement between Exelon and the USFWS, which would then be followed by additional post-modification testing.

3.3.5 Reporting and Consultation

Exelon will submit interim and final study reports to the USFWS, the other members of EPAG, and MDE, as well as FERC by December 31 following the conclusion of each study year. Results will be discussed with the agencies at the subsequent Annual Meeting as described in Section 2. Electronic copies of all data collected from these studies will be provided to the USFWS.

3.4 Upstream American Eel Passage Effectiveness Testing

3.4.1 Background

The USFWS operated an eel ramp in the vicinity of the WFL from 2008 to 2016. In May 2017, Exelon installed and began operation of a new eel ramp as the CWECF. Under Article 414, the CWECF will operate as a trap and transport facility through 2035. The CWECF contains one collection tank. The juvenile eel ladder is constructed of an aluminum cable tray with landscape fabric climbing substrate (Enkamat 7010) attached to the tray bottom. The facility is designed so that eels ascend the riprap between the tailwater surface and the entrance of the ramp. This portion of the riprap is wetted from the attraction flow exiting the eel ramp and the overflow tank down to the tailwater level. Once eels ascend the rip-rap portion, they enter the eel ramp and can ascend to the collection tank. The ramp is covered from the top down to near the entrance to protect juvenile eels from predation when ascending. A large 60% shade cloth is installed below the entrance to help protect juvenile eels between the tailrace and the entrance of the ramp. The facility provides attraction flow to the eel ramp and for use within the collection tank. There are three holding tanks. The CWECF has operated from May 1 through September 15 each year since 2017. In 2021, it is scheduled to operate May 1 until mean daily water temperature, as determined by hourly readings at Exelon's monitoring station 643 (located 0.6 mile downstream of Conowingo Dam), is 10 degrees Celsius or less for three consecutive days (expected to occur in mid-November). Eels that are collected at the facility are transported to upstream locations in the Susquehanna River watershed.

With the Muddy Run Pumped Storage Project FERC License, the EPAG, was established to inform implementation of Exelon's Eel Passage Plan, as indicated in the Pennsylvania Department of Environmental Protection (PADEP) 401 Water Quality Certification. The EPAG is chaired by Exelon and composed of a representative from each of the following: PADEP, Pennsylvania Fish and Boat Commission, USFWS, the Maryland Department of Natural Resources, and the Susquehanna River Basin

Commission. Representatives from New York State's Department of Environmental Conservation have also participated. Each designated representative is knowledgeable of American Eel, the Susquehanna River, as well as ongoing fisheries and other related resource programs being implemented in the Lower Susquehanna River (*e.g.*, American Shad restoration). The EPAG has been actively engaged in American Eel passage measures downstream of Conowingo, including approvals of the design of the American Eel passage facility near the WFL, and is familiar with issues associated with juvenile American Eel monitoring. Monthly remote meetings with EPAG and the Maryland Department of the Environment will be the primary means by which Exelon will consult with the resource agencies regarding this study.

3.4.2 Regulatory Article Text

> *12.7.3 Upstream American Eel Effectiveness Testing*
>
> *Unless the Service and the Licensee agree that no effective technology is available to enable such testing, the Licensee shall conduct an upstream efficiency study on juvenile American eel at the WFL facility in the year immediately following license issuance. The study will determine the American eel upstream passage efficiency of the eelway throughout the upstream migration season. The study will consist of two components, including determining attraction efficiency to the facility and passage efficiency of the facility once an eel enters the structure. Efficiency studies will be repeated following any modifications to the operation or physical structure to evaluate the relative success of the modifications. The Licensee shall provide an annual report on the efficiency study to the Service by December 31 of the study year.*

3.4.3 Upstream American Eel Effectiveness Testing - Methods and Study Plan Development

Exelon has investigated the technology available to conduct this upstream American Eel effectiveness testing. Passive integrated transponder tags are a proven technology for several species of fish; however, American Eel investigations utilizing passive integrated transponder tags have not been successfully completed with eels smaller than 150 mm. At the CWECF, collected eels range in size from 70 mm to 180 mm with an average length of 120 mm. Tagging only eels measuring greater than 150 mm would not be representative of the eels collected at the CWECF and would provide information relative to only a small portion of those eels collected at the CWECF.

The use of various dyes such as Bismarck Brown or Rose Bengal have been used to determine entrainment of juvenile alosines on the Connecticut River, but these fish were counted after being collected in specialized gear and inspected using standard white light. Most eel movement occurs at night and eels avoid bright light, so a red light would be required. Unfortunately, the red light would make it very difficult to detect the subtle color of the dye on the marked eels, potentially biasing the results.

Attempts to place a known number of unmarked eels at the bottom of an eel ramp to determine the percentage of eels that successfully ascend the ramp has yielded mixed results. One of the issues with conducting this type of study is that the ramp must be shut down (turning off the attraction flow) to clear the substrate of all eels prior to placing the unmarked eels at the base of the ramp.

Exelon would prefer to assess attraction efficiency and ramp efficiency using a single proven technology. Exelon has concluded that suitable technology to conduct this combined study is not currently available. However, Exelon will draft a study plan for the ramp efficiency portion of the test, only. The draft study

plan will be provided to resource agencies and will only be implemented following approval of the Exelon's Eel Passage and Restoration Plan.

Exelon will also continue to work with USFWS upon any modifications to the operation or physical structure to evaluate combined attraction flow and passage efficiency should technology become available later in the license term to do such a study. This process will include discussions during annual fish passage meetings between Exelon, USFWS, and other resource agencies to continually assess the current available technology and the feasibility of the implementing upstream American Eel effectiveness testing.

Following the 2019 site inspection, USFWS requested that Exelon complete an assessment of the spray bar that is positioned at the top of the CWECF eel ladder. Exelon used a red-light camera to record video of juvenile eel passing over the top of the ladder into the facility's collection tank during the 2020 passage season. The video was analyzed to assess how eels responded to the spray at the top of the ladder. Samples of the video and assessment results were shared with USFWS and other EPAG members. Although a large portion of the eels traversed the apex and dropped into the collection tank with little hesitation, approximately 25% were observed that hesitated, dropped back from the apex, or travelled laterally across the apex before successfully dropping into the collection tank.

Exelon will be conducting an additional evaluation of the spray bar at the Conowingo eel facility in September 2021, which will supplement the findings of the 2020 spray bar assessment. Methods were discussed with USFWS and other resource agencies during a remote meeting on August 18, 2021 and a written study plan will be provided to resource agencies as well as a written summary of evaluation results after the study's completion.

3.4.4 Monitoring Schedule

At this time, technology is not available for conducting a combined study to investigate attraction efficiency to the facility and passage efficiency of the facility once an eel enters the ramp. Accordingly, testing will be postponed indefinitely until the Exelon and USFWS, the other members of EPAG, and Maryland Department of Environment determine that effective technology is available. The availability of effective technology will be monitored and discussed at monthly meetings and the Annual Meeting with EPAG and the Maryland Department of the Environment. However, Exelon will draft a study plan for the ramp passage efficiency portion of the test, only, and conduct the study following approval of the Exelon's Eel Passage and Restoration Plan (anticipated in 2022).

Efficiency studies will be repeated following any modifications to the operation or physical structure to evaluate the relative success of the modifications, pending effective technology to do so.

Draft study plans for efficiency studies will be provided to the resource agencies by December 31 of the year preceding the study

3.4.5 Reporting and Consultation

When the study is performed, Exelon will submit a study report to USFWS, the other members of EPAG, and Maryland Department of the Environment as well as FERC by December 31 of the study year.

4 DOWNSTREAM PASSAGE

4.1 American Shad and River Herring Route of Passage Study

4.1.1 Background

Downstream passage effectiveness at the Conowingo Project depends on route selection and the survival associated with each route. Adult American Shad and river herring passed upstream of the Project during the upstream passage season need to survive emigration through the Project to remain in the population with the potential for repeat spawning during following years. Additionally, juvenile shad and river herring that are spawned upstream need to successfully migrate through the Project to the ocean, where they will mature before returning to spawn. The required passage criteria for downstream passage at the Project is 80% survival efficiency for adult shad and river herring, and 95% survival efficiency for juvenile shad and river herring (Table 1.3-1). Determining potential preferred routes by emigrating fish would be used to inform overall survival efficiency calculations.

4.1.2 Regulatory Article Text

> *12.7.4 Downstream Adult and Juvenile American Shad and River Herring Effectiveness Testing*
>
> *The Licensee shall conduct downstream passage effectiveness studies of American Shad and river herring in 2027 in coordination with the Service. As part of the Conowingo FEMP for downstream passage, the Licensee will evaluate both juvenile and adult life stages using a study protocol developed cooperatively with the Service to include a Conowingo Pond route of passage study. A route of passage study will be conducted to determine the routes chosen by downstream migrating fish through the Project under various generation conditions to determine if there are preferred routes of passage at the dam. The route of passage study will be conducted for 2 years to account for inter-annual variation in flow conditions. The Licensee will have the option to extend the route of passage study for an additional year.*

4.1.3 Methods and Study Plan Development

Downstream passage of adult and juvenile American Shad and river herring will be evaluated each study period using tagged fish captured from the Susquehanna River. Details of the study, including sample sizes, collection methods, release location, arrangement of telemetry receivers, and statistical analyses will be developed in a study plan, which will be submitted in draft form to the USFWS and other resources agencies. Tagging juvenile American Shad and river herring is challenging due to the small size of the fish. In addition, these fish are very sensitive to stress, handling, holding, and transport. Appropriate techniques and methods will be considered during study design to address these challenges. The details of the study plan will be presented at a meeting with the agencies, where Exelon will obtain verbal and written comments. Based on the comments received, the study plan will be modified by Exelon and submitted to the FERC for approval within six months of study initiation.

4.1.4 Monitoring Schedule

Route selection data collection for adult and juvenile American Shad and river herring will be performed over two passage seasons in 2027 and 2028. If Exelon deems necessary based on its own discretion, the study will be extended an additional year to assess route selection in 2029.

4.1.5 Reporting and Consultation

The interim and final reports for the downstream route of passage studies for adult and juvenile American Shad and river herring will be submitted to the USFWS, the other members of EPAG, and MDE by August 1 and FERC by August 31 following each study year. The final study report will incorporate results from the turbine passage survival study to describe success or failure in achieving the passage efficiency criteria. Results will be discussed with the agencies at the subsequent Annual Meeting as described in Section 2. Electronic copies of all data collected from these studies will be provided to the USFWS.

4.2 American Shad and River Herring Turbine Survival Study

4.2.1 Background

Adult American Shad and river herring passed upstream of the Project during the upstream passage season need to survive emigration through the Project to remain in the population with the potential for repeat spawning during following years. Additionally, juvenile shad and river herring that are spawned upstream need to successfully migrate through the Project to the ocean, where they will mature before returning to spawn. The required passage criteria for downstream passage at the Project is 80% survival efficiency for adult shad and river herring, and 95% survival efficiency for juvenile shad and river herring (Table 1.3-1). Three turbine survival studies of American Shad have been conducted previously (one study of adult shad conducted in 2012; two studies using juvenile shad in 1993 and 2011). The adult shad study conducted in 2012 resulted in immediate survival rates of 86.3% and 93.0% for the Kaplan and Francis turbines, respectively. In 1993, the observed immediate survival for juvenile shad passing through a Kaplan turbine was 94.9% while the immediate survival of juvenile shad observed passing through a Francis turbine in 2011 was 89.9%.

4.2.2 Regulatory Article Text

> *12.7.4 Downstream Adult and Juvenile American Shad and River Herring Effectiveness Testing*
>
> *In addition to the route of passage study, a one year separate and discrete passage study for both adult and juvenile American Shad and river herring shall be conducted to estimate survival through the Kaplan and Francis turbines under best gate efficiency. This study will commence in 2027. The effects of barotrauma during turbine passage will be included as part of the turbine survival studies for all life stages when possible. Results of the studies will be used to determine through-Project survival (i.e. via spill, Francis turbines, Kaplan turbines, etc.), and immediate and latent mortality for each route to achieve the passage criteria.*

4.2.3 Methods and Study Plan Development

Downstream turbine survival of adult and juvenile American Shad and river herring will be evaluated each study period (late spring/fall) using the Normandeau HI-Z Turbine tag with juvenile fish captured from the Susquehanna River. Adult shad and herring will be collected from the East Fish Lift and WFL if available. Details of the study, including sample sizes, release and recapture methods, assessment of immediate and latent mortality, and statistical analyses will be developed in a study plan, which will be submitted in draft form to the USFWS and other resources agencies. The details of the study plan will be presented at a meeting with the agencies, where Exelon will obtain verbal and written comments. Based on the comments received, the study plan will be modified by Exelon and submitted to FERC for approval within six months of study initiation.

4.2.4 Monitoring Schedule

The turbine survival study for adult and juvenile American Shad and river herring will be performed during 2027 and will be completed within a single passage season if sufficient numbers of test specimens (particularly juvenile American Shad and juvenile river herring) are available for study use.

4.2.5 Reporting and Consultation

The draft report for the turbine survival studies for adult and juvenile American Shad and river herring will be submitted to the USFWS, the other members of EPAG, and MDE by August 1 and FERC by August 31, 2028, following the 2027 study season. Results will be discussed with the agencies at the subsequent Annual Meeting as described in Section 2. Electronic copies of all data collected from these studies will be provided to the USFWS.

4.3 Downstream American Eel Passage Effectiveness Monitoring

4.3.1 Background

To effectively spawn in the Sargasso Sea, American Eel in the Susquehanna basin upstream of the Project must successfully pass through the Project and emigrate without mortality or considerable injury. The downstream passage criteria for adult American Eel at the Project is 85% survival efficiency. Survival efficiency for the Project can be determined based on a combination of the proportion of fish passing via specific routes, along with survival when passing via each route.

4.3.2 Regulatory Article Text

> *12.7.5 Downstream American Eel Effectiveness Monitoring*
>
> *The Licensee shall conduct or participate in two separate studies on downstream migrating American eel in the Susquehanna River. The studies can be done concurrently or separately, and will be conducted in conjunction with the American eel downstream studies undertaken by the Licensee of the Muddy Run Hydroelectric Project. The Licensee shall initiate studies when the Service determines that sufficient numbers of downstream migrants can be collected in the upper watershed to conduct a valid study.*
>
> *First, the Licensee shall participate in a basin-wide study coordinated by the Service to determine timing of downstream migration of American eels in the Susquehanna River. To*

complete this study, the Licensee shall contribute $75,000 to the Service to collect and tag fish for use in the basin-wide study. Radio telemetry monitoring will be conducted by the Licensee year-round for 3 consecutive years.

In addition to the basin-wide migration timing study, the Licensee will conduct a study at Conowingo Dam to determine migratory delay, route of downstream passage (i.e., via spill, Francis turbines, Kaplan turbines, etc.), and immediate and latent mortality for each route. If a sufficient number of tagged fish encounter the Project, a route of passage study can be done concurrently with the basin-wide downstream migration study using the same tagged eels assuming appropriate tag technology is available to assess latent mortality of those fish during the study.

4.3.3 Methods and Study Plan Development

The degree to which the two studies outlined here can be performed concurrently will be determined by Exelon in consultation with the EPAG. In accordance with the Muddy Run Pumped Storage Project License, within six months of the trigger date for initiation of downstream American Eel passage studies (or a later date as approved by PADEP in writing), Exelon will submit a plan to the EPAG to conduct a downstream passage study. 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.

4.3.3.1 Basin-Wide Migration Study

In 2021, USWFS is scheduled to begin a basin-wide study to determine timing of downstream migration of American Eels in the Susquehanna River. USFWS has developed the study design in coordination with Exelon and other interested parties. The 2021 study effort does not involve efforts from Exelon at Conowingo; therefore, USFWS has requested that Exelon's $75,000 contribution to the USFWS to collect and tag fish for use in a basin-wide study be held for the 2022 season. Additionally, radio telemetry monitoring is scheduled to be conducted by Exelon in the vicinity of the Conowingo Project in 2022 and 2023. Mobile tracking and data analysis for this study will be the responsibility of the USFWS. Annually, the USFWS will share with Exelon all data collected as part of the basin-wide study.

4.3.3.2 Delay, Route Selection, and Mortality Study

Methods for evaluating downstream passage effectiveness of adult American Eel at the Conowingo Dam to determine migratory delay, route of downstream passage (i.e. via spill, Francis turbines, Kaplan turbines, etc.) and immediate and latent mortality for each route will be developed by Exelon in consultation with the EPAG. A subsequent study plan, will be developed by Exelon in consultation with the EPAG.

4.3.4 Monitoring Schedule

According to the 401 Water Quality Certification issued by PADEP at the Muddy Run Pumped Storage Project, the trigger date for initiation of downstream American Eel passage studies will be determined by PADEP in consultation with other resource agencies and shall not occur prior to October 1, 2026 (PADEP, 2014). To the extent possible, Exelon will coordinate the downstream eel passage studies required at the Muddy Run Pumped Storage Project, with the downstream eel passage studies identified above for the Conowingo Project in terms of timing and methodology. The basin-wide migration study monitoring will be performed over three passage seasons (2021-2023). Accordingly, Exelon will complete the

Conowingo delay, route selection, and mortality study in 2026 to align with the Muddy Run Pumped Storage Project eel studies, and also allow time for analysis of results from the USFWS basin-wide study (2021-2023), which will likely inform the planning and methods used in the Muddy Run Pumped Storage Project and Conowingo eel studies.

4.3.5 Reporting and Consultation

Any interim and final reports for the downstream route of passage studies for adult American Eel will be submitted to the USFWS, the other members of EPAG, and MDE by August 1 and FERC by August 31 following each study year. Results will be discussed with the agencies at the subsequent Annual Meeting as described in Section 2. Electronic copies of all data collected from these studies will be provided to the USFWS.

5 REFERENCES

Millard, M.J., J.W. Mohler, A. Kahnle, and A. Cosman. 2005. Mortality associated with catch-and-release angling of striped bass in the Hudson River. North American Journal of Fisheries Management 25: 1533-1541.

Pennsylvania Department of Environmental Protection (PADEP). 2014. Water quality certification for Muddy Run Pumped Storage Project and related mitigation, FERC Project No. P-2355-018. Submitted to the FERC 12/10/2014.

APPENDIX A. CALCULATING ADJUSTED EFFICIENCY WITH TRAP AND TRANSPORT CREDIT

U.S. Department of the Interior Modified Fishway Prescription for the Conowingo Hydroelectric Project No. 405 (filed June 8, 2016)
FERC License Appendix 1
Appendix B. Calculating Trap and Transport Credit

Credit Towards an Overall Efficiency Criterion (85 percent of the fish entering the Conowingo Tailrace)

For a given number of shad trapped and transported we can estimate the number that would need to pass Conowingo Dam via the fish lift to result in the same number of spawners upstream of York Haven Dam. This number is termed "lift equivalents" (L_e) and is calculated as:

[1] $$L_e = (\sum_{i=1}^{n} TT_i) \cdot (1 - TT_m)/D$$

Where TT_i refers to the number trapped and transported each year during a single or multi-year study to measure passage efficiency, and TT_m is the mortality associated with trapping and transporting shad. Harris and Hightower (2011) estimated mortality of trapped and transported shad in the Roanoke River to be 15 percent. However, SRAFRC (1997) gave estimates of mortality for holding shad prior to trap and transport, mortality during the transport, and delayed mortality following release. When all these factors are considered, the overall mortality associated with trap and transport operations was 6 percent, which was used in this model. The denominator (*D*) in equation [1] will be calculated using the maximum efficiency of each of the two upstream dams with the highest passage efficiency over the three year study and the average of these efficiencies. For example, if the highest efficiencies of Holtwood, Safe Harbor, and York Haven Dams over the three year study were 0.60, 0.78, and 0.50, respectively, then the denominator would be calculated as $D = 0.60 \cdot 0.78 \cdot \left(\frac{0.60+0.78}{2}\right) = 0.3229$. It was assumed that other than the mortality associated with trap and transport operations, no other negative impacts on their fitness occurred compared to shad that would migrate via multiple fish passage facilities to areas upstream of York Haven Dam.

The L_e can be added to the observed number that were lifted past Conowingo Dam during the study period to arrive at an adjusted total number that are passed via the fish lift (L_a).

[2] $$L_a = L_e + \sum_{i=1}^{n} L_i$$

where L_i is the observed number lifted in each year.

During a radio telemetry study at Conowingo Dam, an estimate of passage efficiency will be made and given the total number of shad actually passed (lifted and released into Conowingo Pond + trapped and transported upstream), an estimate of the total number of shad downstream of Conowingo Dam during all years of the study can be made.

[3] $N = (\sum_{i=1}^{n} P_i)/E_o$

where P_i is the total number passed each year and E_o is the estimated passage efficiency during the study. Equation [3] also assumes that no mortality is suffered while attempting to pass Conowingo Dam.

The variance of N can be estimated by the delta method using the estimated variance of E_o.

[4] $Var(N) = [Var(E_o)/E_o^4] \cdot (\sum_{i=1}^{n} P_i)^2$

The adjusted passage efficiency is then the adjusted number that are lifted during the study divided by the total number of shad downstream of Conowingo Dam during all years of the study.

[5] $E_a = L_a/N$

The associated variance from the delta method is:

[6] $Var(E_a) = [Var(N)/N^4] \cdot L_a^2$

The 95 percent confidence interval for $E_a$can be approximated as:

[7] $95\%\ C.I. \approx 1.96 \cdot \sqrt{Var(E_a)}$

If the upper 95% confidence limit is greater than or equal to the efficiency criterion, then the criterion is considered to be met.

APPENDIX B. RESOURCE AGENCY CONSULTATION RECORDS, COMMENTS, AND RESPONSIVENESS MATRIX

APPENDIX B CONTENTS

Fishway Effectiveness Monitoring Plan Draft Distribution, July 29, 2021

US Fish and Wildlife Service Comments, August 27, 2021

Maryland Department of the Environment and Maryland Department of Natural Resources Comments, August 30, 2021

Resource Agency Comments and Exelon Responses

From: Erin Redding
Sent: Thursday, July 29, 2021 9:29 AM
To: Danucalov, Andrea; Bleistine, Ray; Brett Coakley; Mike.Cox@ERM.com; David Frazier; Eberts, Ron; 'Eyler, Sheila'; 'Henning, Aaron'; denise.keehner@maryland.gov; jesus_morales@fws.gov; Martinek, Michael; 'McCollum, Allyson'; 'McCorkle, Richard'; 'Miller, Jeremy'; 'Minkkinen, Steve'; Heather Nelson -MDE-; Tony Prochaska; 'Sadzinski, Robert'; 'Seaborn, David'; 'Seaman, Shawn'; 'Slowik, Adam'; Kirk Smith; Smith, Fred; 'Steffy, Luanne'; 'Tryninewski, Joshua'; 'Williamson, Scott'
Attachments: 20210729_Fishway_Effectiveness_Monitoring_Plan_Draft.pdf

Hello,

Please see the attached Conowingo Fishway Effectiveness Monitoring Plan Draft for your review. Please send any comments to Andrea Danucalov by August 30, 2021.

Thank you,

Erin Redding (she/her)
Certified Senior Ecologist, ESA
Gomez and Sullivan Engineers, D.P.C.
1961 Wehrle Dr.
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eredding@gomezandsullivan.com
I am not *working on Wednesdays.*

From: Eyler, Sheila <sheila_eyler@fws.gov>
Sent: Friday, August 27, 2021 9:36 AM
To: Erin Redding; Danucalov, Andrea; Bleistine, Ray; Brett Coakley; Mike.Cox@ERM.com; David Frazier; Eberts, Ron; 'Henning, Aaron'; denise.keehner@maryland.gov; Morales, Jesus J; Martinek, Michael; 'McCollum, Allyson'; McCorkle, Richard; 'Miller, Jeremy'; Minkkinen, Steve; Heather Nelson -MDE-; Tony Prochaska; 'Sadzinski, Robert'; 'Seaborn, David'; 'Seaman, Shawn'; 'Slowik, Adam'; Kirk Smith; Smith, Fred; lsteffy@srbc.net; Tryninewski, Joshua; 'Williamson, Scott'
Subject: EXTERNAL EMAIL -Re: Conowingo FEMP review
Attachments: Deng et al 2021 A acoustic micro-transmitter enabling tracking of sensitive aquatic species in riverine and estaurine environments.pdf; Mueller et al 2019 Implantation of a new micro acoustic tag in juvenile pacific lamprey and american eel.pdf

CAUTION: This email originated from outside of GSE. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Erin/Andrea,

Thank you for providing the draft Conowingo FEMP for FWS review. The document adequately describes the suite of studies and timeline for implementation required under the new FERC license for the project. The study plan details are vague in this document, which is acceptable, as individual study plans for each component will be developed at a later date and in consultation with the agencies.

Specific Comments:
Page 1-1, Section 1.1, paragraph 1: “substantial improvements” should be changed to “substantial modifications” in line 3.

Page 1-3, Section 1.3, paragraph 1: Upstream passage should be deemed successful under two scenarios during the study. First if fish are being passed into Conowingo Pond, those fish need to enter and pass the fishway and move upstream as stated in the FEMP. However, due to the intensive T&T program in the initial years of fish passage at the project, successful upstream passage will also be considered for fish that enter a fish lift and are dumped into a sorting tank for ultimate trucking upstream.

Page 3-4, Section 3.2.4.1: “substantial improvements” should be changed to “substantial modifications” in line 1.

Page 3-5, Section 3.3.4.1: “substantial improvements” should be changed to “substantial modifications” in line 1.

Page 3-7, Section 3.4.2, paragraph 4: Although USFWS agrees that there are shortcomings to current evaluation methods (tagging and dyes) there may be some utility in using them for components of the effectiveness study (i.e. passage efficiency). Also, there are new developments in radio tag technology that may provide tags small enough to be used to assess upstream elver movement (see attached Deng et al. 2021 and Muller et al. 2019) for both evaluating attraction and passage efficiency. The feasibility of implementing upstream American eel effectiveness testing should be reviewed annually between Exelon and the resource agencies until such time as tagging techniques are deemed appropriate for the necessary assessments. The USFWS also supports additional evaluation of the spray bar at the top of the eel ramp as previous video

assessments demonstrated significant fallback rates at the top of the ramp that could be improved with modifying the pathway of water introduction.

If you have any questions about these comments, please feel free to reach out to me. Thank you again for the opportunity to review and provide comments.

Sheila Eyler
U.S. Fish and Wildlife Service
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177 Admiral Cochrane Dr.
Annapolis, MD 21401
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This email has been received from outside of DOI - Use caution before clicking on links, opening attachments, or responding.

Hello,

Please see the attached Conowingo Fishway Effectiveness Monitoring Plan Draft for your review. Please send any comments to Andrea Danucalov by August 30, 2021.

Thank you,

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PPRP Comments on Exelon's Fishway Effectives Monitoring Plan (FEMP)

PPRP agrees with the Plan purpose:
This FEMP outlines the process and schedule by which passage effectiveness of American Shad (Alosa sapidissima), river herring (collectively, Alosa aestivalis and Alosa pseudoharengus), and American Eel (Anguilla rostrata) will be evaluated over the term of the new license at the Project.

General Comments
There are no specific/defined study plans for any of the studies. The FEMP outlines how each plan will be developed, rather than having plans listed in the response to each study.

USFWS is the only organization that is reviewing and approving. Since this is based on the FERC license, MDE must also review and approve. This should also apply for all data and must be provided to the Resource Agencies not just the Service.

Specific Comments
1.3 states: *... upstream fish passage efficiency as the proportion of the fish in the Project tailwaters that successfully move through the fishway and continue upstream migrations, ...*. Needs to have a caveat for only trucking fish.

1.3 also states: *Downstream fish survival efficiency is the proportion of the fish that approach the upstream side of the Project and survive as they pass the Project and continue downstream migrations.* Define "successful passage criteria", details of how you differentiate between dead/injured fish will need to be defined.

3.1.3 Methods and Study Plan Development
There is no defined study plan in this section but rather states that it will be developed later based upon Millard et al. 2005. The Millard study examined catch and release mortality of striped bass and determined that J-hooks caused greater mortality than circle hooks. The control fish were collected by electrofishing. Other than treatment and control fish, it is unclear how Millard et al. would be a template for this mortality study.

The license article requires that both immediate and delayed mortality be assessed (mortality occurring sometime after release). The draft plan should include an evaluation of post release mortality, which was not a part of the Millard et al. study.

3.4.1 Consider adding figures and /or photos of the facility being described.

3.4.3 Exelon has stated they cannot do an efficiency testing of the ramp because attempts to do so have resulted in "mixed results". In our review of the published studies below, ramp efficiency was successfully measured. Please clarify your concerns/issues further.

3.4.3 The regulatory text requires two parts to the study: 1) attraction efficiency to the facility, and 2) passage efficiency of the facility once and eel enters the structure.
At present, the first component, attraction efficiency to the facility may not be technically feasible at this time. Determining the efficiency of the eelway certainly is. This has been done on three ladders at the Woronoco project on the Westfield River in Massachusetts (Woronoco 2010 & 2012), at the Lawrence dam on the Merrimack River in Massachusetts (Normandeau 2015), and on the Messalonskee Stream in Maine (Hickey 2012). In all cases, eelway efficiency was determined. At Woronoco the results were 99% in 96 hours at the North Ladder, 93% at the Middle Ladder in 66 hours, and 100% at the South Ladder in 18 hours. At the Lawrence Dam results after 36 hours were 55% and 32%. At the Automatic project on the Messalonskee Stream 97% efficiency was reported on the Enkamat side and 90% efficiency on the Plinko side. No times were reported.

The results above are mixed, two systems worked well and one very poorly. The FEMP states: *Exelon has concluded that suitable technology to conduct this study is not currently available.*

While a methodology for an attraction study may not be available, it is available for a ramp efficiency study. This type of study is relatively simple: enclose a known number of eels at the bottom of the ramp, which has been cleared of eels, and count the number in the capture/holding tank at the top over a fixed period such as 6, 12, 18, 24 etc. hours.

If there is a concern that the eelway to be tested will not be able to pass eels during the test, it is possible to set up a temporary ramp for use during the test.

3.4.3 In 2020, fallback at the top of the ramp was 24% in July and 50% in August. Subsequently no changes to the spray bar were done. Fallback likely affects overall eelway efficiency and should be resolved and re-evaluated as part of the overall eelway efficiency study. Within the FEMP, this assessment seems out of place considering review of assessments/studies are not discussed for other sections of the FEMP.

How ramp overcrowding, as directed in the FERC Order, is going to be determined should be explained.

A draft plan for ramp efficiency should be provided to the agencies by December 31 of the year preceding the study.

3.4.5 Reporting and Conclusions
The study report should be provided to the agencies by December 31 of the study year.

4.1.4 States: "Route selection data collection for adult and juvenile American Shad and river herring will be performed over two passage seasons in 2027 and 2028. If Exelon deems necessary based on its own discretion, the study will be extended an additional year to assess route selection in 2029." Please define what criteria will be followed and what determines if Exelon will extend it to a 3rd year and will this data be used as a metric in determining route selection of the target species?

4.1.5 Reporting and Consultation
The report for each year's study should be provided by the end of April to allow sufficient time for comment and study plan adjustments for the upcoming year's study.

4.2.1 Nowhere else in the FEMP do we discuss past studies. If the FEMP is going to do that here then the FEMP should be consistent throughout.

4.2.3 Methods and Study Plan Development
Adult shad and herring should be collected late in the upstream passage season to better replicate the physical condition of out migrating fish. Sensor Fish should be used to evaluate barotrauma (Advanced Telemetry Systems, ARC 800 Sensor Fish). Sensor Fish measure temperature, pressure, acceleration, and rotation during turbine passage. Nadir pressure is measured to assess the potential for barotrauma related injury to fish and the potential for severe acceleration during turbine passage.

4.2.5 Reporting and Consultation
The draft report should be provided to the agencies by April 30 of the year following the study to allow consultation should a second year of study be required.

4.3.3 Why is the silver eel study not until 2026? Data suggests a sufficient number of silvers are present now in the river (York Haven Dam Mortalities).

Appendix A Calculating T&T Credit – History of this calculation should be given explaining that it was a cooperative estimate between USFWS and Maryland DNR.

References

Hickey, S.J. January 26, 2012. Letter to Mr. Steven Shepard, USFWS. Kennebec Water District Upstream and Downstream Proposal. Pg. 4.

Millard, J.M., J.W. Mohler, A. Kahnle, and A. Cosman. 2008. Mortality associated with catch-and-release angling of striped bass in the Hudson River. N. Am Jour. Fish. Mgt. 25: 1533-1541.

Normandeau. 2015. Assessment of eel pass effectiveness at the Lawrence hydroelectric project (FERC No. 2800), Merrimack River, Lawrence, MA.

Woronoco Hydro. 2010. Report on the 2009 testing of the upstream passage for juvenile American eels phase i – passability testing and site observations. FERC # 2631. Accession No. 20110131-5111.

Woronoco Hydro. 2012. Report on the 2011 testing of the upstream passage of juvenile eels, Phase 1 Passability tests of all eel ladders and repeat of Phase II attractiveness testing and observations –article 404. FERC # 2631. Accession No. 20120229-5139.

Resource Agency Comments and Exelon Responses

Comment	Response
USFWS, Received August 27, 2021	
Specific Comments	
Page 1-1, Section 1.1, paragraph 1: "substantial improvements" should be changed to "substantial modifications" in line 3.	"Substantial improvements" has been changed to "substantial modifications".
Page 1-3, Section 1.3, paragraph 1: Upstream passage should be deemed successful under two scenarios during the study. First if fish are being passed into Conowingo Pond, those fish need to enter and pass the fishway and move upstream as stated in the FEMP. However, due to the intensive T&T program in the initial years of fish passage at the project, successful upstream passage will also be considered for fish that enter a fish lift and are dumped into a sorting tank for ultimate trucking upstream.	These scenarios have been added to Section 1.3, paragraph 1.
Page 3-4, Section 3.2.4.1: "substantial improvements" should be changed to "substantial modifications" in line 1.	"Substantial improvements" has been changed to "substantial modifications".
Page 3-5, Section 3.3.4.1: "substantial improvements" should be changed to "substantial modifications" in line 1.	"Substantial improvements" has been changed to "substantial modifications".
Page 3-7, Section 3.4.2, paragraph 4: Although USFWS agrees that there are shortcomings to current evaluation methods (tagging and dyes) there may be some utility in using them for components of the effectiveness study (i.e. passage efficiency). Also, there are new developments in radio tag technology that may provide tags small enough to be used to assess upstream elver movement (see attached Deng et al. 2021 and Muller et al. 2019) for both evaluating attraction and passage efficiency. The feasibility of implementing upstream American eel effectiveness testing should be reviewed annually between Exelon and the resource agencies until such time as tagging techniques are deemed appropriate for the necessary assessments.	Exelon has reviewed the provided Deng *et al.* 2021 and Muller *et al.* 2019 articles. Exelon agrees to discuss with USFWS, and other resource agencies the feasibility of implementing upstream American eel effectiveness testing during annual fish passage meetings, until such time as tagging techniques are deemed appropriate for the necessary assessments.

The USFWS also supports additional evaluation of the spray bar at the top of the eel ramp as previous video assessments demonstrated significant fallback rates at the top of the ramp that could be improved with modifying the pathway of water introduction.	Exelon will be conducting an additional evaluation of the spray bar at the Conowingo eel ramp in September 2021, which will supplement the findings of the 2020 spray bar assessment. Methods were discussed with USFWS and other resource agencies during a remote meeting on August 18, 2021 and a written study plan will be provided as well as a written summary of evaluation results after the study's completion.
Maryland Department of the Environment & Maryland Department of Natural Resources	
PPRP agrees with the Plan purpose: This FEMP outlines the process and schedule by which passage effectiveness of American Shad (*Alosa sapidissima*), river herring (collectively, *Alosa aestivalis* and *Alosa pseudoharengus*), and American Eel (*Anguilla rostrata*) will be evaluated over the term of the new license at the Project.	This comment is noted.
General Comments	
There are no specific/defined study plans for any of the studies. The FEMP outlines how each plan will be developed, rather than having plans listed in the response to each study.	This comment is noted. FERC License, Appendix 1 and Article 401 require submittal of the FEMP within six months following license issuance. In addition, FERC License, Appendix 1 stipulates when the study plans will be initiated. For instance, Appendix 1, Section 12.7.2.1 Trap and Transport Credit for American Shad states that in the fourth year after license issuance, Exelon will work with the USFWS and other resource agencies to implement a one year study to estimate mortality of fish that are trapped and transported to areas upstream of York Haven Dam. Many of the studies will occur in future years, and technologies related to the tagging and tracking of fish evolve rapidly and may not be currently available. Therefore, Exelon thought it prudent to define specific study methodologies in the year prior to undertaking the actual studies, so that the best technologies available at that time could be employed. Upcoming studies and plans will be discussed monthly and annually with the USFWS and other resource agencies to ensure adequate review of study methodologies and other study related logistics.
USFWS is the only organization that is reviewing and approving. Since this is based on the FERC license, MDE must also review and approve.	This Fishway Effectiveness Monitoring Plan is a requirement of Article 401 and a condition of the US Department of the Interior's Section 18

This should also apply for all data and must be provided to the Resource Agencies not just the Service.	Prescription (License Appendix 1). As such, the USFWS and FERC approval are required. An annual meeting with USFWS and the Susquehanna River Anadromous Fish Restoration Cooperative (including National Marine Fisheries Service, Susquehanna River Basin Commission, New York State Department of Environmental Conservation, Pennsylvania Fish and Boat Commission, and Maryland Department of Natural Resources) will take place to discuss the FEMP. Exelon would expect MDE be participate in this meeting as well. Exelon considers the USFWS as well as MDE, MDNR, PFBC, PADEP, and SRBC consulting parties for the FEMP. These resource agencies were sent a draft plan on July 29, 2021 and invited to review and submit comments to Exelon. All comments received by August 31, 2021 have been considered and included in this consultation record and responsiveness matrix. Exelon will continue to consult with these agencies relative to study planning, execution, and review of the data and results as the various components of the FEMP are implemented during the license term.
Specific Comments	
1.3 states: … upstream fish passage efficiency as the proportion of the fish in the Project tailwaters that successfully move through the fishway and continue upstream migrations, ….. Needs to have a caveat for only trucking fish.	The text in this section has been revised to define successful upstream passage per USFWS' second comment above.
1.3 also states: Downstream fish survival efficiency is the proportion of the fish that approach the upstream side of the Project and survive as they pass the Project and continue downstream migrations. Define "successful passage criteria", details of how you differentiate between dead/injured fish will need to be defined.	The issue of differentiating between live, dead, or injured fish has been a topic of debate in recent studies, particularly when studying downstream adult eel passage. Exelon will continue to work with the resource agencies to define successful passage criteria during the drafting of specific study plans outlined in this document.
3.1.3 Methods and Study Plan Development There is no defined study plan in this section but rather states that it will be developed later based upon Millard et al. 2005. The Millard study examined catch and release mortality of striped bass and determined that J-hooks caused greater mortality than circle hooks. The control fish were collected by electrofishing. Other than treatment and control fish,	USFWS proposed the use Millard *et al*. 2005 in FERC License, Appendix I as a conceptual model to guide development of the trap and transport mortality study. As the draft study plan is developed the overall methodology will be refined and resource agencies will be

it is unclear how Millard et al. would be a template for this mortality study. The license article requires that both immediate and delayed mortality be assessed (mortality occurring sometime after release). The draft plan should include an evaluation of post release mortality, which was not a part of the Millard et al. study.	afforded an opportunity to comment on the eventual approach, which will include assessments of post release mortality.
3.4.1 Consider adding figures and /or photos of the facility being described.	Engineering drawings and photos of the facility are provided in Exelon's Eel Passage and Restoration Plan, which was developed to address FERC License Article 415.
3.4.3 Exelon has stated they cannot do an efficiency testing of the ramp because attempts to do so have resulted in "mixed results". In our review of the published studies below, ramp efficiency was successfully measured. Please clarify your concerns/issues further.	Exelon would prefer to assess attraction efficiency and ramp efficiency using a single proven technology. This technology is not currently available. However, Exelon will draft a study plan for a ramp efficiency test, only. The draft study plan will be provided to resource agencies and will only be implemented following approval of the Conowingo Eel Passage and Restoration Plan (anticipated in 2022).
3.4.3 The regulatory text requires two parts to the study: 1) attraction efficiency to the facility, and 2) passage efficiency of the facility once and eel enters the structure. At present, the first component, attraction efficiency to the facility may not be technically feasible at this time. Determining the efficiency of the eelway certainly is. This has been done on three ladders at the Woronoco project on the Westfield River in Massachusetts (Woronoco 2010 & 2012), at the Lawrence dam on the Merrimack River in Massachusetts (Normandeau 2015), and on the Messalonskee Stream in Maine (Hickey 2012). In all cases, eelway efficiency was determined. At Woronoco the results were 99% in 96 hours at the North Ladder, 93% at the Middle Ladder in 66 hours, and 100% at the South Ladder in 18 hours. At the Lawrence Dam results after 36 hours were 55% and 32%. At the Automatic project on the Messalonskee Stream 97% efficiency was reported on the Enkamat side and 90% efficiency on the Plinko side. No times were reported.	Once an eel enters the facility, it is possible to determine the passage efficiency of the ramp, but there must be an understanding that in order to conduct this evaluation, the ramp will be shut down to clear the ramp of eels and make it inaccessible to eels other than the test specimens. During this evaluation, the ramp will not be collecting or attracting eels from the river. It is also not practicable to set up a temporary ramp for use during the test—questions could arise regarding the effectiveness of the temporary ramp. As stated above, Exelon will draft a study plan for a ramp efficiency test, only, and provide it to resource agencies implement the study following approval of the Conowingo Eel Passage and Restoration Plan (anticipated in 2022).

The results above are mixed, two systems worked well and one very poorly. The FEMP states: Exelon has concluded that suitable technology to conduct this study is not currently available. While a methodology for an attraction study may not be available, it is available for a ramp efficiency study. This type of study is relatively simple: enclose a known number of eels at the bottom of the ramp, which has been cleared of eels, and count the number in the capture/holding tank at the top over a fixed period such as 6, 12, 18, 24 etc. hours. If there is a concern that the eelway to be tested will not be able to pass eels during the test, it is possible to set up a temporary ramp for use during the test.	
3.4.3 In 2020, fallback at the top of the ramp was 24% in July and 50% in August. Subsequently no changes to the spray bar were done. Fallback likely affects overall eelway efficiency and should be resolved and re-evaluated as part of the overall eelway efficiency study. Within the FEMP, this assessment seems out of place considering review of assessments/studies are not discussed for other sections of the FEMP.	Exelon will be conducting an additional evaluation of the spray bar at the Conowingo eel ramp in September 2021, which supplement the findings of the 2020 spray bar assessment. Methods were discussed with USFWS and other resource agencies during a remote meeting on August 18, 2021 and a written study plan will be provided as well as a written summary of evaluation results after the study's completion.
3.4.3 How ramp overcrowding, as directed in the FERC Order, is going to be determined should be explained.	The proposed and existing eel ramps are 18 inches wide. Using the USFWS Fish Passage Engineering Design Criteria (2019) of a maximum capacity of 5,000 eels/day per inch of ramp width, assuming a mean eel size of 150 mm total length, the ramps have a capacity of 90,000 eels/day. During the 10 years of operation, if the number of American Eels attempting to migrate through the CEECF exceeds 90,000 eels per day, based on volumetric estimates, or if densities in the collection tank exceed 10 eels per L, the facility will be modified, or operational protocols adjusted to reduce crowding, in consultation with MDE, USFWS, and EPAG, and following approval from FERC. This is described in the Conowingo Hydroelectric Project Eel Passage and Restoration Plan.

3.4.3 A draft plan for ramp efficiency should be provided to the agencies by December 31 of the year preceding the study.	Exelon will provide draft plans to resource agencies for review and comment by December 31 of the year prior to the study.
3.4.5 Reporting and Conclusions The study report should be provided to the agencies by December 31 of the study year.	The text has been changed to, "When the study is performed, Exelon will submit a study report to USFWS, the other members of EPAG, and Maryland Department of the Environment as well as FERC by December 31 of the study year."
4.1.4 States: "Route selection data collection for adult and juvenile American Shad and river herring will be performed over two passage seasons in 2027 and 2028. If Exelon deems necessary based on its own discretion, the study will be extended an additional year to assess route selection in 2029." Please define what criteria will be followed and what determines if Exelon will extend it to a 3rd year and will this data be used as a metric in determining route selection of the target species?	The option for a third year of study was agreed upon between Exelon and USFWS as part of the Department of the Interior Settlement Agreement to account for atypical operational and environmental conditions that may be encountered during the previous two years of study. Data from all study years will be used, to extent they are scientifically valid, to assess route selection.
4.1.5 Reporting and Consultation The report for each year's study should be provided by the end of April to allow sufficient time for comment and study plan adjustments for the upcoming year's study.	Exelon will provide a draft study report to resource agencies by April 30 following the conclusion of each study year. FERC License Appendix 1, requires interim and final reports for downstream passage studies to be submitted to the USFWS by August 1 following each study year. Article 401 requires interim and final reports for downstream passage studies to be submitted to FERC by August 31 following each study year.
4.2.1 Nowhere else in the FEMP do we discuss past studies. If the FEMP is going to do that here then the FEMP should be consistent throughout.	The past studies provide context to establish the baseline turbine survival conditions at the Project. This is relevant as the future studies contemplated in the FEMP related to turbine survival were meant to be "check-in" studies to confirm that the previous turbine survival estimates remain valid, as changes in operational conditions could impact these estimates.
4.2.3 Methods and Study Plan Development Adult shad and herring should be collected late in the upstream passage season to better replicate the physical condition of out migrating fish. Sensor Fish should be used to evaluate barotrauma (Advanced	Use of Sensor Fish will be considered during study plan development. Normandeau has used Sensor Fish technology in other locations.

Telemetry Systems, ARC 800 Sensor Fish). Sensor Fish measure temperature, pressure, acceleration, and rotation during turbine passage. Nadir pressure is measured to assess the potential for barotrauma related injury to fish and the potential for severe acceleration during turbine passage.	
4.2.5 Reporting and Consultation The draft report should be provided to the agencies by April 30 of the year following the study to allow consultation should a second year of study be required.	Exelon will provide a draft study report to resource agencies by April 30 following the conclusion of each study year. FERC License, Appendix 1, requires interim and final reports for downstream passage studies to be submitted to the USFWS by August 1 following each study year.
4.3.3 Why is the silver eel study not until 2026? Data suggests a sufficient number of silvers are present now in the river (York Haven Dam Mortalities).	The Muddy Run Pumped Storage Project FERC license, which incorporates the project's Pennsylvania Water Quality Certificate, requires that a study of downstream eel passage occur no earlier than October 1, 2026. Exelon intends to conduct the eel studies required by the Muddy Run License and the Conowingo License concurrently. Additionally, this date allows for the conclusion of USFWS' current basin-wide eel passage study (expected duration 2021-2023). Allowing for synthesis of the basin-wide study's findings, which are expected to inform the planning of Exelon's silver eel study.
Appendix A Calculating T&T Credit – History of this calculation should be given explaining that it was a cooperative estimate between USFWS and Maryland DNR.	Text has been added to the footnote that references this Appendix and to the first page of Appendix A to give its source as the FERC License, Appendix 1, U.S. Department of the Interior Modified Fishway Prescription for the Conowingo Hydroelectric Project No. 405 (filed June 8, 2016).

Attachment E

Conowingo Hydroelectric Project
(FERC Project No. 405)

Fishway Operations and Maintenance Plan
("FOMP")

CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NUMBER 405

FISHWAY OPERATION AND MAINTENANCE PLAN

Prepared for:

Constellation

Prepared by:

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

GOMEZ AND SULLIVAN
ENGINEERS

January 2023

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Appendix E. Fish Lift and Eel Collection Facility Pre-Season and Post-Season Maintenance Measures

Appendix F. Trap and Transport Logistics Plan

Appendix G. Muddy Run Pumped Storage Project American Eel Passage Plan

Appendix H. Conowingo Hydroelectric Project American Eel Passage and Restoration Plan

Appendix I. Agency Comments and Responsiveness Summary

LIST OF ABBREVIATIONS

cfs	cubic feet per second
CDL	Commercial Driver's License
Conowingo Project	Conowingo Hydroelectric Project
Constellation	Constellation Energy Generation, LLC
CWECF	Conowingo West Eel Collection Facility
C	Celsius
DOT	Department of Transportation
EFL	East Fish Lift
EPAG	Eel Passage Advisory Group
FERC	Federal Energy Regulatory Commission
FOMP	Fishway Operation and Maintenance Plan
fps	feet per second
FWS	US Fish and Wildlife Service
gpm	gallons per minute
L	liter
LLC	Limited Liability Corporation
lpm	liters per minute
m	meter
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
mm	millimeter
NGVD	National Geodetic Vertical Datum
PADEP	Pennsylvania Department of Environmental Protection
PFBC	Pennsylvania Fish and Boat Commission
ppm	parts per million
SRBC	Susquehanna River Basin Commission
USFWS	United States Fish and Wildlife Service
WFL	West Fish Lift

1 INTRODUCTION

Constellation Energy Generation, LLC (Constellation) is the licensee for the 570.15-megawatt Conowingo Hydroelectric Project (Conowingo Project or Project). The Project is located on the Susquehanna River (at river mile 10) in Pennsylvania and Maryland. Conowingo Dam is in Maryland connecting Cecil and Harford counties, as is the lowermost six miles of the Project reservoir, Conowingo Pond. The remaining eight miles of Conowingo Pond are in Pennsylvania, within York and Lancaster counties.

A Project Fishway Operation and Maintenance Plan (FOMP) describing Constellation's fish passage operations and maintenance activities was previously filed with the Federal Energy Regulatory Commission (FERC) on February 2, 2021. A new 50-year license for the Project was issued to Constellation on March 19, 2021. Per Article 413 of the new license Constellation filed a revised FOMP on November 1, 2021, incorporating the terms of the new license. The most recent version of the FOMP describing Constellation's fish passage operations and maintenance activities for the 2022 fish passage season was previously filed with the Federal Energy Regulatory Commission (FERC) on January 24, 2022.

This version of the FOMP updates previous versions to describe Constellation's fish passage operations and maintenance activities to be instituted during the 2023 fish passage season. Major updates include the following.

- Constellation will continue sorting of all fish that enter the Conowingo East Fish Lift (EFL) and West Fish Lift (WFL).
- Constellation will monitor and alert the Resource Agencies if any of the following invasives are observed in the EFL or WFL during the 2023 fish passage season: Silver Carp (*Hypophthalmichthys molitrix*), Bighead Carp (*Hypophthalmichthys nobilis*) and Grass Carp (*Ctenopharyngodon idella*).
- For the 2023 fish passage season the Whooshh system will not be utilized, instead fish will be transported from the EFL holding tank area to the WFL area using a transport transfer tank and skid that will be hauled through the powerhouse ("turbine hall") by a forklift.
- Water temperatures and dissolved oxygen collected at Station 643 after May 1 will be included in the annual FOMP report in addition to the water temperatures and dissolved oxygen collected daily at the WFL during the fish passage season.
- Every 20th river herring of each species (Alewife and Blueback Herring) will be sacrificed with a maximum collection of 50 individuals per species from the Project. Additionally, any river herring mortalities resulting from lifting, sorting, handling, or transporting will be retained for analysis

The purpose of Constellation's 2023 fish passage operation and maintenance activities are to facilitate passage of American Shad (*Alosa sapidissima*) and river herring (Alewife, *Alosa pseudoharengus* and Blueback Herring, *Alosa aestivalis*) as well as discourage the passage of invasive aquatic species.

On August 10, 2022, Constellation met with the United States Fish and Wildlife Service (USFWS), Maryland Department of the Environment (MDE), and Maryland Department of Natural Resources (MDNR) regarding invasive species and to discuss the results of the 2022 fish passage season (Appendix A). At this meeting, the Resource Agencies and Constellation agreed that Constellation will continue to implement sorting of all fish that enter the Conowingo EFL and WFL. Constellation will also monitor and remove the following invasive species during the 2023 fish passage season: Northern Snakehead (*Channa argus*), Blue Catfish (*Ictalurus furcatus*), and Flathead Catfish (*Pylodictis olivaris*). These species will be managed in accordance with Article 419 of the new license, paragraphs (b), (c), and (d) specifically

collecting these species from both the EFL and WFL and placing them in totes and in a refrigeration unit that will be provided by MDNR. MDNR will remove the totes and beneficially reuse the aquatic invasive species. Constellation will also monitor and alert the Resource Agencies if any of the following invasives are observed in the EFL or WFL during the 2023 fish passage season: Silver Carp, Bighead Carp and Grass Carp. American Shad and river herring will be sorted at the EFL and WFL and transported upstream ("100% sorting"), and no volitional passage will take place. The Resource Agencies requested that Constellation operate in this manner for the following fish passage seasons: 2023, 2024, and 2025.

The upgrades planned to the EFL under FERC License, Appendix 1, Section 12.6.1 do not contemplate sorting of aquatic invasive species. Constellation believes that it can accommodate the 100% sorting request for the 2023 fish passage season through operational and logistical changes to the trap and transport program, however, consultation with the Resource Agencies will be required annually as the populations of aquatic invasive species may increase to the point where Constellation may not be able to accommodate this request safely through operational and logistical changes. The EFL volitional upgrades under FERC License, Appendix 1, Section 12.6.1 do not contain a mechanism to sort and remove aquatic invasive species.

In addition, the License requires a total of 80% of the migratory run, up to 100,000 American Shad and 100,000 river herring per year to be trapped and transported to the mainstem Susquehanna River upstream of York Haven. The remainder of the run is to pass volitionally at the EFL. As described above, in response to USFWS concerns with invasive species passing Conowingo Dam via volitional passage at the EFL, Constellation, USFWS, MDE, MDNR, Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Fish and Boat Commission (PFBC), and the Susquehanna River Basin Commission (SRBC) have agreed not to conduct volitional passage in 2023, 2024, or 2025.[1] The EFL and WFL will be operated for trap and transport using existing sorting and holding tank(s). In accordance with the License conditions, Constellation will trap and transport up to 80% of the American Shad and river herring run above York Haven Dam (RM 56.1). However, the remaining portion of the American Shad and river herring run will be transported and discharged upstream of the Safe Harbor Dam (RM 32.2), rather than pass volitionally. To accomplish this, Constellation will transport American Shad and river herring from every fifth transport (20%) above Safe Harbor Dam, and the remaining four transports (80%) will be made above York Haven Dam. As the season progresses, the transport targets will be assessed on a weekly basis, and transports will be adjusted as needed to achieve the 80%/20% proportion. Adjustments will be based on the total number of fish transported to each location, as it is likely that fish transport load size may vary throughout the season due to variances in daily catch numbers.

Article 401 requires Constellation to keep the FOMP revised and updated on an annual basis, as necessary, when new fish passage measures are implemented or planned for the next year. Filing of this FOMP with FERC addresses the Article 401 requirement to file annual FOMP updates by January 31, 2023.

[1] The EFL setup for volitional passage is not setup to accommodate 100% sorting. Previous efforts to remove invasive species in the upper exit trough required the shutdown of the EFL to dewater the exit trough to allow personnel to enter the exit trough and remove the invasive species. The EFL is shutdown during this period and due to safety requirements, such as Lock Out-Tag Out, could result in a shutdown of the EFL for up to five (5) hours. For this reason, Constellation is proposing to accomplish 100% sorting using the trap and transport setup at both fish lifts.

This FOMP specifically includes the following.

- Protocols for the management of invasive fish species during fish lift operations.
- Details of how the Project will be operated during the migration season to provide for adequate fish passage conditions, including:
    - routine maintenance;
    - pre-season preparation and testing at the fish lift and eel passage facilities;
    - post-season maintenance, protection, and winterization of the fish lift and eel passage facilities;
    - sequence of turbine start-up and operation under various flow regimes to enhance fishway operation and effectiveness;
    - procedures for routing fishway operations, including seasonal and daily periods of operation;
    - debris management at the fishway entrance, guidance channels, and the exit; and
    - plant operations to provide near- and far-field attraction.
- Protocols for operation to help prevent the transmission of COVID-19 and ensure the safe and reliable operation of both Projects (Appendix B). COVID-19 protocols will be implemented as necessary based upon applicable federal and state guidelines in place at that time. Any changes in COVID-19 requirements will be communicated to FERC and the resource agencies through an informational filing to the extent the change in COVID-19 protocols impact fish passage.
- Standard operating procedures for monitoring and enumerating fish passage by species, including the American Eel (*Anguilla rostrata*) passage facilities.
- Standard operating procedures for collecting biological samples from target species to assess restoration efforts.
- Standard operating procedures for monitoring and reporting operations that affect fish passage.
- Standard operating procedures in case of emergencies and unit outages to first avoid, and second minimize, potential negative impacts on fishway operations and the effectiveness of upstream passage for target species.
- Trap and transport logistics plan for American Eel, as well as American Shad and river herring.
- Consultation records.

The development of this FOMP has included consultation with resource agencies and has specifically addressed consultation requirements described in Articles 401, 412, 414, 415, 416, 417, 418, and 419. This FOMP also references the articles listed in Table 1-1.

Table 1-1. FERC License Articles Discussed within Fishway Operation and Maintenance Plan

Article	FOMP Section(s)
Article 401. Commission Approval, Reporting, and Filing of Amendments; Appendix 1, Section 12.4	All
Article 406. Conowingo Pond Level Management	Section 3.1
Article 407. Minimum flow requirements	Section 3.1
Article 412. Fish Lift Monitoring	Section 4.3.3.1 Appendix F
Article 413. Fishway Operation and Maintenance Plan	All
Article 414. Additions to American Eel Passage Prescription	Section 5.4
Article 415. American Eel Passage and Restoration Plan	Section 6.2

Article	FOMP Section(s)
Article 416. American Eel Collection and Holding Tank Conditions	Section 5.3.3.1 Section 5.7
Article 417. Upstream American Eel Transport Criteria	Section 5.3.3 Section 6.2 Appendix F
Article 418. Sturgeon Reporting	Section 4.3.3.1
Article 419. Invasive species	Section 1 Section 4.3.1.1 Section 4.3.1.2 Section 7.1 Appendix A

2 PROJECT FACITIES

2.1 Project Configuration

The Project consists of 1) a main dam, 2) a spillway, 3) a reservoir (Conowingo Pond), and 4) an intake and powerhouse.

The Conowingo Dam is a concrete gravity dam with a maximum height of approximately 94 feet and a total length of 4,648 feet. The dam consists of four distinct sections from east to west: a 1,190-foot long non-overflow gravity section with an elevation of 115.7 feet[2]; an ogee shaped spillway, the major portion of which is 2,250 feet long with a crest elevation of 86.7 feet, and the minor portion of which is 135 feet long with a crest elevation of 98.7 feet; an intake-powerhouse section which is 950 feet long; and a 100-foot long abutment section (Figure 2.1-1). The dam and powerhouse also support US Highway Route No. 1, which passes over the top of Conowingo Dam. The EFL and WFL are located at opposite ends of the powerhouse.

Flow over the Conowingo Main Dam spillway is controlled by 50 stony-type crest gates with crest elevations of 86.7 feet and two regulating gates with crest elevations of 98.7 feet. Each of the crest gates are 22.5 feet high by 38 feet wide and have a discharge capacity of approximately 16,000 cubic feet per second (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 approximately 5,000 cfs per gate at a reservoir elevation of 109.2 feet.

Conowingo Pond extends approximately 14 miles upstream from Conowingo Dam to the lower end of the Holtwood Project tailrace. The Conowingo Pond is generally maintained at an elevation of 109.2 feet, with a surface area of approximately 8,500 acres and a total impoundment design volume of 310,000 acre-feet at that elevation.

The Project powerhouse contains eleven main turbines, as well as two house turbines (Table 2.1-1). The house units are located on the far western end of the powerhouse, and discharge into the WFL, whereas the larger units are arranged in order such that Unit 1 discharges near the WFL, and Unit 11 discharges near the EFL (Figure 2.1-2). Units 2 and 5 are equipped with aerating runners, which serve to increase dissolved oxygen levels in the turbine discharge water. The Project intakes for each turbine are individually protected by seven trash racks; five are entirely steel (clear spacing of 5.375 inches) and two are steel framed with wood racks (clear spacing of 4.75 inches). The top two racks are constructed of wood due to frazzle ice accumulations on the steel sections.

2.2 Fish Passage Facilities

2.2.1 West Fish Lift

The WFL (Figures 2.2.1-1 and 2.2.1-2) is located at the west bank of the tailrace below Conowingo Dam and has been in operation since 1972. The WFL was designed to use the outflow from the two house units

[2] Unless noted otherwise elevations are in the National Geodetic Vertical Datum of 1929 (NGVD 1929), as opposed to Conowingo Datum. Conowingo Datum is 0.702 feet higher than NGVD 1929 Datum (i.e., El. 100.00 Conowingo Datum = 100.702 NGVD 1929 Datum).

as an attraction flow for the lift. Fish enter the WFL through one of two entrance gates. Entrance Gate 1 directs attraction water along the downstream face of the dam towards turbine Units 1 and 2. This gate is usually closed when Units 1 and 2 are operating to prevent overcrowding of the crowder channel by Gizzard Shad (*Dorosoma cepedianum*). Entrance Gate 2 directs water downstream along the east wall of the WFL. Entrance Gate 2 is operated when turbine Units 1 and 2 are operating, in conjunction with Entrance Gate 1, or by itself with turbine Units 1 and 2 on or off. Overall, Entrance Gate 2 is used most frequently. The WFL does not have the capability to pass fish into Conowingo Pond and was designed as a collection facility to allow for transport of pre-spawned American Shad to tributaries above the dam. The volume of the existing WFL hopper is approximately 900 gallons. The WFL is outfitted for trap and transport using the existing sorting and holding tank(s). A transport tank and skid will be used in 2023 similar to previous years. Figure 2.2.1-3 illustrates the sorting and holding tank layout. Constellation has a total of four (4) transport tanks and skids to transport American Shad and river herring.

2.2.2 East Fish Lift

The EFL (Figures 2.2.2-1 through 2.2.2-3) is located at the east end of the powerhouse in the first spillway bay of the dam. It is used during the spring to lift fish over the Conowingo Dam directly into Conowingo Pond. Attraction water enters the EFL from one of two gates that replaced the original regulating gates previously in the spillway bay. Water also enters the EFL exit trough at the level of the spillway. Water flows through the exit trough and enters a bypass pipe that returns this water to the spillway creating a flow through the exit trough for the shad to swim upstream after being lifted and deposited into the exit trough from the hopper. Fish enter the hopper through one of three entrance gates; selection of the gate used is dependent on the turbines in use. The EFL has been in operation since 1991 and was operated as a trap and transport facility from 1991-1996. In 1997, the EFL began operation as a volitional-only facility. Due to Resource Agency concerns regarding the passage of aquatic invasive species, Constellation requested authorization from FERC to temporarily suspend upstream fish passage requirements. This request was approved by FERC, and the EFL has not operated in volitional passage mode since that time. The EFL was outfitted for trap and transport during the 2022 fish passage season, using the existing sorting and holding tank(s). Target species were transported from the EFL holding tank area to the WFL area for eventual transport upstream.[3] For the 2023 fish passage season the Whooshh system will not be utilized, instead fish will be transported from the EFL holding tank area to the WFL area using a transfer tank that will be hauled through the powerhouse ("turbine hall") by a forklift[4].

The FERC License, Appendix 1, Section 12.6.1 requires EFL modifications identified as Initial Construction Items. Designs are currently under development in consultation with USFWS; no changes have yet been made.

[3] Whooshh Innovations Inc. conducted a pilot study in October 2021 to determine if fish can be safely moved from the WFL to the EFL. The pilot study was successful and Constellation utilized the Whooshh system during the 2022 fish passage season to convey fish from the EFL area to the WFL holding area. Additional details on the system setup are provided in Appendix B. The results of the pilot study and 2022 fish passage season are provided in the 2022 FOMP annual report.

[4] Constellation is currently in the design phase for a railcar system to be deployed on the catwalk. Once design and construction are complete, this method for fish transport from the EFL holding tank area to the WFL area will be utilized in future years.

2.2.3 Conowingo West Eel Collection Facility

The Conowingo West Eel Collection Facility (CWECF) is located on the west bank of the Conowingo Dam tailrace (Figures 2.2.3-1 and 2.2.3-2). The facility was constructed in 2017 and consists of five main elements: (1) a water supply line; (2) a ramp; (3) a collection tank; (4) multiple holding tanks; and (5) an overflow tank. In September 2022, Constellation also installed an additional temporary ramp and collection tank at the site.

2.2.3.1 Water Supply Line and Attraction Flow

The facility uses up to 70 gallons-per-minute (gpm) of water to provide attraction flow to the eel ramp and for use within the collection and the holding tank(s). An eight-inch diameter gravity feed line supplies water for the CWECF. The water line forms a manifold at elevation 46 feet and contains four two-inch globe valves for the WFL and one three-inch gate valve for the CWECF. The main water line for the CWECF is three inches in diameter, but each fill line for each tank is two inches in diameter. Each tank's fill line has one two-inch gate valve and one two-inch angle valve along with an inline flow meter between these valves. A separate one-inch line with a ball valve continuously discharges water down the ramp and into the collection tank via a spray bar, keeping the substrate moist and creating a flow to attract juvenile eels. Climbing ramp flow is augmented by a one-inch diameter scent line from a tap and ball valve from the collection tank drain providing additional attraction flow via this gravity feed hose. The overflow tank collects the water from the collection tank and the holding tanks that are in service. Two three-inch diameter additional attraction flow pipes drain the overflow tank and are discharged near the entrance of the ramp. These additional flow pipes are discharged above the eel ramp's shade cloth allowing the water to disperse over a larger area and provide additional attraction. All water from the ramp and the additional attraction pipes provides the overall attraction flow down the shoreline riprap to the tailrace.

2.2.3.2 Collection Facility

The CWECF contains one collection tank, which is 40.2 inches wide with a length of 72.0 inches. The depth of the water in the collection tank is 27.0 inches, with a volume of approximately 336.6 gallons. The collection tank has eight inches of freeboard to keep eels from climbing out of the tank. The main flow into the collection tank is provided from the two-inch fill line with the terminus of the pipe about two inches above the waterline providing a constant flow of freshwater to the tank. Also, some water from the spray bar flow also enters the collection tank from the backside of the ramp. The bend of the ramp is custom fitted into the collection tank and ended about four inches above the high-water mark in the tank. The collection tank contains a drain comprised of a four-inch diameter PVC pipe with holes drilled through it and wrapped in 0.04-inch mesh to prevent juvenile eel escapement. The four-inch collection tank drain line contains a one--inch gravity drain line with a ball valve that is directed to the highest point possible (gravity feed) of the ramp, thus providing eel scent from the eels in the collection tank to the ramp. The collection tank also contains a three-inch drain line, positioned about three inches off the bottom. The drain line attaches to a gate valve that remains closed until eels are removed. The three-inch and four-inch flexible drain lines empty into the overflow tank. The collection tank was custom fitted with a lid made from 0.2-inch Lexan. In addition to the in-line flow meter, the collection tank contains a water temperature and dissolved oxygen probe.

The juvenile eel ramp is constructed of an aluminum cable tray. The cable tray contains landscape fabric climbing substrate (Enkamat 7010) attached to the tray bottom. This substrate consists of a dense three-

dimensional mesh of fused filaments, which provides a climbing surface for the juvenile eels. The ramp consists of an approximately 345 inches long by 18 inches wide cable tray positioned at a 42.5° angle, plus a continuous length of tray that is bent and shaped at a 90° angle over a one-inch radius at the top of the ramp to convey juvenile eels into the collection tank. The entrance of the ramp is at elevation 29 feet, which is above the normal high-water line, with a smooth transition to the existing rip-rap shoreline. The facility is designed so that eels ascend the riprap between the tailwater surface and the end of the ramp. This portion of the riprap is wetted from the attraction flow exiting the eel ramp and the overflow tank down to the tailwater level. Once eels ascend the rip-rap portion, they enter the eel ramp and can ascend to the collection tank. The ramp is held in place by six metal braces, evenly spread across the length of the ramp, and each brace is attached to a large substrate along the shoreline. The ramp is covered from the top down to near the entrance to protect juvenile eels when ascending. The large 70% shade cloth is installed below the entrance to help protect juvenile eels between the tailrace and the entrance of the ramp.

2.2.3.3 Holding Facility

The CWECF contains three holding tanks, with a total holding capacity of 51,660 juvenile eels. Each holding tank is 5.5 feet wide with a length of 5.5 feet. The depth of the water in each collection tank is 2.0 feet, providing approximately 455 gallons of water in each tank. A freeboard of eight inches is provided to prevent eels from climbing and escaping. The bottom of each holding tank is sloped to the center drain to help flush all water and eels from the tank. The top of the center drainpipe is fitted with an 18-inch square screen drain that has a height of eight inches. The screen drain is constructed of 0.04-inch mesh to prevent eels from escaping and allows consistent water exchange. This screened box is attached to a four-inch PVC pipe fitted into a four-inch bulkhead fitting that is removed to drain the tank completely. The bulkhead fitting is attached to a 90° PVC fitting and attached to a four-inch flexible hose by a cam fitting that drains into the overflow tank. The main flow into a holding tank is supplied by the two-inch fill line with the terminus of the pipe about two inches above the waterline, providing a constant flow of freshwater to the tank.

The overflow tank is a 150-gallon tank containing three three-inch bulkhead fittings. These bulkhead fittings are attached to a three-inch PVC solid wall pipe that is used to provide the additional attraction flow near the entrance of the ramp. The overflow tank is filled by the collection tank and all in-service holding tank drain lines. Prior to any tank being drained, a very fine mesh bag is hose clamped to the end of the drain hose to ensure that no eels are released into the overflow tank. The drain hose with the mesh bag attached is placed into the overflow, which acts as a water cushion for the eels being collected in the bag.

Table 2.1-1: Conowingo Project Turbine Specifications

Unit	Type	Runner Speed (rpm)	Rated Output (hp)	Approx. Rated Discharge (cfs)
House #1	Francis	360	1,900	247
House #2	Francis	360	1,900	247
1	Francis	81.8	64,500	6,749
2	Francis	81.8	54,000	6,320
3	Francis	81.8	64,500	6,749
4	Francis	81.8	64,500	6,749
5	Francis	81.8	54,000	6,320
6	Francis	81.8	64,500	6,749
7	Francis	81.8	64,500	6,749
8	Mixed-Flow Kaplan	120	85,000	9,352
9	Mixed-Flow Kaplan	120	85,000	9,727
10	Mixed-Flow Kaplan	120	85,000	9,727
11	Mixed-Flow Kaplan	120	85,000	9,727

CONSTELLATION ENERGY GENERATION, LLC

CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

N

0 500 1,000 2,000
Feet

Figure 2.1-1:
Project Overview

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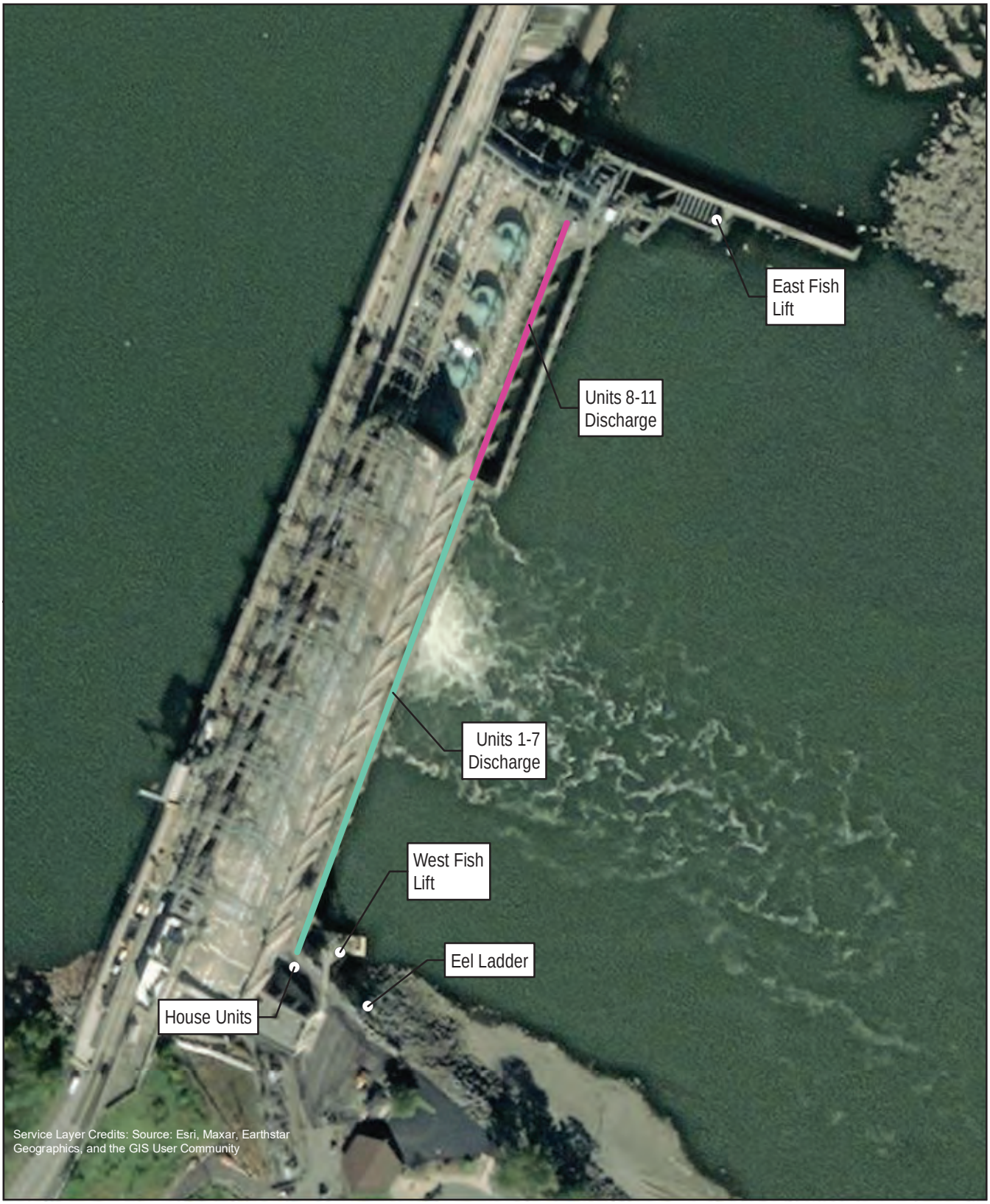
Path: X:\GISMaps\project_maps\fomp\Figure_2_1_1.mxd



CONSTELLATION ENERGY GENERATION, LLC

Constellation

N

CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

0 75 150 300
Feet

Figure 2.1-2:
Project Facilities

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Path: X:\GISMaps\project_maps\fomp\Figure_2_1_2.mxd

ROUTE 21002

℄ House unit No. 1 — River flow — ℄ House unit No. 2

Note*
Steel plate with studs to serve as form and face of CJ

DETAIL F
Scale 0 — 1 Foot
3/4" = 1'-0"

1"ø Williams wedge type, solid bar anchor bolts, or equal
Coupling or welded connection #9 bar

CONCRETE PAD & SUPPORT STEEL FOR CONTROL HOUSE & MOTOR CONTROL CENTER - FOR DETAILS SEE DWG. C-248025

ACTUATOR PLATFORM FOR GATES V4 & V5 FOR DETAILS SEE DWG. C-248028

TOP OF GRATING EL. + 35'-1¼"

Existing fill

Existing retaining wall

Top of tremie conc. El -2.0

Trashrack (M214) (C104) (C105)

60x48 sluice gate V1 (M212)

Chip existing wall, 1'-3" max.

17°45' 161.67 S 59.0 W WS, see detail V(C101)

WP

60x48 sluice gate V2 (M212)

For details and reinforcement see C101 (typ.)

See detail V (C101)

Detail F

Note * (see above, this dwg.)

Steel form, typ (C101)

Tremie concrete (typ)

18"ø corrugated metal pipe, see C101

Projected horizontal reinf. panels 1 & 14, see panel details C102

1" neoprene pad, see detail R (C100)

Anchors see detail F

See Note*

2"key (typ)

1" neoprene pad, see plan (C101)

60x48 sluice gates, V4 & V5 SEE DWG. C-248026 & C-248027

Float finish

Hopper guides, M206

Hopper, M206

Detail K (C105)

Detail G (C105)

96x60 sluice gate, V3 (M212)

Detail H (C105)

6 WF 15.5

Typical panel designation: For details see C102

See detail J (C105)

El. 7.0 — El. 5.0 — El. 4.0 — El. -4.0

Fish hopper (M206)

Strut 1'-6"x 1'-0" for reinforcement see typ. detail C104

For typical beam reinforcement see detail (typ.)

Steel support framing (C100)

Handrail MK 106-4

El. 25.0

3'-0"(typ)

1'-0"(typ)

2'-0"(typ)

2-anchors, see detail F

For panel detail see C102

Fish hopper guides (M206)

El. 7.0

Weld #6 bars to dowels, see A-A, C102 (typ)

El. 0.0

Cut steel support framing flush with conc. (typ.) - Assumed top of rock

El. -2.0

Tremie conc.

El. -4.0

El. -7.0

Projected vertical reinf, see panel details, C102 (typ)

Tremie concrete

℄ 3"ø formed weep hole (typ)

Rock anchorage (C100)

Scale 0 — 4 — 8 Feet
1/4" = 1'-0"
Except as noted

TYPICAL BEAM REINFORCEMENT
NTS

TO BE DETERMINED IN FIELD
EXISTING HANDRAIL
14 #9
#4 ties
#9
TOP OF RUNG LEVEL WITH LANDING
5/8"ø HILTI KWIK-BOLTS 4" EMBEDMENT
BENT ℄ 2"x½
Roughen conc at top of panel (typ)
13 - 3¾" RUNGS @ 1'-0" = 12'-0"

17 #9
#4 ties
#9

PLAN EL 7.0
1:95

SECTION-S

SECTION-M

SECTION-N

SECTION-P

SECTION-R

B-B

REFERENCE DRAWINGS: Work this drawing with C102, C104, C105 & C106

NOTES:
1. ALL STEEL & BOLTS TO BE GALVANIZED
2. FOR LADDER DETAILS NOT SHOWN SEE DWG. H-210000 - SHT #1
3. RUNGS TO BE MADE SKID-PROOF
4. ALL WELDS NOT INDICATED TO BE 3/16" FILLET (TYP)

DATE	LETTER NO.
∴ DWG. TRANSMITTAL	

	BY	DATE	CHKD.	DATE
DSGN	PFW	Nov. 1970	KRC	Nov. 12-70
DWN.	TEG/EB	Nov 1970	SJ	Nov. 1970
DIV.	GROUP LDR.	SECT. HEAD	DEPT. HEAD	DIV. HEAD
CIVIL	SJ			
MECH.				
ELECT				
PLAN.				
STAFF			CH. ENGR.	

REV. NO.	DATE	NATURE OF REVISION	BY	CHKD.	APPD.
3		W.O. 98000-31410202-675C95C106 -10000-08801 REV'D SECT B-B & ADDED NOTE 4 IN PLAN	KRC	KRC	DWW
E2	4/5/83	W.O. GOI-RG-0-4218 ADDED LADDER TO PLAN & DETAILS SECTION-"M", "N", "P", "R" & "S"	TJ	GDM	AG. EM
1	1228-70	Revised conduit. Deleted Fish screen.	TEG	SJ	KRC

PHILADELPHIA ELECTRIC COMPANY
PHILADELPHIA, PENN.

CONOWINGO DAM | FISH COLLECTION FACILITIES

CONCRETE AND REINFORCEMENT
SHEET 2 OF 4

HARZA ENGINEERING COMPANY
APPROVED G.B. Schoegen
CHICAGO, ILLINOIS

DATE DEC. 1970 | DWG. NO. 569 C 103R1

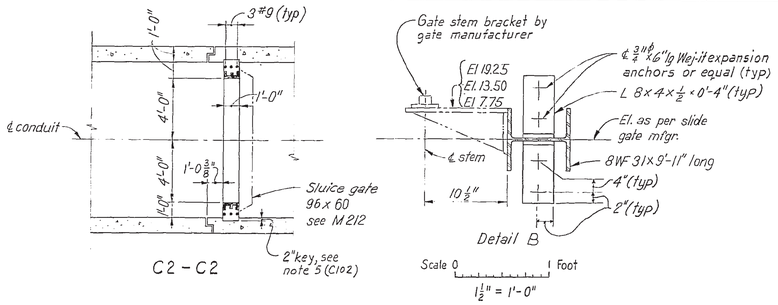
13

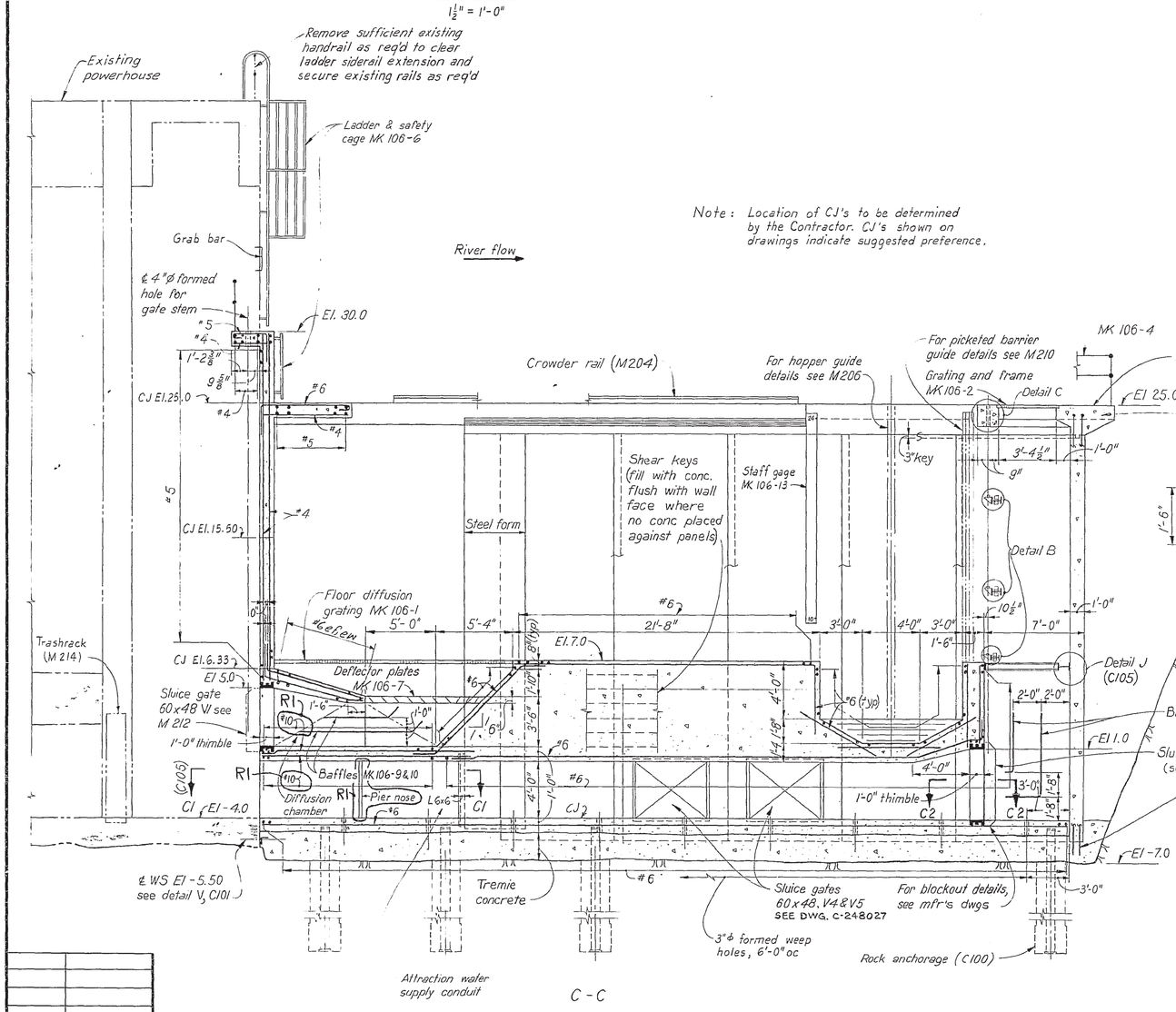
AB-208641-3

TITLE CHECKED

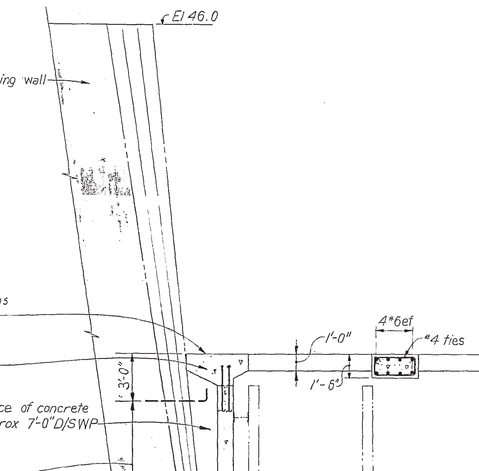
K & E CO. 19-1253

Figure 2.2.1-1: Plan View Layout of the WFL





Note: Location of CJ's to be determined by the Contractor. CJ's shown on drawings indicate suggested preference.



R1 REFERENCE DRAWINGS
Work this drawing with C102, C103, C105 & C106

DWG. TRANSMITTAL				
	BY	DATE	CHKD.	DATE
DSGN.	PEW	Nov 1970	KPL	Nov 1970
DWN.	TEG/FB	Nov 1970	SJ	Nov 1970
DIV.	GROUP LDR.	SECT. HEAD	DEPT. HEAD	DIV. HEAD
CIVIL	SJ			
MECH.				
ELECT.				
PLAN.				
STAFF			CH. ENGR.	

DATE LETTER NO.

REV. NO.	DATE	NATURE OF REVISION	BY	CHKD.	APPD.
1	12-28-70	Revised conduit. Added reference drawings	TEG	SJ	

PHILADELPHIA ELECTRIC COMPANY
PHILADELPHIA, PENN.

CONOWINGO DAM | FISH COLLECTION FACILITIES

CONCRETE & REINFORCEMENT
SHEET 3 OF 4

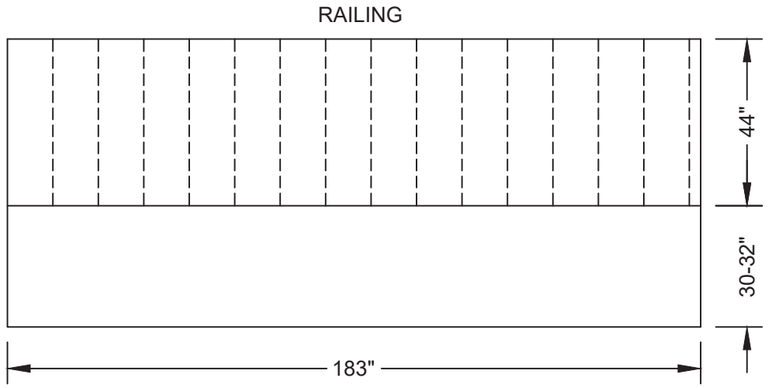
HARZA ENGINEERING COMPANY
APPROVED

CHICAGO, ILLINOIS | DATE DEC. 1970 | DWG. NO. 569 C 104 R1 | 13

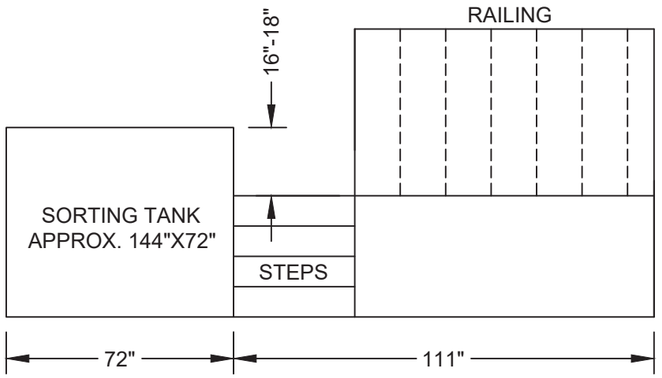
AB-208642-1

D. 19-1253

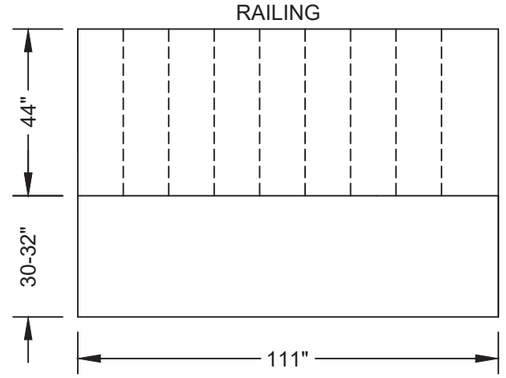
Figure 2.2.1-2: Side-View of the WFL



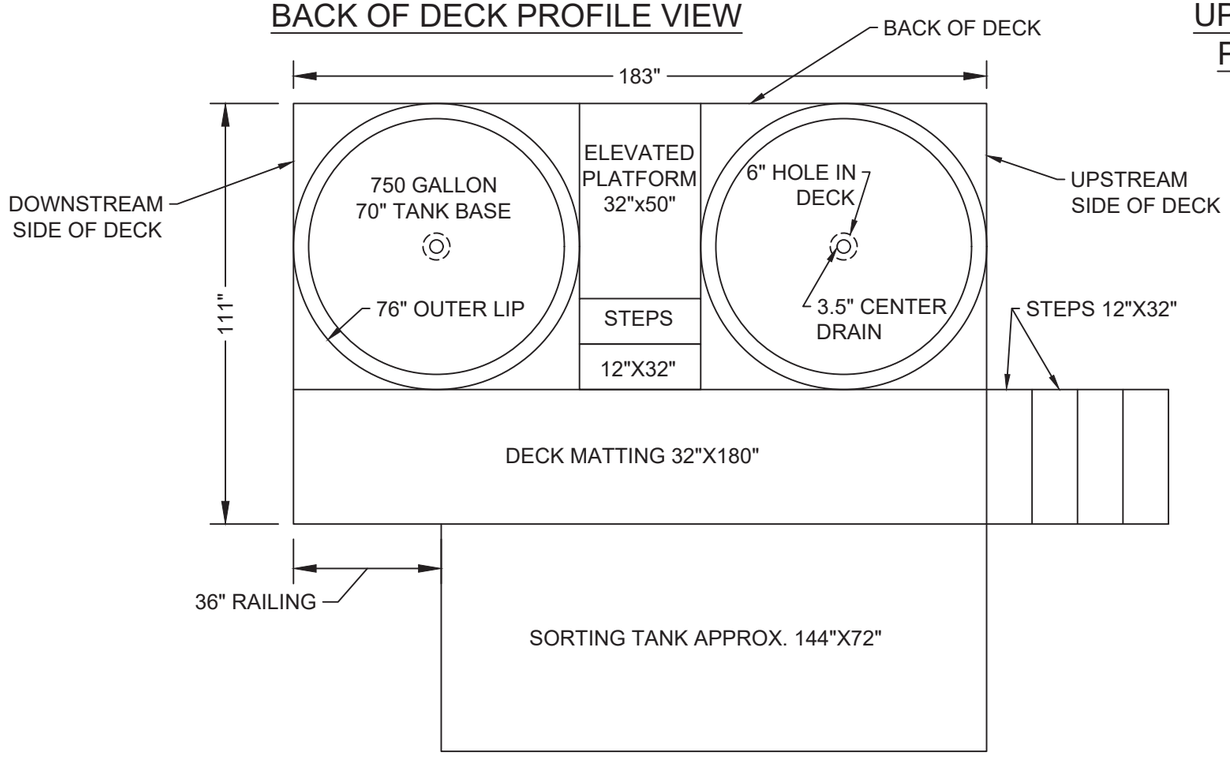
BACK OF DECK PROFILE VIEW



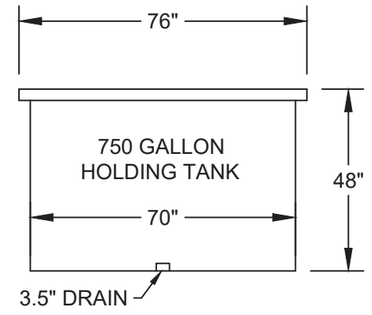
UPSTREAM DECK PROFILE VIEW



DOWNSTREAM DECK PROFILE VIEW



PLAN VIEW



TANK PROFILE VIEW

Constellation

CONOWINGO HYDROELECTRIC PROJECT
INTERIM WEST FISH LIFT TRAP AND
TRANSPORT OPERATION

DATE	#		BY	APP

GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY. Utica, NY. Albany, NY. Henniker, NH
www.gomezandsullivan.com

Figure 2.2.1-3: WFL Sorting and Holding Tank Layout

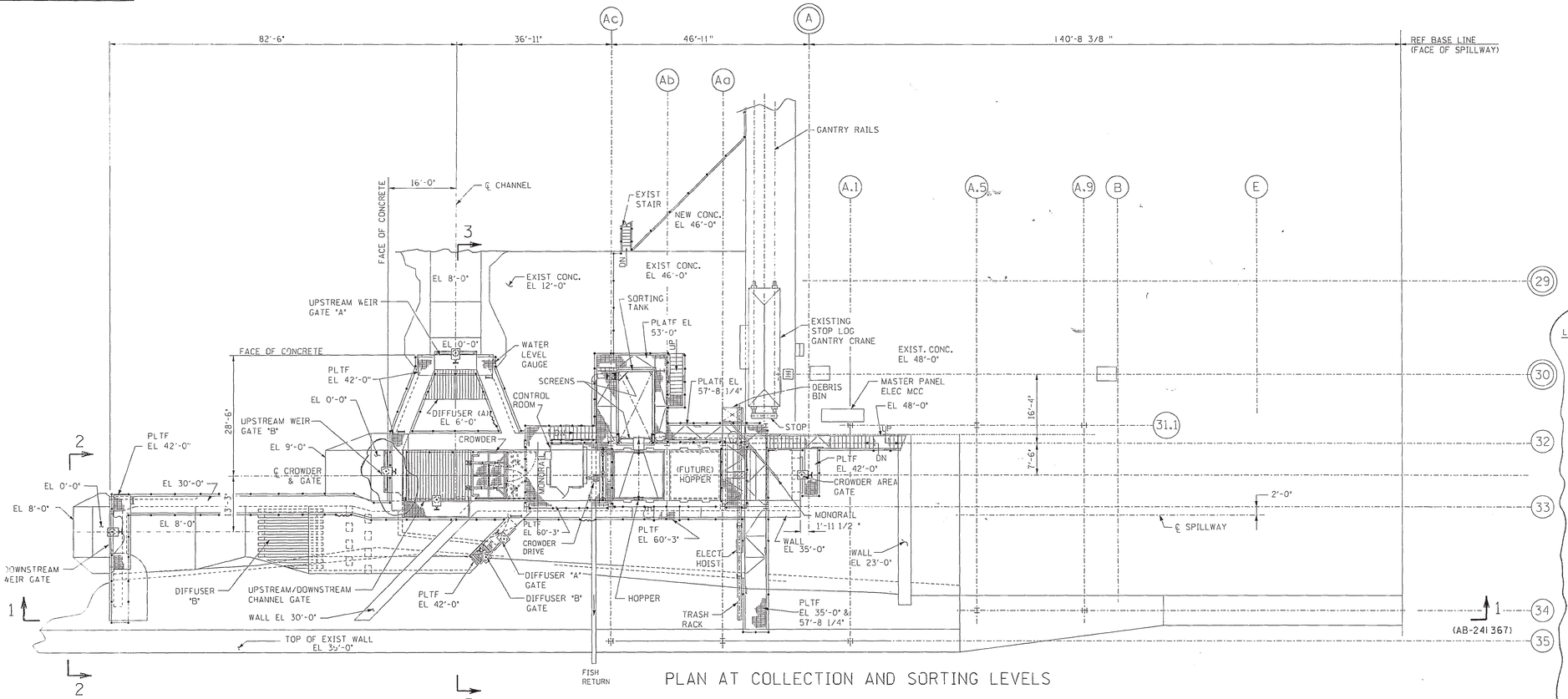
DRAWN BY:	JSC	CHECKED BY:	
APPROVED BY:		GSE PROJECT NO.:	2144

SCALE:
DATE: 12/2/2020

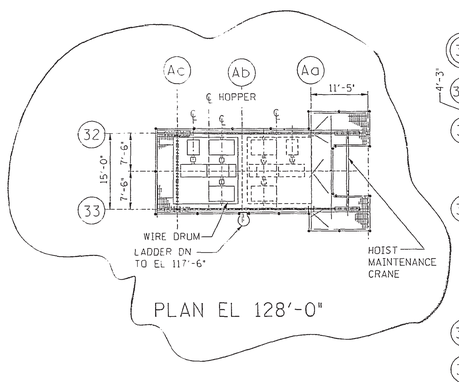
DRAWING NO.: 1

AB-241366

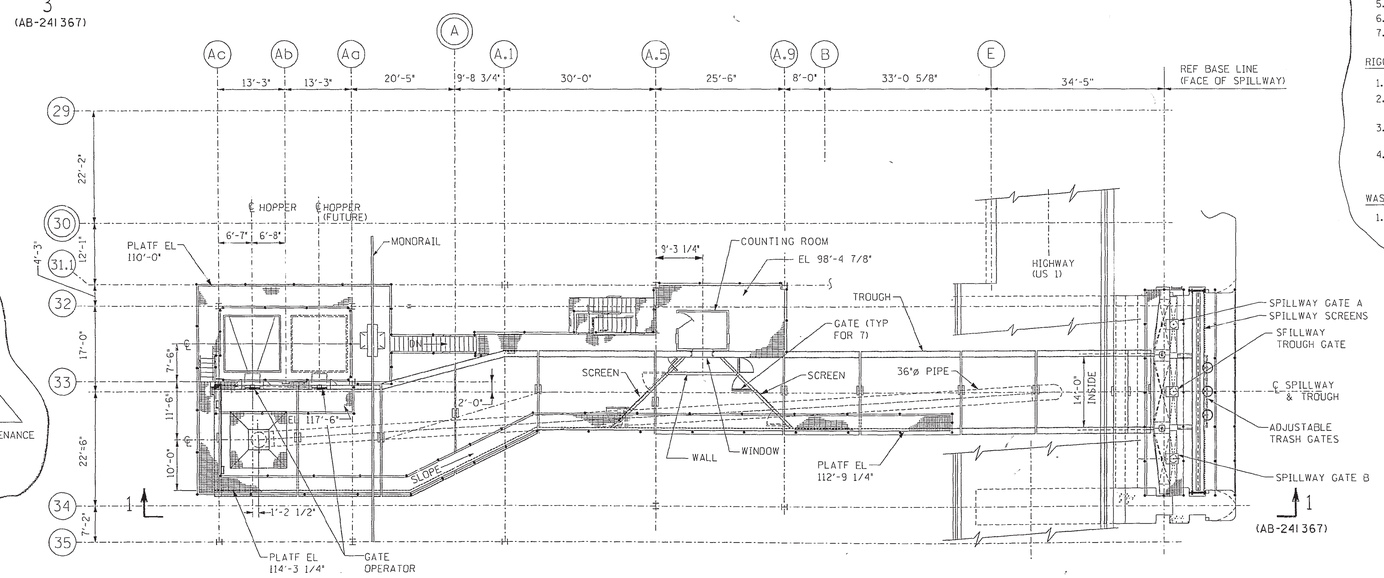
ROUTE 21003



PLAN AT COLLECTION AND SORTING LEVELS



PLAN EL 128'-0"



PLAN AT FISH TROUGH LEVEL

CALLED NORTH

NOTES:

1. SCALE: 3/32" = 1'-0" UNLESS OTHERWISE NOTED.
2. ◯ EXISTING STATION REFERENCE COL'S.
3. GEN. CONTRACTORS SPEC E-3890

REFERENCE DRAWINGS:

GENERAL ARRANGEMENT SECTIONS AB-241367

LIST OF VENDOR DRAWINGS

ACECO

1.	CONTROL ROOM-MODEL 810	ED155426
2.	MODEL 810-3-WALL COUNTING ROOM	ED155427
3.	CROWDER DRIVE ARRANGEMENT	ED155428
4.	FISH CROWDER ARRANGEMENT	ED155429
5.	GATE ASSEMBLY	ED155430

BACHMAN

1.	SEGMENTED WEIR GATE	ED155281
2.	GENERAL ARRANGEMENT	ED155293
3.	GENERAL ARRANGEMENT	ED155294
4.	TROUGH GATE	ED155388
5.	SPILLWAY GATE	ED155389
6.	UPSTREAM/DNSTREAM CHANNEL GATE	ED155390

BAYCRAFT FIBERGLASS & ENG.

1.	TRANSPORTATION TANK	ED155438

L & S WELDING CO.

1.	FISH HOPPER & SCREEN	ED155436

MCNAMARA FAB INC.

1.	REMOVABLE TRASH RACK	ED155174
2.	TRASH RACK	ED155175
3.	STOP GATE	ED155176
4.	TRASH RACK & FISH SCREEN	ED155184
5.	INTAKE	ED155194
6.	TRASH RACK	ED155198
7.	GATES & GATE FRAMES	ED155225

RIGGS DISTLER

1.	HOPPER HOIST #1 CROWDER	ED155378
2.	SPILLWAY GATES A & B DIFFUSER CHANNEL GATES	ED155379
3.	DOWNSTREAM WEIR, HOPPER TROUGH, CROWDER AREA GATES	ED155380
4.	HOPPER #1, UP/DOWNSTREAM CHANNEL & SPILLWAY	ED155381

WASHINGTON ALLUMINUM

1.	FISH SORTING TANK DETAILS	ED155437

THIS DRAWING CREATED ELECTRONICALLY

STATE OF MARYLAND — PROFESSIONAL ENGINEER

APPROVED Kanajbat S. Shah 7-16-91
REGISTERED PROFESSIONAL ENGINEER NO. 17376
STATE OF MARYLAND

12' 6' 0 6' 12' 18'
SCALE 3/32" = 1'-0"

NO	DATE	TABLE OF ADDITIONS & CHANGES USE ONLY PRINTS SHOWING LATEST DATE — DESCRIPTION	REV'D	CHK'D	APP'D
	11/27/89	FINAL AS BUILT	W. Mc	D. H.	L. B. H.
A	5/15	PRELIMINARY FOR CLIENT REVIEW	W. Mc	D. H.	L. B. H.
B	7/31	GENERAL REVISION	W. Mc	D. H.	L. B. H.
C	8/30	FINAL FOR CLIENT REVIEW	W. Mc	W. G. S.	L. B. H.
D	9/30	ISSUED FOR CONSTRUCTION W.O. = 870401	W. Mc	W. G. S.	L. B. H.
1	12/30	GENERAL REVISION ISSUED WITH PECO SIGNATURES	W. Mc	W. G. S.	L. B. H.

STONE & WEBSTER ENGINEERING CORP.
CHERRY HILL, NEW JERSEY

MECHANICAL | JOB. NO. 18827.01

GENERAL ARRANGEMENT
EAST FISH PASSAGE FACILITY
PLANS

CONOWINGO HYDROELECTRIC STATION
PHILADELPHIA ELECTRIC COMPANY

SCALE	DESIGN	EGDS	CHECKED	INSPECTED	APPROVED	DATE
AS NOTED	J. SMETONA		W. McM.	W. G. S.	L. B. H.	11/27/89

APPROVED _____ APPROVED _____
APPROVED _____ APPROVED _____
APPROVED _____ APPROVED _____

DWG NO. AB-241366-2

TITLE CHECKED 1

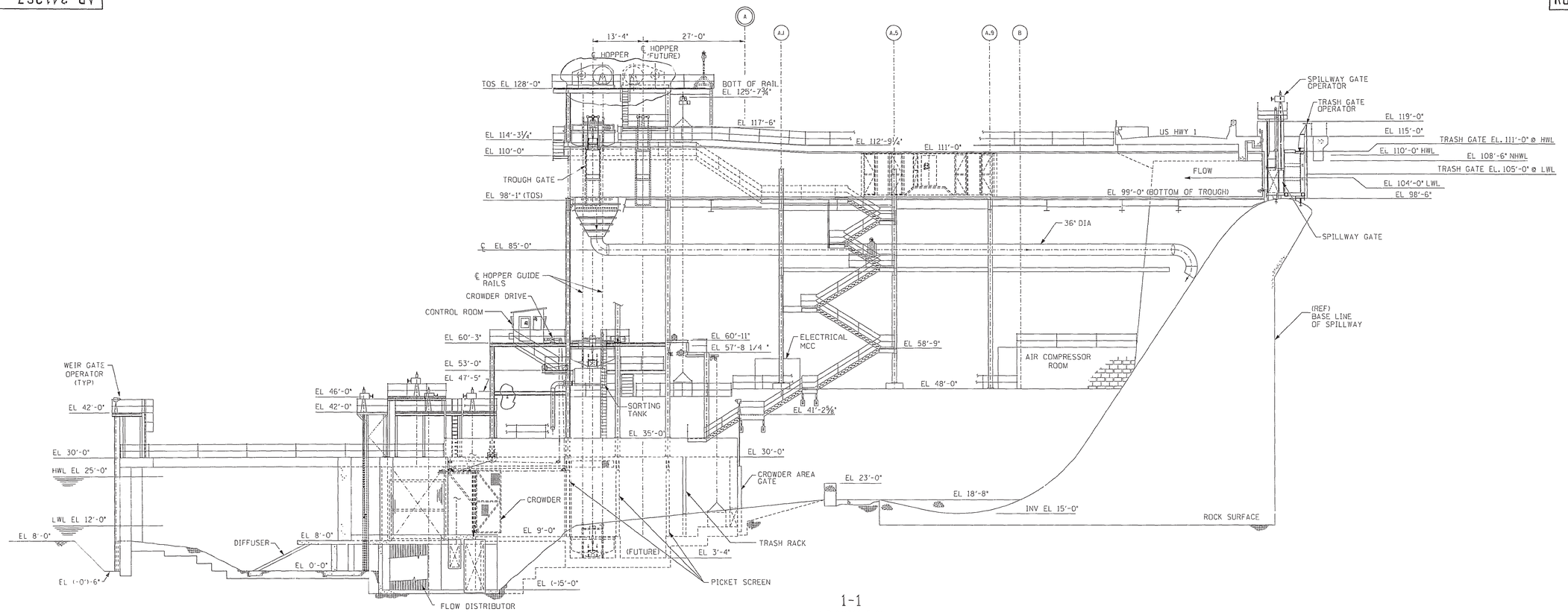
14

Figure 2.2.2-1: Plan View Layout of the EFL

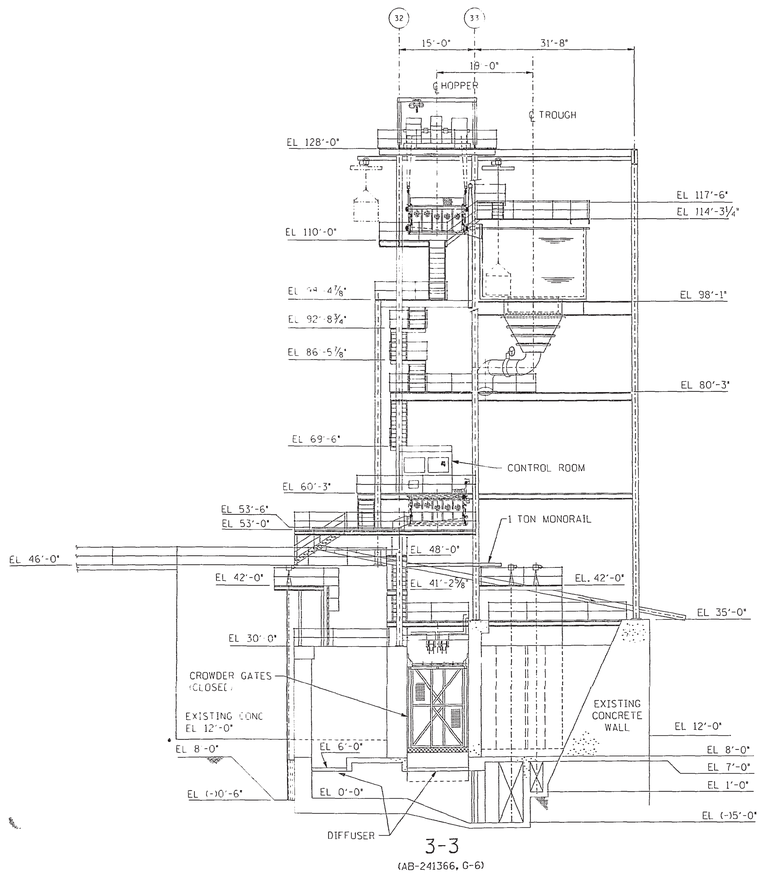
AB-241367

ROUTE 21003

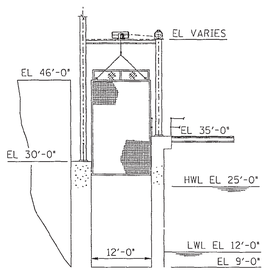
SHEET 1 OF 1



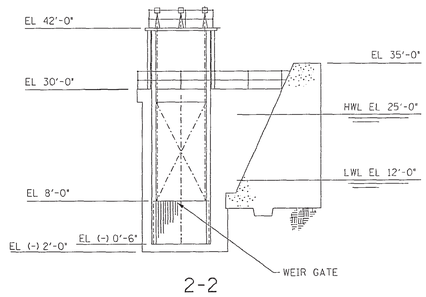
1-1
(AB-241366, E-8)



3-3
(AB-241366, G-6)



PICKET SCREEN (TYPICAL)



2-2
(AB-241366, G-8)

NOTES:
1. FOR LIST OF VENDOR DRAWINGS SEE DRAWING AB-241366.

REFERENCE DRAWINGS:

1. GENERAL ARRANGEMENT (PLAN)	AB-241366
2. HOPPER ARRANGEMENT	AB-241367
3. FISH TROUGH ARRANGEMENT	AB-241370
4. CROWDER & DRIVE ARRANGEMENT	AB-241381

THIS DRAWING CREATED ELECTRONICALLY

APPROVED Virginia B. Blake 9-16-91
REGISTERED PROFESSIONAL ENGINEER NO. 17375
STATE OF MARYLAND

12' 6' 0 6' 12' 18'
SCALE 3 / 32 " = 1'-0"

NO.	DATE	DESCRIPTION	REVID	CHKD	APPD
1	03/07/89	GENERAL REVISION ISSUED WITH PECO SIGNATURES	WMC	WGS	LH
0	10/87/88	FINAL AS BUILT	WMC	WGS	LH
E	5/15/89	PRELIMINARY FOR CLIENT REVIEW	WMC	DH	LH
D	7/31/89	GENERAL REVISION	WMC	DH	LH
C	10/19/89	FINAL FOR CLIENT REVIEW	WMC	WGS	LH
B	11/07/89	ISSUED FOR CONSTRUCTION W.O. # 87040I	WMC	WGS	LH

TABLE OF ADDITIONS & CHANGES USE ONLY PRINTS SHOWING LATEST DATE

STONE & WEBSTER ENGINEERING CORP.
CHERRY HILL, NEW JERSEY

MECHANICAL | JOB. NO. 18827.01

GENERAL ARRANGEMENT
EAST FISH PASSAGE FACILITY
SECTIONS

CONOWINGO HYDROELECTRIC STATION
PHILADELPHIA ELECTRIC COMPANY

SCALE	DESIGN	DRN	CHECKED	INSPECTED	APPROVED	DATE
3/32"=1'-0"	J.P.Z.		W. McM.	W.G.S.	L.B.H.	11/27/89

APPROVED Lee Hunt — APPROVED
APPROVED — APPROVED
APPROVED — APPROVED

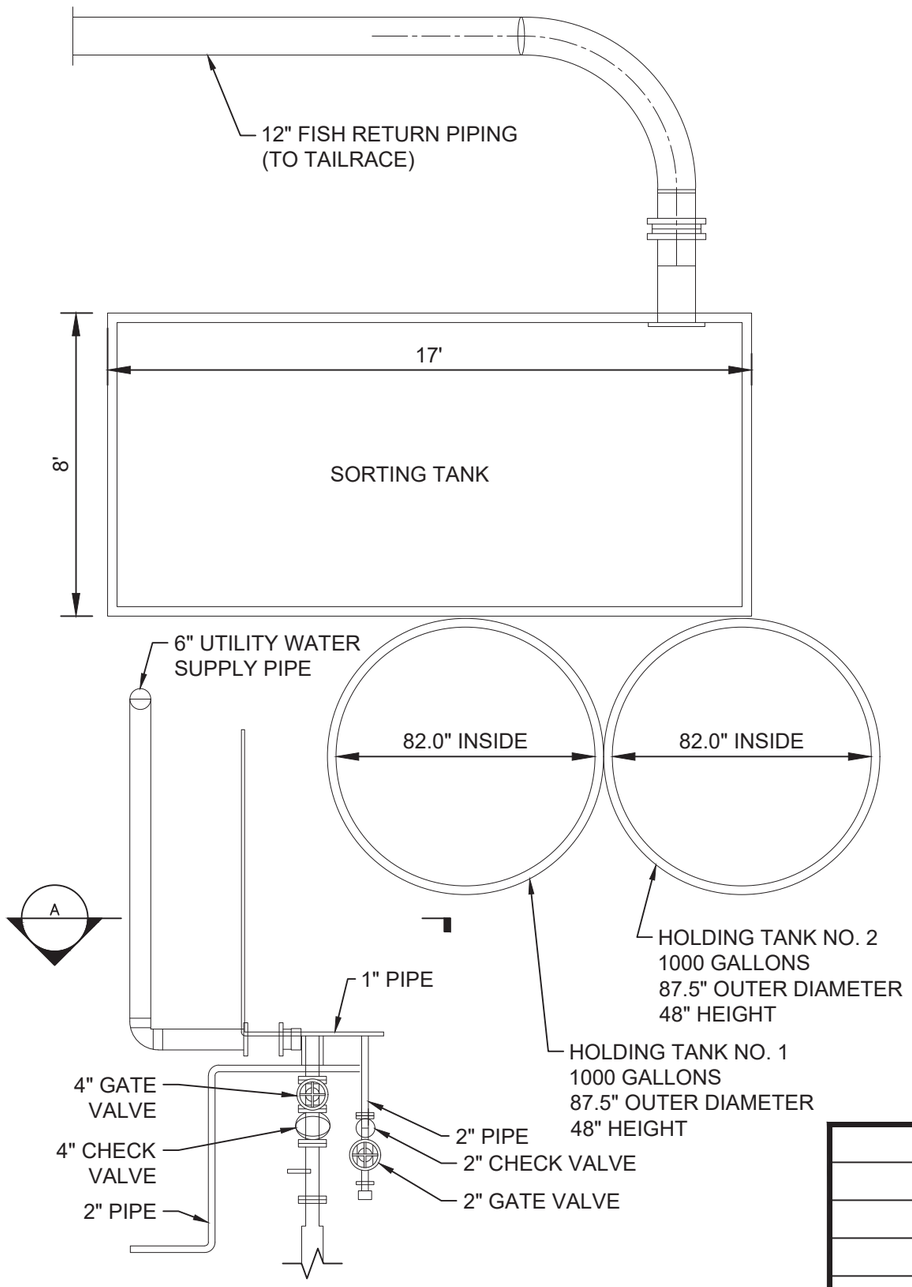
DWG NO. AB-241367-2

TITLE

(0367-2.DGN, COPHEVEL.DGN)

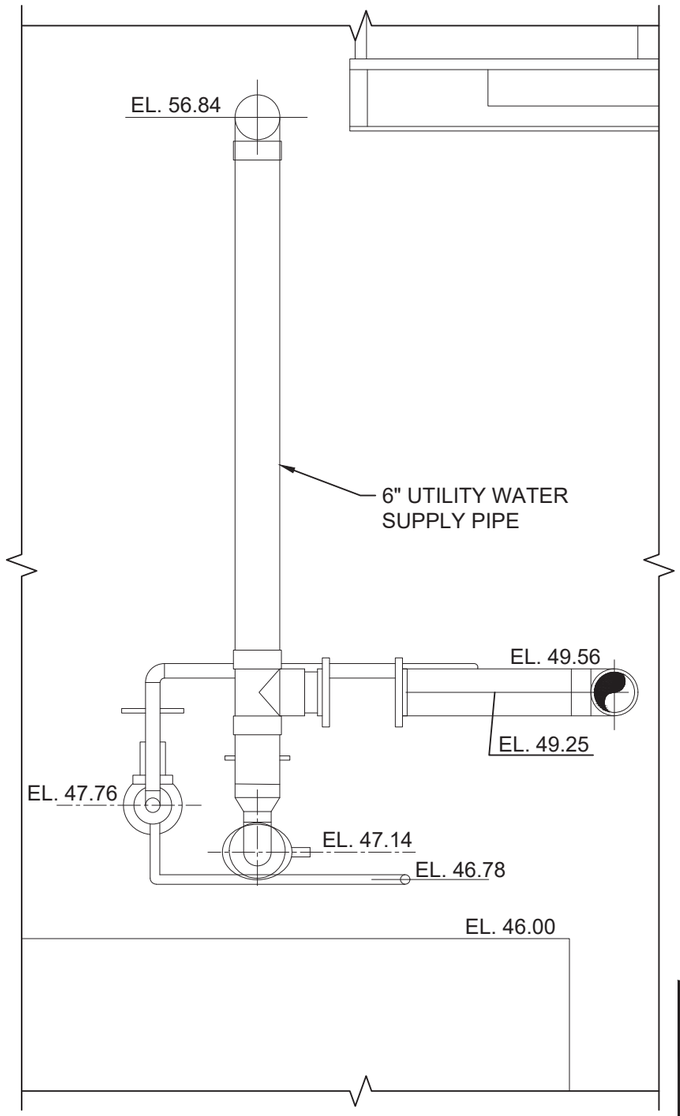
(14)

Figure 2.2.2-2: Side-View of the EFL



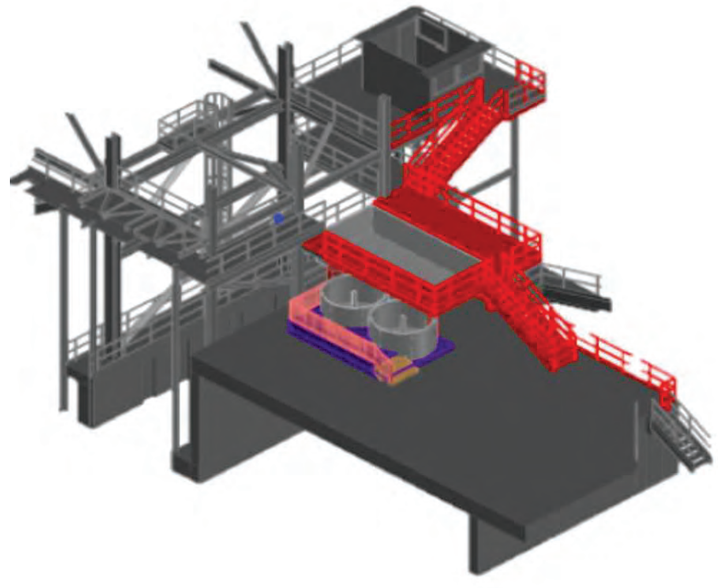
PLAN VIEW

1" = 4'



SECTION A VIEW

1" = 4'



ISOMETRIC VIEW

Constellation

CONOWINGO HYDROELECTRIC PROJECT
INTERIM EAST FISH LIFT TRAP AND TRANSPORT OPERATION

DATE	#		BY	APP

GOMEZ AND SULLIVAN ENGINEERS

Williamsville, NY. Utica, NY. Albany, NY. Henniker, NH
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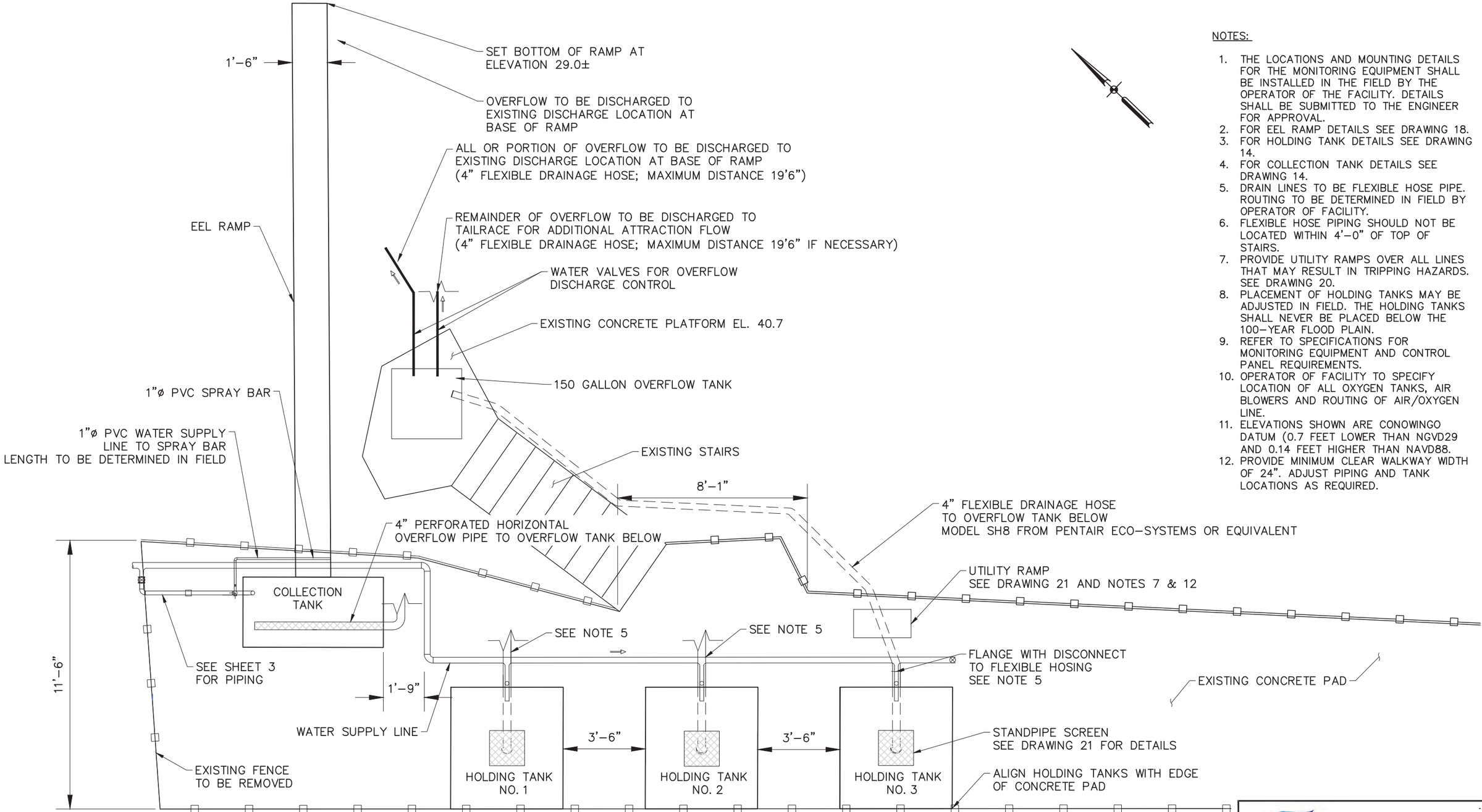
Figure 2.2.2-3: East Fish Lift Sorting and Holding Tank Layout

DRAWN BY:	JSC	CHECKED BY:	
APPROVED BY:		GSE PROJECT NO.:	2144

SCALE:	
DATE:	5/13/2021

DRAWING NO.: 1



NOTES:

1. THE LOCATIONS AND MOUNTING DETAILS FOR THE MONITORING EQUIPMENT SHALL BE INSTALLED IN THE FIELD BY THE OPERATOR OF THE FACILITY. DETAILS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL.
2. FOR EEL RAMP DETAILS SEE DRAWING 18.
3. FOR HOLDING TANK DETAILS SEE DRAWING 14.
4. FOR COLLECTION TANK DETAILS SEE DRAWING 14.
5. DRAIN LINES TO BE FLEXIBLE HOSE PIPE. ROUTING TO BE DETERMINED IN FIELD BY OPERATOR OF FACILITY.
6. FLEXIBLE HOSE PIPING SHOULD NOT BE LOCATED WITHIN 4'–0" OF TOP OF STAIRS.
7. PROVIDE UTILITY RAMPS OVER ALL LINES THAT MAY RESULT IN TRIPPING HAZARDS. SEE DRAWING 20.
8. PLACEMENT OF HOLDING TANKS MAY BE ADJUSTED IN FIELD. THE HOLDING TANKS SHALL NEVER BE PLACED BELOW THE 100–YEAR FLOOD PLAIN.
9. REFER TO SPECIFICATIONS FOR MONITORING EQUIPMENT AND CONTROL PANEL REQUIREMENTS.
10. OPERATOR OF FACILITY TO SPECIFY LOCATION OF ALL OXYGEN TANKS, AIR BLOWERS AND ROUTING OF AIR/OXYGEN LINE.
11. ELEVATIONS SHOWN ARE CONOWINGO DATUM (0.7 FEET LOWER THAN NGVD29 AND 0.14 FEET HIGHER THAN NAVD88.
12. PROVIDE MINIMUM CLEAR WALKWAY WIDTH OF 24". ADJUST PIPING AND TANK LOCATIONS AS REQUIRED.

2' 0 2' 4'

SCALE: 1/2" = 1'–0"

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG

GSE PROJECT NO.: 1714 DATE: 2/17/2017

Constellation

CONOWINGO EEL PASSAGE

GOMEZ AND SULLIVAN ENGINEERS

Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
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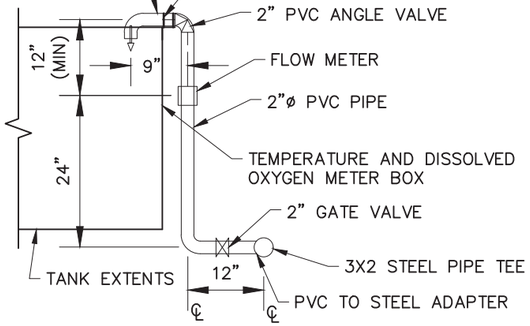
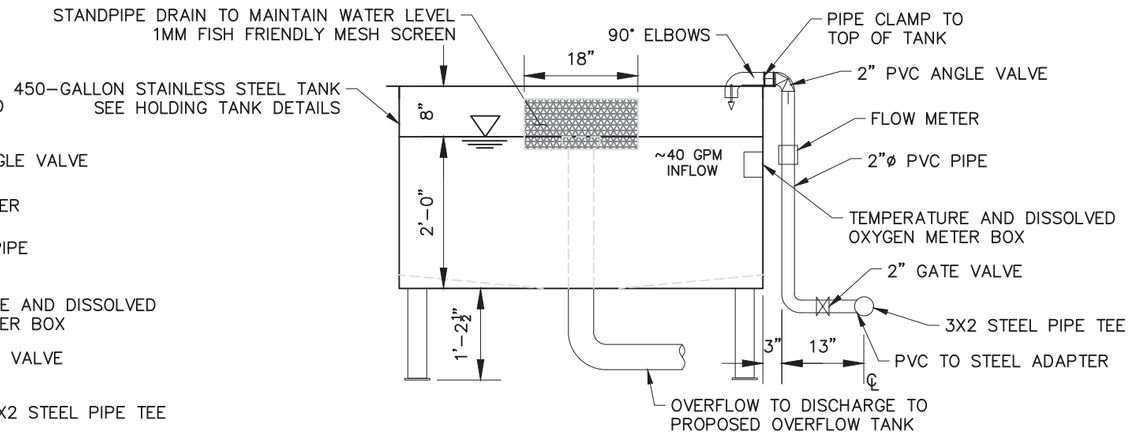
EEL FACILITY PLAN LAYOUT (FIGURE 2.2.3-1)

SCALE: AS NOTED DRAWING NO.: 13



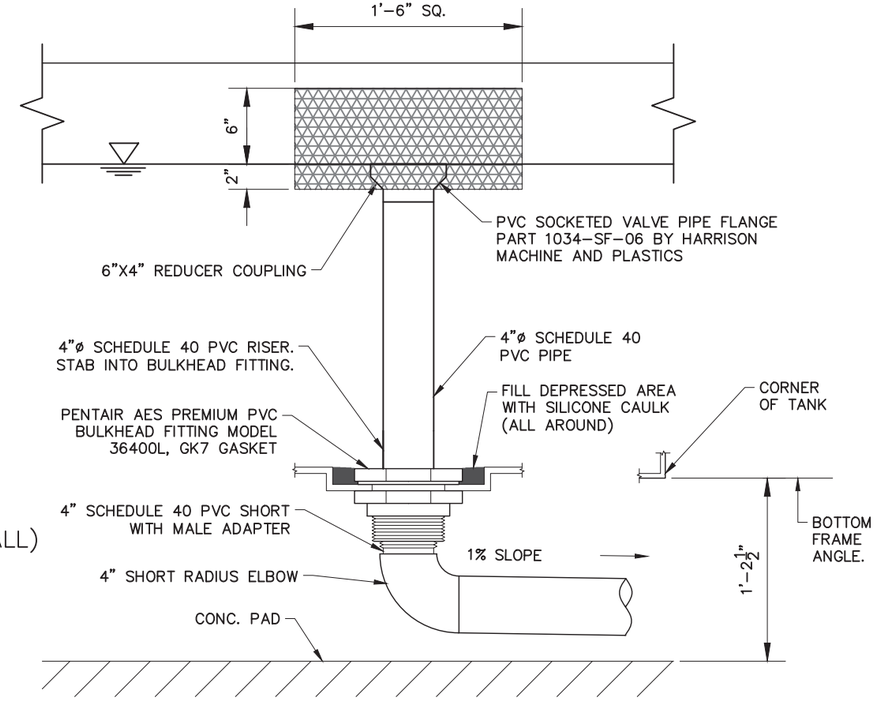
1 TYPICAL RISER DETAIL – HOLDING TANK

Scale: 1" = 1'–0"



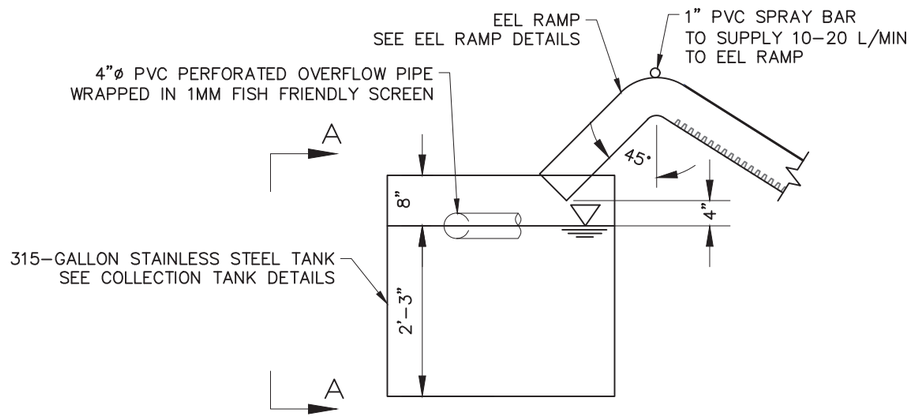
1/14 SECTION OF HOLDING TANK

1" = 1'–0" (APPROXIMATE TANK SIZE 5'6"X5'6"X2'8" TALL)



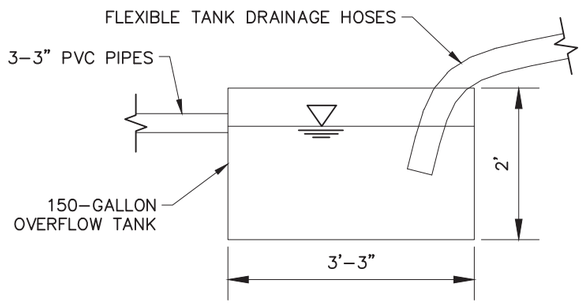
2 STANDPIPE DETAIL – HOLDING TANK

Scale: 1" = 1'–0"



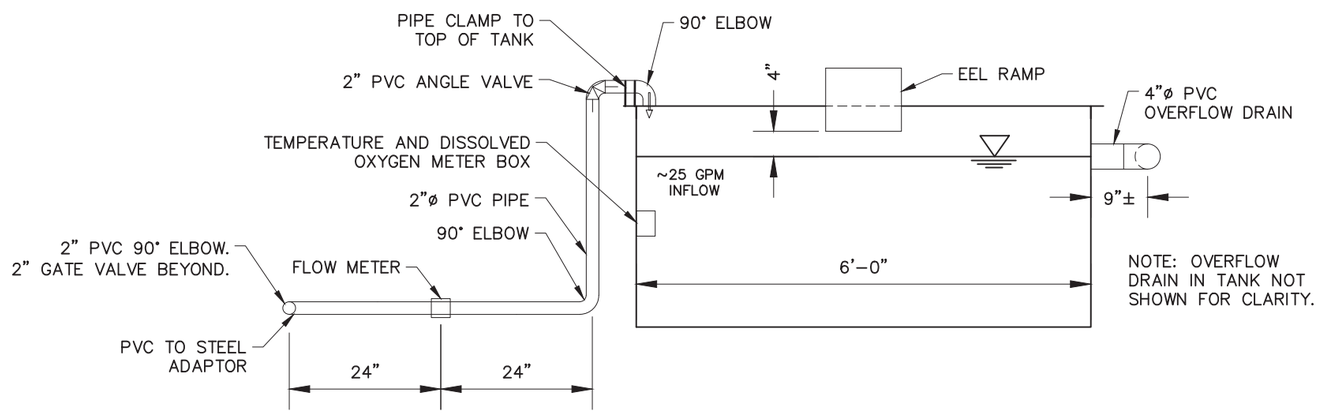
2/14 SECTION OF COLLECTION TANK

1" = 1'–0" (APPROXIMATE TANK SIZE 6'X3'4"X3'1" TALL)



3/14 SECTION OF OVERFLOW TANK

1" = 1'–0" (APPROXIMATE TANK SIZE 39"X58"X24" TALL)



A/14 ELEVATION OF COLLECTION TANK

1" = 1'–0"

NOTES

1. REFER TO SPECIFICATIONS FOR MONITORING EQUIPMENT AND CONTROL PANEL REQUIREMENTS.
2. HOLES IN TANK COVERS FOR DISSOLVED OXYGEN AND AERATION LINES TO BE DRILLED IN FIELD.
3. OPERATOR OF FACILITY TO SPECIFY LOCATION OF ALL OXYGEN TANKS, AIR BLOWERS AND ROUTING OF AIR/OXYGEN LINE.
4. ELEVATIONS SHOWN ARE CONOWINGO DATUM (0.7 FEET LOWER THAN NAGVD 29 AND 0.14 FEET HIGHER THAN NAVD88).

1' 0 1' 2'

SCALE: 1" = 1'–0"

DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG

GSE PROJECT NO.: 1714 DATE: 2/17/2017

Constellation

CONOWINGO EEL PASSAGE

GOMEZ AND SULLIVAN ENGINEERS

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TYPICAL TANK SECTIONS (FIGURE 2.2.3-2)

SCALE: AS NOTED DRAWING NO.: 14

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

3 OPERATIONAL AND ATTRACTION FLOW REQUIREMENTS

3.1 Turbine Start-Up and Operation

The Conowingo Project utilizes a limited active storage reservoir to generate during peak electricity demand periods. The Project is typically operated semi-automatically as the generation setting (in megawatt) is programmed into the control system; however, turbines are brought online 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.

During the upstream American Shad migration season (no earlier than March 1 to no later than June 15) (see Section 4.4), the Project turbine units are preferentially loaded in the following order to provide conditions to optimize fish lift attraction capability during the migratory fish passage season. Generally, the WFL is more effective with Units 1 and 2 off and during periods of minimum flow discharge, having Units 5 and 7 on works well for both the EFL and WFL. Table 3.1-1 below provides an operating order that accommodates both facilities when they are in operation. This schedule may be altered based on unit outages, operational requirements, etc. as necessary.

Table 3.1-1: Turbine Operating Order[5]

Order ON/OFF	Order in which Turbines are turned ON	Order in which Turbines are turned OFF
1st	5	1
2nd	7	2
3rd	3	4
4th	6	8
5th	10	9
6th	11	11
7th	9	10
8th	8	6
9th	4	3
10th	2	7
11th	1	5

Article 406 allows for the Conowingo Pond to fluctuate between elevation 101.2 feet and 110.2 feet, except on weekends between Memorial Day and Labor Day when Constellation is required to maintain a minimum Conowingo Pond elevation of 107.2 feet. Conowingo Pond is typically maintained at approximately 109.2 feet and is typically at least above elevation 105.2 feet to facilitate operation of the Peach Bottom Atomic Power Station.

[5] Columns show the order in which turbine units will be turned on and off. Example, if available flow dictates that four units much be turned on, then units 5,7,3 and 6 will be running. If flow increases and another unit must be turned on, then unit 10 will be started, while units 5,7,3 and 6 remain on.

The Conowingo Project has a maximum turbine discharge capacity of 86,000 cfs. When Project inflows exceed the maximum turbine capacity, all units are operated at maximum wicket gate opening and crest gate operation is used to pass the remainder of the river flow.

Usually, some combination of units are operated over a 24-hour period. The key variables are the number of units operating and the wicket gate settings during lower electrical demand hours versus in the higher electrical demand hours, when the other lower Susquehanna River hydroelectric dams are discharging their maximum flow during the peak electric loading periods. During any low-electrical demand periods, Constellation typically uses some combination of turbine units to provide the minimum flow requirements at the Project. Article 407 establishes the minimum flow regime currently required at Conowingo Dam as shown in Table 3.1-2:

Table 3.1-2: Conowingo Dam Minimum Flow Regime[6]

Date	Minimum Flow
September 15 - March 31	3,500 cfs or natural inflow, whichever is less
April 1 - 30	10,000 cfs or natural inflow, whichever is less
May 1 - June 15	7,500 cfs or natural inflow, whichever is less
June 16 - September 14	5,000 cfs or natural inflow, whichever is less

Natural inflow is measured at the Marietta United States Geological Survey gage (No. 01576000). The downstream discharge must equal these values, or the discharge measured at the Susquehanna River at the Marietta United States Geological Survey gage (No. 01576000), whichever is less.

For unplanned deviations, Constellation must file a report with FERC as soon as possible, but no later than 14 days after the onset of the incident. Each report must describe the incident, including: (1) the cause, (2) the duration and magnitude, (3) any pertinent operational and/or monitoring data, (4) a timeline of the incident and the licensee's response, (5) any environmental effects, (6) documentation that MDE and USFWS were notified and any comments received, or affirmation that no comments were received, and (7) any measures to be implemented to prevent similar incidents in the future. Copies of any such reports will be provided to MDE.

3.2 Near-field and Far-field Attraction Flows

3.2.1 Near-field Attraction Flows

3.2.1.1 West Fish Lift

The WFL will be operated with an attraction flow ranging from approximately 175 to 272 cfs.

[6] Note, the minimum flow requirements under License Article 407 as well as the monitoring method will be updated in future FOMP updates.

3.2.1.2 East Fish Lift

The EFL will be operated with an attraction flow around 300 cfs.[7]

3.2.2 Far-field Attraction Flows

As it relates to far-field attraction flows, Constellation will operate the Project according to the requirements described under Section 3.1 of this document.

[7] Modifications to the EFL to provide up to 900 cfs attraction flow will not be complete for the 2023 fish passage season.

4 WEST AND EAST FISH LIFT OPERATION

4.1 Staffing

During the 2023 fish passage facility operating season, trained and qualified individuals will be on site to operate the fish lifts. The fish lift operating crews will each include a supervising biologist, lift operator, and biological technicians. Constellation will maintain written documentation that all operational personnel have reviewed and understand this FOMP (Appendix C).

The supervising biologists and lift operators will be the individuals with primary responsibility to operate all mechanical and electrical equipment associated with the fish lifts. The lift operators will set the equipment as directed by the supervising biologist. The lift operators will adjust equipment settings throughout the course of each day as hydraulic conditions change so attraction flows from, and in, the fish lifts are optimized. Tailrace level, unit discharge, and the service unit determine the entrance gate position.

If volitional passage at the EFL were to be restarted in the future, a biological technician will identify, count, and record fish species as they pass the viewing window or are removed from the fish lift (Appendix D, Species and Operation Sheet). In addition, the biological technician will assist the supervising biologist with debris removal from screens, the trough, and other water supply areas on an as needed basis throughout the course of each day. The supervising biologists will provide supervision and technical guidance on all aspects of daily operation at the WFL and EFL and are responsible for fine tuning the operation to assure the best possible efficiency. In addition, the supervising biologist is responsible for establishing fishing time and/or lift frequency, and mobilizing transport units and personnel, which is based on fish abundance that can change throughout the day and the season. The supervising biologist will also oversee collection of all data on appropriate datasheets (Appendix D), ensure their accuracy, produce daily and weekly reports, and distribute reports to all pertinent Constellation and Resource Agency personnel.

4.2 Maintenance

Constellation's goal is to maximize fish passage facility equipment operating availability during any fish passage season. Achievement of this goal requires a comprehensive pre-season and post-season maintenance program designed to minimize in-season operational issues. Major maintenance will be completed following the spring fish passage season. Such maintenance will include correction and repair of items identified during the seasonal operation of the equipment that could affect equipment reliability. The intent is to correct such items so that pre-season activities can focus on equipment preparation, start-up and testing after equipment idle time over the winter months. In-season equipment problems will be addressed as they occur to restore operation expeditiously.

Constellation utilizes an electronic work management platform to manage maintenance tasks including tasks associated with the pre-season and post-season maintenance activities. Several tasks are set up in the work orders for pre- and post-season maintenance. Completion of activities is recorded in the work management system as well as any findings and follow-up required. Work orders are scheduled well in advance of the completion date to allow time for vendors to be on-site. Pre-season and post-season maintenance checklists from this work management platform will be submitted with the FOMP annual report described in Section 7.

4.2.1 Pre-Season Maintenance

At least three weeks prior to start-up of each fish passage season, as river and weather conditions allow, the pre-season maintenance measures shown in Appendix E will be performed.

4.2.2 Post-Season Maintenance

Prior to the onset of winter conditions, the post-season maintenance measures shown in Appendix E will be performed.

4.3 Operation

4.3.1 General

4.3.1.1 West Fish Lift

Upon arrival at the Project, the WFL operating crew will notify pertinent Station personnel of their arrival, conduct a pre-job safety briefing and inform the Station that WFL operations will commence at the specified hour. The crew prepares the site for routine operations while the lift operator contacts the control room operator to adjust the house service units for the proper attraction flow and adjusts the entrance weir gate(s) based on current Project turbine operation and fully lowers the hopper. Table 4.3.1-1 illustrates the current WFL operational matrix used to adjust the entrance weir gates.

The WFL 2023 interim trap and transport operation is scheduled to begin as early as March 1 and end no later than June 15 (see Section 4.4). If river flows are forecasted to reach 113,000 cfs, Station personnel will need to remove the crowder door and drive motors to prevent any damage to the motors during a high flow event. The motors will be reinstalled as soon as river flows recede to a safe level.

Attraction flow begins being released one hour prior to the start of daily lift operations. The hopper is lowered in position after the attraction flow begins. The WFL hopper door is located on the bottom of the hopper and is closed when the hopper is seated on the bottom of the channel. The hopper is lowered slowly when it touches the water's surface, so any fish that may be in the hopper pit can escape through the unlatched hopper door or swim around the sides of the hopper. The first lift at the WFL each day is a "clean out" lift to clear the crowder channel of any fish that may have accumulated over night in the crowder channel. Fish collected in the "clean out" lift will be identified, enumerated, and sorted. If a target species is identified and considered in good condition, they will be removed from the sorting tank and placed in a holding tank. Invasive species in the "clean out" lift, will be managed per Article 419 *Aquatic Invasive Species Management* (Appendix A). After completion of the "clean out" lift, the crowder doors are opened to the fishing or "V" position, which allows fish to enter the crowder channel and discourages them from leaving the crowder channel, the time recorded on appropriate datasheets (Appendix D), and fishing officially begins for the day. The "V" position is defined as the crowder doors being partially opened allowing fish to swim past the ends of the open crowder doors, and into the collection channel of the fish lift. During the daily operation of the WFL, the time will be recorded by the lift operator or supervising biologist whenever the crowder doors are opened or closed, and when the hopper is lifted (Appendix D, Operator's Daily Log). The hopper contents will be deposited into the sorting tank. Once the hopper is clear of the sorting tank, the crew of technicians start the sorting process, while the lift operator positions the

fishing equipment for another lift cycle. If target species or invasive species are present in the catch, they are placed in holding tanks or totes until a sufficient number are collected for transport or removed for invasive species management (Appendix A). After the target species are placed in holding tanks and all invasive species are removed and placed in totes, the remaining fish in the sorting tank are released back to the river (tailrace). If sufficient numbers of American Shad or river herring are collected prior to the scheduled end of daily operation, a transport unit will be prepped, loaded, and transported upriver to the designated stocking location.[8] The WFL will be cycled throughout the day based on the presence of target species, invasive species, or Gizzard Shad in the catch. Each lift will be sorted, with the number of species and fish recorded per lift. A minimum of two lifts per hour will be conducted based on hopper load size and time required to sort the catch. The supervising biologist will track the number of target and invasive species throughout the day (Appendix D, Species and Operation Sheet). During the last lift of the day, the crowder doors are closed and the crowder moves to the "full crowd" position and the hopper is raised. The crowder returns to the fishing position with the crowder doors remaining closed in an effort to prevent fish from entering the WFL channel overnight. The WFL does not have a screen that prevents fish from accessing the area under the hopper, which is why the crowder doors remain closed. After depositing the fish in the sorting tank, the hopper is lowered down and seated on the bottom of the channel and kept there overnight. When the hopper is on the bottom of the channel overnight, it diminishes the possibility of debris in the hopper pit area. Also, the hopper is ready for the "clean out" lift the next morning.

At the end of daily operations, the crew will secure the WFL while the supervising biologist prepares and sends the daily email report to Constellation and Resource Agency personnel. The report will include information pertaining to the number of American Shad and river herring collected and transported, the number of invasive species collected, as well as the remaining capacity of the refrigerated unit for storage of invasive species specimens (Appendix D, Daily and Weekly Fish Lift Email Template). Prior to leaving the work site, the supervising biologist will inform the Station that operations have ended for the day and the facility is secure.

4.3.1.2 East Fish Lift

The EFL 2023 interim trap and transport is scheduled to begin as early as March 1 and end no later than June 15 (see Section 4.4). If river flows are forecasted to reach 113,000 cfs, the EFL may be temporarily shut down.

Upon arrival at the Project, the EFL operating crew notifies pertinent station personnel of their arrival, conducts a pre-job safety briefing, and informs the station that EFL operations will commence at the specified hour. The supervising biologist and technicians ready the computer for each individual lift, fish sorting, and data input and open the valve to the sorting tank while the lift operator adjusts the entrance, crowder area, diffuser gate, and attraction flow gates to their proper positions based on the current water levels and Project turbine operation. Tables 4.3.1-2 and 4.3.1-3 illustrate the EFL operational matrix used when the EFL is in operation. During trap and transport operations, attraction flow begins being released one hour prior to the start of daily lift operations. During the previous day's operations, a crowder hoist screen was lowered and stayed down to prevent fish from entering the hopper pit area overnight. The next

[8] Fish may be held a maximum of two days prior to a transport during the early phase of the migration season when water temperatures are cooler. See Section 4.3.4.

morning the hopper is lowered in position after the attraction flow begins. The crowder doors are opened to the fishing or "V" position, the time recorded, and fishing officially begins for the day. Prior to a lift, the crowder doors are closed, the crowder hoist screen is raised, and crowder travels forward. When the crowder is in the full crowded position, the crowder screen is lowered, and the hopper is raised. When the hopper is rising the crowder returns to the fishing position and crowder doors are opened to the fishing or "V" position. After fish and water have been deposited. The sequence is continued until the last lift of the day, when the crowder is returned to the fishing position, the doors remain closed, and the hopper remains out of the water near the operator booth level. Invasive species will be managed per Article 419 *Aquatic Invasive Species Management* (Appendix A).

During daily trap and transport operations at the EFL, the time will be recorded by the lift operator or supervising biologist whenever the crowder doors are opened or closed, and when the hopper is lifted (Appendix D, Operator's Daily Log). The hopper contents will be deposited into the sorting tank during trap and transport operations. Once the hopper is clear of the sorting tank, the crew of technicians start the sorting process, while the lift operator positions the fishing equipment for another lift cycle. If target species or invasive species are present in the catch, they are placed in holding tanks (Figure 2.2.2-3) until a sufficient number are collected for transport or removed and placed in totes for invasive species management (Appendix A). Remaining fish are returned to the Susquehanna River.

Target species fish will be transferred in a transfer tank from holding tanks at the EFL area. Target species will be transfered to the transfer tank from the holding tanks via netting, as was done during previous trap and transport operations. Temporary stairs are on the concrete platform for the purpose of transferring the fish via the nets from the holding tanks into the transfer tank. If sufficient numbers of American Shad or river herring are collected prior to the scheduled end of daily operation, a transport unit will be prepped, loaded, and transported upriver to the designated stocking location (refer to Section 4.3.5.1 Monitoring). Fish will be transported from the EFL holding tank area to the WFL area using a transfer tank that will be hauled through the powerhouse ("turbine hall") by a forklift[9].

The EFL will be cycled throughout the day based on the presence of target species, invasive species, or Gizzard Shad in the catch. A minimum of two lifts per hour will be conducted depending upon hopper load size and time required to sort through the catch to collect target species and cull out any invasive species. Although larger hoppers will be installed with the ability to cycle within a 15-minute time frame, as part of the EFL modifications, the number of lifts conducted each hour or throughout the day will still be dependent upon hopper load size and the time required to thoroughly sort through the catch. Each lift will be sorted, with the number of species and fish recorded per lift. The supervising biologist will track the number of target and invasive species throughout the day (Appendix D, Species and Operation Sheet). During the last lift of the day, the crowder doors are closed, the crowder screen is raised, and the crowder moves to the "full crowd" position, the crowder screen is lowered to prevent fish from escaping the hopper area, and the hopper is raised. The crowder returns to the fishing position with crowder doors closed and remains this way overnight.

[9] Constellation is currently in the design phase for a railcar system to be deployed on the catwalk. Once design and construction are complete, this method for fish transport from the EFL holding tank area to the WFL area will be utilized in future years.

At the end of the day's operations, the supervising biologist prepares and sends the daily email report to Constellation and Resource Agency personnel (Appendix D, Daily and Weekly Fish Lift Email Template). The email report will include information pertaining to the number of American Shad and river herring collected and transported, the number of invasive species collected, as well as the remaining capacity of the refrigerated unit for storage of invasive species specimens.

Prior to leaving the work site, the supervising biologist will inform the Station that operations have ended for the day and the facility is secure.

4.3.2 Debris Management

4.3.2.1 West Fish Lift

Attraction water for the WFL is provided by the Project's house service units, and very little debris is encountered during WFL operations. Occasional cleaning of the picketed barrier (located in the crowder channel downstream of the hopper pit) occurs on an as needed basis to prevent disruption to the attraction water and maintain the velocity in the crowder channel. Debris is manually removed from the picketed barrier and lifted via 5-gal bucket(s) and disposed of in a dumpster on site.

4.3.2.2 East Fish Lift

Floating debris that enters/accumulates in the river level section of the EFL (generally upstream of the crowder), is sluiced through the crowder gates and exits the facility via Entrance Gate C. Sluicing debris from the EFL is conducted on an as-needed basis.

4.3.3 Fish Counts

4.3.3.1 West Fish Lift

The supervising biologist is responsible for recording the fish counts of each hopper load deposited in the sorting tank (unless fish numbers are low in a hopper, Gizzard Shad are estimated, and all other species counted) (Appendix D, Species and Operation Sheet). Per Article 412, during operation of the fish lift, the operating crew will visually quantify the fullness of each lift, for each hopper, and record it on the Operator's Daily Log (Appendix D). Hopper fullness will be quantified as 10, 25, 50, 75, or 100 percent full based on the following estimates of Gizzard Shad within each hopper:

- 10% full (1-100 Gizzard Shad)
- 25% full (101-250 Gizzard Shad)
- 50% full (251-500 Gizzard Shad)
- 75% full (501-750 Gizzard Shad)
- 100% full (751-1,000 Gizzard Shad)
- Over 100% full
    - Slight overcrowding: 1,001 – 1,200 Gizzard Shad
    - Moderate overcrowding: 1,201 - 1,499 Gizzard Shad

- Extreme overcrowding: more than 1,500 Gizzard Shad.[10]

The MDE Settlement Agreement, Section C.8, Commitments Related to Non-Licensing Issues, Hopper Fullness Measurements, also states, "If technology becomes available to do so, Constellation has agreed to implement technology to monitor the fullness of each fish lift hopper, subject to certain cost limitations." The process for visual observations and indexing will be determined in consultation with MDE.[11] Records will be maintained and shared with FERC, MDE, and USFWS, when requested.

As the biological technicians sort through the contents of each lift at the WFL, the supervisor tracks the number of target species (American Shad, river herring) on the Fish Lift Daily Count Worksheet (Appendix D), placed in holding tanks or transport units or set aside for biological information collection, records any resident or invasive fish species identified by the technicians[12], estimates the number of Gizzard Shad, and estimates hopper fullness. Gizzard Shad are estimated since they are quite common and generally comprise more than 90% of the lift's catch. Estimating Gizzard Shad also streamlines the sorting process as it would take too much time to individually count every Gizzard Shad. Other species such as White Perch (*Morone americana*) may be estimated if large numbers are collected in a lift. Once the supervisor has recorded all necessary information on datasheets (Appendix D) (see Section 4.6 for biological parameters that will be collected) and the crew has sorted all target and invasive species, the remaining catch is sluiced back to the Susquehanna River downstream of Conowingo Dam. The requirements for management of invasive species are detailed in Appendix A.

4.3.3.2 East Fish Lift

The supervising biologist is responsible for recording the fish counts of each hopper load deposited in the sorting tank (unless fish numbers are low in a hopper, Gizzard Shad are estimated, and all other species counted) (Appendix D, Species and Operation Sheet). Per Article 412, during operation of the fish lift, the operating crew will visually quantify the fullness of each lift, for each hopper and record on the Operator's Daily Log (Appendix D). Hopper fullness will be quantified as 10, 25, 50, 75, or 100 percent full based on the following estimates of Gizzard Shad within each hopper:

- 10% full (1-361 Gizzard Shad)
- 25% full (361-900 Gizzard Shad)
- 50% full (901-1,800 Gizzard Shad)
- 75% full (1,801-2,700 Gizzard Shad)
- 100% full (2,701-3,600 Gizzard Shad)
- Over 100% full

[10] The measure of "hopper fullness" is not an assessment of safe operating capacity of the WFL. The USFWS Fish Passage Engineering Design Criteria (2017) define safe passage as "the movement of fish through the zone of passage that does not result in unacceptable stress, incremental injury, or death of the fish (e.g., by turbine entrainment, impingement, and increased predation). The USFWS estimates that a maximum safe operating capacity would equate to 1,200 pounds of fish, translating into about 1,000 gizzard shad (personal communication, S. Eyler, USFWS, June 25, 2021, included in Appendix H).

[11] Consultation with MDE began April 15, 2021.

[12] FERC License Article 418 *Sturgeon Reporting* requires Constellation to report the number of Atlantic and Shortnose Sturgeon observed during the preceding calendar year. Sturgeon observed in the fish lifts or incidentally throughout the year will also be reported as part of the FOMP annual report.

- Slight overcrowding: 3,601 – 4,400 Gizzard Shad
- Moderate overcrowding: 4,401 – 5,199 Gizzard Shad
- Extreme overcrowding: more than 5,200 Gizzard Shad.

The MDE Settlement Agreement, Section C.8, Commitments Related to Non-Licensing Issues, Hopper Fullness Measurements, also states, "If technology becomes available to do so, Constellation has agreed to implement technology to monitor the fullness of each fish lift hopper, subject to certain cost limitations." The process for visual observations and indexing will be determined in consultation with MDE.[13] Records will be maintained and shared with FERC, MDE, and USFWS, when requested.

As the biological technicians sort through the contents of each lift at the EFL, the supervisor tracks the number of target species (American Shad, river herring) (Appendix D, Fish Lift Daily Count Worksheet), placed in holding tanks or transport units or set aside for biological information collection, records any resident or invasive fish species identified by the technicians, and estimates the number of Gizzard Shad, and estimates hopper fullness (per description in Section 4.3.3.1). Once the supervisor has recorded all necessary information on datasheets (Appendix D) (see Section 4.6 for biological parameters that will be collected) and the crew has sorted all target and invasive species, the remaining catch is sluiced back to the Susquehanna River downstream of Conowingo Dam. The requirements for management of invasive species are detailed in Appendix A.

4.3.4 Holding

For the purpose of this plan, "holding" refers to the retention of target species overnight in holding tanks at the fish lift facilities, prior to transport. The WFL holding facility contains three tanks (two 750-gallon tanks and one 1,000-gallon tank) and the EFL contains two tanks (EFL holding tanks are 1,000-gallon capacity). The number of tanks operating at any time will be determined by the number of target species being held at the facility. A total of 60 American Shad or 200 river herring are held in the 750-gallon holding tanks and 125 American Shad or up to 800 river herring can be held in the 1,000-gallon tanks. As water temperature approaches 21° Celsius (C) or 70° Fahrenheit (F) and above, fish numbers in the 750-gallon tanks are reduced to 50 American Shad and 150 river herring with fish numbers reduced to 100 American Shad and 600 river herring in the 1,000-gallon tank.

4.3.4.1 Monitoring

Proper operation of the WFL and EFL holding facilities will be ensured through manual monitoring of flow and water quality parameters at least three times each day between lifts and sorting activities during fish lift operations.

Water Exchange: The amount of water flowing into each operational holding tank will be checked at the start of the day and after a tank has been emptied of fish and refilled. If measured flows are not within the design parameters for flow velocity (less than or equal to 1 feet per second (fps) per tank in service), the flow will be adjusted accordingly. The water exchange rate (gallons per minute; gpm) is determined in the

[13] Consultation with MDE began April 15, 2021.

field after properly setting the circulating flow velocity and cannot be measured until operations commence in spring 2023.

Temperature: Water temperature in each operational holding tank will be monitored throughout the day as time allows between sorting and transport activities (minimum of 3 times per day).

Dissolved Oxygen: Concentration of dissolved oxygen in each operational holding tank will be monitored throughout the day as time allows between sorting and transport activities (minimum of 3 times per day). If measured concentrations are not above 5 parts per million (ppm), the oxygen delivery system will be adjusted accordingly.

Results of any inspection items that require further action will be recorded on the Anadromous Fish Holding or Transport Information Sheet (Appendix D). If the flow through the holding tanks, water temperature, or dissolved oxygen is suspected of operating outside of design parameters, immediate action will be taken to correct the issue.

4.3.4.2 Maintenance

After each holding event, the holding tank(s) that were used will be scrubbed and rinsed with river water. Target species will be removed from the holding tanks prior to scrubbing, and cleaning will be coordinated with transport so that the tanks are cleaned after fish are removed for transport.

The holding tanks will be drained and cleaned after operations at the fish lifts have ceased and all target species have been transported.

4.3.5 Transport

For the purpose of this plan, "transport" refers to movement of target species from the sorting or holding tanks to transport tanks and transport to the upstream stocking location(s).

The transport truck will be a rental truck with the driver possessing a Commercial Driver's License (CDL) license with tanker endorsement. A transport skid with a 1,300-gallon tank will be secured to the rental truck with chains and binders. The transport skid contains a pump to circulate the water in the tank. The tank contains an oxygen diffuser and an oxygen manifold connected to an oxygen bottle by a regulator. A monitor on the control panel attached to a water quality probe that displays water temperature and dissolved oxygen concentration continuously is installed in the tank. The water temperature and dissolved oxygen value is recorded every fifteen minutes during the transport trip. A generator powers the control panel and a light on the control panel informs the technician that the pump is running. No alarms are installed as the technician can clearly see the dissolved oxygen values and pump operation. An alarm for water temperature serves no purpose as water temperature cannot be controlled. The transport tanks are insulated to prevent extreme increases in temperature during transport trips.

4.3.5.1 Monitoring

Transport events will occur when the capacity of the holding tanks is approached. Fish will be transported at all water temperatures experienced during the migratory fish season. Standard operating protocol will be to conduct transport trips when 200 American Shad or 1,000 river herring have been collected. The

minimum number of fish to be transported per trip is 50 American Shad and/or 150 river herring. Fish may be held a maximum of two days prior to transport during the early phase of the migration season when water temperatures are cooler. Later in the season, as river temperature approaches 21° C (70° F) the number of fish transported will begin to be reduced to a range of 150-175 American Shad. If available, river herring numbers will be reduced accordingly. Each transport skid tank will be equipped with supplemental oxygen. The tank lid will be secured prior to transport. Monitoring data are recorded on the Anadromous Fish Holding or Transport Information form (Appendix D).

Temperature: Water temperature in the transport skid tank(s) will be monitored.

Dissolved Oxygen: Concentration of dissolved oxygen in the transport tank(s) will be monitored. If measured concentrations fall below 5 ppm, the transport crew will pull over at a safe location to quickly resolve the issue (adjust regulator and manifold pressure, hook up spare oxygen bottle, etc.).

4.3.5.2 Verification and Testing

Temperature and dissolved oxygen meters in the transport skid tanks will be tested once each week using an independent meter(s) to verify accuracy. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, then it will be re-calibrated, repaired, or replaced.

4.3.5.3 Inspection

Prior to each trip, the transport truck and associated equipment will be inspected. The initial inspection will be done before any target species are transferred to a transport tank. The tank will then be filled approximately three-quarters full, immediately prior to inspection and subsequent transfer of target species to the transport tank. The tank and all drains will be secured and examined for leaks. Water quality parameters will be checked prior to target species being added to the tank. The supplemental oxygen system will be checked to verify that it is functioning properly. A final inspection will be conducted after the target species are transferred to the transport tank. Then the transport tank will be filled completely to prevent sloshing when driving. The tank and all drains will again be examined for leaks and water quality parameters will be recorded.

Water quality data will be recorded on the Anadromous Fish Holding or Transport Information Sheet (Appendix D) during each transport trip. The transport system must pass initial inspection before any target species are transferred to the transport tank and final inspection before transport begins. If the transport system does not pass inspection, it may not be used for transport until all issues are resolved and it passes a subsequent inspection.

4.3.5.4 Maintenance

Upon return to the facility, the transport skid tank will be opened to the air until the next transport. Before the next transport, the transport skid tank will be checked to ensure it is clean and ready to be used for transporting target species upriver.

4.4 Fishing Time and Hours of Operation

The fish lifts will begin operation when river temperature reaches 48° F[14] for three consecutive days and no earlier than March 1[15] and continue until river temperatures rise above 72° F for four consecutive days but ending no earlier than June 1 and no later than June 15.

The fish lifts will operate at the following times:

1) in March, from 7 a.m. to 7 p.m.
2) in April, from 6:30 a.m. to 7.30 p.m.; and
3) in May and June from 6:00 a.m. to 8:00 p.m.

Attraction flows will be released at least one hour prior to the start of daily lift operations.

4.5 Outage Prevention and Emergency Protocols

Daily management of fish lift operations by Constellation ensures that the lifts are operated efficiently to minimize downtime and maximize the catch. Any significant problems encountered will be reported, either in daily reports and/or in the annual report issued to the Resource Agencies. Should a problem and/or failure result in an unscheduled outage of the WFL or EFL during the fish migration season, Constellation shall notify Resource Agencies of the outage electronically. Notification will occur the day the outage occurred; however, depending upon the nature of the outage Constellation may require time to evaluate the outage and develop a repair plan. Constellation's evaluation and repair plan shall be coordinated with the Resource Agencies as soon as practical.

Fish lift operations may also be affected by high river flow conditions. When river flows are expected to exceed 113,000 cfs, Constellation will take steps to secure WFL equipment to prevent potential damage. This may include removing the WFL motors, which typically takes one day to complete. Once high flows have receded, another day is required to reinstall the WFL motors. The EFL may be shut down. Upon the cessation of high river flows, Constellation will notify the Resource Agencies as soon as feasible of any damage to either the WFL or EFL that would prevent return to operation and will take steps as necessary in consultation with the Resource Agencies to correct any damage due to high flows and restore equipment to operation.

4.5.1 Contacts

For emergency purposes, a contact list with multiple emergency contacts will be developed for the Conowingo Control Room. These individuals would be responsible for responding to and/or resolving

[14] Water temperatures shall be monitored once daily at 11 a.m. at Monitoring Station 643 (Shures Landing) or some other location agreed upon by Constellation and USFWS. Monitoring will begin by March 1. Prior to the commencement of the fish passage season, Constellation will send daily emails to resource agencies providing the temperature reading for that day.

[15] Because of factors outside of the Constellation's control, safety considerations may preclude Constellation's personnel from performing duties necessary to commence fish passage measures at Conowingo by the commencement date. When such conditions arise, Constellation shall notify the USFWS and the USFWS and Constellation shall consult regarding the anticipated schedule for commencing such measures.

emergency situations at the facilities if Station personnel cannot resolve the problem. The contact list will be updated prior to each migratory fish lift season, or if personnel changes occur during the migratory season.

During fish transport, there is not an alarm system because water temperature and dissolved oxygen are monitored and recorded every fifteen minutes. If a problem arises with dissolved oxygen or the water circulation system, the crew will pull off the road at the closest safe location, determine why the problem is occurring and resolve it. If a solution cannot be quickly accomplished, the crew will stock the fish at the closest safe location to the Susquehanna River.

If a holding event is required overnight, a holding sheet is filled out with the starting water temperature, dissolved oxygen, and the number of fish in the holding tank(s) (Anadromous Fish Holding or Transport Information Sheet, Appendix D). The oxygen supply bottle is checked to ensure that enough oxygen is available to last the entire holding event (overnight). The bottle will be replaced if there is not enough oxygen to last overnight. The water circulation system is checked prior to the end of fish lift operations. The gravity feed water supply system helps ensure a constant supply of water is provided to the holding tanks when the crew is not on site. The following morning, the crew will check and record the water temperature and dissolved oxygen, drain the water down to a safe level to check for any fish mortalities, and record mortalities on the Anadromous Fish Holding or Transport Information Sheet (Appendix D). If there were enough fish held overnight to warrant a transport trip, a truck driver and technician will be scheduled to transport the fish upriver.

4.6 Monitoring

Constellation will monitor flows, water quality, project operations, fishway operations, and fish passage at the lifts and record information on datasheets included in Appendix D. Data are recorded per lift during trap and transport operations. The data are entered into a laptop computer throughout the day, as time allows. At day's end, a computer program summarizes the data and produces the daily report. These data, along with the required station operation data will be entered into a database during the fish passage season, no later than one week after collection.[16] The USFWS will have open access to that database. Other Resource Agencies will be given access, if specifically requested. Due to the short timeline for providing this information weekly, the database will be considered provisional until the final report is drafted, reviewed, and submitted. Recorded passage and operational data will include the following.

- Average daily flows at the Marietta gaging station.
- Daily water temperature and dissolved oxygen collection and reporting of readings[17] at the WFL for each day (including non-operational days) of the fish passage season[18]. Water temperatures and

[16] At the EFL after completion of the planned upgrades, this data will include thirty-minute recordings of: total flow discharging from behind the hopper; total flow discharging from the attraction water supply diffusers; water surface elevation immediately upstream from the entrance gates; and water surface elevation at the tailwater, elevation to the crest of the entrance weir gates.

[17] Dissolved oxygen readings will be provided starting when the Project's National Pollutant Discharge Elimination System permit requires annual data collection through the end of the upstream migration period.

[18] Daily water temperature will be collected at 1100 hours during the fish passage season outside of the WFL in the tailrace. A continuous water temperature and dissolved oxygen logger will be installed in the WFL near the

dissolved oxygen collected at Station 643 after May 1 will be included in the annual report in addition to the water temperatures and dissolved oxygen collected daily at the WFL during the fish passage season.

- Hourly individual turbine unit operations (on/off) and discharge.
- Hourly total discharge from the powerhouse, and through the spillway gates.
- Hourly[19] counts of all captured species at the lift (this is by lift, not the hour during trap and transport)
- Number of fish by species trapped and transported, including date, time, and location of release.
- Weekly collection of a subsample of biological information from passing adult American Shad and river herring consisting of sex ratio, spawning condition, length, weight, and age.
- Biological information will be collected from every 50th American Shad captured at each fish lift for otolith analysis.
- Any American Shad mortalities resulting from lifting, sorting, handling, or transporting at either fish lift will be retained for analysis.
- Lengths (total and fork), weights, sex and scale samples will be taken and recorded for each American Shad collected as a sacrifice or retained as a mortality. Each fish will be individually bagged, labeled, and frozen on-site for later delivery to the PFBC.
- River herring will also be sacrificed for biological information. Every 20th river herring of each species (Alewife and Blueback Herring) will be sacrificed with a maximum collection of 50 individuals per species from the Project. River herring will be processed similar to American Shad. Additionally, any river herring mortalities resulting from lifting, sorting, handling, or transporting will be retained for analysis.
- Any Maryland Department of Natural Resources (MDNR)-tagged American Shad from 2023 tailrace tagging efforts that are collected in the WFL and EFL will be transported upstream after tag data is recorded.
- Any MDNR-tagged American Shad from previous year tailrace tagging efforts that are collected in the WFL and EFL will be sacrificed for PFBC and MDNR analysis.

picketed barrier. The logger will record water temperature and dissolved oxygen every thirty minutes to be compared with Station 643 at the end of the fish passage season.

[19] During trap and transport operations, the counts will be recorded per each lift, not by the hour.

Table 4.3.1-1: WFL Operational Matrix

Station Operation	Service Unit Gate Setting		Flows (cfs)	Weir Depth below Tailrace (ft.)	Attraction Velocity (ft./sec)	Holding Channel (ft./sec)
	No. 1	No. 2				
More than 4 Small Units	35%*	75%	265	6.9	6	1
1 to 4 Small Units	35%*	35%	150	5.1	6	1
No Generation **	35%	0%	75	3.1	6	1

* Considered House Load

** Condition no longer exists during fish passage season

Table 4.3.1-2: Recommended EFL Settings when Entrance Gate A is in Operation

Turbine Units in Operation		Upstream "A" Gate Setting (%)	Diffuser A (%)	Diffuser B (%)	Crowder Area Gate (%)	Spillway Gate (%)
Small	Large					
1	0	95-Bottom	5-10	0	15-20	14
2	0	85-95	5-10	0	15-25	14
3	0	78-85	5-15	0	20-30	14
4	0	74-82	10-20	0	20-40	14
5	0	69-75	10-20	0	25-35	14
6	0	65-70	10-20	0	30-40	14
4	1	68-75	10-20	0	40	14

*Upstream "A" Gate should only be used in the large units are off, unless they are shutting down soon.
*When using Upstream "A" Gate, Diffuser "B" MUST be closed.

Table 4.3.1-3: Recommended EFL Settings when Entrance Gate C is in Operation

Turbine Units in Operation		Downstream "C" Gate Setting (%)	Diffuser A (%)	Diffuser B (%)	Crowder Area Gate (%)	Spillway Gate (%)
Small	Large					
3	1	75-80	0	40	40	14
4	0	72-78	0	40	25	14
4	1	65-74	0	20-55	25-40	14
4	2	50-55	0	40-75	25-40	14
4	3	45-50	0	35-80	30-45	14
4	4	40-50	0	40-70	25-50	14
6	1	55-60	0	30	25	14
6	2	52-57	0	45	40	14
6	3	45-50	0	50	35	14
6	4	42-47	0	50	25	14
7	3	37-47	0	50	30	14
7	4	30-40	0	50	50	14

*When using Downstream "C" Gate, Diffuser "A" should be closed, unless for additional attraction.

*When using Downstream "C" Gate, try to minimize the spill out of Downstream "B" Gate and keep flow under Upstream/Downstream Gate.

5 CONOWINGO WEST EEL COLLECTION FACILITY OPERATION

5.1 Staffing

During the eel passage facility operating season, trained and qualified individuals will operate the CWECF located on the west bank of the Susquehanna River.[20, 21] A supervising biologist will oversee operations and will be assisted by several biologists and/or biological technicians. Supervising biologists have a relevant bachelor's degree and/or a minimum of five-years' experience working at the Conowingo fish lift facilities. New technicians are first scheduled to work with experienced supervising biologist. The supervising biologist trains all biologists and biological technicians, and the FOMP requirements are included in this training. Biological technicians are always supervised.

Truck drivers have, at a minimum, Department of Transportation (DOT) driver's licenses.

Constellation also requires contractors to complete vendor safety training. Daily checks will be conducted by a crew of two trained personnel. Constellation will maintain written documentation that all operational personnel have reviewed and understand this FOMP (Appendix C).

5.2 Maintenance

5.2.1 Pre-Season Maintenance

Approximately two weeks prior to May 1, all eel passage facility components, including the eel ramp, collection, overflow, and holding tanks, as well as the associated water lines will be installed and tested (Appendix E). If any component is not in working order, appropriate action will be taken to resolve the problem.

5.2.2 Post-Season Maintenance

At the end of the eel passage season, all eel facility components will be dismantled, cleaned or stored appropriately (Appendix E). The collection, overflow, and holding tanks, as well as the water lines will be stored appropriately for the winter period.

5.3 Operation

Upon arrival at the Project, the eel passage facility operating crew notifies pertinent Station personnel of their arrival, conducts a pre-job safety briefing, informs the Station that eel passage operations will commence, and asks for a dissolved oxygen tailrace reading and if any issues have been recorded since completion of the last eel passage facility check.

[20] Operation of the CWECF is also governed by the Muddy Run Pumped Storage Station Project FERC License Articles 414-417.

[21] A temporary eel collection facility will be installed on the east side of the Susquehanna River within twelve months after the EFL modification are complete. No eel facility will be operated on the east side near Conowingo dam in 2023. Details of the east side facility will be included in updated versions of the FOMP.

The goal of the facility is to achieve maximum collections of eels while maintaining a minimum combined annual survival rate of 95% for juvenile eel during the trapping, collection, and holding processes. Additionally, the goal of the transport process is to achieve a minimum annual survival rate of 95%. Flow rates (Table 5.3-1) for the trapping, collecting, and holding processes will be the primary metric used to evaluate whether the facility is operating within design parameters. If flows are within the design parameters, then the facility would be operating properly. Additionally, continuous measurements of water temperature and dissolved oxygen as well as visual inspections during daily operation will determine that the facility is operating normally and that conditions are suitable for collecting and holding juvenile eels (Table 5.3-2). The continuous monitors are equipped with alarms that alert personnel when any of the measured parameters are not within design parameters. The proper operation of the continuous monitors and associated alarms will be verified regularly. Operation of the transport system will include continuous monitoring of water quality as shown in Table 5.3-2. When daily eel sampling is complete, the eel passage facility operating crew notifies pertinent Station personnel of any major changes to the facility and that the crew is leaving the site.

5.3.1 Trapping and Collection

For the purposes of this plan, “trapping” includes the operation of a ramp-style trap and “collection” refers to operation of the collection tank where juvenile eels are temporarily held after ascending the ramp. The CWECF is a flow-through system, and no recirculation of any water is used except for attraction flow at the entrance of the ramp.

5.3.1.1 Monitoring

Proper operation of the components will be ensured either through the continuous monitoring of water flow supplied to the ramp and collection tank with an alarm system triggered by low flows or low dissolved oxygen conditions that are not within design parameters. The water flow and water quality parameters measured by the monitoring probes will be logged in the facility control panels where data are stored and available for download.

Water Exchange: The amount of water flowing into the collection tank will be monitored continuously. If measured flow is not within the design parameters flow (5 gpm to 25 gpm (19 to 95 lpm)), a sensor will trigger an alarm that will alert the Conowingo Control Room. Also, in the event of an alarm, a notification will be sent immediately to operational personnel.

Temperature: Water temperature in the collection tank will be monitored continuously.

Dissolved Oxygen: Concentration of dissolved oxygen in each operational holding tank will be monitored continuously. If measured concentrations are not above 5 ppm, a sensor will trigger an alarm that will alert the Conowingo Control Room. Also, in the event of an alarm, notification will be sent immediately to operational personnel.

During any instance when alarms indicate or daily inspections suggest that attraction or ramp flow is not within design parameters and cannot be adjusted to operate within these parameters within 24 hours, it will be considered an emergency, and operators must follow the Emergency Response Protocols outlined in Section 5.6.

5.3.1.2 Verification and Testing

The main flow and spray bar flow will be independently measured once per week to verify that the flow meters are providing accurate measurements. If a flow meter provides measurements that differ from the design parameters, the main flow meter will be re-calibrated or replaced.

Similarly, the temperature and dissolved oxygen meter will be tested once each week using an independent meter(s) to verify that they are accurate. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, or outside the designed parameters, then it will be re-calibrated, repaired, or replaced.

The alarm systems monitoring flow rates will be tested once per week. Monitors will be tested against deliberate deviations from the design range to ensure that these deviations trigger the alarms. The Conowingo Control Room will be contacted prior to any testing of the alarms.

5.3.1.3 Inspection

The ramp, cover, substrate, attraction flow, spray bar, and ramp flow will be visually inspected daily to ensure proper operation. If any component is not functioning properly, corrections and/or repairs will be made as soon as practicable. Results of any inspection items that require further action will be recorded on the Conowingo West Eel Collection Facility Daily Field Sheet (Appendix D).

If an inspection suggests that any structure or flow component is not performing properly and no alarm has been triggered, verification of this potential deviation will be performed as described above and corrective action will be taken as soon as possible. Upon a failed inspection, inspectors will refer to Failed Inspection protocols outlined in Section 5.6..

5.3.1.4 Maintenance

The collection tank will also be drained daily to ensure all eels have been removed. Every day, after all eels have been removed, then the collection tank will be scrubbed.

Debris observed on the ramp and substrate during visual inspections will be removed at the time of the inspection. If the debris cannot be removed upon inspection for any reason, it will be removed as soon as practicable thereafter.

At the end of each sampling season, and if determined to be necessary during the season, the ramp will be cleaned. During this cleaning process the substrate will be inspected for any degradation or damage. Sections of the substrate will be replaced as necessary.

5.3.2 Holding

For the purpose of this plan, “holding” refers to the retention of eels in holding tanks at the eel-passage facility, prior to transport. The holding facility currently contains three tanks. The number of tanks operating at any time will be determined by the number of eels being held at the facility.

5.3.2.1 Monitoring

Proper operation of the holding facility will be ensured through the continuous monitoring of flow and water quality parameters by several probes and logged in the facility control panels where data are stored and available for download, weekly verification of monitors, and daily inspections. Monitoring will be recorded on the Anadromous Fish Holding or Transport Information data form (Appendix D). Monitoring devices will be equipped with alarms that sound in a daily staffed location if levels of any parameter are outside of established limits. Also, in the event of an alarm, notification will be sent immediately to operational personnel.

Water Exchange: The amount of water flowing into each operational holding tank will be monitored continuously. If measured flows are not within the design parameters flow (5 to 40 gpm (19 to 151 lpm) per tank in service), a sensor will trigger an alarm that will alert the Conowingo Control Room.

Temperature: Water temperature in each operational holding tank will be monitored continuously.

Dissolved Oxygen: Concentration of dissolved oxygen in each operational holding tank will be monitored continuously. If measured concentrations are not above 5 ppm, a sensor will trigger an alarm that will alert the Conowingo Control Room.

5.3.2.2 Verification and Testing

The flow into each holding tank will be measured once per week to verify that the flow meters are providing accurate flow measurements. If a flow meter provides measurements that differ from the design parameters, then the holding tank flow meter will be re-calibrated or replaced.

Similarly, the temperature and dissolved oxygen meters will be tested once each week using an independent meter(s) to verify that they are accurate. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, or outside the designed parameters, then it will be re-calibrated, repaired, or replaced.

Alarm systems for holding tanks will be tested once per week. Monitors of flow, temperature, and dissolved oxygen will be tested against deliberate deviations from the design ranges to ensure that these deviations trigger the alarms. The Conowingo Control Room will be contacted prior to any testing of the alarms.

5.3.2.3 Inspection

The holding tanks in use will be inspected daily to ensure proper operation. Results of any inspection items that require further action will be recorded on the Conowingo West Eel Collection Facility Daily Field Sheet (Appendix D). If the flow through the holding tanks, water temperature, or dissolved oxygen is suspected of operating outside of design parameters, investigation of this suspected deviation will be performed via verification measuring, as described above, and, if found to be operating outside of design parameters, immediate action will be taken to find a solution.

5.3.2.4 Maintenance

Every week, the holding tank(s) that were used will be scrubbed and air dried, and this cleaning will be recorded on the associated Conowingo West Eel Collection Facility Daily Field Sheet (Appendix D). Eels will be removed from the holding tanks prior to scrubbing, and every effort will be made to coordinate cleaning with transport so that the tanks are cleaned after eels are removed for transport.

The holding tanks will be drained and cleaned at the end of the trapping season, after operations at the ramp have ceased and all juvenile eels have been transported.

5.3.3 Transport

For the purpose of this plan, "transport" refers to movement of eels from holding tanks to transport tanks and transport to the upstream stocking locations.

When fewer than 150 eels are collected during a sampling event, transport will occur using aerated 19-L buckets with lids, containing the maximum amount of water to prevent sloshing, with no more than 50 eels in each bucket. When counts of juvenile eels are greater than 150 but less than 2,500 individuals, a small, enclosed transport tank (250 L) with supplemental oxygen capability will be used to transport eels to designated locations. When large loads (more than 2,500) of American Eels are transported, a custom-made transport truck and tank unit will be used to deliver eels efficiently and safely to designated stocking locations. The large transport truck has continuous monitoring.

The transport truck is a non-CDL licensed, DOT truck with a 2,498 -L two-chambered transport tank (1,249 L = 12,490 eels per compartment) permanently centered on a flat bed. Each compartment contains a micro pore oxygen diffuser and an oxygen manifold connected to an oxygen bottle by a regulator. A monitor in the cab of the truck attached to a water quality probe that reads water temperature and dissolved oxygen concentration continuously are installed in each compartment. Each compartment has a 968 mm screen drain to release water prior to eels being released to check for any mortality. A 102 mm hose is connected to the 102 mm knife valve that is flush with the floor of the tank to ensure all eels and water are flushed from the tank.

5.3.3.1 Monitoring

Transport of juvenile eels will occur at least once per week. The frequency of transport will be increased if the capacity of the holding tanks is approached or if water temperatures are above 28° C. Standard operating protocol will be to conduct two transport trips per week beginning in mid-June, with additional trips made based on eel numbers and environmental conditions. The number of juvenile eels placed in the transport tank(s) will not exceed 10 juvenile eels per liter, and each transport tank will be equipped with supplemental oxygen/aeration.[22] The tank will be fully enclosed during transport.

Temperature: Water temperature in the transport tank(s) will be monitored every fifteen minutes by reading a monitor in the cab of the truck that is attached to a water quality probe. When water temperatures begin

[22] The maximum of 10 juvenile eels per liter as well as aeration to the collection tanks are in compliance with Article 416.

to increase in late spring/early summer or eel health issues are observed, the monitoring crews are trained to make the decision to conduct daily transports to minimize holding mortalities.

Dissolved Oxygen: Concentration of dissolved oxygen in the transport tank(s) will be monitored continuously by reading a monitor in the cab of the truck that is attached to a water quality probe. If measured concentrations fall below 5 ppm, the transport crew will pull over at a safe location to quickly resolve the issue by adjusting regulator pressure, or, if necessary, hooking up a spare oxygen bottle. If these steps do not resolve the problem, the eels will be transported to and stocked at the nearest practical location.

Monitoring data will be recorded on the American Eel Transport Sheet (Appendix D).

5.3.3.2 Verification and Testing

Temperature and dissolved oxygen meters in the transport tanks will be tested once each week using an independent meter(s) to verify that they are accurate. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, then it will be re-calibrated, repaired, or replaced.

5.3.3.3 Inspection

Prior to each trip, the transport truck and associated equipment will be inspected. The initial inspection will be done before any eels are transferred to a transport tank. The tank will then be filled approximately three-quarters full, immediately prior to inspection and subsequent transfer of eels to the transport tank. All drains and tanks will be secured and examined for leaks. Water quality parameters will be recorded prior to eels being added to the tank. The supplemental oxygen system will be checked to verify that it is functioning properly. A final inspection will be conducted after the eels are transferred to the transport tank. The transport tank will be completely filled to prevent sloshing when driving. All drains and tanks will again be examined for leaks and water quality parameters will be recorded.

Water quality data will be recorded on the American Eel Transport Sheet (Appendix D). The transport system must pass initial inspection before any eels are transferred to the transport tank and final inspection before transport begins. If the transport system does not pass inspection, it may not be used for transport until all issues are resolved and it passes a subsequent inspection.

5.3.3.4 Maintenance

Upon return to the facility, the transport tank will be opened to the air until the next transport. Every week, any transport tank used since a previous cleaning will be scrubbed clean.

5.4 Fishing Time and Hours of Operation

The CWECF will operate beginning May 1 and run continuously until the mean daily water temperature is 10° C or less for three (3) consecutive days, per Article 414. Water temperature will be determined by hourly readings at Constellation's monitoring station 643. This is a longer season than given in Appendix 1, which lists the season as May 1 to September 15.

5.5 Eel Counts

Juvenile eels will be counted during each daily check upon removal from the collection tank. When small numbers of eels (fewer than 1,000) are observed in the collection tank, actual counts will be performed. Large quantities of eels will be counted volumetrically. Volumetric estimates will be performed by placing 200 mL of water in a graduated container and then placing anesthetized juvenile eels in the graduated container and filling to the 400 mL mark. These juvenile eels will be counted after placing in the graduated container for a known number in the 200 mL displacement in the container. One gallon (four liters) of water will be added into a five-gallon (19-liter) graduated bucket, the remaining eels from the collection tank will be added to the five-gallon (19-liter) bucket, and the resulting displacement of water will indicate the number of eels.[23] This process will be repeated until all juvenile eels have been removed from the collection tank. Length measurements, weight, and condition factor will be taken from a maximum of 25 eels on a bi-weekly basis. Eels will be measured to the nearest mm and weighed to the nearest 0.1 grams after being anesthetized.

All data collected will be recorded on the Conowingo West Eel Collection Facility Daily Field Sheet (Appendix D). Any dead eels will be removed, enumerated, and recorded on the Daily Field Sheet. At the CWECF, the number of eels added to a given holding tank will be recorded, and at the other facilities, the number transferred to the holding tank(s) at the CWECF will be recorded.

5.6 Outage Prevention and Emergency Protocols

The goal of the restoration program is to achieve a minimum annual survival rate of 95% for juvenile eel during collection and holding processes. If these survival rates are not met each year, Constellation will, in consultation with the Eel Passage Advisory Group (EPAG), MDE, and USFWS review the reasons that the 95% survival rates were not achieved and, if necessary, develop modifications that will be implemented prior to the start of the eel-passage program in the following year.

5.6.1 Alarms and Contacts

For emergency purposes, a contact list with multiple emergency contacts will be developed for the Conowingo Control Room. These individuals would be responsible for responding to and/or resolving emergency situations at the facilities if Station personnel cannot resolve the problem. Alarm systems, where applicable by facility, for flows, and dissolved oxygen in the collection and holding facilities will be linked to the Conowingo Control Room for immediate alarm notification. Also, in the event of an alarm, a text message will be sent to operational personnel five minutes after the Conowingo Control Room has been notified. The operational personnel will contact the Conowingo Control Room and determine the appropriate action to be taken to correct the problem.

[23] For example, if 100 eels were counted in the displaced 0.05-gallon (200-mL) graduated container, the resulting ratio would be 500 eels per 0.26 gallon (one liter). If the displacement of water in the five-gallon (19-liter) bucket is one gallon (four liters), then 2,000 eels are in the five-gallon (19-liter) bucket.

5.6.2 Failed Inspections

As indicated in the previous sections, routine inspections will be performed at the facilities. Failed inspections will be followed immediately by corrective actions if possible. If there is the potential for increased eel mortality (e.g., low flow to collection or holding tanks, high ambient river water temperatures, low dissolved oxygen concentrations), all eels in the facility will be transported to the next scheduled stocking location as soon as possible and, if necessary, the facility temporarily shut down until the issue is resolved. If there is no potential for increased eel mortality (e.g., attraction flow is not operating within design parameters), then it may not be required to temporarily shut down or immediately transport eels.

If a transport tank fails the initial inspection, no eels will be transferred to it. If eels are transferred to a transport tank that fails the final inspection, all eels must be transferred back to a holding tank unless the cause of failure can be addressed immediately, or to another transport tank if one is immediately available that has already passed initial inspection.

5.7 Reporting

Throughout the collection facilities' operational season, Constellation will email daily summaries of American Eel collection, holding, transport, and stocking to representatives from the EPAG, MDE, USFWS and any other interested Resource Agencies (Appendix D, Daily Conowingo West Eel Collection Facility Email Template).

Table 5.3-1: Design Parameters for Flow at the Eel Trapping, Collecting, and Holding Facilities

	Operation	Minimum Flow	Maximum Flow
Total Attraction Flow	Trapping	5 gpm (18.9 lpm)	145 gpm (548.9 lpm)
Collection Tank Flow	Collection	5 gpm (18.9 lpm)	25 gpm (94.6 lpm)
Holding Tank(s) Flow	Holding	5 gpm (18.9 lpm)	40 gpm (151.4 lpm)

Table 5.3-2: Water Quality Ranges for Eel Collection, Holding, and Transport

	Temperature Range	Dissolved Oxygen Range
Collection Tank	10-32° C	5 -20 ppm
Holding Tanks	10-32° C	5 -20 ppm
Transport Tanks	10-32° C	5 -20 ppm

6 TRAP AND TRANSPORT PLANS

6.1 American Shad and River Herring

FERC License Appendix 1 Section 12.4 and Department of Interior Settlement Agreement Section 3.1 require Constellation to submit to USFWS a detailed logistics plan and operating protocol for trap and transport of American Shad and river herring from both the WFL and EFL. The operating protocols as well as the design plans for American Shad and river herring trap and transport from the EFL are in development and will be incorporated into a future iteration of the FOMP. For the 2023 upstream fish passage migration season, Constellation will trap and transport American Shad and river herring from the WFL and EFL. The logistics plan and operating protocol for American Shad and river herring trap and transport from the fish lifts is included as Appendix F.

6.2 American Eel

The current FERC license for the Muddy Run Pumped Storage Project, which incorporates the terms and conditions of a water quality certification issued by PADEP, contains an American Eel Passage Plan for the CWECF. This plan, included in Appendix G, describes the general operations for American Eel from the CWECF. In addition, Section 5.3 provides a detailed description of the operational aspects of the trapping, collection, holding, and transport components of the CWECF. The EPAG, USFWS, and MDE will meet with Constellation monthly to discuss the on-going implementation of the eel trap and transport program described in Appendix F.

In addition, Article 415 of the Conowingo Project License requires Constellation to develop and submit an American Eel Passage and Restoration Plan. Specifically, Article 415 states:

> *Within six months of license issuance, the licensee must file with the Commission for approval, an eel passage and restoration plan. The plan must include:*
>
> *a) detailed plans for modifications to the East Fish Lift to specifically accommodate a temporary eel trapping facility at a location within the East Fish Lift stilling basin in the vicinity of the foot of the spillway;*
>
> *b) details regarding the annual operation and maintenance of all current and proposed eel fishways; and*
>
> *c) proposed attraction flow velocity and volume, slopes of the ramps, matting, and methods to reduce predation.*
>
> *Within 30 days of license issuance, the licensee must submit the plan to the Maryland Department of the Environment (MDE), the Pennsylvania Department of Environmental Protection (Pennsylvania DEP), the Pennsylvania Fish and Boat Commission (Pennsylvania Fish and Boat), the Susquehanna River Basin Commission (SRBC), the U.S. Fish and Wildlife Service (FWS), and the Maryland Department of Natural Resources (Maryland DNR), for review. In the event that MDE, in consultation with the Pennsylvania DEP, the Pennsylvania Fish and Boat, SRBC, FWS, or the Maryland DNR, determines that additional information, revisions, modifications, or amendments are necessary to the eel*

passage and restoration plan, then within 60 days of receipt of written notice, the licensee must submit such information, revisions or amendments to the above-listed agencies.

The licensee must 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 must 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 must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.

The plan has been developed and was filed with FERC and submitted to USFWS, MDE, and EPAG on September 16, 2021. FERC approved the plan on March 28, 2022 (Appendix H).

7 ANNUAL REPORTING

By December 31 of each year, Constellation will submit an annual report to FERC, USFWS, National Marine Fisheries Service, MDE, MDNR, PFBC, PADEP, and SRBC detailing the implementation of the FOMP, including any deviations from the FOMP, and a process to prevent those deviations in the future; any proposed modifications to the FOMP, or in the case of emergencies or project outages, the steps taken by Constellation to minimize adverse effects on fisheries including any proposed modifications to those steps to further enhance their effectiveness in the future; and operational data for the WFL, EFL, CWECF, and the Project. In December 2023, the annual report will include additional details on the interim trap and transport effort. The report will also include the data described below.[24]

7.1 West Fish Lift and East Fish Lift

1) Description of routine maintenance as well as repairs made to the fishways or eel passage facilities during the previous fish passage season.
2) Average daily flows at the Marietta gaging station.
3) Hours of daily operation (including starting and end times).
4) Daily water temperature and dissolved oxygen collection and reporting of readings[25] at the WFL for each day (including non-operational days) of the fish passage season[26]. Water temperatures and dissolved oxygen collected at Station 643 after May 1 will be included in the annual report in addition to the water temperatures and dissolved oxygen collected daily at the WFL during the fish passage season.
5) Hourly individual turbine unit operations (on/off) and discharge.
6) Hourly total discharge from the powerhouse, and through the spillway gates.
7) Hourly[27] counts of all fish species captured at the lift. (This is recorded by lift during trap and transport operations).
8) Number of fish by species trapped and transported, including date, time, and location of release.[28]
9) Biological information from passing adult American Shad and river herring will be collected and recorded per Section 4.6.
10) Invasive species data per Article 419 (Appendix A)

[24] Article 411 requires Constellation to prepare a fish kill monitoring plan for any fish kills exceeding 50 fish in Conowingo Pond and/or the project tailrace. This plan will be developed after consultation with MDNR, USFWS, and PFBC and will be filed with FERC by March 18, 2022.

[25] Dissolved oxygen readings will be provided starting when the Project's National Pollutant Discharge Elimination System permit requires annual data collection through the end of the upstream migration period.

[26] Daily water temperature will be collected at 1100 hours during the fish passage season outside of the WFL in the tailrace. A continuous water temperature and dissolved oxygen logger will be installed in the WFL near the picketed barrier. The logger will record water temperature and dissolved oxygen every thirty minutes to be compared with Station 643 at the end of the fish passage season.

[27] During trap and transport operations, the counts will be recorded per each lift, not by the hour.

[28] Article 418 also requires Constellation to file a report with FERC, MDE, and MDNR giving the number of Atlantic and Shortnose Sturgeon observed at Conowingo Dam. This report must be filed by January 31 and include all relevant data from the previous calendar year.

7.2 Conowingo West Eel Collection Facility

1) The estimated number of juvenile eels captured each day (i.e., number of eels in collection tank).
2) The number of eels in the holding tanks each day.
3) The number of mortalities observed during collection and holding.
4) The number of eels transported to each stocking location
5) Statistics (average, maximum, minimum) showing operational parameters for the main components (i.e., attraction and tank flows, water temperatures, dissolved oxygen concentrations).
6) A description of any significant problem encountered with the trapping, collecting, and holding systems including results of weekly verification efforts and any repair/maintenance actions taken.

8 ANNUAL MEETING

Constellation will meet with the USFWS and the Susquehanna River Anadromous Fish Restoration Cooperative annually to discuss this FOMP. This meeting will occur no later than January 31 each year unless Constellation and the USFWS agree on a different date. The purpose of the meeting will be to discuss the fish passage results from the previous year, review regulatory requirements for fish lift and eel passage operations, consider invasive species management, and discuss any upcoming modification or testing Constellation proposes for the upcoming fish passage season. Following this meeting, a list of aquatic invasive species will be submitted to FERC prior to the start of the next passage season.

APPENDIX A. FERC LICENSE ARTICLE 419. AQUATIC INVASIVE SPECIES MANAGEMENT

Appendix A Table of Contents

Article 419

Aquatic Invasive Species Consultation Record

Article 419

The Conowingo Hydroelectric Project No 405 Federal Energy Regulatory Commission License, issued March 19, 2021, includes the following Article regarding management of aquatic invasive species:

> *Article 419*. Aquatic Invasive Species Management. *Beginning 90 days after license issuance, the licensee must undertake the following measures for the management of aquatic invasive species:*
>
> *a) Consult annually with the Maryland Department of Natural Resources (Maryland DNR), Maryland Department of the Environment (MDE), the Pennsylvania Department of Environmental Protection (Pennsylvania DEP), Pennsylvania Fish and Boat Commission (Pennsylvania FBC), and the U.S. Fish and Wildlife Service (FWS) to identify a list of aquatic invasive species that must be monitored and file that list with the Commission prior to the start of the fish passage season.*
>
> *b) Notify the Maryland DNR, Pennsylvania DEP, Pennsylvania FBC, and FWS within 24 hours if an aquatic invasive species is captured and removed in the West Fish Lift, captured and removed in the East Fish Lift, or passed from the East Fish Lift into Conowingo Pond. Notification must include: (i) the species name and number of specimens observed or collected; (ii) the disposition of the aquatic invasive species observed or collected; (iii) the approximate size of aquatic invasive species observed or collected; (iv) the date and time of passage; and (v) the estimated flow through the Conowingo Dam at time of passage.*
>
> *c) During operation of the East Fish Lift, observe the fish lift hopper dumping into the fish exit trough. If an aquatic invasive species is viewed in the fish lift hopper or chute, the licensee must close the gate at the viewing window immediately, and institute a drawdown to remove the aquatic invasive species from the trough before releasing the remaining fish into Conowingo Pond. The licensee must also remove any aquatic invasive species that are observed while conducting fish tagging operations in the East Fish Lift trough.*
>
> *d) Remove any invasive species that are collected during the operation of the West Fish Lift.*
>
> *e) For all aquatic invasive species collected at the project, kill or dispatch the aquatic invasive species and as may be requested, place the specimen in a freezer for disposal by Maryland DNR or FWS. If freezer space at the Conowingo Project for storage of aquatic invasive species becomes limited, the licensee must notify Maryland DNR and MDE. If freezer space for storage of invasive species is not limited, the licensee, as may be requested by Maryland DNR, must send the frozen aquatic invasive species to a facility designated by Maryland DNR at the end of the fish passage season and notify*

the Maryland DNR and MDE as to the number and type of frozen aquatic invasive species sent to the designated facility.

f) If, during any upstream migratory fish season, the licensee determines that compliance with the measures set forth in paragraph (c) and (d) of this license article will materially interfere with the licensee's fish passage obligations under this license and U.S. Department of the Interior's modified section 18 prescription (Appendix 1), notify FWS, MDE, Maryland DNR, Pennsylvania DEP, and Pennsylvania FBC via email of that determination. The licensee may suspend compliance with the measures set forth in paragraph (c) and (d) of this license article for the remainder of the upstream migratory fish season, unless MDE and FWS notify the licensee within 72 hours of the licensee's initial notification that they do not concur with the licensee's determination.

g) *In any year where suspension under paragraph (f) of this license article occurs, convene a meeting no later than July 1 with MDE, Maryland DNR, FWS, Pennsylvania DEP, Pennsylvania FBC, and other state resource agencies as appropriate, to address invasive species issues for the subsequent year. The licensee, after said meeting or no later than August 31, and after consultation with said agencies, must file with the Commission, a report of proposed alternative measures for the management of invasive species, provided that said alternative measures do not significantly exceed the scope of the measures required in paragraphs (a) through (d) of this license article, and request Commission approval when necessary.*

Aquatic Invasive Species Consultation Record

CONSTELLATION ENERGY GENERATION, LLC

MUDDY RUN PUMPED STORAGE PROJECT (FERC NO. 2355)
CONOWINGO HYDROELECTRIC PROJECT (FERC NO. 405)

AQUATIC INVASIVE SPECIES & CONOWINGO EFL MEETING SUMMARY
AUGUST 10, 2022, 10:00 AM TO 12:00 PM EST

Call-in Number: Microsoft Teams Call-in 443-529-0267, passcode 3802853#

Attendee	Affiliation
Jay Campbell	Constellation
Andrea Danucalov	Constellation
Michael Utley	Constellation
Kirk Smith	Gomez and Sullivan Engineers
Matt Dunlap	Kleinschmidt Associates
Mike Hreban	Kleinschmidt Associates
Heather Nelson	Maryland Dept. of the Environment
Tony Prochaska	Maryland Dept. of Natural Resources
Bob Sadzinski	Maryland Dept. of Natural Resources
David Seaborn	Maryland Dept. of the Environment
Shawn Seaman	Maryland Dept. of Natural Resources
Steve Adams	Normandeau Associates, Inc.
Ray Bleistine	Normandeau Associates, Inc.
Mike Martinek	Normandeau Associates, Inc.
Kristen Rolison	Stantec
Clint Smith	Stantec
Heidi Wahto	Stantec
David Whitbeck	Stantec
Eleanor Wilson	Stantec
Sheila Eyler	US Fish and Wildlife Service

Introductions

Andrea Danucalov (Constellation) opened the meeting and welcomed everyone, and the meeting participants introduced themselves.

Meeting Purpose

The primary focus of this meeting was to give a brief update on the design and construction status of the West Fish Lift (WFL) and East Fish Lift (EFL) modifications. Additionally, the meeting aimed to discuss the planning and coordination activities for aquatic invasive species (AIS) management during the 2023 fish passage season.

Conowingo WFL and EFL Design and Construction Status

Bids from contractors are currently under evaluation for the WFL modifications. A contract award is expected by the end of August 2022, and construction is expected to begin in June 2023 after the fish passage season ends.

Design work related to the EFL internal modifications are currently at the 90% design phase. The EFL hopper/crowder upgrades are expected to be at the 30% design phase by March 2023. The EFL trap and transport design is expected to be at the 60% design phase by December 2023. For the zone of passage structures, the design is currently at the 60% design phase.

Aquatic Invasive Species Management

Tony Prochaska (MDNR) provided an update on recent resource agency initiatives for AIS. In late June, MDNR submitted a proposal to USFWS to receive funding to implement AIS preventive measures. Funding has been provided to Brett Towler (USGS) to conduct research at the Conte Lab to determine if aquatic stimuli can be used to deter AIS from entering fish passage facilities. The research is not specific to the Conowingo WFL and EFL but could possibly be applied to them, if the research indicates there is a viable method. MDNR is currently seeking funding to develop an AIS management plan; a decision on funding is expected in October 2022. MDNR is instituting a tagging program for AIS to encourage harvest and estimate movement of AIS. This program is expected to run from 2022-2024. The AIS removal work at Conowingo was conducted in 2022 and will continue in 2023. Sheila Eyler (USFWS) stated that USFWS is seeking general funding available through recently passed federal legislation. In addition, USFWS is developing a Northern Snakehead management plan for Chesapeake Bay, which is expected to be available in early 2023.

Andrea Danucalov reviewed Article 419 from the Conowingo license that details the AIS requirements. Andrea indicated that Constellation will soon be filing a letter detailing plans for 2023 AIS management activities at the WFL and EFL as required in Article 419. It was agreed at the meeting that Constellation will monitor and remove the following invasive species during the 2023 fish passage season: Northern Snakehead, Blue Catfish, Flathead Catfish, Silver Carp, Bighead Carp and Grass Carp.

Mike Utley (Constellation) gave a brief update on activities related to the Whooshh system, which is used to convey fish from the EFL to the west side of Conowingo as part of the trap and transport program. He said Whooshh is working on a design to implement the use of two tubes in 2023 to accommodate different sizes of American Shad. The design may incorporate a third smaller tube in the future to accommodate river herring, but Whooshh currently does not manufacture a tube of that size.

The group agreed to hold another meeting in the fall of 2022 to discuss potential longer-terms methodologies/solutions for managing AIS at the WFL and EFL.

The meeting was adjourned.

APPENDIX B. CONSTELLATION PROTOCOLS FOR OPERATION TO HELP PREVENT THE TRANSMISSION OF COVID-19

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

COVID-19
Field Safety Awareness
2/23/2022 Revision 10

We are amid a global pandemic with the coronavirus disease (COVID-19). As the pandemic comes under control in the U.S. due to vaccinations Normandeau employees will follow all current CDC guidelines. Additionally, we intended to comply with all applicable guidelines or requirements of our clients. If CDC guidelines change all staff will be notified. Upon request by a client or partner this COVID-19 Field Safety Awareness Plan will be made available.

This virus is thought to spread mainly from person-to person:

- Between people who are in close contact with one another (within about 6 feet); or
- Through respiratory droplets produced when an infected person coughs or sneezes.
- May be spread by people that are not showing symptoms.
- Maintaining good social distance (about 6 feet) is very important in preventing the spread of COVID-19

Droplets infected with COVID-19 can be transferred to people who are nearby or through ingestion, absorption, or by inhalation into the lungs. Although individuals are thought to be most contagious when they are highly symptomatic (i.e., the sickest), some spread may be possible before people show symptoms; there have been reports of this occurring with this new coronavirus.

It may be possible that a person can get COVID-19 by touching a surface or object that has the virus on it and then touching their own mouth, nose, or possibly their eyes. The virus that causes COVID-19 seems to be spread easily and sustainably in the community.

Purpose of Procedure:

Normandeau personnel working in the field on various environmental tasks studies in the United States will maintain a high standard of personal hygiene and social distancing when possible. All Normandeau field crews will follow NAI's COVID-19 Field Safety Awareness procedures, to prevent the spread of COVID-19.

Normandeau staff will follow all CDC guidelines. Staff with COVID-19 should isolate for 5 days and if they are asymptomatic or their symptoms are resolving (without fever for 24 hours), follow that by 5 days or wearing a mask when around others to minimize the risk of infecting people they encounter.

Individuals who have received their booster shots do not have to quarantine following exposure, but should wear a mask for 10 days after the exposure. For all those exposed, best practice would also include a test for SARS-CoV-2 at day 5 after exposure. If symptoms occur, staff should immediately quarantine until a negative test confirms symptom are not attributable to COVID-19.

All staff will follow client COVID policies. All staff will also follow CDC county community spread levels for face masks. The site is located here https://www.cdc.gov/coronavirus/2019-ncov/your-health/covid-by-county.html.

APPENDIX C. CONSTELLATION OPERATIONAL PERSONNEL FISHWAY OPERATIONS AND MAINTENANCE PLAN REVIEW AND UNDERSTANDING SAMPLE LETTER

Constellation

Sample Letter

[Date]

Kimberly Bose
Secretary
Federal Energy Regulatory Commission
888 First State Street, N.E.
Washington, DC 20426

Re: Constellation Energy Generation, LLC (Constellation)
Conowingo Hydroelectric Project, FERC No. P-405
Fishway Operations Maintenance Plan Notice of Operational Personnel and Manager Review and Understanding

Dear Secretary Bose:

Constellation Energy Generation, LLC (Constellation) operates the Conowingo Hydroelectric Project (Federal Energy Regulatory Commission (the Commission) Project No. 405). As required by the Federal Energy Regulatory Commission license, Article 401 and Article 413 as well as Appendix 1, Section 12.4 Constellation maintains the Conowingo Fishway Operation and Maintenance Plan, which will be updated and filed with the Commission annually. The license requires Constellation to file written documentation with the Commission stating that all fishway operation personnel have reviewed and understand the latest Fishway Operation and Maintenance Plan.

This letter confirms that all fishway operation personnel have reviewed and understand the Conowingo Hydroelectric Project Fishway Operation and Maintenance Plan dated _____.

Please contact Andrea Danucalov at andrea.danucalov@constellation.com or 267-533-1125 with any questions.

Sincerely,

Dusty McKeown
Constellation Plant Manager

Cc: Sheila Eyler, US Fish and Wildlife Service
Richard McCorkle, US Fish and Wildlife Service
Heather Nelson, Maryland Department of the Environment
Shawn Seaman, Maryland Department of Natural Resources
Scott Williamson, Pennsylvania Department of the Environment
Jeremy Miller, Pennsylvania Department of the Environment
Josh Tryninewski, Pennsylvania Fish and Boat Commission
Aaron Henning, Susquehanna River Basin Commission

APPENDIX D. EXAMPLE DATASHEETS RELATED TO FISHWAY OPERATION

Operator's Daily Log

Location (circle) EFL WFL Sheet of
Recorded by Date

Lift No.	Crowder Open Time	Crowded (Y/N)	Weir Gates Open	Crowder Closed Time	Hopper Fullness (10%, 25%, 50%, 75%, 100%)	Hopper Up Time	Units On	
							Sm	Lg

Conowingo Hydroelectric Project
FERC Project Number 405

Species and Operation Sheet

Sheet of Location (circle) EFL WFL

Date Air Temperature Water Temperature Recorded By

	Lift No.										
Operating	Set time										
	Lift time										
	WTH										
	# Sm turbines										
	# Lg turbines										
	Unit 1 on										
	Unit 2 on										
	# Spill gates										
	Hopper fullness										
Species	AMERICAN SHAD										
	ALEWIFE										
	BLUEBACK HERRING										
	GIZZARD SHAD										
	HICKORY SHAD										
	STRIPED BASS										
	WHITE PERCH										
	AMERICAN EEL										
	RAINBOW TROUT										
	BROWN TROUT										
	MUSKELLUNGE										
	CARP										
	QUILLBACK										
	WHITE SUCKER										
	S. REDHORSE										
	WHITE CATFISH										
	YELLOW BULLHEAD										
	BROWN BULLHEAD										
	CHANNEL CATFISH										
	ROCK BASS										
	REDBREAST SUNFISH										
	GREEN SUNFISH										
	PUMPKIN SEED										
	BLUEGILL										
	SMALLMOUTH BASS										
	LARGEMOUTH BASS										
	WHITE CRAPPIE										
	BLACK CRAPPIE										
	TESS. DARTER										
	YELLOW PERCH										
	WALLEYE										
	CHESAPEAKE LOGPERCH										
	N. SNAKEHEAD										
	FLATHEAD CATFISH										
	BLUE CATFISH										

Datasheet developedg by Normandeau Associates

Fish Lift Daily Count Worksheet

Location (circle) EFL WFL _____ Sheet of _____

Date _____ Subsample Size _____

Recorded by _____ Sex Ratio _____

Lift Number	Total Caught	Running Total	Recaptures	Lift Mortalities	Sacrificed	Released Not Recaptures	Into Tanks	Tank Mortalities	Released from Tank	Running Total Available for Transport

Datasheet developedg by Normandeau Associates

Anadromous Fish Holding or Transport Information

Origin Location (circle) EFL WFL Initials _____ Sheet ___ of ___

Holding or Transport (circle) Holding Transport Date _____ _____

Tank Clean (check) _____ _____

Origin _____ Destination _____

Beginning/Departure	**Ending/Arrival**
Time	Time
DO (tank)	DO (tank)
Water Temperature (tank)	Water Temperature (tank)

Species	**Species**
No. Placed in Holding/Truck Tank	No. Placed in Holding/Truck Tank
No. Died in Transit/Holding	No. Died in Transit/Holding
Holding Only	*Holding Only*
No. Released to Tailrace	No. Released to Tailrace
No. Transported	No. Transported
No. Remaining in Tank	No. Remaining in Tank

Species	**Species**
No. Placed in Holding/Truck Tank	No. Placed in Holding/Truck Tank
No. Died in Transit/Holding	No. Died in Transit/Holding
Holding Only	*Holding Only*
No. Released to Tailrace	No. Released to Tailrace
No. Transported	No. Transported
No. Remaining in Tank	No. Remaining in Tank

Transport Trip – 15 minute readings

Time	Temp (C)	DO	Time	Temp	DO	Time	Temp (C)	DO
						River		

Meter and Probe Maintenance

Probe/Meter No.	Date Services	Maintenance Items Performed	Status	By

Daily and Weekly Fish Lift Email Template

PROVISIONAL DATA SUBJECT TO REVISION

The Conowingo [West/East] Fish Lift [Daily/Weekly] report is attached.

Collection

Today ____ American Shad were collected at the [West/East] Fish Lift. The season total is now ____.

Today ____ Alewife were collected at the [West/East] Fish Lift. The season total is now ____.

Today ____ Blueback Herring were collected at the [West/East] Fish Lift. The season total is now ____.

Transport

Today ____ American Shad were transported from the [West/East] Fish Lift to _____. The season total transported is now ____.

Holding

The following fish are in holding: _____

Invasive Species Information

Today ____ Northern Snakeheads were collected at the [West/East] Fish Lift. Approximate size range: _____. Disposition: _____. The season total is now ____.

Today ____ Northern Snakeheads were passed at the [West/East] Fish Lift. Approximate time of passage: _____. Approximate size range: _____. Disposition: _____. The season total is now ____.

Today ____ Flathead Catfish were collected at the [West/East] Fish Lift. Approximate size range: _____. Disposition: _____. The season total is now ____.

Today ____ Flathead Catfish were passed at the [West/East] Fish Lift. Approximate time of passage: _____. Approximate size range: _____. Disposition: _____. The season total is now ____.

Today ____ Blue Catfish were collected at the [West/East] Fish Lift. Approximate size range: _____. Disposition: _____. The season total is now ____.

Today ____ Blue Catfish were passed at the [West/East] Fish Lift. Approximate time of passage: _____. Approximate size range: _____. Disposition: _____. The season total is now ____.

Number of full bins in the refrigerated unit: ____. Number of unfilled bins in the refrigerated unit: ____.

Approximate time when most invasive species were collected (AM/PM): _____.

Date and time of most recent invasive species collection by MDNR or agency partner: _____.

Other pertinent information that may have affected the day's operation (i.e. extreme weather conditions, exceptional equipment issues, etc.)

The next day of operations will be _____.

Note: Species and operation data collection on the Species and Operations Data Sheet will be attached to the daily emails as an Excel file. Each Saturday, the week's data will be attached to the daily email in an Excel file.

Conowingo West Eel Collection Facility Daily Field Sheet

Project Number:	Crew:
Collection Number:	Generation:
Date:	***Control Room DO reading***:
Weather:	

	Collection Tank	Holding Tank # 1	Holding Tank # 2	Holding Tank # 3	Main Flow
Time:					
Flow Meter (gpm):					
Total Flow Volume:					
Temperature (°C):					
Dissolved Oxygen (mg/L):					
In Operation:					
Cleaned (check):					

Actual Counted # of Eels:	**Volumetric Estimates**
Dead eels in collection tank #:	Actual # of eels in 200 mL:
Sacrificed #:	# of eels in 1 Liter:
Eels released into holding tank #:	Displacement of water (L):
# Eels released into tank:	Estimated # of eels:
Dead eels in tank #:	**Total estimated:**
Total # of eels in tank: (not to exceed 17,000	(total estimated equals number estimated plus eels in the 200 mL subsample)
	Estimate Check (QA) (if necessary):
	Actual:
	Estimate:
Holding Tank #:	Holding Tank #:
Total alive:	Total alive:
Dead #:	Dead #:
New total:	New total:
Comments:	

Conowingo Hydroelectric Project
FERC Project Number 405

American Eel Transport Sheet

Facility (circle) CWECF CEECF OECF	Transport Tank (circle) Large Small

Prior to transport, while in holding (H1)		Prior to transport, while in holding	
Date	Time	Date	Time
DO	Temp	DO	Temp
No. eels being held		No. eels being held	
No. dead eels in holding prior to transport		No. dead eels in holding prior to transport	
No. eels being transported		No. eels being transported	

After eels have been loaded (in tank)		Prior to releasing eels (in tank)	
Date	Time	Date	Time
DO	Temp	DO	Temp
No. eels transported			
No. of eel dead during transport			
No. eels released			

Transport Trip – 15 minute readings

Time	Temp (C)	DO	Time	Temp	DO	Time	Temp (C)	DO
						River		

Release Location			
Date	Time	Creek DO	Creek Temp

Release Locations

A – Muddy Creek Forks (York County)	Susquehanna River, continued
B – Conewago Creek, Aberdeen PA (Lancaster County)	6 – For Hunter Access (Perry County)
C – Beaver Creek, Hummelstown, PA	7 – Shikellamy State Park (Northumberland County)
Susquehanna River	8 – Route 487 (Bloomsburg, PA (Columbia County)
1 – Conowingo Pond, Conowingo Creek (Cecil County)	9 – Route 29 Bridge (Luzerne County)
2 – Lake Aldred (York/Lancaster County)	10 – Upstream of Hepburn Street Dam, Williamsport PA (Lycoming County)
3 – Lake Clarke (Lancaster County)	11 – Upstream of Grant Street Dam (Clinton County)
4 – Etters Boat Ramp, Goldboro, PA	12 – City Island (Dauphin County)
5 – West Fairview Access, Route 11/15 (Cumberland County)	

Comments:

Datasheet developed by Normandeau Associates

Daily Conowingo West Eel Collection Facility Email Template

PROVISIONAL DATA SUBJECT TO REVISION

Collection

Today ____ American Eel were collected at the Conowingo West Eel Collection Facility. The season total is now ____.

New collection tank mortalities:

Transport

Today ____ American Eel were transported to _____. The season total transported is now ____.

New transport tank mortalities: ____.

Holding

____ American Eel are in holding.

New holding tank mortalities: ____.

APPENDIX E. FISH LIFT AND EEL COLLECTION FACILITY PRE-SEASON AND POST-SEASON MAINTENANCE MEASURES

West Fish Lift Pre-Season Season Maintenance Measures

1. Inspect/repair three motors and gear boxes and prepare to install
2. Install motors and gear boxes, wire for operation
3. Install hoses for sorting tank
4. Inspect hopper drive motors and gear gases
5. Inspect electric winch used to raise down-river screen
6. Build new scaffolding for platform holding tanks
7. Set up deck and tanks needed for proper operations
8. Lubricate and test all components for proper operation
9. Install pump casing plugs and lubricate sorting tank pump
10. Open main supply valve and start-up sorting tank water supply
11. Test sprayers and install strainers for sorting tank
12. Wire WFL and invasive species trailer

West Fish Lift Post-Season Season Maintenance Measures

13. Remove three motors and gear boxes
14. Remove motors and gear boxes, wire for operation
15. Remove hoses for sorting tank
16. Remove deck and tanks needed for proper operations
17. Remove pump casing plugs and lubricate sorting tank pump
18. Shutdown sorting tank water supply
19. Remove strainers for sorting tank
20. Unwire WFL and invasive species trailer

East Fish Lift Pre-Season Maintenance Measures

1. Unwater fish trap for inspection and repair of all lower components
2. Powerwash EFL
3. Open main air supply valve and purge system
4. Inspect and repair spill gates A & B, and spill trough
5. Inspect and repair hopper through gate
6. Inspect and repair crowder and A diffuser gate
7. Check all air lines and connections
8. Lubricate all cables, sheaves and pulleys, wheels and all crowder moving parts and mating surface
9. Re-install crowder air cylinders and check operation
10. Operate and lubricate crowder doors and drive assembly check/adjust all limits and stops
11. Check/correct take-up on hose reels, lubricate as required
12. Inspect and repair B diffuser gate
13. Operate hopper dump doors and inspect for wear of seals, repair as needed
14. Lubricate all cables, sheaves, wheels and all hopper moving parts and mating surfaces
15. Check condition of hopper air hoses and connections
16. Raise hopper to sorting tank area, check all limits and stops, lubricate as needed
17. Inspect hopper check valves, grating and screening for water system
18. Re-install aluminum slide plates and hopper air cylinders
19. Check all settings on gates, racks, and screen limit and torque switches, adjust and record as found and as left settings
20. Inspect/repair all trash racks and screen doors
21. Exercise gates, screens, and racks, clean and lubricate stems and drive operations
22. Lubricate main hopper hoists, trash rack hoist, screen hoists and monorail hoists, have reading inspected
23. Exercise hand wheel operated trash racks at headworks trash gate ¼ open turn water supply valve
24. Install and test cameras
25. Reconnect water supply
26. Inspection of slope area outside of fish entrance gates for accumulation of sediment/rocks
27. Inspect Auxiliary Water System diffuser pits
28. Calibrate gate settings to match rating curves
29. Inspect/calibrate all recording instruments (e.g., water level loggers, temperature loggers, etc.)
30. Inspect and repair solenoid valves
31. Install hopper sheaves and cables
32. Inspect and repair gearbox diffuser A channel gate
33. Inspect/repair diffuser A gate
34. Inspect/repair A diffuser both gear boxes
35. Inspect/repair A spillway gate gear boxes, trans drives and auma drives
36. Inspect/repair C spillway gate gear boxes, trans drives and auma drives
37. Inspect/repair B diffuser gate
38. Inspect/repair of B diffuser both gear boxes
39. Inspect/repair of A diffuser auma drive box
40. Inspect/repair A spillway gate gear boxes, trans and auma drives
41. Inspect/repair C spillway gate gear boxes, trans and auma drives
42. Inspect/repair B diffuser auma drive box
43. Inspect/repair hopper trough inlet gate gear box
44. Inspect/repair both A diffuser gear boxes and apply new grease for operation
45. Inspect/repair both B diffuser gear boxes and apply new grease for operation
46. Inspect/repair A spillway gate trans drive, apply new grease for operation

47. Inspect/repair C spillway gate trans drive, apply new grease for operation
48. Reinstall C spillway gate gear boxes, trans drive and auma drive
49. Inspect/repair A diffuser gate auma drive
50. Inspect/repair A diffuser gate auma drive, apply new grease for operation
51. Inspect/repair B diffuser gate auma drive, apply new grease for operation
52. Inspect/repair hopper through inlet gear box, apply new grease for operation
53. Locate EFL trailer and wire-up

East Fish Lift Post-Season Maintenance Measures

1. Purge air system. Close main air valve and open all other air valves including drains
2. Lubricate all cables, sheaves, wheels and all mating surfaces
3. Check take-up on hose reels and lubricate as required
4. Inspect all air lines
5. Inspect/repair all electrical components
6. Remove crowder air cylinders
7. Lubricate all hopper cables, sheaves, wheels and all mating surfaces
8. Raise hopper to sorting tank area. Check all limits and stops
9. Operate hopper dump doors and inspect for seal wear. Replace as needed
10. Remove hopper air cylinders, aluminum slide plate and inspect hopper check valves, grating, and screening
11. Exercise gates, screens and trash rack. Clean and lubricate stems and drive operators
12. Dog trash racks and screens
13. Remove trough plugs
14. Lubricate main hopper hoist, screen hoists, trash rack hoist and monorail hoist
15. Visually inspect leakage at spillway gates and through exit gate, if excessive, install service gate and repair
16. Inspect splash guard at weir gates
17. Remove cameras and store

Conowingo West Eel Collection Facility Pre-season Set-up

1. Inspect and repair, (if necessary)

    - Ramp substrate
    - Ramp entrance for smooth transition

2. Install

    - Overflow tank
    - Additional attraction flow pipes from overflow tank
    - Shade cloth below entrance of ramp
    - Drain hoses (collection and holding)
    - Spray bar and spray bar line
    - Scent line
    - Overflow screened drain in collection tank
    - Collection tank overflow line
    - Center screened holding tank drains
    - Lexan covers on all tanks
    - Oxygen/temperature probes and associated wiring
    - Oxygen micro-pore diffusers and oxygen lines
    - Oxygen manifold and regulators
    - Oxygen bottles
    - Fine pore air stone and lines
    - Air blowers and boxes
    - Shade covering for eel facility

Other measures (Station support)

- Fill 8” supply pipe
- Open 3” water supply pipe for eel facility from 8” manifold
- Flush 3” eel facility pipe
- Bleed air from each of the tank fill lines
- Power up the control panels for monitoring
- Calibrate dissolved oxygen/temperature probes
- Calibrate flow meter monitors
- Turn on modems and webmaster
- Check alarms for each of the monitoring parameters

Conowingo West Eel Collection Facility Post-season Tear-down

1. Remove, clean, and store

    - Overflow tank
    - Additional attraction flow pipes from overflow tank
    - Shade cloth below entrance of ramp
    - Drain hoses (collection and holding)
    - Spray bar and spray bar line

- Scent line
- Overflow screened drain in collection tank
- Collection tank overflow line
- Center screened holding tank drains
- Lexan covers on all tanks
- Oxygen/temperature probes and associated wiring
- Oxygen micro-pore diffusers and oxygen lines
- Oxygen manifold and regulators
- Oxygen bottles
- Fine pore air stone and lines
- Air blowers and boxes
- Shade covering for eel facility

Other measures (Station support)

- Drain 8” supply pipe
- Drain 3” water supply pipe for eel facility from 8” manifold
- Drain water from each of the tank fill lines
- Winterize the control panels
- Power down modems and webmaster
- Disable alarms

APPENDIX F. TRAP AND TRANSPORT LOGISTICS PLAN

NORMANDEAU ASSOCIATES
Environmental Consultants

Trap and Transport Logistics Plan for Adult American Shad and River Herring at Conowingo Dam (FERC Project No. 405)

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Appendices

Appendix 1: Guidelines for the Operation of the West Fish Lift Collection Facility, Conowingo Dam

Appendix 2: Guidelines for the Operation of the East Fish Lift Collection Facility, Conowingo Dam

1.0 Introduction

On April 21, 2016, Constellation and the U.S. Department of the Interior (DOI), U.S. Fish and Wildlife Service (USFWS) reached an agreement (DOI Settlement Agreement; USFWS 2016) to improve efforts to restore American Shad and river herring to the Susquehanna River. This agreement included the Modified Prescription Fish Passage Requirements and Related Licensee Commitments as Attachment A. The Conowingo Hydroelectric Project Federal Energy Regulatory Commission (FERC) License issued March 19, 2021 (FERC, 2021) includes the Modified Prescription Fish Passage Requirements and Related Licensee Commitments as Appendix 1 (FERC License Appendix 1). Constellation will modify fish passage facilities at the Conowingo Hydroelectric Project (Project) to facilitate transport of up to 100,000 American Shad and 100,000 river herring annually to one or more locations upstream of York Haven Dam.

The number of American Shad and river herring transported annually will be approximately 80 percent of the number of each species captured in the Conowingo West Fish Lift (WFL) and East Fish Lift (EFL), up to a maximum of 100,000 of each species. Trap and transport operations will continue until Constellation can achieve a measured 85 percent upstream passage efficiency for American Shad at the Project without reliance on the trap and truck credit provided for in FERC License Appendix 1 Section 12.7.2.1.

This Logistics Plan addresses near-term operations to support the collection and transport of American Shad and river herring. Constellation will review this plan annually and update it as needed to reflect any agreed upon changes in the program. Initial construction items will begin within one year of issuance of the new FERC license. Initial construction items will require certain modifications to be able to sort and transport fish. A Fish Passage Design Team that includes Constellation and its consultants, USFWS, Maryland Department of Natural Recourses (MDNR), Maryland Department of Environment (MDE), and Pennsylvania Fish and Boat Commission (PFBC) has been engaged in the design and approval of the modifications to the WFL and EFL. Construction item logistics will be like the process used successfully in the 1990s. Modifications to the fish lifts will facilitate the sorting of target species from other species, the holding of target species sorted for transport, and the loading of transport tanks. The initial modifications may not be sufficient to sort and transport 100,000 each of American Shad and river herring, but the populations are very low, and those numbers are not available for passage at this time. Following completion of initial construction items, additional modifications to the WFL, EFL, and Zone of Passage structures will be made to further improve the process of collecting, sorting, and transporting fish and to provide the capacity to transport up to 100,000 each of American Shad and river herring. (See Section 8 for additional information.)

Due to an increase in invasive fish species (Northern Snakehead, Blue Catfish, and Flathead Catfish) observed in the Conowingo tailrace and the passage of 21 Northern Snakeheads into Conowingo Pond during the abbreviated fish passage season in 2020 (due to COVID-19), the resource agencies and Constellation instituted an interim trap and transport program. This interim program includes the operation of the WFL and EFL to sort and transport American Shad and river herring as well as the management of invasive fish per Article 419.

2.0 Background

From 1980 – 1990, target species were sorted at the WFL and transported upstream. Upon completion of the Conowingo EFL in spring 1991, both the EFL and WFL were used to collect and transport American Shad and river herring to various locations upstream. Trap and transport operations occurred at both fish lifts through 1996, resulting in the transport of 168,989 American Shad with an overall mortality rate of 1.7% (Table 2-1). During this period (and through the next several years as the progeny of transported shad returned to Conowingo Dam), the annual returns of adult American Shad to Conowingo increased dramatically (Figure 2-1). The EFL switched to volitional fish passage in 1997 because of the completion of the fish passage facilities at Holtwood and Safe Harbor Dams. Within several years of volitional passage at the four dams, the annual returns of adult American Shad to Conowingo dropped dramatically (Figure 2-2). The return to a trap and transport program is intended to reverse the steep decline in the Susquehanna American Shad run.

Transport of fish from the EFL was accomplished using specialized 750-gallon circular tanks mounted on custom-made trailer units that could be transferred across the face of the dam via the catwalk (Figure 2-3). The customized trailer units were necessary because of the narrow width of the catwalk.

Larger circular transport tank units (approximately 1,000-gallon capacity) were utilized to transport anadromous fish species from the WFL because there was no constraint for getting a larger truck and tank to the WFL (Figure 2-4). Target species were either loaded from the WFL holding tanks or directly from the sorting tank into the transport unit prior to transport upriver to pre-determined stocking locations.

3.0 Initial Phase

3.1 Interim Trap and Transport

Trap and transport operations, which began in 2021, included only the use of the Conowingo WFL to sort and transport American Shad and river herring. A transport tank and skid was manufactured and used in 2021 for the transport of American Shad and river herring from the WFL. A temporary deck was built adjacent to the sorting tank to hold two of the three holding tanks that will be used to hold anadromous fish prior to transport (Figure 3-1).

At the WFL, each lift will be sorted by technicians who will place target species in the holding tanks or directly into the transport skid if warranted. Invasive fish will be managed per Article 419 requirements. The WFL lift cycle time will be determined by the number of fish observed in each lift. If only a small number of fish are observed, the cycle time will be shortened, whereas if several anadromous or invasive fish are observed, the cycle time will be increased to allow the technicians ample time to thoroughly sort through the catch.

Hopper fullness will also be estimated for each lift per Article 412[1]. Hopper fullness is estimated based on the approximate number of Gizzard Shad, the dominant species, in the WFL and EFL as follows[2]:

West Fish Lift

- 10% full (1-100 Gizzard Shad)
- 25% full (101-250 Gizzard Shad)
- 50% full (251-500 Gizzard Shad)
- 75% full (501-750 Gizzard Shad)
- 100% full (751-1,000 Gizzard Shad)
- Over 100% full
    - Slight overcrowding: 1,001 – 1,200 Gizzard Shad
    - Moderate overcrowding: 1,201-1,499 Gizzard Shad
    - Extreme overcrowding: more than 1,500 Gizzard shad.

East Fish Lift

- 10% full (1-361 Gizzard Shad)
- 25% full (361-900 Gizzard Shad)
- 50% full (901-1,800 Gizzard Shad)
- 75% full (1,801-2,700 Gizzard Shad)
- 100% full (2,701-3,600 Gizzard Shad)
- Over 100% full
    - Slight overcrowding: 3,601 – 4,400 Gizzard Shad
    - Moderate overcrowding: 4,401 – 5,199 Gizzard Shad
    - Extreme overcrowding: more than 5,200 Gizzard shad.

Hopper fullness will be recorded on the Operator's Daily Log (Appendix 1, Attachment II).

During trap and transport operations at the EFL, the existing configuration, (one 3,300-gallon hopper, one sorting tank, etc.) will be utilized prior to the modifications listed in the FERC License Appendix 1, Section 12.6.1 (Figure 3-2). No volitional passage will take place.

[1] The measure of "hopper fullness" is not an assessment of safe operating capacity of the WFL. The USFWS estimates that a maximum safe operating capacity would equate to 1,200 pounds of fish, translating into about 1,000 gizzard shad.

[2] Note, the ranges of fish associated with each hopper fullness estimate overlap as the Gizzard Shad can vary substantially in size.

The catch data from the EFL and WFL will be reported by lift, and will include the following: time of lift, species and number of fish per species (including invasive species, per Article 419), and hopper fullness (per Article 412).

At day's end, the supervising biologist will email a daily summary report containing the following provisional information:

- Target species information
    - number of anadromous fish collected, transported, and in holding,
    - updated season total number of each target species,
- Invasive species information
    - number and type of invasive species name and number of specimens observed or collected,
    - disposition of invasive species observed or collected
    - approximate size of invasive species observed or collected
    - time of passage, if applicable
    - estimated flow-through the Conowingo Dam at time of passage
    - status of refrigerated storage unit
- and any other pertinent information.

Up to four trucks and transport skids will be used to transport fish upstream from the fish lifts. Each transport skid will include the following equipment: a transport tank (approximately 1,300-gallon capacity), an electric water circulation pump, a dissolved oxygen (DO) injection system, and a DO/temperature monitor (Figure 3-3).

During the future upgrade phase of trap and transport, new sorting and holding tanks along with the new platforms for fish loading, and appurtenant facilities will be designed, manufactured, and procured. Designs and specifications for all new trap and transport equipment will be developed in consultation with the USFWS and submitted to the USFWS and FERC for approval as stated in FERC License Appendix 1, Section 12.5.5.

4.0 WFL and EFL Operations

4.1 Lift Operation (date and times)

The fish lifts will begin operation when river temperature reaches 48° F[3] for three consecutive days and no earlier than March 1[4], until river temperatures rise above 72° F for four consecutive days, but ending no earlier than June 1 and no later than June 15.

The fish lifts will operate at the following times:

1) in March, from 7 a.m. to 7 p.m.;
2) in April, from 6:30 a.m. to 7.30 p.m.; and
3) in May and June from 6:00 a.m. to 8:00 p.m.

Attraction flows will be released at least one hour prior to the start of daily lift operations.

The last lift of the day will occur thirty minutes prior to the scheduled end time to better ensure that adequate daylight exists for safe and accurate sorting or loading of fish into transport units (if fish numbers warrant a late-night transport). Safe operations are the highest priority when conducting fish passage operations and will not be compromised at any time.

In the case of severe weather conditions, safety considerations may preclude Constellation's personnel from performing duties necessary to commence fish passage measures at Conowingo by the commencement date. When such conditions arise, the USFWS and MDE shall be notified, as well as other resource agencies, and the USFWS and Constellation shall consult regarding the anticipated/modified schedule for commencing fish passage operations.

4.2 Collection of Biological Information and Fish Counts

Per FERC License Appendix 1, Section 12.4, a weekly collection of biological information from a sample of American Shad and river herring will be completed. Data to be collected include the following: sex ratio (male: female), spawning condition (green/ripe), length and weight, and scale and otolith samples for age determination. The age structures, along with the corresponding length, weight, and sex data will be provided to the PFBC to assist them with meeting their annual obligations for the Atlantic States Marine Fisheries Commission.

Enumeration of fish by species will occur for each lift deposited in the sorting tank. When sorting, the Supervising Biologist will be responsible for recording and identifying the number of fish by species. Gizzard Shad numbers, unless observed in low numbers for a specific lift, will be estimated with most of the other species individually counted by the sorting technicians.

Every effort will be made to avoid trapping a population unrepresentative of the migrating population. Weekly assessment of sex ratio will assist those conducting the operation as to what portion of the

[3] Water temperatures shall be monitored once daily at 11 a.m. at Monitoring Station 643 (Shures Landing) or some other location agreed upon by Constellation and USFWS.

[4] Because of factors outside of the Constellation's control, safety considerations may preclude Constellation's personnel from performing duties necessary to commence fish passage measures at Conowingo by the commencement date. When such conditions arise, Constellation shall notify the USFWS and the USFWS and Constellation shall consult regarding the anticipated schedule for commencing such measures.

"run" is male versus female throughout the season. It is a common occurrence to have a higher proportion of males arrive early in the migration season, with a larger proportion of females arriving later.

4.3 Selection of Target Species for Transport

The sole purpose of the trap and transport program is to transport as many pre-spawned American Shad and river herring as possible upstream safely and expeditiously of the dams to facilitate ready access to suitable spawning habitat. This program is the best means to improve the Susquehanna River populations. In any given year, up to 100,000 shad and herring, if available, will be transported upriver.

When sorting fish, the technicians will conduct a quick visual screening to ascertain if each target fish collected is suitable for transport upriver. Fish that are in post-spawn condition (e.g., thin/emaciated, significant scale loss), or those with severe cuts or bruises will not be transported upriver but may be used for collection of biological information or returned to the Conowingo tailrace. Every effort will be made to transport as many healthy fish as possible upriver to meet the target numbers stated in the FERC License, Appendix 1.

5.0 Monitoring During Holding and Transport Operations

5.1 Holding Facility

The minimum number of fish to be transported per trip is 50 American Shad and/or 150 river herring. Until enough American Shad or river herring are collected on any given day to warrant a transport event, they will be held in circular holding tanks continually supplied with river water. An aeration system utilizing bottled oxygen will supplement ambient DO conditions as needed. Each holding tank will be fitted with a cover to prevent escape, reduce solar gain, and to reduce stress.

American Shad and river herring will be held a maximum of two days before a transport occurs. During a holding event, DO and water temperature will be routinely monitored and recorded to ensure suitable water quality throughout the day. At the end of the day if enough fish have not been collected to warrant transport, the fish will be held overnight. A full bottle of oxygen will be placed in service, the regulator adjusted for adequate oxygen disbursement, and a final DO and water temperature value recorded on the holding event data sheet prior to the end of operations. The circulating water velocity in the holding tanks will be checked on a regular basis throughout the season to assure that velocity is adequate for fish to orient into and to be sure that fish are not over exercised by high velocity. The holding tanks in use will be inspected throughout the day to ensure proper operation.

5.2 Transport Tank Skids

Prior to each trip, the transport truck and associated equipment will be inspected. The initial inspection will be done before any target species are transferred to a transport tank. Prior to fish being loaded from a holding or sorting tank into the transport tank, the transport tank will be filled with river water to a specified level. The tank and all drains will be secured and examined for leaks. Oxygen will also be supplied simultaneously to ensure that the amount of DO in the transport tank is at saturation. A final inspection will be conducted after the target species are transferred to the

transport tank. Then the transport tank will be filled to prevent sloshing when driving. The tank and all drains will again be examined for leaks and water quality parameters will be recorded. The tank lid will be closed and secured prior to transport.

Water temperature and DO values are monitored continuously and will be recorded every 15 minutes during the transport trip. The water temperature and DO reading will be collected and recorded at the fish release location prior to fish release. Appropriate flow is indicated by an indicator light on the control panel.

Prior to the start of transport operations, each transport unit will be filled to capacity with water, the water circulation pump turned on, and the entire unit checked for leaks, loose hose connections, etc. The velocity of the circulating water will be checked and adjusted to verify that the velocity is within the range of approximately 0.5 to 1.0 feet per second. Velocity measurements in each transport unit will be checked and recorded on a regular basis unless a unit has not been in service for several days or weeks. In that case, the transport unit will be checked prior to its initial transport after preseason calibration.

Transport events will occur when the capacity of the holding tanks is approached. Standard operating protocol will be to conduct transport trips when 200 American Shad or 1,000 river herring have been collected. The minimum number of fish to be transported per trip is 50 American Shad and/or 150 river herring. Fish may be held a maximum of two days prior to a transport during the early phase of the migration season when water temperatures are cooler. Later in the season, as river temperature approaches 21°C (70°F) the number of fish transported will begin to be reduced to a range of 150-175 American Shad. If available, river herring numbers will be reduced accordingly. Each transport skid tank will be equipped with supplemental oxygen/aeration. The tank lid will be secured prior to transport.

6.0 Data Collection/Reporting

Operational and environmental conditions and holding/transport numbers will be collected on a daily, weekly, and seasonal basis as appropriate.

Data to be recorded includes:

- Species counts per lift at each facility when the lift is operated in sorting mode.
- Number of American Shad and river herring collected, held, transported, sacrificed for biological information, or released back to river per day at each facility
- Biological information from a subsample of passing American shad and river herring, collected weekly and including sex ratio, spawning condition, length, weight, and age.
- Number of mortalities during holding events
- Number of mortalities during transport events
- Generation status of station turbines (on/off) and generation changes observed during fish lift operations

- Ambient river temperature and DO
- Qualitative description of weather conditions
- Equipment malfunctions or maintenance issues

All fish sorted or transported by each fish lift, including diadromous and resident species will be counted or estimated during the upstream anadromous fish passage season. A quality control check of data will be conducted each evening. After data verification is completed each day, a daily summary of fish lift operations per facility will be produced. The daily report will include the total number of migratory fish held overnight or transported upriver, hours of fishway operation, and documentation of any fish lift operation issues. Constellation will provide daily and weekly updates to the resource agencies that summarize fish lift operations. Constellation will also keep the resource agencies apprised of any modifications or interruptions to fish lift operations if they occur. A long–term data base will be created to incorporate Conowingo Station Data with fish lift data as specified in the FERC License Appendix 1, Section 12.4. USWFS and MDE will have full access to this database, as well as other resource agencies upon request.

Constellation shall provide the resource agencies with annual fish lift reports that will be part of the overall Fishway Operation and Maintenance Plan due by December 31 of each year. The annual report shall include summary information of the data listed above as well as the specific items listed in FERC License Appendix 1, Section 12.4.

7.0 Program Expansion Potential

For the 9-year period 2012 through 2020, the total number of American Shad collected or passed by both the EFL and WFL has ranged from 23,629 (in 2012) to 5,177 (in 2019) (Table 7-1). At the EFL in years 2012, 2013, and 2017, 1,000 or more shad were caught on four days of operation each season, dropping to three days of 1,000 or more shad in years 2014, 2015, and 2016. Based on these observations, Constellation will supply up to four transport units initially to transport the number of anadromous fish anticipated during the early stages of the trap and transport program for the EFL and WFL combined. If the population grows, the program will have the ability to expand simply by adding additional transport units. Annual internal reviews of the program will be conducted to improve overall success. Any modifications will be discussed with the resource agencies prior to, or during, the annual meeting to gain approval for the proposed adjustments to the program.

8.0 Initial Construction Items

The initial construction phase comprises primarily additional modifications to the facilities to better handle larger numbers of American Shad and river herring. Modifications will take place within three years of license issuance are described in the FERC License Appendix 1, Section 12.6.1 as follows:

> ***12.6.1 Initial Construction Items***
>
> *East Fish Lift Modifications*
> *The Licensee shall modify the EFL facility to provide 900 cfs attraction flow to the EFL. Modifications to the EFL facility will include replacing spillway gates A & B, replacing the crowder system, addressing structural vibration issues, replacing diffuser gates A*

and B, replacing the control system, and upgrading the electrical system to allow for a 15-minute lift cycle.

Replace the current 3,300-gallon hopper with two 6,500-gallon hoppers at the EFL
The Licensee shall remove the current hopper and install two 6,500-gallon hoppers within the existing superstructure of the EFL. One hopper will replace the current 3,300- gallon hopper and the second hopper will be located immediately upstream from the current location of the existing EFL hopper (see Figure 10). Access to both hoppers will be provided by the current entrance gates (A, B, and C) and the hoppers will share the same holding pool.

Trap and Transport Facilities at the EFL
The Licensee shall reduce cycle time at each hopper at the EFL to be able to lift fish four times per hour and complete modifications to the EFL structure to allow for trapping and sorting fish at the EFL facility and transporting them to the western side of the dam to a truck for transport upstream. Modifications to the EFL shall include two new sorting tanks; a loading tank; and a hy-rail truck and forklift, or functionally similar equipment, to facilitate movement of American shad from sorting tanks at the EFL to the west shore. These improvements shall be accomplished without losing a season of the passage provided by the EFL.

Trap and Transport Facilities at the WFL
WFL modifications shall be made to facilitate trap and transport including: decreasing lift cycle time by replacing the crowder linkage system and raising the elevation of the sorting tank(s), and providing a mechanism to allow for direct sluicing of fish into tanks mounted on the transport vehicle. These initial improvements shall be accomplished without losing a season of the passage provided by the EFL or trap and transport from the WFL.

Provide a Zone of Passage (ZOP) to the Fish Passage Facilities
The Licensee shall construct and maintain structures, to provide American shad and river herring a ZOP (i.e., route of passage) as described in this section.

In advance of any ZOP development and/or construction, the Service and Licensee will review CFD modeling results from the tailrace. The Licensee shall run the model under a predetermined number of structures arrangements (e.g., different angles, different spacing between the weirs, different weir slopes). In consultation with the Service, the Licensee shall choose to construct the configuration of structures that provides the most conducive hydraulic conditions for fish passage of river herring. The area to be considered for potential ZOP improvements includes approximately 2,500 feet on the west bank and 3,500 feet on the east side of Rowland Island. Based on CFD modeling results that analyze discharge velocities and turbulence, the Licensee shall provide stone weirs, and/or other suitable alternatives or measures that provide a contiguous zone of passage (ZOP) from the southern tip of Rowland Island to one or both of the lifts. The Licensee shall install up to ten stone weirs, with the option of considering other configurations for structures, so long as the total cost does not exceed the cost estimated for up to ten weirs. Model results will guide the placement and formation of these structures to provide for the hydraulic conditions necessary for the weakest

> *swimmers (river herring) to reach the lifts. Specifically, the ZOP must be designed to maintain instantaneous velocities below 3 feet per second, separated only by brief regions of higher velocity that river herring may traverse in seconds at burst speeds up to 6 feet per second, over the full range of operational flows for the EFL, and in all generation scenarios.*
>
> *After ZOP construction is completed, the Licensee shall assess the ZOP for upstream migrating river herring under the full range of the current fish passage design flows (i.e., up to 113,000 cfs of river flow).*

Five years after issuance of the FERC License, Constellation will be required to begin initial upstream passage efficiency tests[5] per FERC License Appendix 1, Section 12.7.2. A post-modification efficiency test will begin in the first fish passage season immediately following any future required physical or operational modification implemented to approve attraction efficiency. A periodic efficiency test will be conducted every fifth year after a previous efficiency study determines that the adjusted efficiency of the project is achieving 85 percent passage efficiency for American Shad.[6]

In the fourth year after license issuance, Constellation will work with USFWS and other resource agencies to develop a one-year study to estimate the mortality of fish that are trapped and transported to areas upstream of York Haven Dam. This study will include assessment of immediate mortality (mortality occurring during transport) as well as delayed mortality (mortality occurring during some time period after release).

9.0 Trap and Transport Program Safety Protocols

All Constellation safety protocols will be followed during the construction phase that will modify both the EFL and WFL for conducting trap and transport activities. Procedures and guidelines for conducting all aspects of the program, (collection, holding, and transport of target fish species and invasive species) will be reviewed before and during facility operations to ensure that all work is being conducted as efficiently and safely (Appendices 1 and 2). Any issues that arise will be dealt with and resolved as soon as possible to minimize any delays or impacts to the trap and transport program.

10.0 Literature Cited

United States Fish and Wildlife Service. 2016. Decision Document and Modified Prescription for Fishways Pursuant to Section 18 of the Federal Power Act. United States Department of Interior. Federal Energy Regulatory Commission. 6/7/2016.

[5] The Conowingo Fishway Effectiveness Monitoring Plan will provide details on efficiency testing and determining of mortality rates during trap and transport. This plan will be filed with FERC in September 2021.
[6] Early Periodic Efficiency Tests may be delayed by up to two years to coincide with the schedule for tests at Muddy Run agreed upon in the 2015 Settlement Agreement between the Service and the Licensee.

Table 2-1: Conowingo Trap and Transport Mortality Rates (1991-1996)

Year	Conowingo WFL			Conowingo EFL			Mixed WFL & EFL			Overall Mortality
	# Transported	# Mortalities	% Mortality	# Transported	# Mortalities	% Mortality	# Transported	# Mortalities	% Mortality	Percentage
1991	10,183	117	1.1	9,738	335	3.4	3,861	172	4.4	2.6
1992	4,586	151	3.3	7,543	866	11.5	3,635	202	5.6	7.7
1993	3,973	112	2.8	6,983	518	7.4	215	13	6.0	5.8
1994	4,062	7	0.2	23,186	93	0.4	1,433	22	1.5	0.4
1995	12,212	53	0.4	37,648	137	0.4	5,906	33	0.6	0.4
1996	9,361	30	0.3	22,923	84	0.4	1,541	1	0	0.3
Total										**1.79**

Transport Mortality from EFL higher during the first three years due to design issues with customized trailer transport units.
During the "debugging process", transport issues were addressed and resolved.
Information derived from SRAFRC annual reports 1991-1996.

Table 7-1: Lift counts of American Shad and River Herring at the Conowingo EFL & WFL (2012-2020)

Year	Passed at Conowingo EFL		Collected at Conowingo WFL		Combined EFL and WFL	
	American Shad	River Herring	American Shad	River Herring	American Shad	River Herring
2012	22,143	52	1486	7	23,629	59
2013	12,733	7	2,030	2	14,763	9
2014	10,425	136	513	246	10,938	382
2015	8,341	13	875	46	9,216	59
2016	14,276	34	861	34	15,137	68
2017	16,265	65	736	5	17,001	70
2018	6,992	60	465	27	7,457	87
2019	4,787	15	390	13	5,177	28
2020	485	1	No Operation	0	485	1

Figure 2-1: American Shad Collections at Conowingo Dam, 1985 - 2001.

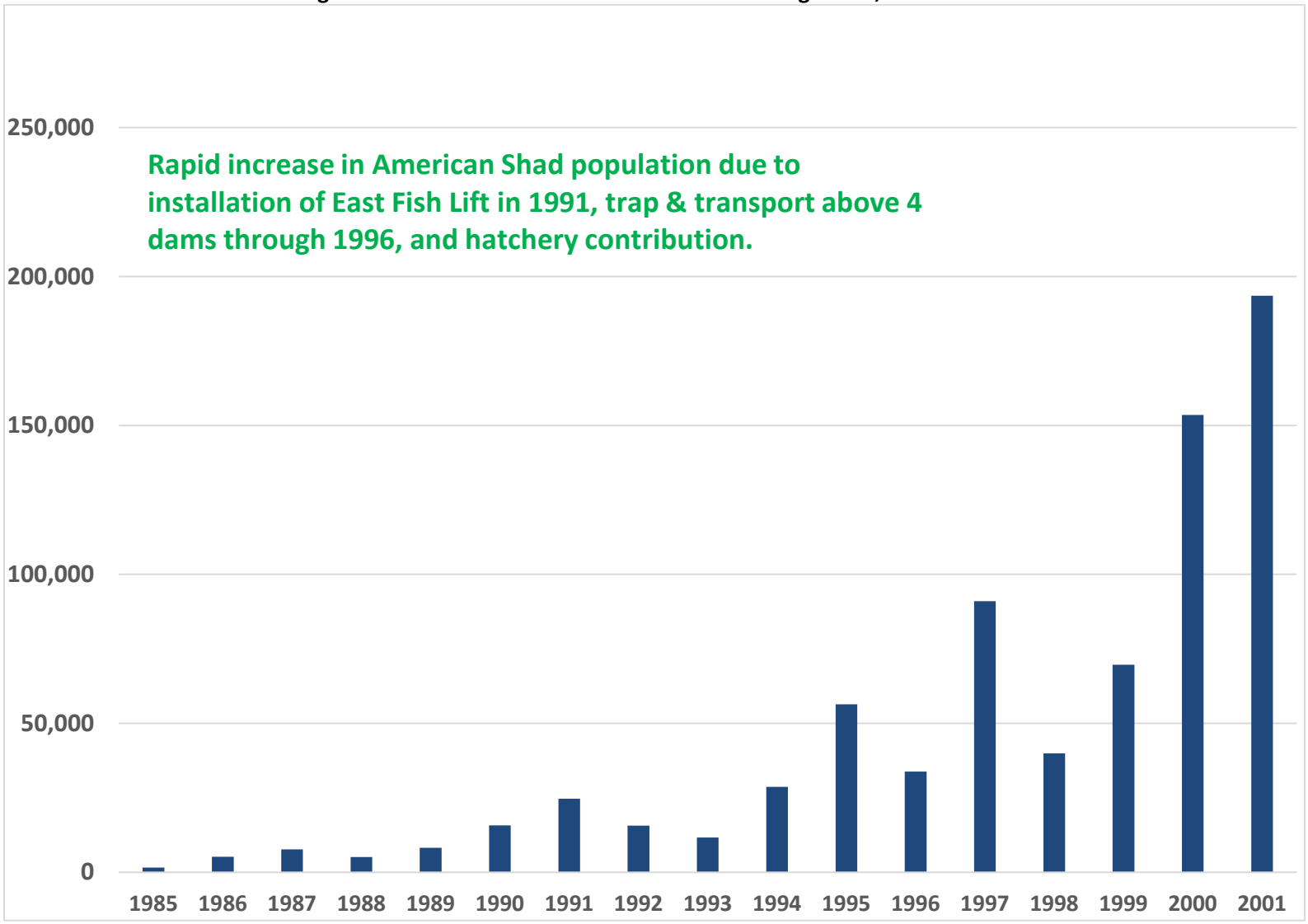


Figure 2-2. American Shad Collections at Conowingo Dam, 2002 - 2020.

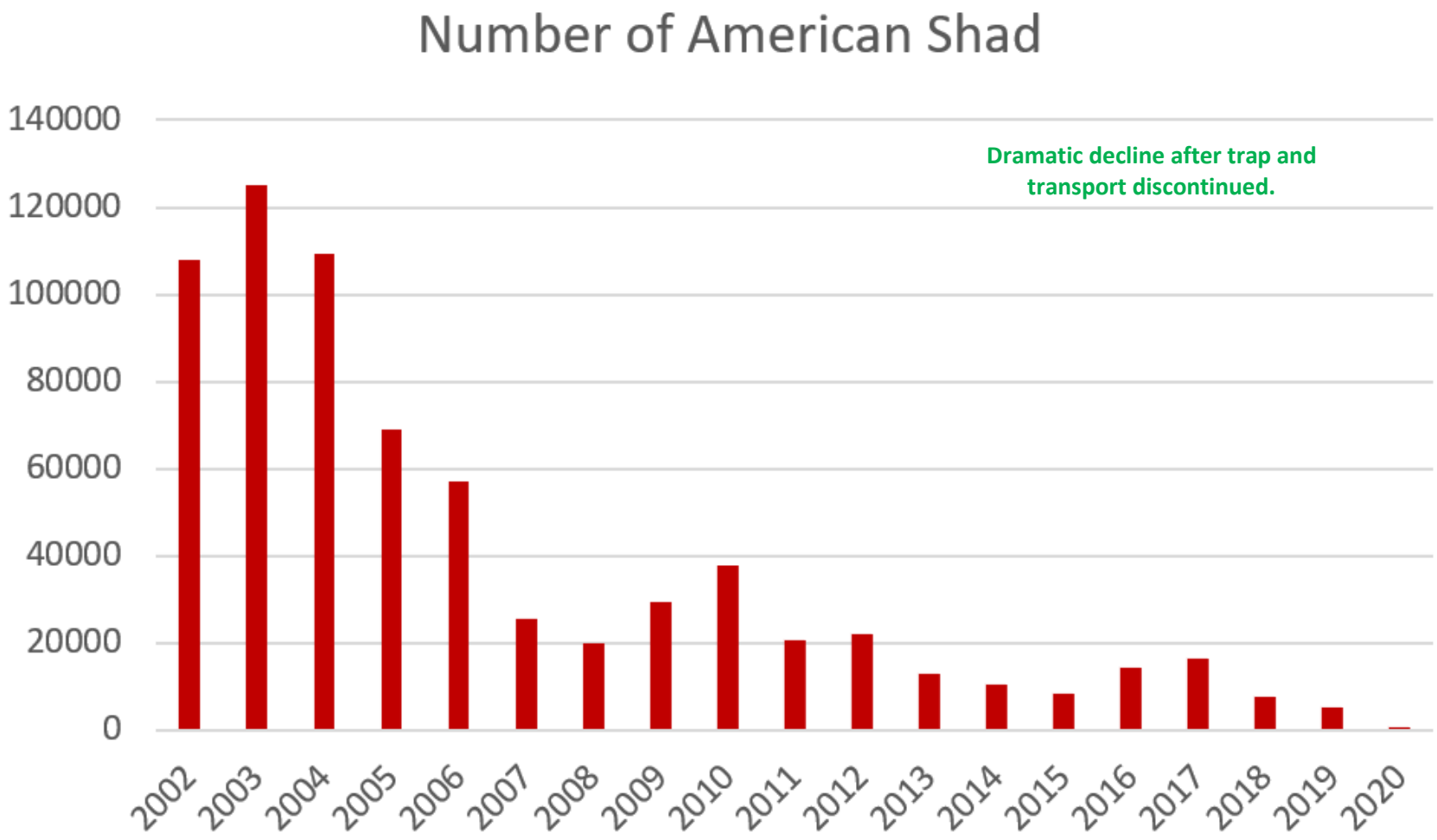
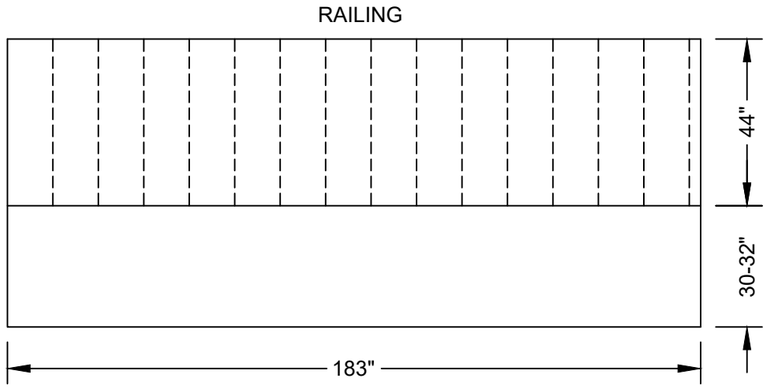
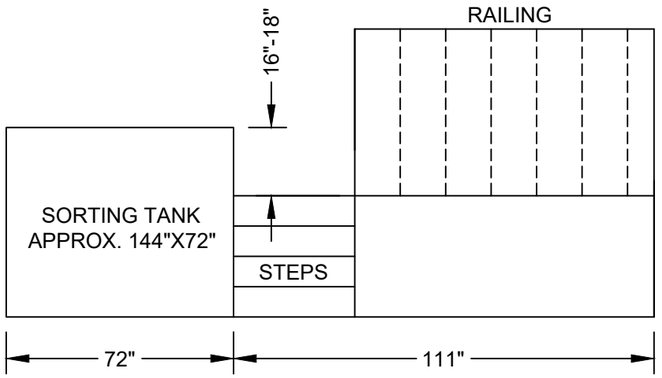


Figure 2-3: East Fish Lift Transport Unit, 1991-1996

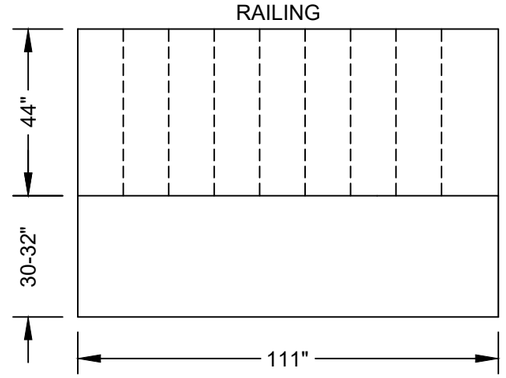
Figure 2-4: West Fish Lift Transport Unit, 1980-1999



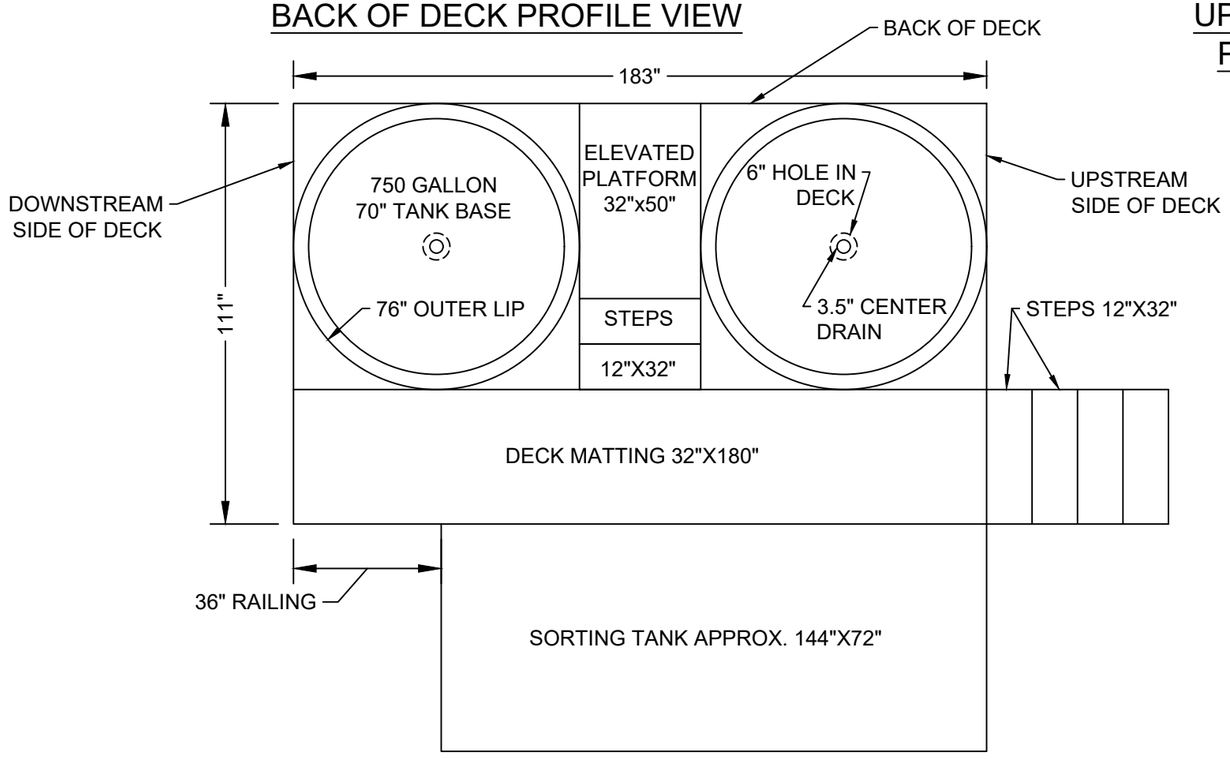
BACK OF DECK PROFILE VIEW



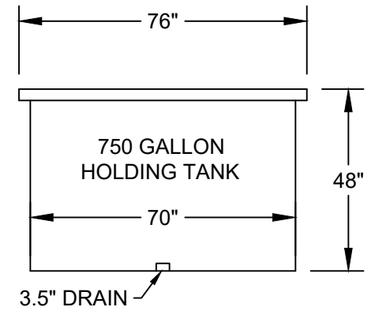
UPSTREAM DECK PROFILE VIEW



DOWNSTREAM DECK PROFILE VIEW



PLAN VIEW



TANK PROFILE VIEW

Constellation.

CONOWINGO HYDROELECTRIC PROJECT
INTERIM WEST FISH LIFT TRAP AND TRANSPORT OPERATION

DATE	#		BY	APP

GOMEZ AND SULLIVAN ENGINEERS

Williamsville, NY. Utica, NY. Albany, NY. Henniker, NH
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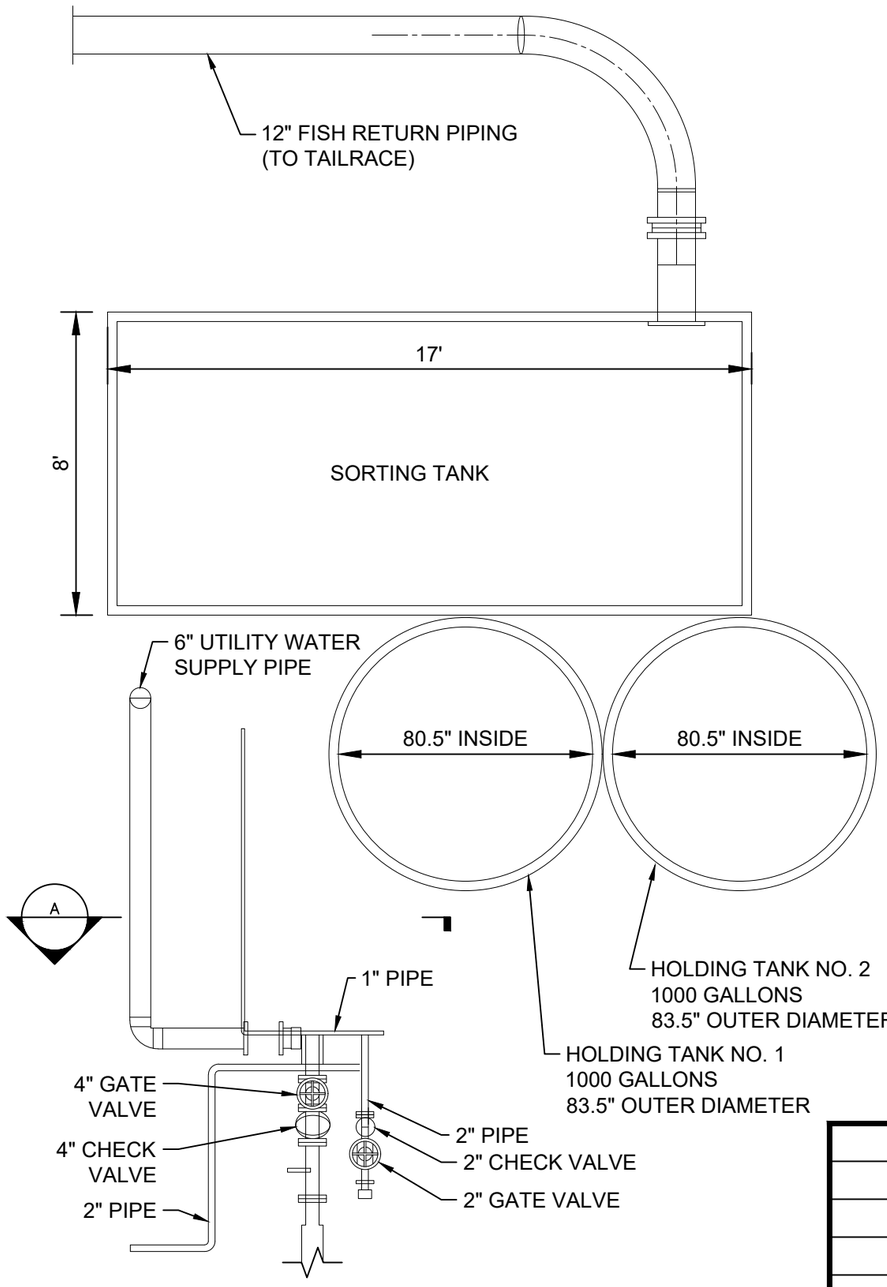
DRAWN BY:	JSC	CHECKED BY:	
APPROVED BY:		GSE PROJECT NO.:	2144

SCALE:

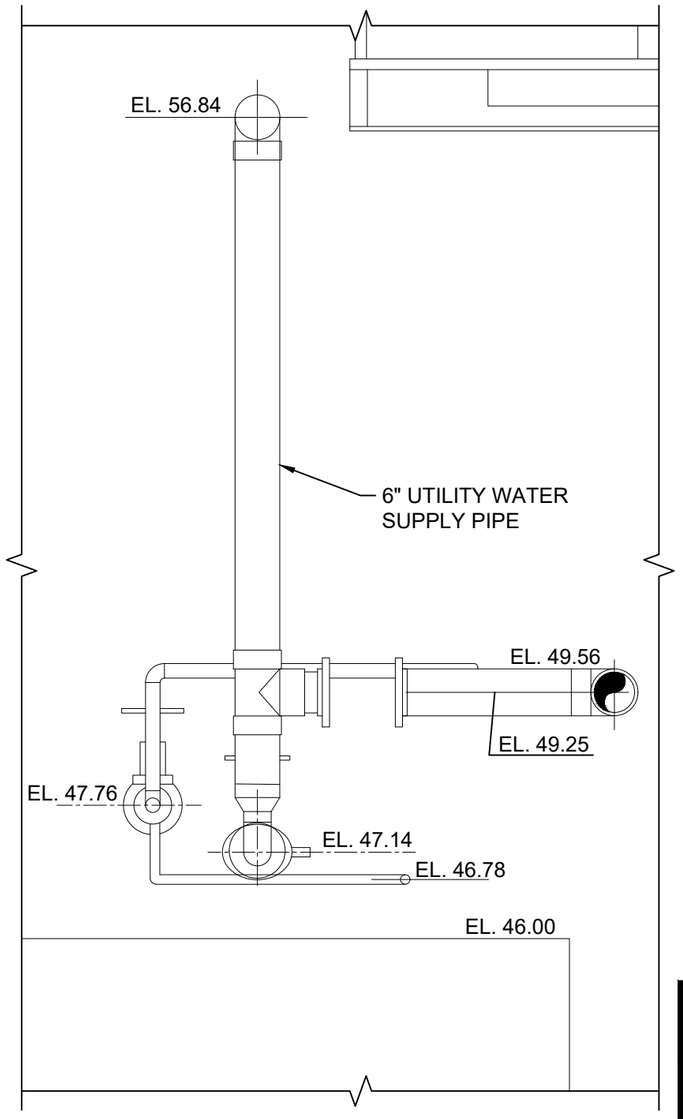
DATE: 12/2/2020

DRAWING NO.: 1



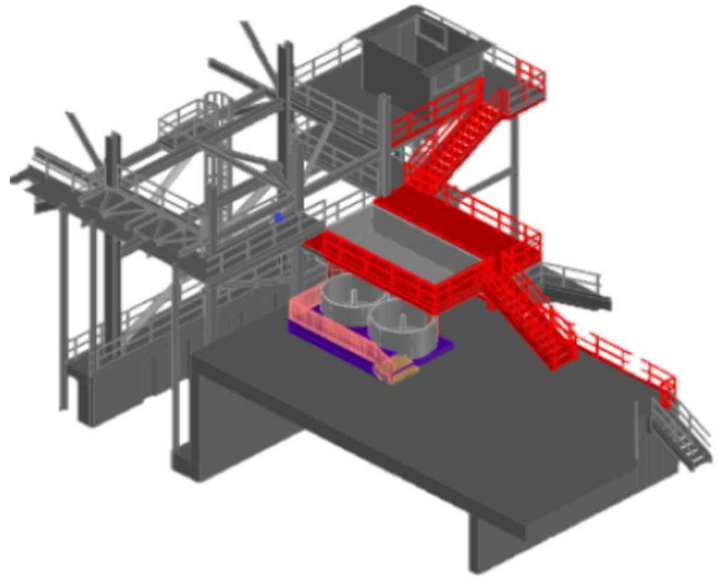
PLAN VIEW

1" = 4'



SECTION A VIEW

1" = 4'



ISOMETRIC VIEW

Constellation.

CONOWINGO HYDROELECTRIC PROJECT
INTERIM EAST FISH LIFT TRAP AND TRANSPORT OPERATION

DATE	#		BY	APP

GOMEZ AND SULLIVAN ENGINEERS

Williamsville, NY. Utica, NY. Albany, NY. Henniker, NH
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DRAWN BY:	JSC	CHECKED BY:	
APPROVED BY:		GSE PROJECT NO.:	2144

SCALE:	
DATE:	5/13/2021

DRAWING NO.: 1

Figure 3-3: Transport Skid

Appendix 1: Guidelines for the Operation of the West Fish Lift Collection Facility, Conowingo Dam

GUIDELINES FOR THE OPERATION OF THE WEST FISH COLLECTION FACILITY, CONOWINGO DAM

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Prepared by:

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This guideline and all information contained herein is confidential proprietary information of Normandeau Associates, Inc. (Normandeau). The contents of this guideline shall not be disclosed outside of Constellation and shall not be duplicated, used or disclosed, in whole or in part, for any purpose other than to evaluate Normandeau's performance in the conduct of Constellation's Trap and Transport program at Conowingo Hydroelectric Project, as applicable to this guideline.

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1.0 Purpose

This document provides general guidelines for the operation of the West fish lift located at Conowingo Dam.

2.0 Scope

This guideline applies to personnel involved in the operation of the facility. This procedure specifies the correct methods necessary for safe, proficient operation of the facility.

3.0 References

3.1 Constellation Generation: Safety, Environmental, & Fundamentals Reference

4.0 Safety

4.1 Safety precautions and provided in reference 3.1 are to be observed at all times. Other applicable safety precautions, etc., as announced by Constellation shall be observed.

5.0 General Information

Upon arrival at the facility, notify the Control Room operator or designate and request appropriate service unit gate settings to correspond with turbine unit operation. The service units' discharge is routed into the facility and provides the facility's attraction water. Positioning of weir gates based on service unit gate settings as given in Attachment I provides a guideline to establish the desired attraction flow in the holding channel and at the entrances to the facility.

5.2 Depending on service unit availability, the largest volume of attraction water, based on the number of turbines units in operation (Attachment 1), should be utilized. During daily operation, each change (increase or decrease) in the number of turbine units operated requires that the weir gates be repositioned per Attachment I. In addition, should a change (increase or decrease) in the volume of attraction water discharged from the facility be required a request to change the service unit gate setting must be made through the Shift Manager and/or his designate.

5.3 Experimental operation has determined that the volume of attraction water discharged from the facility is a critical component of efficient facility operation. Based on service unit availability the facility can be operated at any level of discharge (within the range of its operational criteria; station discharges that range from 0 to 120,000 cfs). When the house unit is the only service unit operating set both weir gates 3.1 ft. below tailrace elevation or close either weir gate and open the other weir gate 6.2 ft. below tailrace elevation. Although the desired gate settings of both service units is 35% when one and/or a combination of 4 small turbine units are in operation, the facility can be operated by setting both weir gates 5.1 ft. below tailrace elevation at higher levels of station discharge. In addition, when five or more small turbines are in operation either weir gate may be closed and the other one set 10.2 ft. below tailrace elevation. Modified operation of the facility, one entrance open; occurs on an as

needed basis when large numbers of rough fishes (gizzard shad and/or carp) are attracted to the facility and decrease efficient collection of American shad.

In addition, although Attachment I lists the normal gate setting for the house service unit as 35%, at times, particularly early in the season when the station is at full generation it may be operated at a gate setting that ranges from 45 to 60%. When this occurs, an adjustment to the other house unit gate setting is made to ensure that the volume of attraction water discharged through facility equals the volumes prescribed in Attachment I. This ensures that the weir gate settings given in Attachment I provide the desired attraction flows at the entrances.

Once the service units have been adjusted per the request to Constellation and weir gates have been set in accordance with Sections 5.1 to 5.4, a clean out lift can be conducted (crowder doors not open) to remove fish that collected in the holding channel since the last day the facility was operated. After completion of the first lift (clean out lift) additional lifts are conducted at least twice per hour or on an as-needed basis based on visual observations indicating significantly large numbers of fish have collected in the holding/trapping area. Lifts are conducted throughout the day using the controls and indicators on the control panel as follows in Sections 6, 7, and 8.

6.0 Facility Operation Mode

6.1 The west fish lift has two equipment operation modes. The equipment is most often operated in the test mode to allow flexibility based on fishing conditions.

6.2 The equipment is also designed to operate in a run mode. In this mode only one function at a time is possible.

7.0 Standard Operations

7.1 Entrance Weirs

7.1.1 These weirs are operated by a manual control which will position the top of the weir to a selected depth.

7.1.2 Weir gate position is changed by depressing the corresponding pushbutton "raise", "stop", and "lower" on the control panel.

7.1.3 Weir gate position is determined by reading the individual counters mounted on the weir lifting drive shaft.

7.2 Crowder

7.2.1 Crowder operations begin with the hopper fully lowered. The crowder unit is positioned at the weir end of the structure with the crowder gates in the "intermediate close" position.

7.2.2 The crowder gates are closed by depressing the "close" pushbutton. A limit switch is activated stopping the motor when the crowder gates are fully closed.

7.2.3 The crowder assembly is moved towards the hopper end of the structure by depressing the" crowder forward" pushbutton. The crowder assembly moves at fast speed (20-25 feet per minute) until it is approximately 5 ft. from its maximum forward position where a speed adjustment switch changes the crowder to slow speed. The speed adjustment switch slows the crowder assembly's speed to 6-10ft per minute. A limit switch stops the crowder at the maximum forward position.

7.2.4 After the loaded hopper clears the channel (Section 7.3) the crowder assembly is moved back to the weir end of the channel. This is accomplished by depressing the crowder "reverse" pushbutton. The crowder assembly will move at slow speed until a speed adjustment switch changes the crowder to fast speed. The crowder will continue at fast speed until it reaches its fishing position where a limit switch stops crowder movement.

7.2.5 Once the crowder assembly comes to a stop the crowder gates are opened by depressing the crowder gate "open" pushbutton. The crowder gates are allowed to swing out until they are at least half way opened. At this point the gates are stopped by depressing the crowder gate "stop" pushbutton. The "intermediate close" pushbutton is depressed to return the crowder gates to the fishing position.

7.3 Hopper

7.3.1 When the crowder is fully forward the hopper "fast raise" pushbutton is depressed.

7.3.2 As the hopper nears the surface of the water in the channel the lift operator shall visually assess the number of fish in the hopper and the hopper fullness (i.e. 10, 25, 50, 75, 100, or over 100 percent full). If the number of fish exceeds hopper capacity {changes during season based on water temperature and DO) for one lift, a split lift is conducted (Section 8.1). If the number of fish present in the hopper is not excessive the lift proceeds as described below.

7.3.3 After clearing the channel the hopper continues to be raised until it approaches the swing arresting tracks mounted on the bottom of the hopper travel assembly. At this point the hopper is manually stopped by depressing the hopper lift "stop" pushbutton.

7.3.4 The lift operator shall observe the position of the hopper to be certain that it has come to a complete stop.

7.3.5 After the hopper is stopped the "slow raise" pushbutton is depressed. The hopper continues upward until the primary limit switch is engaged. The primary limit switch stops the hopper's movement in preparation for engagement of the hopper travel assembly. Should the primary limit switch fail, a secondary mechanical backup limit switch is engaged.

7.3.6 When the hopper's upward movement ceases the "hopper travel" (-) pushbutton is depressed. This starts the hopper travel assembly moving towards the sorting tank. The hopper travel "stop" pushbutton is depressed such that the hopper will be stopped directly over the sorting tank. In order to achieve this position a painted mark on the overhead support structure is matched with a similar mark on the hopper travel assembly.

7.3.7 As the hopper assembly approaches the sorting tank and deck area, the lift operator shall make sure that all personnel are cleared from the area. In addition, he shall ensure that a sufficient volume of water is in the sorting tank (a minimum of 12 inches).

7.3.8 The hopper "fast lower" pushbutton is depressed to begin the loaded hopper's descent. When the hopper is immediately (approximately l foot) above the sorting tank the hopper "stop" pushbutton is depressed. The hopper "slow lower" pushbutton is depressed right after the hopper "stop" pushbutton is depressed (before the hopper comes to a complete stop). As soon as the hopper door is tripped the hopper “stop" pushbutton is depressed. Immediately thereafter the hopper "fast raise" pushbutton is depressed.

7.3.9 The empty hopper is raised rapidly until it approaches the swing arrest tracks. At this point the hopper "stop" pushbutton is depressed. The hopper "slow raise" pushbutton is depressed to return the hopper to the fully raised position. The hopper is stopped at this position by the primary limit switch or by a secondary limit switch.

7.3.10 The hopper travel assembly is returned to the tailrace end of the hopper travel track by depressing the "hopper travel" (+-) pushbutton. The hopper travel assembly is stopped by a limit switch when it reaches the point directly over channel.

7.3.11 The hopper "slow lower" pushbutton is depressed to lower the empty hopper down towards the channel. The hopper "stop" button is pushed when the hopper clears the swing arrest tracks. Depressing the hopper "fast lower" button resumes hopper movement towards the channel. When the hopper is submerged and comes to a rest on the channel floor a limit switch is activated to stop the release of the hopper cables. The lift operator shall carefully observe the cable motion and/or amount of slack to be certain that the hopper hoist motors have stopped.

7.3.12 The lift is shut down when the last lift of the day has been completed and all trash has been removed as described in Section 10.0. When the weir gates have been lowered to the lowest setting and the crowder doors have been closed, the lift operator shall double check all equipment before locking the control panel cabinet.

8.0 Special Operating Instructions to Maximize Collection of American Shad

8.1 Split Lift

8.1.1 If there are an excessive number of fish to be handled in a single lift as mentioned in Section 7.3.2, the hopper is returned to the bottom of the channel. This is accomplished by repeating the process given in Section 7.3.11.

8.1.2 The crowder assembly is moved back towards the weir end of the channel by depressing the crowder "reverse" pushbutton. When the crowder is approximately 5 ft. back from the maximum crowd position the assembly is stopped by depressing the crowder "stop" pushbutton. Note, in this position the crowder gates remain closed.

8.1.3 Once the crowder has been positioned the hopper is operated according to procedures in Sections 7.3.3 to 7.3.11 until the channel contains remaining fish that can be handled in one lift.

8.1.4 The final lift of a split lift is conducted by bringing the crowder assembly to the maximum crowd position as described in Section 7.2.3 and operating the hopper in a normal cycle. To avoid repeated split

lifts the operator must decrease fishing time (time crowder gate is open) on subsequent lifts (i.e., reduce fishing time from 30 min. to 20 min.).

8.2 Fast Fishing

8.2.1 Fast fishing is conducted on an as needed basis to increase efficiency of the facility by reducing mechanical delays associated with a normal lift cycle.

8.2.2 When fast fishing is conducted the crowder assembly remains stationary with the crowder gates in the intermediate close position. The hopper is run through a continuous normal cycle as described in Sections 7.3.3 to 7.3.11. This mode of operation is followed until the number of fish in a given lift is small enough to enable crowding.

8.2.3 If the number of fish being lifted in the fast fish mode exceeds the handling, holding and transportation capabilities of the sorting and transportation crew, the crowder gates must be closed.

9.0 Equipment Failure

9.1 If any mechanical and/or electrical failures occur during daily operations, contact an Constellation Representative concerning the continuation or termination of operations for the day.

10.0 Trash Removal

10.1 Trash accumulates on the picket barrier and on the crowder door screens. Thus, trash removal activities are to be conducted as needed or at the end of each day.

10.2 Following the last lift of each day the picket barrier is cleaned. In order to remove trash from the picket barrier, the picket barrier must be lifted out of the water. It is lifted by a chain hoist mounted on the superstructure directly above the barrier. The controls for hoist operation are mounted above the larger control box in the operator's booth and consist of two buttons. The upper button, when depressed, raises the picket barrier. It must remain depressed for the hoist to continue lifting. Properly attired crew (wearing life jackets) stationed on the fish lift deck, pick the trash off the barrier as it is raised in intervals. When all trash is removed and bagged for proper disposal, the "lower" barrier hoist control pushbutton is depressed until the barrier comes to a rest on the floor of the holding channel.

10.3 During the course of a season's operation at times a sufficiently large amount of debris can/will accumulate on the screens of the crowder doors preventing forward operation of the crowder assembly. At least weekly or on an as needed basis to remove trash from the crowder door screens the lift operator depresses the crowder swing "open" pushbutton. When the crowder doors are open and as to be parallel to the current in the channel, the crowder swing "stop" pushbutton is depressed. The crowder doors are left in this position as a trash removal crew deploys an air lance. The air lance is used to dislodge trash so that it will either be swept by the current through the opened doors or through the hinge crack which forms between the side screens and the door screens when the crowder doors are opened (Note: This procedure is conducted with one station service unit in operation at house load). Once the screens are cleaned normal operation of the facility is resumed and/or the doors are closed if the process is conducted at the end of daily operation.

11.0 Reporting

11.1 Complete a Conowingo Fish Collection Facility Operators Daily Log Sheet {Attachment II) and provide a copy of each sheet to Constellation at the end of season.

12.0 Attachments

I. Matrix of service unit settings used to obtain desired attraction and holding channel velocities at the Conowingo West Fish Collection Facility.

II. Conowingo Fish Collection Facility Operators Daily Log.

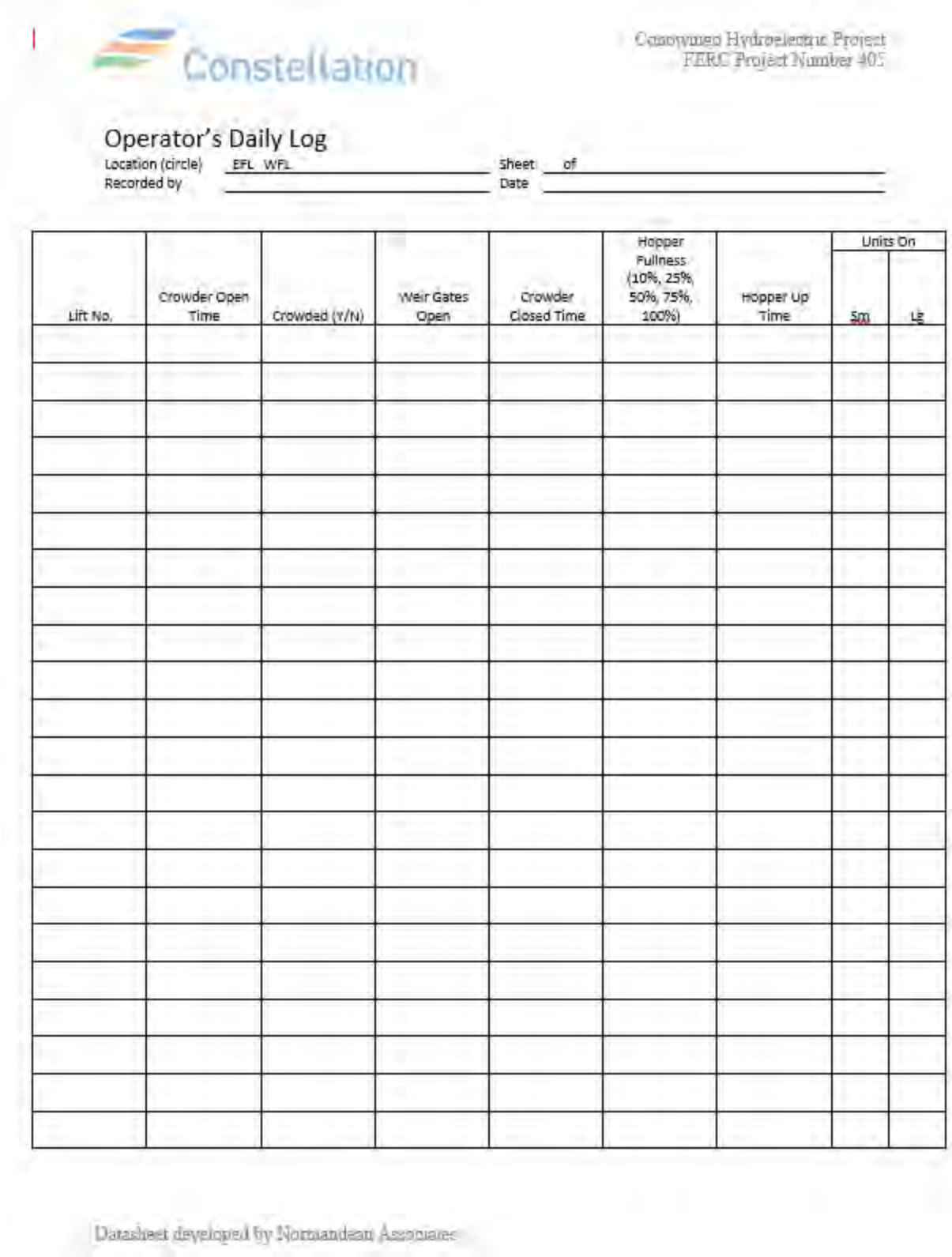
III. Equipment settings during and at the conclusion of the fishing season.

Attachment I: Matrix of service unit settings used to obtain desired attraction and holding channel velocities at the Conowingo West Fish Collection Facility at various station operating conditions.

Station Operation	Service Unit Gate Setting		Flows (cfs)	Weir Depth below Tailrace (ft.)	Attraction Velocity	Holding Channel (ft./sec)
	No. 1	No. 2				
More than 4 Small Units	35%*	75%	265	6.9	6	1
1 to 4 Small Units	35%*	35%	150	5.1	6	1
No Generation **	35%	0%	75	3.1	6	1

* Considered House Load

** Condition no longer exists during fish passage season



Constellation

Conowingo Hydroelectric Project
FERC Project Number 405

Operator's Daily Log

Location (circle) EFL WFL Sheet of

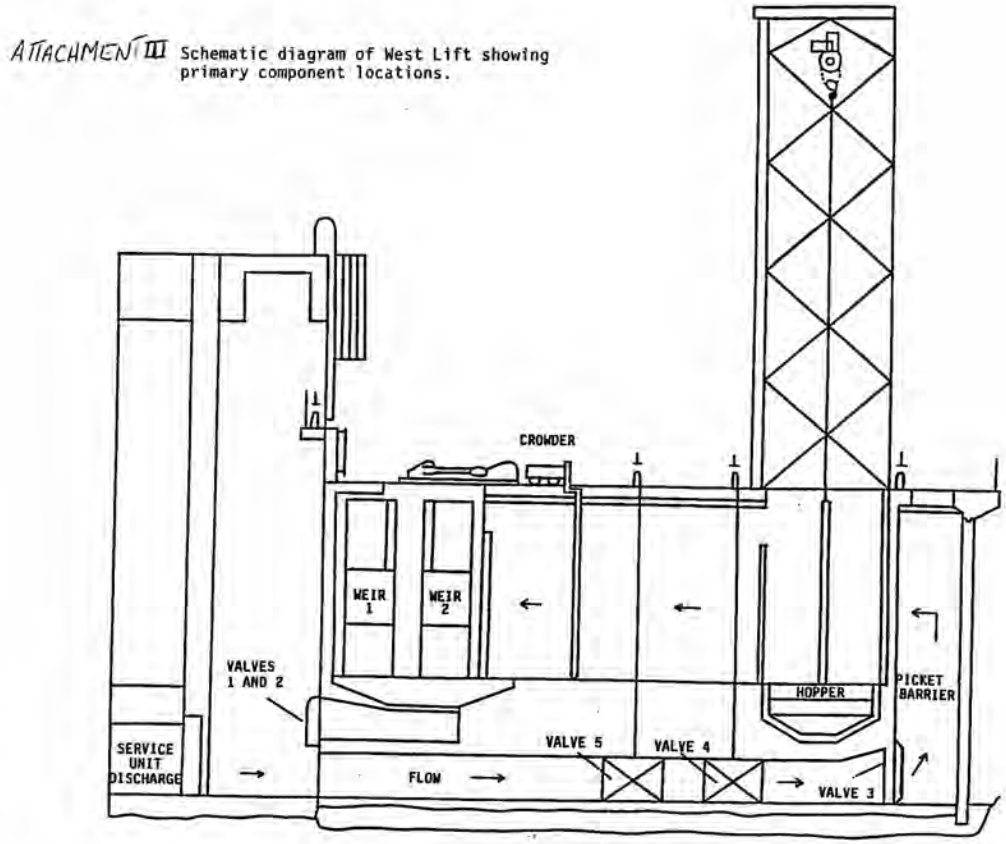
Recorded by Date

Lift No.	Crowder Open Time	Crowded (Y/N)	Weir Gates Open	Crowder Closed Time	Hopper Fullness (10%, 25%, 50%, 75%, 100%)	Hopper Up Time	Units On	
							Sm	Lg

Datasheet developed by Normandeau Associates

Attachment II: Conowingo Fish Lift Collection Facility Operator's Daily Log

Attachment III: Equipment settings during and at the conclusion of the fishing season.



Appendix 2: Guidelines for the Operation of the East Fish Lift Collection Facility, Conowingo Dam

GUIDELINES FOR THE OPERATION OF THE EAST FISH PASSAGE FACILITY, CONOWINGO DAM

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482 Old Holtwood Road
Holtwood, Pennsylvania 17532

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1.0 Purpose

This document provides a general guideline for the operation of the East Fish Passage Facility located at Conowingo Dam.

2.0 Scope

This guideline applies to personnel involved in the operation of the facility. Instructions contained in this procedure may be utilized to operate the facility in a trap and transport mode or enable direct passage of fish into Conowingo Pond.

3.0 References

3.1 Constellation (current revision) "Fundamentals, Safety & Environmental Handbook".

4.0 Safety

4.1 Safety precautions and guidelines provided in Reference 3.1 are to be observed at all times. Other applicable safety precautions, etc., as announced by Constellation shall be observed.

5.0 General Information/Instructions to Operate the Facility in Trap and Transport Mode

5.1 Upon arrival at the facility, notify the Control Room or designate. Also, make note of the station's prevailing generation status and which turbines are in operation. Obtain and record the existing tailrace and forebay (pond) elevation.

5.2 The operator shall refer to the applicable matrix table pertaining to the appropriate pond elevation to select the operating/fishing settings. In addition, the operator needs to make sure that when any or all mixed-flow turbines (Units 8, 9, 10 and 11) are in operation, upstream entrance A is usually closed. Under these conditions upstream entrance C can be utilized individually to attract fish into the facility. When Units 8, 9 10, and 11 are off entrance A is utilized and entrance C is closed. The operator determines and selects what entrances are to be utilized based on the American shad catch and prior experience.

5.3 Based on the pond elevation, tailrace elevation, and turbine unit generation the operator will select the appropriate settings of the facility components to establish desired flow rates in and at the entrances to enable efficient operation. The settings for the following components are modified throughout the day to accommodate variations in pond and tailrace elevations and turbine unit generation:

- Upstream weir gate A
- Downstream weir gate C
- Diffuser A and B channel gates

- Crowder area gate
- Hopper stop position switch
- Spillway gates A and B

Note: Butterfly valve, spillway trough gate, and hopper trough gate need to be closed.

5.4 Prior to releasing attraction water into the facility (accomplished by the operation of spillway gates A and B), the operator determines the settings in 5.3 above and positions the gates and equipment using the controls and indicators of the control room panel. Once this is accomplished, the spillway regulating gates are set to the desired position. After the hydraulics in the facility reach equilibrium, daily trap and transport operations are ready to be conducted. If any mechanical and/or electrical failures occur during operations, contact a Constellation representative concerning the continuation or termination of operations for the day.

5.5 Spillway gates A and B, diffuser A and B channel gates, upstream weir gates A and B, crowder area gate, and downstream weir gate all have the following associated controls and indicators on the control panel.

5.5.1 Incremental position meter indicator (percentage open) according to a predetermined scale indicator.

5.5.2 Momentary open and close spring return to middle switches to adjust the equipment to the desired position.

5.5.3 A green indicator light which will be energized by a limit switch when the equipment reaches its fully closed position. This same limit switch will stop the equipment at the fully closed position.

5.5.4 A red indicator light which will be energized by a limit switch when the equipment reaches its fully opened position. This same limit switch will stop the equipment at the fully open position. NOTE: Both lights will be illuminated in intermediate position.

5.6 The upstream/downstream channel gate is no longer in service.

5.7 When all the above mentioned equipment is adjusted and the proper velocities have been achieved (velocities in the crowder channel from 0.5 to 1.5 fps, velocities in the vicinity of the upstream/downstream gate from 1.0 to 2.0 fps, and velocities at any entrance from 4.0 to 6.0 fps) a clean out lift can be initiated (crowder doors closed) to remove fish that may have entered the holding channel overnight (see Sections 5.7.1 to 5.7.18). During the fishing and lifting processes the lift operator will observe the pictures on the video monitors. These monitors (2) are located in the control booth to the right of the control panel. The pictures on the monitors are views as seen from two separate fixed cameras. One camera is mounted downstream and above the crowder channel. This camera provides a view of the channel, crowder unit and its operations. The other camera is mounted below the control booth and provides a limited view of the hopper as it moves up or down and may provide (at times based on lighting) a view of the fish being lifted. The lift operator will view the screen(s) when the hopper and crowder units are in motion to verify correct equipment position and functions. After satisfactory completion of the clean out lift additional lifts are conducted at least twice per hour or on an as needed basis. More frequent lifts may be made if significantly large numbers of fish (based on visual observation) have collected in the crowder area. Also, if the holding channel becomes overloaded with fish, "fast fishing" method may need to be utilized (Section 5.7.12). Lifts are conducted throughout the day using the controls and indicators of the control panel as follows:

5.7.1 Start with crowder screen lowered and hopper trough gate closed, crowder assembly in the fishing position, hopper in the lowered position, and crowder doors fully closed. If any or all of this equipment is not in position, make the necessary adjustments to set the equipment in this position before commencing lift operations (crowder doors, crowder, hopper hoist, hopper trough gate, and crowder screen green lights illuminated on the control panel).

CROWDER OPERATION

5.7.2 Depress the crowder screen "open" push button and the crowder screen will move to the fully raised position where a limit switch will stop the screen and energize a red light.

5.7.3 Depress crowder door "trap" push button and crowder doors will move to the trap position (doors open to 45 degree angle).

5.7.4 When enough fish have collected in the crowder section or a set fishing time has elapsed, depress the crowder door "close" push button, and crowder doors will move to the fully closed position, where a green light indicates "doors closed".

5.7.5 Following operator's visual confirmation of door position, move the crowder assembly from the fish position to the crowd position, depress the crowder "crowd" push button.

5.7.6 Once crowder "crowd" button is depressed, crowder will move at fast speed until it is approximately 6 ft from the maximum forward position where a limit switch reduces the crowder speed. The crowder will continue at slow speed until it reaches the maximum forward position where a limit switch stops the crowder and energizes a red light.

5.7.7 At this point the crowder screen shall be lowered. Depress the crowder screen "close" push button and the crowder screen will move to the fully lowered position where a limit switch will stop the screen and energize a green light.

5.7.8 After the crowder screen is fully lowered, the crowder assembly can be returned to the fishing position. The crowder should not be moved until the crowder screen is fully lowered and the crowder screen cannot be raised until the hopper returns to the fully lowered position.

5.7.9 To return the crowder assembly to the fishing position, depress the crowder "fish" push button. The crowder will move at slow speed until it is approximately 6 ft from the crowd position, where a limit switch increases the crowder speed. The crowder will continue at fast speed until it reaches the fish position, where a limit switch stops the crowder and energizes a green light.

5.7.10 At any time after the crowder switches to fast speed, it can be manually stopped using the "stop" push button.

5.7.11 Once the crowder assembly returns to the fishing position, depress the crowder door "trap" push button and crowder doors will move to the trap position (doors open to 45 degree angle).

5.7.12 Occasionally, large numbers of fish may enter the holding channel during the fishing time. When overloading is observed, conduct "Fast Fishing" as follows:

- Depress the crowder door "close" push button and the crowder doors will move to the fully closed position or operator may leave crowder doors in “trap” position.

- Depress the crowder screen "open" push button and it will move into the fully raised position. Immediately after the crowder screen is fully raised depress the crowder screen "close" push button and it will move into the fully lowered position.
- Use the hopper hoist controls to make the initial lift. (See Hopper Operation Section)
- Repeat the above procedure and continue to make as many lifts as necessary in order to thin out the fish in the holding channel.
- Close the crowder doors (if open during “Fast Fish” operations and depress the crowder "crowd" push button to move the crowder assembly forward and conduct the final lift.

HOPPER OPERATION

5.7.13 Start with the hopper door closed and the hopper fully lowered and the hopper hoist and hopper door green light illuminated on the control panel.

5.7.14 Depress hopper hoist "slow raise" push button and hopper will raise at slow speed to fully raised position. When the hopper reaches the discharge location at the fully raised position a limit switch stops the hopper and energizes a red light.

5.7.15 The fully raised position will be the sorting and trucking station which has been set using the hopper stop position switch on the control panel. An upper limit switch will provide a means of automatically stopping the hopper in the event that the fully raised limit is exceeded. When the hopper is fully raised to the sorting and trucking station, the hopper door can be opened. Before the hopper door is opened, the operator will shout "stand clear" to the sorting crew to ensure that it is secure and safe prior to opening the door.

5.7.16 When the hopper contents are completely discharged, the hopper can be returned to the fully lowered position using the hopper hoist "slow lower" or "fast lower" push buttons. Once the hopper reaches the water, it must be lowered in the slow lower mode so that the cables supporting the hopper do not become too slack. A limit switch will automatically stop the hopper and energize the green light when the fully lowered position is reached.

5.7.17 When the hopper is fully lowered, the hopper door can be closed. Depress the hopper door "close" push button. The hopper door will close and a green light will illuminate. (Note that the hopper door must be open when lowering the hopper into the water).

5.7.18 With the hopper fully lowered and the hopper door closed, the crowder screen can be raised as described in the crowder Section 5.7.8 and the fishing cycle can be repeated.

5.7.19 Repeat the above cycles as described for each lift until the last lift of the day is completed. Following the last lift, the crowder doors are to remain in the closed position until the start of the next day's operation.

5.7.20 At the end of daily operation and after trash has been removed (Section 7.0) position the equipment and gates as follows:

- Spillway gates A & B (closed)
- Downstream weir gate C (90% open)
- Diffuser A & B channel gates (open a minimum of 15%)
- Crowder area gate (open a minimum of 10%)

6.0 General Information and Instruction to Allow Passage of Fish Directly into Conowingo Pond

6.1 Prior to allowing any fish direct access into Conowingo Pond the hopper operation must be modified and the overhead trough must be opened.

6.2 To modify the hopper operation the following steps must be completed.

6.2.1 Raise the hopper up to sorting tank and empty the contents.

6.2.2 Change hopper stop position switch on the control panel from the sorting tank position to the spillway trough position. This will enable the hopper to be raised to the trough.

6.2.3 Raise hopper to control room level and install the plates over the drainage holes (up to 5 plates may need to be installed).

6.2.4 Lower the hopper to the level of concrete walkway.

6.2.5 Close the hopper door utilized during trap and transport operations. When closed, activate the air system for volitional passage enabling door on trough side of hopper to open.

6.2.6 Manually reverse plates in bottom of the hopper so they angle toward door on trough side of hopper. Open and close the hopper door a few times. This builds up air pressure in the line and assures that the door is working properly.

6.2.7 After the above steps are completed, open the hopper door and lower the hopper back into the fishing position.

6.3 To fill the trough, crack open the spillway trough gate slightly allowing the trough to fill gradually (butterfly valve closed; the butterfly valve is a manually operated valve that has visual indication of percent openings in 25% intervals). Once the water level in the trough equals the pond elevation, fully open the spillway trough gate.

6.4 After the trough is full, utilize a staff gauge located in the trough to obtain the pond elevation. Set the manually operated adjustable trash racks located at the pond entrance of the trough so a minimum of six inches of the racks are above the water level. This prevents large surface trash from entering the trough.

6.5 Based on pond and tailrace elevations and turbine unit operation, utilize the appropriate matrix table to position all equipment listed in Section 5.3, except spillway gates A and B. After all desired settings have been obtained, open spillway gates A and B to prescribed settings. Once the hydraulics in the facility have reached equilibrium, open the butterfly valve to 60%.

6.6 After completion of steps in Section 6.5 a clean out lift and subsequent lifts can be conducted following the steps outlined in Section 5.7 (exclude step 5.7.14). When the hopper is fully raised to the spillway trough, release the fish into the trough.

6.7 If trough operations are complete for a period of time, the trough will have to be dewatered. When the trough is dewatered it should be drained slowly and then stopped at a level which is low enough to enable personnel to enter the trough and allow remaining fish to be captured and removed. Fishes can either be stocked into Conowingo Pond or released into tailrace.

6.8 To resume trap and transport operations modify the hopper by reversing steps in Section 6.0. In addition, the hopper stop position switch MUST be set to the SORT position before normal fishing can be continued.

7.0 Removal of Trash from The Facility

7.1 During the daily operation of the lift in the trap and transport mode, debris enters the facility through spillway gates A and B and accumulates behind the trash racks. Trash rack A is located downstream of the crowder area gate. Trash rack B is located upstream of diffuser gates A and B. During the day, on an as needed basis (when flows in crowder area are affected), remove floating trash with a long-handled net from the upstream side of trash rack A.

7.2 After the final lift of the day and prior to setting all equipment in the proper position, close the crowder area gate and diffuser gates A and B and spill trash that accumulated in the stilling basin over the angled wall.

7.3 After the equipment has been positioned at the end of daily operation (Section 5.7.20), proceed to the area where the trash racks and hopper dividing screens are located.

7.3.1 Trash racks A and B and hopper dividing screens I and II are controlled by individual push button stations located at each piece of equipment which raise and lower the hoists as required.

7.3.2 Fully raise each trash rack and hopper dividing screen and remove any debris that has collected on them. Pick the trash that is within reach by hand and use a long-handled rake for more distant trash. Debris that accumulates in the channel as a result of hand cleaning the racks and screens needs to be removed by using a long-handled net. The collected trash must then be disposed of properly. A hoist is provided to lift trash from elevation 35 ft to elevation 45 ft.

7.4 If the facility has been operated in an upstream passage mode, trash is removed from the stilling basin and crowder channel following procedures outlined in Sections 7.2 and 7.3. Floating trash that accumulates in the downstream end of the trough is removed on an as needed basis during the day with a long-handled net to prevent damage to fish being sluiced into the trough from the hopper.

8.0 Reporting

8.1 Check and correct recorded data and produce the daily report. Record American Shad and River Herring numbers on Daily summary sheet

8.2 Send daily report via email to all pertinent Constellation and Resource Agency personnel.

APPENDIX G. MUDDY RUN PUMPED STORAGE PROJECT AMERICAN EEL PASSAGE PLAN

PENNSYLVANIA WATER QUALITY CERTIFICATION EA 36-033

APPENDIX 1

Exelon Generation
American Eel Passage Plan

Muddy Run Pumped Storage Hydroelectric Project (P-2355-018)

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IV. Upstream Passage (2031 - Term of New License)

I. Introduction

Pursuant to the Federal Power Act, Exelon Generation (Exelon) filed new license applications with the Federal Energy Regulatory Commission (FERC) in August 2012 for the Muddy Run Pumped Storage Hydroelectric Facility (Muddy Run) and the Conowingo Hydroelectric Project (Conowingo). This American Eel Passage Plan ("Eel Plan") is a condition of, and incorporated into, the Water Quality Certification for the Muddy Run Project. Under Section 401(d) of the Clean Water Act, the Eel Plan becomes a condition of the FERC license for the Muddy Run project.

II. Eel Passage Advisory Group

To inform implementation of the Eel Plan, Exelon will establish an Eel Passage Advisory Group (EPAG) by May 1, 2014. EPAG will be chaired by Exelon and composed of a representative from each of the following (collectively, the "Resource Agencies"): the Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Fish and Boat Commission (PAFBC), United States Fish and Wildlife Service (USFWS), the Maryland Department of Natural Resources (MDNR), Maryland Power Plant Research Project (PPRP) and the Susquehanna River Basin Commission (SRBC). Each designated representative shall be knowledgeable of American eel, the Susquehanna River, and ongoing fisheries and other related resource programs being implemented in the Lower Susquehanna River (*e.g.*, American shad restoration).

III. Upstream Passage for American Eel (2015-2030)

Consistent with the implementation plan set forth below, Exelon will trap, hold and transport American eels from the Conowingo Dam and transport them to designated points in the Susquehanna River watershed consistent with the level of effort established and described in this plan. Any trapping, holding, transportation or monitoring of eels or other eel related activities addressed in this plan that occurs in Maryland waters is expressly subject to any permits, licenses or authorizations that may be required by the State of Maryland related to such activities.

A. Trapping

Subject to required regulatory approvals, Exelon will design, install and operate an eel trapping facility along the western shore of the Conowingo Dam near the location of the current USFWS trapping location and facility, unless an alternate location is approved by the PADEP and MDNR in writing, according to the following schedule, unless an alternative schedule is approved by the PADEP in writing. In the event that the MDNR, USFWS 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, Exelon 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 a trapping facility to the Resource Agencies and FERC by October 15, 2015;
2. Hold preconstruction meeting with MD and USFWS within 150 days of approval of the design plans and designs by FERC, MDNR and USFWS;
3. Begin construction within 180 days of receipt of approval of the design plans and specifications by the MDNR and USFWS;
4. Begin operation by May 1, 2017.

Beginning in 2014 and until Exelon's trapping facility along the western shore of the Conowingo Dam is completed, Exelon will work with the USFWS to trap eels using the USFWS trapping facility and will assist in the financial support of the USFWS trapping facility through a payment of $20,000 per year to an entity approved by the PADEP with the capability of providing financial support to the USFWS Maryland Fisheries Resource Office for the eel trapping program. This payment will be made by May 1 of each year. In 2014, Exelon will participate in this effort using USFWS facilities, including the USFWS trapping facility, tanks and trucks. Beginning May 1, 2015, or such later date approved by the PADEP and MDNR, in writing, Exelon will use its own holding and transport facilities and continue working with the USFWS to trap eels using the USFWS trapping facility. Exelon will begin

operating the program independently, subject to USFWS supervision and input, using its own trapping facility when construction of that facility is completed.

Subject to required regulatory approvals, Exelon also will design, install and operate a temporary eel trapping facility on Octoraro Creek at a location approved by the PADEP in writing according to the following schedule, unless an alternative schedule is approved by the PADEP in writing. In the event that the MDNR, FERC, PADEP or the USFWS 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, Exelon 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. Conduct field evaluation using visual observation, electrofishing and other methods approved by the PADEP and USFWS, in writing, to evaluate and rank trapping locations on Octoraro Creek by September 15, 2014.
2. Submit complete design plans and specifications to the Resource Agencies by November 1, 2014;
3. Hold preconstruction meeting with PADEP and USFWS within 45 days of approval of the design plans and designs by FERC, PADEP and USFWS;
4. Begin construction within 90 days of receipt of approval of the design plans and specifications by PADEP and USFWS;
5. Begin operation by May 1, 2015.

If, after three years of operation, PADEP in consultation with EPAG determines the temporary eel trapping facility at Octoraro Creek is successful, Exelon will design, install, and operate a permanent eel trapping facility at this location in accordance with a schedule established by PADEP in consultation with the other Resource Agencies.

If, after three years of operation, PADEP in consultation with EPAG determines the temporary eel trapping facility at Octoraro Creek is unsuccessful, site-determination studies for an additional permanent trap will be performed beginning in 2017. Congregations of juvenile eels will be documented visually via bi-weekly nighttime surveys during the migration period; the locations surveyed will focus on the East Fish Lift area, the river banks and possibly lower-river tributaries, but will exclude the Conowingo Dam spillway. Based on the results of the site-determination studies, Exelon 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 PADEP, MDNR and USFWS during 2018 and, if necessary, 2019, 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 Exelon.

Based on the results of the site-determination studies, Exelon, 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 in 2018 to install an eel trap at the selected location, unless a different date is established by the PADEP, MDNR and USFWS, that trap will be designed and constructed in 2019-2020, and operated beginning in 2021 subject to required regulatory approvals. If a second year of study is needed, the dates would advance by a year. Exelon will not be required to maintain and operate more than two permanent eel traps at any time during the term of the new license.

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 facility 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. Exelon 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.*[1] 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, Exelon will pay to have 60 elvers/year sent to the USFWS or such other entity that the PADEP 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.

[1] This introduced parasite has been documented in juvenile eels collected at Conowingo Dam (Minkkinen and Park 2012) and could affect the overall success of adult outmigration due to reduced swimming ability and potentially higher mortality of migrating silver eels (Szekely et al 2009).

B. Holding

Subject to required regulatory approvals, Exelon also will design, install and operate the holding facility for the west shore Conowingo Dam and the Octoraro Creek traps according to the following schedule, unless an alternative schedule is approved by the PADEP in writing. In the event that the MDNR, FERC, PADEP or the USFWS 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, Exelon 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 by April 15, 2015;
2. Hold preconstruction meeting with PADEP and USFWS within 150 days of approval of the design plans and designs by FERC, PADEP and USFWS;
3. Begin construction within 180 days of receipt of approval of the design plans and specifications by PADEP and USFWS;
4. Begin operation by May 1, 2016.

Periodically, consistent with standards established by the PADEP, MDNR and USFWS, 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 PADEP in consultation with the other Resource Agencies. If necessary, aeration will be provided to the holding tanks.

C. Transport

Subject to required regulatory approvals, Exelon will design, construct and operate vehicle(s) to transport eels from the western shore and Octoraro facilities according to the following schedule, unless an alternative schedule is approved by the PADEP in writing. In the event that the FERC, MDNR, PADEP or the USFWS 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, Exelon 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 by April 15, 2015;
2. Begin construction within 180 days of receipt of approval of the design plans and specifications by PADEP, MDNR and USFWS;
3. Begin operation by May 1, 2016.

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 PADEP 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.

D. Release

Exelon will release eels at locations identified in Appendix A in amounts consistent with the release information provided to and approved by the PFBC in writing. Where feasible, eels will be released at public access locations. Unless otherwise directed by PFBC 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, Exelon 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.

Modification of, or revisions to, the release locations in Appendix A shall occur after consultation with EPAG and consistent with the approval of the PFBC.

E. Quality Assurance/Quality Control

Exelon will develop a detailed quality assurance/quality control ("QA/QC) program according to the following schedule, unless an alternative schedule is approved by the PADEP in writing. In the event that the MDNR, PADEP or the USFWS determine that additional information, revisions, or amendments are necessary to the QA/QC program, then within 60 days of receipt of written notice Exelon shall submit to the Resource Agencies and 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, 2014;
2. Implement the QA/QC program approved by the PADEP when trapping and transport begins.

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 PADEP, MDNR or USFWS 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.

F. Reporting, Monitoring, and Periodic Evaluation

1. Reporting and EPAG Meetings

During the eel passage season, Exelon 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 from 2015 through 2030, Exelon 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, Exelon will file an Annual Report with EPAG that analyzes annual data, including results from QA/QC.

Upon request, Exelon will meet with EPAG on or before February 15 of each year in which the Annual Report is filed.

2. Periodic Evaluation

Every three years, unless a different period is established by the PADEP in writing beginning in 2018 through 2030, Exelon 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. Exelon will propose locations and methods for this survey at least one year in advance to the Resource Agencies. Exelon shall implement the survey based on approval of the PADEP of the proposed locations and methods.

To implement the evaluations, eels will be captured by electrofishing, or other methods approved by the PADEP 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 PADEP in consultation with EPAG.[2] 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.

[2] It is anticipated that two weeks of electrofishing will be conducted during each third-year evaluation.

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.

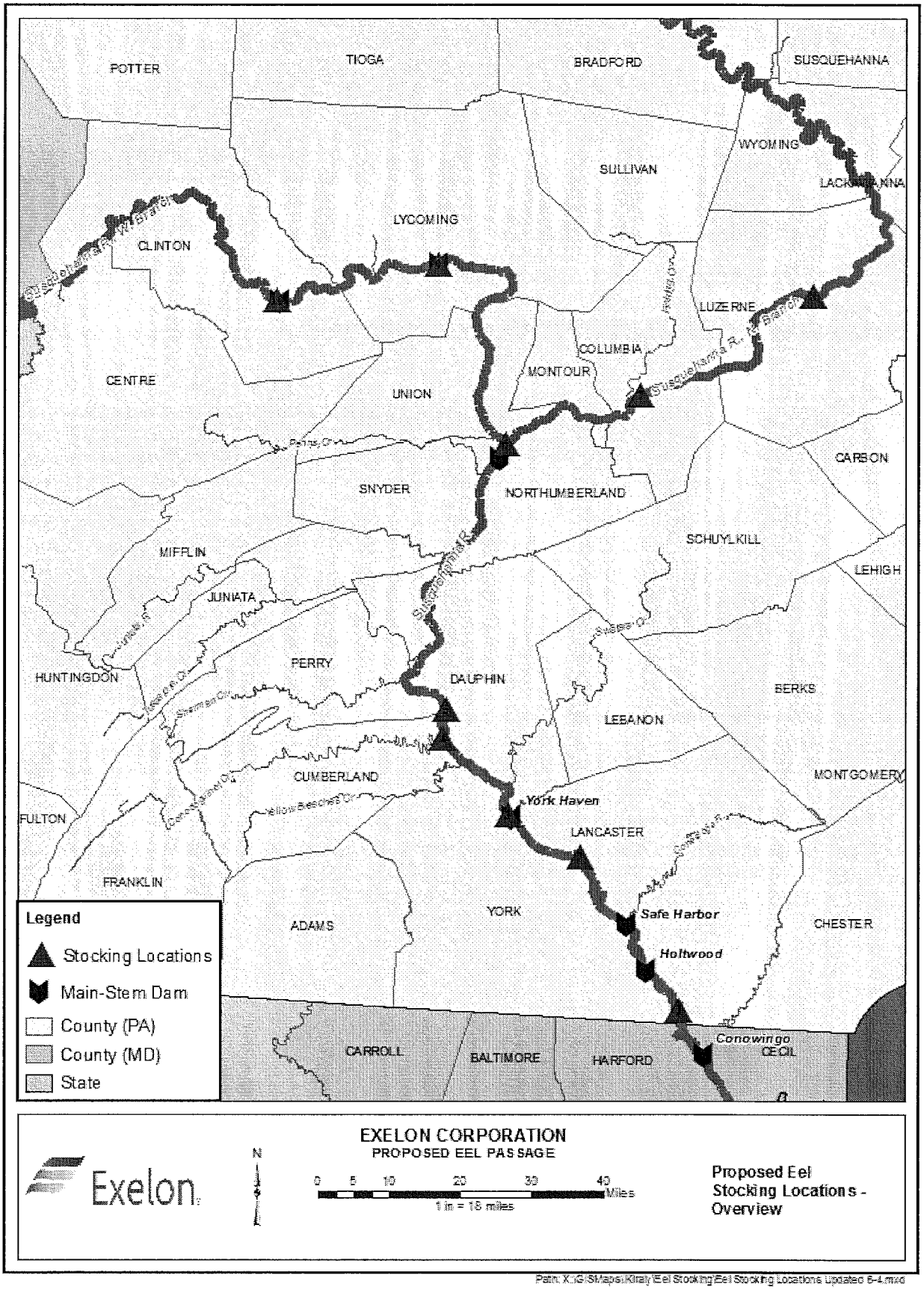
III. Upstream Passage (2031 - Term of New License)

If the upstream American eel passage trap and transport program terminates in 2030, Exelon will construct and operate a volitional upstream eel facility at Conowingo Dam through the term of the new license. Exelon will design and construct the volitional upstream eel facility, which will be operated in consultation with EPAG. In no event will Exelon be required to participate in the trap and transport program once the volitional upstream eel passage facility is operational.

If the upstream eel trap and transport and periodic evaluation program continues beyond 2030, Exelon will continue to provide access to the Conowingo eel collection facilities for as long as the program continues. Exelon, however, shall bear no cost responsibility for the trap and transport and periodic evaluation program until 2046, at which time cost responsibility shall be shared among all participants in the program.

APPENDIX A
LOCATIONS OF EEL RELEASE

Site Number	Location	Water	County
1	Conowingo Pool	Susquehanna River	Lancaster
2	Between Holtwood and Safe Harbor	Susquehanna River	Lancaster/York
2	Between Safe Harbor and York Haven Dam	Susquehanna River	Lancaster
3	Upstream of York Haven Dam	Susquehanna River	Dauphin
4	West Fairview Access (Route 11/15)	Susquehanna River	Cumberland
5	Fort Hunter Access	Susquehanna River	Perry
6	Shikellamy State Park	Susquehanna River	Northumberland
7	Route 487 Bloomsburg	North Branch Susquehanna River	Columbia
8	Route 29 Bridge (Wilkes Barre)	North Branch Susquehanna River	Luzerne
9	Upstream of Hepburn Street Dam (Williamsport)	West Branch Susquehanna River	Lycoming
10	Upstream of Grant Street Dam	West Branch Susquehanna River	Clinton



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APPENDIX H. CONOWINGO HYDROELECTRIC PROJECT AMERICAN EEL PASSAGE AND RESTORATION PLAN

CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NUMBER 405

AMERICAN EEL PASSAGE AND RESTORATION PLAN

Prepared for:

Exelon.

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GOMEZ AND SULLIVAN ENGINEERS

and

NORMANDEAU ASSOCIATES
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September 2021

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LIST OF ABBREVIATIONS

CEECF	Conowingo East Eel Collection Facility
cfs	cubic feet per second
Conowingo Project or Project	Conowingo Hydroelectric Project
CWA	Chester Water Authority
CWECF	Conowingo West Eel Collection and Holding Facility
DO	dissolved oxygen
EFL	East Fish Lift
EPAG	Eel Passage Advisory Group
EPRP	American Eel Passage and Restoration Plan
Exelon	Exelon Generation Corporation, LLC
FERC or Commission	Federal Energy Regulatory Commission
hp	horsepower
L	Liter
MD	Maryland
MDE	Maryland Department of the Environment
MDE Settlement	Joint Offer of Settlement and Explanatory Statement of Exelon Generation Company, LLC and The Maryland Department of the Environment
m	meter
mL	milliliter
mm	millimeter
MRPSP	Muddy Run Pumped Storage Project
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
OECF	Octoraro Creek Eel Collection Facility
PA	Pennsylvania
ppm	parts per million
rpm	revolutions per minute
SRBC	Susquehanna River Basin Commission
USFWS	United States Fish and Wildlife Service
WQC	Water Quality Certificate

1 BACKGROUND

Exelon Generation Company, LLC (Exelon) is the licensee for the 570.15-megawatt Conowingo Hydroelectric Project (Conowingo Project or Project). The Project is located on the Susquehanna River (at river mile 10) in Pennsylvania and Maryland. Conowingo Dam is in Maryland, connecting Cecil and Harford counties, as are the lowermost six miles of the Project reservoir, Conowingo Pond. The remaining eight miles of Conowingo Pond are in Pennsylvania, within York and Lancaster counties.

The Conowingo Project Federal Energy Regulatory Commission (FERC or Commission) License requires Exelon to develop and submit an American Eel Passage and Restoration Plan (EPRP). Specifically, Article 415 states:

> *Within six months of license issuance, the licensee must file with the Commission for approval, an eel passage and restoration plan. The plan must include:*
>
> *a) detailed plans for modifications to the East Fish Lift to specifically accommodate a temporary eel trapping facility at a location within the East Fish Lift stilling basin in the vicinity of the foot of the spillway;*
>
> *b) details regarding the annual operation and maintenance of all current and proposed eel fishways; and*
>
> *c) proposed attraction flow velocity and volume, slopes of the ramps, matting, and methods to reduce predation.*
>
> *Within 30 days of license issuance, the licensee must submit the plan to the Maryland Department of the Environment (MDE), the Pennsylvania Department of Environmental Protection (Pennsylvania DEP), the Pennsylvania Fish and Boat Commission (Pennsylvania Fish and Boat), the Susquehanna River Basin Commission (SRBC), the U.S. Fish and Wildlife Service (FWS), and the Maryland Department of Natural Resources (Maryland DNR), for review. In the event that MDE, in consultation with the Pennsylvania DEP, the Pennsylvania Fish and Boat, SRBC, FWS, or the Maryland DNR, determines that additional information, revisions, modifications, or amendments are necessary to the eel passage and restoration plan, then within 60 days of receipt of written notice, the licensee must submit such information, revisions or amendments to the above-listed agencies.*
>
> *The licensee must 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 must 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 must include the licensee's reasons, based on project-specific information.*
>
> *The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.*

The Joint Offer of Settlement and Explanatory Statement of Exelon Generation Company, LLC and The Maryland Department Of The Environment (MDE Settlement) (2019) also requires the development of an Eel Passage and Restoration Plan that will:

> *(i) provide for modification of the EFL to accommodate a temporary eel trapping facility in the EFL stilling basin (the "Temporary Eel Trapping Facility"); (ii) contain details regarding the operation and maintenance of all existing and proposed eel fishways at the Project, including continued use of the EFL for eel passage after shad and herring season has ended; and (iii) establish attraction flow speed and volume, slopes of ramps, matting, and methods to reduce predation.*

Exelon also operates the Muddy Run Pumped Storage Project (MRPSP) on the Susquehanna River in Pennsylvania (PA). The MRPSP FERC license includes an American Eel Passage Plan that requires Exelon to trap, transport, and stock eels in the Susquehanna River watershed from the Octoraro Eel Collection Facility (OECF) located at the Chester Water Authority (CWA) facility (located in Nottingham, PA) and the Conowingo West Eel Collection Facility (CWECF) located on the west bank at Conowingo Dam. Under the MRPSP License, the eel collection season starts May 1 and ends September 15 at the OECF. The CWECF will begin operation on May 1 and continue until the mean daily water temperature, as determined by hourly readings at Exelon's monitoring station 643 (located 0.6 miles downstream of Conowingo Dam) or by manual readings taken at an alternative location within the Project tailrace, is 10 degrees Celsius or less for three consecutive days. The Conowingo East Eel Collection Facility (CEECF)[1] will commence operation 10 days following the end of EFL operation and will continue to operate until the mean daily water temperature is 10 degrees Celsius or less for three consecutive days, as determined by hourly readings at Exelon's monitoring station 643 (located 0.6 miles downstream of Conowingo Dam) or by manual readings taken at an alternative location within the Project tailrace.

[1] The temporary eel collection facility at the East Fish Lift stilling basin will be installed within twelve (12) months of completing the East Fish Lift modifications described in the FERC License, Appendix 1.

2 PROJECT CONFIGURATION

The Project consists of 1) a main dam, 2) a spillway, 3) a reservoir (Conowingo Pond), and 4) an intake and powerhouse.

The Conowingo Dam is a concrete gravity dam with a maximum height of approximately 94 feet and a total length of 4,648 feet. The dam consists of four distinct sections from east to west: a 1,190-foot long non-overflow gravity section with an elevation of 115.7 feet[2]; an ogee shaped spillway, the major portion of which is 2,250 feet long with a crest elevation of 86.7 feet, and the minor portion of which is 135 feet long with a crest elevation of 98.7 feet; an intake-powerhouse section which is 950 feet long; and a 100-foot long abutment section (Figure 2.0-1). The dam and powerhouse also support US Highway Route No. 1, which passes over the top of Conowingo Dam. The East and West Fish Lifts are located at opposite ends of the powerhouse.

Flow over the Conowingo Main Dam spillway is controlled by 50 stony-type crest gates with crest elevations of 86.7 feet and two regulating gates with crest elevations of 98.7 feet. Each of the crest gates are 22.5 feet high by 38 feet wide and have a discharge capacity of approximately 16,000 cubic feet per second (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 approximately 5,000 cfs per gate at a reservoir elevation of 109.2 feet.

Conowingo Pond extends approximately 14 miles upstream from Conowingo Dam to the lower end of the Holtwood Project tailrace. The Conowingo Pond is generally maintained at an elevation of 109.2 feet, with a surface area of approximately 8,500 acres and a total impoundment design volume of 310,000 acre-feet at that elevation.

The Project powerhouse contains eleven main turbines, as well as two house turbines (Table 2.0-1). The house units are located on the far western end of the powerhouse, whereas the larger units are arranged in order such that Unit 1 discharges near the western end of the dam, and Unit 11 discharges near the eastern end of the dam. Units 2 and 5 are equipped with aerating runners, which serve to increase dissolved oxygen (DO) levels in the turbine discharge water. The Project intakes for each turbine are individually protected by seven trash racks; five are entirely steel (clear spacing of 5.375 inches) and two are steel framed with wood racks (clear spacing of 4.75 inches). The top two racks are constructed of wood due to frazzle ice accumulations on the steel sections.

[2] Unless noted otherwise, elevations are in the National Geodetic Vertical Datum of 1929 (NGVD 1929), as opposed to Conowingo Datum. There is 0.702-foot difference between Conowingo Datum and NGVD 1929 Datum (i.e. El. 100.00 Conowingo Datum = 100.702 NGVD 1929 Datum).

Table 2.0-1: Conowingo Project Turbine Specifications

Unit	Type	Runner Speed (rpm)	Rated Output (hp)	Approx. Rated Discharge (cfs)
House #1	Francis	360	1,900	247
House #2	Francis	360	1,900	247
1	Francis	81.8	64,500	6,749
2	Francis	81.8	54,000	6,320
3	Francis	81.8	64,500	6,749
4	Francis	81.8	64,500	6,749
5	Francis	81.8	54,000	6,320
6	Francis	81.8	64,500	6,749
7	Francis	81.8	64,500	6,749
8	Mixed-Flow Kaplan	120	85,000	9,352
9	Mixed-Flow Kaplan	120	85,000	9,727
10	Mixed-Flow Kaplan	120	85,000	9,727
11	Mixed-Flow Kaplan	120	85,000	9,727

EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405
Eel Passage and Restoration Plan

N

0 250 500 1,000 Feet

1 inch = 500 feet

Figure 2.0-1:
Project Configuration

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Path: X:\GISMaps\project_maps\eel_passage_and_restoration\figure_2_0-1_configuration.mxd

3 UPSTREAM TRAPPING, TRANSPORT, AND STOCKING FOR AMERICAN EEL

Exelon will trap and hold American Eels and then transport them to designated stocking locations in the Susquehanna River watershed in compliance with Article 414 and FERC License Appendix 1. Article 414 reads:

> *Upon license issuance, in addition to complying with U.S. Department of the Interior's section 18 prescription (Appendix 1), the licensee must:*
>
> *a) Operate all current and proposed eel fishways on the west side of the Conowingo Dam from May 1 until mean daily water temperature, as determined by hourly readings at Exelon's monitoring station 643 (located 0.6 mile downstream of Conowingo Dam), is 10 degrees Celsius or less for three consecutive days.*
>
> *b) Operate all current and proposed eel fishways on the east side of Conowingo Dam from 10 days after the date that American shad operations cease at the East Fish Lift until mean daily water temperature, as determined by hourly readings at Exelon's monitoring station 643 (located 0.6 mile downstream of Conowingo Dam), is 10 degrees Celsius or less for three consecutive days*[3].
>
> *c) Maintain the upstream eel passage trap and transport program through 2035 .*
>
> *d) During the 10 years of operating the East Fish Lift with the eel temporary modifications (12.6.1 of the section 18 prescription), if the number of eels exceeds the maximum capacity of eels per unit of ramp area, redesign and construct the East Fish Lift - Eel Temporary Modifications to reduce crowding.*
>
> *e) If, after 10 years of operating the East Fish Lift with the eel temporary modifications (12.6.1 of the section 18 prescription), the 10-year average annual catch of the East Fish Lift is greater than or equal to 50% of the comparable 10-year average catch of eels at the eel trapping facility at the West Fish Lift, design, install, and operate a permanent eel trapping facility at the location of the East Fish Lift, in accordance with a schedule agreed upon by the Maryland Department of the Environment (MDE) and the U.S. Fish and Wildlife Service (FWS), and approved by the Commission. The 10-year average must be based on comparable dates of operation, as the East Fish Lift eel temporary modifications will operate a shorter period than the eel trapping facility at the West Fish Lift. The licensee must maintain and operate the eel trapping facility at the West Fish Lift for the term of the new license, but is not required to maintain and operate more than two permanent eel traps (e.g., the eel trapping facility at the West Fish Lift and either an eel trapping facility at the location of the East Fish Lift or Octoraro Creek, or comparable facility required under the Muddy Run Project License (FERC No. 2355) at any time, unless otherwise directed by the Commission.*
>
> *Unless otherwise directed by the Commission, the licensee must not make any modifications, undertake any construction, or make any changes to the operation of any eel fishway without the agreement of the MDE and FWS and approval from the Commission.*

[3] Station 643 will operate through October 31 each year. Beginning November 1, water temperature readings will be taken manually at the CWECF.

> *The Commission reserves the right to require changes to any proposed modification. Modifications must not begin until the licensee is notified by the Commission that the modifications are approved. Upon Commission approval, the licensee must implement proposed modifications, including any changes required by the Commission.*

All activities addressed in this EPRP that occur in Maryland waters are subject to any permits, licenses, or authorizations that may be required by the State of Maryland. All activities addressed in this EPRP that occur in Pennsylvania waters are subject to any permits, licenses, or authorizations that may be required by the Commonwealth of Pennsylvania.

3.1 Description of Facilities

Per MRPSP FERC license requirements, Exelon currently operates two American Eel collection facilities, the CWECF on the west shore of the Susquehanna River near Conowingo Dam and the OECF on Octoraro Creek below the Pine Grove Dam in Chester County, Pennsylvania. In addition to these two collection facilities, Exelon will design, construct, and operate a temporary eel collection facility in the vicinity of the Conowingo EFL, the CEECF. Features of each collection facility are detailed below.

3.1.1 Conowingo West Eel Collection Facility

The CWECF is located on the right (west) bank of the Conowingo Dam tailrace (Figure 3.1.1-1). Beginning in 2005, US Fish and Wildlife Service (USFWS) began collecting eels near the base of the Conowingo Dam at various locations. Information from these initial studies assisted in directing restoration efforts in the Susquehanna watershed above Conowingo Dam. During 2005 and 2006 exploratory efforts were conducted to determine the best placement and design of a temporary trapping facility. In 2007, elvers were observed climbing up the riprap where water was spilling over from pumps operated to supply water for the West Fish Lift operations. Since 2008, eels have been trapped and transported near this area on the west side of the Conowingo Dam in some capacity. From 2008 through 2016, excess water from the West Fish Lift operations was used as attraction flow over riprap. Elvers that found this attraction flow would crawl up the riprap to the trap and they were then transported and stocked in tributaries to the Susquehanna River and the Susquehanna River mainstem. In 2013, the USFWS increased the number of holding tanks and water supply and drainpipe sizes to improve holding capability. From 2005 to 2016, annual eel captures ranged from 19 to 293,141, with a total of 839,120 eel captures during the entire 2005-2016 period. The current facility was constructed in 2017 per USFWS design criteria and consists of four main elements: (1) a water supply line; (2) a ramp; (3) a collection tank; and (4) multiple holding tanks.

3.1.2 Octoraro Creek Eel Collection Facility[4]

The OECF is located on the left bank of Octoraro Creek immediately downstream of the CWA's Pine Grove Low-Head Dam (Figure 3.1.2-1). The facility was constructed in 2015 and consists of three main elements: (1) a water supply line and a submersible pump; (2) two ramps; and (3) a collection tank. Eels collected at the OECF are transported directly to, and held at, the CWECF at Conowingo Dam prior to transport upstream.

3.1.3 Conowingo East Eel Collection Facility

The CEECF will be located at the stilling basin dissipation wall within the EFL at Conowingo Dam, as called for in the MDE Settlement (2019) (Figure 3.1.1-1). The CEECF is an experimental facility that will operate for 10 years on a temporary basis to determine its suitability as a potential permanent location for the collection of eels. The location of the facility within the EFL was recommended by MDE to evaluate the feasibility of capturing eels on the easterly side of Conowingo Dam, as the American Eel Passage Plan

[4] Details governing the Octoraro Creek Eel Collection Facility are contained in the MRPSP American Eel Passage Plan.

contained in the MRPSP FERC license as well as the Conowingo FERC license, Appendix 1 precludes the construction of any American Eel collection facilities below the Conowingo spillway. The facility will consist of three main elements: (1) a water supply line; (2) a ramp; and (3) a collection tank. Eels collected at the CEECF will be transported directly to, and held at, the CWECF prior to transport upstream. This facility will be installed and put in service 12 months after modifications related to upstream American Shad and river herring passage at the EFL are completed. Operation of the facility will start each season ten (10) days following the end of the operation of the East Fish Lift.[5]

3.2 Trapping and Collection

3.2.1 Design

For the purposes of this plan, "trapping" includes the operation of a ramp-style trap and "collection" refers to operation of the collection tank where juvenile eels are temporarily held after ascending the ramp. All facilities are a flow-through system and no recirculation of any water is used except for attraction flow.

Conowingo West Eel Collection Facility

This facility was put in service on May 1, 2017 upon approval by FERC and the Muddy Run Eel Passage Advisory Group (EPAG)[6]. Under Conowingo License Article 414, the CWECF will operate through 2035. The CWECF contains one collection tank, which is 1.02 meter (m) wide with a length of 1.83 m. The depth of the water in the collection tank is about 686 millimeters (mm), with a volume of approximately 1,274 liters (L). With a maximum density of 10 eels per L, the collection tank can hold up to 12,740 eels at once. The collection tank has 203 mm of freeboard to keep eels from climbing out of the tank. The main flow into the collection tank is provided from the 51-mm fill line with the terminus of the pipe about 51 mm above the waterline providing a constant flow of freshwater to the tank. Also, some water from the spray bar flow also enters the collection tank from the backside of the ramp. The upper end of the ramp is custom fitted into the collection tank and ends about 102 mm above the high-water mark in the tank. The collection tank contains a drain comprised of a 102-mm diameter PVC pipe with holes drilled through it and wrapped in 1-mm mesh to prevent juvenile eel escapement. The 102-mm collection tank drain line contains a 25-mm gravity drain line with a ball valve that is directed to the highest point possible (gravity feed) of the ramp, thus providing eel scent from the eels in the collection tank to the ramp. The collection tank also contains a 76-mm drain line, positioned about 76 mm off the bottom. The drain line attaches to a gate valve that remains closed until eels are removed. The 76 and 102-mm flexible drain lines empty into the overflow tank. The collection tank was custom fitted with a lid made from 6-mm polycarbonate sheet. In addition to the in-line flow meter, the collection tank contains a water temperature and DO probe.

The juvenile eel ramp is constructed of an aluminum cable tray. The cable tray contains landscape fabric climbing substrate (Enkamat 7010) attached to the tray bottom. This substrate consists of a dense three-dimensional mesh of fused filaments, which provides a climbing surface for the juvenile eels. The ramp consists of an approximately 8.75 m long by 457 mm wide cable tray positioned at a 42.5° angle, plus a continuous length of tray that is bent and shaped at a 90° angle over a 25 mm radius at the top of the ramp to convey juvenile eels into the collection tank. The entrance of the ramp is at elevation 29 feet, which is above the normal high-water line (elevation ±21 feet), with a smooth transition to the existing rip-rap shoreline. The facility is designed so that eels ascend the riprap between the tailwater surface and the entrance of the ramp. This portion of the riprap is wetted from the attraction flow exiting the eel ramp and the overflow tank down to the tailwater level. Once eels ascend the rip-rap portion, they enter the eel ramp

[5] The East Fish Lift operation will operate until river temperatures rise above 72 degrees Fahrenheit for four consecutive days, but ending no earlier than June 1 and no later than June 15.

[6] EPAG is a requirement under the MRPSP License and is chaired by Exelon with membership consisting of representatives of Pennsylvania Department of Environmental Protection, Pennsylvania Fish and Boat Commission, USFWS, the Maryland Department of Natural Resources, and the SRBC.

and can ascend to the collection tank. The ramp is held in place by six metal braces, evenly spread across the length of the ramp, and attached to large substrate along the shoreline. The ramp is covered from the top down to near the entrance to protect juvenile eels when ascending. The large 60% shade cloth[7] is installed below the entrance to help protect juvenile eels between the tailrace and the entrance of the ramp.

The facility uses up to 265 L per minute of water to provide attraction flow to the eel ramp and for use within the collection tank. A 203-mm diameter gravity feed line supplies water for the CWECF. The water line forms a manifold at elevation 46 feet and contains four 51 mm globe valves for the Conowingo West Fish Lift and one 76 mm gate valve for the CWECF. The main water line for the CWECF is 76 mm in diameter, but each fill line for each tank is 51 mm in diameter. Each fill line has one 51 mm gate valve and one 51 mm angle valve along with an inline flow meter between these valves. A separate 25 mm line with a ball valve continuously discharges water down the ramp and into the collection tank via a spray bar, keeping the substrate moist and creating a flow to attract juvenile eels. Climbing ramp flow is augmented by a 25-mm diameter scent line from a tap and ball valve from the collection tank drain providing additional attraction flow via this gravity feed hose. The overflow tank collects the water from the collection tank and the holding tanks that are in service. Two 102-mm diameter additional attraction flow pipes drain the overflow tank and are discharged near the entrance of the ramp. These additional flow pipes are discharged above the shade cloth allowing the water to disperse over a larger area and provide additional attraction. All water from the ramp and the additional attraction pipes provides the overall attraction flow down the shoreline riprap to the tailrace. Engineering drawings for the facility are in Appendix A.

Octoraro Creek Eel Collection Facility

The OECF collection tank is 660 mm wide with a length of 1,575 mm. The depth of the water in the collection tank is about 299 mm, with a volume of approximately 310.4 L. With a maximum density of 10 eels per L, the collection tank can hold up to 3,104 eels at once. The collection tank has 209 mm of freeboard to keep eels from climbing out of the tank. The collection tank is filled by allowing some of the spray bar flow to enter the collection tank, thus providing a constant flow of freshwater to the tank. The collection tank contains two drains that are comprised of a 76-mm PVC pipe with holes drilled through it and wrapped in 1-mm mesh to prevent juvenile eels from escaping. The drain line is directed to the highest point possible (gravity feed) to the cover of the ramp to add the scent of the eels into the ramp. The upper end of the ramp is custom fitted into the collection tank and ends about 50 mm above the high-water mark in the tank. The collection tank is custom fitted with a lid that is held down by clamps.

Each ramp consists of approximately 12.34 m x 305 mm wide cable trays positioned at approximately a 30° angle, plus a continuous length of tray that was bent and shaped at a 90° angle over a 25 mm radius at the top to convey juvenile eels into the collection tank. The entrance of each ramp is located underwater, during all tailwater elevations, with a smooth transition to the existing riverbed adjacent to a quiescent pool located in the creek. Ramps are held in place by a scaffold structure located approximately mid-length and four T-shaped solid metal braces, evenly spread across the length of the ramp and driven into the ground beneath the ramps. Ramps are covered from the top down to near the tailwater median flow height to protect juvenile eels when ascending. One cable tray contains a landscape fabric climbing substrate (Enkamat 7010) attached to the tray bottom. The other cable tray contains Milieu small substrate, with staggered vertical tubes.

Water flow to the ramps is supplied from a one horsepower (hp) submersible pump that is installed in a 114-L barrel in the forebay above CWA's Pine Grove Low-Head Dam. The barrel contains about 50, 38 mm holes that are covered with 1 mm mesh screen to prevent any material from entering the pump, lines

[7] The percentage listed refers to the percentage of sunlight and corresponding UV rays that is blocked by the shade cloth.

and manifold that could cause clogging. The barrel is deployed in the forebay about 1.2 m below the water surface. The underground 51 mm water line is encased in 203-mm PVC, to protect the line. The 51 mm water line is attached to a 51 mm manifold with seven 25 mm ball valves that supply water to the spray bars and additional attraction flow lines. Water is continuously discharged down the ramp and into the collection tank via a spray bar, keeping the substrates moist and creating a flow to attract juvenile eels. Climbing ramp flow is augmented by additional attraction flow from the overflow of the collection tank via a gravity feed 25 mm scent line hose. Two additional 25 mm hoses are attached to the cover of each ramp near the water's edge to create splashing and additional attraction flow for the juvenile eels. The facility uses up to 265 L per minute of water to provide attraction flow to the eel ramp and for use within the collection tank. Each ramp has one spray bar and two attraction flow lines. Engineering drawings for the facility are in Appendix B.

Conowingo East Eel Collection Facility [8]

The temporary CEECF will be installed each year ten (10) days after the completion of the upstream anadromous fish migration season, beginning the first eel season after the completion of the modifications to the EFL under the FERC License, Appendix 1, Section 12.6.1[9], and will be located in the EFL stilling basin in the vicinity of the spillway.[10] The temporary CEECF will be operated for ten (10) years, beginning after the EFL modifications are completed. If, after 10 years of operating the CEECF, the 10-year average annual catch of the CEECF is greater than or equal to 50% of the comparable 10-year average catch of eels at the CWECF, Exelon will design, install, and operate a permanent eel trapping facility at the location of the CEECF, in accordance with a schedule agreed upon by MDE and USFWS and approved by FERC. The 10-year average must be based on comparable dates of operation, as the CEECF will operate a shorter period than the CWECF. Exelon will maintain and operate the CWECF and either an eel trapping facility at the location of the CEECF or Octoraro Creek, or comparable facility required under the MRPSP FERC License at any time, unless otherwise directed by FERC. No modifications, construction, or other changes will be made to the operation of any eel fishway at the Conowingo Dam without the agreement of MDE and USFWS and approval of FERC.

The CEECF will contain one collection tank positioned on a platform, which is 660 mm wide with a length of 1,575 mm. The depth of the water in the collection tank is about 299 mm, with a volume of approximately 310.4 L. With a maximum density of 10 eels per L, the collection tank can hold up to 3,104 eels at once. The collection tank has 209 mm of freeboard to keep eels from climbing out of the tank. The collection tank is filled by a 25-mm fill line and also filled by allowing some of the spray bar flow to enter the collection tank, thus providing a constant flow of freshwater to the tank. The top end of the ramp is custom fitted into the collection tank and ends about 50 mm above the high-water mark in the tank. The 76-mm collection tank drain line contains a 25-mm gravity drain line with a ball valve that is directed to the highest

[8] The attached drawings for the temporary eel facility at the EFL are based upon the most current EFL designs and will be resubmitted to the Resource Agencies and FERC for approval, if there are any changes to the EFL designs resulting from FERC License Appendix 1, Section 12.6.1. The Fishway Operations and Maintenance Plan will also be updated to reflect any changes in flows, unit operation, or other aspects with respect to eel collection facilities at Conowingo.

[9] The construction schedule for the EFL modifications for river herring and American Shad has not been finalized. The CEECF will be installed after the EFL modifications are complete. Exelon will provide schedule updates at a minimum during the annual EPAG meetings and will also update this plan accordingly and submit it to the resource agencies for review and FERC for approval. Exelon also participates in monthly design-planning meetings with resource agencies, and schedule is discussed during these meetings.

[10] Due to safety concerns, no equipment will be placed in the spillway. This is confirmed in the MDE Settlement, Draft Article XX. Eel Passage, i, "…in no case, shall any temporary or permanent eel ramps be required to be constructed in the Conowingo Dam spillway area. Additionally, the MRPSP FERC License requirements also exclude the spillway as a potential location for an eel facility due to safety concerns.

point possible (gravity feed) of the ramp, thus providing eel scent from the eels in the collection tank to the ramp. The collection tank also contains a 76-mm drain line, positioned near the bottom of the collection tank. The drain line attaches to a knife valve that remains closed until eels are removed. The collection tank is custom fitted with a lid that is held down by clamps. The EFL gravity-feed water supply, which withdraws water from approximately elevation 100.7 feet from Conowingo Pond, will provide water for the attraction flow for the CEECF. (Attraction flow will be approximately 265 L-per-minute). Proper operation of the components will be ensured through daily inspections and recording of water temperature and DO levels and weekly calibration of the water supply systems.

The juvenile eel ramp is constructed of an aluminum cable tray. The cable tray contains landscape fabric climbing substrate (Enkamat 7010) attached to the tray bottom. This substrate consists of a dense three-dimensional mesh of fused filaments, which provides a climbing surface for the juvenile eels. The ramp consists of an approximately 5 m long by 457 mm wide cable tray positioned at a 30° angle, plus a continuous length of tray that is bent and shaped at a 90° angle over a 25 mm radius at the top of the ramp to convey juvenile eels into the collection tank. The base of the ramp is at approximately elevation 17.8 feet, which is above the minimum tailwater line of approximately 12.9 feet (elevation at a flow of 4,000 cfs), with a smooth transition to the existing concrete stilling basin/east fish lift area floor. The facility is designed so that eels ascend the concrete floor between the tailwater surface and the end of the ramp. This portion of the concrete is wetted from the attraction flow exiting the eel ramp down to the tailwater level. Once eels ascend the concrete portion, they enter the eel ramp and can ascend to the collection tank. The ramp is held in place by metal braces, evenly spread across the length of the ramp, and attached to the existing concrete structures. The ramp is covered with a metal plate from the top down to near the normal high-water line (elevation ±21 feet) to protect juvenile eels from avian predators when ascending. A large 60% shade cloth is installed below the entrance to help protect juvenile eels between the tailrace and the entrance of the ramp.

A gravity feed water line supplies at least 265 L per minute to the collection tank and ramp for eel attraction. A 51-mm diameter gravity feed line supplies water for the CEECF. The water line forms a manifold at elevation 48 feet and contains one 51-mm ball valve and two 25-mm ball valves for the CEECF (i.e., supply water to the spray bars and additional attraction flow lines). The main water line for the CEECF is 25 mm in diameter. The fill line has one 25-mm ball valve. A separate 25-mm line with a ball valve continuously discharges water down the ramp and into the collection tank via a spray bar, keeping the substrate moist and creating a flow to attract juvenile eels. Climbing ramp flow is augmented by additional attraction flow from the overflow of the collection tank via a gravity feed 25-mm scent line hose and 25 -mm ball valve. Two additional 25-mm hoses are attached to the cover of each ramp near the water's edge to create splashing and additional attraction flow for the juvenile eels. All water from the ramp and the additional attraction pipes provides the overall attraction flow down the concrete to the tailrace. Engineering drawings for the facility are in Appendix C and an annotated presentation of the drawings is included in Appendix D.

During the 10 years of operation, if the number of American Eels attempting to migrate to the CEECF exceeds 90,000 eels per day, which is the maximum capacity of American Eels per unit of ramp area[11], or if densities in the collection tank exceed 10 eels per L, the facility will be modified, or operational protocols adjusted to reduce crowding, in consultation with MDE, USFWS, and EPAG.

[11] The maximum capacity of American Eels per unit of ramp area is based on the USFWS Fish Passage Engineering Design Criteria (USFWS, 2019), which gives a guideline of 5,000 eels per day per inch of ramp width, assuming that the mean eels are a size of 150 mm, total length.

3.2.2 Construction

Both the CWECF and OECF are constructed and have been in operation since 2017 and 2015, respectively. Modifications to the EFL to improve passage of American shad and river herring will be constructed as required by the Conowingo License, Appendix 1. The CEECF will be constructed, to be operational within 12 months of completion of construction of the EFL American shad and river herring improvements.

3.2.3 Operational Protocols

All trapping and collection facilities will be operated in accordance with the schedule outlined in Section 5 and the following protocols.

The CEECF will be operated using the following gate position downstream of the facility inside the EFL[12].

- Downstream Weir Gate C: 100% open
- Downstream Weir Gate B: 0% open
- Upstream Weir Gate A: 0% open (to keep debris out of EFL)
- Diffuser Gate A: 100% open
- Diffuser Gate B: 100% open
- Crowder Area Gate: 100% open
- Crowder doors: fully open
- Crowder Screen Hoist: fully lowered (to keep debris out of hopper area)
- Crowder Dividing Screen: fully raised
- Crowder Channel Screen: fully raised
- Trash Rack A: fully raised
- Trash Rack B: raised a few feet (bottom of rack at full generation elevation)

Attraction flows for the CEECF will be from the gravity-fed water system from the headpond only. The Spillway Gates A and B along with the Spillway Trough Gate will be fully closed and locked out for safety measures prior to and during eel passage season at the CEECF.

The ramp will be removed when flows are forecast to exceed 113,000 cfs and will be reinstalled when flows have receded to a level that will allow for safe access.

Monitoring

At each facility, proper operation of the components will be ensured either through the continuous monitoring of water flow supplied to the ramp and collection tank with an alarm system triggered by low flows or low DO conditions that are not within design parameters (CWECF), or by daily inspections and continuous recording of water temperature and DO levels and weekly calibration of the water supply systems (OECF and CEECF). If an alarm at the CWECF is triggered by low DO or flow, an alarm sounds in the Station control room and a text message/email is sent to Exelon's contractor. If Exelon station personnel are unable to resolve the issue, the contractor will come to the site to troubleshoot and correct the issue. Daily Field Sheets are included in Appendix E. The collection tanks hold American Eel at densities not exceeding 10 elvers per L unless otherwise agreed to by Exelon, MDE, and the USFWS. If deemed necessary by MDE, USFWS, or FERC, Exelon will provide aeration to the collection tanks.

During any instance when alarms indicate or daily inspections suggest that attraction or ramp flow is not within design parameters and cannot be adjusted to operate within these parameters within 24 hours, it will

[12] This section will be updated if there are if there are any changes to the CEECF operation required by updated EFL designs per from Appendix 1 Section 12.6.1 of the Conowingo License. Any changes to operation protocols will be resubmitted to the Resource Agencies and FERC for approval.

be considered an emergency, and operators must follow the Emergency Response Protocols outlined in Section 3.6.

Verification and Testing

The main flow and spray bar flow will be independently measured once per week to verify that the flow meters are providing accurate measurements. If a flow meter provides measurements that differ from the design parameters the main flow meter will be re-calibrated or replaced.

Similarly, the temperature and DO meter will be tested once each week using an independent meter(s) to verify that they are accurate. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, or outside the designed parameters, then it will be re-calibrated, repaired, or replaced.

The alarm systems monitoring flow rates will be tested once per week. Monitors will be tested against deliberate deviations from the design range to ensure that these deviations trigger the alarms. The Conowingo Control Room will be contacted prior to any testing of the alarms.

Inspection

The ramp, cover, substrate, attraction flow, spray bar, and ramp flow will be visually inspected daily to ensure proper operation. If any component is not functioning properly, corrections and/or repairs will be made as soon as practicable. Results of any inspection items that require further action will be recorded on a Daily Field Sheet (Appendix E).

If an inspection suggests that any structure or flow component is not performing properly and no alarm has been triggered, verification of this potential deviation will be performed as described above and corrective action will be taken as soon as possible. If equipment function cannot be immediately repaired, inspectors will refer to Inspection Response Protocols outlined in Section 3.6.

Maintenance

The collection tanks will be drained daily to ensure all eels have been removed. At least once per week, the collection tank(s) will be scrubbed. Scrubbing the tanks is performed with water, a brush, and scouring pad. No chemicals are used.

Debris that would block or hinder passage of eels that is observed on the ramp and substrate during visual inspections will be removed at the time of the inspection. If the debris cannot be removed upon inspection for any reason, it will be removed as soon as practicable thereafter.

At the end of each sampling season, and if determined to be necessary during the season, the ramp will be cleaned. During this cleaning process the substrate will be inspected for any degradation or damage. Sections of substrate will be replaced if necessary. Maintenance activities are recorded on a Daily Field Sheet (Appendix E).

American Eel Counting

Juvenile eels will be counted during each daily check upon removal from the collection tank. When small numbers of eels (fewer than 1,000) are observed in the collection tank, actual counts will be performed. Large quantities of eels will be counted volumetrically. Volumetric estimates will be performed by placing 200 mL of water in a graduated container and then placing anesthetized juvenile eels in the graduated container until it is filled to the 400 mL mark. These juvenile eels will be counted to determine the number of eels displaced by 200 mL of water. Four Ls of water will be added into a 20-L graduated bucket, the

remaining eels from the collection tank will be added to the 20-L bucket, and the resulting displacement of water will indicate the number of eels[13]. This process will be repeated until all juvenile eels have been removed from the collection tank. Length measurements, weight, and condition factor will be taken from a maximum of 25 eels on a bi-weekly basis. Eels will be measured to the nearest mm and weighed to the nearest 0.1 grams after being anesthetized.

All data collected will be recorded on the Daily Field Sheet (Appendix E). Any dead eels will be removed, enumerated, and recorded on the Daily Field Sheet. At the CWECF, the number of eels added to a given holding tank will be recorded, and at the other facilities, the number transferred to the holding tank(s) at the CWECF will be recorded.

3.3 Holding

For this plan, "holding" refers to the retention of eels in holding tanks after removal from the collection tank.

Conowingo West Eel Collection Facility

The only facility with holding capabilities other than in a collection tank is the CWECF. Eels from the OECF and CEECF are transported daily to the CWECF for holding. At the CWECF, there are three holding tanks positioned along a concrete pad. Juvenile eels captured in the collection tank(s) are counted and transferred to one of the three holding tanks. Eel that are transferred to holding tanks are recorded on the Daily Field Sheet (Appendix E).

3.3.1 Design

The CWECF contains three stainless steel holding tanks, with a total holding capacity of 51,660 juvenile eels at a maximum density of 10 eels per L of water. Each holding tank is 1.68 m wide and 1.68 m long. The depth of the water in each collection tank is 0.61 m, providing approximately 1,722 L of water in each tank. A freeboard of 203 mm is provided to prevent eels from climbing and escaping. The bottom of each holding tank is sloped to the center drain to help flush all water and eels from the tank. The top of the center drainpipe is fitted with a 457-mm square screen drain that has a height of 203 mm. The screen drain is constructed of 1-mm mesh to prevent eels from escaping and allows consistent water exchange. This screened box is attached to a 102-mm PVC pipe fitted into a 102-mm bulkhead fitting that is removed to drain the tank completely. The bulkhead fitting is attached to a 90° PVC fitting and attached to a 102-mm flexible hose by a cam fitting that drains into an overflow tank. The main flow into a holding tank is supplied by the 51-mm fill line with the terminus of the pipe about 51-mm above the waterline, providing a constant flow of freshwater to the tank.

An overflow tank holds the overflow water discharged from the holding tank system, where it is discharged to the bottom of the ramp to provide attraction flow and eel scent. The overflow tank is a 568-L tank containing three 76 mm bulkhead fittings. These bulkhead fittings are attached to 76-mm PVC solid wall pipe that is used to provide the additional attraction flow near the entrance of the ramp. The overflow tank is filled by the collection tank and all in-service holding tank drain lines. Prior to any tank being drained, a very fine mesh bag is hose clamped to the end of the drain hose to ensure that no eels are released into the overflow tank. The drain hose with the mesh bag attached is placed into the overflow, which acts as a water cushion for the eels being collected in the bag.

[13] For example, if 100 eels were counted in the displaced 200 mL graduated container, the resulting ratio would be 500 eels per L. If the displacement of water in the 20-L bucket is four L, then 2,000 eels are in the 20-L bucket.

3.3.2 Operational Protocols

The number of holding tanks operating at any time will be determined by the number of eels being held at the CWECF. The number of juvenile eels in each holding tank will not exceed 17,222 eels, which is 10 juvenile eels per L. Juvenile eels may be held in holding tanks for a maximum of seven days prior to transport unless conditions (water temperature above 28.0°C or air temperature above 32.0°C on consecutive days) warrant transports to be conducted on multiple days throughout the week. Specifically, EPAG agreed that transports should occur at least twice per week starting in mid-June and continue through September 15. Additionally, daily transports are also conducted pre-emptively as water temperatures near 28°C or eels become crowded in the holding tanks. The CWECF is maintained daily and decisions to transport are made in real-time based on eel condition, environmental conditions, and the number of eels in holding. A transport vehicle is left on-site to facilitate the ability to conduct transports as needed.

Monitoring

Proper operation of the holding facility will be ensured through the continuous monitoring of flow and water quality parameters, weekly verification of monitors, and daily inspections.

Water Exchange: The amount of water flowing into each operational holding tank will be monitored continuously. If measured flows are not within the design parameters flow (19 to 151 L per minute per tank in service), a sensor will trigger an alarm that will alert the Conowingo Control Room. Also, in the event of an alarm, an e-mail notification will be sent immediately to operational personnel. Contact lists are updated regularly and will be distributed to resource agencies, Station staff, and contractors each season.

Temperature: Water temperature in each operational holding tank will be monitored continuously. If measured temperature is not within the design parameters (10-35° C), a sensor will trigger an alarm that will alert the Conowingo Control Room. Also, in the event of an alarm, an e-mail notification will be sent immediately to operational personnel.

Dissolved Oxygen: Concentration of DO in each operational holding tank will be monitored continuously. If measured concentrations are not within the design parameters (5-20 ppm), a sensor will trigger an alarm that will alert the Conowingo Control Room. Also, in the event of an alarm, an e-mail notification will be sent immediately to operational personnel.

Verification and Testing

The flow into each holding tank will be measured once per week to verify that the flow meters are providing accurate flow measurements. If a flow meter provides measurements that differ from the design parameters, then the holding tank flow meter will be re-calibrated or replaced.

Similarly, the temperature and DO meters will be tested once each week using an independent meter(s) to verify that they are accurate. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, or outside the designed parameters, then it will be re-calibrated, repaired, or replaced.

Alarm systems for holding tanks will be tested once per week. Monitors of flow, temperature, and DO will be tested against deliberate deviations from the design ranges to ensure that these deviations trigger the alarms. The Conowingo Control Room will be contacted prior to any testing of the alarms.

Inspection

The holding tanks in use will be inspected daily to ensure proper operation. Results of any inspection items that require further action will be recorded on a Daily Field Sheet. If the flow through the holding tanks,

water temperature, or DO is suspected of operating outside of design parameters, investigation of this suspected deviation will be performed via verification measuring, as described above, and, if found to be operating outside of design parameters, immediate action will be taken to find a solution. Upon a failed inspection, inspectors will refer to Failed Inspection protocols outlined in Section 3.6.

Maintenance

Every week, the holding tank(s) that were used will be scrubbed and air dried, and this cleaning will be recorded on the associated Daily Field Sheet. Eels will be removed from the holding tanks prior to scrubbing, and every effort will be made to coordinate cleaning with transport so that the tanks are cleaned after eels are removed for transport.

The holding tanks will be drained and cleaned at the end of the trapping season, after operations at the ramp have ceased and all juvenile eels have been transported.

American Eel Counting

During daily inspections of holding tanks, and immediately prior to transfer to transport tanks, any dead eels will be removed, enumerated, and recorded on the Daily Field Sheets.

3.4 Transport

For the purpose of this plan, "transport" refers to movement of eels from holding tanks to transport tanks and transport to the upstream stocking locations.

3.4.1 Design

Conowingo West Eel Collection Facility

When fewer than 150 eels are collected during a sampling event, transport will occur using aerated 19-L buckets with lids, containing the maximum amount of water to prevent sloshing, with no more than 50 eels in each bucket. When counts of juvenile eels are greater than 150 but less than 2,500 individuals, a small, enclosed transport tank (250 L) with supplemental oxygen capability will be used to transport eels to designated locations. When large loads (more than 2,500) of American Eels are transported, a custom-made transport truck and tank unit will be used to deliver eels efficiently and safely to designated stocking locations.

The transport truck is a non-CDL licensed, Department of Transportation truck with a 2,498-L two-chambered transport tank (1,249 L = 12,490 eels per compartment)[14] permanently centered on a flat bed. Each compartment contains a micro pore oxygen diffuser and an oxygen manifold connected to an oxygen bottle by a regulator. A monitor in the cab of the truck attached to a water quality probe that reads water temperature and DO concentration continuously is installed in each compartment. Each compartment has a 968-mm screen drain to release water prior to eels being released to check for any mortality. A 102-mm hose is connected to the 102-mm knife valve that is flush with the floor of the tank to ensure all eels and water are flushed from the tank. Engineering drawings for the transport facility are in Appendix F.

Octoraro Creek Eel Collection Facility

All juvenile eels that are captured at the OECF will be transported to the CWECF at Conowingo Dam daily where they will be held before subsequent transport and release at designated locations in the Susquehanna River watershed. When less than 150 eels are collected at the OECF during a sampling event, the eels will be transported in aerated 19-L buckets with lids that contain the maximum amount of water to prevent sloshing, with up to 50 eels in each bucket. When counts of juvenile eels are greater than 150 individuals,

[14] Transport tanks are designed to hold eels at densities less than 10 juvenile eels per liter.

a small, enclosed transport tank (250 L) filled completely to prevent sloshing and equipped with supplemental oxygen to maintain DO levels in the tank, will be used. When more eels are collected in a single day than the OECF collection tank or the transport tank can accommodate, multiple trips to transport eels from the OECF to the CWECF holding tanks are made.

Conowingo East Eel Collection Facility

All juvenile eels that are captured at the CEECF will be transported to the CWECF at Conowingo Dam daily where they will be held before subsequent transport and release at designated locations in the Susquehanna River watershed. Eels collected at the CEECF during a sampling event will be transported in aerated 19-L buckets with lids that contain the maximum amount of water to prevent sloshing, with no more than 50 eels in each bucket.

3.4.2 Operation Protocols

Monitoring

Transport of juvenile eels will occur at least once per week. Eels will be trucked to appropriate release locations on the same day of removal from holding. The frequency of transport will be increased if the capacity of the holding tanks is approached or if water temperatures are above 28°C. Specifically, EPAG agreed that transports should occur at least twice per week starting in mid-June and continue through September 15. Additionally, daily transports are also conducted pre-emptively as water temperatures near 28°C or eels become crowded in the holding tanks. Multiple daily transports could occur if holding capacity is expected to be exceeded at the CWECF. The number of juvenile eels placed in the transport tank(s) will not exceed 10 juvenile eels per L, and each transport tank will be equipped with supplemental oxygen for aeration. The tank will be fully enclosed during transport.

Temperature: Water temperature in the transport tank(s) will be monitored with the same meter used to monitor DO; the probe measures both parameters.

Dissolved Oxygen: A continuous supply of DO is provided with an oxygen bottle, regulator, and diffuser. Concentration of DO in the transport tank(s) will be monitored. If measured concentrations fall below 5 ppm, the transport crew will pull over at a safe location to quickly resolve the issue (adjust regulator pressure, hook up spare oxygen bottle, etc.).

Verification and Testing

Temperature and DO meters in the transport tanks will be tested once each week using an independent meter(s) to verify that they are accurate. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, then it will be re-calibrated, repaired, or replaced.

Inspection

Prior to each trip, the transport truck and associated equipment will be inspected to confirm that all equipment is operating as intended. The initial inspection will be done before any eels are transferred to a transport tank. Any necessary adjustments will be made, and the tank will then be filled approximately three-quarters full, immediately prior to inspection and subsequent transfer of eels to the transport tank. All drains and tanks will be secured and examined for leaks. Water quality parameters will be recorded prior to eels being added to the tank. The supplemental oxygen system will be checked to verify that it is functioning properly. A final inspection will be conducted after the eels are transferred to the transport tank. The transport tank will be completely filled to prevent sloshing when driving. All drains and tanks will again be examined for leaks again and water quality parameters will be recorded.

Water quality data during transports will be recorded. The transport system must pass initial inspection before any eels are transferred to the transport tank and final inspection before transport begins. If the transport system does not pass inspection, it may not be used for transport until all issues are resolved and it passes a subsequent inspection. These data are recorded on the Transport Data Sheet located in Appendix E.

Maintenance

Upon return to the CWECF, the transport tank will be opened to the air until the next transport. Transport tanks will be cleaned weekly.

American Eel Counting

The number of eels transferred to the transport tank from holding tanks will be recorded on the Daily Field Sheets and will be recorded as the total number of live eels currently present in the holding tanks.

Transport mortality will be determined by visually inspecting the transport tanks prior to and after the eels are released. Additionally, release areas will be inspected prior to leaving the stocking site. The stocking location is monitored until the water returns to pre-stocking conditions (i.e. water and sediment have settled following stocking). Most eels will seek cover as soon as they are stocked. Eels that have died will be visible lying belly-up and motionless on the stream bottom. Dead eels are retrieved by the stocking crew when access allows. Any dead eels observed during transport and release will be considered transport mortality. Eel mortalities from collection, holding, and transport will be reported to MDE, USFWS, and EPAG in the final report.

3.5 Stocking

Proposed stocking locations are summarized on Table 3.5-1 and shown in Figure 3.5-1. Stocking locations will be finalized and the amount stocked at each location will be determined in consultation with MDE, USFWS, and EPAG by February 1 each year. Progress in stocking these locations will be reported to MDE and EPAG after each transport trip and will be summarized during the annual eel passage meeting, during which input will be received on future stocking locations.

In addition to these stocking locations, which are focused on stocking eels to areas upstream of the Conowingo Project in the Susquehanna River watershed, MDE, USFWS, and EPAG will consider requests for eels to support research or alternative stocking projects (Appendix G). All requests are subject to approval from Exelon, MDE, USFWS, and EPAG. Requests for research or alternate stocking projects within New York State are also subject to approval from the New York State Department of Conservation. No more than 20% of the average annual catch will be provided in a given year for research or alternate stocking projects and transport of eels will be provided by the entity requesting the eels.

Each year, prior to April 1, 60 juvenile eels will be sampled randomly from tributaries below Conowingo Dam and sent to the USFWS or another resource agency for wild fish health screening. Protocols for selecting, preserving, and handling these eels will be developed in consultation with the receiving entity. Results of the wild fish health screening will be shared with MDE, USFWS, and EPAG.

3.6 Emergency Response Protocols

The goal of the restoration program is to achieve a minimum annual survival rate of 95% for juvenile eel during collection and holding processes. If these survival rates are not met in a given year, Exelon will, in consultation with MDE, USFWS, and EPAG, review the reasons that the 95% survival rates were not achieved and, if necessary, develop modifications that will be implemented prior to the start of the eel passage program in the following year.

3.6.1 Alarms and Contacts

For emergency purposes, a contact list with multiple emergency contacts will be developed for the Conowingo Control Room. These individuals will be responsible for responding to and resolving emergency situations at the facilities if station personnel cannot resolve the problem. Alarm systems, where applicable by facility, for flows, and DO in the collection and holding facilities, will be linked to the Conowingo Control Room for immediate alarm notification. Also, in the event of an alarm, an e-mail notification or text message will be sent to operational personnel five minutes after the Control Room has been notified. The operational personnel will contact the Conowingo Control Room and determine the appropriate action to be taken to correct the problem.

3.6.2 Inspection Response Protocols

As indicated in the previous sections, routine inspections will be performed at the facilities. Equipment that is not functioning as intended will be repaired or corrected immediately, if possible. If a facility is not functioning as intended and there is the potential for increased eel mortality (e.g., low flow to collection or holding tanks, high ambient river water temperatures, low DO concentrations), all eels in the facility will be transported to the next scheduled stocking location as soon as possible and, if necessary, the facility temporarily shut down until the issue is resolved. If there is no potential for increased eel mortality (e.g., attraction flow is not operating within design parameters), then it may not be required to temporarily shut down or immediately transport eels.

If an initial inspection determines that a transport tank or associated equipment are not functioning as intended prior to having eels transferred to it, no eels will be transferred to it until repairs have been completed and the equipment has been tested for proper function. If eels are transferred to a transport tank that then fails the final inspection, all eels must be transferred back to a holding tank unless the cause of failure can be addressed immediately, or to another transport tank if one is immediately available that has already passed initial inspection. Inspection forms are included in Appendix E.

3.7 Quality Assurance and Quality Control

As detailed in previous sections, 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 MDE, USFWS, and EPAG.

Various alarms and inspections, along with regular and seasonal maintenance, will ensure that the facilities are operating properly. All staff responsible for operating and maintaining trapping, holding, and transport components of the facilities will be trained and familiar with the specifications and operational parameters of applicable facilities/components. Supervising biologists will be responsible for training new staff members. Additionally, all operating personnel will be required to read and understand the Conowingo Fishway Operation and Maintenance Plan, as well as this Plan. Pertinent equipment and parts that are critical to operation of the facilities will be obtained and securely stored, to reduce the probability and extent of potential eel passage facility shutdowns.

Table 3.5-1: Stocking Locations for Juvenile Eel in the Susquehanna River Watershed

Site Number	Location	Water Body	County	Driving Distance (Miles)	Minimum Transport Time (hr:min)[15]
1	Conowingo Pool	Susquehanna River	Lancaster	< 20	< 0:30
2	Between Holtwood and Safe Harbor	Susquehanna River	Lancaster/York	25	0:40
3	Between Safe Harbor and York Haven Dam	Susquehanna River	Lancaster	36	0:55
4	Upstream of York Haven Dam	Susquehanna River	Dauphin	55	1:20
5	West Fairview Access (Route 11/15)	Susquehanna River	Cumberland	72	1:30
6	Fort Hunter Access	Susquehanna River	Dauphin	75	1:30
7	Shikellamy State Park	Susquehanna River	Northumberland	125	2:25
8	Route 487 Bloomsburg	N. Br. Susquehanna River	Columbia	130	2:40
9	Route 29 Bridge (Wilkes Barre) Nesbitt Park, (Kingston)	N. Br. Susquehanna River	Luzerne	142	2:50
10	Upstream of Hepburn Street Dam (Williamsport)	W. Br. Susquehanna River	Lycoming	155	3:00
11	Upstream of Grant Street Dam	W. Br. Susquehanna River	Clinton	180	3:10
12	City Island	Susquehanna River	Dauphin	70	1:30

[15] Actual transport times may be longer, due to slower driving with a loaded vehicle and multiple stocking locations per trip.

EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405
Eel Passage and Restoration Plan

N

0 250 500 1,000 Feet

1 inch = 500 feet

Figure 3.1.1-1:
Locations of Conowingo West Eel Collection and Holding Facility and Conowingo East Eel Collection Facility

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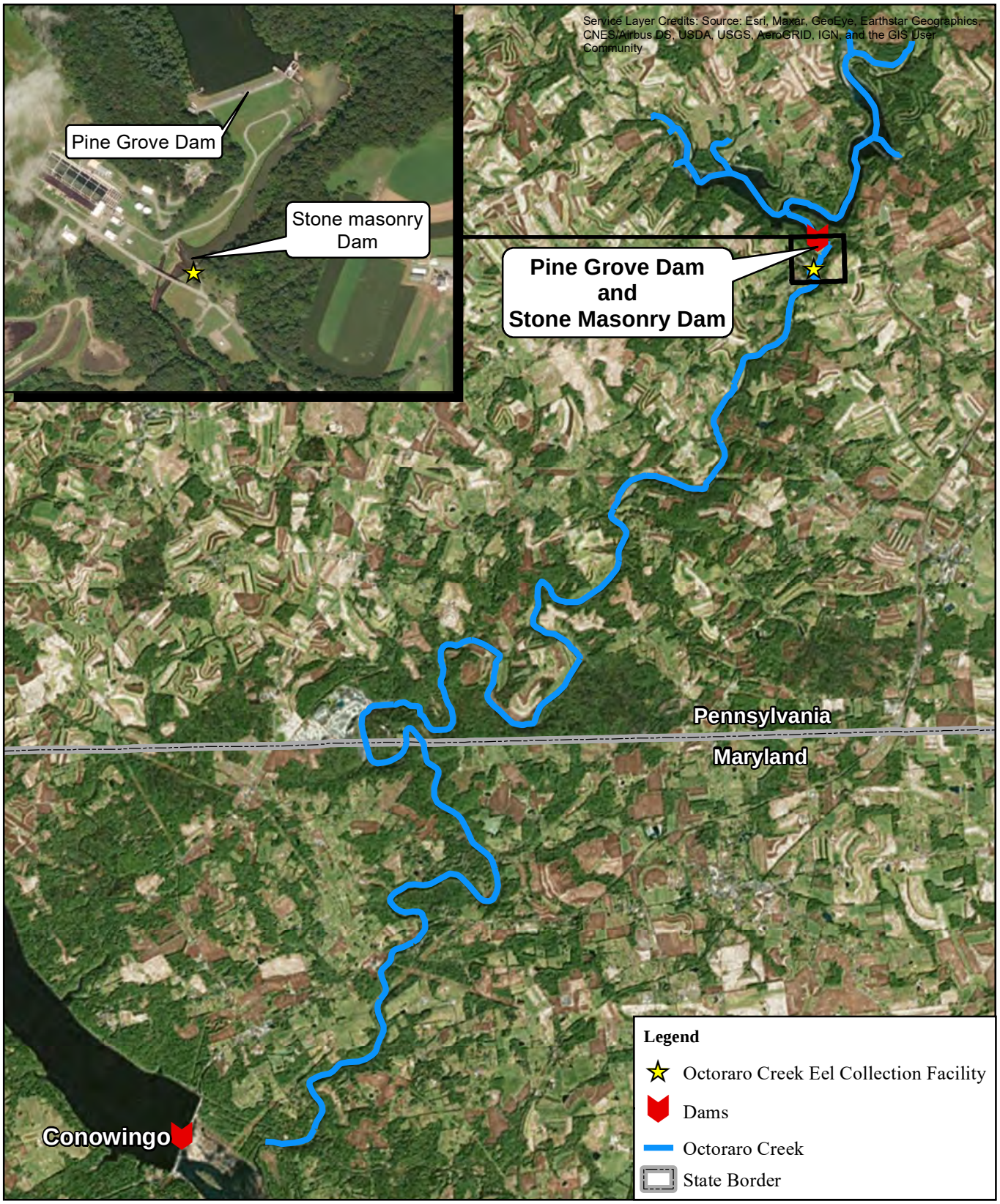
Path: X:\GISMaps\project_maps\eel_passage_and_restoration\figure_3_1_1-1_eel_collection_facilities.mxd



EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405
Eel Passage and Restoration Plan

N

0 0.75 1.5 3 Miles

1 inch = 1.5 miles

Figure 3.1.2-1:
Location of Octoraro Creek Eel Collection Facility

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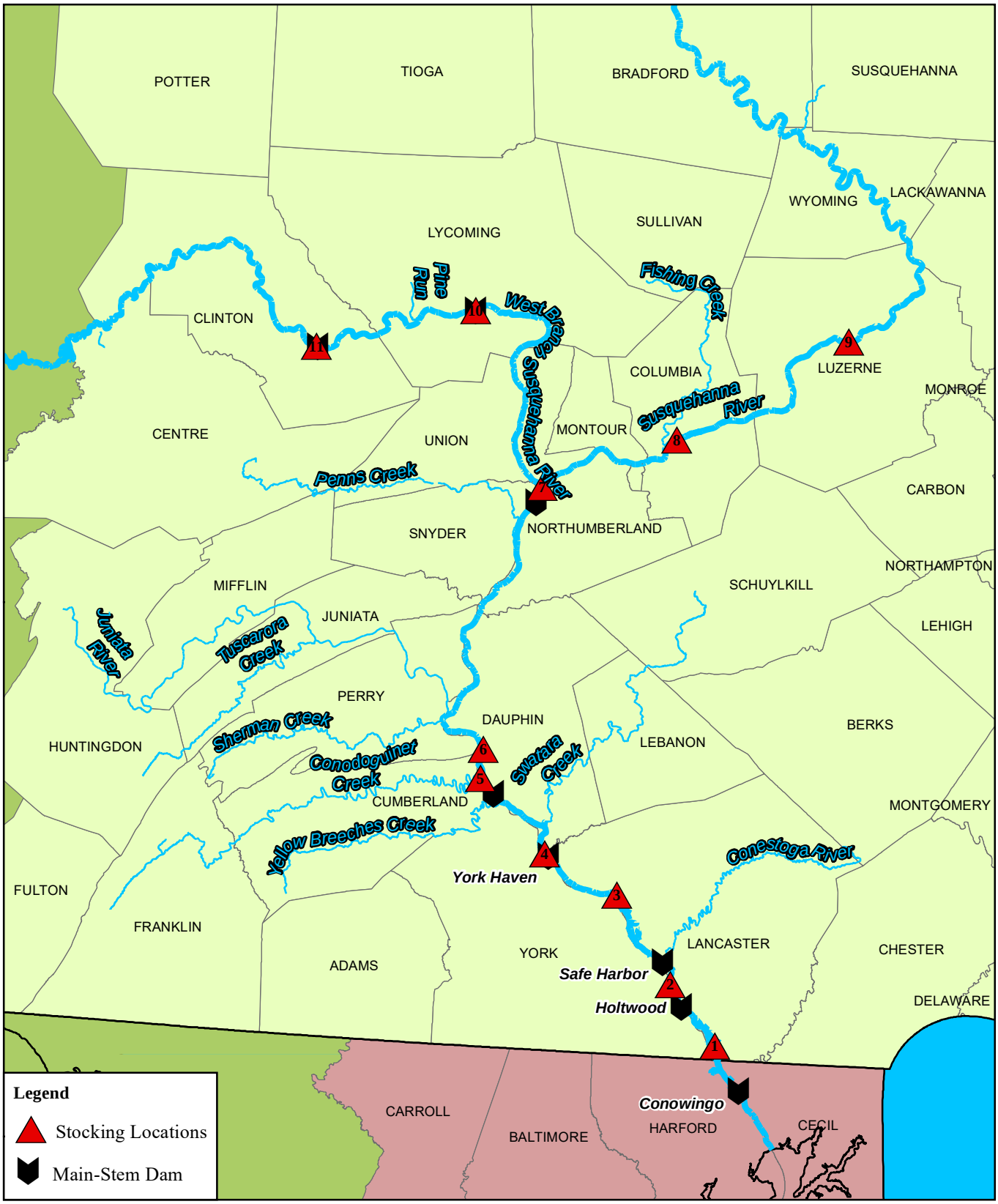
Path: X:\GISMaps\project_maps\eel_passage_and_restoration\figure_3_1_2-1_octoraro_eel_facility.mxd



EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405
Eel Passage and Restoration Plan

N

0 10 20 40 Miles
1 inch = 20 miles

Figure 3.5-1:
Stocking Locations for Eel in the Susquehanna River Watershed

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4 IMPLEMENTATION SCHEDULE

This Eel Passage and Restoration Plan will be implemented following FERC approval. The CWECF operated has operated since 2017. It is anticipated that this plan will be approved prior to the 2022 eel passage season. and the CWECF will begin operation per this plan on May 1, 2022.

Preliminary drawings for the CEECF have been developed (Appendix C). Design, including all reviews, will be further developed as the EFL modification designs are completed and approved. Permitting and other consultations will begin when the design is at least 60% finalized. Installation and operation of the temporary eel collection tank and eel ramp will occur no later than twelve (12) months following the completion of the EFL modifications.

5 ANNUAL SCHEDULES AND DURATION OF OPERATIONS

Each facility will operate annually in accordance with the schedule outlined below. During periods of operation, the facilities will each be operated 24 hours per day, seven days per week.

Facility	Start	End*
CWECF	May 1	Mean Daily Water Temperature < 10°C for three (3) consecutive days in the fall
CEECF	No more than ten (10) days after ceasing EFL shad passage operations	Mean Daily Water Temperature < 10°C for three (3) consecutive days in the fall
OECF	May 1	September 15

*Water temperatures will be monitored hourly at Station 643, approximately 0.6 miles downstream of Conowingo Dam, or by manual readings taken at an alternative location within the Project tailrace unless MDE, USFWS, EPAG, and FERC require a different location.

The operational schedule of the facilities may also be temporarily modified due to extreme hydrological conditions, as defined below, or by agreement between Exelon, MDE, USFWS, and EPAG. "Extreme Hydrologic Conditions" means the occurrence of events beyond Exelon's control that may potentially damage the facility(s) such as, but not limited to, abnormal precipitation, extreme runoff, flood conditions, or other hydrologic conditions such that the operation of the eel facilities is impractical or is inconsistent with the safe operation of the Project.

The trap and transport program will continue through the year 2035 at the Conowingo Project, at a minimum, prior to development of volitional passage structures. However, trapping operations at these specific facilities could change. Exelon is required to maintain and operate the CWECF for the term of the new license but is not required to maintain and operate more than two permanent eel traps (this includes the CWECF and either the CEECF or OECF (or comparable facility required under the MRPSP License) at any time and, in no case, shall any temporary or permanent eel ramps be required to be constructed in the Conowingo Dam spillway area. The OECF is required to be run through 2030 consistent with the MRPSP FERC License.

6 REPORTING AND MEETINGS

6.1.1 Daily Operation Summaries

Throughout the collection facilities' operational season, Exelon will email daily summaries of American Eel collection, holding, transport, and stocking to representatives from MDE, USFWS, and EPAG and any other interested resource agencies. Daily reports will include:

- The estimated number of juvenile eel captured (i.e., number of eels in collection tank).
- The estimated number of eels in the holding tanks.
- The number of eels transported or moved.
- The disposition (location and status) of any transported eels, and
- The count of any mortalities encountered at the CWECF and during transport.

6.1.2 Annual Reports

Due to different season requirements and different reporting requirements between the Conowingo and Muddy Run License requirements, annual reports will include, but not be limited to, the following information:

- The estimated number of juvenile eel captured each day (i.e., number of eels in collection tank).
- The estimated number of eels in the holding tanks.
- The number and dates of eels transported to each stocking location or moved.
- The number of mortalities observed during collection, holding, and transport.
- Statistics (average, maximum, minimum) showing operational parameters for the main components (i.e., flows, temperatures, DO concentrations).
- A description of any significant problem encountered with the trapping, collecting, and holding systems including results of weekly verification efforts and any repair/maintenance actions taken.

Draft annual reports will be submitted to MDE, USFWS, and EPAG by December 1 each year. The draft reports will detail eel collection, holding, and transport from May 1 through September 15 of each year. For the CWECF and the CEECF, eel collection, holding, and transport counts from September 16 through the close of the season will be added to this report as an addendum, and a draft updated report will be submitted to MDE, USFWS, and EPAG for review and comment by December 31[16]. Following review by MDE, USFWS, and EPAG, the final OECF report will be submitted to MDE, USFWS, and EPAG as well as filed with FERC by January 15 of the following year. The final CWECF and CEECF reports will be submitted to MDE, USFWS, and EPAG as well as filed with FERC by February 15 of the following year.

Report	Draft Report Submission Date	Final Report Filing Date
CWECF and CEECF annual reports (May 1 to Sept 15 period)	December 1	February 15
CWECF and the CEECF annual report addendum (Sept 16 to end of season period)	December 31	February 15
OECF annual report (May 1 to Sept 15 period)	December 1	January 15
Fishway Operation and Maintenance Plan annual report	---	December 31

[16] The Fishway Operation and Maintenance Plan annual report will be filed on December 31 and will include daily counts of American eel collected at each facility.

6.1.3 Teleconferences and Remote Meetings

Monthly remote meetings with MDE, USFWS, and EPAG will include discussions of each operating eel passage facility, and also be used to administer implementation of this EPRP.

6.1.4 Meetings

Exelon will meet with MDE, USFWS, and EPAG annually to discuss this EPRP. This meeting will occur no later than January 31 each year unless Exelon and MDE, USFWS, and EPAG agree on a different date. The purpose of the meeting will be to discuss the eel passage results from the previous year and discuss any modifications for the upcoming eel passage season.

7 VOLITIONAL UPSTREAM PASSAGE FOR AMERICAN EEL

License Article 414 requires Exelon to maintain the upstream eel passage trap and transport program for American Eels through 2035.[17] Exelon will work with the Resource Agencies to resolve the timing issues between the two licenses related to volitional and/or trap and transport of American eels.

[17] This date differs from the Offer of Settlement and Explanatory Statement between Exelon and the US Department of Interior (2016), which states, "The Licensee shall conduct trap and transport of American eels until 2030, and will implement volitional American eel passage starting in the 2031 season," and, "Consistent with the Eel Passage Plan established by the Muddy Run license, construction of the volitional passage facility will eliminate the Licensee's obligation to participate in the trap and transport program once the volitional upstream eel passage facility is operational. However, if the upstream eel trap and transport and periodic evaluation program continues beyond 2030, the Licensee will continue to provide access to the Conowingo eel collection facilities for as long as the program continues. The Licensee, however, shall bear no cost responsibility for the trap and transport and periodic evaluation program until 2046, at which time cost responsibility shall be shared among all participants in the program."

8 REFERENCES

Exelon Generation Company, LLC. (2016). *Conowingo Hydropower Project Settlement Agreement Between Exelon Generation Company, LLC and the United States Department of the Interior Fish & Wildlife Service.*

Exelon Generation Company, LLC and the Maryland Department of the Environment. (2019). *Joint Offer of Settlement and Explanatory Statement Of Exelon Generation Company, LLC and the Maryland Department of the Environment.*

Federal Energy Regulatory Commission. (2015). *Final Multi-Project Environmental Impact Statement For Hydropower Licenses.* Federal Energy Regulatory Commission, Office of Energy Projects, Division of Hydropower Licensing. Washington, DC: Federal Energy Regulatory Commission.

USFWS. (2019). *Fish Passage Engineering Design Criteria.* Fish and Aquatic Conservation, Fish Passage Engineering Ecological Services, Conservation Planning Assistance. Northeast Region: USFWS. Retrieved from https://www.fws.gov/northeast/fisheries/pdf/USFWS-R5-2019-Fish-Passage-Engineering-Design-Criteria-190622.pdf

APPENDIX A. CONOWINGO WEST EEL COLLECTION FACILITY DRAWINGS

PROJECT OWNER:

Exelon®
EXELON GENERATION COMPANY, LLC

CONOWINGO HYDROELECTRIC PROJECT FERC NO. 405

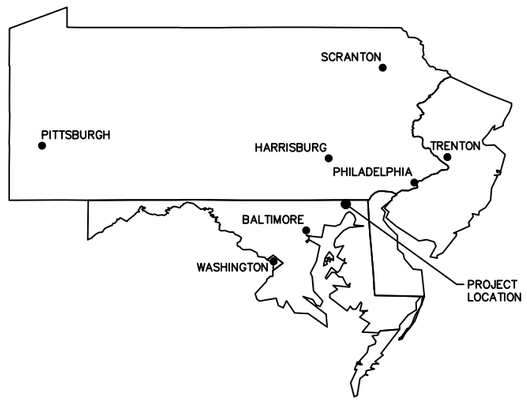
PROJECT TITLE:

CONOWINGO EEL PASSAGE

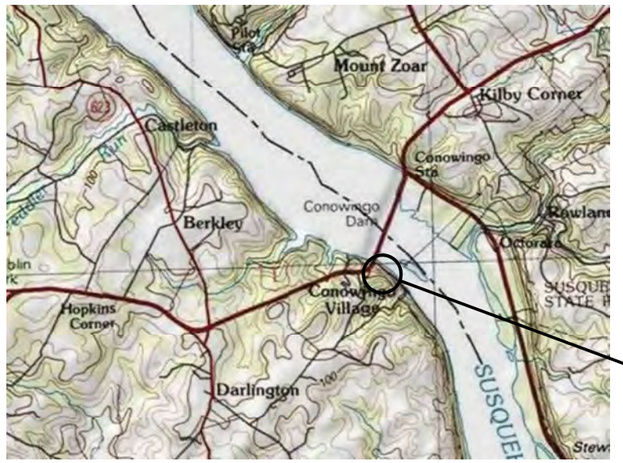
PROJECT ENGINEER:

GOMEZ AND SULLIVAN ENGINEERS

DRAWING INDEX	
DRAWING NO.	DRAWING TITLE
CS	COVER SHEET AND LOCATION PLAN
1	GENERAL NOTES
GP-1	SITE ACCESS PLAN
2	PROPOSED PIPE LAYOUT
3	EEL FACILITY PIPING CONFIGURATION
4	8" PIPELINE 3D PROFILE (INSIDE)
5	8" AND 3" PIPELINES 3D PROFILE (OUTSIDE)
6	EEL FACILITY PIPELINE 3D PROFILE
7	DETAILED PIPE LAYOUT PLANS, SHEET 1
8	DETAILED PIPE LAYOUT PLANS, SHEET 2
9	SECTIONS AND DETAILS
10	EXCAVATION AND CONCRETE ENCASEMENT PLAN
11	EXCAVATION, CONCRETE ENCASEMENT, AND ROAD SECTIONS
12	PIPE SUPPORTS
13	EEL FACILITY PLAN LAYOUT
14	TYPICAL TANK SECTIONS
15	HOLDING TANK PLAN AND SECTIONS
16	HOLDING TANK SECTIONS AND DETAILS
17	COLLECTION TANK PLAN AND SECTIONS
18	EEL RAMP SECTIONS AND DETAILS
19	EEL RAMP ELEVATION AND PIPE SUPPORT DETAILS
20	SITE AND SEDIMENT AND EROSION CONTROL PLAN AND DETAILS
21	MISCELLANEOUS DETAILS



1 CS LOCUS PLAN
NOT TO SCALE



2 CS LOCATION PLAN
NOT TO SCALE

DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG
GSE PROJECT NO.: 1714 DATE: 2/17/2017

Exelon®
EXELON GENERATION COMPANY, LLC

CONOWINGO EEL PASSAGE

GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

COVER SHEET AND LOCATION PLAN

SCALE: AS NOTED DRAWING NO.: CS

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

STRUCTURAL DESIGN DATA NOTES

1. DESIGN REFERENCES
   AMERICAN SOCIETY OF CIVIL ENGINEERS 7–10
   UNITED STATES GEOLOGICAL SURVEY EARTHQUAKE HAZARDS PROGRAM 2014 MAPPING
   AMERICAN SOCIETY OF CIVIL ENGINEERS MANUAL 79
   AMERICAN IRON AND STEEL INSTITUTE WELDED STEEL PIPE
   AMERICAN WATER WORKS ASSOCIATION C208–12
   AMERICAN WATER WORKS ASSOCIATION M11
   AMERICAN SOCIETY OF MECHANICAL ENGINEERS B16.9
   AMERICAN SOCIETY OF MECHANICAL ENGINEERS PRESSURE VESSEL CODE
   US BUREAU OF RECLAMATION WELDED STEEL PENSTOCKS MONOGRAPH NO.3
   AMERICAN CONCRETE INSTITUTE 318
   AMERICAN WELDING SOCIETY D.1.1
   AMERICAN INSTITUTE OF STEEL CONSTRUCTION STEEL CODE
2. RISK CATEGORY: III
3. TERRAIN/EXPOSURE CATEGORY: D
4. DEAD LOAD
   UNIT WEIGHT OF CONCRETE: 150PCF
   UNIT WEIGHT OF STEEL: 490PCF
   UNIT WEIGHT OF WATER: 62.4PCF
5. WIND LOADS
   BASIC WIND SPEED (3 SECOND GUST): 120 MPH
   DIRECTIONALITY FACTOR (Kd): 0.95
   TOPOGRAPHIC FACTOR (Kzt): 1.0
   HEIGHT OF STRUCTURE: 0–15' ABOVE FIN. GRADE
   DESIGN WIND PRESSURE: 37 PSF
6. HYDROSTATIC
   NORMAL POOL: EL. 108.5
   MAX POOL (IDF): EL. 116.5
   WATER HAMMER: 140% STATIC HEAD
   STATIC HEAD: ±71.1 FT
   ASSUMED TRANSIENT/SURGE PRESSURE: 52 PSI
   DESIGN PRESSURE: 150 PSI
7. HYDRODYNAMIC
   TOTAL FLOW IN SYSTEM = 1400 GPM (3.08 CFS)
   DESIGN FLOW TO EEL FACILITY = 145 GPM (0.319 CFS)
   ADDITIONAL FLOW CAPACITY (FOR WEST FISH LIFT & FUTURE USE) = 1255 GPM (2.76 CFS)
8. THERMAL
   ΔTmax = 48° F (BETWEEN INSTALLATION AND EXTREME ANNUAL AIR/WATER TEMPERATURES)
9. DAM HAZARD CLASSIFICATION: HIGH

EROSION AND SEDIMENT CONTROL NOTES:

1. THE LIMIT OF DISTURBANCE SHALL BE CLEARLY DELINEATED IN THE FIELD PRIOR TO THE PRE–CONSTRUCTION MEETING AND ANY GRADING ACTIVITIES TO ENSURE COMPLIANCE WITH THE APPROVED PLAN.
2. THE APPROVED EROSION AND SEDIMENT CONTROL PLAN MUST BE KEPT AT THE PROJECT SITE.
3. THE SOIL CONSERVATION DISTRICT (SCD) RESERVES THE RIGHT TO MODIFY THE EROSION AND SEDIMENT CONTROL PLANS.
4. THE SCD MAY REVOKE THE APPROVAL OF THE EROSION AND SEDIMENT CONTROL PLAN IF WORK PERFORMED AT THE PROJECT SITE DOES NOT CONFORM TO THE PROVISIONS OF THE GRADING PERMIT, TO THE APPROVED PLAN OR TO ANY WRITTEN INSTRUCTIONS FROM MDE, COUNTY DPW OR THE SCD.
5. THE CONTRACTOR SHALL CONSTRUCT ALL EROSION AND SEDIMENT CONTROL MEASURES PER THE APPROVED PLAN AND CONSTRUCTION SEQUENCE AND SHALL HAVE THEM INSPECTED AND APPROVED BY THE SEDIMENT CONTROL INSPECTOR PRIOR TO BEGINNING ANY OTHER LAND DISTURBANCES.
6. THE CONTRACTOR SHALL ENSURE THAT ALL RUNOFF FROM DISTURBED AREAS IS DIRECTED TO THE SEDIMENT CONTROL DEVICES AND SHALL NOT REMOVE ANY EROSION OR SEDIMENT CONTROL MEASURE WITHOUT PRIOR PERMISSION FROM THE SEDIMENT CONTROL INSPECTOR.
7. THE FOLLOWING MINOR PLAN MODIFICATIONS MAY BE APPROVED BY THE SEDIMENT CONTROL INSPECTOR IN THE FIELD:
   A. SEDIMENT CONTROL STRUCTURES (EXCEPT BASINS AND TRAPS) MAY BE MOVED TO MEET THE EXISTING CONTOURS AND FIELD CONDITIONS, WHEN MOVING THESE STRUCTURES WOULD HAVE NO IMPACT ON THEIR FUNCTION OR DESIGN CRITERIA.
   B. SUBSTITUTION OF PERIMETER CONTROL MEASURES MAY BE MADE PROVIDED THE MEASURE SUBSTITUTED IS EQUIVALENT (I.E., SILT FENCE FOR STRAW BALES) OR IS AN UPGRADE OF THE ORIGINAL MEASURE (I.E., SILT FENCE TO A PERIMETER BERM WITH PROPERLY SIZED OUTLET).
   C. ADDITION AND EXTENSION OF PERIMETER CONTROLS (INCLUDING STONE CONSTRUCTION ENTRANCES) MAY BE MADE TO MEET FIELD CONDITIONS.
8. THE CONTRACTOR SHALL PROTECT ALL POINTS OF CONSTRUCTION INGRESS AND EGRESS TO PREVENT THE DEPOSITION OF MATERIALS ONTO PUBLIC ROADS. ALL MATERIALS DEPOSITED ONTO PUBLIC ROADS SHALL BE REMOVED IMMEDIATELY.
9. ON–SITE TEMPORARY STOCKPILE AREAS MUST BE PLACED AS SHOWN ON THE APPROVED PLAN. IF THE CONSTRUCTION SCHEDULE IS TO EXCEED 3 DAYS, THE STOCKPILE AREAS MUST BE STABILIZED. STOCKPILE AREAS SHOULD NOT EXCEED FIFTEEN FEET IN HEIGHT. IF A STOCKPILE IS TO EXCEED FIFTEEN FEET IN HEIGHT, IT MUST BE SHOWN ON THE PLAN TO BE TERRACED WITH PIPE SLOPE DRAINS INSTALLED AND APPROVED BY SCD. UPON THE COMPLETION OF THE USE OF THE STOCKPILE AREA, EXISTING GROUND SURFACES SHALL BE RESTORED TO THEIR ORIGINAL CONDITIONS AND PERMANENTLY STABILIZED.

EROSION AND SEDIMENT CONTROL NOTES CONTINUED:

10. VARIOUS STEPS IN THE SEQUENCE OF CONSTRUCTION MAY REQUIRE THE CONTRACTOR TO REMOVE EXCESS EXCAVATED MATERIAL TO AN APPROVED LOCATION OR TO IMPORT MATERIAL FROM AN APPROVED LOCATION. FOR PURPOSES OF THIS PLAN, AN APPROVED LOCATION SHALL BE ONE WHICH IS OPERATING UNDER AN APPROVED EROSION AND SEDIMENT CONTROL PLAN AND AN ACTIVE GRADING PERMIT AT THE TIME OF CONSTRUCTION.
11. THE CONTRACTOR SHALL INSPECT DAILY AND MAINTAIN CONTINUOUSLY IN AN EFFECTIVE OPERATING CONDITION ALL EROSION AND SEDIMENT CONTROL MEASURES UNTIL SUCH TIME AS THEY ARE REMOVED WITH PRIOR PERMISSION FROM THE SEDIMENT CONTROL INSPECTOR.
12. FOLLOWING INITIAL SOIL DISTURBANCE OR RE–DISTURBANCE, PERMANENT OR TEMPORARY STABILIZATION SHALL BE COMPLETED WITHIN:
   A. THREE (3) CALENDAR DAYS AS TO THE SURFACE OF ALL PERIMETER CONTROLS, DIKES, SWALES, DITCHES, PERIMETER SLOPES, AND ALL SLOPES EQUAL TO OR GREATER THAN 3 HORIZONTAL TO 1 VERTICAL (3:1), AND
   B. SEVEN (7) DAYS AS TO ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT SITE.
   THE ABOVE REQUIREMENTS DO NOT APPLY TO THOSE AREAS WHICH ARE SHOWN ON THE PLAN AND ARE CURRENTLY BEING USED FOR MATERIAL STORAGE OR FOR THOSE AREAS ON WHICH ACTUAL CONSTRUCTION ACTIVITIES ARE CURRENTLY BEING PERFORMED OR TO INTERIOR AREAS OF A SURFACE MINE SITE WHERE THE STABILIZATION MATERIAL WOULD CONTAMINATE THE RECOVERABLE RESOURCE.
   MAINTENANCE SHALL BE PERFORMED AS NECESSARY TO ENSURE THAT THE STABILIZED AREAS CONTINUOUSLY MEET THE APPROPRIATE REQUIREMENTS OF THE MOST CURRENT MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL.
13. SEDIMENT CONTROL PRACTICES WILL BE MAINTAINED UNTIL THE ENTIRE CONTRIBUTING AREA TO THE PRACTICE HAS BEEN PERMANENTLY STABILIZED AND MEETS THE SATISFACTION OF THE SEDIMENT CONTROL INSPECTOR. SEDIMENT CONTROLS MAY ONLY BE REMOVED WITH THE AUTHORIZATION OF THE SEDIMENT CONTROL INSPECTOR.
14. ALL AREAS DISTURBED BY THE REMOVAL OF SEDIMENT CONTROL DEVICES MUST BE IMMEDIATELY STABILIZED.
15. SURFACE DRAINAGE FLOWS OVER UNSTABILIZED CUT AND FILL SLOPES SHALL BE CONTROLLED BY EITHER PREVENTING DRAINAGE FLOWS FROM TRAVERSING THE SLOPES OR BY INSTALLING PROTECTIVE DEVICES TO CONVEY THE WATER DOWNSLOPE WITHOUT CAUSING EROSION. DIKES SHALL BE INSTALLED AND MAINTAINED AT THE TOP OF CUT OR FILL SLOPES UNTIL THE SLOPE AND DRAINAGE AREA TO IT ARE FULLY STABILIZED, AT WHICH TIME THE DIKES MUST BE REMOVED AND FINAL GRADING DONE TO PROMOTE SHEET FLOW DRAINAGE. EROSION CONTROL MEASURES MUST BE IMPLEMENTED AT POINTS OF CONCENTRATED FLOW WHERE EROSION IS LIKELY TO OCCUR.
16. SEDIMENT REMOVED SHALL BE PLACED AND STABILIZED IN APPROVED AREAS, BUT NOT WITHIN A FLOODPLAIN, WETLAND OR FOREST RETENTION AREA. WHEN PUMPING SEDIMENT LADEN WATER, THE DISCHARGE MUST BE DIRECTED TO A SEDIMENT TRAPPING DEVICE PRIOR TO RELEASE FROM THE SITE.
17. FOR APPROVED DEWATERING STRATEGIES FOR TRAPS AND BASINS, SEE SECTION F OF THE 2011 MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL. PUMPING SEDIMENT LADEN WATER INTO THE WATERS OF THE STATE WITHOUT FILTRATION IS STRICTLY FORBIDDEN.
18. THE DEVELOPER IS RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS PRIOR TO ANY CONSTRUCTION ACTIVITIES. FURTHER, THE ISSUANCE OF A GRADING PERMIT DOES NOT RELIEVE THE DEVELOPER OF THE RESPONSIBILITY TO OBTAIN ANY ADDITIONAL LOCAL, STATE OR FEDERAL PERMITS.

GENERAL NOTES:

1. THESE DRAWINGS DO NOT INCLUDE NECESSARY COMPONENTS FOR CONSTRUCTION SAFETY. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR CONSTRUCTION SAFETY AND FOR COMPLIANCE WITH ALL OSHA REGULATIONS DURING CONSTRUCTION.
2. CONTRACTOR SHALL DETERMINE LOCATION OF EXISTING UTILITIES BEFORE COMMENCING WORK. CONTRACTOR AGREES TO BE FULLY RESPONSIBLE FOR DAMAGES WHICH MAY OCCUR BY FAILURE TO LOCATE AND PRESERVE EXISTING UTILITIES.
3. CONTRACTOR SHALL CONTACT THE LOCAL CALL BEFORE YOU DIG CENTER TWO FULL WORKING DAYS IN ADVANCE OF DIGGING. THE CONTACT NUMBER FOR MARYLAND IS 811.
4. THE LOCATIONS AND INFORMATION ABOUT UNDERGROUND PIPES, UTILITIES OR OTHER STRUCTURES ARE COMPILED FROM AVAILABLE RECORD DATA AND VISIBLE FIELD OBSERVATIONS AND ARE NOT REPRESENTED AS BEING EXACT OR COMPLETE.
5. THE CONTRACTOR SHALL RECORD TIE MEASUREMENTS, DEPTHS, DIMENSIONS, MATERIALS, FIELD CONDITIONS AND OTHER PERTINENT DATA ABOUT ALL UNDERGROUND PIPES, UTILITIES AND STRUCTURES ENCOUNTERED DURING THE WORK, BOTH EXISTING AND CONSTRUCTED. CONTRACTOR SHALL SUBMIT RECORD DRAWINGS WITH THIS INFORMATION TO THE CONSTRUCTION MANAGER WHO WILL SUBMIT TO THE ENGINEER, UPON COMPLETION OF THE WORK.
6. THE CONTRACTOR SHALL TAKE PRECAUTIONS TO PROTECT AND PREVENT DAMAGE TO ELECTRICAL AND MECHANICAL EQUIPMENT, CONTROLS, AND OTHER EXISTING STRUCTURES FROM CONSTRUCTION ACTIVITIES.
7. DIMENSIONS AND EXISTING CONDITIONS SHALL BE VERIFIED IN FIELD BY CONTRACTOR.
8. DO NOT SCALE DRAWINGS. CONTRACTOR SHALL NOTIFY CONSTRUCTION MANAGER WHO SHALL NOTIFY ENGINEER OF ANY DISCREPANCIES IN THE DRAWINGS.
9. DO NOT CHANGE SIZE OR SPACING OF STRUCTURAL ELEMENTS WITHOUT PRIOR APPROVAL FROM ENGINEER.
10. DETAILS SHOWN ARE TYPICAL; SIMILAR DETAILS APPLY TO SIMILAR CONDITIONS UNLESS OTHERWISE INDICATED.
11. THE CONTRACTOR SHALL PROVIDE AND DESIGN TEMPORARY BRACING/SHORING OF STRUCTURES AND EQUIPMENT DURING CONSTRUCTION AS REQUIRED UNTIL FINAL STRUCTURAL ELEMENTS NEEDED FOR STABILITY ARE INSTALLED..
12. CONTRACTOR SHALL NOTIFY THE CONSTRUCTION MANAGER WHO SHALL NOTIFY THE ENGINEER IN WRITING OF PROPOSED DEVIATIONS OR SUBSTITUTIONS OF DIMENSIONS, MATERIALS, OR EQUIPMENT SHOWN ON THE DRAWINGS AND MAKE ONLY THOSE DEVIATIONS OR SUBSTITUTIONS ACCEPTED BY ENGINEER.
13. IF CONTRACTOR OBSERVES FIELD CONDITIONS WHICH VARY SIGNIFICANTLY FROM WHAT IS SHOWN ON THESE PLANS, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE CONSTRUCTION MANAGER WHO SHALL NOTIFY THE ENGINEER FOR RESOLUTION OF THE CONFLICTING INFORMATION.
14. THE CONTRACTOR SHALL NOT BEGIN DEMOLITION UNTIL AFTER RECEIVING WRITTEN AUTHORIZATION FROM THE OWNER TO BEGIN DEMOLITION.
15. THE OWNER SHALL BE RESPONSIBLE FOR HAZARDOUS MATERIAL ABATEMENT AND PROTECTION OF WORKERS. MEASURES SHALL BE TAKEN, AS REQUIRED, PRIOR TO AND DURING CONSTRUCTION TO IDENTIFY, EVALUATE, AND REMOVE ANY ENCOUNTERED HAZARDOUS MATERIALS.
16. ALL ELECTRICAL WORK TO BE DESIGNED AND CONSTRUCTED BY OTHERS.
17. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING WITH THE OWNER AND OTHER CONTRACTORS (AS NECESSARY) FOR ISOLATION AND DRAINAGE OF THE EXISTING HEADER PIPE.
18. PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION, EXELON SHALL CONSULT AND COOPERATE WITH THE STATE HISTORIC PRESERVATION OFFICER (SHPO) TO DETERMINE THE NEED FOR, AND EXTENT OF ANY ARCHEOLOGICAL OR HISTORIC SURVEYS, AND MITIGATION MEASURES THAT MAY BE NECESSARY. IF ANY PREVIOUSLY UNRECORDED ARCHAEOLOGICAL OR HISTORIC SITES ARE DISCOVERED DURING THE COURSE OF CONSTRUCTION, CONSTRUCTION ACTIVITY IN THE VICINITY SHALL BE HALTED, AND A QUALIFIED ARCHEOLOGIST SHALL BE CONSULTED TO DETERMINE THE SIGNIFICANCE OF THE SITES.

SURVEY NOTES

1. EXISTING PROJECT DRAWINGS AND FIELD MEASUREMENTS WERE USED TO DEVELOP THIS DRAWING SET.
2. HORIZONTAL DATUM IS NAD83 MARYLAND STATE PLANE US FEET.
3. THE VERTICAL DATUM IS CONOWINGO DATUM (0.7 FEET LOWER THAN NGVD29 AND .14 FEET HIGHER THAN NAVD88).

GENERAL CONCRETE NOTES:

1. THE FOLLOWING STANDARDS SHALL BE USED
   - CONCRETE DESIGN STANDARD: ACI 318;
   - CONCRETE DETAILING STANDARD: ACI 315;
   - CONCRETE SPECIFICATION STANDARD: ACI 301;
   - CONCRETE FIELD REFERENCE MANUAL: ACI MNL–15
2. ALL CORNERS, INTERSECTIONS, AND ENDS IN CONCRETE STRUCTURES SHALL BE REINFORCED WITH ADDITIONAL BARS. REFER TO SECTIONS AND DETAILS ON SHEET 11.
3. REINFORCEMENT STEEL SHALL EXTEND THROUGH CONCRETE CONSTRUCTION JOINTS AT LEAST A FULL DEVELOPMENT LENGTH ON EITHER SIDE OF JOINT.
4. ALL REINFORCING STEEL SHALL CONFORM WITH ASTM A615, GRADE 60 UNLESS GRADE 75 IS SPECIFIED. ALL REINFORCING SHALL BE PLAIN DEFORMED BARS.
5. PROTECT CONCRETE FROM PREMATURE DRYING IMMEDIATELY AFTER PLACEMENT. CURING OF CONCRETE SHALL START WITHIN TWO HOURS AFTER FINISHING OPERATIONS ARE COMPLETE. REFER TO THE PROJECT SPECIFICATIONS FOR ADDITIONAL CURING, THERMAL, AND MOISTURE RETENTION REQUIREMENTS.
6. CONCRETE FINISHES SHALL BE AS REQUIRED BY ACI 301, UNLESS OTHERWISE NOTED. ALL CONCRETE REMAINING EXPOSED TO VIEW AT THE COMPLETION OF CONSTRUCTION SHALL RECEIVE A BROOM FINISH. THE FINISH SHALL BE INSTALLED IMMEDIATELY UPON FORM REMOVAL.
7. THE CONTRACTOR SHALL COORDINATE THE SIZE OF ALL OPENINGS, PENETRATIONS, JOINTS AND UTILITIES WITH THE OWNER. THE FINAL SIZE AND LOCATION OF ALL ITEMS AFFECTING THE CONCRETE WORK SHALL BE INDICATED ON THE CONCRETE REINFORCING DRAWINGS AT THE TIME OF SUBMISSION TO THE ENGINEER FOR REVIEW. IF ADDITIONAL OPENINGS ARE REQUIRED THAT ARE NOT SHOWN, CONTRACTOR SHALL IDENTIFY SUCH OPENINGS TO THE OWNER'S PROJECT MANAGER WHO SHALL NOTIFY THE ENGINEER.
8. ALL EXPOSED EDGES SHALL HAVE A 3/4" CHAMFER UNLESS OTHERWISE NOTED.
9. CONCRETE COVER SHALL BE AS FOLLOWS:

COVER	DESCRIPTION
3"	CONCRETE IN CONTACT WITH THE GROUND.
2"	CONCRETE GREATER THAN 12" THICK OR EXPOSED TO WEATHER.
*	CONCRETE LESS THAN OR EQUAL TO 12" THICK SHALL USE COVER REQUIREMENTS IN ACI 318.

10. ALL CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 4500PSI AT 28 DAYS.

GENERAL EARTHWORK NOTES:

1. PLACE FOUNDATIONS ON COMPETENT BEDROCK OR ON A SUITABLE SUBGRADE UNLESS OTHERWISE APPROVED. IF PLACED ON BEDROCK, REMOVE ORGANICS, DEBRIS, AND LOOSE SOIL/ROCK AND PRESSURE WASH PRIOR TO PLACING CONCRETE. IF ON SOIL; OVER EXCAVATE ±1FT AND REPLACE WITH COMPACTED STRUCTURAL FILL.
2. NO BORINGS ARE AVAILABLE.
3. PROVIDE BACKFILL WITH POSITIVE DRAINAGE AWAY FROM STRUCTURES.

GENERAL STEEL NOTES:

1. STRUCTURAL STEEL:
   - STEEL PLATE, SHAPES, AND BARS – ASTM A36
   - STAINLESS STEEL PLATE AND SHAPES – ASTM A276, TYPE 304
   - STEEL PIPE – ASTM A106, GRADE B (Fy=35KSI, Fu=50KSI)
   - STEEL FITTINGS – ASTM A105 (Fy=36KSI, Fu=70KSI)
2. DESIGN, FABRICATION, AND ERECTION SHALL BE AS PER SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS (AISC 360–10).
3. WHERE STEEL MEMBERS ARE WELDED AND NO SIZE IS SPECIFIED, PROVIDE FULL LENGTH FILLET WELDS BOTH SIDES OF MEMBER. WELD SIZES SHALL BE AS FOLLOWS UNLESS NOTED OTHERWISE:

MEMBER THICKNESS	WELD SIZE
3/16"	3/16"
1/4"	3/16"
5/16"	3/16"
3/8"	1/4"
7/16"	1/4"
1/2"	5/16"
9/16"	3/8"
5/8"	7/16"

4. SPLICING OF STRUCTURAL STEEL MEMBERS IS PROHIBITED WITHOUT PRIOR APPROVAL OF THE ENGINEER AS TO LOCATION AND TYPE OF SPLICE TO BE MADE. ANY MEMBER HAVING A SPLICE NOT SHOWN AND DETAILED ON SHOP DRAWINGS WILL BE REJECTED.
5. ALL WELDING SHALL CONFORM TO THE AMERICAN WELDING SOCIETY CODE. USE E70 SERIES ELECTRODES FOR ALL STRUCTURAL STEEL WELDS.
6. UNLESS OTHERWISE SPECIFIED, ALL STRUCTURAL STEEL SHALL BE HOT–DIP GALVANIZED AFTER FABRICATION, INCLUDING BOLTS, WASHERS, AND SHIMS.
7. ULTRASONIC INSPECTION OR OTHER APPROVED METHOD, BY THE TESTING LABORATORY SHALL BE PROVIDED FOR ALL WELDS CALLED FOR ON THE STRUCTURAL DRAWINGS OR SHOP DRAWINGS AS FULL PENETRATION OR COMPLETE JOINT PENETRATION WELDS.
8. ALL BOLTED CONNECTIONS SHALL CONFORM TO ASTM F3125, GRADE A325, UNLESS NOTED OTHERWISE.
9. REFER TO THE CONSTRUCTION SPECIFICATIONS FOR PIPE COATING REQUIREMENTS.
10. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL PRIOR TO STARTING FABRICATION

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

DATE	#		BY	APP

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GSE PROJECT NO.: 1714 DATE: 2/17/2017

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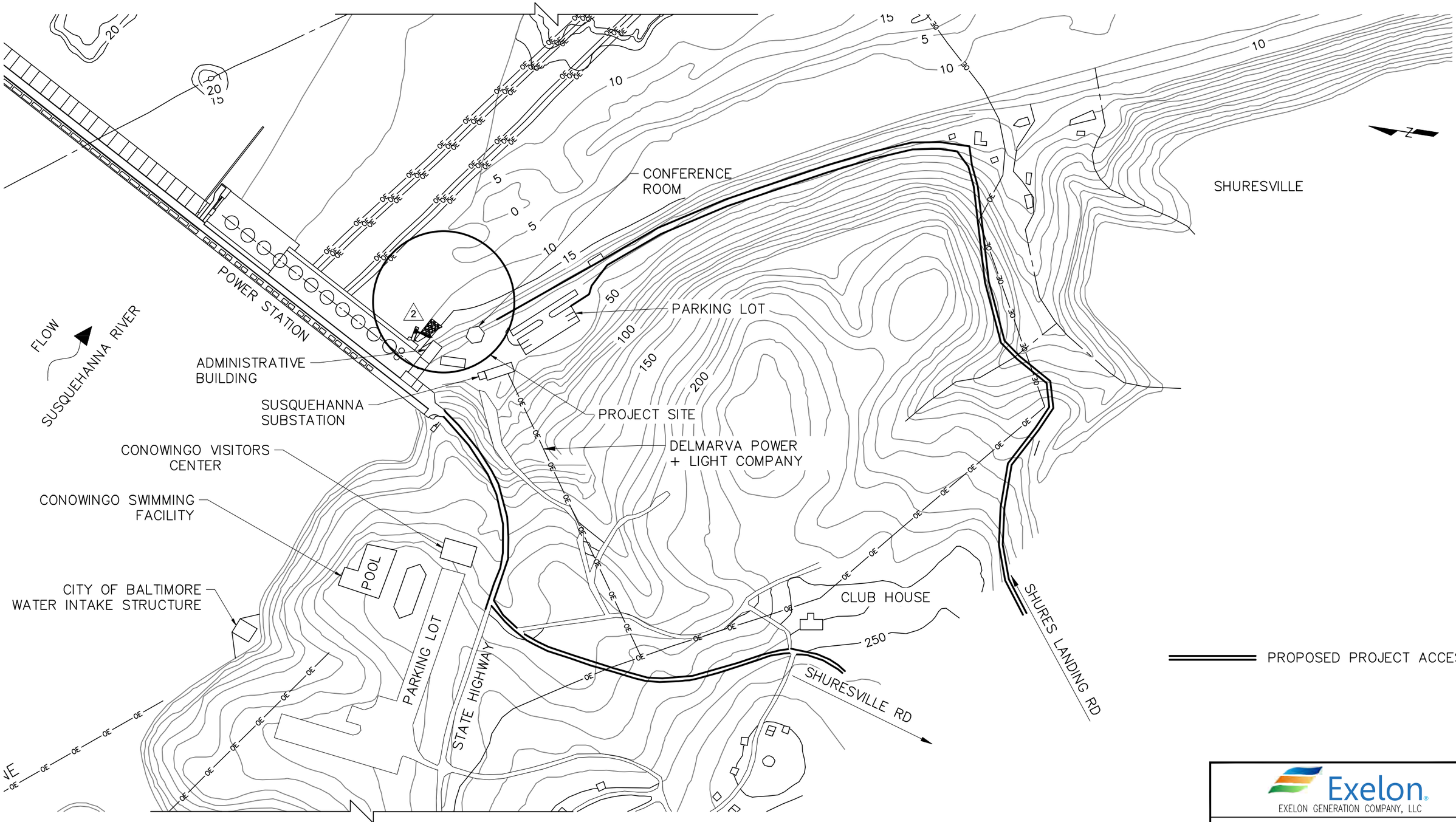
GENERAL NOTES

SCALE: AS NOTED DRAWING NO.: 1



NOTE: THIS DRAWING REFERENCES CONOWINGO DATUM, IN CONTRAST TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29). CONOWINGO ELEVATIONS ARE 0.7 FT LOWER THAN NGVD 29 ELEVATIONS SUCH THAT 108.5 FT CONOWINGO DATUM EQUALS ELEVATION 109.2 FT NGVD 29. CONOWINGO DATUM IS 0.14 FT HIGHER THAN NAVD 88.

2000' 0 2000' 4000'

SCALE: 1" = 2000'–0"

DATE	#		BY	APP

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SITE ACCESS PLAN

SCALE: AS NOTED DRAWING NO.: GP–1

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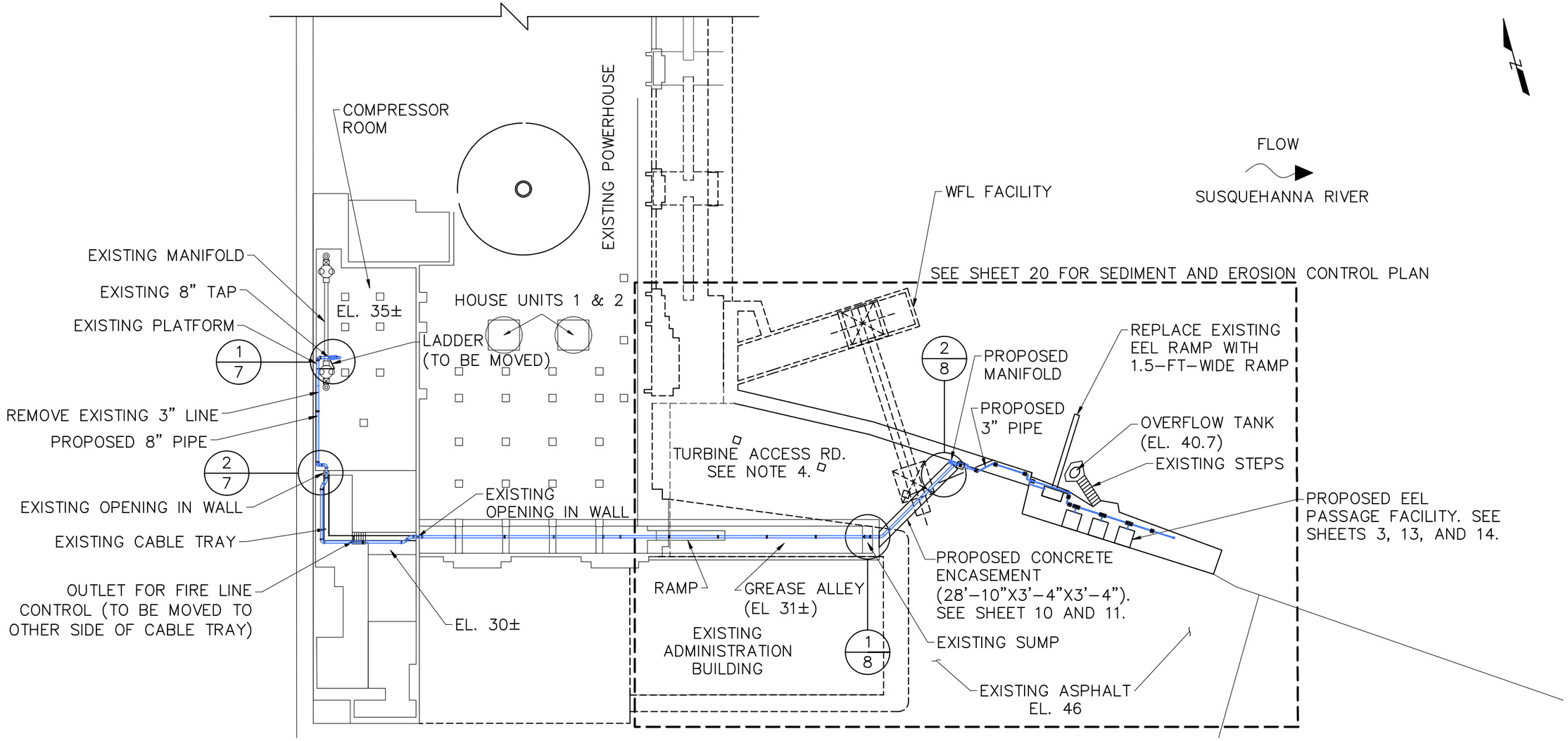

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29 AND 0.14 FEET HIGHER THAN NAVD88)
2. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB. SEE SHEET 12 FOR TYPICAL SUPPORT DETAILS.
3. CONTRACTOR SHALL REMOVE EXISTING 3" PIPE THAT EXISTS ALONG THE ALIGNMENT OF THE PROPOSED 8" PIPE. AVOID OR MOVE OTHER PIPES UPON EXELON'S APPROVAL.
4. LOCATE AND PROTECT EXISTING BURIED DRAINS BENEATH TURBINE ACCESS ROAD (SEE EXISTING P.E. CO. DRAWING H-80531). RAILROAD TIES AND TRACKS MAY ALSO BE BURIED UNDER TURBINE ACCESS ROAD. IF ENCOUNTERED, AND PENDING SHPO CONSULTATION, THE RAILS AND TIES SHALL BE PRESERVED IN PLACE.

16' 0 16' 32'

SCALE: 1" = 16'-0"

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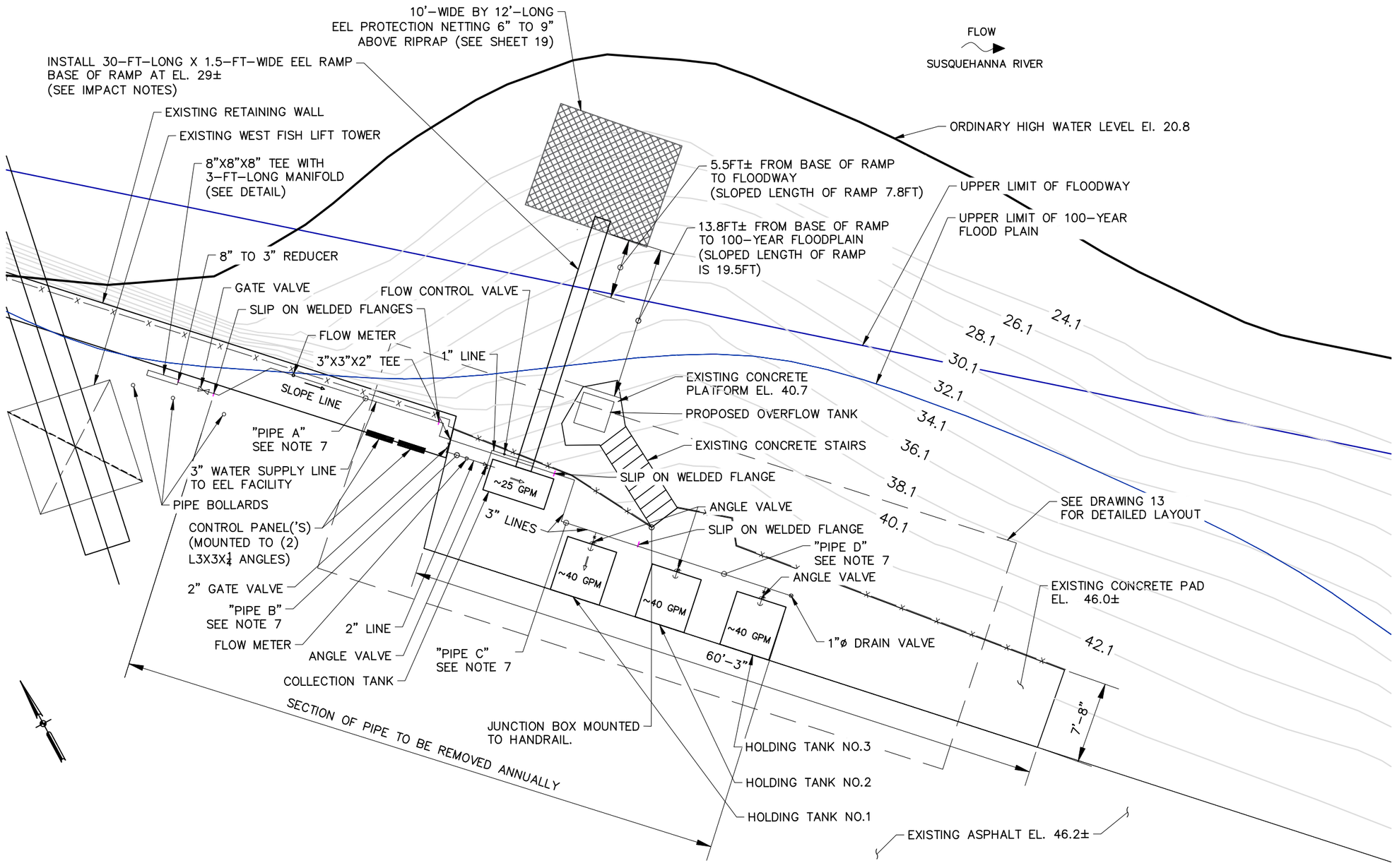
PROPOSED PIPE LAYOUT

SCALE: AS NOTED DRAWING NO.: 2

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



IMPACTS TO FLOODPLAIN

1. LINEAR FEET OF EEL RAMP WITHIN 100–YEAR FLOODPLAIN IS 13.8 FT.
2. AREA OF EEL RAMP WITHIN 100–YEAR FLOOD PLAIN IS 20.7 FT^2.
3. AREA OF EEL RAMP PIPE SUPPORT IS 2 FT^2.
4. AREA OF TWO FLEXIBLE DRAINAGE HOSES IS 9.2 FT^2.
5. AREA OF ANTI–PREDATOR NETTING IS 120 FT^2.

NOTES

1. ELEVATIONS SHOWN ARE IN CONOWINGO DATUM.
2. CONTOUR DATA WAS OBTAINED FROM THE HARFORD COUNTY GIS AND RECORDS MANAGEMENT. CONTOURS WERE DEVELOPED FROM LIDAR DATA COLLECTED ON 3/9/2013 AND 4/6/2013 WITH VERTICAL ACCURACY OF 0.223 FEET.
3. FLOODWAY AND 100–YEAR FLOODPLAIN LINES WERE OBTAINED FROM FEMA'S NATIONAL FLOOD HAZARD LAYER.
4. SEE DRAWING 6 FOR ADDITIONAL PIPING INFORMATION.
5. SEE DRAWING 13 FOR DETAILED LAYOUT.
6. SEE DRAWING 14 FOR TYPICAL TANK SECTIONS.
7. PIPES SHALL BE CLEARLY MARKED AND LABELED WITH 1" HIGH LETTERS.

5' 0 5' 10'

SCALE: 1" = 5'–0"

DATE	#		BY	APP

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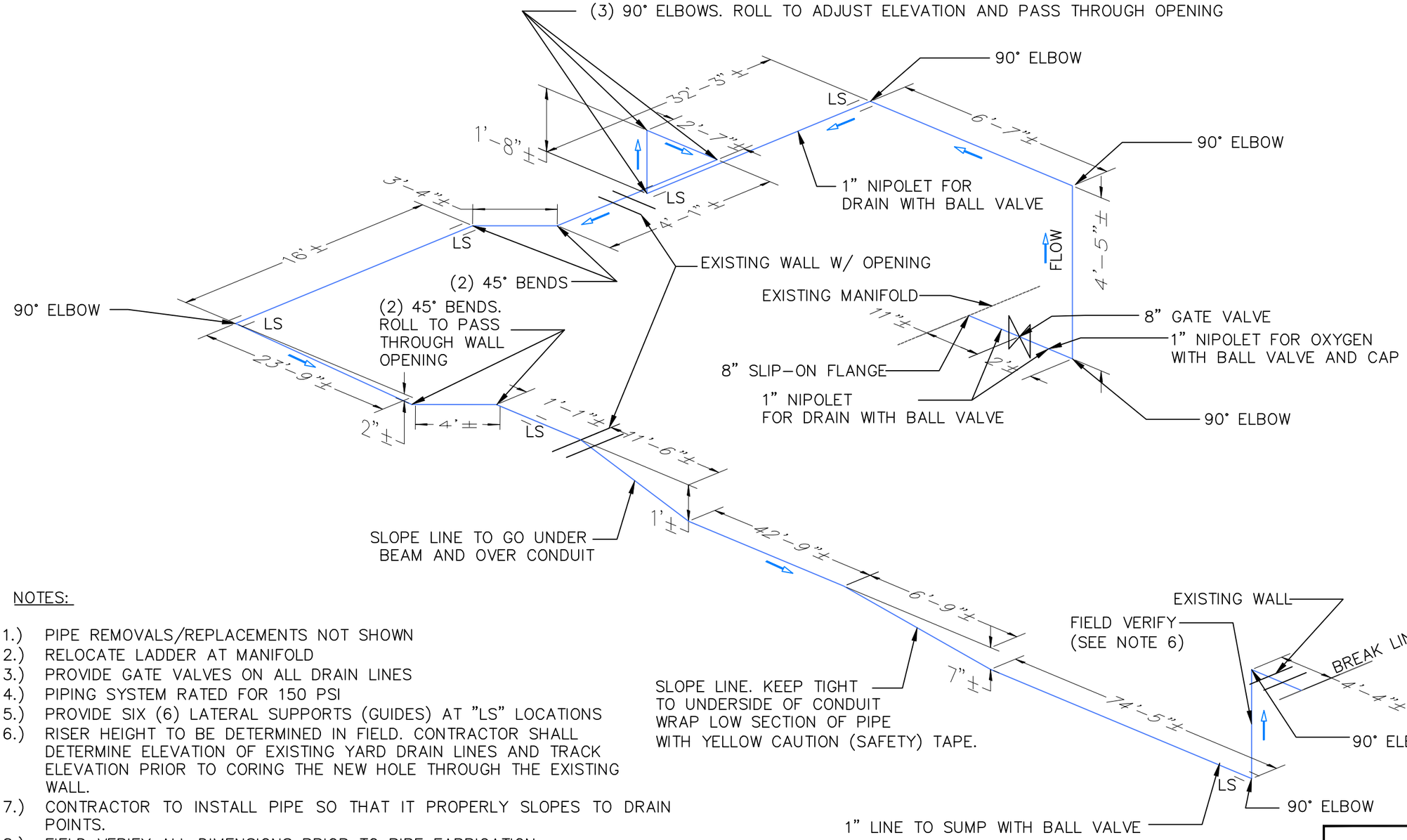
EEL FACILITY PIPING CONFIGURATION

SCALE: AS NOTED DRAWING NO.: 3

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



NOTES:

1.) PIPE REMOVALS/REPLACEMENTS NOT SHOWN
2.) RELOCATE LADDER AT MANIFOLD
3.) PROVIDE GATE VALVES ON ALL DRAIN LINES
4.) PIPING SYSTEM RATED FOR 150 PSI
5.) PROVIDE SIX (6) LATERAL SUPPORTS (GUIDES) AT "LS" LOCATIONS
6.) RISER HEIGHT TO BE DETERMINED IN FIELD. CONTRACTOR SHALL DETERMINE ELEVATION OF EXISTING YARD DRAIN LINES AND TRACK ELEVATION PRIOR TO CORING THE NEW HOLE THROUGH THE EXISTING WALL.
7.) CONTRACTOR TO INSTALL PIPE SO THAT IT PROPERLY SLOPES TO DRAIN POINTS.
8.) FIELD VERIFY ALL DIMENSIONS PRIOR TO PIPE FABRICATION.
9.) REFER TO NOTES 4 & 5 ON DRAWING 7 REGARDING ISOLATION OF THE PRESSURIZED MANIFOLD.

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

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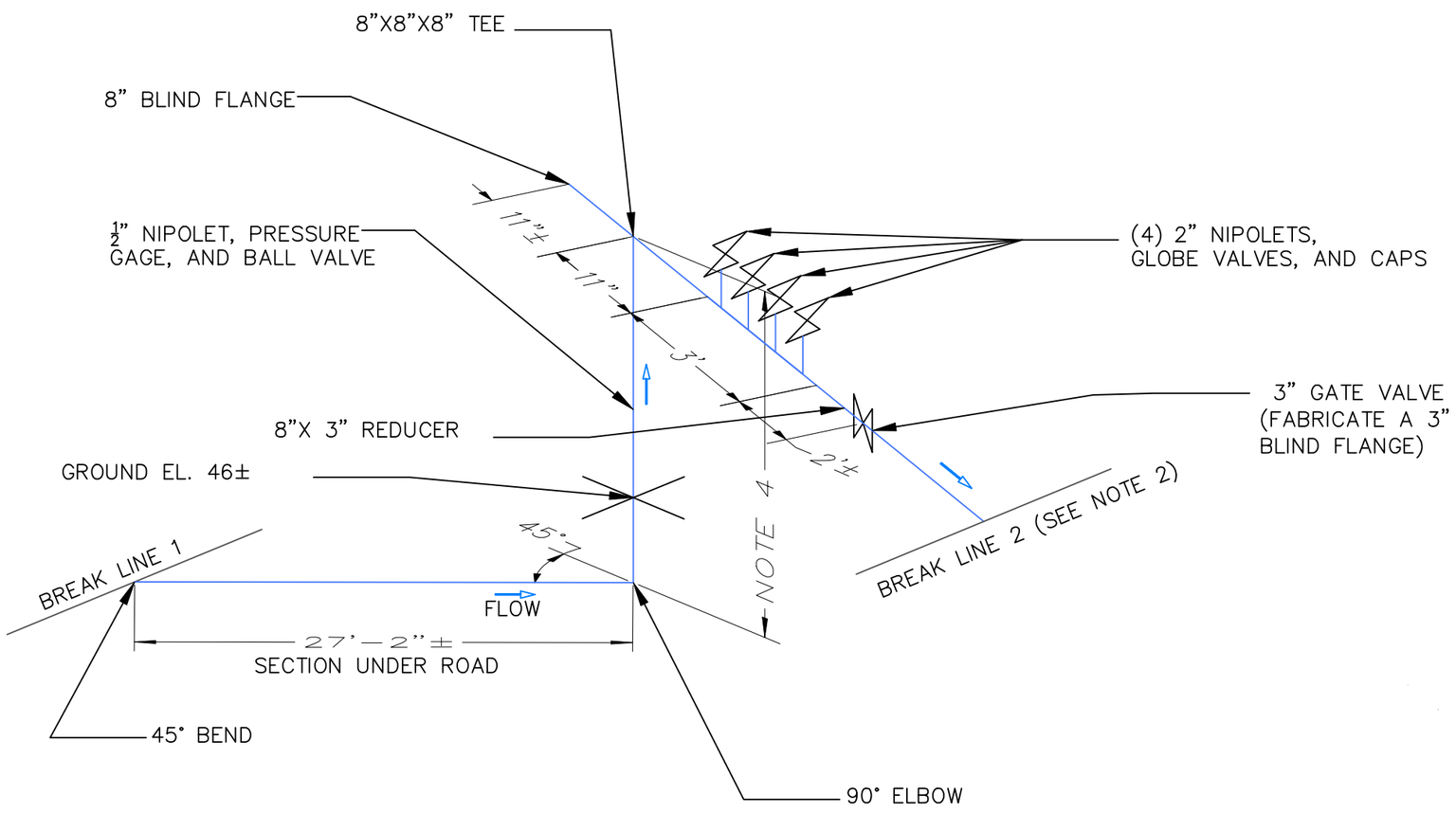
8" PIPELINE 3D PROFILE (INSIDE)

SCALE: AS NOTED DRAWING NO.: 4



NOTES:

1.) PIPING SYSTEM RATED FOR 150 PSI
2.) SEE ATTACHED SHEET 6 FOR CONTINUED PIPE PROFILE TO EEL PASSAGE STORAGE TANKS
3.) PIPING UNDER ROAD TO BE ENCASED IN CONCRETE.
4.) RISER HEIGHT TO BE DETERMINED IN FIELD. CONTRACTOR SHALL DETERMINE ELEVATION OF EXISTING YARD DRAIN LINES AND TRACK ELEVATION. CENTERLINE OF MANIFOLD SHALL BE AT ELEVATION 48±.
5.) 3-INCH SCHEDULE 40 STEEL CONDUIT (ELECTRICAL) TO BE INSTALLED ABOVE PIPE. SEE DRAWING 11.
6.) LENGTH OF PIPING IN BILL OF MATERIALS ASSUMES 10% CONTINGENCY. ALL LENGTHS OF PIPE TO BE FIELD VERIFIED PRIOR TO FABRICATION.
7.) BILL OF MATERIALS DOES NOT INCLUDE VALVES AND PIPING ATTACHED TO OR DOWNSTREAM OF THE EEL FACILITY TANKS. REFER TO SHEET 18 FOR EEL FACILITY SUPPLIES.

BILL OF MATERIALS

Piping

Item Description	Total Length
8-inch Schedule 40 Steel Pipe	±282 ft.
3-inch Schedule 40 Steel Pipe	±110 ft.
2-inch Schedule 40 PVC Pipe	±19 ft.
1-inch Schedule 40 Steel Pipe	±2 ft.

Valves

# of Item	Item Description
1	8-inch Steel Gate Valve
6	1-inch Steel Ball Valve
1	1/2-inch Steel Ball Valve
4	2-inch Steel Globe Valve
1	3-inch Steel Gate Valve
4	2-inch PVC Gate Valve
4	2-inch PVC Angle Valve

Fittings

# of Item	Item Description
3	8-inch Class D Slip-on Steel Flange
6	1-inch Steel Nipolet
6	1-inch Steel Threaded Cap
10	8-inch, 90-degree, Short Radius, Steel Elbow
5	8-inch, 45-degree Steel Bend
1	1/2-inch Steel Nipolet
1	1/2-inch Steel Threaded Cap
1	8"x8"x8" Steel Tee
1	8-inch Steel Blind Flange
4	2-inch Steel Nipolet
4	2-inch Steel Threaded Cap
1	8"x3" Steel Reducer (2' Long)
4	3-inch Slip-on Steel Flange
2	3-inch, 45-degree Steel Bend
4	3-inch, 90-degree, Short Radius Steel Elbow
4	3"x3"x2" Steel Tee
2	3-inch Steel Blind Flange
9	2-inch, 90-degree, PVC Elbow
4	Steel to PVC Adaptor
2	3-inch Steel Threaded Cap

Instruments

# of Item	Item Description
1	1/2-inch Pressure Gage
1	3-inch Flow Meter
4	2-inch Flow Meter

BILL OF MATERIALS, CONT'D

Pipe Supports

# of Item	Item Description
5	2-inch Pipe Stand
15	3-inch Pipe Stand
5	Type A Lateral Support
1	Type B Lateral Support
4	Type C Lateral Support
3	Type A Vertical Hanger Support
14	Type B Vertical Hanger Support
2	Type C Vertical Hanger Support

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8" & 3" PIPELINES 3D PROFILE (OUTSIDE)

SCALE: AS NOTED DRAWING NO.: 5

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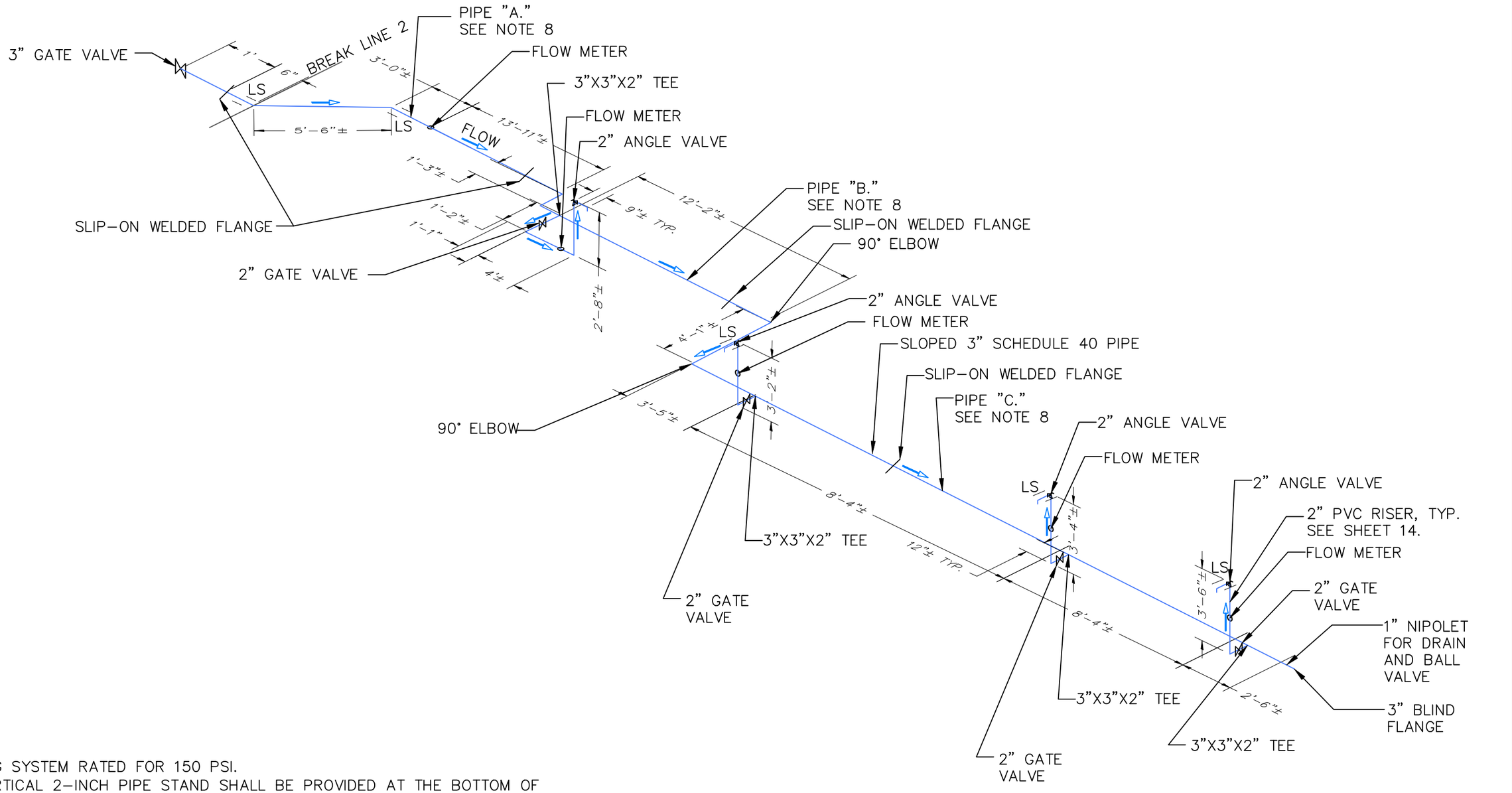

NOTES:

1.) PIPING SYSTEM RATED FOR 150 PSI.
2.) A VERTICAL 2–INCH PIPE STAND SHALL BE PROVIDED AT THE BOTTOM OF EACH 2–INCH RISER.
3.) SLOPE PIPE TO DRAIN WITH DOWNSTREAM END 6" ABOVE GRADE.
4.) PROVIDE VERTICAL PIPE STANDS AT "LS" LOCATIONS SHOWN ON DRAWING.
5.) MAXIMUM SPACING OF PIPE STANDS SHALL BE 12 FEET FOR 3–INCH PIPING.
6.) PROVIDE LATERAL SUPPORT, TYPE C AT THE TOP OF EACH 2–INCH RISER.
7.) LABEL PIPE SEGMENTS AS SPECIFIED ON DRAWING 3.
8.) FIELD VERIFY ALL DIMENSIONS PRIOR TO FABRICATION.

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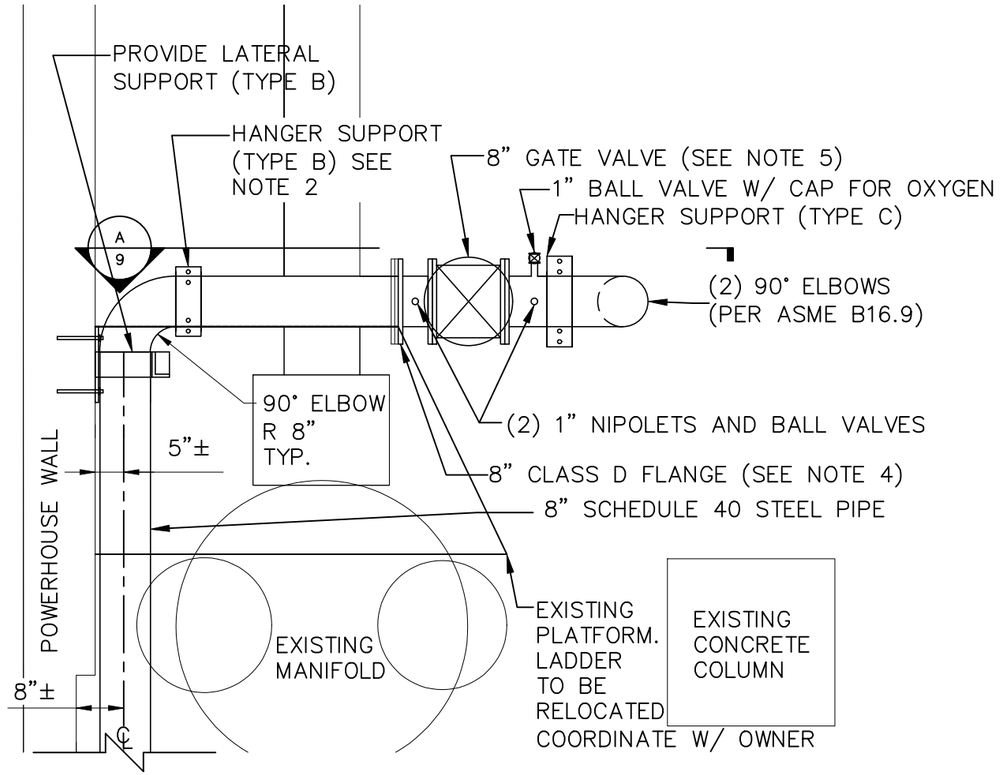
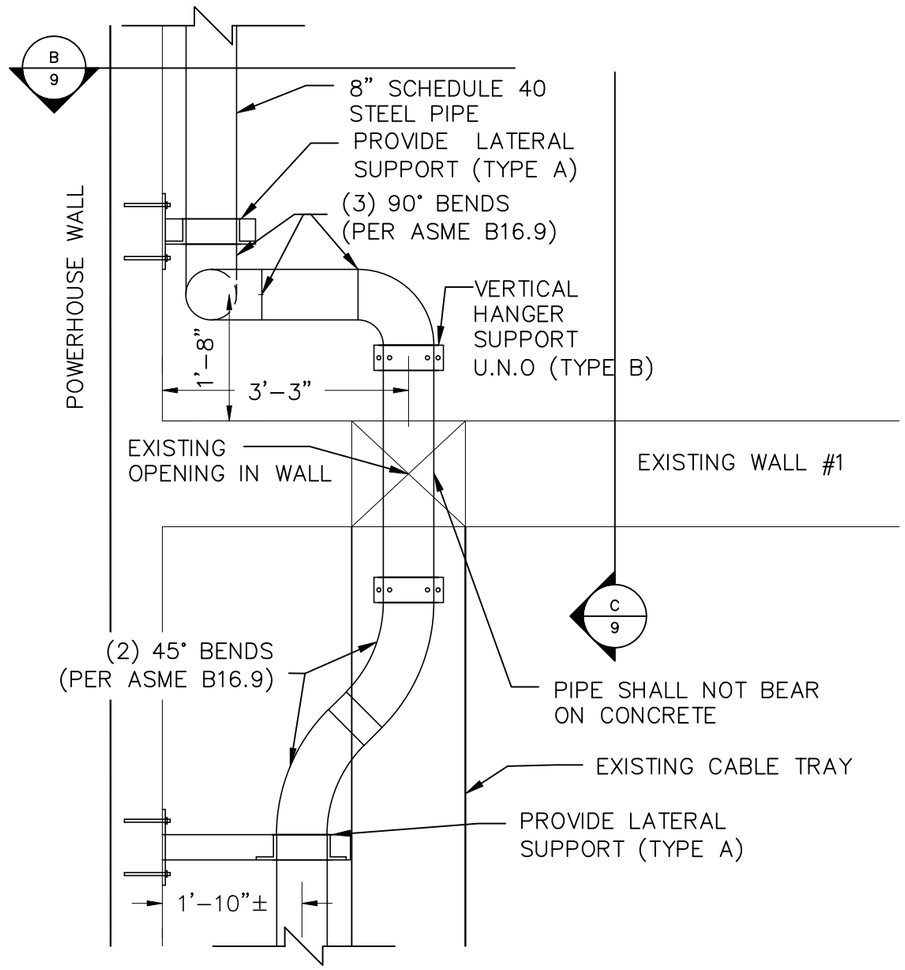
EEL FACILITY PIPELINE 3D PROFILE

SCALE: AS NOTED DRAWING NO.: 6



1/7 PLAN OF PIPE AT EXISTING MANIFOLD
Scale: 1"=1'



2/7 PLAN OF PIPE THROUGH WALL #1
Scale: 1"=1'

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29)
2. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB. SEE SHEET 12 FOR TYPICAL SUPPORT DETAILS.
3. CONTRACTOR SHALL REMOVE EXISTING 3" PIPE THAT EXISTS ALONG THE ALIGNMENT OF THE PROPOSED 8" PIPE. AVOID OR MOVE OTHER PIPES UPON EXELON'S APPROVAL.
4. EXISTING MANIFOLD IS UNDER PRESSURE AND MUST BE ISOLATED (DOUBLE ISOLATED PREFERRED) PRIOR TO COMMENCING ANY WORK. BLIND FLANGE IS TO BE CAREFULLY REMOVED IN SUCH A MANNER TO CHECK LINE IS NOT PRESSURIZED.
5. THE NEW GATE VALVE IS TO BE INSTALLED AND CLOSED WITHIN 2 HOURS OF THE REMOVAL OF THE EXISTING BLIND FLANGE. TEMPORARILY SUPPORT THE VALVE UNTIL NEW SUPPORTS ARE INSTALLED.

1' 0 1' 2'
SCALE: 1" = 1'-0"

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DETAILED PIPE LAYOUT PLANS, SHEET 1

SCALE: AS NOTED DRAWING NO.: 7

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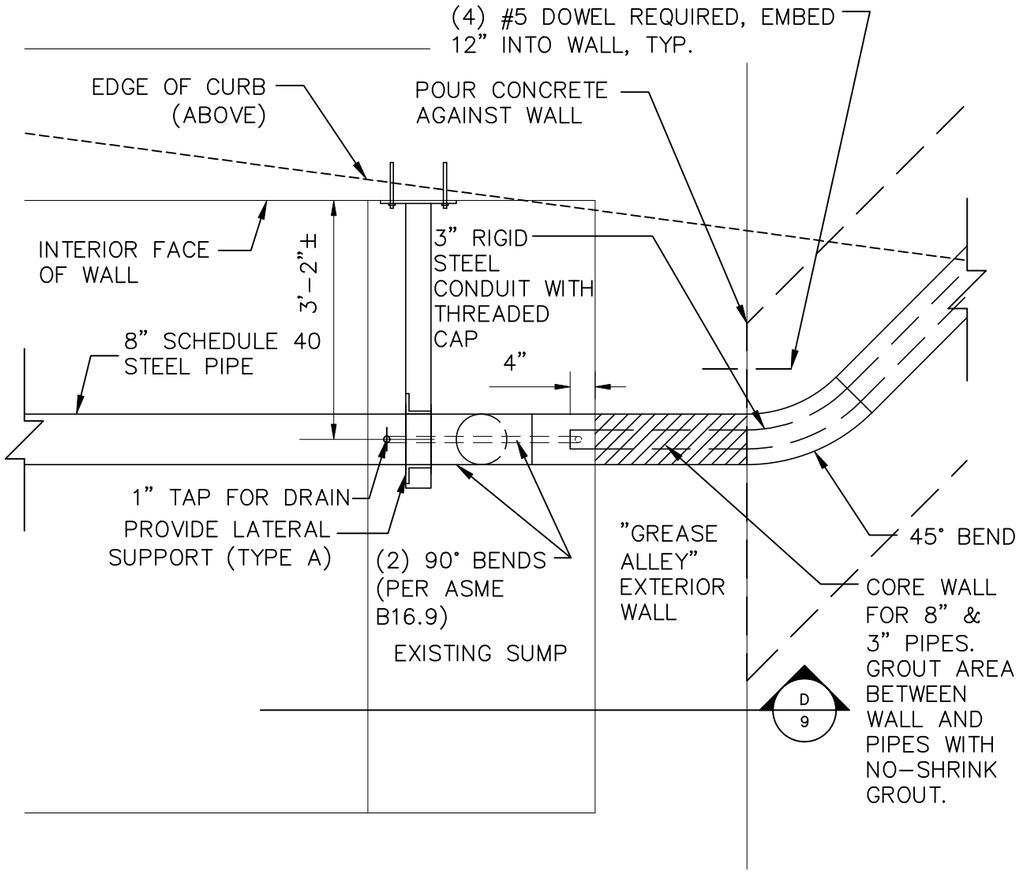
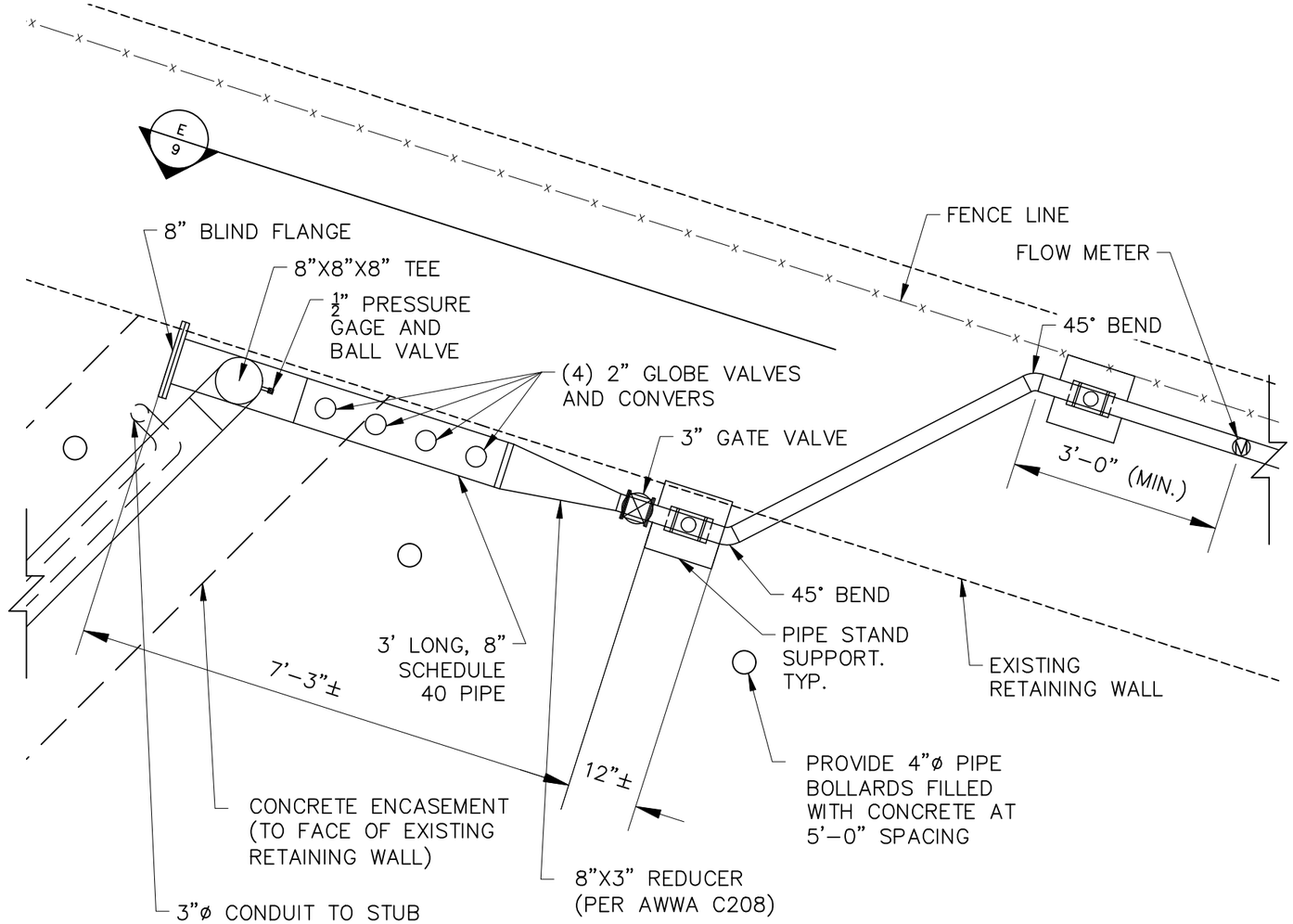


1/8 PLAN OF PIPE AT END OF ALLEY
Scale: 1"=1'



2/8 PLAN OF PROPOSED MANIFOLD
Scale: 1"=1'

NOTE: 3" RIGID STEEL CONDUIT TO STUB UP 4" ABOVE FINISH GRADE. PLACE 12" AWAY FROM MANIFOLD.

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29)
2. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB. SEE SHEET 12 FOR TYPICAL SUPPORT DETAILS.

1' 0 1' 2'
SCALE: 1" = 1'-0"

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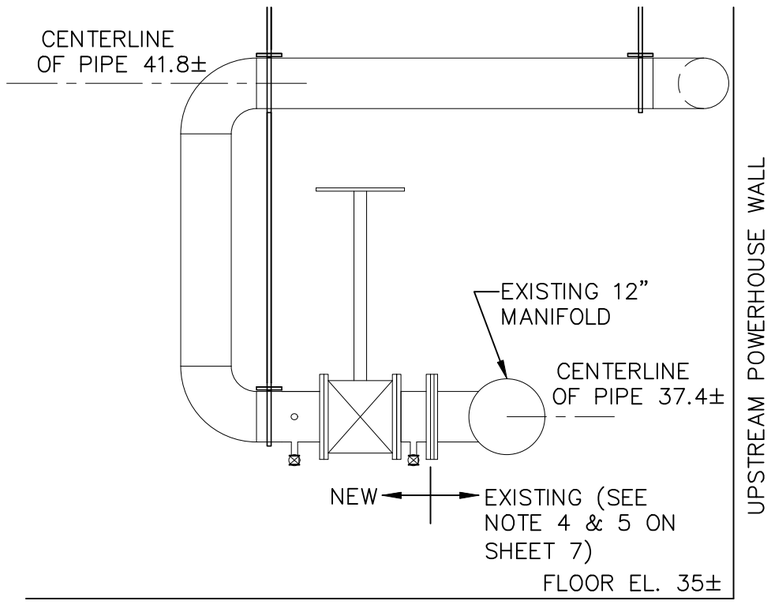
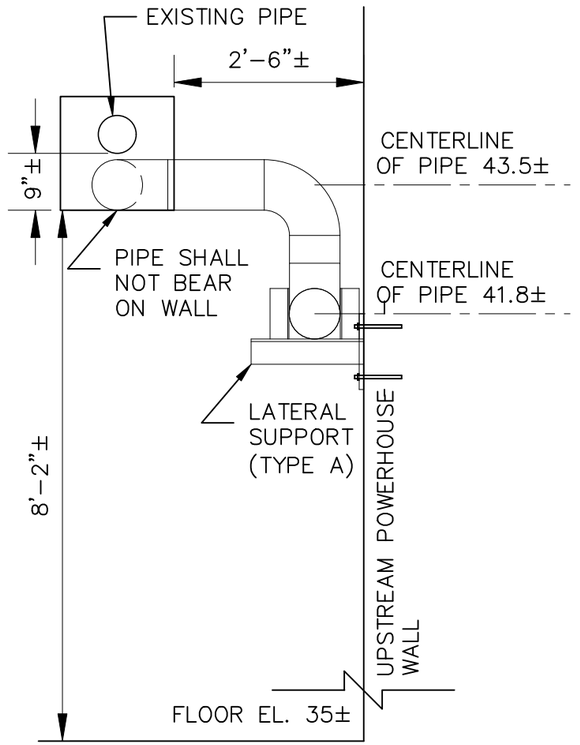
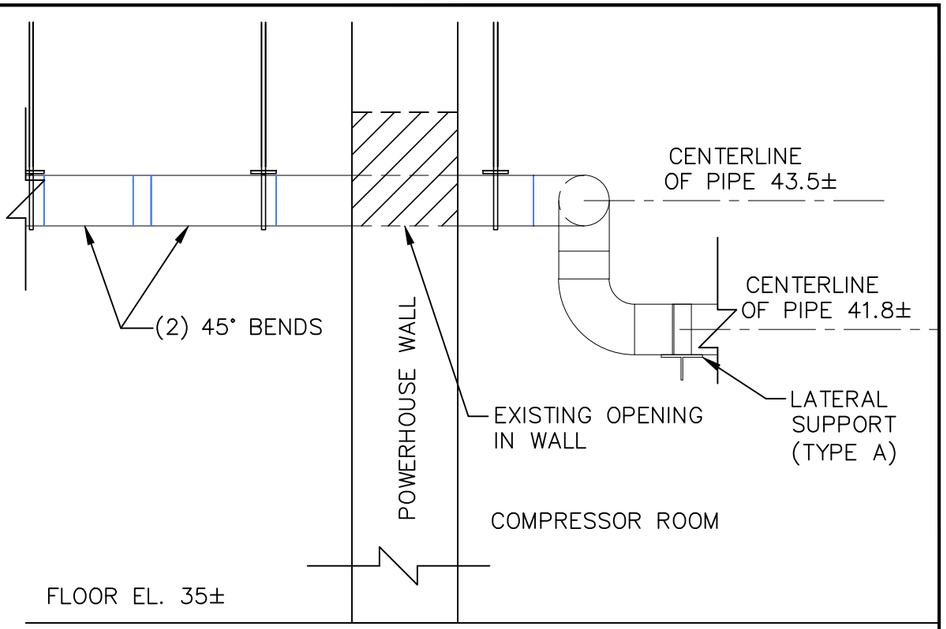
DETAILED PIPE LAYOUT PLANS, SHEET 2

SCALE: AS NOTED DRAWING NO.: 8

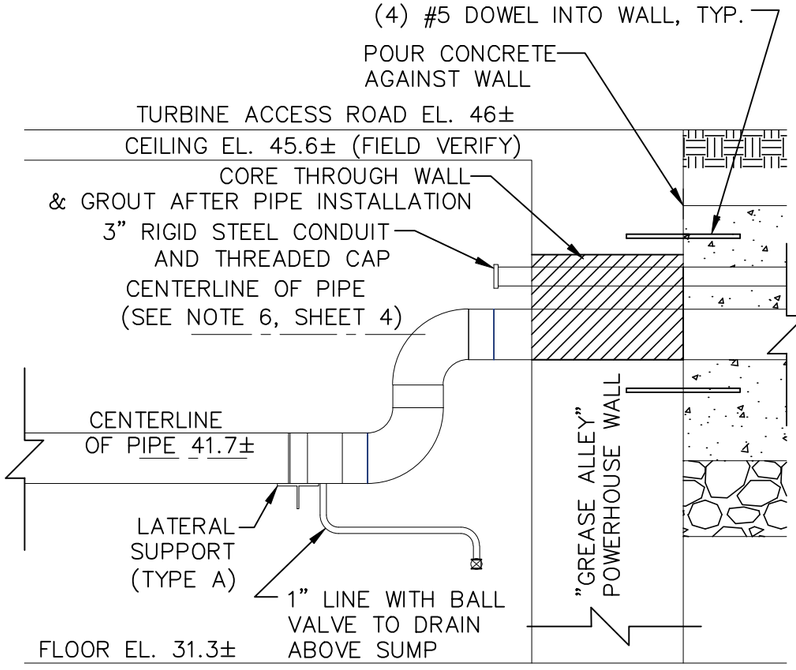


A/9 ELEVATION AT EXISTING MANIFOLD
Scale: 1"=1'



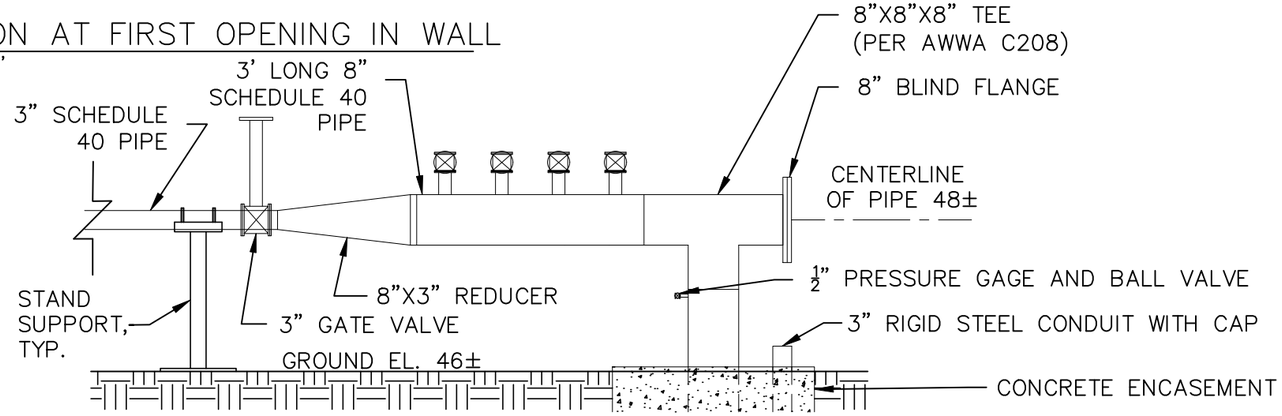


C/9 ELEVATION AT FIRST OPENING IN WALL
Scale: 1"=1'



D/9 ELEVATION AT END OF "GREASE ALLEY"
Scale: 1"=1'

B/9 SECTION AT FIRST OPENING IN WALL
Scale: 1"=1'



E/9 MANIFOLD DETAIL ELEVATION
Scale: 1"=2'

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29)

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SECTIONS AND DETAILS

SCALE: AS NOTED | DRAWING NO.: 9

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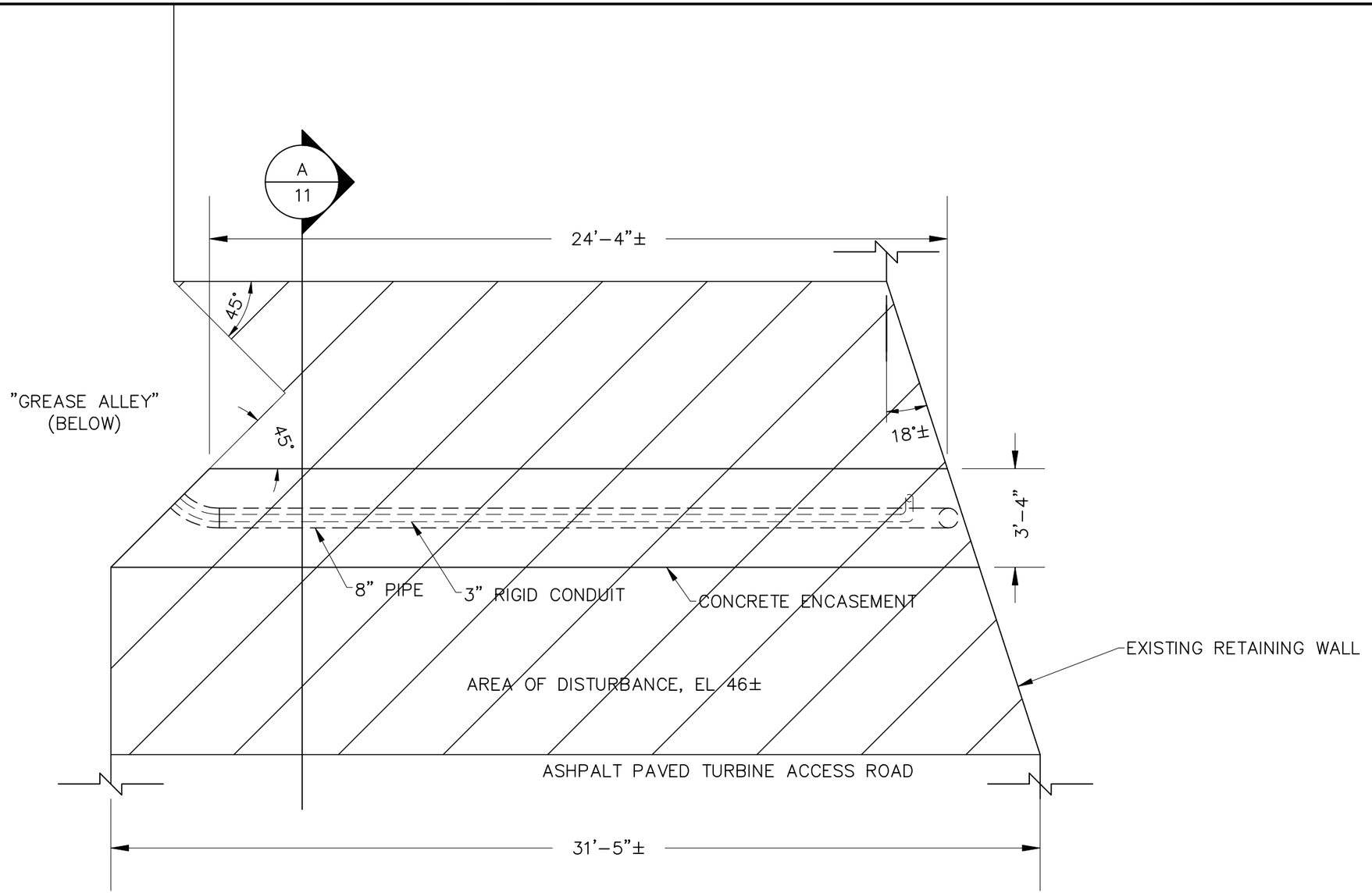

NOTES:

1. THE 8" PIPE SHALL RUN UNDER THE EXISTING YARD DRAINAGE LINES. EXCAVATE BY HAND TO LOCATE DRAIN LINES AND TO ENSURE LINES ARE NOT DAMAGED OR DISTURBED DURING INSTALLATION OF NEW PIPE. ELEVATION ACROSS DRIVEWAY WILL BE DEPENDENT ON LOCATION OF DRAIN LINES AND RAILROAD TRACKS.
2. MAXIMUM AREA OF DISTURBANCE EQUAL TO 507 SQ. FT.

2' 0 2' 4'

SCALE: 1" = 2'–0"

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GSE PROJECT NO.: 1714 DATE: 2/17/2017

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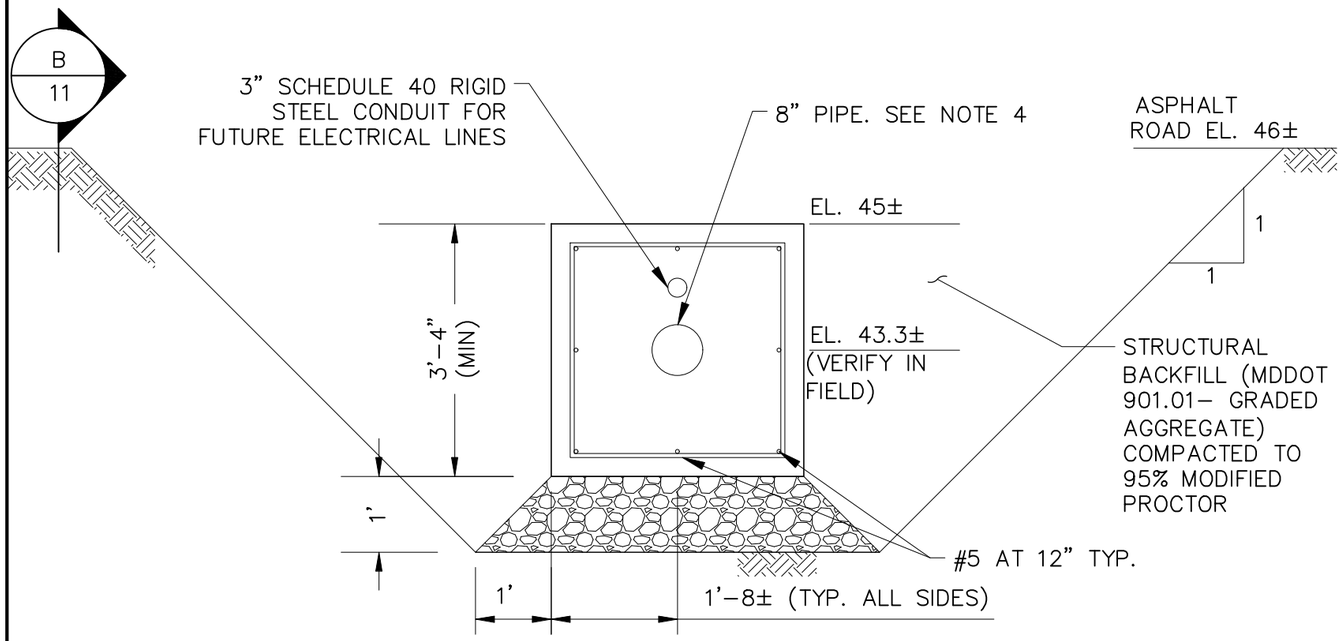
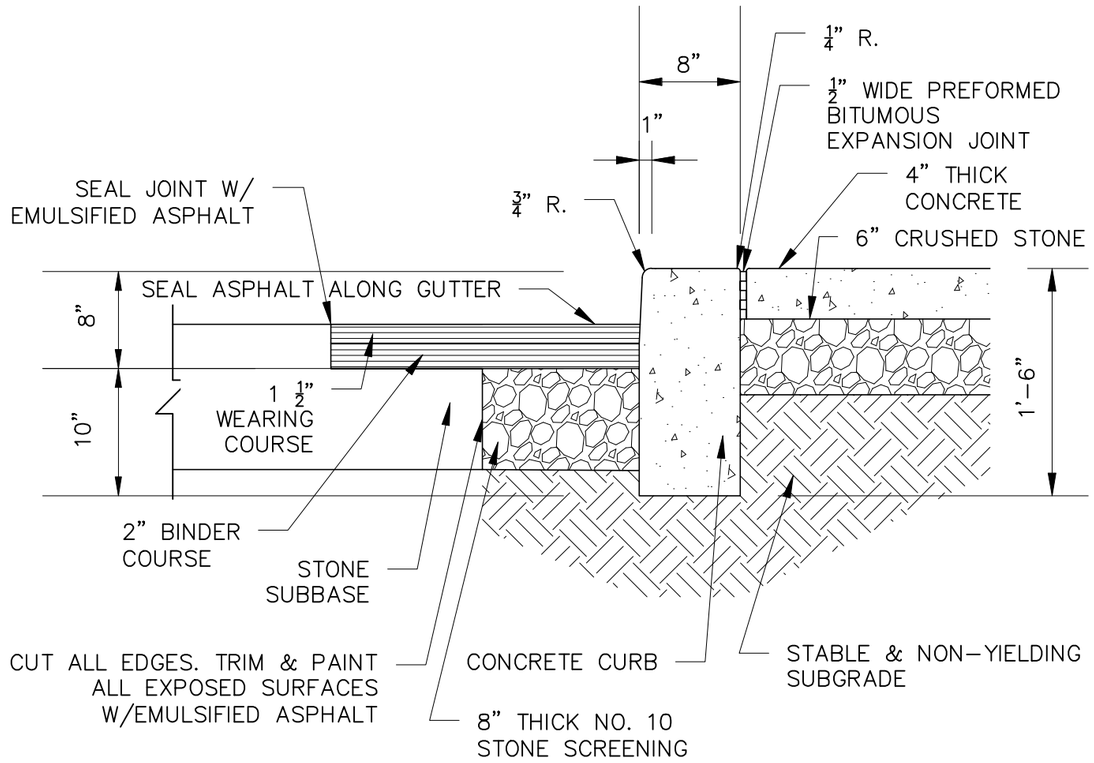
EXCAVATION AND CONCRETE ENCASEMENT PLAN

SCALE: AS NOTED DRAWING NO.: 10

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



A 11 CONCRETE ENCASEMENT SECTION AND EXCAVATION DETAIL
Scale: 1"=1'



B 11 ROAD BASE DETAIL TYP.
Scale: 1"=6"

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29)
2. A BUOYANT FORCE OF 950 LB MUST BE RESISTED DURING POUR AND CURING OF CONCRETE
3. GROUND SHALL BE COMPACTED TO ASTM D 1557 (95% MODIFIED PROCTOR).
4. THE 8" PIPE SHALL RUN UNDER THE EXISTING YARD DRAINAGE LINES. EXCAVATE BY HAND TO LOCATE DRAIN LINES, TO LOCATE POSSIBLE RAILROAD TRACKS, AND TO ENSURE LINES ARE NOT DAMAGED OR DISTURBED DURING INSTALLATION OF NEW PIPE.
5. ASPHALT ROAD TO BE REPLACED PER SECTION B.
6. EROSION AND SEDIMENT CONTROL REQUIREMENTS ARE SHOWN ON DRAWING 20.

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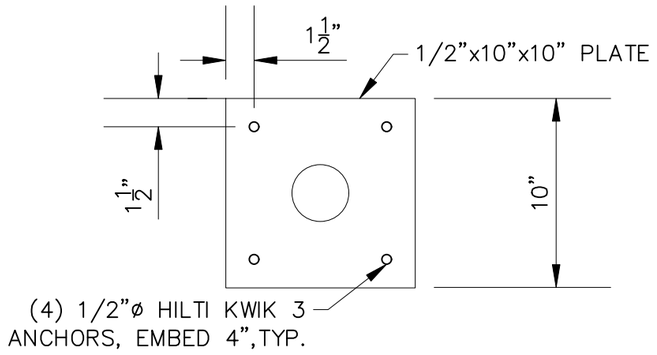
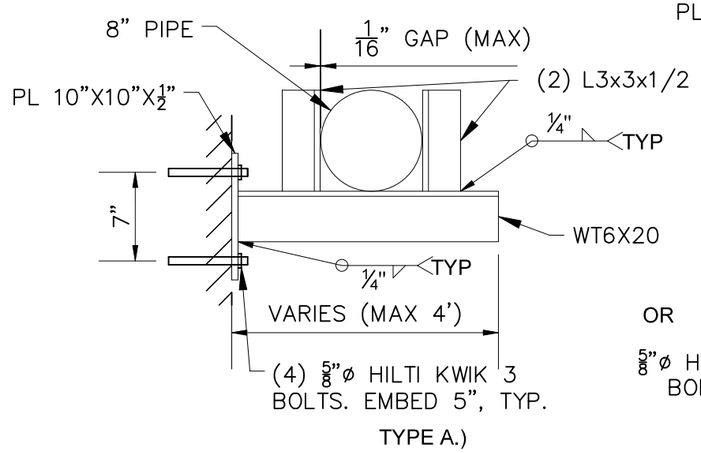
EXCAVATION, CONCRETE ENCASEMENT AND ROAD SECTIONS

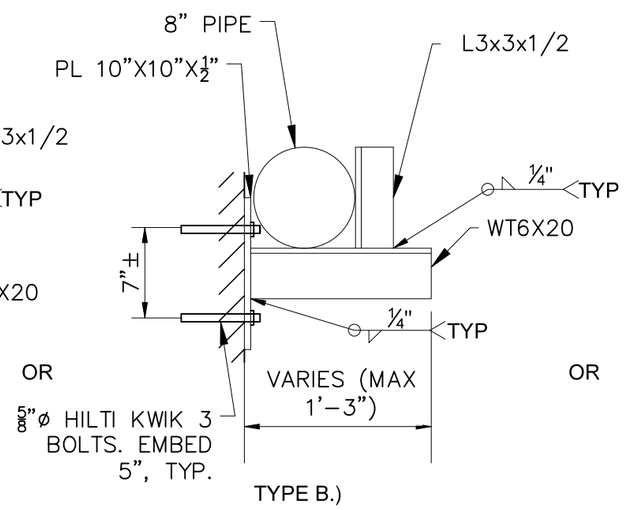
SCALE: AS NOTED DRAWING NO.: 11

IT IS A VIOLATION OF THE LAW FOR ANY PERSON, TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



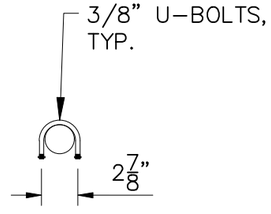
B/12 STAND PIPE SUPPORT BASE (TYP.)
Scale: 3"=1'



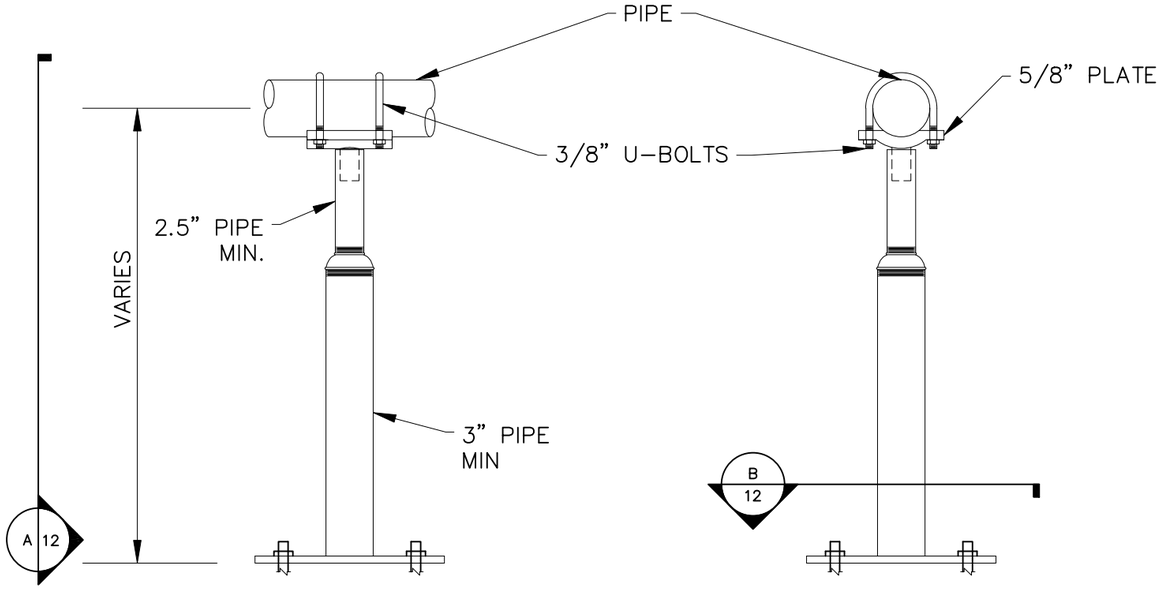


OR

OR

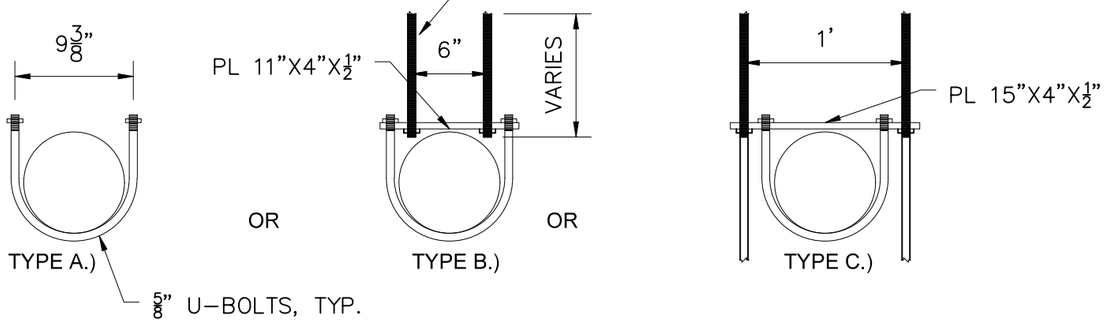


2/12 8" LATERAL PIPE SUPPORT (TYP.)
Scale: 2"=1'



ADJUSTABLE STAND
1/12 VERTICAL PIPE SUPPORT (TYP.)
Scale: 3"=1'

A/12 ELEVATION STAND PIPE SUPPORT
Scale: 3"=1'



3/12 8" HANGER (VERTICAL) PIPE SUPPORTS (TYP.)
Scale: 2"=1'

NOTES

1. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB.
2. LATERAL SUPPORTS MUST BE CAPABLE OF SUPPORTING 1000 LB HORIZONTAL LOAD AND 1500 POUND VERTICAL LOAD.

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PIPE SUPPORTS

SCALE: AS NOTED DRAWING NO.: 12

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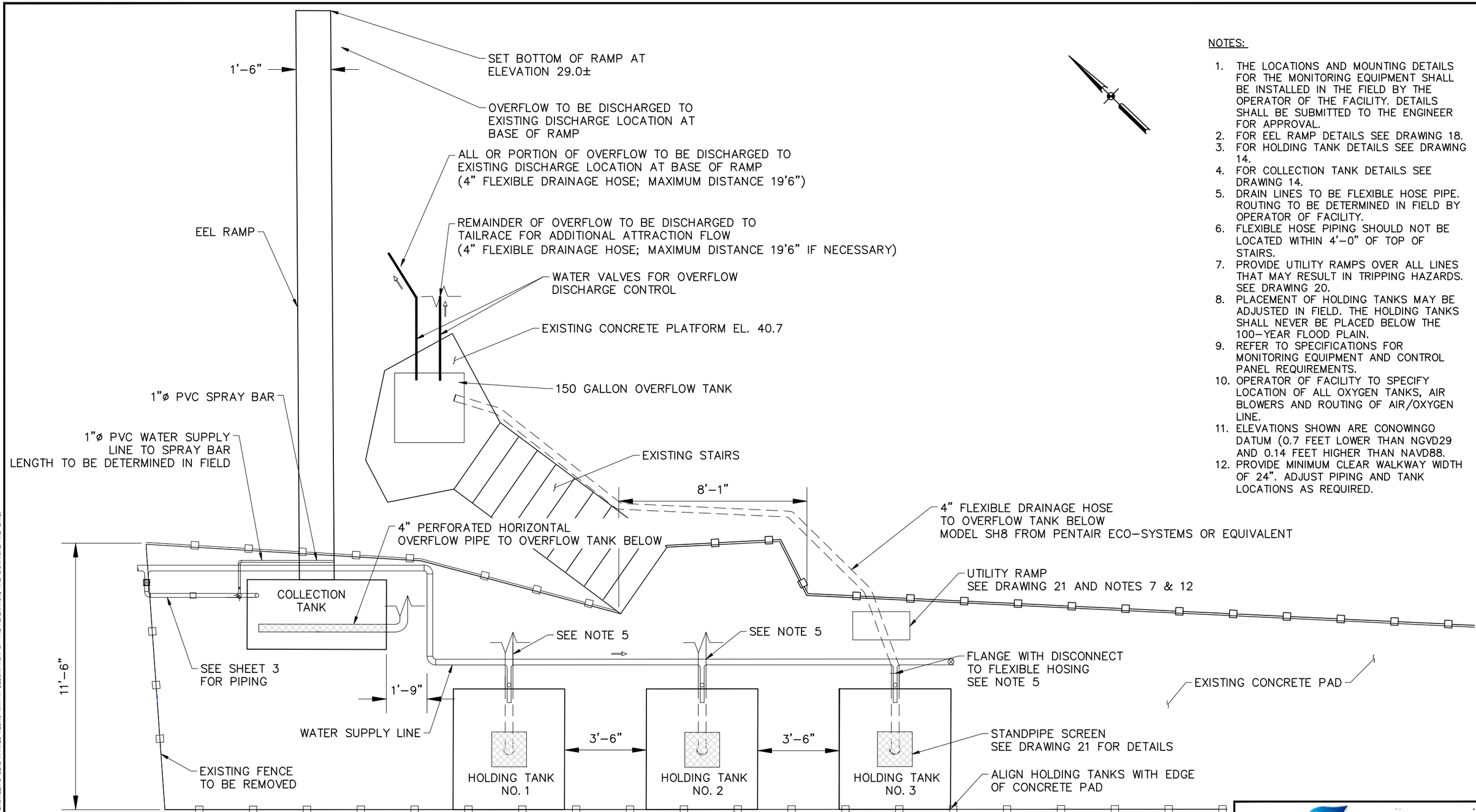

NOTES:

1. THE LOCATIONS AND MOUNTING DETAILS FOR THE MONITORING EQUIPMENT SHALL BE INSTALLED IN THE FIELD BY THE OPERATOR OF THE FACILITY. DETAILS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL.
2. FOR EEL RAMP DETAILS SEE DRAWING 18.
3. FOR HOLDING TANK DETAILS SEE DRAWING 14.
4. FOR COLLECTION TANK DETAILS SEE DRAWING 14.
5. DRAIN LINES TO BE FLEXIBLE HOSE PIPE. ROUTING TO BE DETERMINED IN FIELD BY OPERATOR OF FACILITY.
6. FLEXIBLE HOSE PIPING SHOULD NOT BE LOCATED WITHIN 4'–0" OF TOP OF STAIRS.
7. PROVIDE UTILITY RAMPS OVER ALL LINES THAT MAY RESULT IN TRIPPING HAZARDS. SEE DRAWING 20.
8. PLACEMENT OF HOLDING TANKS MAY BE ADJUSTED IN FIELD. THE HOLDING TANKS SHALL NEVER BE PLACED BELOW THE 100–YEAR FLOOD PLAIN.
9. REFER TO SPECIFICATIONS FOR MONITORING EQUIPMENT AND CONTROL PANEL REQUIREMENTS.
10. OPERATOR OF FACILITY TO SPECIFY LOCATION OF ALL OXYGEN TANKS, AIR BLOWERS AND ROUTING OF AIR/OXYGEN LINE.
11. ELEVATIONS SHOWN ARE CONOWINGO DATUM (0.7 FEET LOWER THAN NGVD29 AND 0.14 FEET HIGHER THAN NAVD88.
12. PROVIDE MINIMUM CLEAR WALKWAY WIDTH OF 24". ADJUST PIPING AND TANK LOCATIONS AS REQUIRED.

2' 0 2' 4'

SCALE: 1/2" = 1'–0"

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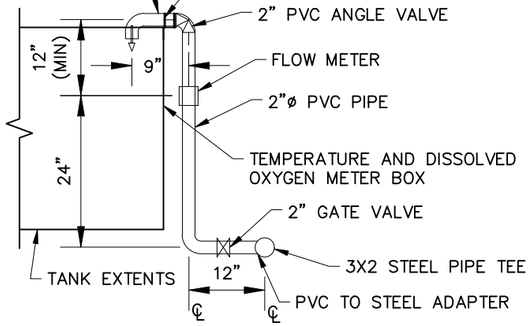
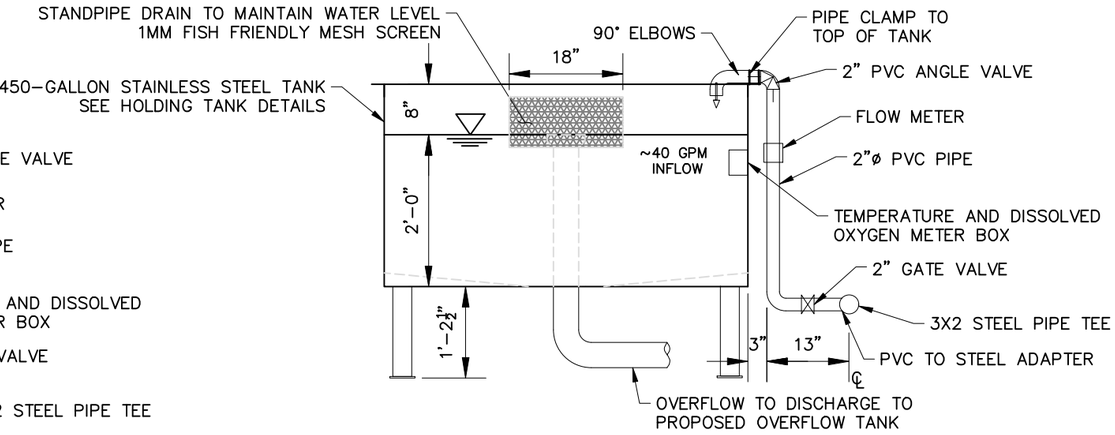
EEL FACILITY PLAN LAYOUT (FIGURE 2.2.3-1)

SCALE: AS NOTED DRAWING NO.: 13



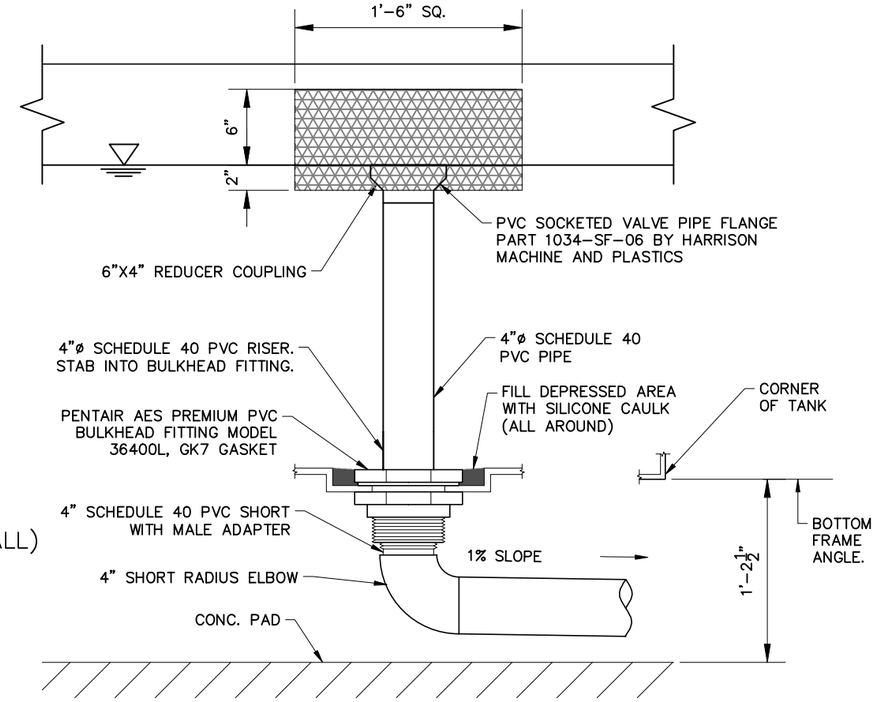
1 TYPICAL RISER DETAIL – HOLDING TANK

Scale: 1" = 1'–0"



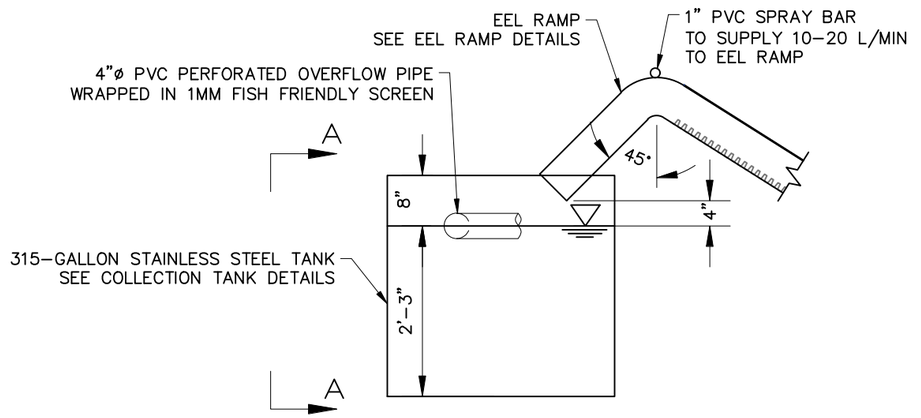
1/14 SECTION OF HOLDING TANK

1" = 1'–0" (APPROXIMATE TANK SIZE 5'6"X5'6"X2'8" TALL)



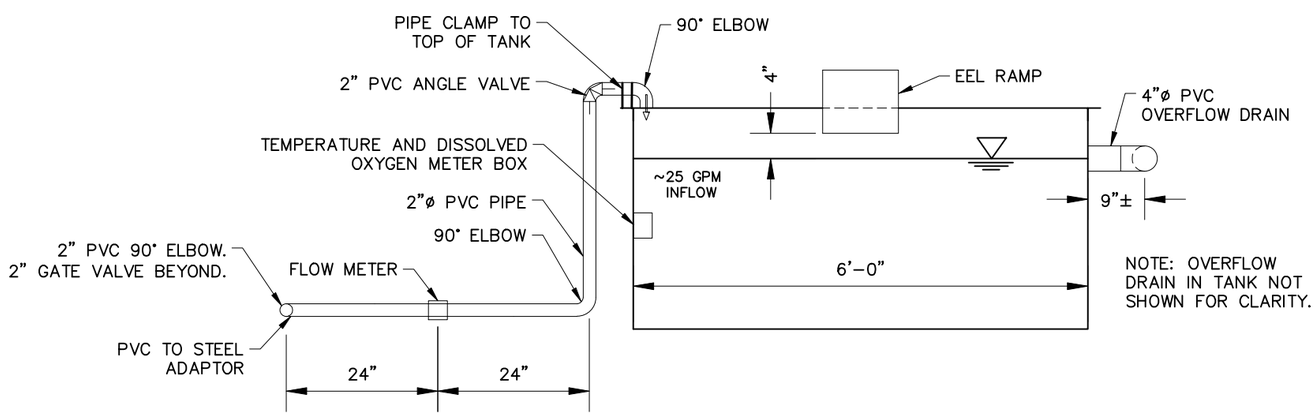
2 STANDPIPE DETAIL – HOLDING TANK

Scale: 1" = 1'–0"



2/14 SECTION OF COLLECTION TANK

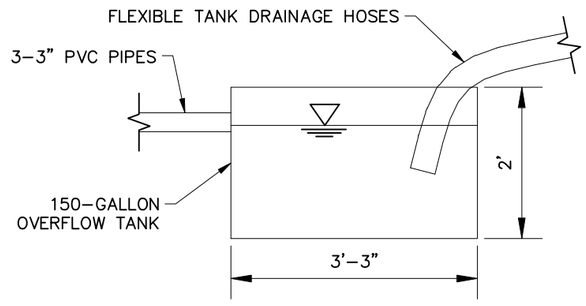
1" = 1'–0" (APPROXIMATE TANK SIZE 6'X3'4"X3'1" TALL)



NOTE: OVERFLOW DRAIN IN TANK NOT SHOWN FOR CLARITY.

A/14 ELEVATION OF COLLECTION TANK

1" = 1'–0"



3/14 SECTION OF OVERFLOW TANK

1" = 1'–0" (APPROXIMATE TANK SIZE 39"X58"X24" TALL)

NOTES

1. REFER TO SPECIFICATIONS FOR MONITORING EQUIPMENT AND CONTROL PANEL REQUIREMENTS.
2. HOLES IN TANK COVERS FOR DISSOLVED OXYGEN AND AERATION LINES TO BE DRILLED IN FIELD.
3. OPERATOR OF FACILITY TO SPECIFY LOCATION OF ALL OXYGEN TANKS, AIR BLOWERS AND ROUTING OF AIR/OXYGEN LINE.
4. ELEVATIONS SHOWN ARE CONOWINGO DATUM (0.7 FEET LOWER THAN NAGVD 29 AND 0.14 FEET HIGHER THAN NAVD88).

1' 0 1' 2'

SCALE: 1" = 1'–0"

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TYPICAL TANK SECTIONS (FIGURE 2.2.3-2)

SCALE: AS NOTED DRAWING NO.: 14

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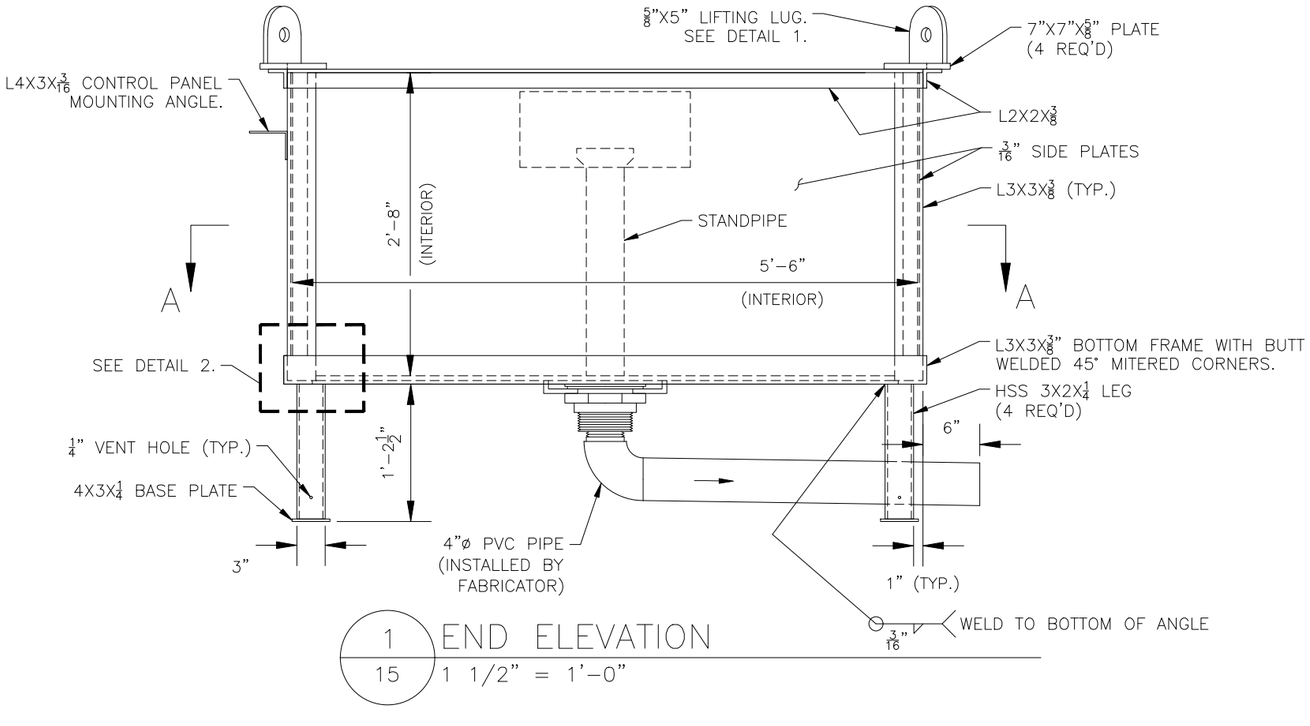
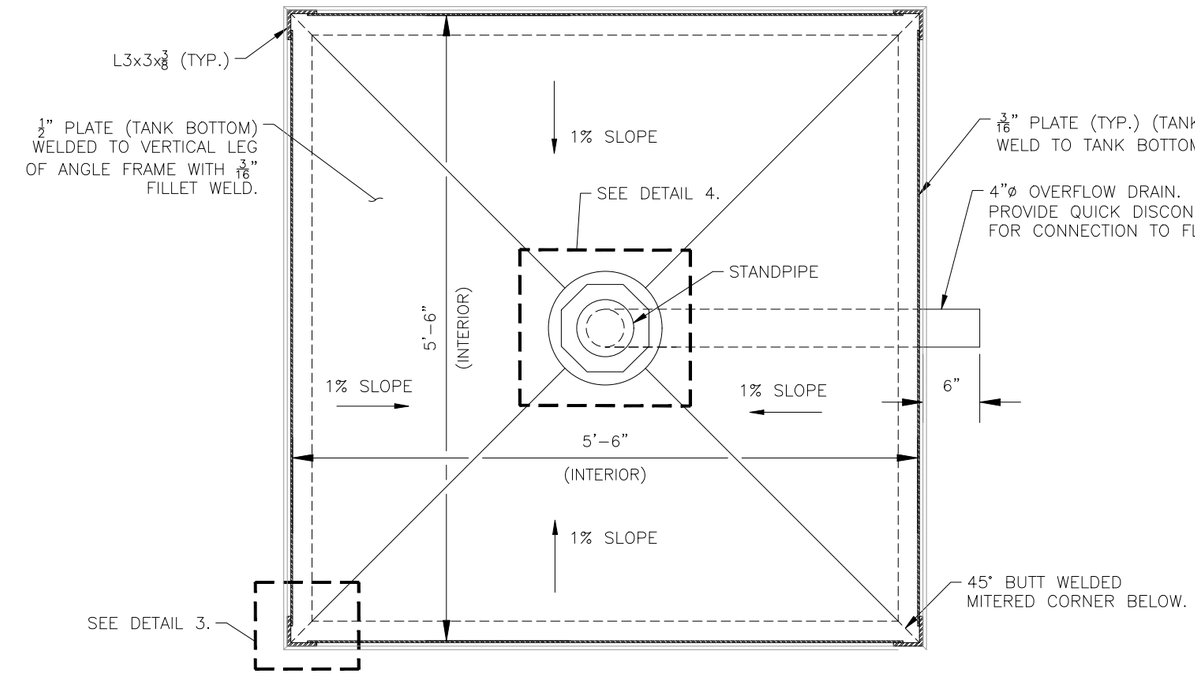


1/15 END ELEVATION

1 1/2" = 1'-0"

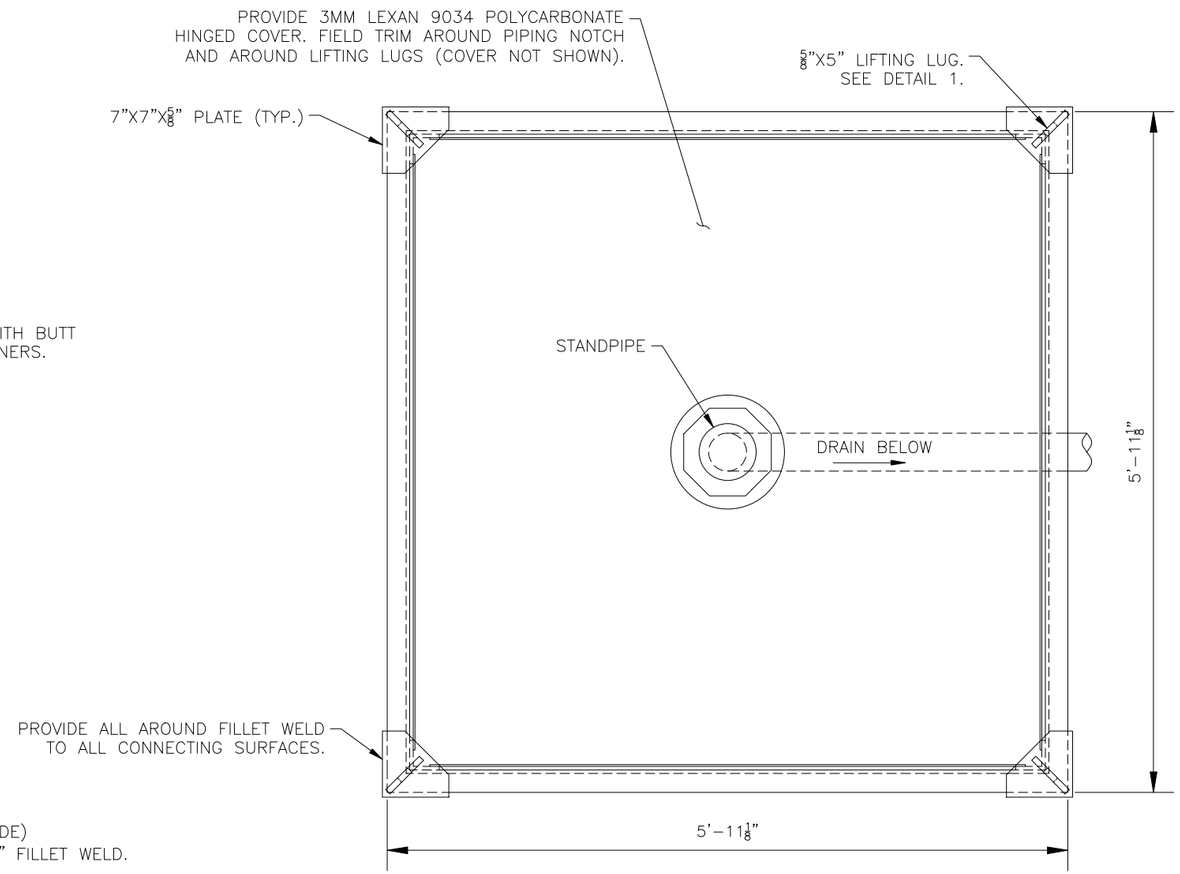


A/15 PLAN THROUGH TANK

1 1/2" = 1'-0"

8" 0 8" 16"

SCALE: 1 1/2" = 1'-0"



2/15 PLAN – TOP OF TANK

1 1/2" = 1'-0"

NOTES:

1. USE STAINLESS STEEL ELECTRODES.
2. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE CONTINUOUS.
3. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE 3/16" FILLET WELDS.
4. ALL OVERLAPPING SURFACES TO BE FULLY WELDED WITH 3/16" FILLET WELDS.
5. LIFTING LUGS ARE DESIGNED TO LIFT TANK ASSUMING TANK IS COMPLETELY DRAINED.
6. SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL.
7. TANK FABRICATOR SHALL DRILL/CUT HOLES IN TANK SIDES FOR MONITORING EQUIPMENT (TEMPERATURE AND OXYGEN METERS). LOCATIONS AND SIZES TO BE DETERMINED DURING MEETING WITH OWNER'S REPRESENTATIVE(S) AND ENGINEER.
8. LOCATION OF CONTROL PANEL MOUNTING ANGLE TO BE DETERMINED DURING THE SITE MEETING WITH OWNER, OWNER'S REPRESENTATIVE, AND ENGINEER.
9. FITTINGS ATTACHED TO TANKS TO BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.

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HOLDING TANK PLAN AND SECTIONS

SCALE: AS NOTED DRAWING NO.: 15

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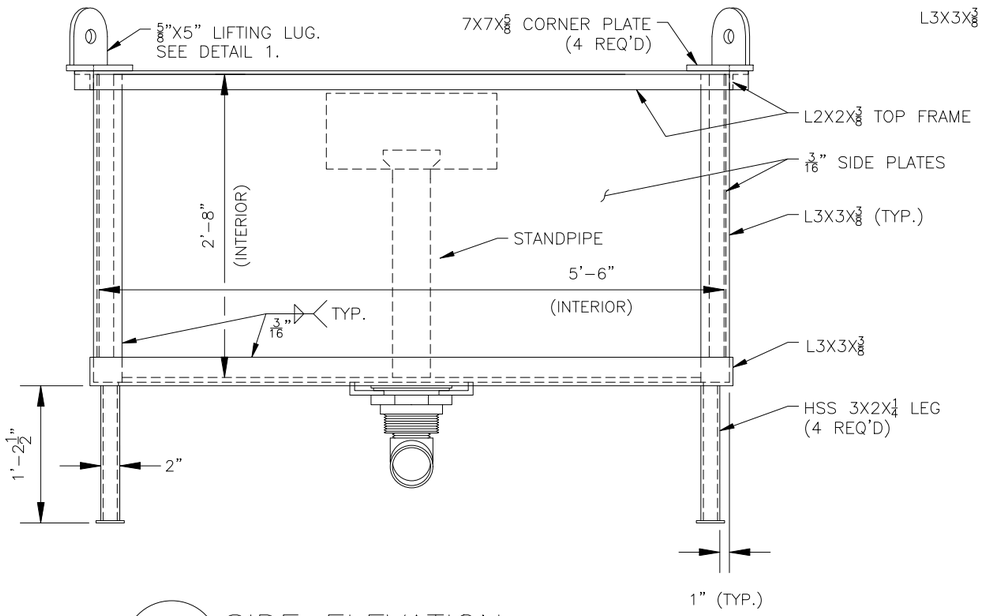
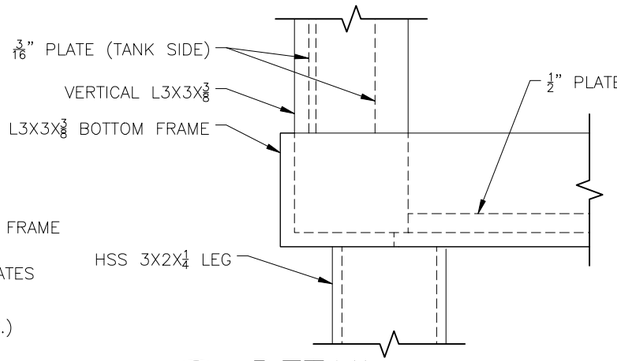
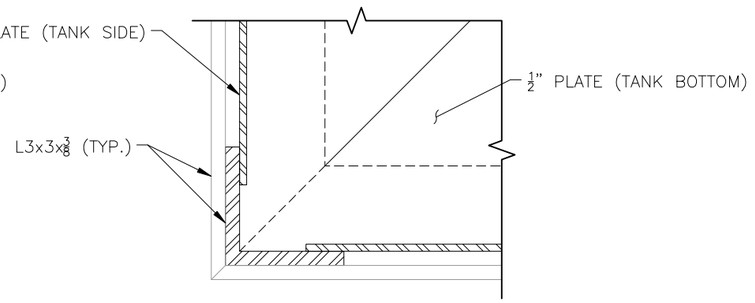


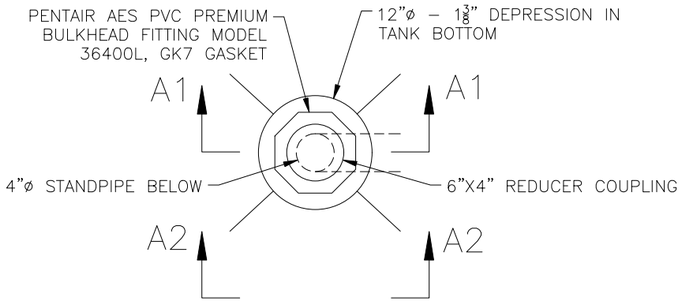
1/16 SIDE ELEVATION
3/4" = 1'-0"



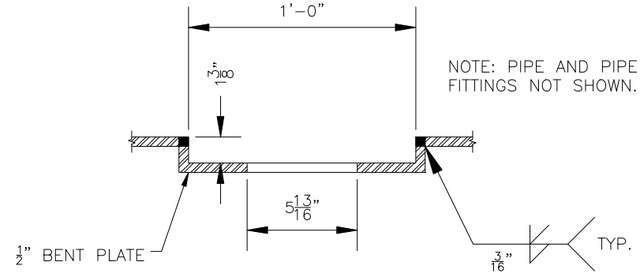
2 DETAIL
Scale: 6" = 1'-0"



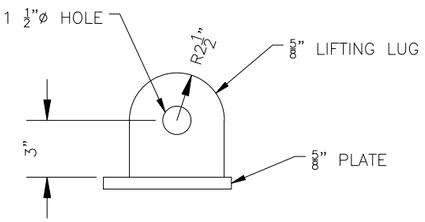
3 DETAIL
Scale: 6" = 1'-0"



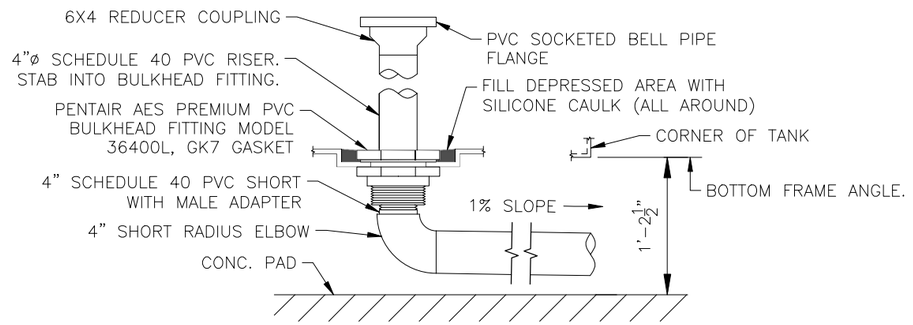
4 DETAIL
Scale: 1 1/2" = 1'-0"



A1/16 SECTION THROUGH TANK BOTTOM
3" = 1'-0"



1 DETAIL
Scale: 3" = 1'-0" (SEE NOTE 8)



A2/16 SECTION OF TANK BOTTOM
1 1/2" = 1'-0"

NOTES:

1. USE STAINLESS STEEL ELECTRODES.
2. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE CONTINUOUS.
3. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE 3/16" FILLET WELDS.
4. ALL OVERLAPPING SURFACES TO BE FULLY WELDED WITH 3/16" FILLET WELDS.
5. SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL.
6. BULKHEAD FITTINGS TO BE PROVIDED AND INSTALLED BY THE FABRICATOR AT THE FABRICATION PLANT.
7. TANK FABRICATOR SHALL DRILL/CUT HOLES IN TANK SIDES FOR MONITORING EQUIPMENT (TEMPERATURE AND OXYGEN METERS). LOCATIONS AND SIZES TO BE DETERMINED DURING MEETING WITH OWNER'S REPRESENTATIVE AND ENGINEER.
8. LIFTING LUGS ARE DESIGNED TO LIFT TANK ASSUMING TANK IS COMPLETELY DRAINED.

4" 0 4" 8"
SCALE: 3" = 1'-0"

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HOLDING TANK SECTIONS AND DETAILS

SCALE: AS NOTED DRAWING NO.: 16

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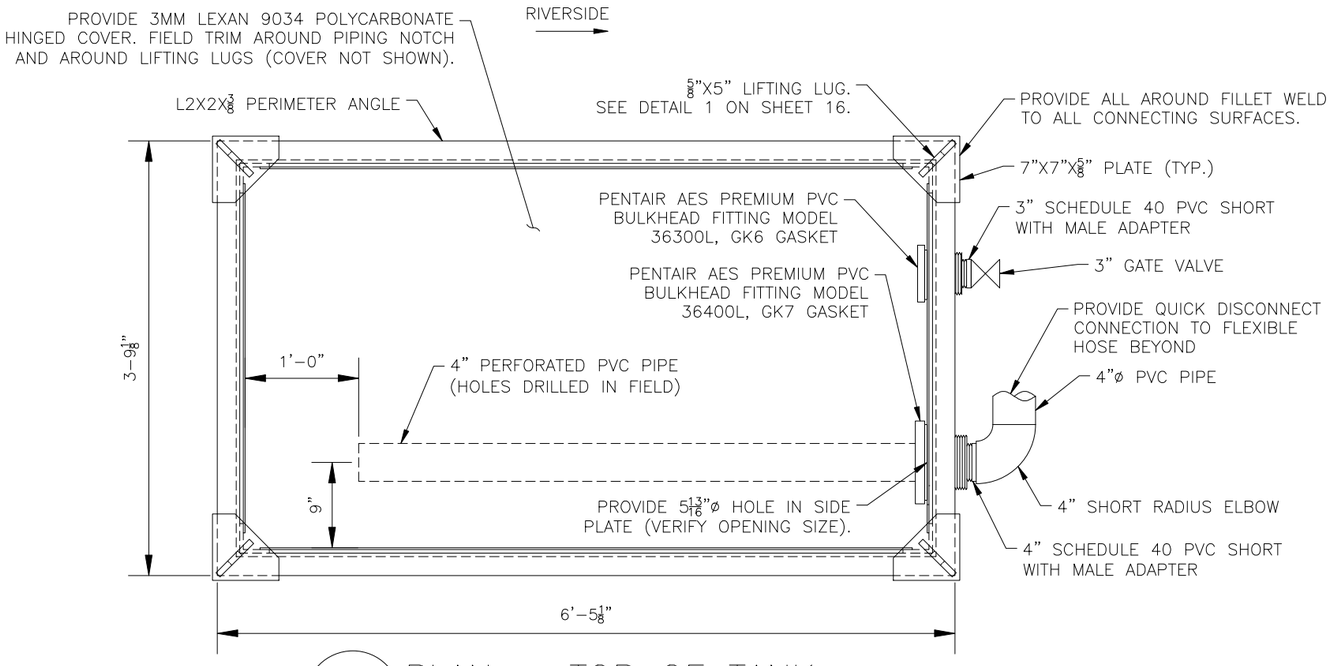
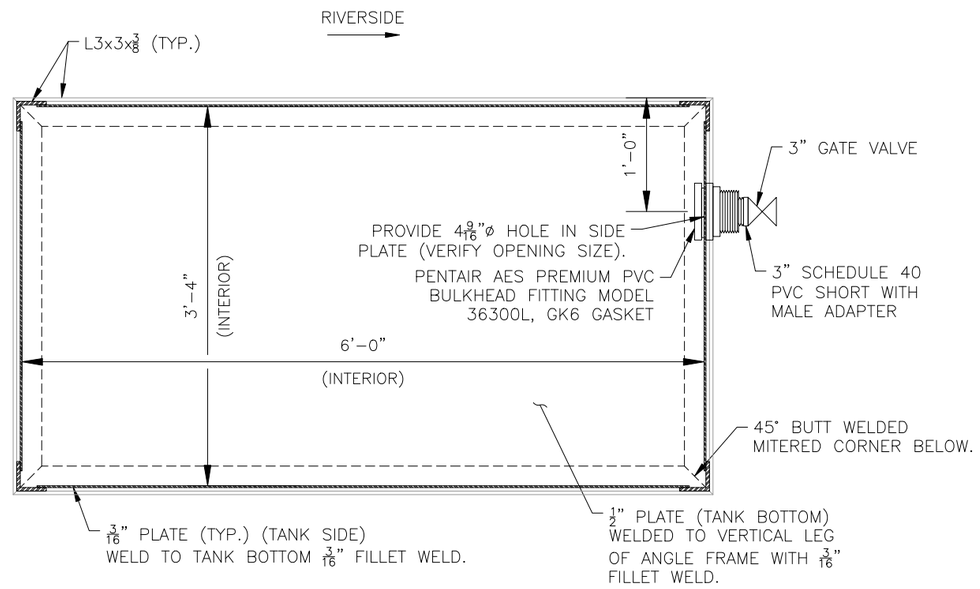
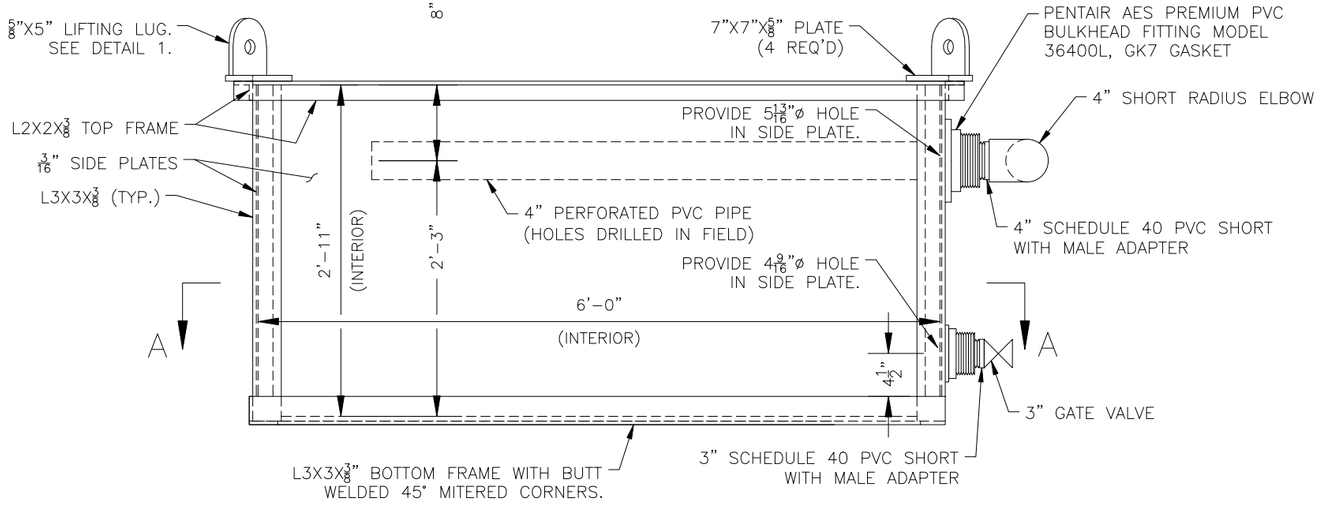


1/17 PLAN – TOP OF TANK
1 1/2" = 1'-0"



A/17 PLAN THROUGH TANK
1 1/2" = 1'-0"



2/17 SIDE ELEVATION
1 1/2" = 1'-0"

NOTES:

1. USE STAINLESS STEEL ELECTRODES.
2. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE CONTINUOUS.
3. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE 3/16" FILLET WELDS.
4. ALL OVERLAPPING SURFACES TO BE FULLY WELDED WITH 3/16" FILLET WELDS.
5. SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL.
6. FABRICATION DETAILS SHALL BE SIMILAR TO THOSE SHOWN FOR THE FABRICATION TANK.
7. TANK FABRICATOR SHALL DRILL/CUT HOLES IN TANK SIDES FOR MONITORING EQUIPMENT (TEMPERATURE AND OXYGEN METERS). LOCATIONS AND SIZES TO BE DETERMINED DURING MEETING WITH OWNER'S REPRESENTATIVE AND ENGINEER.
8. LIFTING LUGS ARE DESIGNED TO LIFT TANK ASSUMING TANK IS COMPLETELY DRAINED.
9. FITTINGS ATTACHED TO TANKS TO BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.

8" 0 8" 16"
SCALE: 1 1/2" = 1'-0"

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DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG
GSE PROJECT NO.: 1714 DATE: 2/17/2017

Exelon
EXELON GENERATION COMPANY, LLC

CONOWINGO EEL PASSAGE

GOMEZ AND SULLIVAN ENGINEERS
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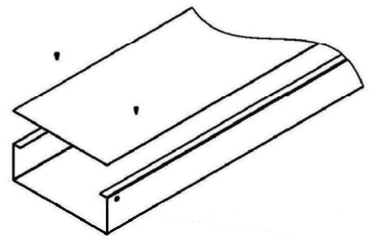
COLLECTION TANK PLAN AND SECTIONS

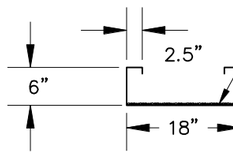
SCALE: AS NOTED DRAWING NO.: 17

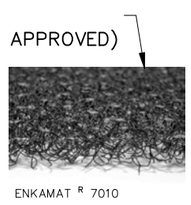


NOTES

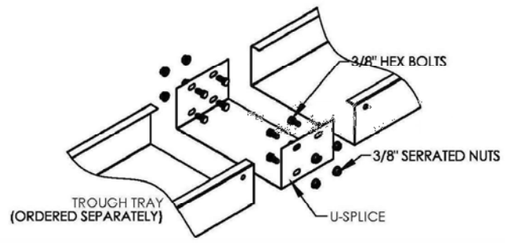
1. PROVIDE COVER WITH (10) #8 SELF DRILLING TEK SCREWS FOR MOUNTING. RECOMMENDED ATTACHMENT LOCATIONS: 3/8" FROM EDGES WIDTH WISE AND 1" FROM END LENGTH WISE, FOLLOWED BY 29–1/2" O.C.

1/18 COVER DETAIL
NOT TO SCALE





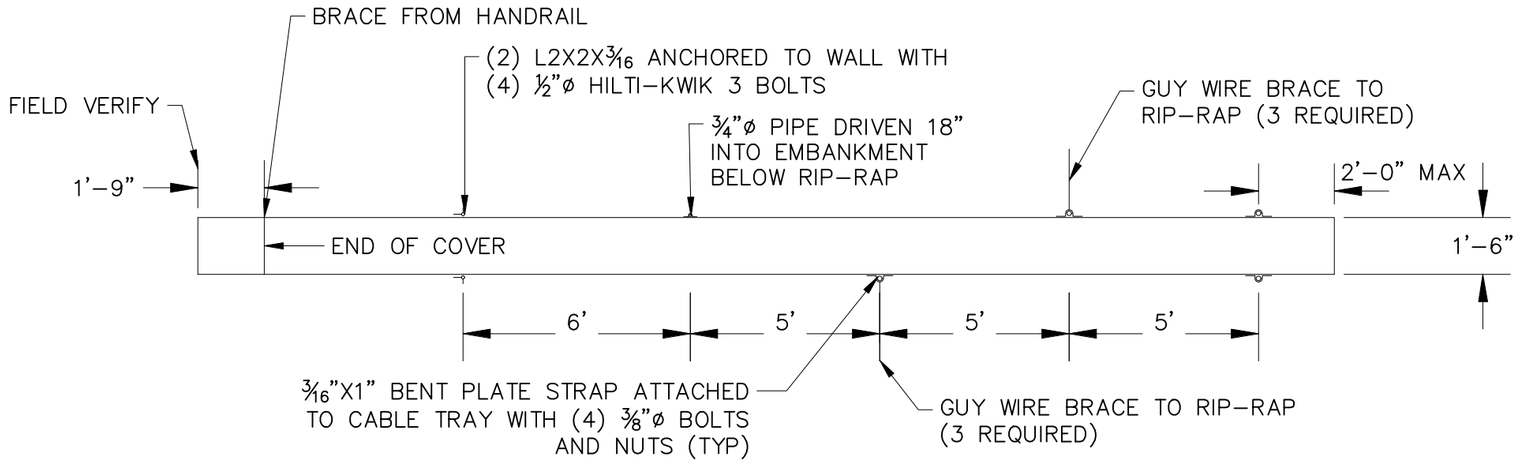
1/18 EEL RAMP ELEVATION
Scale: 1"=1'



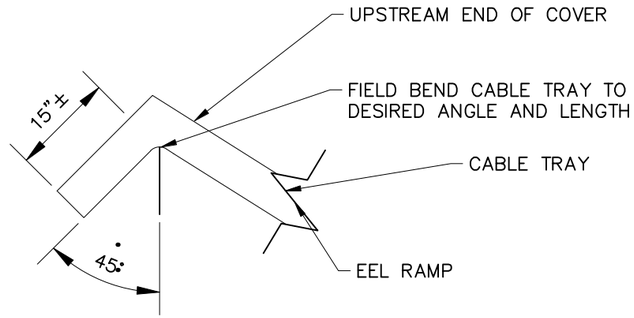
NOTES:

1. USE TO JUNCTION TRAY SECTIONS TOGETHER.
2. FEED PROVIDED 3/8"X3/4" HEX HEAD BOLT THRU TRAY AND U–SPLICE AND ATTACH 3/8" SERRATED NUTS ON OUTSIDE OF U–SPLICE.
3. RECOMMENDED TORQUE: FOR 3/8" FASTENERS: 25–35 FT–LBS.
4. IF DESIRED, ADDITIONAL HOLES MAY BE FIELD DRILLED IN THE BOTTOM OF THE TRAY THRU THE C–SPLICE AND ADDITIONAL HARDWARE (BY OTHERS) ATTACHED.

4/18 U–SPLICE DETAIL
NOT TO SCALE



3/18 EEL RAMP PLAN
Scale: 1"=2'



5/18 BENT SECTION OF EEL RAMP
Scale: 1"=1'

2' 0 2' 4'
SCALE: 1" = 2'–0"

1' 0 1' 2'
SCALE: 1" = 1'–0"

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DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG
GSE PROJECT NO.: 1714 DATE: 2/17/2017

Exelon
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CONOWINGO EEL PASSAGE

GOMEZ AND SULLIVAN ENGINEERS
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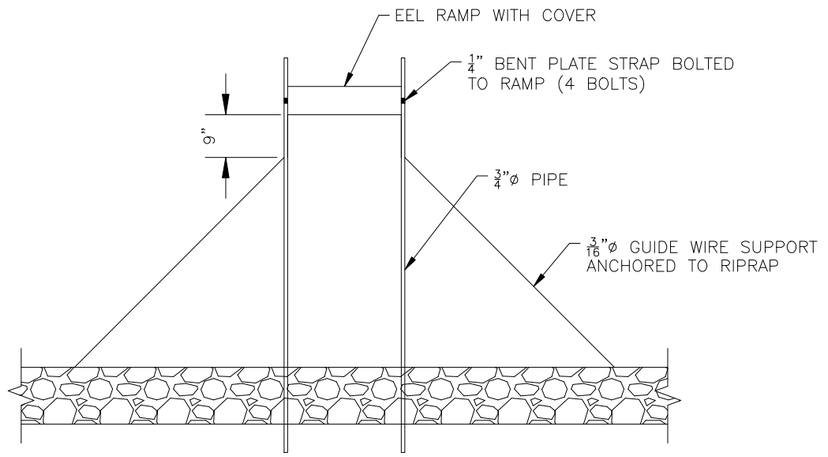
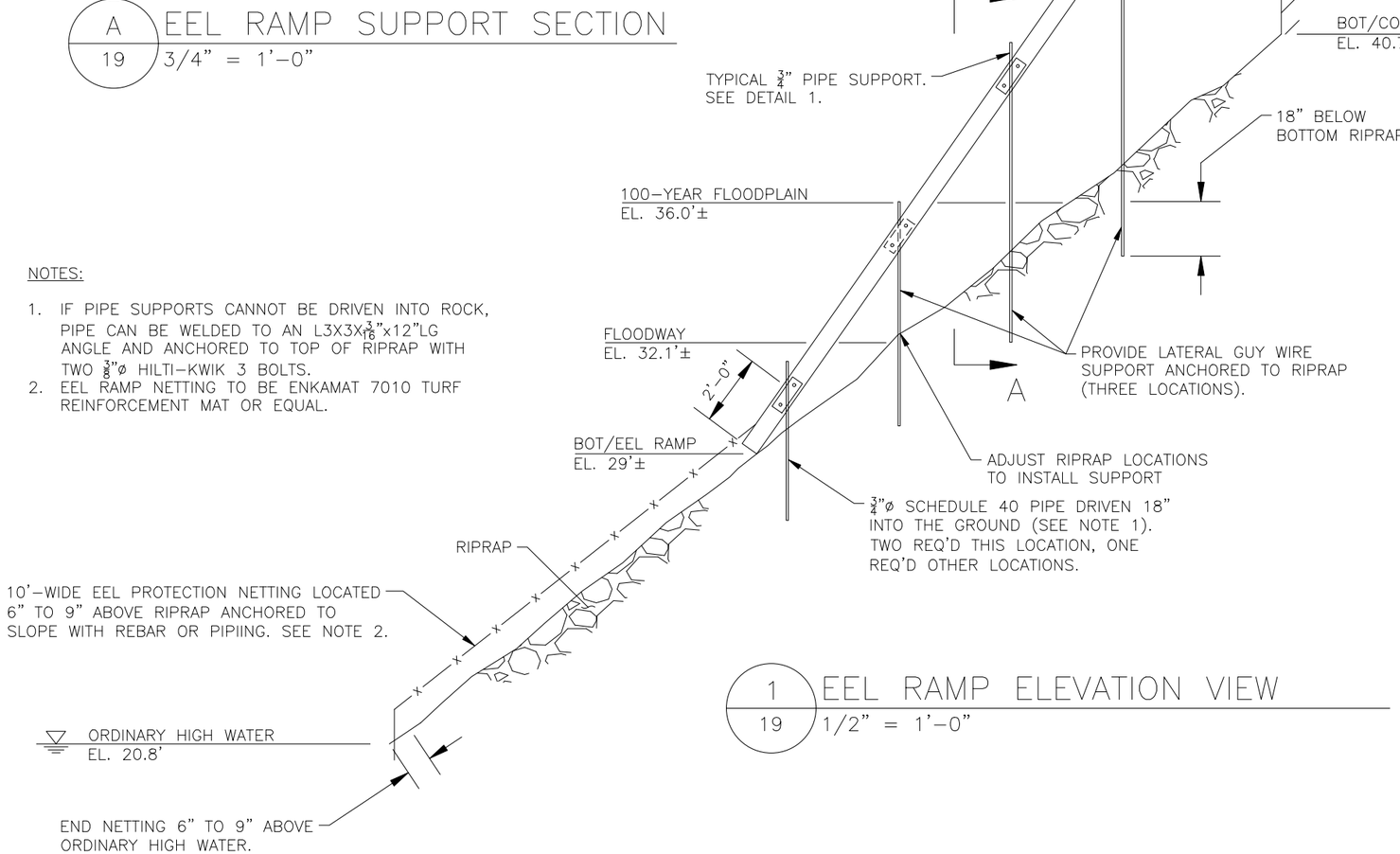
EEL RAMP SECTIONS AND DETAILS

SCALE: AS NOTED DRAWING NO.: 18



A / 19 EEL RAMP SUPPORT SECTION
3/4" = 1'–0"



NOTES:

1. IF PIPE SUPPORTS CANNOT BE DRIVEN INTO ROCK, PIPE CAN BE WELDED TO AN L3X3X3/16"x12"LG ANGLE AND ANCHORED TO TOP OF RIPRAP WITH TWO ¾"ø HILTI–KWIK 3 BOLTS.
2. EEL RAMP NETTING TO BE ENKAMAT 7010 TURF REINFORCEMENT MAT OR EQUAL.

1 / 19 EEL RAMP ELEVATION VIEW
1/2" = 1'–0"

2' 0 2' 4'
SCALE: 1/2" = 1'–0"

EEL FACILITY EQUIPMENT LIST

QUANTITY	ITEM DESCRIPTION	MANUFACTURER
60 feet	Eel Ramp cable tray	Monosystems
1	200-foot roll of Enkamat 7010 Substrate	
1	Overflow tank	Plastic Mart
150 sq-ft	Lexan for tank covers	
4	Dock Ramp	
8	Dock ramp panels	
	TANK DRAINAGE	
4	PVC socketed valve pipe flange	
6	6" X 4" Reducer Coupling	Pentair Ecosystems
30 feet	4" Schedule 40 PVC pipe	Pentair Ecosystems
6	4" Schedule 40 PVC short radius elbow	Pentair Ecosystems
6	4" diameter aluminum quick disconnect fitting	Pentair Ecosystems
6	4" schedule 40 PVC short with male adapter	Pentair Ecosystems
2	3" PVC Bulkhead fitting	Pentair Ecosystems
2	3" PVC gate valve	Pentair Ecosystems
60 feet	4-inch Schedule 40 PVC Pipe	Pentair Ecosystems
10 feet	1-inch Schedule 40 PVC Pipe	Pentair Ecosystems
300 feet	4" Suction Discharge Hose (Model SH8)	Pentair Ecosystems
	OXYGEN/AIR DIFFUSER PIPING	
3	linear piston air pump (SL44B)	Pentair Ecosystems
200 feet	3/4" Vinyl clear tubing for air lines	Pentair Ecosystems
200 feet	1/4" vinyl clear tubing for air lines	Pentair Ecosystems
250 feet	1/4" thick walled rubber tubing for O2	Pentair Ecosystems
50	3/4" polyethylene tubing for airlines	Pentair Ecosystems
200	3/4" hose clamps	Pentair Ecosystems
100	1/4" hose clamps	Pentair Ecosystems
4	O2 bottle regulators	Pentair Ecosystems
4	Reducer from 3/4" to 1/4", prior to splitter	Pentair Ecosystems
3	three way splitters for air lines (needle valves)	Pentair Ecosystems
3	O2 flow meter manifold	Pentair Ecosystems
2	Pump blower boxes with louvers	Pentair Ecosystems
12	Fine pore diffusers (AS300)	Pentair Ecosystems
	SPRAY BAR AND OVERFLOW PIPE	
10 feet	1" PVC solid wall pipe (spray bar)	Pentair Ecosystems
10	1" PVC cap, adapter, ball valve	Pentair Ecosystems
5	3" PVC bulkhead fitting for overflow tank drains	Pentair Ecosystems
	SHADING/EEL PROTECTION	
2	12' X 10' shade cloth (SC70) for eel protection	Pentair Ecosystems
1,250 sq-ft	60% black UV shade cloth over eel facilty	GreenhouseMegastore
	MONITORING EQUIPMENT	
2	3" flow meter	PDIR
6	2" flow meter	PDIR
5	Temperature/DO sensor	PDIR
1	cellular modem	PDIR
2	controller	PDIR
	ADDITIONAL SUPPLIES FOR EEL PROCESSING	
2	Fish measuring board (FMB2)	Pentair Ecosystems
1	Dissecting microscope	Pentair Ecosystems
2	Dissection kit	Pentair Ecosystems
	Digital scale	Pentair Ecosystems
	zip ties	
100	spat bags	Pentair Ecosystems
	Nets of various sizes, small to large	Pentair Ecosystems
2	1,000 ml graduated container	Pentair Ecosystems
2	2,000 ml graduated container	Pentair Ecosystems
5	brushes, bottle, hose, pipe, long handle	Pentair Ecosystems

DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG
GSE PROJECT NO.: 1714 DATE: 2/17/2017

Exelon
EXELON GENERATION COMPANY, LLC

CONOWINGO EEL PASSAGE

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EEL RAMP ELEVATION AND PIPE SUPPORT DETAILS

SCALE: AS NOTED DRAWING NO.: 19

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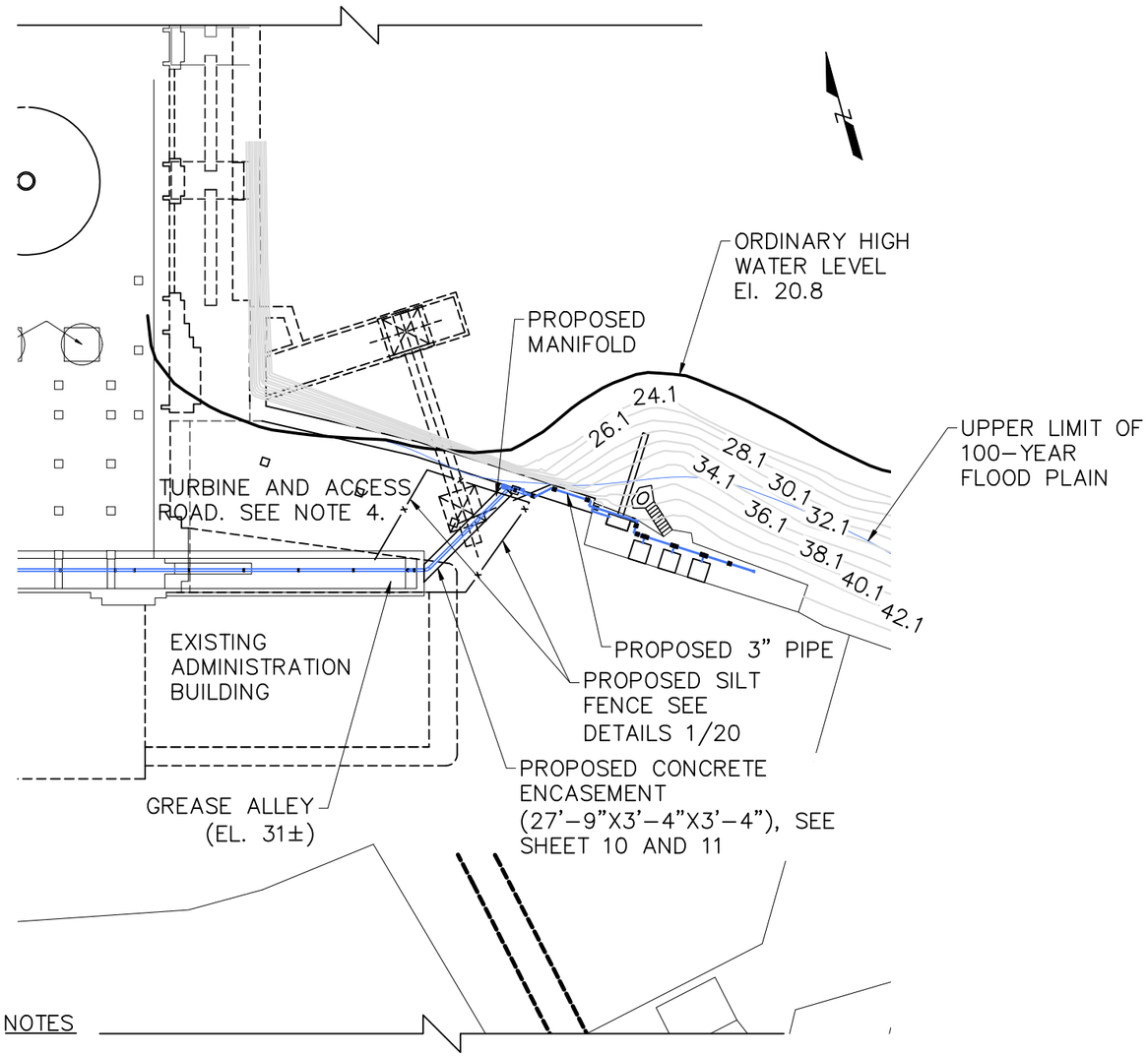
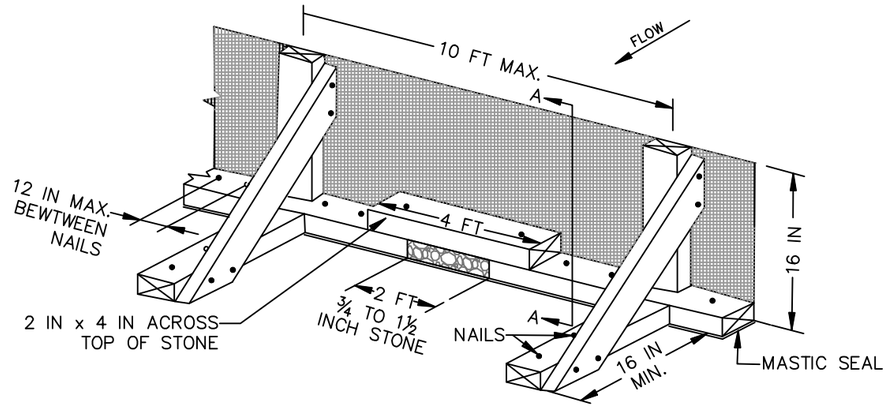


NOTES

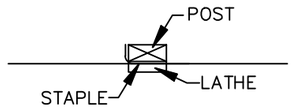
1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29 AND 0.14 FEET HIGHER THAN NAVD 88)
2. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB. SEE SHEET 12 FOR TYPICAL SUPPORT DETAILS.
3. CONTRACTOR SHALL REMOVE EXISTING 3" PIPE THAT EXISTS ALONG THE ALIGNMENT OF THE PROPOSED 8" PIPE. AVOID OR MOVE OTHER PIPES UPON EXELON'S APPROVAL.
4. LOCATE AND PROTECT EXISTING BURIED DRAINS BENEATH TURBINE ACCESS ROAD (SEE EXISTING P.E. CO. DRAWING H-80531). RAILROAD TIES AND TRACKS MAY ALSO BE BURIED UNDER TURBINE ACCESS ROAD. IF ENCOUNTERED, AND PENDING SHPO CONSULTATION, THE RAILS AND TIES SHALL BE PRESERVED IN PLACE.

20' 0 20' 40'

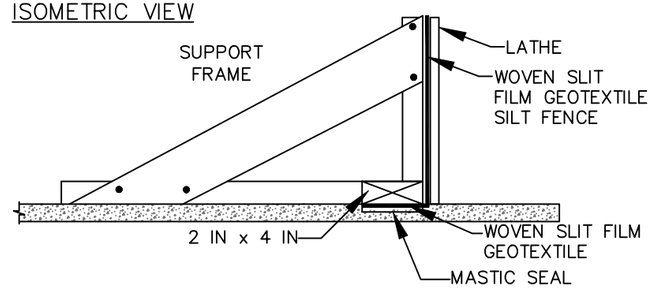
SCALE: 1" = 20'-0"



ISOMETRIC VIEW



JOINING ADJACENT SECTIONS OF GEOTEXTILE



SECTION A-A

1/20 SILT FENCE
Scale: 1"=1'

CONSTRUCTION SPECIFICATIONS

1. USE NOMINAL 2 INCH X 4 INCH LUMBER.
2. USE WOVEN SLIT FILM GEOTEXTILE, AS SPECIFIED IN SECTION H-1 MATERIALS.
3. PROVIDE MANUFACTURER CERTIFICATION TO THE AUTHORIZED REPRESENTATIVE OF THE INSPECTION/ENFORCEMENT AUTHORITY SHOWING THAT THE GEOTEXTILE USED MEETS THE REQUIREMENTS IN SECTION H-1 MATERIALS.
4. SPACE UPRIGHT SUPPORTS NO MORE THAN 10 FEET APART.
5. PROVIDE A TWO FOOT OPENING BETWEEN EVERY SET OF SUPPORTS AND PLACE STONE IN THE OPENING OVER GEOTEXTILE.
6. KEEP SILT FENCE TAUT AND SECURELY STAPLE TO THE UPSLOPE SIDE OF UPRIGHT SUPPORTS. EXTEND GEOTEXTILE UNDER 2x4.
7. WHERE TWO SECTIONS OF GEOTEXTILE ADJOIN: OVERLAP, FOLD, AND STAPLE TO POST IN ACCORDANCE WITH THIS DETAIL. ATTACH LATHE.
8. PROVIDE A MASTIC SEAL BETWEEN PAVEMENT, GEOTEXTILE, AND 2x4 TO PREVENT SEDIMENT-LADEN WATER FROM ESCAPING BENEATH SILT FENCE INSTALLATION.
9. SECURE BOARDS TO PAVEMENT WITH 40D 5 INCH MINIMUM LENGTH NAILS.
10. REMOVE ACCUMULATED SEDIMENT AND DEBRIS WHEN BULGES DEVELOP IN SILT FENCE OR WHEN SEDIMENT REACHES 25% OF FENCE HEIGHT. REPLACE GEOTEXTILE IF TORN. MAINTAIN WATER TIGHT SEAL ALONG BOTTOM. REPLACE STONE IF DISPLACED.

DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG
GSE PROJECT NO.: 1714 DATE: 2/17/2017

Exelon
EXELON GENERATION COMPANY, LLC

CONOWINGO EEL PASSAGE

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SITE AND SEDIMENT AND EROSION CONTROL PLAN AND DETAILS

SCALE: AS NOTED DRAWING NO.: 20

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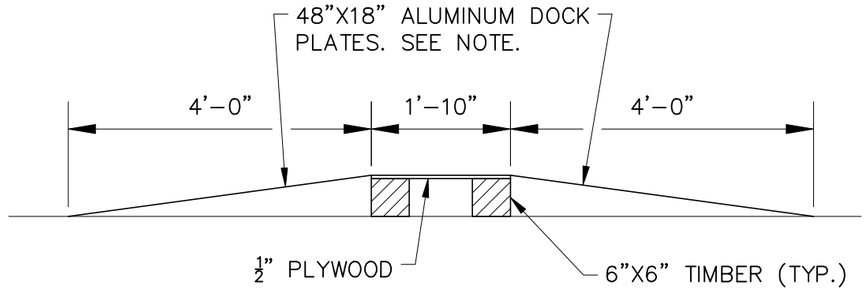
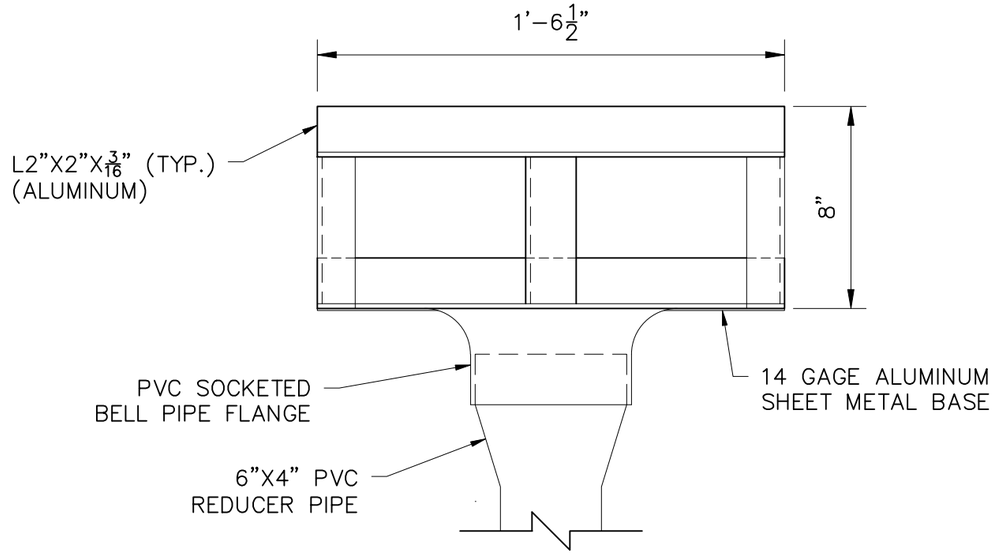


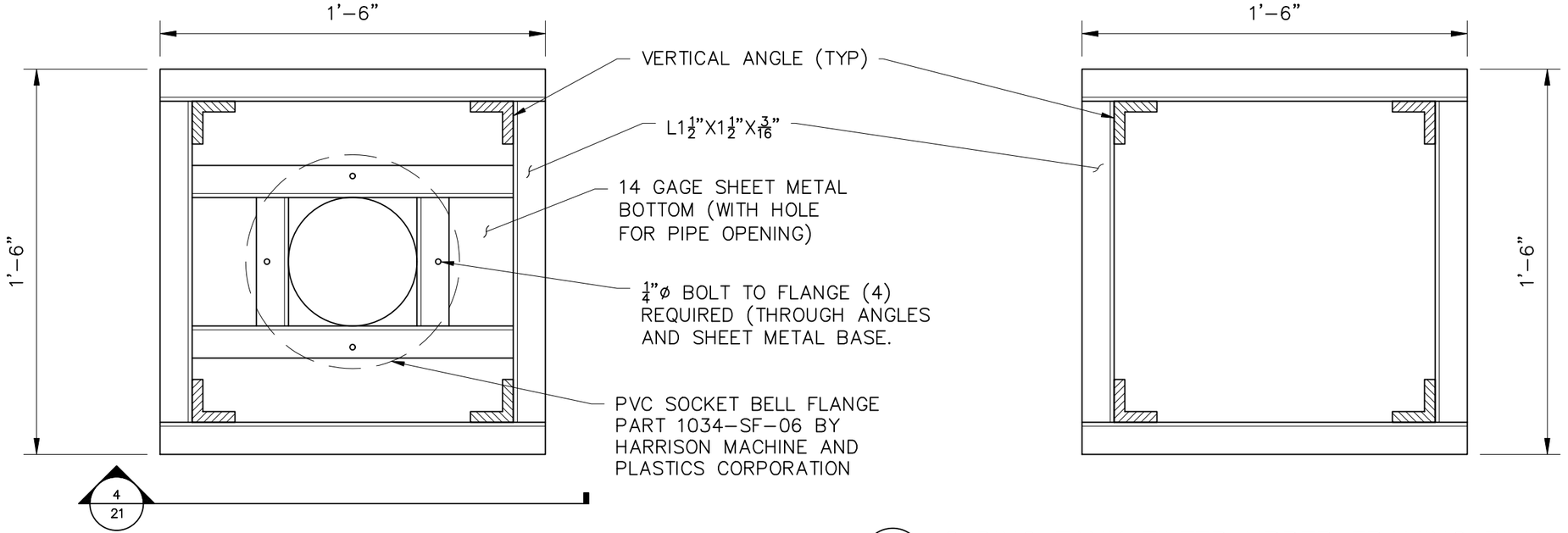
NOTE: PROVIDE 48"X18"X7" ALUMINUM HAND TRUCK DOCK PLATE RATED 500 LBS BY GLOBAL INDUSTRIES OR OR EQUAL. ANCHOR TO 6X6 TIMBERS WITH (4) ¼"ø ROUND HEADED LAG SCREEN. (PROVIDE 4 RAMPS – 8 PANELS.)

1 / 21 DETAIL
Scale: 1" = 1 '– 0"

1' 0 1' 2'
SCALE: 1" = 1'–0"



4 / 21 HOLDING TANK FILTER ELEVATION VIEW
Scale: 4" = 1 '– 0"



2 / 21 HOLDING TANK FILTER LOWER FRAMING PLAN
Scale: 4" = 1 '– 0"

3 / 21 HOLDING TANK FILTER UPPER FRAMING PLAN
Scale: 4" = 1 '– 0"

NOTES:
1. 1MM FILTER SCREEN TO BE WRAPPED AROUND AND FASTENED TO THE FILTER FRAME.
2. DO NOT LIFT OR PRY FRAME FROM EXTERIOR EDGES. LIFT FROM SOCKETED BELL PIPE FLANGE.
3. PROVIDE (4) FRAME STRUCTURES.

3' 0 3' 6'
SCALE: 4" = 1'–0"

DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG
GSE PROJECT NO.: 1714 DATE: 2/17/2017

Exelon
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MISCELLANEOUS DETAILS

SCALE: AS NOTED DRAWING NO.: 21

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APPENDIX B. OCTORARO CREEK EEL COLLECTION FACILITY DRAWINGS

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LITTLE BRITAIN TWP.
LANCASTER COUNTY

APPROX. MUNICIPAL BOUNDARY LINE

LOWER OXFORD TWP.
CHESTER COUNTY

OCTORARO CREEK

Existing Dam

EXIST. 1 HP SUBMERSIBLE PUMP CONTAINED WITHIN 1MM MESH SCREENED BARREL

EDGE OF WATER

APPROX. ORDINARY HIGH WATER MARK

Stone Steps

Top Steps
Elev.=253.99

100-YEAR FLOOD PLAIN (ZONE A)

Existing 1 ½ Story Stone Art Building

Wood Ramp

Shed

APPROX. QUIESCENT POOL

APPROX. SHORELINE EL. 237.0
(SURVEYED MAY 2019)

EXIST. FENCE

ELECTRICAL PANEL

FIRST FLOOR EL. 254.55±

Steps

Survey Control Point
Traverse Nail
Elev.=264.17

EXIST. 6" PVC

(2) VERTICAL 45° BENDS

Conc. Pad With Art Piece

45° BEND

EXISTING EEL RAMP (SEE R1)

17'-6"

3'-4"

17'-2"

5'-7"

1'-4"

1'-10"

2'

1'-5"

1'-2"

1'-3"

5'

APPROX. ORDINARY HIGH WATER MARK EL. 238.5

Exist. Eroded Area

Sign
Danger
Dam

EXIST. UTILITY POLES

EXIST. EEL COLLECTION TANK
(APPROX. 85 GALLONS) SEE R1

SCAFFOLDING STRUCTURE

Guy Wire

Underground Electric

EXIST. BURIED 2" WATER LINE WITH ADJACENT 2" CONDUIT FOR ELECTRIC (INSIDE PVC PIPING)

SEE BENCHMARK NOTES

EXIST. 8" PVC (TO BE REROUTED TO PROPOSED LOCATION)

SCAFFOLDING STRUCTURE

BURIED TAILRACE CENTERLINE

15' BURIED TAILRACE BUFFER

EXIST. GRAVEL DRIVE

OH

UE

240

245

250

255

260

265

NOTES:
1. THE DIMENSIONS NOTED ARE AS MEASURED IN THE FIELD.

BENCHMARK NOTES:
SOUTHEAST CORNER OF CONCRETE PAD
ELEV. = 252.64 FT
NORTHING = 172329.0 FT
EASTING = 2447865.2 FT
VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83
PA SOUTH ZONE

LEGEND

- MINOR CONTOUR
- MAJOR CONTOUR
- EDGE OF WATER
- ORDINARY HIGH WATER MARK
- FEMA 100-YEAR FLOODPLAIN
- OH — OVERHEAD ELECTRIC LINE
- UE — UNDERGROUND ELECTRIC LINE
- x — FENCE
- SURVEY CONTROL POINT
- UTILITY POLE
- BENCHMARK

5' 0 5' 10'
SCALE: 1" = 5'

ISSUE	DESCRIPTION	BY	APP

DRAWN BY: JSC
CHECKED BY: HNN
APPROVED BY:
PROJECT NO. 1714 DATE: 4/6/2021

OCTORARO CREEK EEL COLLECTION FACILITY

TEMPORARY FACILITY PLAN

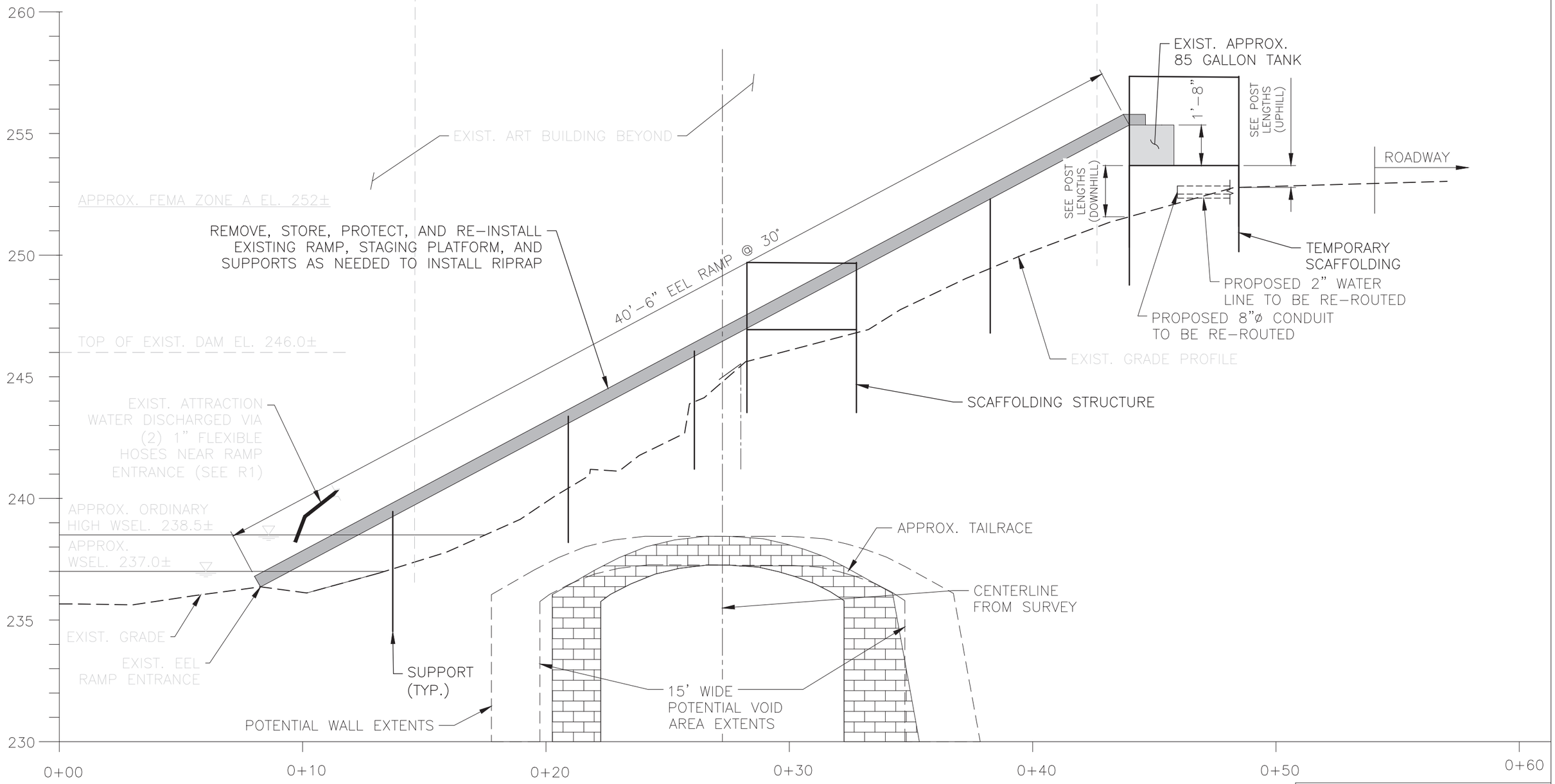
Exelon Generation Company, LLC
300 Exelon Way
Kennett Square, PA 19348

Gomez and Sullivan Engineers, D.P.C.
288 Genesee Street
Utica, NY 13502

SCALE: 1" = 5' (34"x22")

DRAWING: OCTORARO

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



1/2 PROFILE
Scale: 1" = 2'-0"

NOTES:
1. THE DIMENSIONS NOTED ARE AS MEASURED IN THE FIELD.

SCAFFOLDING POST LENGTHS:
1. UPSTREAM DOWNHILL = 1'-4"
2. DOWNSTREAM DOWNHILL = 3'-6"
3. UPSTREAM UPHILL = 2'-3"
4. DOWNSTREAM UPHILL = 11"

2' 0 2' 4'
SCALE: 1" = 2'

OCTORARO CREEK EEL COLLECTION FACILITY

TEMPORARY FACILITY PROPOSED PROFILE

ISSUE	DESCRIPTION	BY	APP

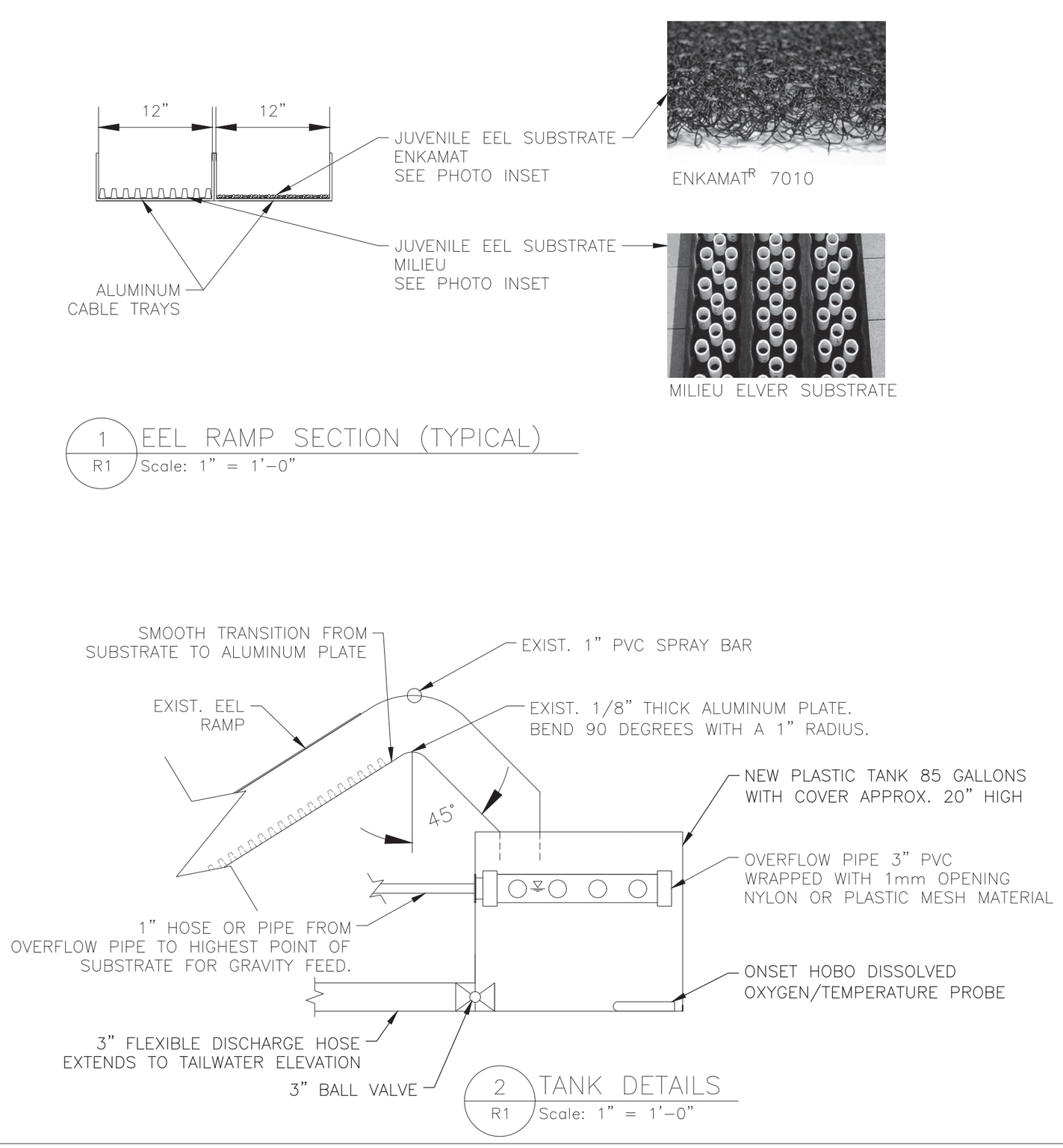
DRAWN BY: JSC
CHECKED BY: HNN
APPROVED BY:
PROJECT NO. 1714 DATE: 4/6/2021

Exelon Generation Company, LLC
300 Exelon Way
Kennett Square, PA 19348

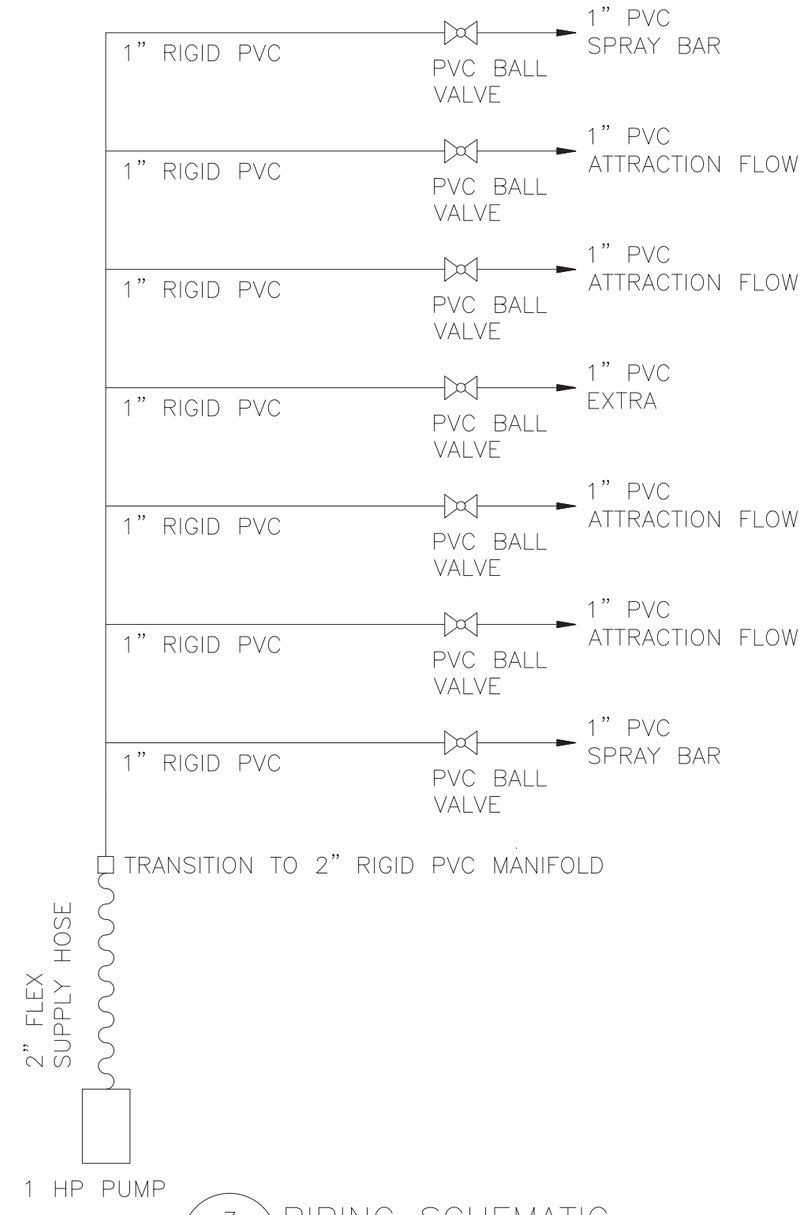
Gomez and Sullivan Engineers, D.P.C.
288 Genesee Street
Utica, NY 13502

SCALE: 1" = 2' (34"x22")
DRAWING: OCTORARO 2 OF 2

1 / R1 EEL RAMP SECTION (TYPICAL)
Scale: 1" = 1'-0"



2 / R1 TANK DETAILS
Scale: 1" = 1'-0"



3 / R1 PIPING SCHEMATIC
Scale: NTS

2' 0 1' 2'
SCALE: 1" = 1'

ISSUE	DESCRIPTION	BY	APP

DRAWN BY: JSC
CHECKED BY: HNN
APPROVED BY:
PROJECT NO. 1714 DATE: 4/6/2021

OCTORARO CREEK EEL COLLECTION FACILITY

TYPICAL EEL LADDER SECTION AND DETAILS (DONE BY OTHERS)

Exelon Generation Company, LLC
300 Exelon Way
Kennett Square, PA 19348

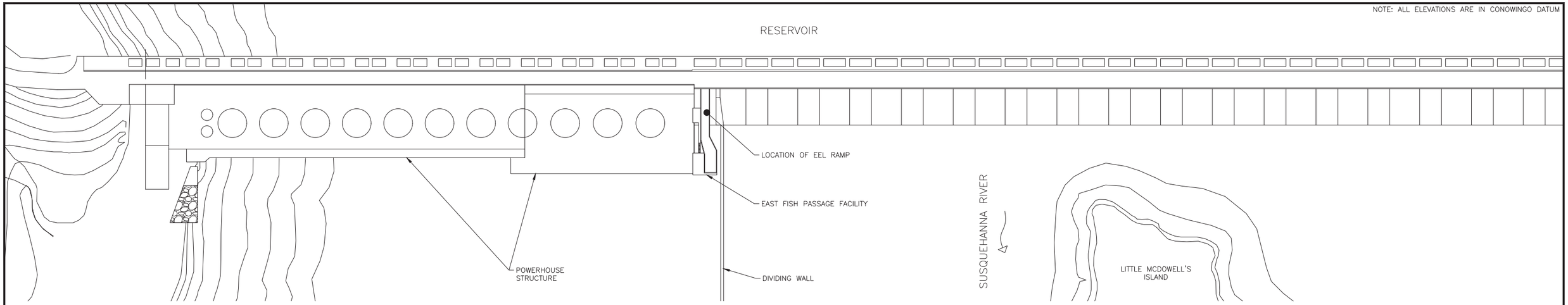
Gomez and Sullivan Engineers, D.P.C.
288 Genesee Street
Utica, NY 13502

SCALE: AS SHOWN (34"X22") | DRAWING: OCTORARO | R1

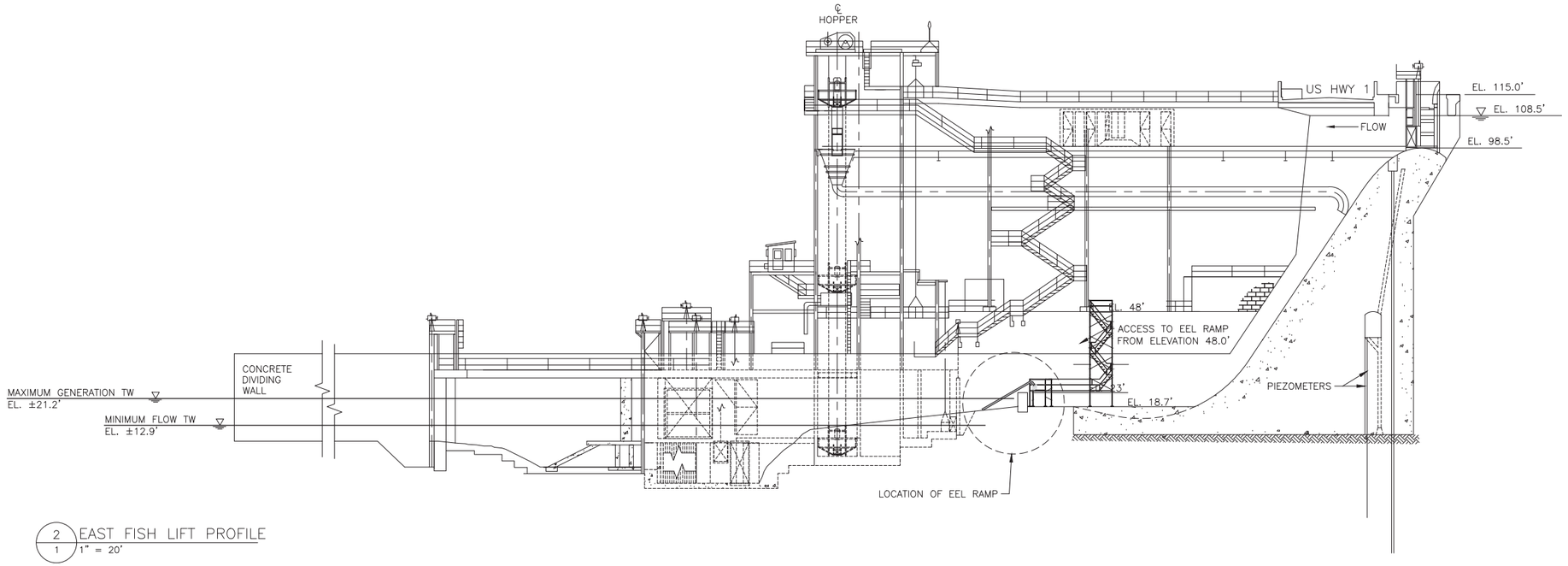
IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

APPENDIX C. CONOWINGO EAST EEL COLLECTION FACILITY DRAWINGS

NOTE: ALL ELEVATIONS ARE IN CONOWINGO DATUM



1/1 CONOWINGO DAM PLAN
1" = 1000'



2/1 EAST FISH LIFT PROFILE
1" = 20'

PRELIMINARY DRAWINGS
TO BE REVISED PENDING FINALIZATION OF EAST FISH LIFT MODIFICATIONS FOOTPRINT

NO.	DATE	DESCRIPTION	BY	APP
1	5/22/20	CONCEPTUAL CONOWINGO EFL EEL FACILITIES	BAS	-

FOR: Exelon, EXELON GENERATION COMPANY, LLC
BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY:	BAS
DRAWN BY:	BAS
CHECKED BY:	HNN
APPROVED BY:	-
PROJECT NO.:	2132
DATE:	4/15/2021

CONOWINGO EAST EEL COLLECTION FACILITY

PROPOSED EEL RAMP LOCATION AND PROFILE

SCALE: AS NOTED

DRAWING NO.: 1

NOTE: ALL ELEVATIONS ARE IN CONOWINGO DATUM

EXISTING STATION WATER GRAVITY FEED MANIFOLD

2" CAM LOCK FITTING AND VALVE ON EXISTING MANIFOLD FOR CONNECTION TO 2" FLEX SUPPLY HOSE. PROVIDE SIZE ADAPTER IF NECESSARY.

2" FLEX SUPPLY HOSE

SEE DETAIL 2/C3 FOR TYPICAL GUY WIRE ANCHOR

EXISTING HOPPER

CROWDER AREA GATE

LANDING AT ELEV. 48.0'

ADD'L 5 FT. X 7 FT. SCAFFOLD W/ LEVELING JACKS.

CROWDER

UP

6"

3'

45°

45°

UP

GUY WIRES TYP.

13'-6"

3'

ACCESS PLATFORM TO EEL FACILITY W/ OSHA COMPLIANT HANDRAILS

OSHA COMPLIANT MODULAR 5 FT X 7 FT. SCAFFOLDING TOWER WITH STAIRS AND LEVELING JACKS. METALTECH OR APPROVED EQUAL.

TOE OF SPILLWAY

NEW EEL RAMP WATER GRAVITY FEED MANIFOLD

EEL RAMP

4'

TOE OF BUCKET (BELOW)

TRASH RACK B

NOTE: SEAL SPILLWAY GATES DURING EEL PASSAGE SEASON TO PREVENT LEAKAGE INTO STILLING BASIN.

1/2 ACCESS PLAN
1/4" = 1'-0"

4' 0 4' 8'
SCALE:1/4"=1'-0"

EL. 58.8'

REMOVE EXISTING HANDRAILS AS NEEDED FOR ACCESS

7'-0"

3'-6"

EL. 48.0'

EL. 46.0'

8'-2"

OSHA COMPLIANT MODULAR 5 FT X 7 FT. SCAFFOLDING TOWER WITH STAIRS AND LEVELING JACKS. METALTECH OR APPROVED EQUAL.

D-PLATE WALL ANCHORS FOR TIE-OFF TYP. SEE 2/C3 FOR DETAILS

8'-2"

2/C3

GUY WIRES TYP.

EL. 35.0'

OSHA COMPLIANT HANDRAIL FOR TEMPORARY STAGING PLATFORM

ADD'L 5 FT. X 7 FT. SCAFFOLD W/ LEVELING JACKS.

8'

ACCESS PLATFORM TO EEL FACILITY

MIN 13'

6"

EL. 23.0'

5'-0"

1/C3

EL. 18.7'

2/2 ACCESS PROFILE
1/4" = 1'-0"

PRELIMINARY DRAWINGS
TO BE REVISED PENDING FINALIZATION OF EAST FISH LIFT MODIFICATIONS FOOTPRINT

NO.	DATE	DESCRIPTION	BY	APP
1	5/22/20	CONCEPTUAL CONOWINGO EFL EEL FACILITIES	BAS	-

FOR: Exelon
EXELON GENERATION COMPANY, LLC

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY:	BAS
DRAWN BY:	BAS
CHECKED BY:	HNN
APPROVED BY:	-
PROJECT NO.:	2132
DATE:	4/15/2021

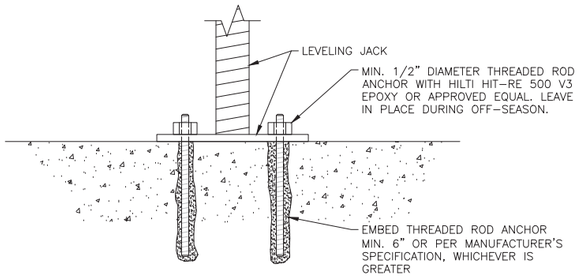
CONOWINGO EAST EEL COLLECTION FACILITY

PROPOSED EEL RAMP ACCESS

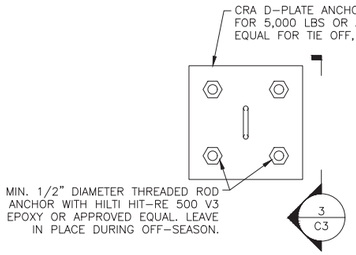
SCALE: 1/4" = 1'-0"

DRAWING NO.: 2

NOTE: ALL ELEVATIONS ARE IN CONOWINGO DATUM

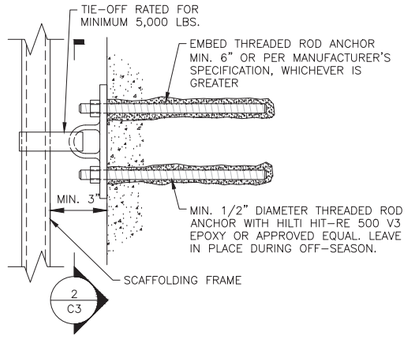


1 / C3 LEVELING JACK ANCHORS
NOT TO SCALE

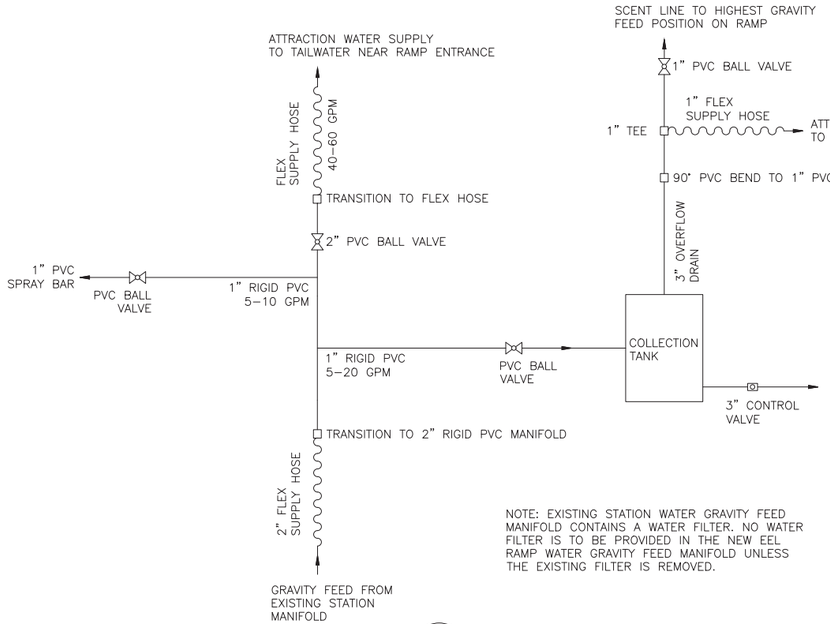


2 / C3 D–PLATE ANCHOR ELEVATION
NOT TO SCALE

NOTE: PROVIDE SIMILAR ANCHOR POINT FOR GUY WIRES



2 / C3 D–PLATE ANCHOR SECTION
NOT TO SCALE



4 / C3 PIPING SCHEMATIC
NO SCALE

PRELIMINARY DRAWINGS
TO BE REVISED PENDING FINALIZATION OF EAST FISH LIFT MODIFICATIONS FOOTPRINT

NO.	DATE	DESCRIPTION	BY	APP
1	5/22/20	CONCEPTUAL CONOWINGO EFL EEL FACILITIES	BAS	-

FOR: Exelon, EXELON GENERATION COMPANY, LLC

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY:	BAS
DRAWN BY:	BAS
CHECKED BY:	HNN
APPROVED BY:	-
PROJECT NO.:	2132
DATE:	4/15/2021

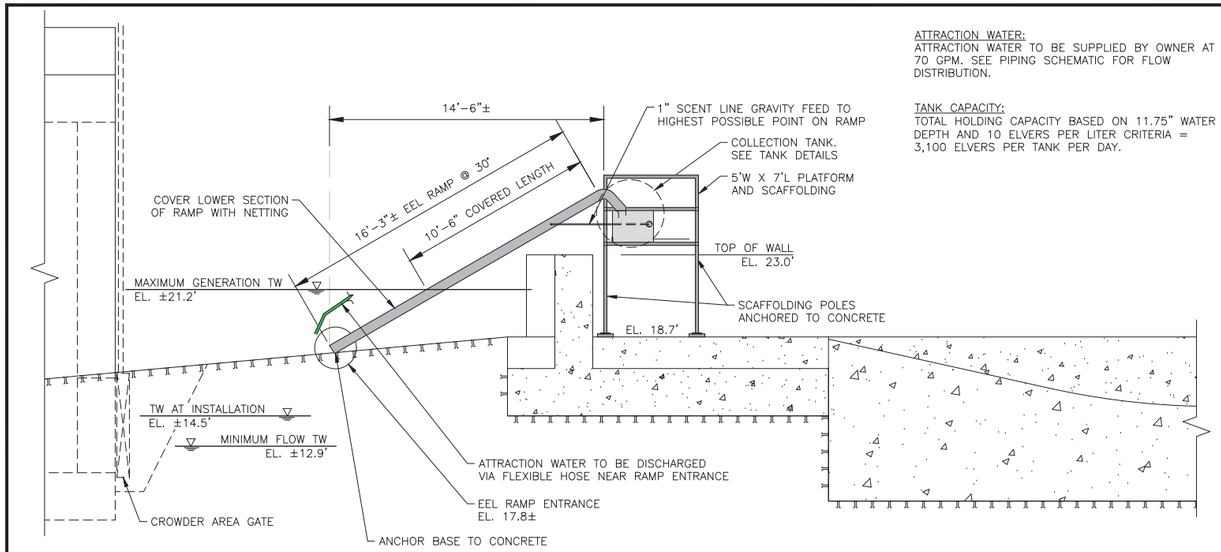
CONOWINGO EAST EEL COLLECTION FACILITY

ANCHORING AND PIPING DETAILS

SCALE: AS NOTED

DRAWING NO.: 3

NOTE: ALL ELEVATIONS ARE IN CONOWINGO DATUM

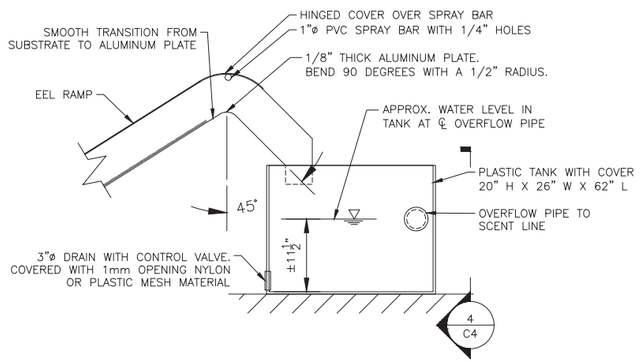


1 / C4 EEL RAMP PROFILE
1/4" = 1'-0"

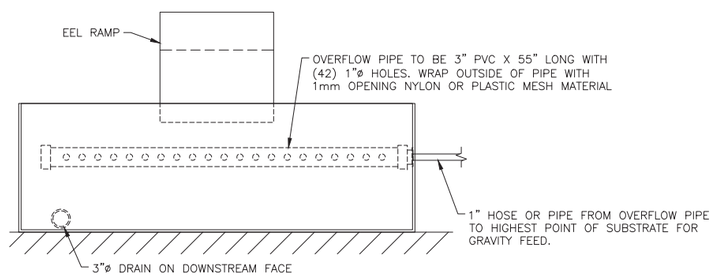
ATTRACTION WATER:
ATTRACTION WATER TO BE SUPPLIED BY OWNER AT 70 GPM. SEE PIPING SCHEMATIC FOR FLOW DISTRIBUTION.

TANK CAPACITY:
TOTAL HOLDING CAPACITY BASED ON 11.75" WATER DEPTH AND 10 ELVERS PER LITER CRITERIA = 3,100 ELVERS PER TANK PER DAY.

2 / C4 EEL RAMP SECTION
1"=1'-0"



3 / C4 COLLECTION TANK DETAILS
1" = 1'-0"



4 / C4 COLLECTION TANK SECTION
1" = 1'-0"

PRELIMINARY DRAWINGS
TO BE REVISED PENDING FINALIZATION OF EAST FISH LIFT MODIFICATIONS FOOTPRINT

NO.	DATE	DESCRIPTION	BY	APP
1	5/22/20	CONCEPTUAL CONOWINGO EFL EEL FACILITIES	BAS	-

FOR: EXELON GENERATION COMPANY, LLC
BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Honniker, NH
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DESIGNED BY:	BAS
DRAWN BY:	BAS
CHECKED BY:	HNN
APPROVED BY:	-
PROJECT NO.:	2132
DATE:	4/15/2021

CONOWINGO EAST EEL COLLECTION FACILITY

EEL RAMP DETAILS

SCALE: AS NOTED

DRAWING NO.: 4

APPENDIX D. ANNOTATED CONOWINGO EAST EEL COLLECTION FACILITY DESIGN PRESENTATION

Conowingo Hydroelectric Facility
and
Muddy Run Pumped Storage Project

FERC Project Nos. 405 and 2355

Eel Passage Advisory Group (EPAG) Teleconference

Remote Meeting
October 15, 2020, 2:00 pm to 3:30 pm

Exelon Generation®

Agenda

Review East Fish Lift (EFL) Temporary Eel Facility Design

Review EFL Temporary Eel Facility Drawings and photos of existing structure

Questions and 3D model presentation

Source: NYSDEC Wiki Commons

EFL Eel Facility Design

Water Levels (Conowingo Datum)

- Based on 5% and 95% exceedance flows during passage season (June 1 – November 30)
- Minimum Tailwater (95% exceedance) = El. 12.79’
- Maximum Tailwater (5% exceedance) = El. 21.17’

Eel Ramp

- 18-inches wide, 30° slope, approx. 16’-3” length
- Enkamat substrate, throughout ramp and along concrete to low water level
- Solid cover above max. water level and netting along the remainder
- Ramp entrance elevation = El. 17.8’ +/-

EFL Eel Facility Design (cont.)

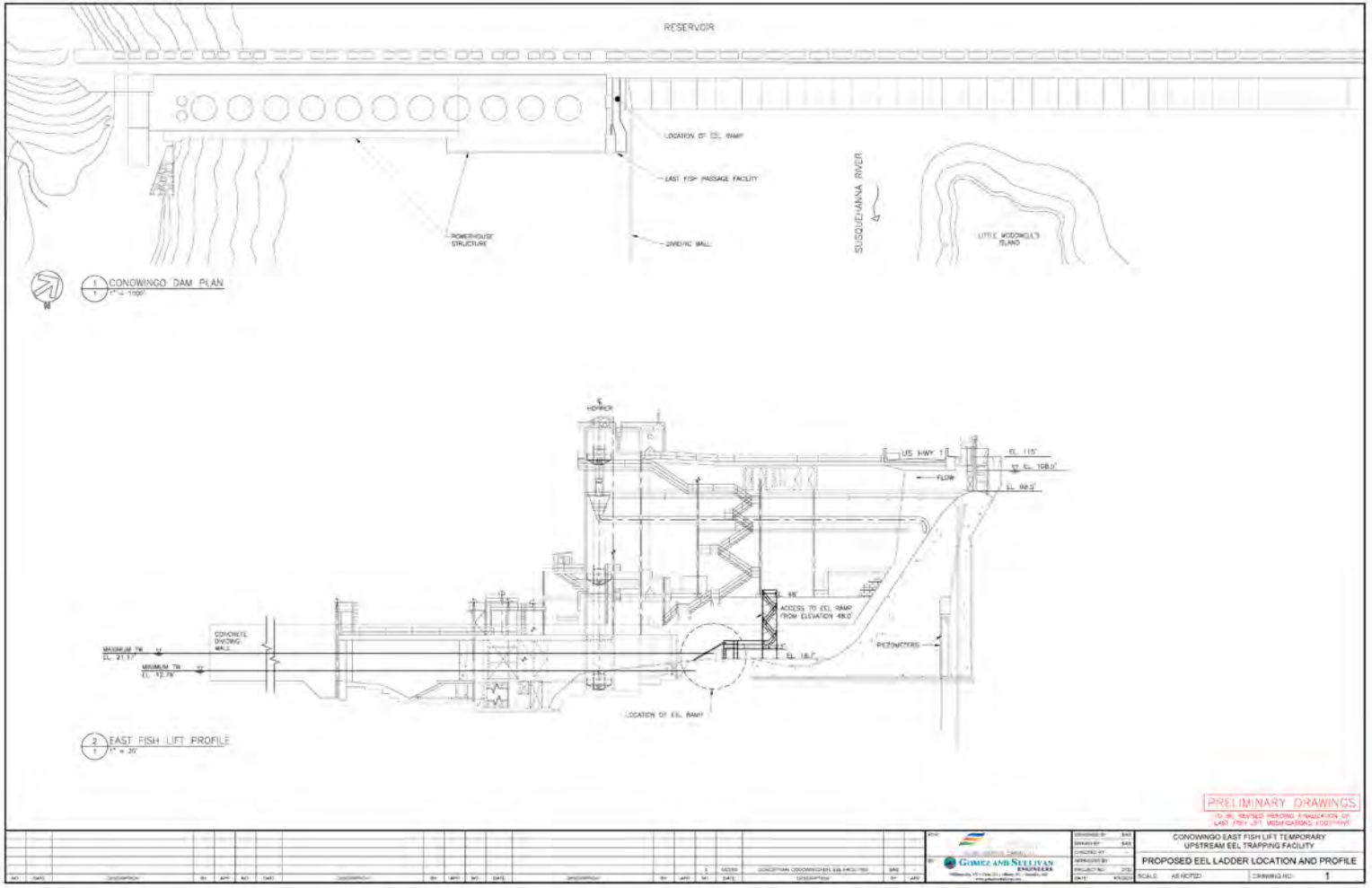
Collection Tank

- Approximately 80-gallon capacity (3100 eels @ 10 eels per liter)
- 11.75-inch +/- water depth

Water Supply

- 1-inch PVC spray bar
- Scent line from tank to highest gravity fed position on ramp
- Overflow line from tank to base of ramp.

EFL Eel Facility Drawings (pg. 1)



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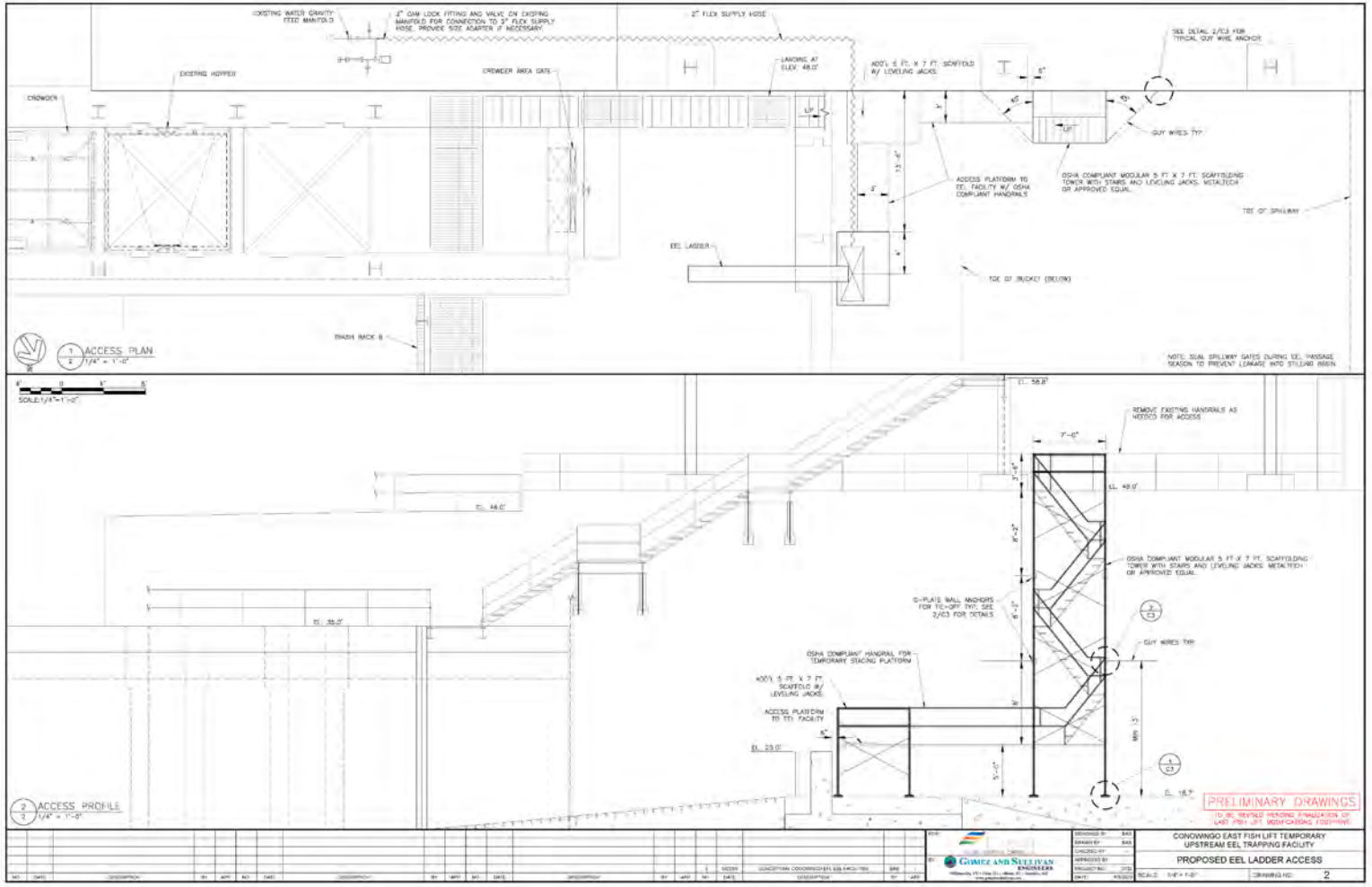
EFL Eel Facility Drawings (pg. 2)



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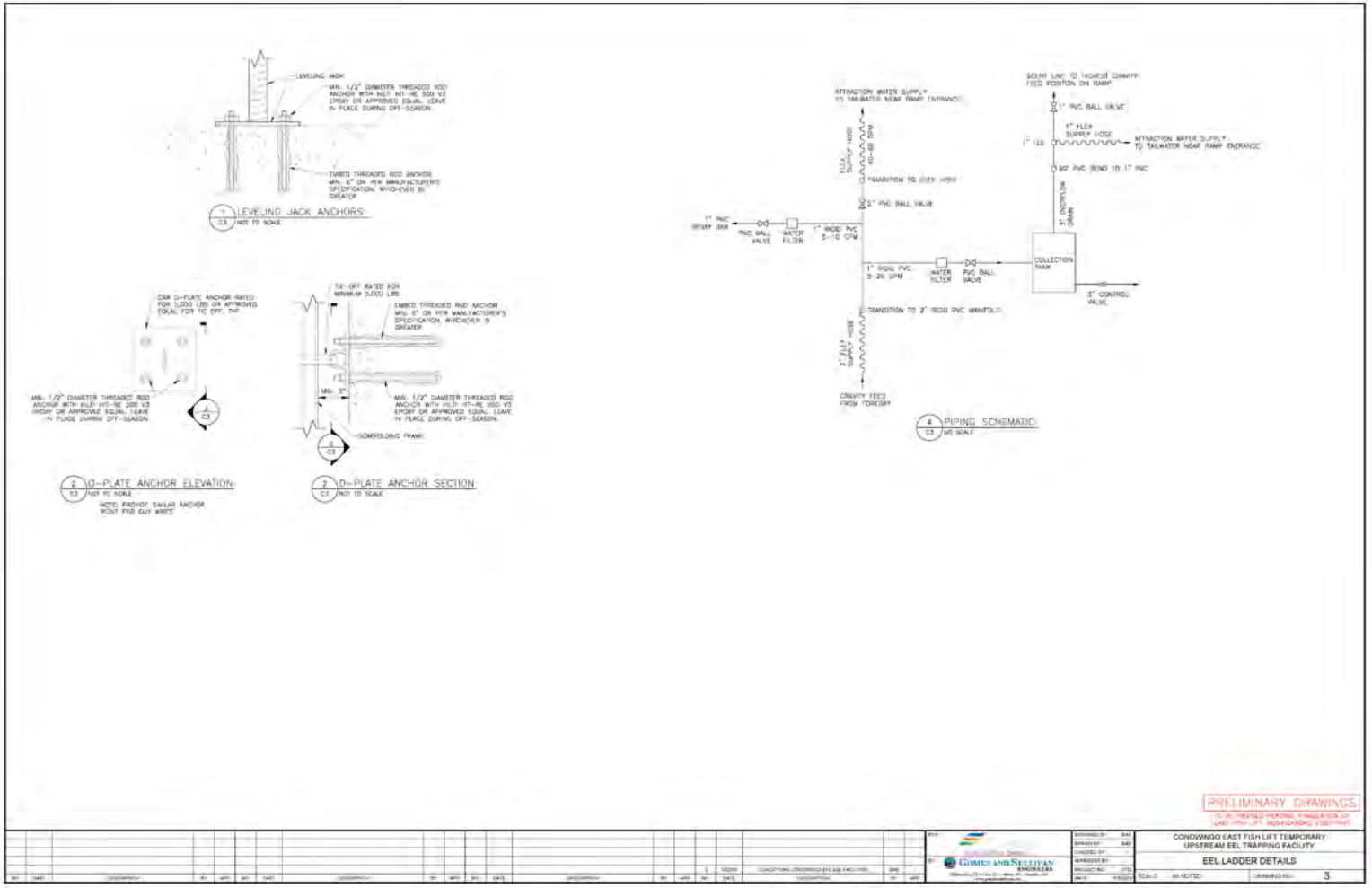
EFL Eel Facility Drawings (pg. 3)



Exelon Generation

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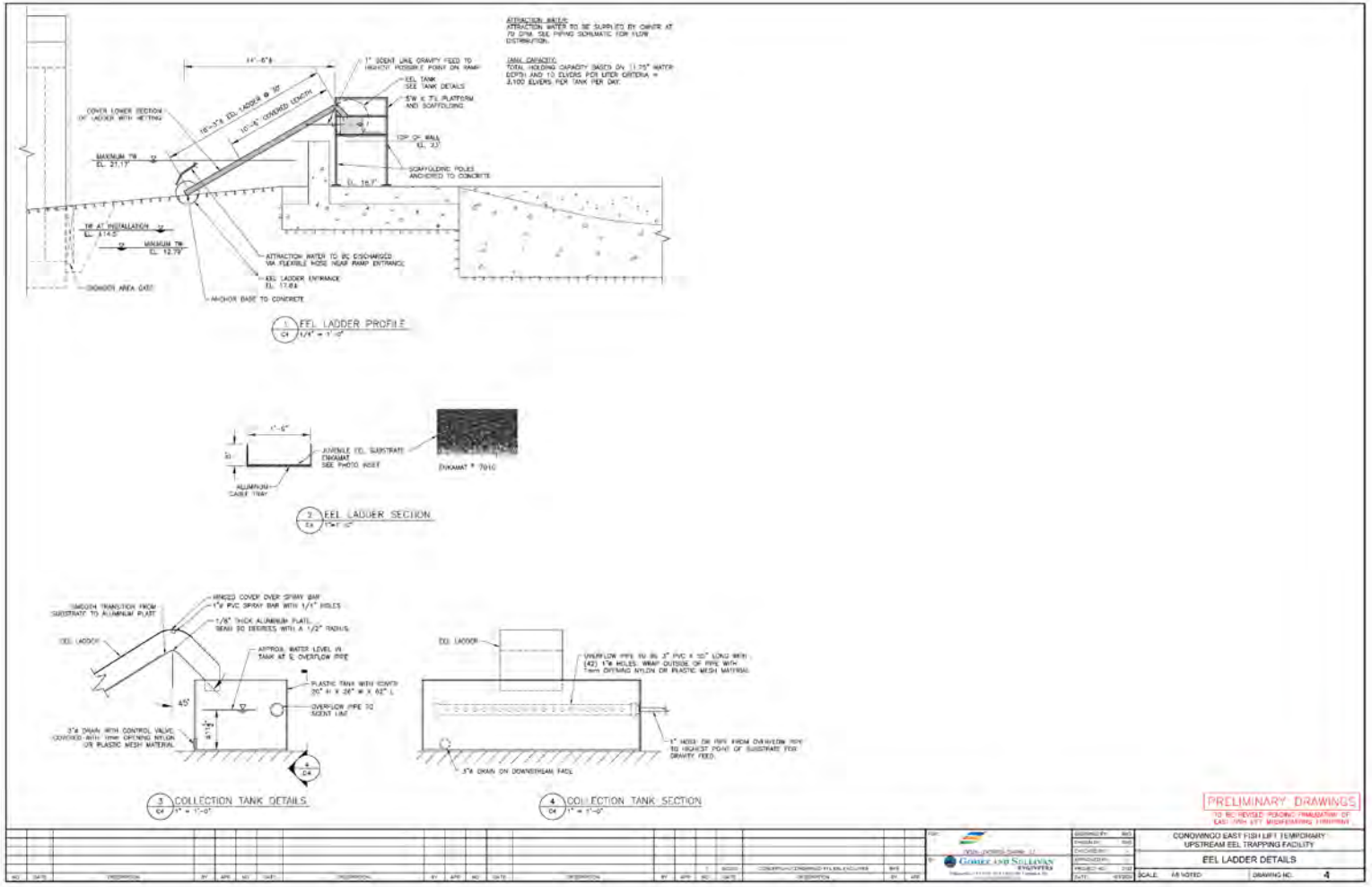
EFL Eel Facility Drawings (pg. 4)



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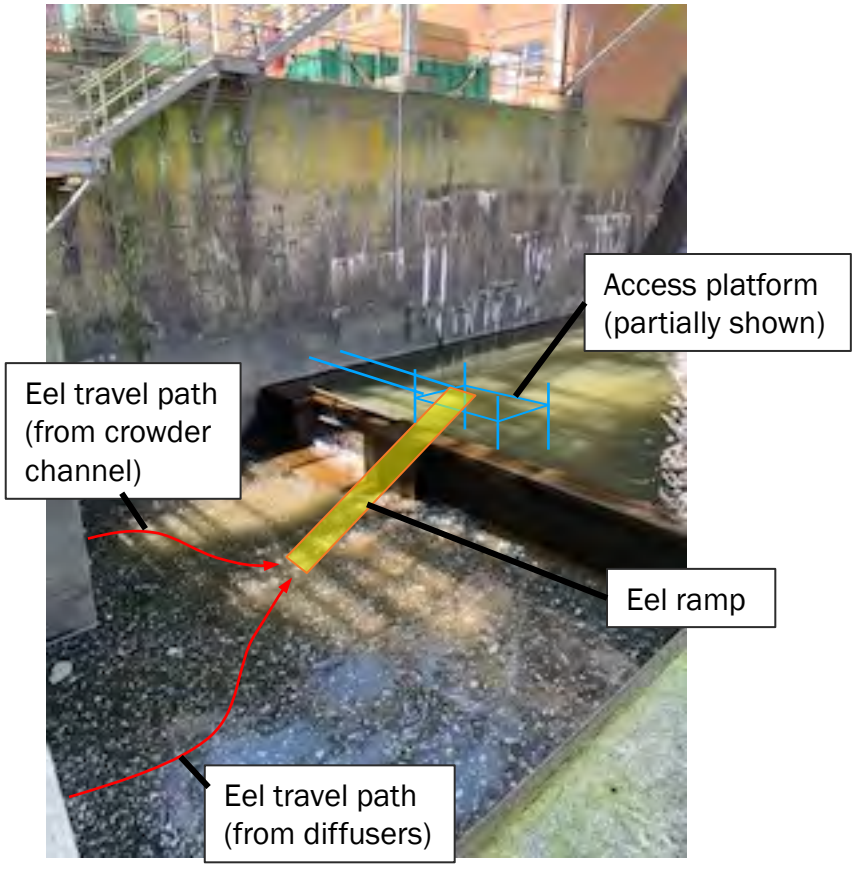
GOMEZ AND SULLIVAN ENGINEERS

East Fish Lift Photos



Dissipation Wall

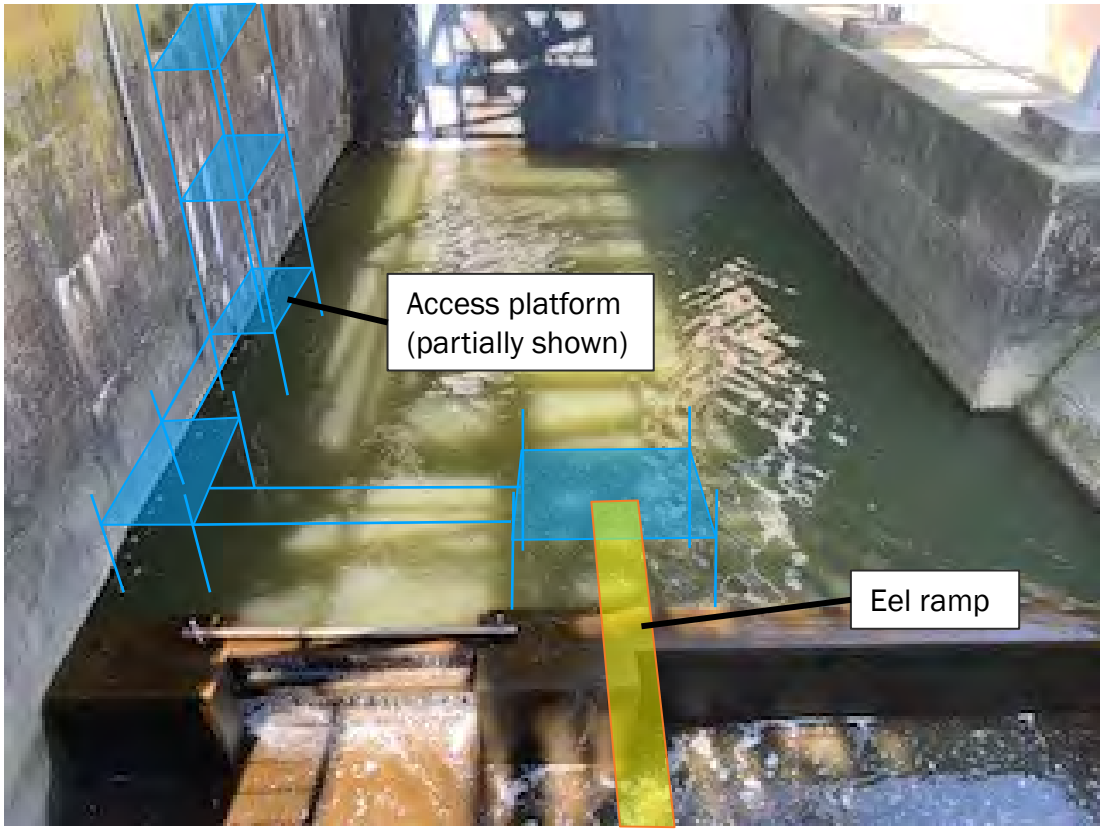
Exelon Generation

Gomez and Sullivan Engineers

East Fish Lift Photos

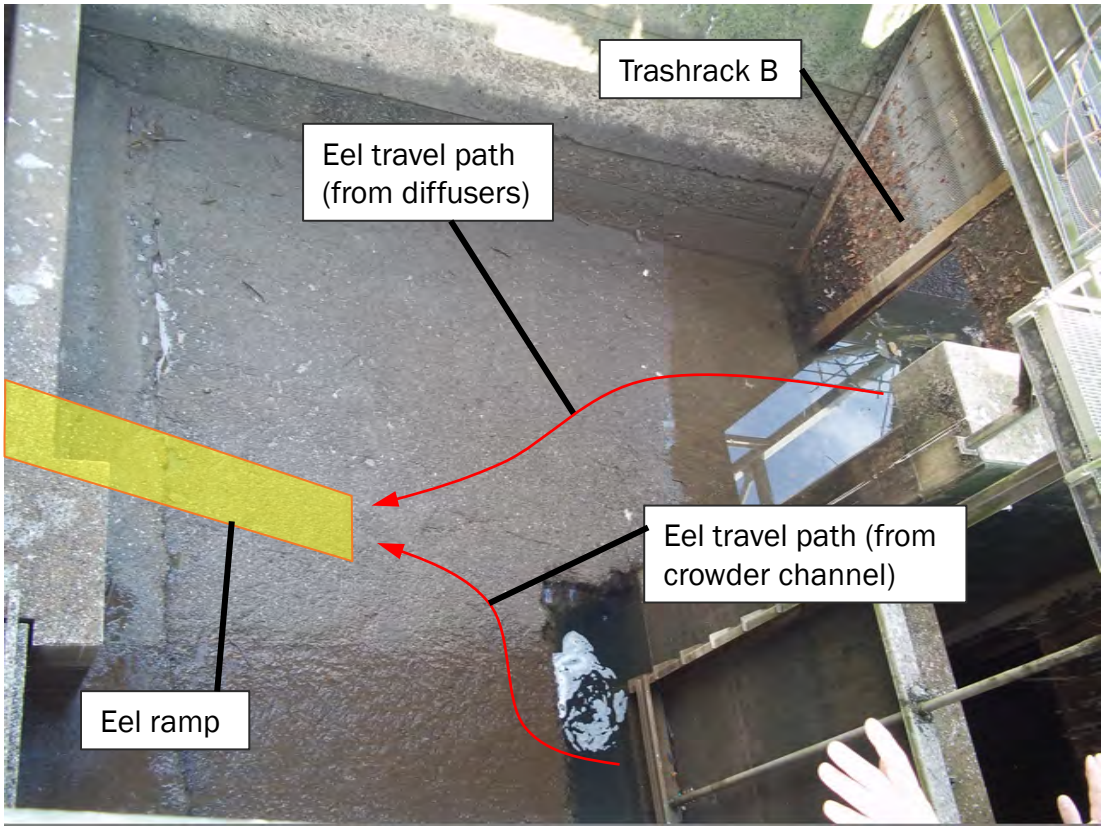
Trashrack B from Crowder Area Gate

East Fish Lift Photos



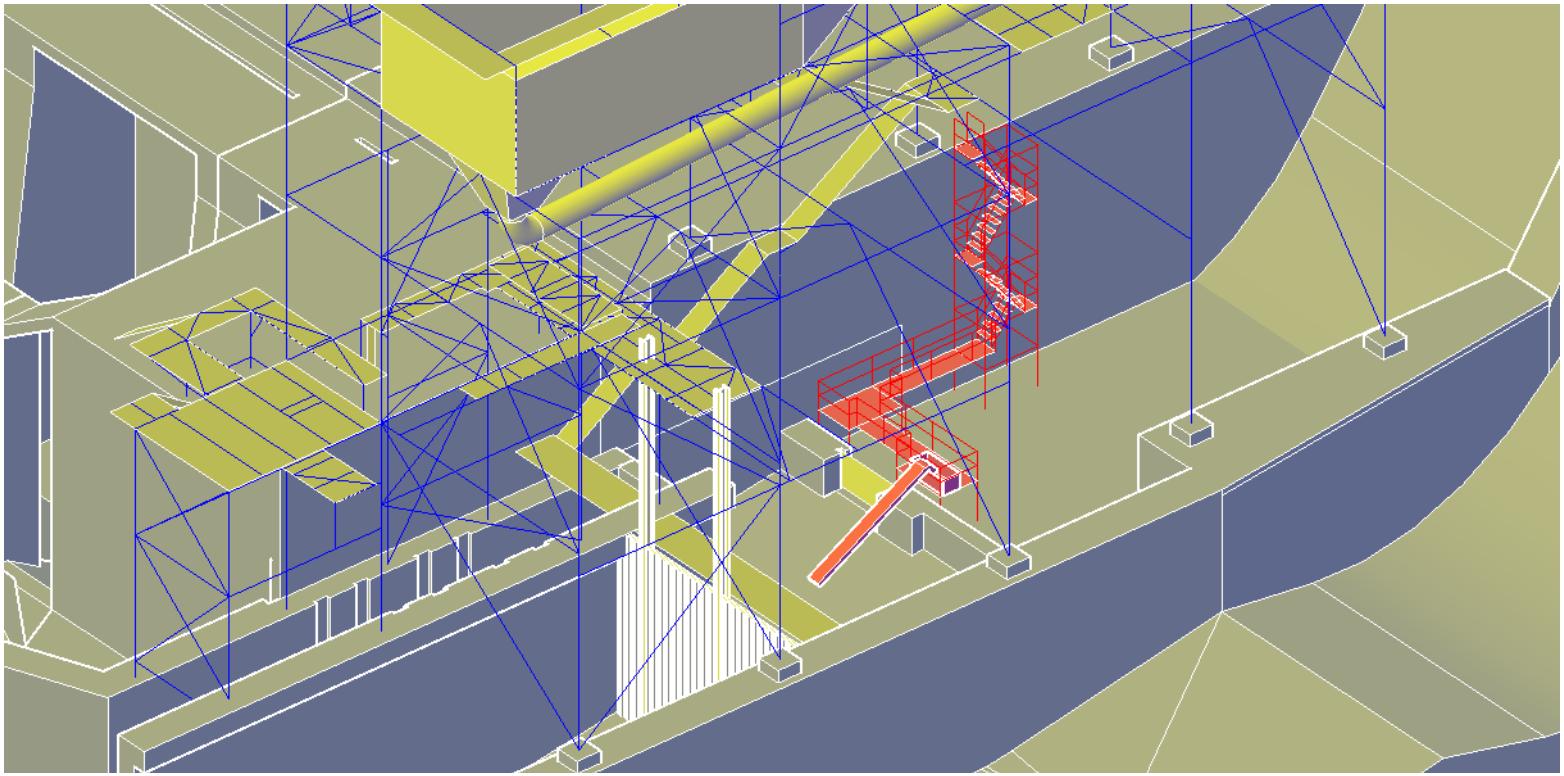
Upper Basin from Crowder Area Gate

East Fish Lift Photos



Stilling Basin Wall to Trashrack B and Crowder Area Gate

3D Model



3D model of EFL with proposed Eel Facilities shown in red

Exelon Generation
Gomez and Sullivan Engineers

APPENDIX E. DAILY AND WEEKLY DATA SHEETS

Conowingo West Eel Collection Facility Daily Field Sheet

Project Number:	Crew:
Collection Number:	Generation:
Date:	***Control Room DO reading***:
Weather:	

	Collection Tank	Holding Tank # 1	Holding Tank # 2	Holding Tank # 3	Main Flow
Time:					
Flow Meter (gpm):					
Total Flow Volume:					
Temperature (°C):					
Dissolved Oxygen (mg/L):					
In Operation:					

Actual Counted # of Eels:	**Volumetric Estimates**
Dead eels in collection tank #:	Actual # of eels in 200 mL:
Sacrificed #:	# of eels in 1 Liter:
Eels released into holding tank #:	Displacement of water (L):
# Eels released into tank:	Estimated # of eels:
Dead eels in tank #:	**Total estimated:**
Total # of eels in tank: (not to exceed 17,000	(total estimated equals number estimated plus eels in the 200 mL subsample)
	Estimate Check (QA) (if necessary):
	Actual:
	Estimate:
Holding Tank #:	Holding Tank #:
Total alive:	Total alive:
Dead #:	Dead #:
New total:	New total:

Comments:

Octoraro Creek Eel Collection Facility at Pine Grove Daily Field Sheet

Biological Data, Monday and Thursday (sheet 2)
Calibration, Wednesday

Project Number:		Collection Number:
Date:		Time:
Weather:		Rain Gauge Amount (tenths of inch):
	Collection Tank	Head pond
Temp (°C):		
DO (mg/L):		

Number of eels collected:	**Dissolved Oxygen Probe Download**		
Number of eels transported:		Before	After
Location transported to:	Date:		
Number of dead eels:	Time:		
Answer following questions with YES or NO	DO (mg/L):		
Water running down ramp?	Temp (°C):		
Was the spray bar cleaned?	**Dissolved Oxygen Probe Reading** (inserted later)		
Was the ramp vandalized?		Before	After
Is end of ramp underwater?	DO (mg/L):		
Was the hydro operating?	Temp (°C):		
Was the probe cleaned?	Time:		

Design Parameters - Calibration (Weekly checks, Wednesday)

	Enkamat	Milieu	
Spray bar:			gallons/min
Collection tank:			gallons/min
Top Attraction:			gallons/min
Bottom Attraction:			gallons/min
TOTAL:			gallons/min

Estimate	
Number in 200 ml:	**Estimate check:**
Volumetric estimate:	Actual count:

Equation for estimating number of eel volumetrically: E = 5XD

Where, E = Estimated number of eels in collection X = number of eels in displaced 200 ml sample D = Displaced amount of 2 liter water in bucket when all eels have been added.

Comments

Conowingo East Eel Collection Facility Daily Field Sheet

Project Number:	Crew:
Collection Number:	Generation:
Date:	***Control Room DO reading***:
Weather:	

	Collection Tank
Time:	
Flow Meter (gpm):	
Total Flow Volume:	
Temperature (°C):	
Dissolved Oxygen (mg/L):	

Actual Counted # of Eels:	**Volumetric Estimates**
# dead eels in collection tank:	Actual # of eels in 200 mL:
Eels released into holding tank #:	# of eels in 1 Liter:
# Eels released into tank:	Displacement of water (L):
Yes/No	Estimated # of eels:
Was the end of the ramp underwater?	**Total estimated:**
Was water flowing down the ramp?	(total estimated equals number estimated plus eels in the 200 mL subsample)
	Estimate Check (QA) (if necessary):
	Actual:
	Estimate:

Comments:

American Eel Transport Sheet	
Facility (circle) CWECF CEECF OECF	Transport Tank (circle) Large Small

Prior to transport, while in holding (H1)		Prior to transport, while in holding	
Date	Time	Date	Time
DO	Temp	DO	Temp
No. eels being held		No. eels being held	
No. dead eels in holding prior to transport		No. dead eels in holding prior to transport	
No. eels being transported		No. eels being transported	

After eels have been loaded (in tank)		Prior to releasing eels (in tank)	
Date	Time	Date	Time
DO	Temp	DO	Temp
No. eels transported			
No. of eel dead during transport			
No. eels released			

Release Location			
Date	Time	Creek DO	Creek Temp

Release Locations
A – Muddy Creek Forks (York County)
B – Conewago Creek, Aberdeen PA (Lancaster County)
C – Beaver Creek, Hummelstown, PA

Susquehanna River
1 – Conowingo Pond, Conowingo Creek (Cecil County)
2 – Lake Aldred (York/Lancaster County)
3 – Lake Clarke (Lancaster County)
4 – Etters Boat Ramp, Goldboro, PA
5 – West Fairview Access, Route 11/15 (Cumberland County)
6 – For Hunter Access (Perry County)
7 – Shikellamy State Park (Northumberland County)
8 – Route 487 (Bloomsburg, PA (Columbia County)
9 – Route 29 Bridge (Luzerne County)
10 – Upstream of Hepburn Street Dam, Williamsport PA (Lycoming County)
11 – Upstream of Grant Street Dam (Clinton County)
12 – City Island (Dauphin County)

Daily Conowingo West Eel Collection Facility Email Template

PROVISIONAL DATA SUBJECT TO REVISION

Collection

Today ____ American Eel were collected at the Conowingo West Eel Collection Facility. The season total is now ____.

New collection tank mortalities:

Transport

Today ____ American Eel were transported to _____. The season total transported is now ____.

New transport tank mortalities: ____.

Holding

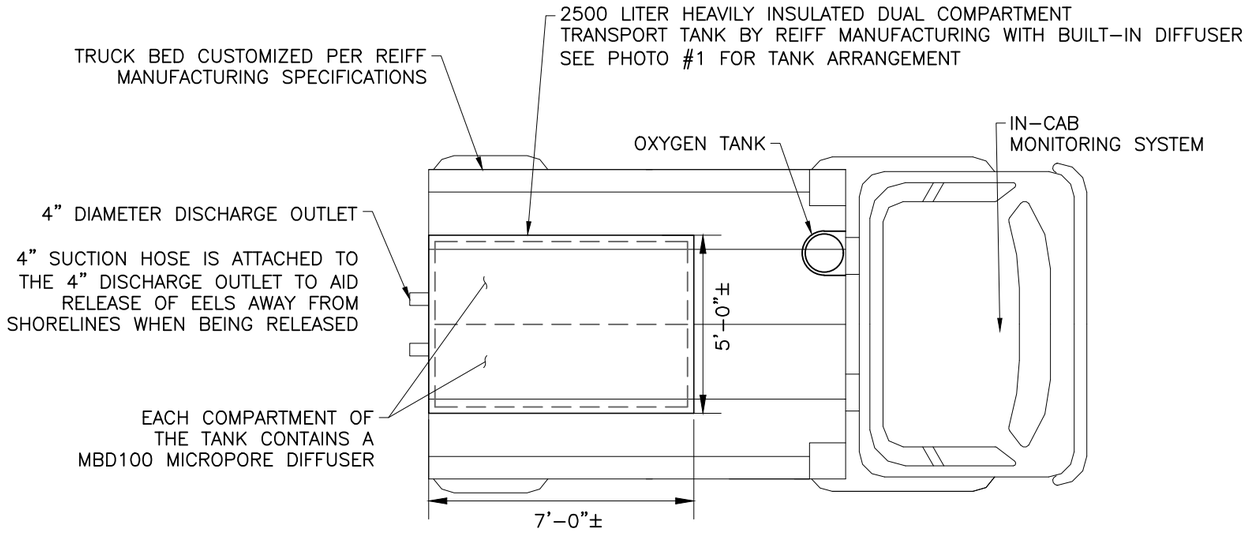
____ American Eel are in holding.

New holding tank mortalities: ____.

Meter and Probe Maintenance

Probe/Meter No.	Date Services	Maintenance Items Performed	Status	By

APPENDIX F. CONOWINGO TRANSPORT FACILITY DRAWINGS



TRANSPORT TRUCK PLAN
SCALE: 1/4" = 1'

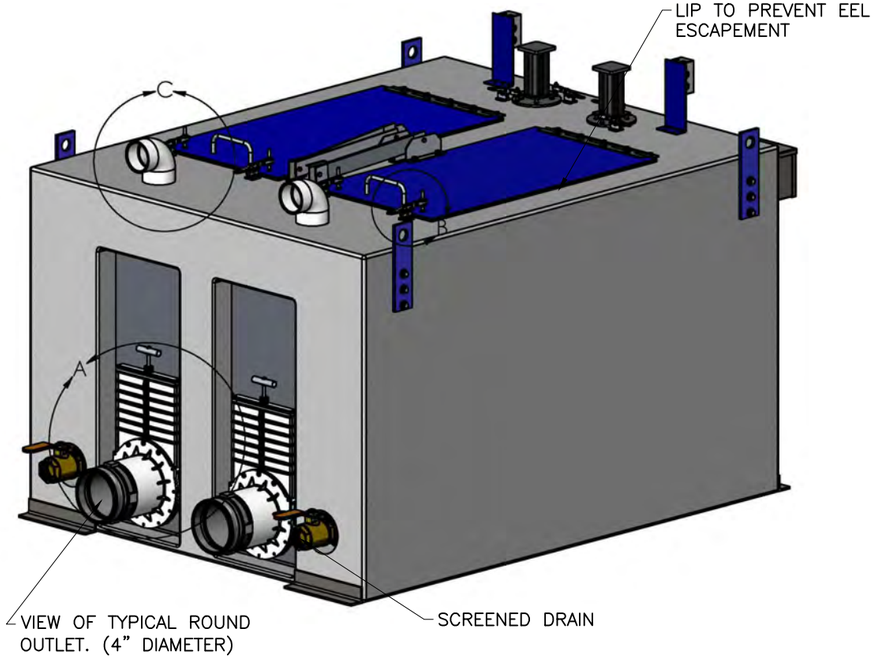


PHOTO 1: ISOMETRIC VIEW OF REIFF MANUFACTURING TRANSPORT TANK

REIFF MANUFACTURING
TRANSPORT TANK ARRANGEMENT

NOTES:

TRANSPORT TRUCK AND MONITORING

1. TRANSPORT TRUCK HAS CAPACITY TO TRANSPORT 25,000 EELS (2,500 LITERS) IN ONE TRIP.
2. TRANSPORT TRUCK INCLUDES CONTINUOUS IN–CAB MONITORING SYSTEM FOR INSUFFICIENT WATER TEMPERATURE AND DISSOLVED OXYGEN PARAMETERS. NO BACK–UP PUMP AND NO ALARMS (FLOW IS NOT NEEDED FOR EELS AND THE TECHNICIAN MONITORS THE IN–CAB MONITORING SYSTEM).

TRANSPORT TANK

1. TANK HAS CAPACITY TO HOLD 25,000 EELS (2,500 LITERS) WITH 4" OF FREEBOARD.
2. TANK INCLUDES LIP TO PREVENT EEL ESCAPEMENT.
3. TANK MANUFACTURED BY REIFF MANUFACTURING.
4. EELS WILL BE EMPTIED DIRECTLY FROM TANK VIA 4" SUCTION HOSE ATTACHED TO THE 4" DRAIN (KNIFE VALVE) TO AID RELEASE OF EELS AWAY FROM SHORELINES AT DESIRED STOCKING LOCATIONS.
5. TANK INCLUDES $1\frac{1}{2}$" SCREENED DRAIN TO LOWER WATER LEVELS AS NEEDED.
6. OTHER DETAILS OF THE TANK CAN BE FOUND ON THE REIFF MANUFACTURING DRAWINGS.

FINAL

NO.	DATE	DESCRIPTION	BY	APP
0	4/15/19	CONOWINGO EEL TRANSPORT FACILITIES	KBS	-

FOR: Exelon
EXELON GENERATION COMPANY, LLC

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY:	CRS
DRAWN BY:	CRS
CHECKED BY:	-
APPROVED BY:	-
PROJECT NO.:	1385
DATE:	

CONOWINGO AMERICAN EEL TRANSPORT FACILITY

PLAN, SECTION, DETAILS - EEL TRANSPORT

SCALE:

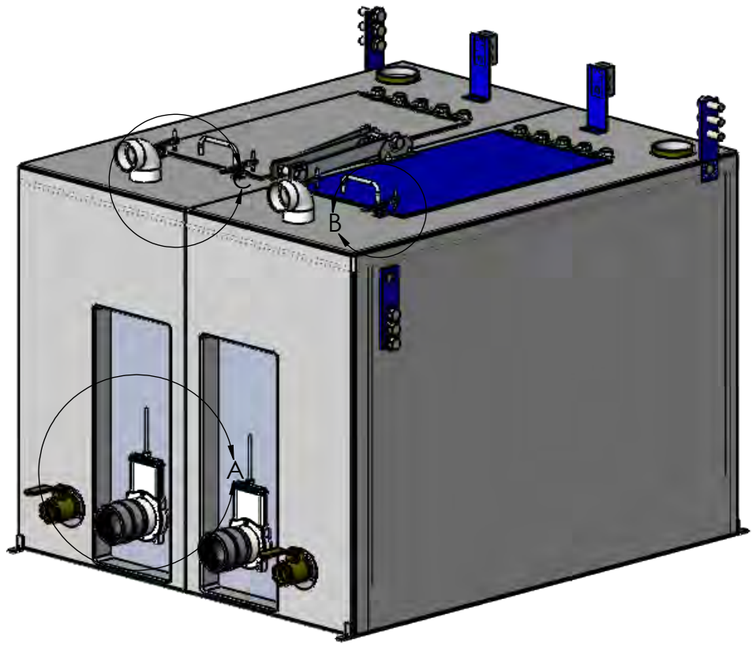
SHEET 1 of 4

Tank Notes:

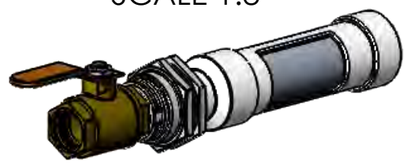
- Inner Tank structure to be built out of 0.19" thick 5025-H32 Aluminum 2 Tank Insulation 2lb. density El Foam P200 or equal (7.9 Rs per in.).
- External Tank to be made of 0.125" thick FRP with additional in corners and bottom for reinforcement.
- Urethane clear coat over outer gelcoal layer for durability and ease of cleaning.
- [2] 4" Round outlet with external mount Valterra 4" Knife gates. (1) per compartment. Gates are mounted to Tank with machined Alum plate.
- (2) - 24 Point Four Systems microbubble diffuser. (1) per compartment.
    - Each diffuser stone is countersunk in tank bottom.
    - Stones have removable alum covers for maintenance and repair.
    - Countersunk pockets have drainline for water drainage of pockets.
    - (2) Oxygen Flowmeter, (1) per stone.
    - (1) Oxygen Regulator.
- (2) Ventilation scoop. SCH 40 PVC elbow with Alum perforated screening. (1) per compartment mounted on access hatch doors.
- (2) Access hatch 18" x 36" with 21" x 39" signle hinge doors. (1) per compartment.
    - Each door has heavy duty Stainless Steel piano style hinge.
    - (1) Alum fabricated jack knife door lock hinge. Hinge holds door in open position to keep accidental closure from occuring.
- Details NOT shown in Submittal drawings include: Point Four oxygen stones and internal oxygen lines. (placement pocket and flush mount cover is shown.

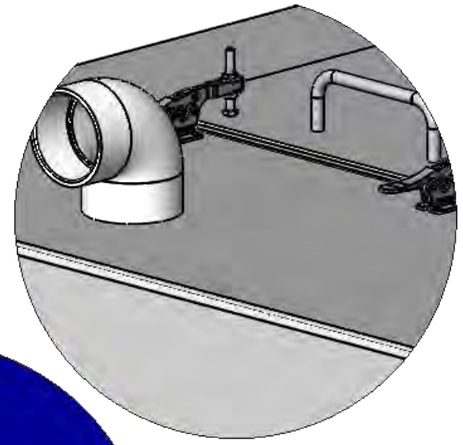
External Valterra Gate Notes

- Gate is double sealed with easily replacable seals.
- Gate is double flanged with full gate able to be removed easily for maintenance or repair.
- Gate seal when gate is closed to be drip ligt, and leak proof, when properly adjusted.
- Bolts for mounting of flanges to allow for seal tension adjustment.
- Outer removable flange has threaded pipe slub in slip flange for mounting threaded 4". Female thread to Male camlock quick coupler.

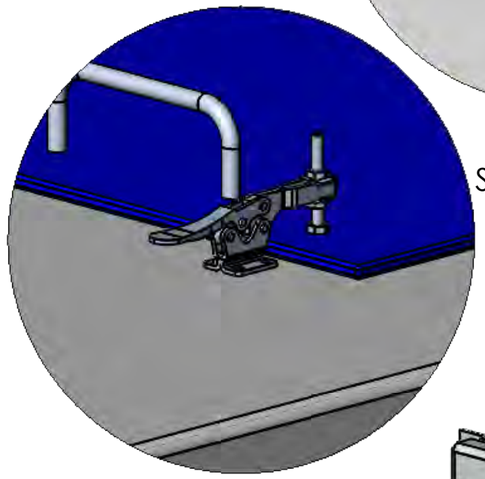


SCREENED TEMPERING VALVE
DETAIL
SCALE 1:8



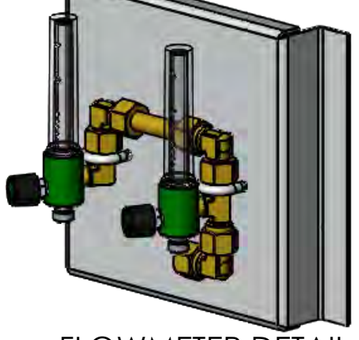


DETAIL C
SCALE 1 : 6



DETAIL B
SCALE 1 : 4

DETAIL A
SCALE 1 : 8



FLOWMETER DETAIL
SCALE 1:4

FINAL

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DRAWN	CA	3/23/2016
CHECKED		

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www.reiffmfg.com
670 B Street, Walla Walla, WA 99362 (509) 525-1081

Reiff MFG.
CITY/COUNTY AIRPORT
670 B Street
WALLA WALLA,WA.99362
PHONE: 509-525-1081

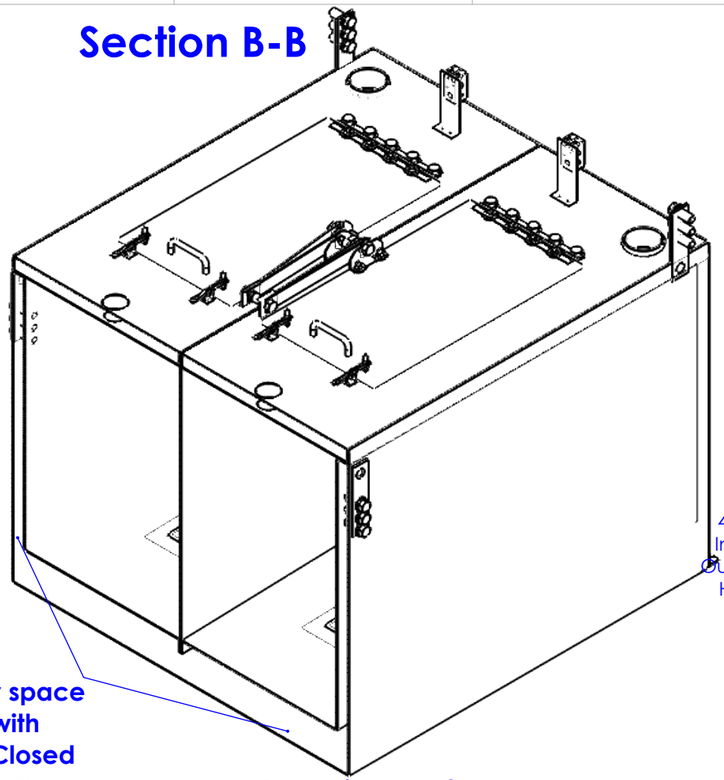
CUSTOMER:
Normandeau - PA

TITLE:
660gal 2 comp fish trans

SIZE	JOB. NO.	REV
B	650gal 2 Comp	1

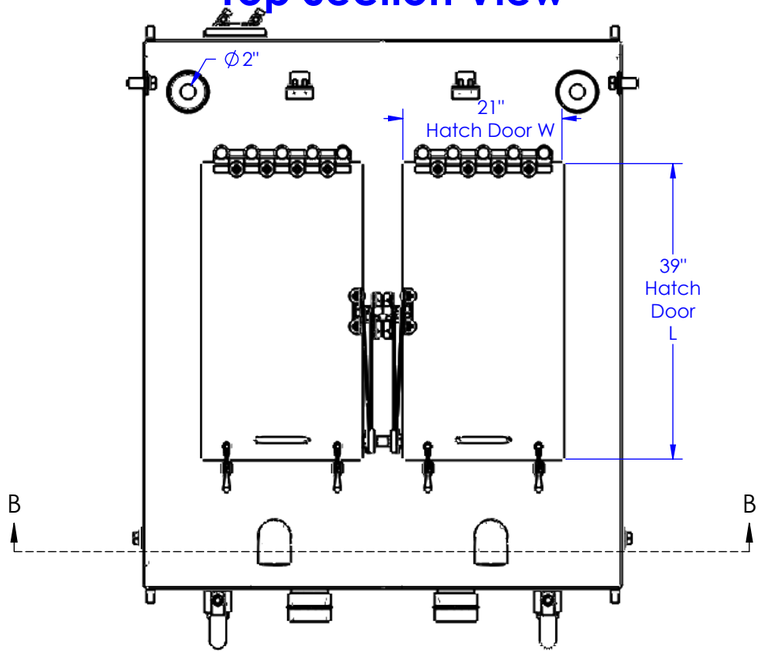
SCALE: 1:20 WEIGHT: SHEET 2 OF 4

Section B-B

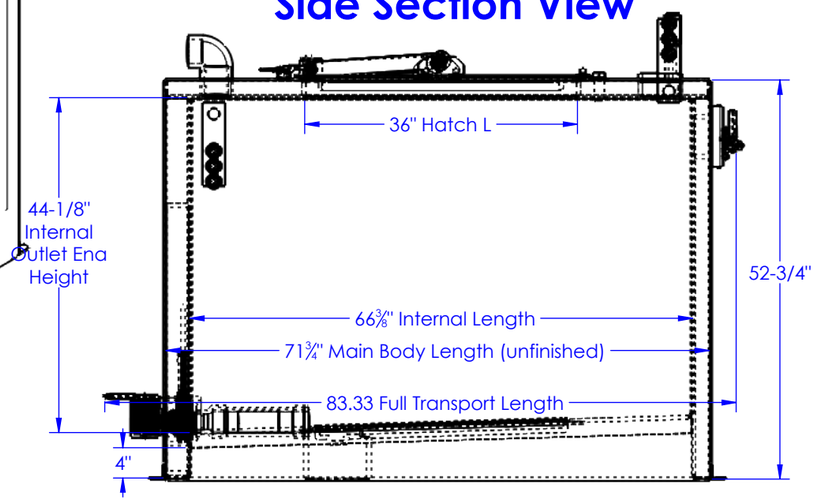


Empty space filled with P200 Closed Cell Foam

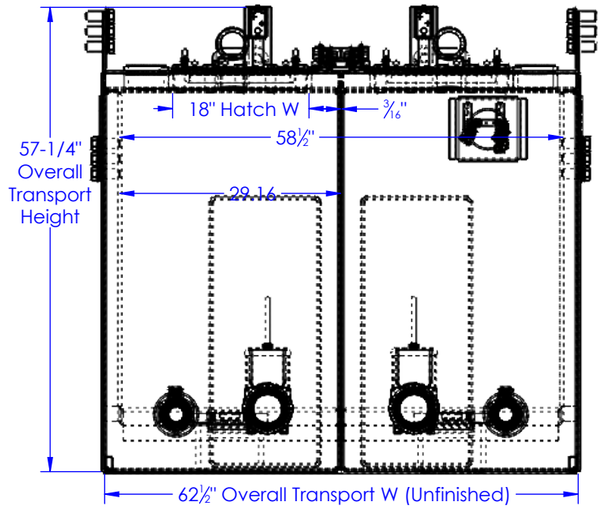
Top Section View



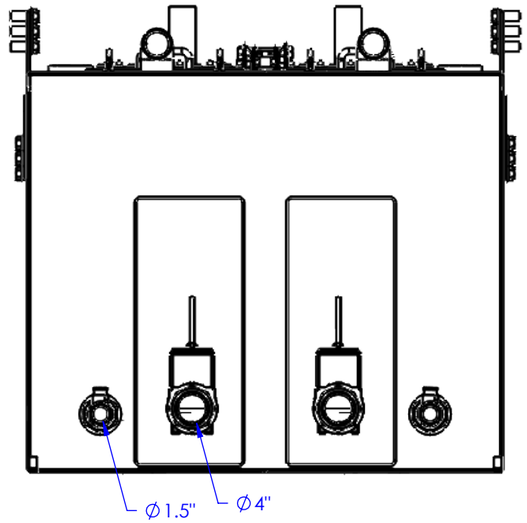
Side Section View



Cab End Section View



Outlet End Section View



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CUSTOMER SUBMITTAL APPROVAL Signature or Initial: (upon approval) Date Signed: (MM/DD/YYYY)	MATERIAL FINISH DO NOT SCALE DRAWING	Reiff Manufacturing; Reiff MFG. CITY/COUNTY AIRPORT 670 B Street WALLA WALLA,WA.99362 PHONE: 509-525-1081

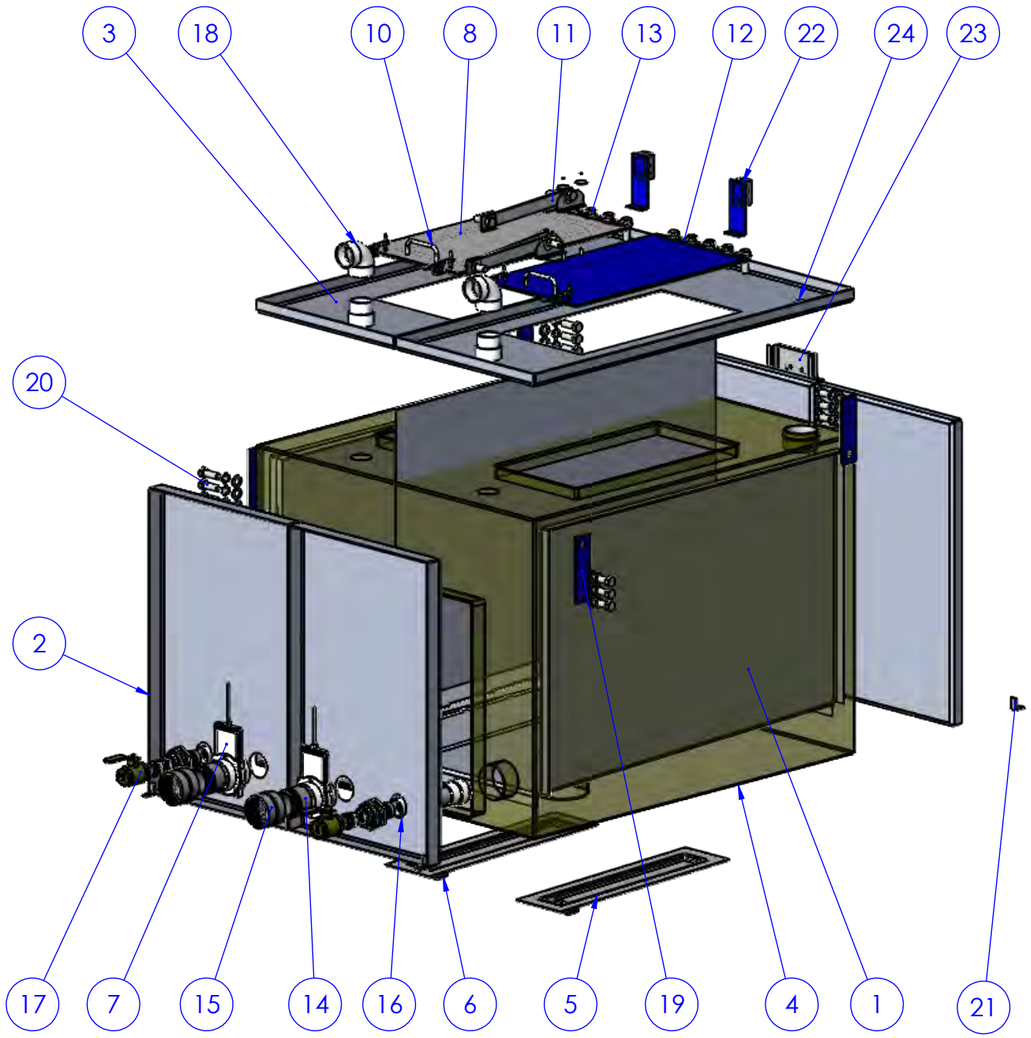
CUSTOMER: Normandeau - PA

TITLE: 660gal 2 comp fish trans

SIZE	JOB. NO.	REV
B	650gal 2 Comp	1

SCALE: 1:20 WEIGHT: SHEET 3 OF 4

NOTE #	PART	QTY.	DESCRIPTION
1	660 gal Alum Interior Body Piece	2	Tank Body made from 0.19" thick 5052-H32 fabricated Alum Sheet.
2	660 gal Alum Interior Ends	4	Tank Body made from 0.19" thick 5052-H32 fabricated Alum Sheet.
3	660 gal Alum Interior Top	2	Tank Body made from 0.19" thick 5052-H32 fabricated Alum Sheet.
4	Fiberglass Outer Shell	1	White and Clear gel coated, Chop Applicated 0.15" FRP Outer Shell.
5	Point Four System's 24" O2 diffuser stone FRP pockets	2	Pockets are recess mounted to allow flush mounting of O2 stone cover.
6	0.125" 5052-H32 flush mount O2 stone covers	2	Flush Alum covers secured with removable hardware for servicing of O2 stones.
7	4" Valterra External Mount ABS Plastic KnifeGate	2	Valterra 4" ABS Plastic, Alum plate flange mounted exterior fish release knife gate valve.
8	15" x 32" un-insulated 0.25" thick Alum hatchway access door	2	Alum Angle reinforced large access top door for loading fish into transport tank.
9	USS DeStaCo 225 horizontal toggle clamps	4	Toggle clamps for seccuring top hatch door and appling gasket seal pressure. 500 lbs. pressure per clamp.
10	Alum 6" access door handle	2	
11	Reiff Jack-Knife Door Hinge	2	Hinge that is installed to hold door in open position and prevent injury due to accidental closing.
12	18" L Heavy Duty 3" stainless steel hinge	2	18" length Heavy Duty 3" Stainless Stell Piano Style Hinge for Hatch Door.
13	0.25" Bolt hardware		Used to mount hatch door, toogle clamps, other non-load bearing items.
14	4" Male NPT PVC Pipe Stub	2	4" Male NPT PVC pipe stub for attaching camlock fitting to 4" gate valve flange.
15	4" Female NPT to Male Camlock quick connector	2	Female NPT end is threaded onto male pipe stub for attachment of hose with camlock fitting.
16	1.5" PVC screened bulkhead fitting	2	PVC tank wall threaded bulkhead fitting for mounting tempering valve, screened internally.
17	1.5" Tempering and Dewatering ball valve	2	Threaded manual operated ball valve mounted to bulkhead.
18	3" SCH40 90 Elbow Vent	2	Screened Vent elbow for air circulation and keep tank from over pressurization.
19	0.375" thick powder coated Alloy Steel Tank lifting Bracket	4	**Lifting backets that can be used for lifting tank WHILE EMPTY.**
20	0.375" Stainless Steel lifting eye Hardware	12	Hardware for securing lifting eye to backing on tank (3 per lifting eye).
21	3" x 3" x 0.25" Alum Angle	4	Alum Angle for bolting or mounting Transport to bed of truck
22	0.125" thick Alum Outlet Box Bracket Mount and Electric J Box	4	1 Bracket per Aerator with mounted Aerator plug in electrical J box.
23	Oxygen Flow Meters and Mount	2	**(1) Alum mounting bracket, (2) O2 flow meter, Brass fittings connected to green O2 lines.**
24	2" Bulkhead	2	
Extra	Hardware not shown on tank		EI Foam Insulation, Diffuser Stone (MBD100), O2 regulator, Plumbing for O2 delivery, and internal wire routing



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CUSTOMER:
Normandeau - PA

TITLE:
660gal 2 comp fish trans

SIZE	JOB. NO.	REV
B	650gal 2 Comp	1

SCALE: 1:24 WEIGHT: SHEET 4 OF 4

Conowingo 250-L Transport Tank

Conowingo 19-L Transport Buckets

APPENDIX G. SUSQUEHANNA RIVER AMERICAN EEL ELVER REQUEST FORM

Susquehanna River American Eel Elver Request Form

Submit requests to Aaron Henning of the Susquehanna River Basin Commission (ahenning@srbc.net) by November 15 to be considered for eel distribution the following calendar year. Approval of this request is not a binding contract for the agencies or Exelon to provide eels.

Principal Investigator:_____

Organization Affiliation:_____

Email Address:_____ **Phone Number:**_____

Project Title:_____

Brief Project Description (a project proposal can be attached to this form):_____

_____

_____

_____

Total # Eels requested (by calendar year):_____

Estimated Duration of Holding:_____

Ultimate Disposition of Eels (released or other):_____

Proposed release location, including waterbody, county, municipality, and state:_____

_____

An 8.5"x11" map of the stocking location should be attached to this request

Project Start and End Dates:_____

Have scientific collection and/or stocking permits been secured?:_____

Is this a new or ongoing request?:_____

Has sufficient funding been secured to implement the project?:_____

Has a transport mechanism been approved by the agencies?:_____

Additional Information:

For projects requesting large numbers of eels (i.e. >500/yr), the agencies may require the requestor to give a presentation of the proposed study plan at the annual SRAFRC/Hydro Meeting in December or at another time agreed to by the Resource Agencies.

Annual study reports must be filed with the Resource Agencies each year prior to November 15. Study reports should include the number of eels received by date, the disposition of eels (stocked, retained, died in transport, etc.), the conditions monitored during transport, latitude, longitude, and number of elvers released at each stocking event, and any available information related to the project results. Future eel requests may be denied if annual study reports are not filed in a timely manner.

All requests are subject to approval from the following agencies: Susquehanna River Basin Commission, U.S. Fish and Wildlife Service, Pennsylvania Fish and Boat Commission, Pennsylvania Department of Environmental Protection, New York State Department of Environmental Conservation, and Maryland Department of Natural Resources. No more than 20% of the average annual catch will be provided in a given year for research or alternate stocking projects.

All proposed transport procedures will need to be submitted to the agencies for approval no later than April 1. Procedures need to include details on vehicle, transport tank size, mechanism to continuously monitor temperature and dissolved oxygen during transport, and ability to provide supplemental oxygen during transport. Water quality measurements for transport will need to be reported in the annual report along with number of eels transported and number of mortalities during transport. An inspection of the transport vehicle and water quality monitoring mechanisms may be required by a resource agency staff or Exelon representative prior to approving transport procedures.

All parties receiving eels must comply with Exelon's standard operating procedures for eel transfer and also complete a Chain of Custody form (attached).

Standard Operating Procedures for American Eel Transfer from Exelon

The purpose of this protocol is to ensure the health of the eels removed from and transported to locations as designated by the eel request form. Exelon's ability to hold eels for longer than 24-hours may be limited during the summer due to the increased stress and mortality related to high water temperatures.

A minimum notice of 24 hours is required for an anticipated pickup. No pickups will be facilitated by Exelon on weekends or holidays.

Pickup personnel should be limited to 1-2 people and the names of those individuals must be provided to Exelon prior to arrival, ideally when the pickup is scheduled. For anyone arriving on

station, proper PPE must be worn including closed toe shoes, long pants, and short sleeve shirts. Hard hats and safety glasses will need to be worn on site, but can be provided temporarily by Exelon if notified prior to arrival on station.

Planned pickup time should be around 7:30 a.m. No transfers will occur after 5:00 pm.

Exelon reserves the right to deny transfer of eels if they believe the transport vehicle and supporting equipment could jeopardize safety and survival of eels.

Exelon will notify resource agency staff if the requested eels are (or anticipated to be) available. Agency staff will approve transfer and coordinate with the requestor and Exelon to arrange pickup details for the next day.

ATTACH CHAIN OF CUSTODY FORM

CHAIN OF CUSTODY SHEET: JUVENILE EELS PROVIDED TO RESOURCE AGENCY PERSONNEL FROM THE CONOWINGO EEL COLLECTION FACILITY

Date: _____ **Time:** _____

NUMBER OF EELS PROVIDED:

CECF Collection Tank: _____

Holding Tank # 1: _____

Holding Tank # 2: _____

Holding Tank # 3: _____

Total number of eels provided for Transport: _____

WATER TEMPERATURE:

Collection/Holding Tank: _____

Transport Truck: _____

SIGNATURES:

Normandeau/Exelon Representative: _____

Agency Representative: _____

Agency Rep. Printed Name and Agency: _____

APPENDIX H. FINAL STUDY REPORT: BIOLOGICAL AND ENGINEERING STUDIES OF AMERICAN EEL AT CONOWINGO PROJECT 2011 EEL SAMPLING BELOW CONOWINGO DAM

FINAL STUDY REPORT
BIOLOGICAL AND ENGINEERING STUDIES OF AMERICAN EEL AT CONOWINGO PROJECT
2011 Eel Sampling below Conowingo Dam

RSP 3.3

CONOWINGO HYDROELECTRIC PROJECT

FERC PROJECT NUMBER 405

Prepared for:

Exelon.

Prepared by:

Normandeau Associates, Inc.

Gomez and Sullivan Engineers, P.C.

August 2012

EXECUTIVE SUMMARY

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt Conowingo Hydroelectric Project (Conowingo Project). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014. FERC issued the final study plan determination for the Conowingo Project on February 4, 2010, approving the revised study plan with certain modifications.

The final study plan determination required Exelon to conduct biological and engineering studies of American eel (*Anguilla rostrata*). The objectives of the study are to: 1) summarize available scientific and commercial information regarding the American eel; 2) identify suspected factors affecting American eel abundance; 3) describe the spatial distribution and size characteristics of American eels in the Conowingo tailrace; 4) examine the engineering feasibility and costs of upstream and downstream passage options, including consideration of potential fallback of eels after exiting an upstream passage device; (5) examine the potential impact of upstream and downstream passage of American eels on the Susquehanna River; (6) assess the cumulative impacts to the biodiversity of the Susquehanna River ecosystem of upstream and downstream passage of American eel; and (7) if deemed beneficial to American eel abundance, identify potential locations for an upstream eel passage facility at Conowingo Dam.

An initial study report (ISR) was filed on February 22, 2011 that covered study objective 3, containing Exelon's 2010 study findings. An initial study report meeting was held on March 9, 10 and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May 27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) describing the results of the 2011 biological sampling at the spillway side of the dam was filed on January 23, 2012. This final study report detailing the 2011 sampling is being filed with the Final License Application for the Project. A separate report was developed to address the remaining study objectives 1, 2, and 4 thru 7.

The 2011 study began June 24, 2011 and ended on September 5, 2011. Heavy rainfall in the spring of 2011 delayed implementation of the study. Construction and deployment of the spillway elver ramps could not be completed until spillway water levels stabilized to safely allow work crews access to the

spillway. During the May 2011 relicensing meeting, the potential impacts of a delayed study start were discussed and it was felt that the heavy rainfall and high river flows probably hindered the upstream elver migration, thus indicating that a late start may not significantly impact the 2011 study results. The USFWS sampling area, (West bank), is accessible at higher river flows which allowed them to start on May 20, 2011 as planned. The spillway area sampled by Normandeau Associates is not accessible during spill conditions, which delayed the set-up and start of sampling. Heavy rainfall associated with Hurricane Irene and Tropical Storm Lee forced both studies, (USFWS and Normandeau), to conclude early.

Two capture methods were deployed for eels. Elver ramps and associated collection facilities were placed on the west and east sides of the spillway below Conowingo Dam. In 2011, two ramps per sample location, each with a different substrate, were deployed. Additional attraction water was provided to each set of ramps which appeared to attract more elvers to the ramp locations and improved upon the elver catch observed in 2010. On the west side a submersible pump provided water which drained down the East Lift wing wall creating water movement at the base of the ramps. The east side ramps were placed downstream of a creek which provided natural water movement and potential attractant. In addition, both sample areas had PVC pipes placed between the dual ramps, which were fed with water provided from a gravity-flow system within Conowingo Dam creating more attraction flow than previously used in 2010.

In concert with the substrate utilized in the 2010 study, (Enkamat®), a second substrate (AkwaDrain™) was placed in a separate parallel ramp. Two different mesh-sized baited eel pots that targeted larger yellow eels were situated adjacent to the two ramps. Both gear types (excluding the new AkwaDrain™ ramp) were consistent with those used in 2010 and previous years by USFWS to enhance data comparability between the two sampling areas.

Elvers and yellow eels were sampled between June 24 and September 5, 2011. A total of 1,159 eels were collected. Of these, 1,100 were elvers collected from the ramps. The east ramps collected 539 elvers, with 133 harvested in the Enkamat® substrate and 406 captured from the AkwaDrain™ substrate. The west ramps collected 561 elvers, with 405 harvested in the Enkamat® substrate and 156 collected in the AkwaDrain™ substrate. Elver lengths ranged from 87 to 188 mm total length (TL), with an average size of 124.9 mm. Yellow eels harvested from the eel pots totaled 59; all yellow eels were collected from the west side. The length range of eels collected in pots ranged from 300 to 689 mm TL, with an average length of 515.4 mm.

Hourly water temperatures were recorded throughout the study period. Water temperatures typically rose and fell three to four degrees Fahrenheit (°F) every day. The water temperature in the Conowingo

spillway ranged from a low of 73.7° F on September 3 to a high of 90.8° F on July 24. A comparison of water temperatures to elver catch at the ramps revealed no apparent relationship.

The study period encompassed three new moon periods and two full moon periods. A possible, but weak and limited relationship between the number of elvers collected and moon periods was observed during part of the study period.

Normandeau Associates also conducted three nighttime surveys to document areas of elver congregation in the spillway. During these surveys, elvers were only observed in abundance below crest gate #30.

Seventy-seven eels were preserved for otolith ageing. A total of 73 of the 77 otoliths preserved were aged successfully. The majority of elvers were split at age I or II, and III to V years of age, at 30% for each group. A large gap in age at years VI to VIII is apparent due to a lack of specimens in the 189 to 299 mm size range. Larger eels were aged IX to XVII, plus one at age XIX.

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LIST OF ABBREVIATIONS

Exelon	Exelon Generation Company, LLC
F	Fahrenheit
FERC	Federal Energy Regulatory Commission
ft	feet
h	hour
in	inch
ISR	Initial Study Report
L	liter
min	minute
mm	millimeter
MW	megawatt
PIT	Passive Integrated Transponder
RSP	Revised Study Plan
TL	total length
USFWS	United States Fish and Wildlife Service
USR	Updated Study Report

1.0 INTRODUCTION

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt Conowingo Hydroelectric Project (Conowingo Project). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014. FERC issued the final study plan determination for the Conowingo Project on February 4, 2010, approving the revised study plan with certain modifications.

The final study plan determination required Exelon to conduct biological and engineering studies of American eel (*Anguilla rostrata*). The objectives of the study are to: 1) summarize available scientific and commercial information regarding the American eel; 2) identify suspected factors affecting American eel abundance; 3) describe the spatial distribution and size characteristics of American eels in the Conowingo tailrace; 4) examine the engineering feasibility and costs of upstream and downstream passage options, including consideration of potential fallback of eels after exiting an upstream passage device; (5) examine the potential impact of upstream and downstream passage of American eels on the Susquehanna River; (6) assess the cumulative impacts to the biodiversity of the Susquehanna River ecosystem of upstream and downstream passage of American eel; and (7) if deemed beneficial to American eel abundance, identify potential locations for an upstream eel passage facility at Conowingo Dam.

An initial study report (ISR) was filed on February 22, 2011 that covered study objective 3, containing Exelon's 2010 study findings. An initial study report meeting was held on March 9, 10 and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May 27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) describing the results of the 2011 biological sampling at the spillway side of the dam was filed on January 23, 2012. This final study report detailing the 2011 sampling is being filed with the Final License Application for the Project. A separate report was developed to address the remaining study objectives 1, 2, and 4 thru 7.

2.0 METHODS

The 2011 study objectives were to acquire; 1) eel spatial distribution data in the tailrace and spillway pool, and 2) collect associated biological and physical data (Appendix A). In order to maximize elver and yellow eel catch, (the life stages targeted by this study), we utilized two capture methods. Elver ramps and associated collection facilities were placed on the west and east sides of the spillway below Conowingo Dam (Figure 2-1). Baited eel pots that targeted larger yellow eels were fished adjacent to these two ramp locations.

During the 2010 study, we had utilized one elver ramp per site containing Enkamat® substrate. In 2011, two ramps per site, each with different substrates (Figure 2-2) were deployed. In addition to the Enkamat® substrate utilized in 2010, a second substrate, AkwaDrain™, was placed in a separate ramp adjacent to the Enkamat® ramp.

The west ramps were constructed and placed parallel to the wing wall near the East Fish Lift on June 23, 2011 (Figures 2-3 and 2-4), with additional water cascading down from the top of the wing wall to create disturbance and additional flow for attraction purposes. The west spillway ramps operated for nearly two weeks prior to the installation of the east spillway ramps.

The east side spillway sampling location used in 2010 was structurally damaged by heavy spring rainfall. Therefore, on July 1, 2011, the east spillway ramps (Figure 2-5) were deployed at a location adjacent to the location used in 2010. The east ramps were constructed on scaffolding located near the mouth of a small intermittent stream entering the Susquehanna River near the base of the dam (Figure 2-6). This provided natural water flow patterns that may have attracted elvers to the ramp.

The ramps were constructed with galvanized ductwork, and Enkamat® or AkwaDrain™ substrate was attached to the tray bottom with industrial grade adhesive (Figure 2-7). These substrates allowed elvers to climb the ascending section of the ramps. As advised by USFWS personnel, the substrate did not extend to the top of the ramp so the climbing elvers were forced to swim the final section of the ascending ramp; this configuration prevented them from using the substrate to pull themselves back up the descending section of the ramp to avoid capture. Each ramp unit was supported by scaffolding, which provided a sturdy base. The angle of each ramp was measured, the east ramp angle was 40°, and the west ramp angle was 35°. Each ramp consisted of approximately 20 ft. of cable tray, 12 in. wide, plus tray and sheet metal curved at the top to convey elvers into secure mesh bags which were housed in holding containers which were medium sized plastic trash cans. All ramps were fastened to scaffolding and located at or near spillway drainage or overflow.

Water flow to each ramp was supplied from a gravity-flow system within Conowingo Dam (Figure 2-8). Water was continuously released down the ramp via a spray bar to provide even sheet flow across the entire width of the ascending and descending sections of the ramps (Figure 2-9), keeping the substrate moist and creating a small amount of flow to attract elvers. The spray bars also directed water into each holding container and played a role in keeping the collected elvers aerated and alive.

Climbing ramp flow was augmented by an additional attraction flow directed to the bottom of the ramp and released between the ramps at each location (Figure 2-9). This attraction water was provided to each set of ramps which appeared to attract more elvers to the ramp locations and improved upon the elver catch observed in 2010.

On the west side a submersible pump provided water which drained down the East Lift wing wall creating water movement at the base of the ramps. The east side ramps were placed downstream of a creek which provided natural water movement and potential attractant.

In addition, both sample areas had PVC pipes placed between the dual ramps which were fed with water from a gravity-flow system within Conowingo Dam providing more attraction flow. Attraction flow volumes from the PVC pipes on both sets of ramps were measured. The west ramp was nearly 57 L/min (15 gpm), while the estimated attraction flow volume on the east ramps was 45 L/min (12 gpm). These volumes were a slight increase to the amounts used in 2010, due in part to the distance of the ramps from the water source. In addition to added attraction flow, water was siphoned from the holding containers where elvers were collected and redirected down each ramp to provide a scent trail to potentially attract elvers to the ramps.

Holding containers were checked for elvers on Mondays, Wednesdays and Fridays during the entire 2011 study with exceptions on holidays, (July 4, Labor Day), when the holding containers were checked the following day. Wednesday and Friday samples represented a 48 h fishing effort while Monday samples included the weekend days and represented a 72 h effort.

Yellow eels were collected with two different size mesh eel pots. The mesh of the pots was 0.25 in. (modified pot) and 0.5 in. (cloth pot). (Figure 2-10). These two sized mesh pots were fished adjacent to each set of elver ramps. Two pots at each end of the spillway were baited and fished for a 48-h period every other week.

Once captured, eels were sedated with MS-222, counted and measured (Figure 2-11). All captured eels were scanned for PIT tags previously inserted by USFWS (Figure 2-12). At the request of USFWS

personnel, PIT tags were implanted into yellow eels captured during the 2011 study period. These tags were provided by USFWS, and the corresponding PIT tag numbers were recorded. After PIT tagging, yellow eels were released back into the Susquehanna River at the point of capture. A subsample of captured elvers and yellow eels was frozen for otolith analysis. All remaining elvers were placed in the USFWS tank located near the West Fish Lift facility for upstream transport.

Water temperature was determined by an ONSET Water Temp Pro2 recording device which was located in the Conowingo spillway at the west ramp. (Figure 2-13). This device measured water temperature on an hourly basis throughout the entire study. Data were retrieved monthly. Data on daily rainfall (measured at Conowingo Dam) and percent lunar fractions at Havre de Grace, MD (www.usno.navy.mil/USNO/astronomical-applications/data-services/lunar-ecl-us) were also collected throughout the study period.

A representative sample of elvers and yellow eels were frozen for otolith removal and aging. Otoliths were removed from the eels, embedded in clear epoxy, and dried for 12 hours. Utilizing a double-bladed, slow speed saw, a 0.2-mm thick transverse section was cut through the nucleus perpendicular to the sulcus. Adhesive was applied to the cut otolith which was then placed on a glass slide. The sample was polished using a series of fine grade lapping films, which were periodically inspected to insure no damage to the polished otolith. After polishing, Toluidine Blue stain was applied to the sample to assist readers when counting the annular rings. All otolith samples were read by two readers. If the two readers agreed on the analysis, the age estimate was accepted. If readers of the slides weren't in agreement on an age, that slide was re-analyzed. If no consensus was met, the otolith was rejected. The age reported herein is the freshwater age (*i.e.,* the numbers of annuli outside the transition mark - the end of larval growth in salt water).

During the 2011 study period, three nighttime surveys were conducted below the Conowingo spillway area to examine potential evening movements of elvers. Correlating with full and new moon periods, two boat crews utilizing headlamps, and LED marine rechargeable spotlights with night vision covers, (red lenses), traversed the spillway area looking for elver abundance. A fourth survey was scheduled but was cancelled due to heavy rains that created unsafe conditions in the spillway area.

3.0 RESULTS

Elvers and yellow eels were sampled between June 24 and September 5, 2011. Heavy rains from Hurricane Irene and Tropical Storm Lee forced the early termination of this year's study. A major spill event at Conowingo Dam was imminent so all equipment was removed on 6 September.

A total of 1,159 eels were collected from the Conowingo Dam spillway in 2011 (Table 3-1). Of these, 1,100 were elvers collected from all elver ramps combined. This represents a substantial increase in the number collected in 2010, when the east elver ramp collected 158 elvers and the west elver ramp collected 8. In 2011, the east elver ramps collected 539 elvers, with 133 harvested in the Enkamat® substrate and 406 captured from the AkwaDrain™ substrate (Table 3-1). Generally, the east ramps collected elvers evenly throughout the study period. However, on July 11, the AkwaDrain™ substrate collected 239 elvers, with none collected in the adjacent Enkamat® ramp. The west elver ramps collected 561 elvers, with 405 harvested in the Enkamat® substrate and 156 collected in the AkwaDrain™ substrate (Figure 3-1). Overall, the majority of elvers were collected in the Enkamat® substrate on the west side (405), and the AkwaDrain™ substrate (406) on the east side. Both of these ramps were located adjacent to walls suggesting that elvers may utilize structures to help orientate them upstream. Elver lengths ranged from 87 to 188 mm TL, with an average size of 124.9 mm (Figure 3-2).

A subsample of elvers (N = 46) and yellow eels (N = 31) caught was frozen for ageing by otolith analysis. All remaining elvers not used for otolith research (1,007) were placed in the USFWS tank located near the West Fish Lift facility for upstream transport (Table 3-2). Yellow eels harvested from the eel pots totaled 59, all of which were collected on the west side. The size of eels collected in the pots ranged from 300 to 689 mm TL, with an average length of 515.4 mm (Figure 3-3). Twenty-seven of the 59 yellow eels were PIT tagged and released back at the point of capture. No recaptures were encountered during the study period.

Water temperature was recorded on an hourly basis throughout the study period. Water temperatures typically rose and fell three to four degrees Fahrenheit each day at all ramps. The water temperature in the Conowingo spillway ranged from a low of 73.7° F on September 3 to a high of 90.8° F on July 24 (Table 3-3). A comparison of water temperature to elver catch revealed no apparent relationships (Figure 3-4).

The 2011study period encompassed three new moon periods (0% lunar phase) and two full moon periods (100% lunar phase). Eels have been observed to move in abundance during new moon periods or periods of little illumination. During the 2010 survey, a correlation between full moon periods and elver collection was observed. The 2011 survey had little data to support any association with movement and

lunar illumination. However, when moon phase is plotted against the number of elvers collected; a slight positive relationship was observed on July 11. (Figure 3-4). July 11 was also the largest single day collection of elvers during 2011.

Three nighttime surveys were conducted in the Conowingo spillway to document locations of elver congregation (Figure 3-5). Elvers were only observed in abundance below crest gate #30 (Figures 2-1 and 3-6). Located immediately downstream of crest gate #30 is a plateau of concrete or macadam. Elvers were observed at this location during all three nighttime surveys. Elvers were also observed, (although not in abundance) near seeps, or areas where water trickled over the spillway sill , and when water cascaded down bedrocks associated near these seeps. In these areas where elvers were observed, predatory fish such as channel catfish, and striped bass also were observed.

Rainfall occurred on 25 of the 74 days during the 2011 elver study. Daily rainfall at Conowingo Dam plotted against the number of elvers collected does not show any relationship between rainfall events and elver movement (Figure 3-7).

Seventy-seven eels were preserved for otolith research. A sample from each size range was collected in the 2011 study. Four otoliths were deemed unreadable. Seventy-three eels were aged successfully. The dominate age group collected (I to V years of age) comprised 60% of the otoliths examined. A large gap in age at years VI to VIII is apparent due to lack of specimens in the 189 to 299 mm size range. Larger eels were aged IX to XVII, plus one eel aged at XIX years (Table 3-4).

The 2011 study ended abruptly due to heavy rainfall from Hurricane Irene and Tropical Storm Lee that forced Conowingo Dam to spill water through forty-three of its fifty crest gates (Figure 3-8).

4.0 DISCUSSION

The low elver catch in 2010 and agency comments provided on that study report prompted some changes for the 2011 study. An additional ramp with a different substrate was added to each spillway sampling location. Additional attraction flow was also provided for both sets of ramps. The west side ramps were located in the same general position as in the 2010 study, but were oriented parallel to the river in 2011 rather than perpendicular in 2010. The east side ramps were relocated due to structural damage at the 2010 sampling location from heavy spring rains. The new location was constructed close to the 2010 placement.

Although the 2011 study period was bookended by heavy rains that attributed to a late start and early finish, the overall elver catch was significantly higher in 2011 (1,159), than in 2010 (258) . Once the study was underway, the elver ramps collected eels for 74 days as compared to 106 days in 2010. Collection of elvers and yellow eels was consistent throughout the entire study period with a few exceptions. The east spillway facility collected 239 elvers from a single ramp on July 11, 2011.

Predation from both land-based animals and birds was not directly observed but may have occurred at the east side. On several collection days, animal tracks were present in the muddy areas near the ramps. This same area exhibited an abundance of avian fecal matter and feathers littered on and around the ramp platform. Predation may have been an issue, but evidence does not exist to quantify. The 2011 catch of elvers was much higher than the total collected in 2010. An increase in elver catch during the 2011 study period may be attributed to additional ramps, (four in 2011, as opposed to two in 2010), additional attraction water and the addition of scent attraction.

In contrast to 2010, both sides of the spillway captured nearly equal numbers of elvers, with the west side collecting slightly more than the east. The absence of eels from ~189 to 299 mm is generally similar to previous year's collections by Normandeau Associates and USFWS. Attempts to collect this size range of yellow eels with smaller-mesh pots (.25 inch) failed. Enkamat® is reportedly size-selective for eels less than 260 mm (Soloman and Beach 2004), but neither Enkamat® nor either type of pot deployed was successful catching eels in the 189 to 299 mm size range.

Elvers were observed during the 3 night surveys below crest gate #30 near the macadam plateau. The macadam and the water cascading over it is an attractant to elvers migrating upstream. Water trapped in the spillway sill after the cessation of full generating conditions, and water seeping from the crest gate provided this attraction flow. Without these two water sources, particularly the leakage from crest gate

#30, water would not flow over the macadam plateau and would likely not attract large numbers of elvers to this particular location.

5.0 2011 USFWS SAMPLING RESULTS

The 2011 USFWS report on elver sampling on the West bank of the Conowingo tailrace is contained in Appendix B. During the 2011 sampling season, USFWS reported that approximately 85,000 elvers were collected from their West side facility and some 62,000 elvers were transported to upstream tributaries of the Susquehanna River in Pennsylvania.

REFERENCES

Soloman, D.J. and M.H. Beach. 2004. Manual for provision of upstream migration facilities for eel and elver. Science Report SC020075/SR2. Environment Agency, Bristol, UK.

TABLE 3-1: DAILY COLLECTION OF YELLOW EELS AND ELVERS FROM EAST AND WEST SPILLWAY AREAS IN 2011.

Date	E. Ramp Enka Mat	E. Ramp Akwa Drain	E. Ramp Cloth Pot	E. Ramp Modified Pot	W. Ramp Enka Mat	W. Ramp Akwa Drain	W. Ramp Cloth Pot	W. Ramp Modified Pot	Lunar %	Rain
6/24	-	-	-	-	-	-	-	-	39	0
6/25	-	-	-	-	-	-	-	-	30	0
6/26	-	-	-	-	-	-	-	-	21	0
6/27	-	-	-	-	0	0	0	0	14	0.01
6/28	-	-	-	-	-	-	-	-	8	0
6/29	-	-	-	-	7	1	5	0	3	0
6/30	-	-	-	-	-	-	-	-	1	0
7/1	-	-	-	-	15	16	0	0	0	0
7/2	-	-	-	-	-	-	-	-	2	0
7/3	-	-	-	-	-	-	-	-	6	0.05
7/4	-	-	-	-	-	-	-	-	13	0
7/5	0	2	0	0	0	0	0	0	22	0
7/6	-	-	-	-	-	-	-	-	32	0
7/7	-	-	-	-	-	-	-	-	43	0
7/8	0	2	0	0	58	2	14	5	50	0.05
7/9	-	-	-	-	-	-	-	-	66	0.8
7/10	-	-	-	-	-	-	-	-	76	0
7/11	0	239	0	0	18	21	0	0	85	0
7/12	-	-	-	-	-	-	-	-	92	0.82
7/13	2	11	0	0	3	17	6	0	97	0
7/14	-	-	-	-	-	-	-	-	100	0
7/15	2	1	0	0	59	18	0	0	100	0
7/16	-	-	-	-	-	-	-	-	98	0
7/17	-	-	-	-	-	-	-	-	94	0
7/18	3	2	0	0	3	13	0	0	88	0
7/19	-	-	-	-	-	-	-	-	81	0
7/20	3	8	0	0	12	7	8	1	73	0.02
7/21	-	-	-	-	-	-	-	-	64	0
7/22	36	11	0	0	5	11	0	0	55	0
7/23	-	-	-	-	-	-	-	-	45	0
7/24	-	-	-	-	-	-	-	-	36	0.04
7/25	3	13	0	0	15	13	0	0	27	0
7/26	-	-	-	-	-	-	-	-	19	0.99
7/27	21	0	0	0	0	0	0	0	11	0
7/28	-	-	-	-	-	-	-	-	5	0
7/29	10	22	0	0	6	2	0	0	2	0.03
7/30	-	-	-	-	-	-	-	-	0	0.02
Totals	**80**	**311**	**0**	**0**	**201**	**121**	**33**	**6**	**1598**	**2.83**

TABLE 3-1: CONTINUED.

Date	E. Ramp Enka Mat	E. Ramp Akwa Drain	E. Ramp Cloth Pot	E. Ramp Modified Pot	W. Ramp Enka Mat	W. Ramp Akwa Drain	W. Ramp Cloth Pot	W. Ramp Modified Pot	Lunar %	Rain
7/31	-	-	-	-	-	-	-	-	1	0
8/1	2	0	0	0	6	0	0	0	5	0
8/2	-	-	-	-	-	-	-	-	11	0.04
8/3	0	5	0	0	6	3	2	0	20	0
8/4	-	-	-	-	-	-	-	-	30	0.12
8/5	1	0	0	0	9	3	0	0	41	0
8/6	-	-	-	-	-	-	-	-	50	0
8/7	-	-	-	-	-	-	-	-	63	0.37
8/8	2	3	0	0	0	0	0	0	74	1.8
8/9	-	-	-	-	-	-	-	-	83	0
8/10	0	0	0	0	5	0	5	5	90	0.33
8/11	-	-	-	-	-	-	-	-	95	0
8/12	4	0	0	0	3	6	0	0	99	0
8/13	-	-	-	-	-	-	-	-	100	0
8/14	-	-	-	-	-	-	-	-	99	1.05
8/15	5	4	0	0	3	3	0	0	96	1.83
8/16	-	-	-	-	-	-	-	-	92	0.07
8/17	3	0	0	0	28	7	5	1	86	0
8/18	-	-	-	-	-	-	-	-	79	0.13
8/19	10	18	0	0	5	1	0	0	71	0.32
8/20	-	-	-	-	-	-	-	-	62	0
8/21	-	-	-	-	-	-	-	-	50	0
8/22	3	7	0	0	47	7	0	0	43	0.22
8/23	-	-	-	-	-	-	-	-	33	0
8/24	2	4	0	0	12	2	2	0	24	0
8/25	-	-	-	-	-	-	-	-	15	0
8/26	9	6	0	0	28	0	0	0	8	0.47
8/27	-	-	-	-	-	-	-	-	3	0
8/28	-	-	-	-	-	-	-	-	0	4.8
8/29	5	36	0	0	13	2	0	0	1	0.014
8/30	-	-	-	-	-	-	-	-	4	0
8/31	5	3	0	0	5	1	0	0	9	0
9/1	-	-	-	-	-	-	-	-	18	0
9/2	2	4	0	0	31	0	0	0	27	0
9/3	-	-	-	-	-	-	-	-	38	0
9/4	-	-	-	-	-	-	-	-	50	0
9/5	0	4	0	0	3	0	0	0	60	0.7
Totals	**53**	**94**	**0**	**0**	**204**	**35**	**14**	**6**	**1730**	**12.26**

TABLE 3-2: NUMBER OF ELVERS PROVIDED TO USFWS FOR UPSTREAM TRANSPORTATION IN 2011.

Date	No. of Elvers
5-Jul-11	16
8-Jul-11	74
11-Jul-11	268
13-Jul-11	29
15-Jul-11	81
22-Jul-11	63
25-Jul-11	47
27-Jul-11	21
29-Jul-11	45
1-Aug-11	7
3-Aug-11	14
5-Aug-11	13
8-Aug-11	19
10-Aug-11	5
12-Aug-11	13
15-Aug-11	15
17-Aug-11	39
19-Aug-11	17
22-Aug-11	62
24-Aug-11	20
26-Aug-11	43
29-Aug-11	39
31-Aug-11	14
2-Sep-11	35
6-Sep-11	8
Total	**1007**

TABLE 3-3: MEAN DAILY WATER TEMPERATURES RECORDED AT THE SPILLWAY ELVER RAMPS, 2011.

Date	Water Temp.	Date	Water Temp.
24-Jun-11	80.5	31-Jul-11	88.2
25-Jun-11	81.1	1-Aug-11	88.6
26-Jun-11	80.8	2-Aug-11	88.1
27-Jun-11	80.6	3-Aug-11	86.5
28-Jun-11	80.5	4-Aug-11	85.2
29-Jun-11	81.2	5-Aug-11	85.9
30-Jun-11	81.2	6-Aug-11	85.4
1-Jul-11	80.9	7-Aug-11	85.6
2-Jul-11	81.3	8-Aug-11	86.1
3-Jul-11	81.3	9-Aug-11	86
4-Jul-11	82.1	10-Aug-11	85.5
5-Jul-11	83.1	11-Aug-11	84.8
6-Jul-11	83.2	12-Aug-11	84.1
7-Jul-11	83.6	13-Aug-11	83.2
8-Jul-11	83.7	14-Aug-11	82.2
9-Jul-11	83.8	15-Aug-11	82.4
10-Jul-11	84.2	16-Aug-11	81.8
11-Jul-11	84.5	17-Aug-11	82.2
12-Jul-11	85.5	18-Aug-11	81.9
13-Jul-11	85.7	19-Aug-11	82.1
14-Jul-11	84.4	20-Aug-11	82.2
15-Jul-11	84.3	21-Aug-11	81.9
16-Jul-11	84.2	22-Aug-11	81.7
17-Jul-11	84.4	23-Aug-11	80.8
18-Jul-11	84.9	24-Aug-11	81.2
19-Jul-11	86.1	25-Aug-11	80.9
20-Jul-11	87	26-Aug-11	81.2
21-Jul-11	87.9	27-Aug-11	81.1
22-Jul-11	89.1	28-Aug-11	79.5
23-Jul-11	89.8	29-Aug-11	78.3
24-Jul-11	90.8	30-Aug-11	76.6
25-Jul-11	89.7	31-Aug-11	75.3
26-Jul-11	88.8	1-Sep-11	74.6
27-Jul-11	88	2-Sep-11	73.9
28-Jul-11	87.1	3-Sep-11	73.7
29-Jul-11	87.9	4-Sep-11	74.2
30-Jul-11	88.6	5-Sep-11	74.8

TABLE 3-4: AGES OF 73 AMERICAN EELS COLLECTED IN THE CONOWINGO DAM SPILLWAY BY SIZE GROUP.

Elver Size Range (mm)										Elver Totals		
75-99		100-124		125-149		150-174		175-274				
Age	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	No.	Percent
I	9	I	2	–	–	–	–	–	–	I	11	25.0
II	1	II	7	II	3	–	–	–	–	II	11	25.0
–	–	–	–	III	5	III	2	–	–	III	7	15.9
–	–	–	–	IV	1	IV	7	IV	6	IV	14	31.8
–	–	–	–	–	–	V	1	–	–	V	1	0.2
											44	

Yellow Eel Size Range (mm)										Yellow Eel Totals		
275-349		350-449		450-549		550-649		650+				
Age	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	No.	Percent
IX	1	–	–	–	–	–	–	–	–	IX	1	3.4
X	1	X	3	–	–	–	–	–	–	X	4	13.7
–	–	XI	1	XI	1	–	–	–	–	XI	2	6.8
–	–	XII	1	XII	4	XII	1	–	–	XII	6	20.7
–	–	–	–	XIII	2	XIII	2	–	–	XIII	4	13.7
–	–	–	–	XIV	2	XIV	2	–	–	XIV	4	13.7
–	–	–	–	XV	1	XV	1	–	–	XV	2	6.8
–	–	–	–	–	–	XVI	2	XVI	1	XVI	3	10.3
–	–	–	–	–	–	XVII	1	XVII	1	XVII	2	6.8
–	–	–	–	–	–	–	–	XVIII	–	XVIII	–	0.0
–	–	–	–	–	–	–	–	XIX	1	XIX	1	3.4
											29	

FIGURE 2-1: LOCATION OF ELVER RAMPS, AND EELS POTS FISHED IN SPILLWAY REACH BELOW CONOWINGO DAM.

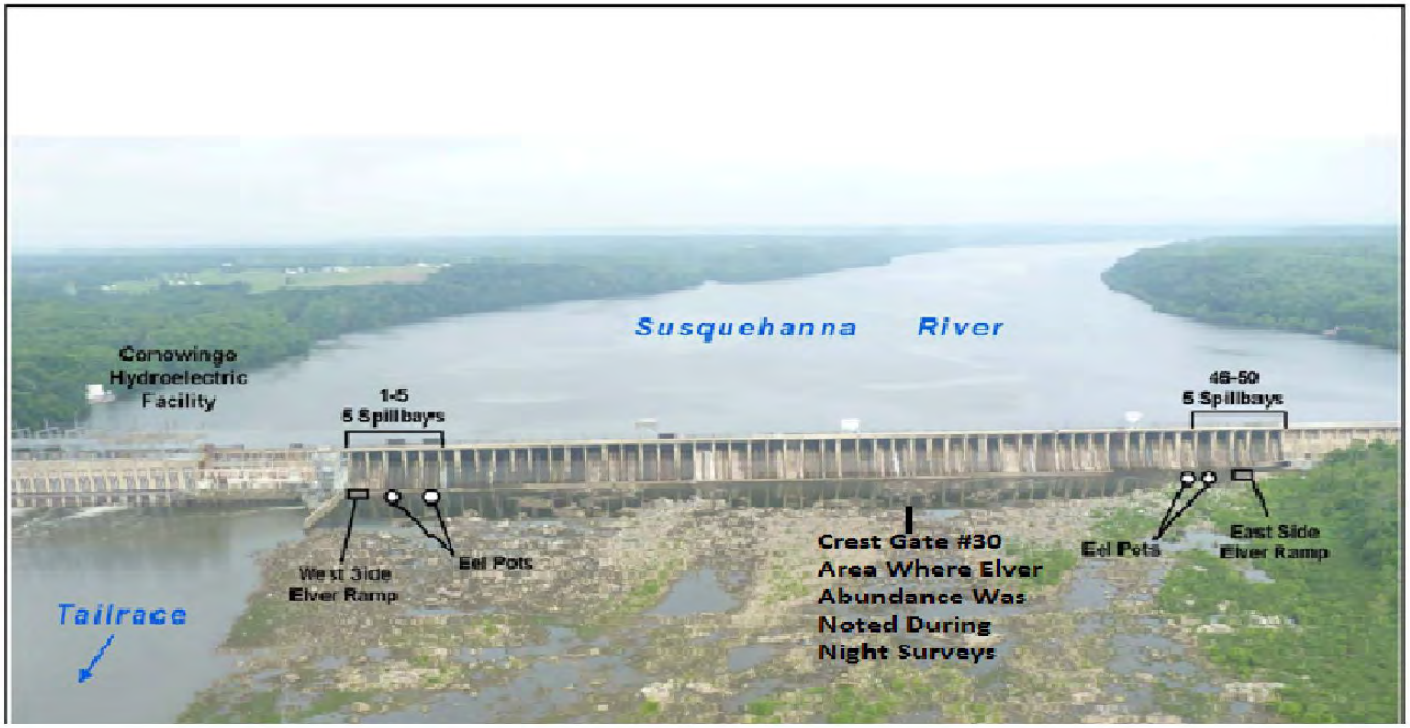

FIGURE 2-2: ENKAMAT® AND AKWADRAIN™ SUBSTRATE.

FIGURE 2-3: WEST SIDE ELVER RAMPS WITH ADDITIONAL ATTRACTION WATER.

FIGURE 2-4: COMPARISON AND SAMPLING LOCATIONS OF 2010 AND 2011 WEST SPILLWAY RAMP LOCATION.

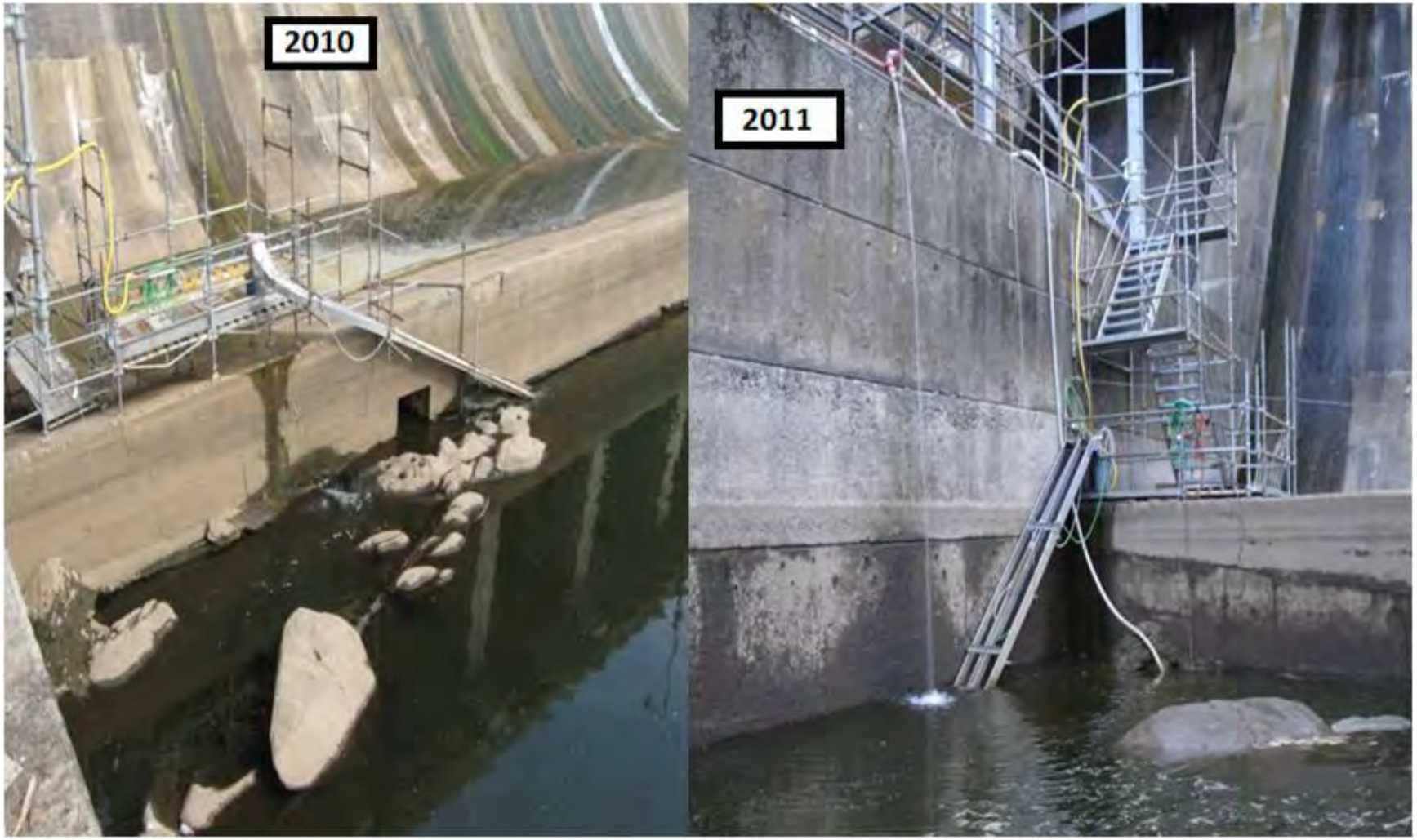

FIGURE 2-5: LOCATION AND CONFIGURATION OF EAST SIDE ELVER RAMPS IN 2010 AND 2011.

FIGURE 2-6: EAST RAMP WITH NATURAL ATTRACTION FLOW FROM INTERMITTENT STREAM.

FIGURE 2-7: CONSTRUCTION OF ELVER RAMPS USING TWO DIFFERENT SUBSTRATES.

FIGURE 2-8: WATER SUPPLY MANIFOLD, SPRAY BARS, AND HOLDING CONTAINERS.

FIGURE 2-9: PHOTO OF SPRAY BAR AND ADDITIONAL FLOW.

FIGURE 2-10: BAITING AND SETTING EEL POTS.

FIGURE 2-11: PROCESSING OF COLLECTED SPECIMENS.

FIGURE 2-12: COLLECTION OF YELLOW EELS AND PITT TAG SCANS.

FIGURE 2-13: WATER QUALITY MEASURING DEVICE, HOBO.

FIGURE 3-1: COMPARISON OF ELVER CATCH TO ENKAMAT® AND AKWADRAIN™ SUBSTRATES.

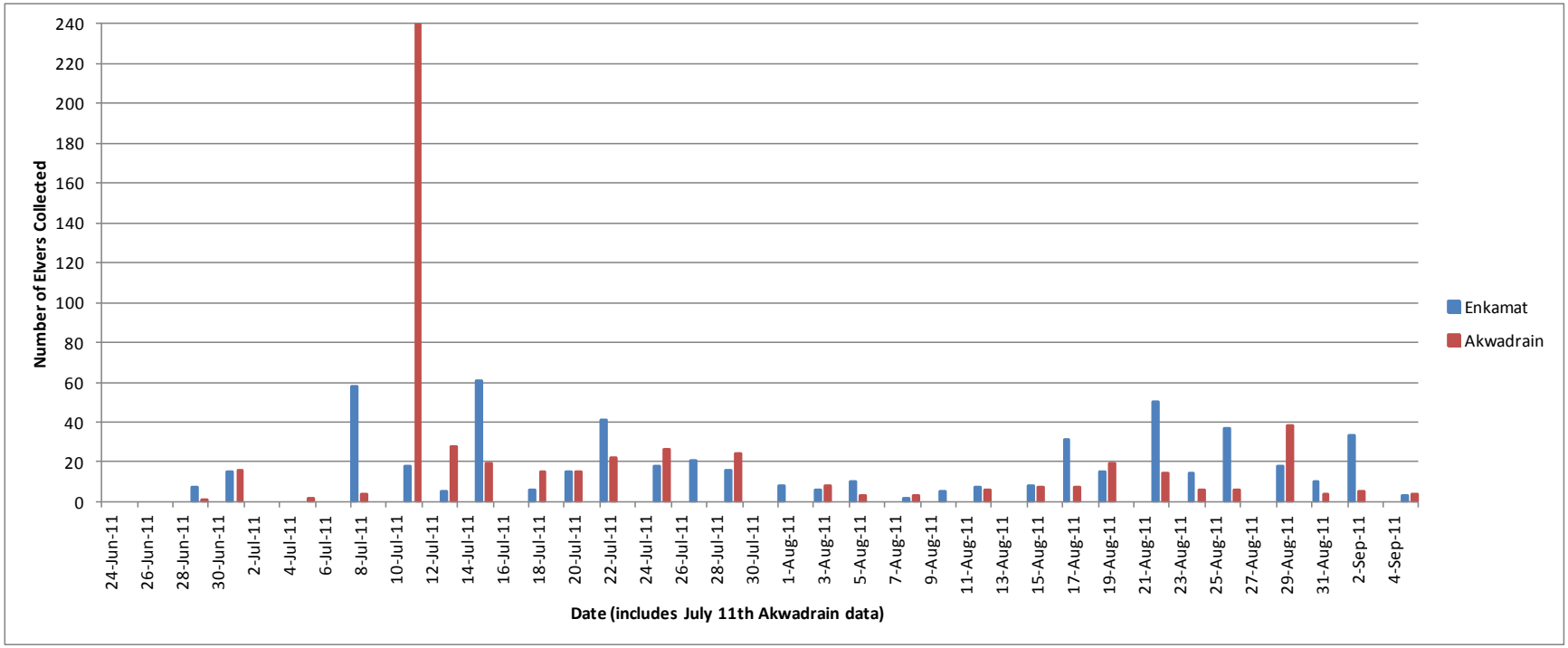

FIGURE 3-1: CONTINUED.

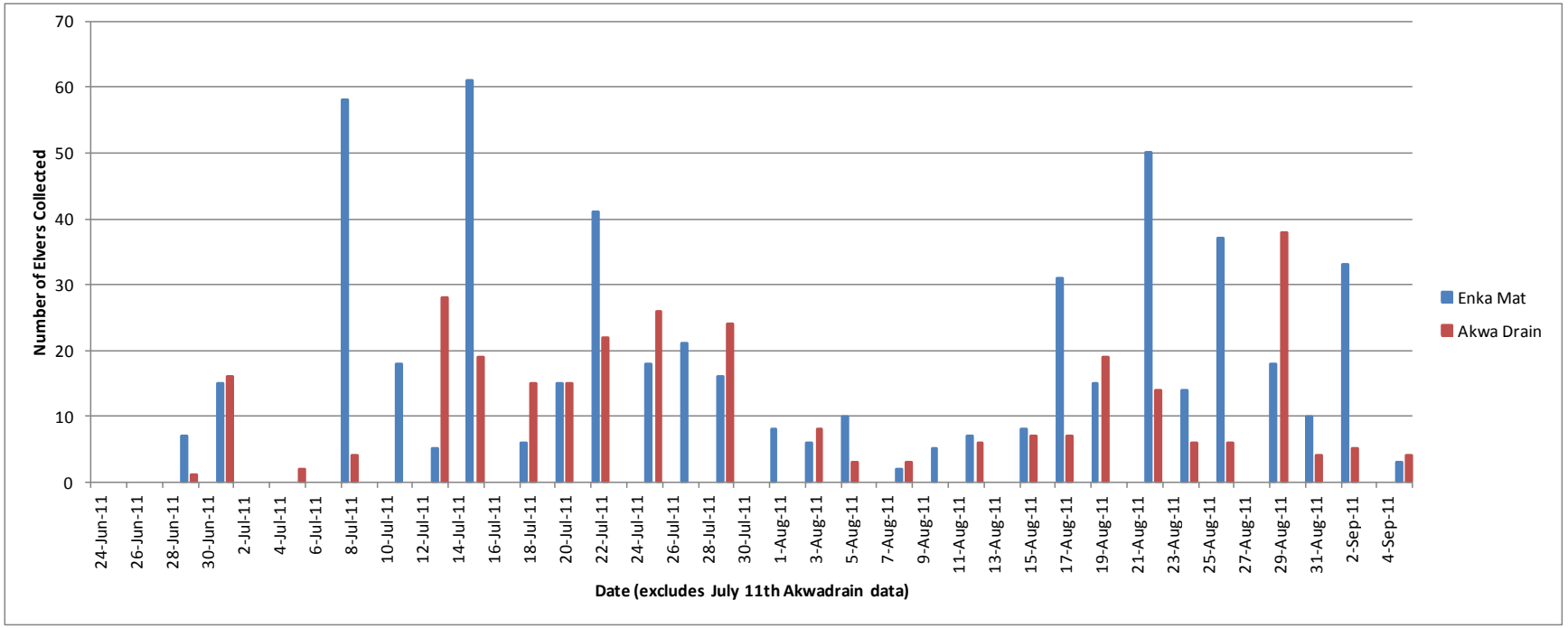

FIGURE 3-2: SIZE RANGE OF ELVERS CAUGHT IN SPILLWAY RAMPS.

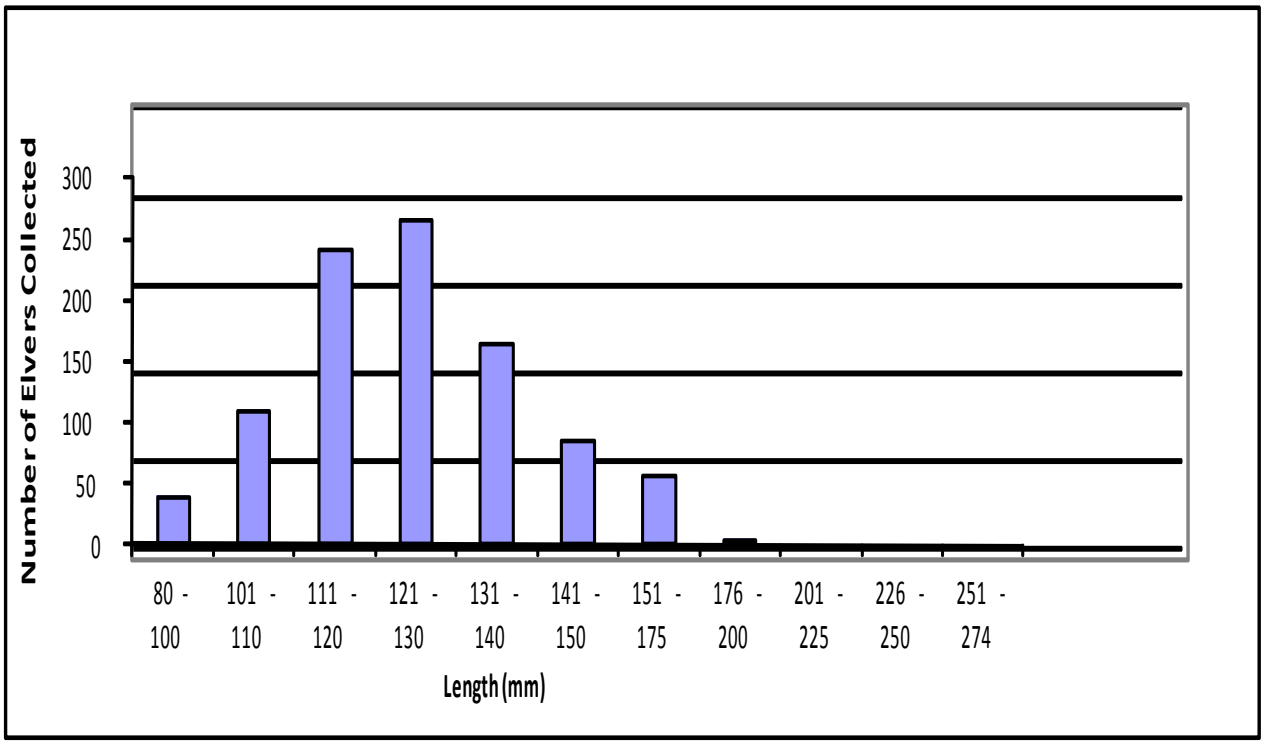

FIGURE 3-3: SIZE RANGE OF YELLOW EELS CAUGHT IN SPILLWAY POTS.

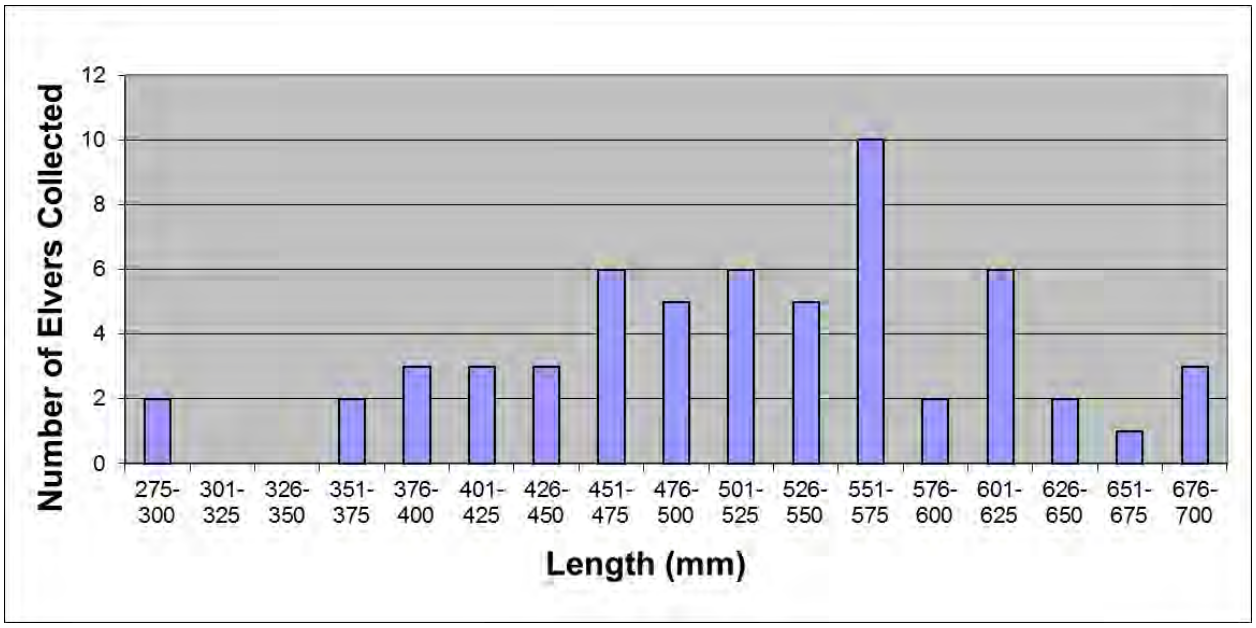

FIGURE 3-4: ELVERS COLLECTED IN RELATION TO WATER TEMPERATURE (°F) AND LUNAR CYLCE IN THE CONOWINGO SPILLWAY.

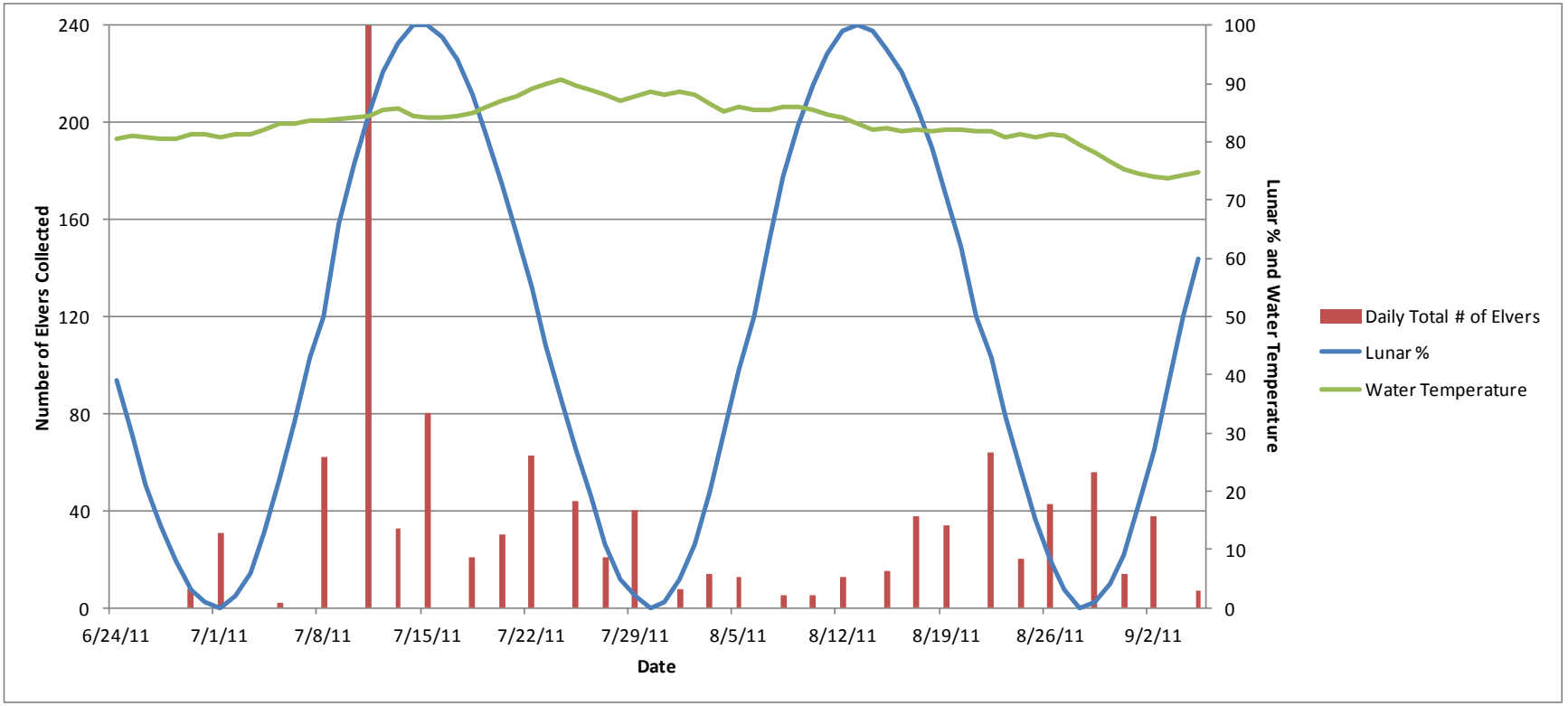

FIGURE 3-5: EVENING ASSESSMENT OF ELVER MOVEMENT.

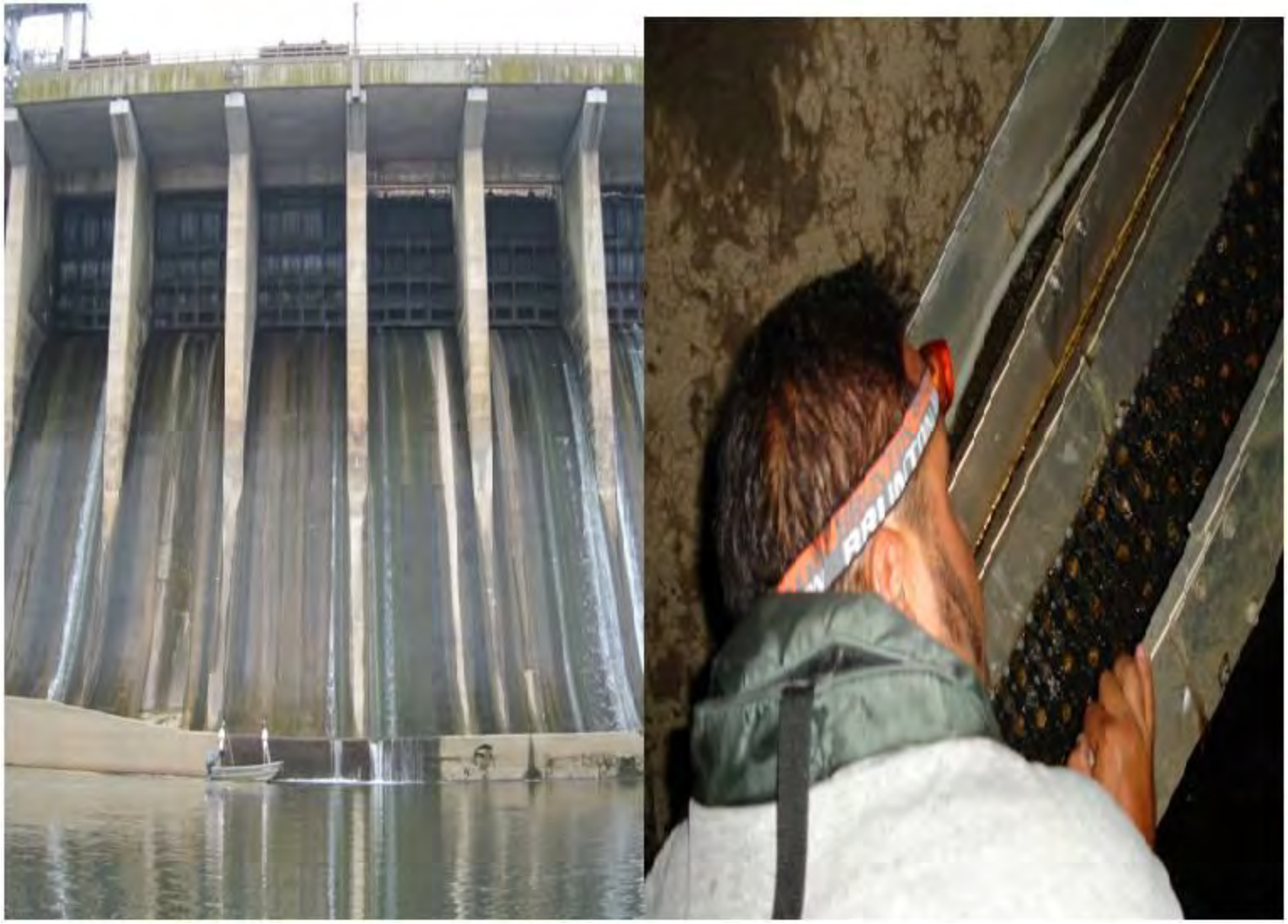

FIGURE 3-6: AREA IN FRONT OF SPILLBAY 30 WHERE ELVERS WERE OBSERVED.

FIGURE 3-7: NUMBER OF ELVERS COLLECTED IN SPILLWAY RAMPS IN RELATION TO RAINFALL (INCHES) AT CONOWINGO DAM. EXCLUDES DAYS OF NO RECORDED RAINFALL.

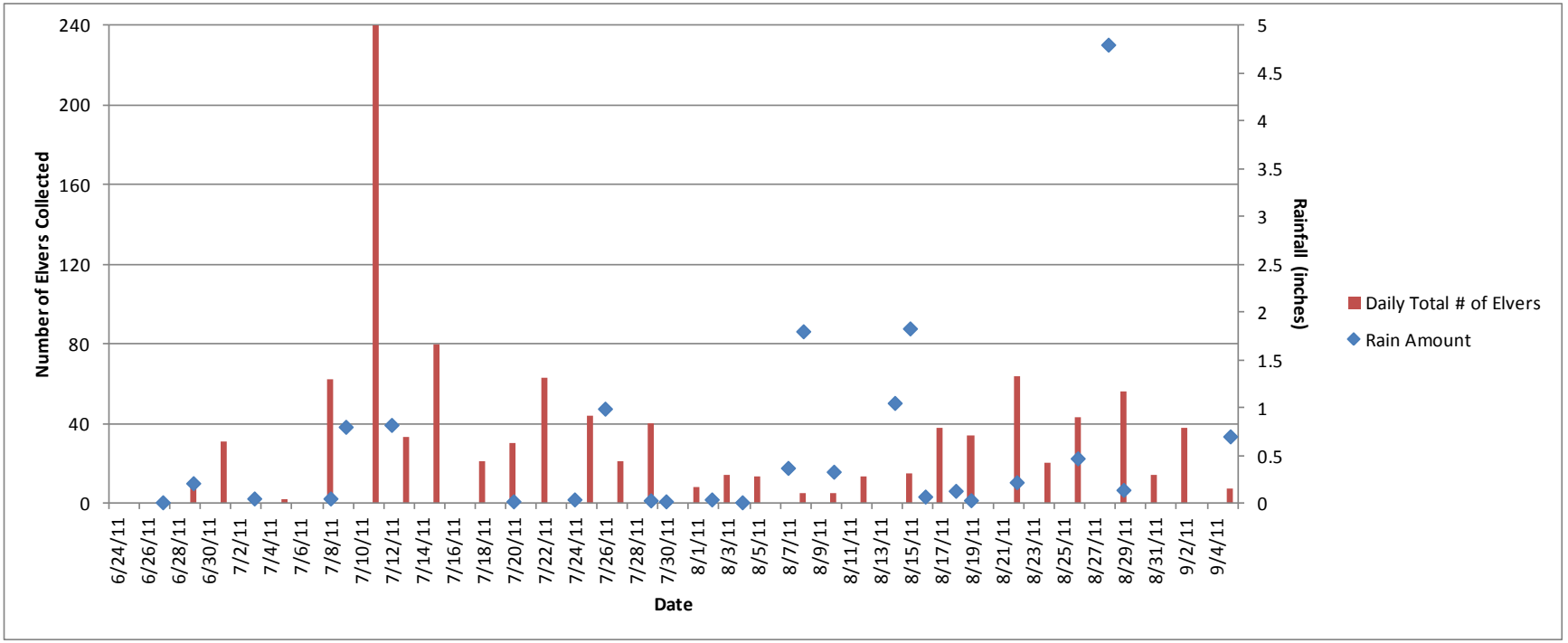

FIGURE 3-8: HURRICANE IRENE AND TROPICAL STORM LEE ENDED THE 2011 SEASON.

APPENDIX A -2011 STUDY PLAN

2011 STUDY WORK PLAN
CONOWINGO HYDROELECTRIC PROJECT

May 13, 2011

3.3 Biological and Engineering Studies of American Eel at the Conowingo Project

3.3.1 Study Request

The FERC, Lower Susquehanna Riverkeeper, MDNR, PaDEP, PFBC, SRBC, and USFWS have requested engineering and biological studies to assess the passage of American eel over the Conowingo Dam. The study requests generally recommend the following elements: (1) assessment of the optimal location for an upstream American eel passage facility; (2) an assessment of the rate of drop-back of migrating American eels; and (3) documentation of seasonal eel abundance and size/age distribution below the Conowingo Dam. Exelon does not plan to address Study Request Component 2 (drop-back study) during the field studies that gather siting and biological data, per the recommendation by MDNR to defer this aspect in their study request letter. Rather, this field study would be more appropriate pre-construction during evaluations of potential design and exit location for an upstream eel passage facility.

In section 5.0 of the Conowingo PAD, Exelon proposed to complete a literature based study on American eel to: (1) summarize available scientific and commercial information; (2) identify suspected factors affecting the American eel population; (3) examine the engineering feasibility of upstream and downstream passage options for American eel; and (4) examine the potential impact of upstream and downstream passage of American eels in the Susquehanna River on the American eel population.

3.3.2 Existing Information (18 CFR § 5.11(d)(3))

Results of 2010 elver and yellow eel biological studies performed in the tailrace (by USFWS) and spillway (by Exelon) below Conowingo Dam were submitted to FERC and participating agencies for review on February 22, 2011. Elvers and yellow eels were sampled between June 14 and September 30, 2010**.** A total of 258 eels were collected on the spillway side of Conowingo Dam. Of these, 166 were elvers collected from the elver ramps. The east elver ramp collected 158 elvers, while the west elver ramp collected eight. Elver lengths ranged from 92 to 154 mm TL. Baited eel pots yielded 91 yellow eels and one elver. The east-side eel pots collected one yellow eel, while the west-side pots collected 90 yellow eels. The length range of yellow eels collected in pots ranged from 301 to 640 mm TL. Seven yellow eels were fin-clipped recaptures from the location where tagged.

Otoliths from 65 eels were aged. Most elvers were age I or II, although 15% had spent four years in fresh water. Most yellow eels were aged VII, VIII, or IX. However, ages IV through VI were likely under sampled by the gears utilized since no eels were collected between 155-300 mm.

The findings in 2010 suggested that the comparatively low numbers of elvers collected in the spillway (relative to 24,000 elvers collected by USFWS in the tailrace) may have resulted from a delayed start, or possibly from additional factors including attraction flow volume, ramp substrate material, and/or ramp location. Consequently, Exelon plans to repeat the spillway study in 2011 to acquire additional information while adjusting for, to the extent feasible, any effects of those factors identified above. For example, different substrate material may allow collection of small yellow eels between 150-300 mm that eluded capture in 2010. Section 3.3.6 below presents plans to collect additional biological information in the spillway area in 2011.

3.3.2 Resource Management Goals (18 CFR § 5.11(d)(2))

The SRAFRC Alosid Management and Restoration Plan for the Susquehanna River Basin was completed November 15, 2010 and provides for restoration of American eels to their historical habitats above dams. ASMFC's eel management plan calls for provision of upstream eel passage facilities at dams throughout the Atlantic coast of the United States.

3.3.3 Purpose (18 CFR § 5.11(d)(1))

The purpose of the 2011 study is to: 1) describe the spatial distribution and size characteristics of American eels in the Conowingo tailrace; 2) identify potential locations for an upstream eel passage facility at Conowingo Dam. Thus, the goals are to refine and improve upon the information learned during the 2010 study.

3.3.4 Project Nexus (18 CFR § 5.11(d)(4))

Conowingo Dam is an impediment to upstream passage of American eel.

3.3.5 Investigation Area

The study area for the desktop portion of this study plan includes the lower Susquehanna River from Conowingo Dam upstream to above the York Haven Dam. The field biological studies will occur in the Conowingo tailrace and below the spillway.

3.3.6 Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Field Studies in 2011

Task 1A—Collect Eel Spatial distribution data in the tailrace and spillway pool

Spatial distribution and abundance data will be collected from the tailrace and from below the spillway. Recent USFWS methodology in the tailrace has utilized separate gear types to capture elver-stage eels and larger yellow eels. Exelon will utilize both elver ramps and baited eel pots to collect a broad range of eel sizes within the spillway pool.

Elvers in the tailrace will be collected using the USFWS ascent ramp(s) and collection facility on the west bank. The USFWS west bank facility is typically deployed in May and will be sampled regularly (2-3 times per week) through late summer. This is already a known location where elvers congregate in sizeable numbers. Seasonal abundance and biological data may be obtained from this location.

Historical observations of elver use of the spillway pool exist from the 1960s to the 1980s. Elvers in the spillway pool will be collected by a system of self-contained devices consisting of elver ascent ramps and collection buckets. One station will be located on the spillway lip, adjacent to the east fish lift, and a second station located on the spillway lip adjacent to the eastern river shore. Similar systems have been used below the Roanoke Rapids (NC) Project and others to collect eels in a spillway area. Exelon safety standards will be followed for these locations. The spillway pool collection ramps will be fished from late May through October 2011. This study period is contingent upon the termination of spill conditions at the Project. Upon start-up of ramp and attraction flows, elver ramps will fish continuously and be visited each Monday-Wednesday-Friday each sampling week. If elver numbers dictate, more frequent visits to tend collection tanks or larger collection tanks will be utilized as necessary. This component will determine seasonal use of the spillway pool by elvers as well as contrast spatial abundance with the tailrace.

In 2010, Enkamat substrate was used in the elver ramps, conforming by study design to techniques used over several years in the tailrace ramps utilized by the USFWS. In March 2011, Normandeau biologists attended an eel symposium in Gloucester, MA and intend to incorporate ideas gleaned from the meeting into the design of the elver ramps for the 2011study. Alternate substrate materials will be examined and one selected for use in combination with Enkamat. For example, an alternate substrate such as Akwadrain or equivalent will be fitted to an elver ramp used in tandem with a ramp with Enkamat to compare efficacy. Moreover, such a substrate ideally would pass elvers as well as yellow eels. For this study, attraction flow will be provided simultaneously to both ramps, if the water source is able to provide sufficient flow volume. Substrate coverage will be refined to better lead eels to the collection facilities, as will ramp flow through the substrate.

Among other potential modifications to increase the efficacy of the ramps, further research prior to 2011 start-up will examine appropriate ramp angles for the length of ramp used and the amount of attraction flow. Attraction flow is important and the volume achieved in 2010 may have been too little to attract elvers, given the volume and number of spillway lip overflows available. Attraction flow will be increased as feasible given the in-house supply capability. Periodic review of catch results and ramp performance may also lead to changes to ramp structure throughout the study period. Periodic nighttime observations of the study equipment and surrounding spillway area may be necessary to help ascertain best placement of the catch-gear in the spillway area. Such observations may lead to mid-season relocation of ramp entrances if feasible. Exelon will conduct up to four night surveys of the spillway lip/pool area, timed to match high/peak catch rates of elvers in the spillway and the USFWS WFL facility (June/July 2011). Exelon is currently establishing safety protocols for field crews when conducting these nighttime surveys.

Yellow eels in the tailrace and spillway pool will be collected with baited eel pots. Spillway pool eel pots will be fished at intervals along the spillway lip where lock-out and safety protocol permits. Typically, about 0.5 pound of bait is adequate for a 48-h set. Eel pots will be modified to catch a broader range of size classes. The eel pots will be fished bi-weekly from May through October or as tailrace and spillway pool conditions permit.

Task 1B—Collect Biological and Physical Data

Captured eels will be counted, measured, and scanned for PIT tags. Large counts of elvers may be estimated volumetrically. Yellow eels from both locations will be measured. The first ten specimens from six representative size ranges will be sacrificed for age analysis via otoliths. All remaining yellow eels will have pectoral fins clipped; right pectoral fin for eels captured in east spillway pots, left pectoral for west, then provided to the USFWS for insertion of PIT tags (personal communication with Steve Minkkinen (USFWS). Representative samples of tailrace and spillway pool elvers will be measured. A representative sample from a variety of predetermined size classes will be sacrificed for otolith analysis, including those in the 151 to 300 mm size range that have been uncommon in sampling to date. All other elvers will be placed into the USFWS west bank facility for transport if desired.

Daily and weekly catch data will describe temporal occurrence in relation to several physical variables. Physical data recorded for each sample will include: water temperature, rainfall during the sample period, and percent lunar fraction. Tailrace water temperatures will be obtained from the Exelon tailrace continuous monitor (Station 643). Spillway pool temperatures will be monitored with two ONSET temperature loggers, one at each end of the spillway pool. Percent lunar fraction for a nearby location will be obtained from the Naval Observatory website.

Size structure from each gear type will be determined, including how size structure changes during the sampling season. Size structure informs the choice of substrate material for any upstream passage device.

Task 2: Develop Study Report

Study results will be summarized in a report that will include the study methodology, results of the desktop and field studies, and conclusions. The report will be distributed to interested stakeholders and submitted to the FERC.

3.3.7 Level of Effort and Cost (18 CFR § 5.11(d)(6))

Exelon believes that the proposed level of effort is adequate to analyze this issue. The estimated total cost for the field study outlined in this plan is approximately $100,000.

3.3.8 Study Reporting and Schedule

In accordance with 18 CFR § 5.15(c)(1), a Study Report will be prepared and submitted to FERC and resource agencies by January 21, 2012.

APPENDIX B - USFWS 2011 EEL COLLECTION REPORT, CONOWINGO DAM TAILRACE

American Eel sampling at Conowingo Dam 2011

Steve Minkkinen, Ian Park, Maryland Fishery Resources Office, 1/25/2012

Background

Eels are a catadromous species that ascend freshwater environments as juveniles then reside in riverine habitats until reaching maturity at which time they migrate to the Sargasso Sea where they spawn once and die. Larval eels are transported by ocean currents to rivers along the eastern seaboard of the continent. Unlike anadromous shad and herring, they have no particular homing instinct. Historically, American eels were abundant in East Coast streams, comprising more than 25 percent of the total fish biomass in many locations. However, Atlantic coast commercial landings have been declining sine the 1970's.

The Atlantic States Marine Fishery Commission Fishery Management Plan for American Eel lists access to freshwater habitat as a priority for protecting the population. Although the Chesapeake Bay and tributaries support a large portion of the coastal eel population, eels have been essentially extirpated from the largest Chesapeake tributary, the Susquehanna River. The Susquehanna River basin comprises 43% of the Chesapeake Bay watershed. Construction of Conowingo Dam in 1928 effectively closed the river to upstream migration of elvers at river mile ten (Figure 1).

Mainstem Susquehanna fish passage facilities (lifts and ladder) were designed and sized to pass adult shad and herring and are not effective (due to attraction flow velocities and operating schedules) in passing juvenile eels (elvers) upriver. Specialized passages designed to accommodate elvers are needed to allow them access to the watershed above dams.

Survey methods and Equipment Placement

To determine the best method to reintroduce eels into the Susquehanna River above Conowingo Dam, we have collected baseline information on eel abundance, migration timing, catch efficiency, and attraction parameters at the base of the Conowingo Dam since the spring of 2005. Information from the study will assist in determining the potential for reintroducing eels into the Susquehanna watershed above Conowingo Dam.

The 2011 American eel sampling below Conowingo took place on the west side of the dam adjacent to the West Fish Lift. This sampling served as an attempt to further survey the population of juvenile eels (elvers) at the base of Conowingo Dam. In 2007, elvers were observed climbing up the rip rap where water was spilling over from pumps operated to supply water for the West fish lift operations. From 2008 through 2011 we used this excess water as attraction flow for our elver trap, constructed from industrial cable tray with landscape fabric attached to the bottom (Figure 2). Elvers that found this attraction flow would crawl up the rip rap to the trap and then climb into the trap. The top of the cable tray emptied into a fine mesh collection bag placed in collection tanks (Figure 3). Aerated water was supplied to the collection and holding tanks using a 1/8 HP Sweetwater™ Blower. In 2009 and 2010 we made an attempt

to attract elvers directly from the Susquehanna River at the base of the riprap as well. In 2011 we discontinued the experimental trap going down to the river's edge. Elvers were sedated with, Finquel Tricane Methanesulfonate (MS-222), measured for total length (TL), and individually counted. Large numbers of eels were counted volumetrically. The collection of substantial numbers of eels allowed for the experimental stocking of elvers into Buffalo Creek, Pine Creek and Conowingo Creek. Stocking in Buffalo Creek and Pine Creek is part of a compensatory mitigation for the Sunbury Riverfront Stabilization Project for the City of Sunbury (DA Permit Application Number: NAB 2005-02860-PO5) (attachment 1).

All of the elvers stocked were marked with a 6 hour immersion in buffered oxytetracycline (OTC) at a concentration of 550 ppm prior to release. A subsample of elvers captured was also sent to the Lamar Fish Health Center (Lamar, PA) for disease testing before any stocking occurred.

In previous years, eel pots with a 6 mm square mesh were set around the base of the West Fish Lift to catch larger eels. In 2011, we changed our collection device from a cylindrical eel pot to a double throated rectangular trap with a 25 mm by 13 mm mesh that is more consistent with local commercial gear. Yellow eels captured in eel pots were sedated with a concentrated solution of MS-222 (450g/L), measured, fin clipped, and had a Passive Integrated Transponder (PIT) tag inserted in the dorsal musculature and released.

In 2011, young-of-year (glass eels) were collected by Maryland Department of Natural Resources (Maryland DNR) in Turville Creek, MD. These eels were then transported to the United State Geological Survey lab in Wellsboro, Pennsylvania. The glass eels were held in the lab until June, and then released in Buffalo and Pine Creek (Table 1).

Results

Eels were sampled between 23 May and 8 September 2011 and elvers were collected throughout the sampling timeframe (Table 2). A total of 85,000 elvers were collected during 2011 with the majority collected in two pulses. The first wave occurred in the month of July and the second wave occurred at the end of August through the beginning of September during high flows associated with hurricane Irene and tropical storm Lee. Sampling ended abruptly due to flooding subsequently caused by tropical storm Lee. The seasonal pattern of migration in 2011 was similar to that observed in 2008 when a majority of the eel collection occurred in the end of June through the end of July. During 2009 the migration was later and more protracted with the majority of elvers being collected in the end of July through August. In 2008, 2010 and 2011 we saw multiple waves of elvers throughout our sampling efforts; where as in 2009 there did not appear to be spikes in collections, but more of a steady level of migration through the sampling period (Figure 4).

Juvenile eel lengths ranged from 84 to 225 mm TL (Figure 5), slightly larger than previous years sampling. In 2011, 75%of elvers measured were between 110 and 149 mm, and from 2005-2009 56% of elvers measured were between 110 and 149 mm.

Yellow and silver eel collections in eel pots have taken place from 2007 - 2011. In 2011, we caught 224 yellow and silver eels that ranged from 333 to 659 mm TL. Of the 224 captures, 127 eels had new PIT tags inserted, 55 were recaptures from tagging done in 2011 or in previous year, and the rest were released without being tagged. This year we caught significantly more yellow and silver eels than in previous years. The largest number of yellow and silver eels previously caught was in 2009, when we had 68 new captures (Table 3). The addition of the 127 new captures brings the total number of PIT-tagged yellow eels in the study to 289. We are tracking annual growth rates of the 31 PIT tagged eels that have been recaptured after at least one year after tagging (Table 4).

A total of ten stockings from elvers captured at Conowingo Dam were conducted, with an estimated total of 62,000 elvers being stocked in Buffalo, Pine and Conowingo Creek (Table 1).

To evaluate stocking success at Buffalo and Pine Creek, we conducted electrofishing surveys using 3 backpack shockers and a barge shocker in August 2011. We duplicated methods used by the Maryland Biological Stream Survey (2007) to quantify the catch per unit effort (CPUE) and the biomass of eels. Two sites, bracketing the eel release sites, in each creek were surveyed (Table 1). At each site, 75 meters of stream were blocked off using ¼" mesh block net. In order to quantify the fauna in the stream, two passes with the electrofishing units were conducted and all species of fish collected were enumerated. Captured eels were measured to assess growth and a subsample of the eels collected was brought back to confirm previous marking of otoliths by OTC. In August of 2011, 441 elvers were recaptured in Buffalo Creek. All but 9 of these were recaptured at the Strawbridge Rd site. An attempt was made to sample at the foot bridge on Rte. 1003 but high flows prevented a depletion study from being conducted. The average TL of stocked elvers from Conowingo was 127 mm, and the average TL of glass eels stocked was 80mm, while the average TL of recaptured eels in Buffalo Creek was 137 mm (Figure 6). Sampling Pine Creek in 2011 provided 20 recaptured elvers, 12 of which were recaptured at the Darling Run site, and the rest were caught at the Ansonia Bridge site. The average TL of recaptured eels in Pine Creek was 143 mm. In addition to eels, 4,854 individuals of 30 fish species were collected in Buffalo Creek and 3,663 individuals of 23 fish species were collected in Pine Creek during electrofishing surveys. (Minkkinen et al. 2011)

Maryland DNR conducts an American eel young of year (glass eel) survey to characterize trends in American eel recruitment over time (ASMFC 2000). Sampling takes place at Turville Creek, MD using a modified Irish elver ramp. We compared estimated recruitment of glass eels from Turville Creek to captures of elvers below Conowingo dam one year later. Based on four years of data it appears that the glass eel recruitment index at Turville Creek does predict elver abundance the following year at Conowingo Dam (Figure 7).

A subsample of elvers was sacrificed to evaluate the presence of the parasite *Anguillicola crassus*. A total of 46 eels were euthanized using MS-222, then examined for the presence of *Anguillicola crassus* in the swim bladder. The samples were collected in 2010 and 2011, with 19 samples from 2010 and 27 samples from 2011. *Anguillicola crassus* was found in 22 of the samples, with the highest infection rate of 6 being found in one eel. There does not appear to be any relation between the length of an eel and the infection rate (Figure 8) or an increase in infection rate from one year to the next.

Discussion

Throughout the project we have compared elver captures to several environmental factors. This year we increased the environmental factors analyzed. The factors we looked at were lunar fraction, river flow in Havre De Grace MD, barometric pressure, air temperature, daily precipitation levels, and the average daily values of dissolved oxygen, salinity, water temperature, pH, turbidity, and chlorophyll. In years past we have not been able to determine what environmental factors control the timing of the elver migration below Conowingo Dam. Typically elvers reach the dam between the first week of May through the end of June and peak captures usually occur in June and July. Using Pearson correlation it appears that turbidity, river flow and precipitation have the largest correlation value and these three values are directly related to one another (Table 5). With an increase of rain, for example the tropical storm that was observed this year, there was an increase in elver collection.

Interruptions in power supply to our pumps have impacted elver catch on several occasions. We have implemented several sampling design changes in an attempt to ensure that we would have an uninterrupted supply of water throughout the sample period. We have also increased the size of our collection and holding tanks in an effort to increase survival and decrease stress while holding the elvers for stocking. These measures have improved our ability to capture and hold larger numbers of elvers for stocking above the dam.

In 2012 we will attempt to release an additional 36,000 elvers in Pine Creek. We also will attempt to release elvers into Conowingo Creek in Maryland and Buffalo Creek in Pennsylvania. Elvers will be marked with OTC before being released. The Maryland Biological Stream Survey plans on conducting surveys in Conowingo Creek to evaluate the stocking effort. The Maryland Fishery Resources Office will survey elvers released in Buffalo Creek and Pine Creek using methods identical to those used in 2010 and 2011.

Figure 1. Map of the Maryland Biological Stream Survey (MBSS) sampling sites of tributaries to the Susquehanna River in Maryland. The numbers in boxes indicates eel counts at each sampling site. Note the difference in densities of eels in tributaries below Conowingo Dam compared to above the Dam.

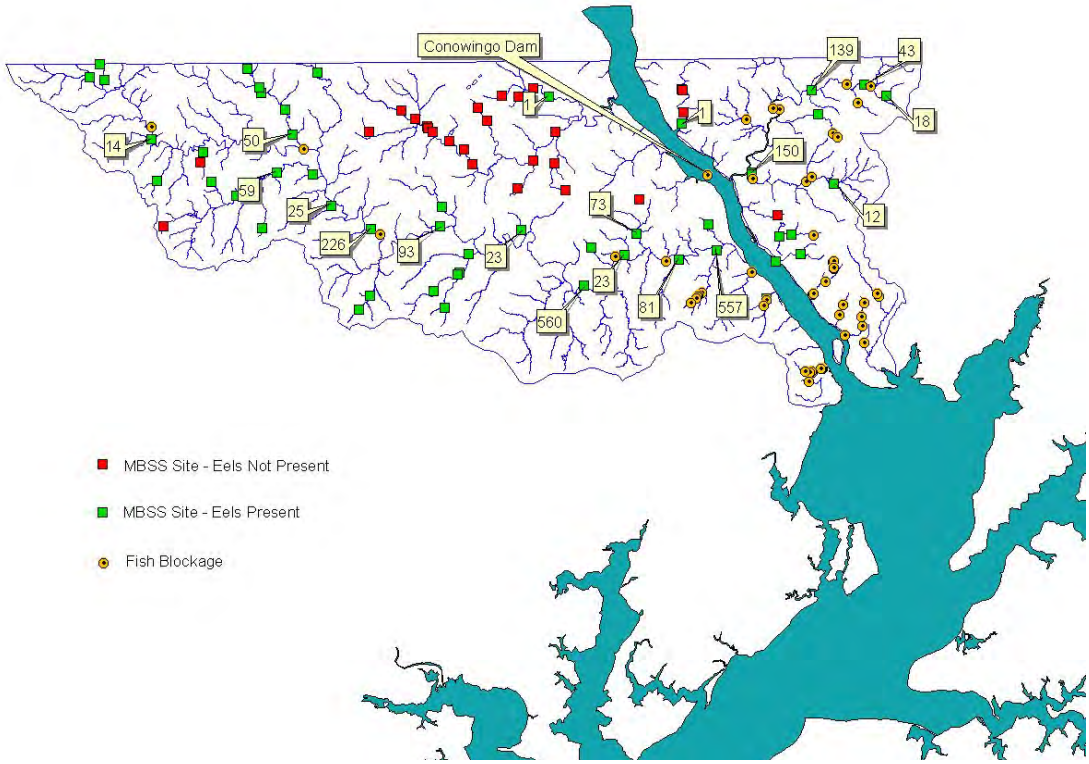

Figure 2. Eel trap constructed of industrial cable tray and landscape fabric.

Figure 3. The cable tray emptying into a collection bag in a holding tank.

Figure 4 Elver capture in relation to date for 2008 – 2011.

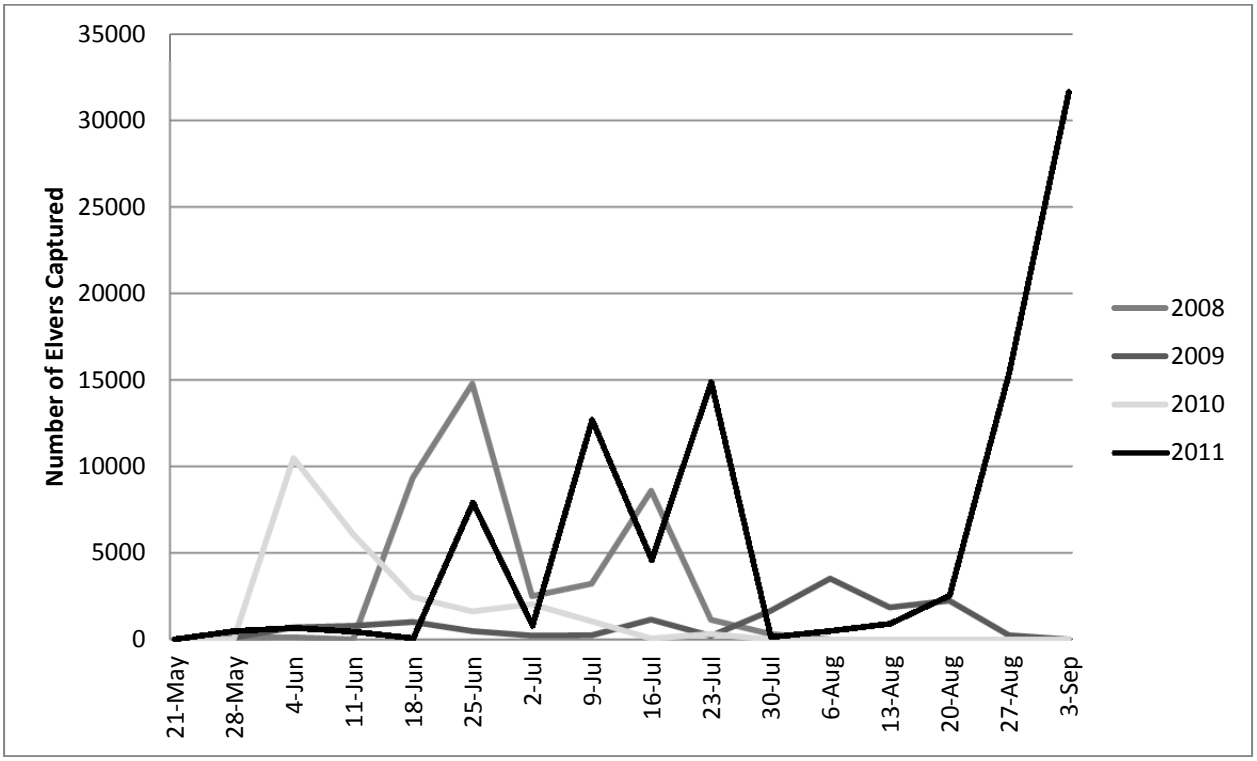

Figure 5 Length frequency of elvers captured below Conowingo Dam 2005-2011.

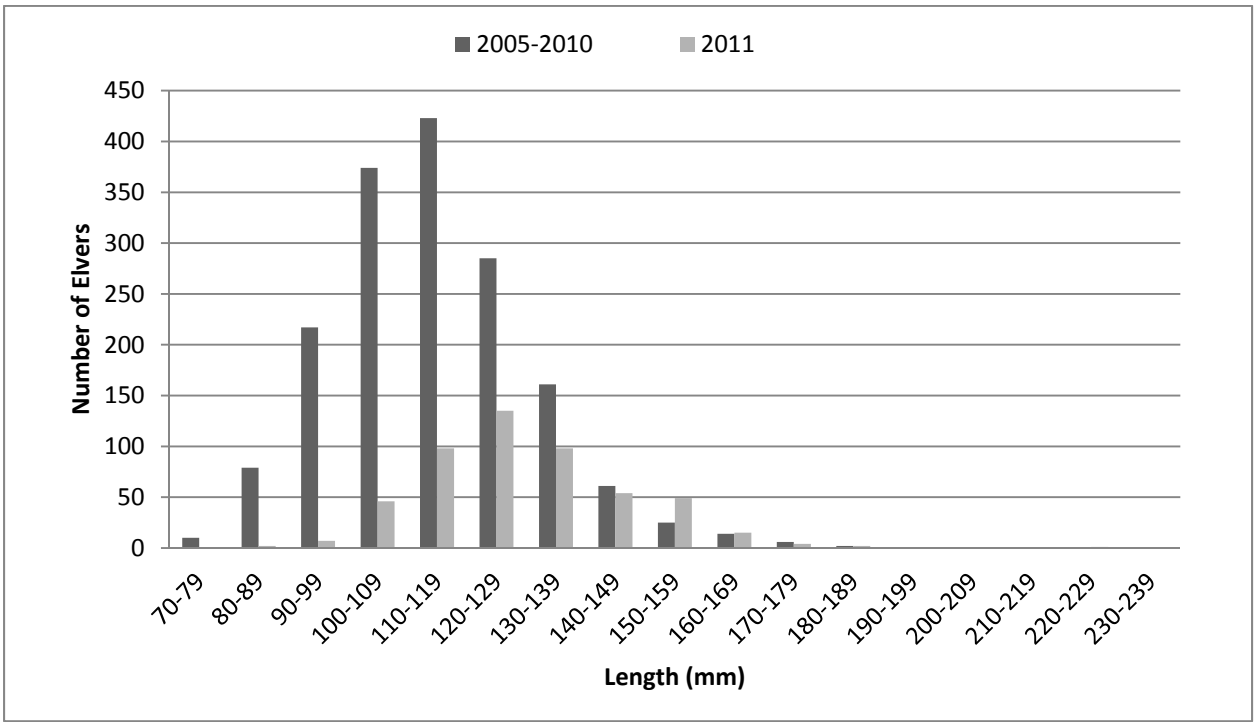

Figure 6 Length frequency of elvers recaptured in Buffalo Creek 2011

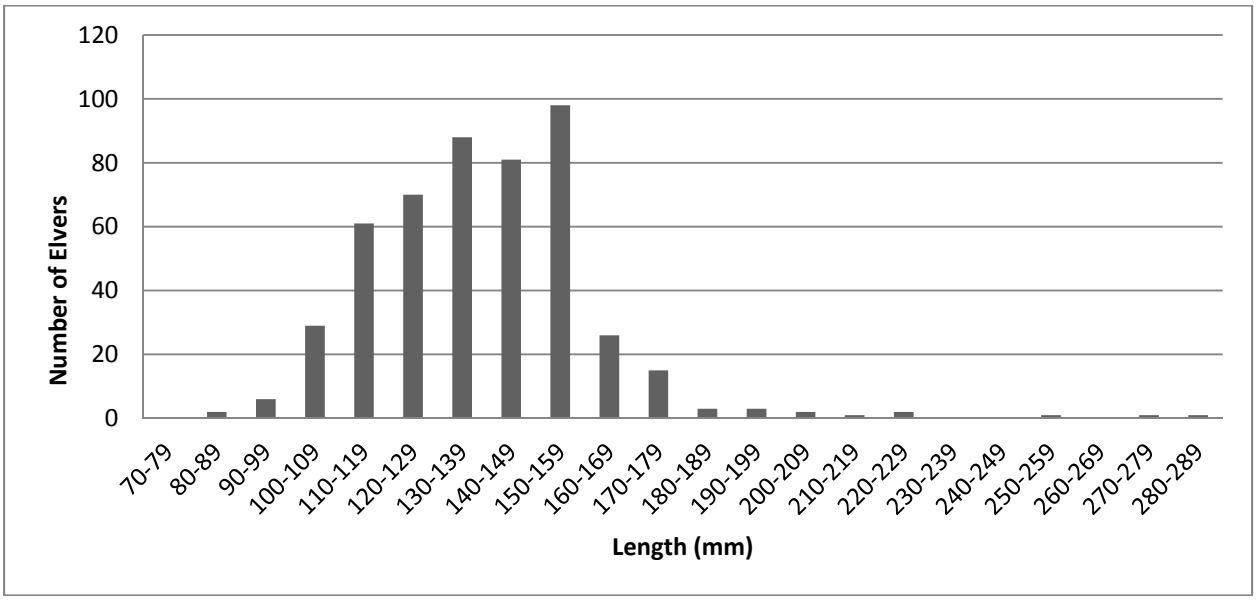

Figure 7 Yearly catch rates of glass eels from Turville Creek and elvers from Conowingo Dam

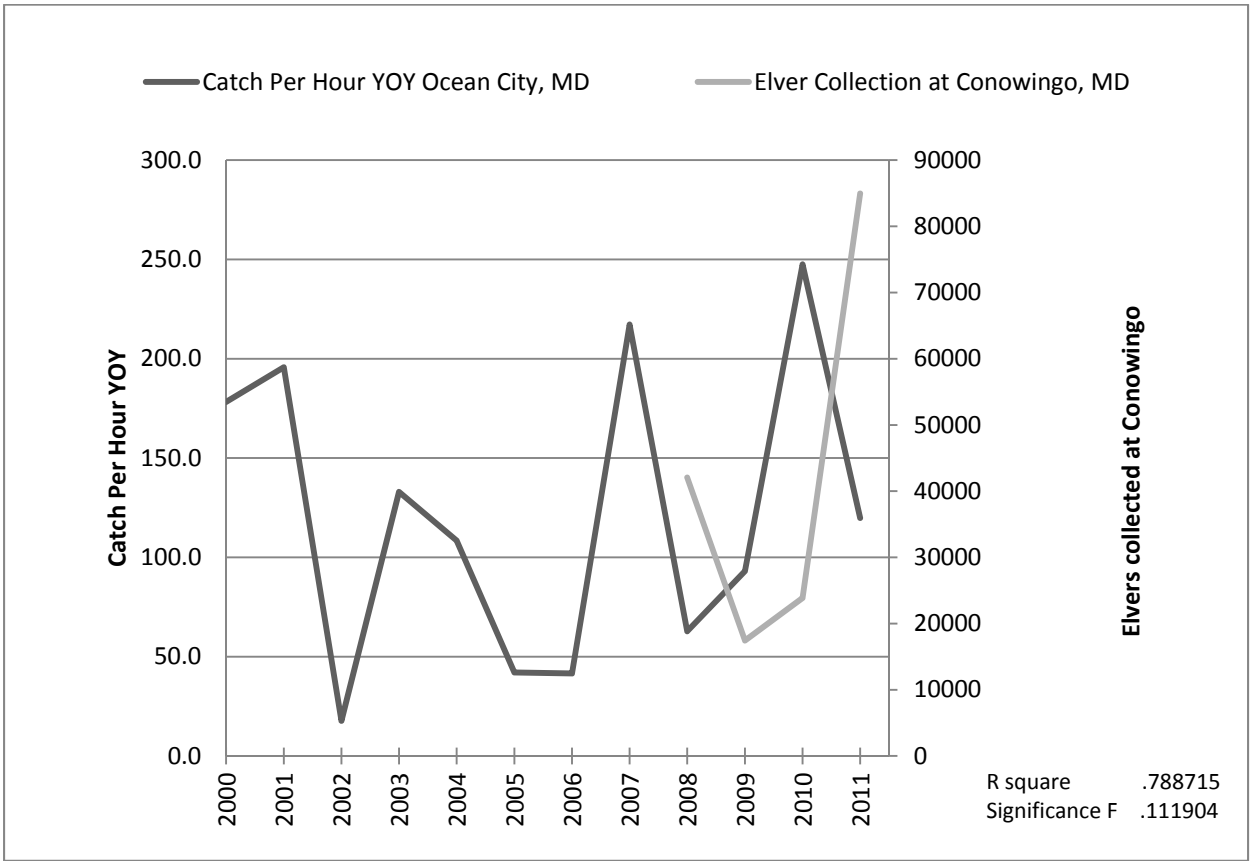

Figure 8 The number of *Anguillicola crassus* present in different lengths of elvers.

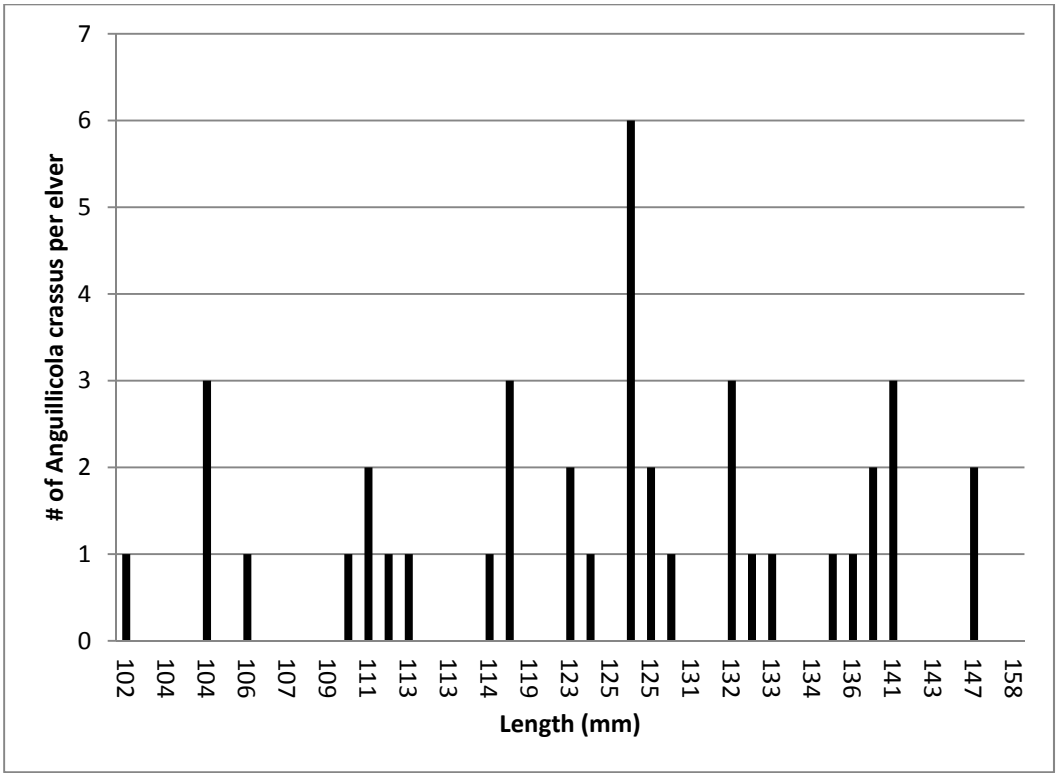

Table 1. Date, location, and number of elvers collected and stocked in 2011

STOCKING DATE	TOTAL ELVERS	STOCKING SITE	Latitude	Longitude	Origin
6/21/2011	16110	Buffalo Creek	40 58.864' N	76.57.081' W	Turville Creek
6/21/2011	16109	Buffalo Creek	40 59.139' N	76 55.930' W	Turville Creek
6/22/2011	10666	Pine Creek	41 44.633' N	77 26.031' W	Turville Creek
6/22/2011	10666	Pine Creek	41 16.285' N	77 19.894' W	Turville Creek
6/22/2011	10666	Pine Creek	41 44.203' N	77 25.822' W	Turville Creek
6/22/2011	1797	Conowingo Creek	39 43.852' N	76 10.701' W	Conowingo Dam
6/30/2011	7222	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
7/14/2011	6326	Buffalo Creek	40 59.139' N	76 55.930' W	Conowingo Dam
7/18/2011	4390	Buffalo Creek	40 59.139' N	76 55.930' W	Conowingo Dam
7/28/2011	3603	Buffalo Creek	40 59.139' N	76 55.930' W	Conowingo Dam
8/22/2011	1528	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
8/31/2011	8940	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
9/2/2011	8084	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
9/7/2011	12205	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
9/8/2011	7844	Conowingo Creek	39 43.852' N	76 10.701' W	Conowingo Dam

Table 2. Number of eels caught at the base of Conowingo Dam on the West side of the dam during 2011.

Date	# of Elvers		Date	# of Elvers
5/23/2011	34		7/20/2011	282
5/25/2011	8		7/22/2011	1380
5/27/2011	1		7/25/2011	2013
5/31/2011	41		7/27/2011	3603
6/3/2011	476		7/29/2011	34
6/6/2011	511		8/1/2011	87
6/8/2011	70		8/2/2011	16
6/10/2011	121		8/5/2011	58
6/13/2011	382		8/8/2011	250
6/15/2011	79		8/10/2011	126
6/17/2011	21		8/12/2011	149
6/20/2011	71		8/15/2011	257
6/22/2011	6		8/17/2011	184
6/24/2011	21		8/19/2011	506
6/27/2011	1217		8/22/2011	928
6/29/2011	4467		8/24/2011	850
6/30/2011	1817		8/26/2011	797
7/1/2011	439		8/29/2011	1344
7/3/2011	378		8/30/2011	2648
7/5/2011	162		8/31/2011	3358
7/7/2011	288		9/1/2011	3548
7/11/2011	1132		9/2/2011	4573
7/12/2011	5514		9/3/2011	3880
7/13/2011	1660		9/4/2011	7250
7/14/2011	2074		9/6/2011	6275
7/15/2011	2340		9/7/2011	6424
7/16/2011	2187		9/8/2011	7844
7/18/2011	780			

Table 3. Number of Passive Integrated Transponder Tags (PIT) applied to yellow eels by year.

Year	# of Tags Applied
2007	51
2008	32
2009	68
2010	11
2011	127

Table 4. Growth of yellow eels caught and recaptured in pots at the base of Conowingo dam by year.

	Average Length (mm)					*Average Annual Growth Increase (mm)*
ID	**2007**	**2008**	**2009**	**2010**	**2011**	
257C63E092	594	617	*	*	*	23
257C6534CA	733	770	*	*	*	37
257C6526C0	463	474	*	*	*	11
257C65EB48	404	510	521	*	*	58.5
257C655F24	426	445	*	*	*	19
257C65F2F2	338	390	505	*	*	83.5
257C63E581	551	589	*	*	*	38
257C65F8B0	475	511	*	*	*	36
257C65E87B	405	471	510	*	*	55
257C65FBAB	377	405	440	*	*	31.5
257C652B3A	466	490	*	*	*	24
257C63C580	391	520	*	557	*	55.3
257C660193	386	428	*	*	*	21
257C63CE9A	458	*	565	*	*	53.5
257C63CF54	484	*	624	*	*	70
257C652735	457	*	590	*	*	66.5
257C6534A4	386	*	478	*	*	46
257C66192F	447	*	580	*	*	66.5
257C63D36E	*	419	433	*	*	14
257C652BF4	*	364	383	395	449	28.3
257C65342C	*	393	516	*	*	123
257C65B1E0	*	479	543	*	*	64
257C660279	*	497	575	*	*	78
257C65E54F	*	454	*	550	*	48
1C2D05239A	*	*	612	626	*	14
1C2D0529B9	*	*	495	578	*	83
257C63D39B	*	*	432	462	470	19
257C6553FB	*	335	*	*	446	37
257C655957	*	321	*	*	377	18.6
1C2D05286B	*	*	476	*	508	16
1C2D052453	*	*	368	*	465	48.5

Table 5 Pearson Correlation performed on number of elvers captured and environmental variables

	# eels	*Lunar Fraction*	*Avg. Att Flow*	*Barrometric Pressure*	*Air Temp*	*Precipitation Sum*	*AVG of DO (conc.)*	*AVG of Salinity (ppt)*	*AVG of Temp (°C)*	*AVG of pH*	*AVG of Turbidity (NTU)*	*AVG of Chlorophyll a (µg/l)*
# eels	1											
Lunar Fraction	0.0260	1										
AVG Flow	0.4241	0.0330	1									
Barrometric Pressure	0.1454	-0.2805	0.1595	1								
Air Temp	-0.2163	0.0302	-0.2621	-0.4116	1							
Precipitation	0.3088	0.0424	0.2415	0.0207	-0.3217	1						
AVG of DO	-0.0735	-0.1243	0.2647	0.2474	0.0248	-0.1219	1					
AVG of Salinity	-0.2894	-0.0734	-0.5819	-0.1535	0.1199	-0.1368	-0.5397	1				
AVG of Temp	-0.2502	0.0874	-0.6924	-0.2893	0.5639	-0.1738	-0.3882	0.6475	1			
AVG of pH	-0.5675	-0.1282	-0.3780	-0.0321	0.2888	-0.2476	0.6206	-0.0170	0.3254	1		
AVG of Turbidity	0.6111	0.1400	0.8525	0.0083	-0.1800	0.2524	0.0581	-0.4502	-0.4174	-0.4150	1	
AVG of Chlorophyll a	-0.1177	-0.4422	0.2031	0.1431	-0.0758	-0.0637	0.6783	-0.3313	-0.2645	0.6269	0.1055	1

REFERENCES

ASMFC (Atlantic States Marine Fisheries Commission). 2000. Standard procedures for American eel young of the year survey.

Maryland DNR. 2007. Maryland Biological Stream Survey: Sampling Manual Field Protocols. 65 pp.

Minkkinen S.P., Devers J.L. & W.A. Lellis. 2011. Experimental Stocking of American Eels in the Susquehanna River Watershed. Report of U.S. Fish and Wildlife Service to City of Sunbury, Pennsylvania.

APPENDIX I. AGENCY CONSULTATION RECORDS

From: Danucalov, Andrea H:(Exelon Power) <Andrea.Danucalov@exeloncorp.com>
Sent: Friday, April 16, 2021 4:52 PM
To: denise.keehner@maryland.gov; Heather Nelson -MDE-; David Seaborn -MDE-; 'Eyler, Sheila'; 'McCorkle, Richard'; jesus_morales@fws.gov; 'Minkkinen, Steve'; 'Henning, Aaron'; 'McCollum, Allyson'; 'Miller, Jeremy'; 'Williamson, Scott'; Eberts, Ron; Tony Prochaska -DNR-; Brett Coakley -DNR-; 'Seaman, Shawn'; Bob Sadzinski - MD DNR; 'Steffy, Luanne'; 'Tryninewski, Joshua'
Cc: Bleistine, Ray; David Frazier; Ian Kiraly; Erin Redding; Kirk Smith; Martinek, Michael; 'Slowik, Adam'
Subject: Conowingo Eel Passage and Restoration Plan
Attachments: Conowingo_Eel_Passage_and_Restoration_Plan (MDE Version).pdf

All,

On March 19, 2021, the Federal Energy Regulatory Commission issued a new license for the Conowingo Hydroelectric Project (P-405) to Exelon Generation, LLC (Exelon). Article 415 of the license requires Exelon to develop an *American Eel Passage and Restoration Plan* and submit the Plan to the Maryland Department of the Environment (MDE), the Pennsylvania Department of Environmental Protection (PADEP), the Pennsylvania Fish and Boat Commission (PFBC), the Susquehanna River Basin Commission (SRBC), the U.S. Fish and Wildlife Service (USFWS), and the Maryland Department of Natural Resources (MDNR) within 30 days of license issuance (April 18, 2021). Accordingly, please find attached to this email a copy of the Plan for your review and comment.

Please send your comments to me at andrea.danucalov@exeloncorp.com by May 18, 2021.

The approval of the Plan by MDE will also be completed pursuant to Section 2.5(g), Procedure for Approval of Plans, of the Conowingo Dam Water Quality Settlement Agreement between MDE and Exelon, dated October 29, 2019. In addition, the document will be posted on our web portal on Monday, April 19, 2021. I will send the link separately.

Article 415 of the license also requires Exelon to file a final version of the Plan with FERC within 6 months of license issuance (September 19, 2021).

Please let me know if you have any questions, comments, or concerns.

Have a good weekend!

Andrea

Andrea Danucalov
FERC License Compliance Manager
Exelon.
Exelon Generation
Conowingo Hydroelectric Generating Station
2569 Shures Landing Road
Darlington, MD 21034
Skype: 267.533.1125
Cell: 610.301.1664
andrea.danucalov@exeloncorp.com

From: Eyler, Sheila <sheila_eyler@fws.gov>
Sent: Thursday, May 6, 2021 8:53 AM
To: Danucalov, Andrea; denise.keehner@maryland.gov; Heather Nelson -MDE-; David Seaborn -MDE-; McCorkle, Richard; Morales, Jesus J; Minkkinen, Steve; 'Henning, Aaron'; 'Miller, Jeremy'; Eberts, Ron; 'Seaman, Shawn'; Bob Sadzinski - MD DNR; 'Tryninewski, Joshua'
Cc: Bleistine, Ray; David Frazier; Ian Kiraly; Erin Redding; Kirk Smith; Martinek, Michael; 'Slowik, Adam'
Subject: Re: [EXTERNAL] Conowingo Eel Passage and Restoration Plan

Andrea,

FWS has reviewed the Conowingo Eel Passage and Restoration Plan. Generally, we have no significant concerns with the document. We recommend the following edits and additions be included in the final version of the Plan:

1. Background, Page 2: Exelon states that the Conowingo East Eel Collection Facility (CEECF) (the temporary eel facility to be placed in the vicinity of the stilling basin at the East Fish Lift (EFL) will begin operation on May 1. This is inconsistent with the license and EFL operations. According to the license, operation of the CEECF will not commence until 10 days following the end of the operation of the EFL, as correctly stated in section 3.1.3.
2. Reporting and Meetings, Page 23: Regarding eel transport in Sections 6.1.1 and 6.1.2, Exelon describes reporting on transport in the text but does not include the reporting on transport in the bulleted list of items to be included in the daily and annual reports. Transport information (i.e. number transported by date and location) should be included in bulleted lists for both sections.
3. Appendix D: Daily datasheets for transport efforts should be included in this section or added as a separate appendix item.

Thank you for the opportunity to review.

Sheila Eyler
U.S. Fish and Wildlife Service
Mid-Atlantic Fish & Wildlife Conservation Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
717-387-2117

From: Henning, Aaron <ahenning@srbc.net>
Sent: Friday, May 7, 2021 7:53 AM
To: Danucalov, Andrea; denise.keehner@maryland.gov; Heather Nelson -MDE-; David Seaborn -MDE-; 'Eyler, Sheila'; 'McCorkle, Richard'; jesus_morales@fws.gov; 'Minkkinen, Steve'; 'McCollum, Allyson'; 'Miller, Jeremy'; 'Williamson, Scott'; Eberts, Ron; Tony Prochaska -DNR-; Brett Coakley -DNR-; 'Seaman, Shawn'; Bob Sadzinski - MD DNR; Steffy, Luanne; 'Tryninewski, Joshua'
Cc: Bleistine, Ray; David Frazier; Ian Kiraly; Erin Redding; Kirk Smith; Martinek, Michael; 'Slowik, Adam'
Subject: RE: Conowingo Eel Passage and Restoration Plan

Andrea,

Thank you for the opportunity to comment on the eel plan. The Susquehanna River Basin Commission submits the following comments for consideration:

- In Table 3.5-1, Site 9 refers to rt. 29 bridge in Wilkes Barre. Rt. 29 crosses the Susquehanna River in Nanticoke and does not offer a safe offload point. Consider Nesbitt Park, Kingston PA for comparable alternative access (-75.8851, 41.2513)
- In Table 6.1.1 Daily Operations Summary, in addition to the two listed items please include the following in daily reports: The number of eels transported or moved from the CECF (even if zero), disposition (location and status) of any eels transported from the CECF, any mortalities encountered at the CECF or during transport
- On page 10, paragraph two the document states: “During the 10 years of operation if the number of American Eels attempting to migrate to the CEECF exceeds the maximum capacity of American Eels per unit of ramp area, or if densities exceed 10 eels per L, the facility will be modified….” The “maximum capacity of American eels per unit of ramp area” needs a clear definition and determination on how this will be measured, by who and when.

Aaron Henning
Fisheries Biologist
Susquehanna River Basin Commission
4423 North Front St.
Harrisburg, PA 17110
Office: (717) 238-0423 ext.1184
Mobile: (717) 884-5937
ahenning@srbc.net

Maryland
Department of
the Environment

Larry Hogan, Governor
Boyd K. Rutherford, Lt. Governor

Ben Grumbles, Secretary
Horacio Tablada, Deputy Secretary

May 14, 2021

Via electronic mail
Ms. Andrea Danucalov
FERC License Compliance Manager
Exelon Generation
Conowingo Dam
2569 Shures Landing Road
Darlington, MD 21034
Andrea.Danucalov@exeloncorp.com

Re: Conowingo Dam, Draft American Eel Passage and Restoration Plan

Dear Ms. Danucalov:

The Maryland Department of the Environment, Wetlands and Waterways Program, (MDE) has consulted with the Maryland Department of Natural Resources, Power Plant and Research Program, (MDNR) to review and comment on the Draft American Eel Passage and Restoration Plan (Plan) submitted by Exelon Generation Company, LLC (Exelon) on April 16, 2021 in accordance with the Federal Energy and Regulatory Commission (FERC) License, specifically License Article 415. A requirement of License Article 415 is that the Plan be submitted to MDE within 30 days of the FERC License issuance for the operation of the hydropower facility at the Conowingo Dam. Exelon has prepared the Plan and is seeking initial agency comments prior to a formal submission by a requisite due date per the FERC License. MDE and MDNR are offering the attached comments requesting additional information, revisions and modifications to the Plan. MDE and MDNR are not approving in whole or in part the Plan. Please see Attachment I for comments regarding the Plan.

If you would like to discuss these comments further, please contact David Seaborn, Deputy Program Manager, MDE, Wetlands and Waterways Program via email at david.seaborn@maryland.gov to arrange a time to discuss with the appropriate MDE and MDNR staff.

Sincerely,

Heather L. Nelson, Manager
Wetlands and Waterways Program
Water and Science Administration

Attachment

(Via electronic mail)
cc: Bob Sadzinski, MDNR
Shawn Seaman, MDNR
Sheila Eyler, USFWS

Attachment I

General Comments:

1) The history of the WFL eel ramp does not include the time when U.S. Fish and Wildlife Service (USFWS) setup the ramp and operated it. Please include the complete history of the ramp.

2) Regarding FERC Article 414: The trigger for the eel ramp to operate within the East Fish Lift (EFL) is based on the closing of the EFL after the shad season. The Plan should describe what happens if the EFL does not operate or operates intermittently. We anticipate the Conowingo East Eel Collection Facility (CEECF) would operate during those extended periods when the EFL is not operating and after 1 May of any year.

3) The east side eel ramp is based on "modifications" of the new EFL. The Plan should include a construction timeline for the rebuilding of the EFL and any provisions to capture eels during this period. Interim eelway collections during construction or modifications to the eelway or EFL should not be considered as years to be compared between the CEECF and the west side eelway.

4) Maryland recommends including an eelway shakedown period that does not affect the ten-year comparison clock for the ramp to become permanent.

5) Small "tweaks" (*e.g.,* flow changes, gate openings/closings, ramp substrate(s)) should not be considered as modifications and should be differentiated from modifications requiring approval from the FERC. This needs to be defined in the Plan.

6) The Plan should address how the parties resolve disagreements regarding modifications to the eel collection facilities. (see Page 90 of the FERC Order)

7) Significant numbers of eels were observed during nighttime observations below the spillway during an Exelon study conducted in 2011. These eels could be redirected to the new eel ramp if access including attraction water could be provided through the wing wall. Exelon should consider this option (or other alternatives) to provide passage to eels attracted to the spill gate area? Since the EFL is being redesigned, this may be a minor modification to significantly improve the catchability of eels on the east side of the river.

8) Studies to determine ramp efficiency should be implemented during the first full season of operation and any time the ramp substrate is changed, or ramp flows are significantly changed by using a known number of eels released at the base of the ramp versus the number captured in the holding tank. Identified problems with the ramp must be addressed immediately.

Specific Comments:

1) 3.2.1 Design Conowingo East Eel Collection Facility (CEECF)

a. The Plan states that the CEECF be supplied with at least 265 liters per minute (70 gal/min, 1.2 gal/sec) of water. This flow may be insufficient to attract eels past the diffuser's flow and to the ramp. Additional attraction water may need to be provided such that it does not spill or sheet across the concrete pad creating false attraction when tailwater is low.

b. Nighttime observations should also be made of the concrete pad to ensure no eels are congregating toward this flow.

c. How does Exelon plan to determine if ramp density (overcrowding) is an issue?

2) 3.2.3 Operational Protocols

The plan states that:

- Weir gate C open 100% open.
- Weir gates B 0% open.
- Weir gates A 0% open
- Diffuser gates A 100% open
- Diffuser gates B 100% open

a. The plan should describe the amount of flow from diffusers. How will this configuration affect internal EFL flow patterns, and the amount of flow at Weir Gate C?

i. Exelon should also include diffuser Gate C into the operation plan along with options for the operation of entrance Gate A.

ii. Sufficient flow from the weir gate(s) is necessary to attract eels while maintaining velocities suitable for entry. The plan should also address the potential for attraction of eels into flow from the diffuser(s).

b. Prior to initial operation of the CEECF, operation flows should be observed and agreed to by agency representatives/personnel. Any subsequent modifications to flows or gate operations should also be observed and agreed to by agency representatives/personnel.

c. Entrance gates should be constructed with bar racks to reduce the number of predators accessing the EFL during the operation of the eel ramp.

d. Internal and zone-of-passage (ZOP) flow modeling should be conducted at the CEECF to ensure no velocity barriers exist for American Eels.

e. Monitoring- aeration of the collection tanks at the CEECF and CWECF should be performed unless DO is continuously monitored in those tanks.

3) 3.4 Transport, 3.4.1 Design

a. The plan should include density of eels in 19-liter buckets and 250-liter tank during transport to stocking locations.

b. If density is same as in large tanks (10 eels per liter) then continuous DO monitoring is needed.

EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT (FERC NO. 405)
EEL PASSAGE AND RESTORATION PLAN REMOTE MEETING SUMMARY
JULY 9, 2021, 1:00 PM TO 2:30 PM EST
Call-in Number: Microsoft Teams Call-in 716-402-6612, passcode 20670122

Attendees

Attendee	Affiliation	Email
Andrea Danucalov	Exelon	andrea.danucalov@exeloncorp.com
Erin Redding	Gomez and Sullivan Engineers	eredding@gomezandsullivan.com
Ben Sawyer	Gomez and Sullivan Engineers	bsawyer@gomezandsullivan.com
Kirk Smith	Gomez and Sullivan Engineers	ksmith@gomezandsullivan.com
Heather Nelson	Maryland Department of the Environment	hnelson@maryland.gov
David Seaborn	Maryland Department of the Environment	David.seaborn@maryland.gov
Shawn Seaman	Maryland Dept. of Natural Resources	shawn.seaman@maryland.gov
Ray Bleistine	Normandeau Associates, Inc.	rbleistine@normandeau.com
Mike Martinek	Normandeau Associates, Inc.	mmartinek@normandeau.com
Jeremy Miller	PA Dept of Environmental Protection	jeremmille@pa.gov
Josh Tryninewski	PA Fish and Boat Commission	jtryninews@pa.gov
Aaron Henning	Susquehanna River Basin Commission	ahenning@srbc.net
Sheila Eyler	US Fish and Wildlife Service	sheila_eyler@fws.gov
Rick McCorkle	US Fish and Wildlife Service	richard_mccorkle@fws.gov
Jesus Morales	US Fish and Wildlife Service	jesus_morales@fws.gov
Don Pugh	Consultant for Maryland	don.pugh@outlook.com

Meeting Purpose

Andrea Danucalov began the meeting. The focus of this meeting will be to review the resource agencies' comments on Exelon's Draft Eel Passage and Restoration Plan (EPRP). Exelon would like to finalize the EPRP and submit it to FERC. Following this meeting, an updated draft EPRP will be distributed to resource agencies for a final review.

Conowingo East Eel Collection Facility Design and Planned Operation

Ben Sawyer shared a 3-D model of the Conowingo East Eel Collection Facility (CEECF) on his screen. Major features were highlighted to show how the facility will be laid out.

The CEECF is in the stilling basin. A scaffolding stairway leads down from the dam to a walkway that allows for access to the collection tank, positioned at the top of the ramp. The ramp runs from the stilling basin down over the dissipation wall.

Eels may access the ramp via multiple routes. Once they reach and ascend the ramp, they are collected from the tank and carried out of the facility in buckets. The EPRP discusses which gates will be open or closed.

Ben showed the model in low and in high water level conditions. The model can show approximate low and high water levels.

Attraction flow for the CEECF is sourced from the dam. Water is supplied via the same pipe that feeds the stilling basin. The pipe is from the forebay located between Unit 11 and the EFL. Flow will be tapped off that pipe and sent to the CEECF via pipes or hoses. A manifold is located on top of the concrete at the powerhouse level. All the provided flow comes off the existing manifold, and all the flow will eventually come out the bottom of the ramp. The flow will then continue out the crowder channel or the diffuser channel.

There will be no water upstream of the dissipation wall where the scaffolding is placed. The scaffolding area will be dry, even during high water conditions.

The attraction flow will be 70 gallons per minute (0.16 cfs). Jesus Morales asked the manifold's flow capacity. Ben did not have this information available. Ray Bleistine said that the pipe that feeds the manifold is a six-inch pipe and previously provided water for the east lift. There is sufficient flow for the 70 gpm. Mike Martinek said that there is a two-inch hose called out for this facility, so flows will be very similar to flow at the Conowingo West Eel Collection Facility.

Jesus asked which gates will be open for eels to enter the East Fish Lift. He noted that most of the time, more water will be coming into the East Fish Lift than 70 gpm. He asked what the expectation is for how fish will find their way through the gates to the ramp. He also asked if the gates be completely open, screened, or covered. Gate C will be fully open. Mike said that there are no plans for screening the entrances to the channels; however, areas susceptible to avian predation will be screened. Jesus asked for confirmation that when the water level is dry, the attraction flow will be the only water coming down the concrete slab. Mike confirmed that this statement is correct.

Don Pugh asked how much flow will pass through the diffuser gates. Mike said that the attraction flow of 70 gpm will pass through the diffuser gates. Don expressed doubt that the eels would be able to locate the 70 gpm attraction flow where there would also be potentially thousands of gallons of flow coming downstream from the Conowingo operating units. Don thinks that the eels will instead be attracted to the flow from the dam. Jesus agreed and said that there would be more water going into Gate A than water coming out. Jesus said that he thinks some eels will eventually locate the ramp; however, he is wondering what will draw eels into the east fish lift to begin with. He acknowledged that they may follow the wall on that leads to Gate C and enter the fish lift there. Ray said that there are historic observations of eels in this area, before the east fish lift was built. Eels were observed coming through leakage from the regulating gate. An eel ramp at this location is in response to agency requests. The ramp cannot be put into the spillway due to safety and operation concerns. Ray said that there is no guarantee that there are eels here; this is an experiment. Benefits of the site include access and water availability.

Jesus agreed that this location is experimental and agreed that there are positive aspects of this location. He said he still wonders if something else could be done to improve the attraction flow for eels as the 70 gpm will be competing with the flow from the powerhouse. Ray said that the specifications for the CEECF are aligned with the CWECF as Exelon is required to compare the two facilities after ten years of operation. Ray said that he is concerned that having a different set up in the CEECF may bias the required comparisons. Don said the CEECF's purpose is to collect eels, not to replicate the CWECF for comparison. Conditions on the west side of the river are different; eels come up the edge of the river into an open area. This area is not open. Ray said that the eels could come up the wingwall. Don said that that the attraction flow is not sufficient to bring eels into the fish lift. They may wander into the fish lift, but could still miss the attraction flow due to water movement within the lift. Mike said that when the units are operating, flow from the dam will be too great for eels to swim up to the dam. The flow will push eels toward the wingwall where they will find Gate C. Don said that the eels will only be pushed to the wingwall

and Gate C if units 10 and 11 are running. Otherwise they could swim up to Gate A, which will be closed. Mike said that if unit 5 is on, the eels will be throughout the tailrace. Don said that this makes his point that collecting on the west side does not collect all the eels in the river that are trying to pass upstream of Conowingo Dam. The locations of the eels in the river downstream of the dam are unknown as they are too small for tracking studies.

Regarding diffuser flows, Don asked if the water could go through the diffusers and down the channel. It can.

Don said that predators entering the east fish lift may also be an issue. He asked if there will be bar racks in front of the gate. Bar racks are not currently planned for in front of the gates. Ray said there is an eddy below the CWECF where predatory fish rest; however, there is no evidence that it is impacting the CWECF catch. Don said that it is not possible to know if predatory fish are impacting the CWECF catch or not because no one knows how many eels are available. It is known that the species of predatory fish in the eddy do like to eat eel. Aaron Henning said that there were eels in the stomachs of some of the snakeheads caught this summer.

Conowingo Eel Passage and Restoration Plan – Agency Comments and Exelon's Responses

A comments response matrix was shared on the meeting screen and Kirk Smith led the group through a discussion. For each comment, Kirk summarized Exelon's response and solicited further comments or questions from the resource agencies. The matrix and meeting discussion begin on the next page.

	Comment	How Addressed
MDE & MDNR		
General Comments		
	Meeting Discussion: Ray said that the C-channel will be narrowed with supports and steel plates, making it even more challenging to create a hole for attraction flow here.	
8	Studies to determine ramp efficiency should be implemented during the first full season of operation and any time the ramp substrate is changed, or ramp flows are significantly changed by using a known number of eels released at the base of the ramp versus the number captured in the holding tank. Identified problems with the ramp must be addressed immediately.	FERC License, Appendix 1, Section 12.7.3 requires that upstream American Eel effectiveness testing be completed in the year immediately following license issuance unless Exelon and the USFWS agree that effective technology is not available. Based on the available scientific literature, Exelon and USFWS agree that the appropriate, proven tagging technology does not currently exist to conduct ramp efficiency studies for the size range of eels currently collected at Conowingo Dam (mean length 125 mm). Per the FERC License, Appendix 1, Section 12.7.3, available technology will be reconsidered and the potential for tests of upstream passage efficiency will be discussed at annual meetings with USFWS. In addition, Section 12.7.3 requires that when technology is available and following any modifications to the operation or physical structure an upstream efficiency study will be conducted to evaluate the relative success of the modifications. This language has been added to the Eel Passage and Restoration Plan. Additionally, to perform a comparative analysis with the CWECF, substantial modifications such as changing ramp substrate or attraction flow should be avoided during the 10-year comparative period so as not bias results.
	Meeting Discussion: Don said that Maryland is requesting a ramp efficiency study, rather than a passage efficiency study. The requested study would involve containing a fixed number of eels at the base of the eel ramp and then, over a set time-period, seeing what percentage of the eels reach the collection tank. Ray said that, at Conowingo, it would be a challenge to keep other eels from entering the ramp via the sides of the ramp, as the eels climb up the rip-rap. Ray also noted that closing off the ramp for a day to eels that are trying to move upstream could result in not passing thousands of eels. Don agreed that this type of study would be difficult at the CWECF, but it could be possible at the CEECF. Exelon now understands Don's request and will consider it further.	

	Comment	How Addressed
Specific Comments		
1	**3.2.1** Design Conowingo East Eel Collection Facility (CEECF) a. The Plan states that the CEECF be supplied with at least 265 liters per minute (70 gal/min, 1.2 gal/sec) of water. This flow may be insufficient to attract eels past the diffuser's flow and to the ramp. Additional attraction water may need to be provided such that it does not spill or sheet across the concrete pad creating false attraction when tailwater is low. b. Nighttime observations should also be made of the concrete pad to ensure no eels are congregating toward this flow. c. How does Exelon plan to determine if ramp density (overcrowding) is an issue?	a. There will be no flow provided through the EFL diffusers. The weir and diffuser gates are open to allow eels the opportunity to enter the EFL via multiple locations, but there will be no flow provided through the gates via the conventional operation of the EFL. Attraction flow to the CEECF will be provided from a separate water source. This flow will consist of 70 gpm of water discharged through the ramps attraction flow system as described in Section 3.2.1. Therefore, there is no potential for the creation of false attraction by the EFL diffusers when the tailwater is low. b. Nighttime observations are not necessary, since the EFL will not be providing flow through diffusers; thus, eliminating the potential for false attraction. c. The proposed eel ramp is 18 inches wide. Using the USFWS Fish Passage Engineering Design Criteria (2019) of a maximum capacity of 5,000 eels/day per inch of ramp width, assuming a mean eel size of 150 mm total length, the proposed ramp will have a capacity of 90,000 eels/day. During the 10 years of operation, if the number of American Eels attempting to migrate through the CEECF exceeds 90,000 eels per day, based on volumetric estimates, or if densities in the collection tank exceed 10 eels per L, the facility will be modified, or operational protocols adjusted to reduce crowding, in consultation with MDE, USFWS, and EPAG, and following approval from FERC. This information has been added to page **Error! Bookmark not defined.**.
	Meeting Discussion: Don asked where the maximum ramp capacity metric comes from, other than the USFWS' guidelines. Jesus suggested that Alex Haro may know the source of this metric. Don said that he has asked Alex Haro, and Alex did not know either. (At the end of the meeting, Jesus typed in the chat that the maximum capacity metric was taken from the UK Environment Agency's eel manual.)	

https://gomezandsullivan.sharepoint.com/:w:/r/sites/Exelon-Licensing/Shared%20Documents/02130M-Conowingo%20C%20and%20I/2132-Eel%20Passage%20and%20Restoration%20Plan/Meetings/20210709/20210709_Exelon_Meeting_Summary_EPRP_Only.docx?d=w2f089ab3f2c0436d88a5a180454bb60b&csf=1&web=1&e=KXDIfD

	Comment	How Addressed
2	**3.2.3** Operational Protocols The plan states that: Weir gate C open 100% open. Weir gates B 0% open. Weir gates A 0% open Diffuser gates A 100% open Diffuser gates B 100% open	Appendix D has been added to provide additional information regarding operations.
	e. Monitoring- aeration of the collection tanks at the CEECF and CWECF should be performed unless DO is continuously monitored in those tanks.	Daily DO checks and weekly downloads of continuous monitoring data will be performed. Aeration will be provided if DO monitoring indicates that it is necessary. See Section 3.2.1 for details.
	Meeting Discussion: Don asked for confirmation that there will be a daily check as well as logged continuous monitoring. Ray confirmed that Normandeau will perform manual daily checks of water quality and a HOBO is also in place to collect continuous monitoring data. These data are downloaded on an established schedule. This approach is similar to how monitoring is completed at the Octoraro Creek Eel Collection Facility.	
3	3.4 Transport, 3.4.1 Design a. The plan should include density of eels in 19-liter buckets and 250-liter tank during transport to stocking locations. b. If density is same as in large tanks (10 eels per liter) then continuous DO monitoring is needed.	a. The density of eels in the transport buckets and transport tank are less than less than 10 juvenile eels per liter. Section 3.4 has been revised to clarify this. b. Eels are transported with continuous DO supply. This has been clarified in Section 3.4.2.
	Meeting Discussion: Don asked if Normandeau has ever transported eels in 5-gallon buckets. Mike said yes; this is done when eel numbers are low. No more than 50 eels are placed in a 5-gallon bucket. Normandeau puts a blower in the bucket during transport to ensure there is sufficient oxygen.	

https://gomezandsullivan.sharepoint.com/:w:/r/sites/Exelon-Licensing/Shared%20Documents/02130M-Conowingo%20C%20and%20I/2132-Eel%20Passage%20and%20Restoration%20Plan/Meetings/20210709/20210709_Exelon_Meeting_Summary_EPRP_Only.docx?d=w2f089ab3f2c0436d88a5a180454bb60b&csf=1&web=1&e=KXDIfD

Agency Comments on April 16, 2021 Draft and Exelon Responses

	Comment	How Addressed
MDE & MDNR		
General Comments		
1	The history of the WFL eel ramp does not include the time when U.S. Fish and Wildlife Service (USFWS) setup the ramp and operated it. Please include the complete history of the ramp.	A brief history of the WFL eel ramp has been incorporated into Section 3.1.1.
2	Regarding FERC Article 414: The trigger for the eel ramp to operate within the East Fish Lift (EFL) is based on the closing of the EFL after the shad season. The Plan should describe what happens if the EFL does not operate or operates intermittently. We anticipate the Conowingo East Eel Collection Facility (CEECF) would operate during those extended periods when the EFL is not operating and after 1 May of any year.	Exelon does not anticipate any periods when the EFL would not be operating in some capacity from May 1 to June 15. Exelon must operate the EFL, as required by the FERC license. Not operating the EFL or operating the EFL intermittently would require FERC to approve a variance request in advance of any changes to operation of the EFL. Also, per the MDE Settlement the temporary eel facility is to start operating twelve months after the EFL modifications required under Appendix 1 of the FERC license (i.e., the DOI Fishway Prescription) in order to allow for the construction of the upgrades required by the license to occur. Exelon does not anticipate a scenario where the EFL will not be operated in either trap and transport or volitional mode after the EFL initial modifications are complete. Given this, there does not appear to be any circumstance where the CEECF would operate prior to the closing of the typical American Shad passage season.
3	The east side eel ramp is based on “modifications” of the new EFL. The Plan should include a construction timeline for the rebuilding of the EFL and any provisions to capture eels during this period. Interim eelway collections during construction or modifications to the eelway or EFL should not be considered as years to be compared between the CEECF and the west side eelway.	Exelon is developing a schedule to complete the upgrades to the EFL. Per the MDE Settlement, Exelon and MDE agreed to initiate operation of the CEECF 12 months after completion of the EFL upgrades. Due to safety concerns and the required EFL upgrade requirement, collection of eels will not occur until completion of the EFL upgrades. There are no specific requirements in the MDE Settlement or FERC License to capture eels on the east side of the dam during the EFL construction period. However, operation of the CWECF and the

		OECF will continue during the EFL construction period and will continue to provide a source of eels for upstream transport.
4	Maryland recommends including an eelway shakedown period that does not affect the ten-year comparison clock for the ramp to become permanent.	The current CEECF design follows USFWS's Fish Passage Engineering Design Criteria (2019) in relation to attraction flow, general design configuration, and substrate material. The design has also been discussed with EPAG, USFWS, and MDE. The CWECF and OECF did not require shakedown periods after their initial construction and have not required any substantive modifications since operation began. As part of the normal operating procedure before the start of the eel passage season, each ramp undergoes a series of pre-season checks as well. Exelon anticipates the same for the proposed CEECF and therefore is not proposing a shakedown period.
5	Small "tweaks" (*e.g.,* flow changes, gate openings/closings, ramp substrate(s)) should not be considered as modifications and should be differentiated from modifications requiring approval from the FERC. This needs to be defined in the Plan.	Article 414 has been added to Section 3 for reference. The language of Article 414 does not suggest that small changes or "tweaks" to design or operation may be made without MDE, USFWS, and FERC approval; therefore, Exelon considers it appropriate to have all changes to the design or operation approved by FERC before they are implemented to ensure license compliance.
6	The Plan should address how the parties resolve disagreements regarding modifications to the eel collection facilities. (see Page 90 of the FERC Order)	Exelon maintains regular consultation with MDE, USFWS and EPAG through monthly virtual meetings, emails and phone calls, and annual meetings, and meeting records are maintained. Exelon will attempt to resolve any disagreements regarding modifications to the eel collection facilities through conversations held during these meetings, phone calls, and emails. In the case of unresolved disagreements between MDE, USFWS, and EPAG regarding modifications, FERC will maintain and exercise its decision authority based upon the consultation record.
7	Significant numbers of eels were observed during nighttime observations below the spillway during an Exelon study conducted in 2011. These eels could be redirected to the new eel ramp if access including attraction water could be provided through the wing wall. Exelon should consider this option (or other alternatives) to provide	Three nighttime surveys were conducted in 2011. Elvers were observed in the same area below Crest gate #30 during all three surveys, which is located approximately 1,200 feet away from the EFL.

	passage to eels attracted to the spill gate area? Since the EFL is being redesigned, this may be a minor modification to significantly improve the catchability of eels on the east side of the river.	However, crest gate #30 was leaking a significant amount of water since it had been opened during high spring river flows that resulted in spill, and it had not been resealed prior to the survey. It was concluded that eels would not have been attracted to that location if the crest gate had not been leaking. A copy of the 2011 study is attached as Appendix H. Exelon is not proposing any modifications to the EFL wingwall as it serves to regulate the tailwater elevation in the vicinity of Gate C of the EFL as generation and spillway flows change. In addition, there is a channel at the terminus of the wingwall that maintains connectivity between the spillway and tailrace under nearly all flow conditions experienced at the Project.
8	Studies to determine ramp efficiency should be implemented during the first full season of operation and any time the ramp substrate is changed, or ramp flows are significantly changed by using a known number of eels released at the base of the ramp versus the number captured in the holding tank. Identified problems with the ramp must be addressed immediately.	FERC License, Appendix 1, Section 12.7.3 requires that upstream American Eel effectiveness testing be completed in the year immediately following license issuance unless Exelon and the USFWS agree that effective technology is not available. Based on the available scientific literature, proven tagging technology does not currently exist to conduct ramp efficiency studies for the size range of eels currently collected at Conowingo Dam (mean length 125 mm). Per the FERC License, Appendix 1, Section 12.7.3, available technology will be reconsidered and the potential for tests of upstream passage efficiency will be discussed at annual meetings with USFWS. In addition, Section 12.7.3 requires that when technology is available and following any modifications to the operation or physical structure an upstream efficiency study will be conducted to evaluate the relative success of the modifications. This language has been added to the Eel Passage and Restoration Plan. Testing of ramp efficiency by placing a known number of unmarked eels at the bottom of an eel ramp to determine the percentage of eels that successfully ascend the ramp has had mixed results. A method for marking juvenile eels (size range 70 to 130 mm) needs to be developed in

	order to detect eels as they enter, ascend, and exit the eel ramp. This would allow testing to occur without shutting down the ramp for some length of time and eliminate concerns of eels not in the test group infiltrating the ramp and skewing the results. Until a marking technique is developed for small eels that provides reliable detectability to ensure accurate results, it is our consensus that this type of study be delayed. Exelon will continue to work with the resource agencies to address this issue.
Specific Comments	
1 3.2.1 Design Conowingo East Eel Collection Facility (CEECF) a. The Plan states that the CEECF be supplied with at least 265 liters per minute (70 gal/min, 1.2 gal/sec) of water. This flow may be insufficient to attract eels past the diffuser's flow and to the ramp. Additional attraction water may need to be provided such that it does not spill or sheet across the concrete pad creating false attraction when tailwater is low. b. Nighttime observations should also be made of the concrete pad to ensure no eels are congregating toward this flow. c. How does Exelon plan to determine if ramp density (overcrowding) is an issue?	a. There will be no flow provided through the EFL diffusers. The weir and diffuser gates are open to allow eels the opportunity to enter the EFL via multiple locations, but there will be no flow provided through the gates via the conventional operation of the EFL. Attraction flow to the CEECF will be provided from a separate water source. This flow will consist of 70 gpm of water discharged through the ramps attraction flow system as described in Section 3.2.1. Therefore, there is no potential for the creation of false attraction by the EFL diffusers when the tailwater is low. b. Nighttime observations are not necessary, since the EFL will not be providing flow through diffusers; thus, eliminating the potential for false attraction. c. The proposed eel ramp is 18 inches wide. Using the USFWS Fish Passage Engineering Design Criteria (2019) of a maximum capacity of 5,000 eels/day per inch of ramp width, assuming a mean eel size of 150 mm total length, the proposed ramp will have a capacity of 90,000 eels/day. During the 10 years of operation, if the number of American Eels attempting to migrate through the CEECF exceeds 90,000 eels per day, based on volumetric estimates, or if densities in the collection tank exceed 10 eels per L, the facility will be modified, or operational protocols adjusted to reduce crowding, in consultation with MDE, USFWS, and EPAG, and following approval from

		FERC. This information has been added to page 11.
2	3.2.3 Operational Protocols The plan states that: Weir gate C open 100% open. Weir gates B 0% open. Weir gates A 0% open Diffuser gates A 100% open Diffuser gates B 100% open	Appendix D has been added to provide additional information regarding operations.
	a. The plan should describe the amount of flow from diffusers. How will this configuration affect internal EFL flow patterns, and the amount of flow at Weir Gate C? i. Exelon should also include diffuser Gate C into the operation plan along with options for the operation of entrance Gate A. ii. Sufficient flow from the weir gate(s) is necessary to attract eels while maintaining velocities suitable for entry. The plan should also address the potential for attraction of eels into flow from the diffuser(s).	The weir and diffuser gates are open to allow eels the opportunity to enter the EFL via multiple locations; however, there will be no flow provided through the EFL diffusers or through the gates via the conventional operation of the EFL. Attraction flow to the CEECF will be provided from a separate water source. This flow will consist of 70 gpm of water discharged through the ramps attraction flow system as described in Section 3.2.1. Note that items have been added to the Operational Protocols list on page 12. Exelon has attached a copy of the PowerPoint presented at the October 15, 2020 EPAG meeting, which provides additional information regarding the operation of the temporary eel facility at the EFL (Appendix D).
	b. Prior to initial operation of the CEECF, operation flows should be observed and agreed to by agency representatives/personnel. Any subsequent modifications to flows or gate operations should also be observed and agreed to by agency representatives/personnel.	As described above, there will be no attraction flow provided through conventional operation of the EFL. Therefore, observation of flows is not necessary, aside from regular inspections made by the ramp operating staff. The magnitude (70 gpm) of attraction flow water for the eel ramp itself is provided based on the USFWS Fish Passage Engineering Design Criteria (2019).
	c. Entrance gates should be constructed with bar racks to reduce the number of predators accessing the EFL during the operation of the eel ramp.	The proposed eel ramp design does not require bar racks on the EFL entrance gates. The only EFL entrance gate that will be open during operation of

		the eel ramp will be Gate C. There is no provision within the MDE Settlement to modify the current EFL entrance gates with bar racks.
	d. Internal and zone-of-passage (ZOP) flow modeling should be conducted at the CEECF to ensure no velocity barriers exist for American Eels.	There will be no attraction flow provided through conventional operation of the EFL. The 70-gpm magnitude of attraction flow water for the eel ramp itself is provided based on the USFWS Fish Passage Engineering Design Criteria (2019). The 70-gpm (0.16 cfs) attraction flow is not expected to form any velocity barriers within the EFL, so flow modeling is unnecessary.
	e. Monitoring- aeration of the collection tanks at the CEECF and CWECF should be performed unless DO is continuously monitored in those tanks.	Daily DO checks and weekly downloads of continuous monitoring data will be performed. Aeration will be provided if DO monitoring indicates that it is necessary. See Section 3.2.1 for details.
3	3.4 Transport, 3.4.1 Design a. The plan should include density of eels in 19-liter buckets and 250-liter tank during transport to stocking locations. b. If density is same as in large tanks (10 eels per liter) then continuous DO monitoring is needed.	a. The density of eels in the transport buckets and transport tank are less than less than 10 juvenile eels per liter. Section 3.4 has been revised to clarify this. b. Eels are transported with continuous DO supply. This has been clarified in Section 3.4.2.
PADEP		
1	Page 10, Paragraph 2: Please provide description of maximum capacity of American Eels per unit of ramp area for CEECF.	The proposed eel ramp is 18 inches wide. Using the USFWS Fish Passage Engineering Design Criteria (2019) of a maximum capacity of 5,000 eels/day per inch of ramp width, assuming a mean eel size of 150 mm total length, equates to a capacity of 90,000 eels/day. This information has been added to page 11.
2	Table 3.5-1 Stocking Locations for Juvenile Eel in the Susquehanna River Watershed: Site #6 Fort Hunter should be Dauphin County not Perry County.	The county has been corrected in the table.
SRBC		

1	In Table 3.5-1, Site 9 refers to Rt. 29 bridge in Wilkes Barre. Rt. 29 crosses the Susquehanna River in Nanticoke and does not offer a safe offload point. Consider Nesbitt Park, Kingston PA for comparable alternative access (-75.8851, 41.2513).	Comment noted. This alternative access point has been added to Table 3.5-1.
2	In Table 6.1.1 Daily Operations Summary, in addition to the two listed items please include the following in daily reports: The number of eels transported or moved from the CECF (even if zero), disposition (location and status) of any eels transported from the CECF, any mortalities encountered at the CECF or during transport.	These items are now included in the list of items for daily reports. (Note, this comment refers to Section 6.1.1, not Table 6.1.1.)
3	On page 10, paragraph two the document states: "During the 10 years of operation if the number of American Eels attempting to migrate to the CEECF exceeds the maximum capacity of American Eels per unit of ramp area, or if densities exceed 10 eels per L, the facility will be modified…." The "maximum capacity of American eels per unit of ramp area" needs a clear definition and determination on how this will be measured, by who and when.	The proposed eel ramp is 18 inches wide. Using the USFWS Fish Passage Engineering Design Criteria (2019) of a maximum capacity of 5,000 eels/day per inch of ramp width, assuming a mean eel size of 150 mm total length, the proposed ramp will have a capacity of 90,000 eels/day. This information has been added to page 11. During the 10 years of operation, if the number of American Eels attempting to migrate through the CEECF exceeds 90,000 eels per day, based on volumetric estimates, or if densities in the collection tank exceed 10 eels per L, the facility will be modified, or operational protocols adjusted to reduce crowding, in consultation with MDE, USFWS, and EPAG, and following approval from FERC.
USFWS		
1	Background, Page 2: Exelon states that the Conowingo East Eel Collection Facility (CEECF) (the temporary eel facility to be placed in the vicinity of the stilling basin at the East Fish Lift (EFL) will begin operation on May 1. This is inconsistent with the license and EFL operations. According to the license, operation of the CEECF will not commence until 10 days following the end of the operation of the EFL, as correctly stated in section 3.1.3.	The text in the Section 1. Background has been corrected.
2	Reporting and Meetings, Page 23: Regarding eel transport in Sections 6.1.1 and 6.1.2, Exelon describes reporting on transport in the text but does not include the reporting on transport in the bulleted list of items to be included in the daily and annual reports. Transport information (i.e. number transported by date and location) should be included in bulleted lists for both sections.	Transport information has been added to the list of items to be included in the daily and annual reports on page 25.
3	Appendix E: Daily datasheets for transport efforts should be included in this section or added as a separate appendix item.	Daily transport sheets have been added to what is now Appendix E.

From: Kirk Smith
Sent: Wednesday, August 18, 2021 10:33 AM
To: Erin Redding; Danucalov, Andrea; Bleistine, Ray; Brett Coakley; Mike.Cox@ERM.com; David Frazier; Eberts, Ron; 'Eyler, Sheila'; 'Henning, Aaron'; denise.keehner@maryland.gov; Ian Kiraly; jesus_morales@fws.gov; Martinek, Michael; 'McCollum, Allyson'; 'McCorkle, Richard'; 'Miller, Jeremy'; 'Minkkinen, Steve'; Heather Nelson -MDE-; Tony Prochaska; 'Sadzinski, Robert'; David Seaborn -MDE-; 'Seaman, Shawn'; 'Slowik, Adam'; Smith, Fred; 'Steffy, Luanne'; 'Tryninewski, Joshua'; 'Williamson, Scott'
Subject: Exelon EPAG July Meeting Summary and August Meeting Agenda
Attachments: EPAG_Meeting_Summary_20210715.pdf; EPAG_Meeting_Agenda_20210819.pdf; Conowingo_Eel_Passage_and_Restoration_Plan_2021.pdf

Hello,

Please see the attached Exelon EPAG July 2021 Meeting Summary and August 2021 Meeting Agenda.

Also attached is a revised version of the *American Eel Passage and Restoration Plan* required by Article 415 of the new license. The plan was previously distributed in April 2021 and has been revised based on resource agency comments.

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Maryland DNR / Power Plant Research Program

Comments, Questions and Recommendations

Exelon's Proposed American Eel Passage and Restoration Plan

9/1/21

Received 9/2/2021

Section 2 – Project Configuration:

- 2nd Paragraph: Be consistent with acronym definitions (i.e. define WFL. Use of both WFL and West Fish Lift is below).
- 2nd Paragraph: Figure 2.0-1 should depict all that is described in the text (i.e. spillway, abutment sections, etc.)

Section 3.2.1 - Conowingo West Eel Collection Facility

- 2nd Paragraph: Suggest including the elevation of the normal high-water line in the text.
- 3rd Paragraph: What is defined as 'large 60% shade cloth'. Additional clarification is needed.

Section 3.2.1 - Octoraro Creek Eel Collection Facility

- 2nd Paragraph: Add angle to 90-degrees.
- 3rd Paragraph: Define L as Liter and use consistently throughout.

Section 3.2.1 - Conowingo East Eel Collection Facility

- How was the location of the ramp determined?
- Does the attraction water come off the top of the pond?
- What is the general difference in water temperatures during the summer? Water temperatures in the tailrace compared to the CEECF attraction water should be recorded.
- The plan should describe how predators prevented from entering the EFL?
- Clarify the amount of attraction water coming out of the entrance gate C and how that will be a signal for eels to enter the EFL
- The plan should describe the flows when the eel ramp will be pulled.
- Provide an approximate year of project initiation/operation startup. We realize this is defined in the schedule section but mention of it here is recommended.
- 2nd Paragraph last sentence: Sentenced needs to be edited. Use of with versus will.
- 3rd Paragraph:
    - Include elevation of normal high-water line.
    - 7th sentence: is it 'tailwater level', or 'existing tailwater elevation'.

Section 3.2.2 – Construction

- Provide an estimated construction date.

Section 3.2.3 – Operational Protocols: Intro

- Re: Operation of CEECF - Diffuser gates A & B are to be open. With only 70 gal/min 'attraction flow' it might be better to close them off to get max guidance in the open channel for any eels that enter the EFL.

- Section 3.2.3 references a schedule outlined in Section 4. Section 4 needs more detailed information detailing actual operation and monitoring schedules at all three facilities.

Section 3.2.3 – Operational Protocols: Monitoring

- Are there specific monitoring forms? If so, please include in the plan
- Continuous monitoring / alarm systems at both the OECK and CEECF should be considered for replacement instead of daily inspections.

Section 3.2.3 – Operational Protocols: Inspection

- Page 12 states: *if an inspection suggests that any structure or flow component is not performing properly and no alarm has been triggered, verification of this potential deviation will be performed as described above and corrective action will be taken as soon as possible.* The plan should define this process.
- Alarms are mentioned but not discussed in enough detail.
- Please reference or clarify use, operation, etc. of alarms.
- What defines a failed inspection?

Section 3.2.3 – Operational Protocols: Maintenance

- Will the CEECF ramp be accessible for daily clearing obstructions?
- Is there a process or specific procedure for scrubbing the collection tank?
- What triggers a determination that the ramp needs to be cleaned?
- Are there specific maintenance logs/sheets?
- Are they provided in this plan and where will they be stored?
- Is anyone qualified to conduct the monitoring and maintenance activities or will this be a requirement?

Section 3.3 – Holding (Conowingo West Eel Collection Facility)

- Include a reference that all eels transferred to holding tanks will be recorded on the daily inspection sheet.
- Maryland is concerned that the plan continues to recommend holding eels for seven days until water temperatures exceed 28°C on consecutive days. Eels in crowded conditions can become stressed and develop fungus, as has been observed. Eels should be transported within 48 hours of capture. A recommended alternative would be the transportation and stocking to the Conowingo Pond and Lake Aldred eels that, held 48 hours, when the number held does not meet the threshold for stocking at upriver locations.

Section 3.3.2 – Operational Protocols

- What is the QA/QC process associated with the inspection sheets such that holding time and temperatures are met for transport?

Section 3.3.2 – Operational Protocols / Monitoring

- What defines continuous? Operation is noted later as 24 hours a day 7 days a week. This implies that monitoring will be conducted non-stop during the collection season/operation.
- 2nd Paragraph: Please reference and maintain/update a contact list including operational personnel in the plan.
- 4th Paragraph: Is there an elevated concentration that will trigger an alarm or just the minimum?

Section 3.3.2 – Operational Protocols / Inspection

- Once per day? Continuous measurements on other systems and only daily for holding tanks? Please clarify.

Section 3.4.1 – Design

Conowingo West Eel Collection Facility

- How often is the water quality probe calibrated and maintained?
- Where are the calibration and maintenance forms located in this plan?

  GLOBAL note for calibration forms as it is discussed in other sections of the plan
- Appendix F references engineering drawings for transport facility. Are there drawings for the 19-L buckets and enclosed transport tank?

Octoraro Creek Eel Collection Facility

– the holding tank has a capacity of 3,140 eels. The transport truck for more than 150 eels is a 250 liter tank which can transport 2,500 eels. In 2021, more than 2,500 eels were collected on July 13 – 3,474, 14 – 4,738 and 15 – 6,168. The plan should describe operations when more eels are collected in a single day than the holding tank or the transport tank can accommodate.

- How are the 19-L buckets loaded and transported?

Conowingo East Eel Collection Facility

- How are 19-L buckets transported?
- What are the plans to transport eels from CEECF to CWECF if a significant number of eels are collected? All in the 19-L bucket?

Section 3.4.2 Operation Protocols Monitoring (1st Paragraph):

- Is there a maximum amount of trips that are prohibitive per week based on staff or equipment limitations?
- Will this be an area of concern if the capacity of the holding tanks are continuously met and/or water temperatures exceed 28-degrees C?
- How are oxygen levels monitored and maintained?
- What is the calibration program for monitoring these levels?

Section 3.4.2 Operation Protocols Temperature

- Please provide additional detail on how the temperature will be monitored.

Section 3.4.2 Operation Protocols Dissolved Oxygen

- Regarding prior note on calibration protocols – this should be addressed in the plan.

Section 3.4.2 Operation Protocols Inspection (1st Paragraph)

- Please reference and provide an inspection check list.

Section 3.4.2 Operation Protocols Inspection (2nd Paragraph)

- How and where is this data recorded - data logger or field form?
- Please define the criteria for passing inspection. This is a vague statement.

Section 3.4.2 Operation Protocols Maintenance

- What is defined as the facility? Conowingo?
- Clarify the meaning here. Are you saying all tanks will be cleaned weekly?

Section 3.4.2 Operation Protocols American Eel Counting (1st Paragraph)

- Is it determined or recorded?

Section 3.4.2 Operation Protocols American Eel Counting (2nd Paragraph)

- What does this evaluation consider?
- Will all deceased eels float to the top of the tank or remain in the tank after release?
- At the release site how long is the area inspected to evaluate for mortality?
- Is the mortality evaluation process defined or is it subjective depending on the transport staff?

Section 3.6 – Emergency Response Protocols

- Maryland advises that if 95% survival is not achieved then modifications are deemed necessary.

Section 3.6.1 – Alarms and Contacts

- The contact list should be maintained, updated and provided in this plan.
- Is temperature included in the alarm system process?

Section 3.6.2 – Failed Inspections (2nd Paragraph)

- All inspections, passed or failed will be recorded how?
- Where are the forms/sheets documenting the inspections?

Section 3.7 – Quality Assurance and Quality Control

- A QA/QC plan should be developed and included as an appendix.
- Please define training requirements and how training records will be maintained.
- Table 3.5-1: In support of stocking locations, consider adding written directions and/or maps from Conowingo Dam to each of the stocking locations. In the event a new driver is needed how will they locate the site?

Section 4 – Implementation Schedule

- We believe the second sentence should be both CWECF and CEECF.

Section 6 – Reporting and Meetings

- Plan should identify (and be updated) as to which emails and staff receive these reports.
- Daily reports should include alarms, maintenance and cleaning operations that occurred if any

Section 6.1.2 - Annual Reports

- Draft reports for the CWECF and CEECF are proposed to be submitted on December 1 (up to Sept 15) and December 31 (16th to end of season). Final report filing dates are February 15. While time may be short between the end of the eel passage season and December 1, it is much preferable that there be only one report for the season.

Appendix I - Agency Consultation Records

General Comments #4

The recommended shakedown period was not intended for ramp efficiency (efficiency test) but to see if eels were attracted into the EFL and then to the ramp location. With additional attraction flow (See comment 1a below) a shakedown period will still be necessary. Tweaks are standard practice as indicated by the many tweaks and upgrades at the CWEFC and the shakedown periods for the rebuilt east and west fish lifts. Maryland would again strongly recommend a period of time when tweaks and upgrades be made and this time period not counted towards a fully functioning CEEFC evaluation period.

General Comments #8

Maryland disagrees with Exelon in that ramp efficiency testing technology is not available. Determining the efficiency of an eel ramp is feasible and has been done at a number of other projects. As Exelon described, a ramp efficiency test is simple. Enclose a known number of eels at the bottom of the ramp, which has been cleared of eels, and count the number in the capture/holding tank at the top over a fixed period such as 6, 12, 18, 24, etc. hours.

Ramp efficiency has been evaluated on three ladders at the Woronoco project (FERC # 2631) on the Westfield River in Massachusetts (Woronoco 2010 & 2012), at the Lawrence dam (FERC # 2800) on the Merrimack River in Massachusetts (Normandeau 2015), and on the Messalonskee Stream in Maine (Hickey 2012). In all cases, eelway efficiency was determined. At Woronoco the results were 99% in 96 hours at the North Ladder, 93% at the Middle Ladder in 66 hours, and 100% at the South Ladder in 18 hours. At the Lawrence Dam results after 36 hours were 55% and 32%. At the Automatic project on the Messalonskee Stream 97% efficiency was reported on the Enkamat side and 90% efficiency on the Plinko side. No times were reported.

Exelon states that where ramp efficiency tests have been done the results are mixed. That is true in that in the above projects two had high efficiencies and one was poor. Exelon expressed concern that eels infiltrating the eelway might affect the result as happened at Lawrence. The report surmises that eels at Lawrence may have infiltrated the ramp due to gaps in the wooden channel where sections were joined or were not detected under the substrate which was not checked prior to the tests. Infiltration would not be an issue at the ramps at Conowingo as they

are aluminum trays with a climbing material where all eels in the ramp could be observed and removed prior to the test. Any concerns with shutting down the west ramp could be mitigated by installing a temporary ramp or scheduling the test when eels movement is expected to be low.

Specific Comments 1a

Maryland disagrees with the proposed attraction flow for the eel ramp (70 gpm) which results in 0.16 cfs. This ramp must attract eels away from the flow from the turbines and leakage from the spill and into the EFL; 70 gpm is virtually no attraction flow and therefore must be increased to a flow such that eels are attracted into the EFL.

Specific Comments 1b

Night time observations are reasonable as a means of observing eels in the EFL to note concentration locations and to compare observations with captures.

Specific Comments 2a

Closing diffusers would direct flow to the open channel providing a stronger signal in the open channel to guide eels to the ramp.

Specific Comments 2b

As noted above, 70 gal/min is insufficient to attract eels into the EFL. It is concerning that Exelon has proposed an eelway with no attraction flow beyond ramp and side splash flows.

Specific Comment 2c

That there is no provision in settlement to include bar racks is does not justify rejecting them.. Many modifications to both fishways have been included as designs are developed. Adding slots for bar racks is a less than minor modification to protect eels from snakeheads and other invasives lying in wait in the EFL.

References

Hickey, S.J. January 26, 2012. Letter to Mr. Steven Shepard, USFWS. Kennebec Water District Upstream and Downstream Proposal. Pg. 4.

Normandeau. 2015. Assessment of eel pass effectiveness at the Lawrence hydroelectric project (FERC No. 2800), Merrimack River, Lawrence, MA.

Woronoco Hydro. 2010. Report on the 2009 testing of the upstream passage for juvenile American eels phase i – passability testing and site observations. FERC # 2631. Accession No. 20110131-5111.

Woronoco Hydro. 2012. Report on the 2011 testing of the upstream passage of juvenile eels, Phase 1 Passability tests of all eel ladders and repeat of Phase II attractiveness testing and observations –article 404. FERC # 2631. Accession No. 20120229-5139.

From: Miller, Jeremy <jeremmille@pa.gov>
Sent: Friday, September 3, 2021 6:32 AM
To: Danucalov, Andrea H:(Exelon Power) <Andrea.Danucalov@exeloncorp.com>
Cc: Eberts, Ron <reberts@pa.gov>; Williamson, Scott <scwilliams@pa.gov>
Subject: RE: [External] American Eel Passage and Restoration Plan

Andrea,

DEP has reviewed the revised Conowingo American Eel Passage and Restoration Plan dated August 2021 and have no further comments or questions.

Thank you for the opportunity to review.

Jeremy

Jeremy Miller | Aquatic Biologist
Department of Environmental Protection | Clean Water Program
Southcentral Regional Office
909 Elmerton Ave | Harrisburg, PA 17110
Phone: 717.705.4777 | Fax: 717.705.4760
www.dep.pa.gov
DEP's 24-hour Emergency Response Number is 1.800.541.2050

Agency Comments on August 18, 2021 Draft and Exelon Responses

	Comment	How Addressed
MDE & MDNR, Received September 2, 2021		
Section 2 – Project Configuration		
1	2nd Paragraph: Be consistent with acronym definitions (i.e. define WFL. Use of both WFL and West Fish Lift is below).	WFL has been removed from the document.
2	2nd Paragraph: Figure 2.0-1 should depict all that is described in the text (i.e. spillway, abutment sections, etc.)	This figure has been updated.
Section 3.2.1 - Conowingo West Eel Collection Facility		
3	2nd Paragraph: Suggest including the elevation of the normal high-water line in the text.	The elevation of the normal high-water line has been added to the text.
4	3rd Paragraph: What is defined as 'large 60% shade cloth'. Additional clarification is needed.	The percentage listed refers to the percentage of sunlight and corresponding UV rays that are blocked by the shade cloth. This explanation has been added as a footnote to the text.
Section 3.2.1 - Octoraro Creek Eel Collection Facility		
5	2nd Paragraph: Add angle to 90-degrees.	The word "angle" has been added to the text.
6	3rd Paragraph: Define L as Liter and use consistently throughout.	L is defined as liter in Section 3.2.1, the first paragraph under Conowingo West Eel Collection Facility. The document has been checked for consistency as liter has been replaced with L in one location within the document.
Section 3.2.1 - Conowingo East Eel Collection Facility		

	Comment	How Addressed
7	How was the location of the ramp determined?	The MDE Settlement Joint Explanatory Statement, Section A.2.a.i says, "Exelon will develop an 'Eel Passage and Restoration Plan' that will (i) provide for modification of the EFL to accommodate a temporary eel trapping facility in the EFL stilling basin (the 'Temporary Eel Trapping Facility')". The MDE Settlement Draft License Article Eel Passage says, "The Eel Passage and Restoration Plan shall include (i) detailed plans for modifications to the East Fish Lift to specifically accommodate a temporary eel trapping facility at a location within the East Fish Lift stilling basin in the vicinity of the foot of the spillway ('EFL Eel Temporary Modifications')". Due to the language of the MDE Settlement draft license article, Article 415 then specifically calls for a temporary eel trapping facility at a location within the East Fish stilling basin. The MDE Settlement is referenced in Section 3.1.3. The stilling basin location allows for a water source, power source, and safety from vandalism. No facility can be placed below the spillway itself due to safety concerns. The CEECF is considered experimental and temporary. The design for the CEECF is not finalized and will be developed further, as necessary, in consultation with the resource agencies, after the design of the EFL modifications for American Shad and river herring are complete.
8	Does the attraction water come off the top of the pond?	Attraction flow water to the CEECF comes from a 6-inch gravity feed water line from the headpond near elevation 100.7 feet (full pond elevation is 109.2 feet) to valve located near the EFL. Then the water line is reduced to a 2-inch line to feed the CEECF.

	Comment	How Addressed
9	What is the general difference in water temperatures during the summer? Water temperatures in the tailrace compared to the CEECF attraction water should be recorded.	Available data from Exelon's 2010 water quality study[18] conducted during relicensing indicates there is little to no thermal stratification during summer in Conowingo Pond at sampling locations near the dam. In addition, a comparison of water temperatures measured at monitoring locations throughout the water column just upstream of the dam indicated that temperatures were comparable to those measured in the tailrace at monitoring station 643. Water temperature from the continuous monitor located in the collection tank can be compared to temperature data recorded in the tailrace at monitoring station 643.
10	The plan should describe how predators prevented from entering the EFL?	Predators will not be excluded from the EFL but will be excluded from the diffuser pits and above the crowder screen hoist by grating with 7/8-inch opening. This grating opening may change depending on the final design of the EFL modifications.
11	Clarify the amount of attraction water coming out of the entrance gate C and how that will be a signal for eels to enter the EFL	The attraction flow out of entrance gate C will be 265 L-per-minute. This is the same amount of attraction flow used at the CWECF, which as of September 2021 had captured over 580,000 moving along the west side of the tailrace, along the margin of the main generation flow. The CEECF is intended to collect eels that may move along the east side of the tailrace to the EFL entrances along the margin of the main generation flow. The amount of attraction flow has been added to Section 3.2.1.
12	The plan should describe the flows when the eel ramp will be pulled.	The ramp should be pulled when flows are forecasted to exceed 113,000 cfs. This has been added to Section 3.2.3. The ramp will be redeployed once flows have receded to a level that allow for safe access.

[18] Normandeau Associates, Inc. and Gomez and Sullivan Engineers, P.C., 2012. Seasonal and Diurnal Water Quality in Conowingo Pond and Below Conowingo Dam.

	Comment	How Addressed
13	Provide an approximate year of project initiation/operation startup. We realize this is defined in the schedule section but mention of it here is recommended.	The construction schedule for the EFL modifications for river herring and American Shad has not been finalized. The CEECF will be installed after the EFL modifications are complete. Exelon will provide schedule updates at a minimum during the annual EPAG meetings and will also update this plan accordingly and submit it to the resource agencies for review and FERC for approval. Exelon also participates in monthly design-planning meetings with resource agencies, and schedule is discussed during these meetings. This has been added to Section 3.2.1.
14	2nd Paragraph last sentence: Sentenced needs to be edited. Use of with versus will.	This sentence has been corrected.
15	3rd Paragraph: Include elevation of normal high-water line. 7th sentence: is it 'tailwater level', or 'existing tailwater elevation'.	This sentence has been revised to reference the elevation of the base of the ramp (+/-17.8 ft) relative to the minimum tailwater elevation (+/-12.9 ft) expected to occur during the operational season for the CEECF (mid-June to early November).
Section 3.2.2 – Construction		
16	Provide an estimated construction date.	The construction schedule for the EFL modifications for river herring and American Shad has not been finalized. The CEECF will be installed after the EFL modifications are complete. Exelon will provide schedule updates at a minimum during the annual EPAG meetings and will also update this plan accordingly and submit it to the resource agencies for review and FERC for approval. Exelon also participates in monthly design-planning meetings with resource agencies, and schedule is discussed during these meetings.
Section 3.2.3 – Operational Protocols: Intro		

	Comment	How Addressed
17	Re: Operation of CEECF - Diffuser gates A & B are to be open. With only 70 gal/min 'attraction flow' it might be better to close them off to get max guidance in the open channel for any eels that enter the EFL.	If eels are near the bottom of the channel, having the Diffuser C open will help guide eels into the stilling basin, otherwise they could become trapped in this area and have no way out. The situation is similar at the Crowder Area Gate. Leaving Diffuser Gate A and B open along with Crowder Area Gate will allow eels to reach the CEECF, without becoming isolated and trapped in these passages.
18	Section 3.2.3 references a schedule outlined in Section 4. Section 4 needs more detailed information detailing actual operation and monitoring schedules at all three facilities.	Section 3.2.3 should refer to Section 5, which outlines the annual schedule and duration of operation at each of the facilities. The text has been revised to reflect this. Monitoring schedules are outlined in Section 3.2.3 under the monitoring subheading.
Section 3.2.3 – Operational Protocols: Monitoring		
19	Are there specific monitoring forms? If so, please include in the plan	The CWECF Daily Field Sheet is included in Appendix E.
20	Continuous monitoring / alarm systems at both the OECF and CEECF should be considered for replacement instead of daily inspections.	30-minute readings of temperature and DO will be recorded using an Onset HOBO Probe in the collection tanks at both the CEECF and OECF. These data are downloaded and reviewed regularly to identify any water quality related issues with the operation of the facilities. Daily inspections by operation staff are an important component of maintaining the proper functioning of each facility, and Exelon does not believe discontinuing these procedures would be appropriate.
Section 3.2.3 – Operational Protocols: Inspection		
21	Page 12 states: if an inspection suggests that any structure or flow component is not performing properly and no alarm has been triggered, verification of this potential deviation will be performed as described above and corrective action will be taken as soon as possible. The plan should define this process.	Items such as faulty or incorrectly positioned attraction flow hoses or components such as a spray bar incorrectly spraying water due to blockages of the holes, etc. are examples of items included in the visual inspection. These items are not identifiable by the alarm system and must be covered during the daily inspections. Observed anomalies are recorded on the Daily Field Sheet. The CWECF Daily Field Sheet is included in Appendix E.

	Comment	How Addressed
22	Alarms are mentioned but not discussed in enough detail.	Text has been added to Section 3.2.3 (Monitoring).
23	Please reference or clarify use, operation, etc. of alarms.	Refer to text in Section 3.2.3 (Monitoring).
24	What defines a failed inspection?	The term failed inspection refers to when a facility is not operating as intended. This term and Section 3.6.2 have been revised for clarity.
Section 3.2.3 – Operational Protocols: Maintenance		
25	Will the CEECF ramp be accessible for daily clearing obstructions?	The ramp will be accessible; however, very few obstructions are anticipated to be found near the ramp area due to trash racks preventing debris from entering through the gravity feed line and no debris are expected to enter the stilling basin due to the elevation of the EFL walls that surround it.
26	Is there a process or specific procedure for scrubbing the collection tank?	Scrubbing the tanks is performed with water, a brush, and scouring pad. No chemicals are used.
27	What triggers a determination that the ramp needs to be cleaned?	The ramp will need to be cleaned if debris block or hinders passage of eels at the entrance or on the ramp.
28	Are there specific maintenance logs/sheets?	The Daily Field Sheet is used to record all information including any issues that might be observed. There is also a weekly calibration sheet that is used to verify that the eel ramp equipment is working properly.
29	Are they provided in this plan and where will they be stored?	Data sheets are in Appendix E. They are stored in files at Normandeau's office and data are digitized.
30	Is anyone qualified to conduct the monitoring and maintenance activities or will this be a requirement?	The eel ramps are checked daily by experienced personnel. If a new employee is used to assist with the ramp checks, that employee is always teamed and trained by an experienced member of the maintenance staff.
Section 3.3 – Holding (Conowingo West Eel Collection Facility)		
31	Include a reference that all eels transferred to holding tanks will be recorded on the daily inspection sheet.	This reference has been added.

	Comment	How Addressed
32	Maryland is concerned that the plan continues to recommend holding eels for seven days until water temperatures exceed 28°C on consecutive days. Eels in crowded conditions can become stressed and develop fungus, as has been observed. Eels should be transported within 48 hours of capture. A recommended alternative would be the transportation and stocking to the Conowingo Pond and Lake Aldred eels that, held 48 hours, when the number held does not meet the threshold for stocking at upriver locations.	Health of eels in holding is a top priority. The Muddy Run Eel Passage Plan call for weekly transport, but EPAG agreed that transports should occur twice per week starting in mid-June and continue through September 15. Daily transports are conducted pre-emptively before water temperatures exceed 28°C or eels become crowded. SRBC has traditionally suggesting stocking locations and the locations are approved by EPAG. Alternative stocking approaches can be discussed during annual meetings with EPAG and MDE. Exelon would propose 100 eels in holding over a 48-hour period as a threshold to determine transport to Conowingo Pond and Lake Aldred versus locations further upstream.
Section 3.3.2 – Operational Protocols		
33	What is the QA/QC process associated with the inspection sheets such that holding time and temperatures are met for transport?	The CWECF is maintained daily and decisions to transport are made in real-time based on eel condition, environmental conditions, and the number of eels in holding. A transport vehicle is on-site to facilitate the ability to conduct transports as needed.
	Section 3.3.2 – Operational Protocols / Monitoring	
34	What defines continuous? Operation is noted later as 24 hours a day 7 days a week. This implies that monitoring will be conducted non-stop during the collection season/operation.	Flow, DO, and temperature are monitored and recorded continuously at the CWECF holding tanks. These meters are in place throughout the entire collection season and operate 24/7.
35	2nd Paragraph: Please reference and maintain/update a contact list including operational personnel in the plan.	Contact lists are updated regularly and will be distributed to resource agencies, Station staff, and contractors each season.
36	4th Paragraph: Is there an elevated concentration that will trigger an alarm or just the minimum?	The upper DO threshold is 20 ppm. This has been added to the text.
37	Section 3.3.2 – Operational Protocols / Inspection Once per day? Continuous measurements on other systems and only daily for holding tanks? Please clarify.	Eel tanks are typically checked every morning. Continuous measurements of temperature, flow and DO are recorded for the holding tanks, as well as the collection tank.
Section 3.4.1 – Design		

	Comment	How Addressed
	Conowingo West Eel Collection Facility	
38	How often is the water quality probe calibrated and maintained?	Water quality data are downloaded weekly. The probe is checked weekly versus a calibrated meter, and then the probe is calibrated, as necessary.
39	Where are the calibration and maintenance forms located in this plan? *GLOBAL note for calibration forms as it is discussed in other sections of the plan*	This form has been added to Appendix E.
40	Appendix F references engineering drawings for transport facility. Are there drawings for the 19-L buckets and enclosed transport tank?	There are no engineering drawings for the 19-L buckets or the smaller enclosed transport tank. Pictures of these have been provided in Appendix F.
	Octoraro Creek Eel Collection Facility	
41	The holding tank has a capacity of 3,140 eels. The transport truck for more than 150 eels is a 250 liter tank which can transport 2,500 eels. In 2021, more than 2,500 eels were collected on July 13 – 3,474, 14 – 4,738 and 15 – 6,168. The plan should describe operations when more eels are collected in a single day than the holding tank or the transport tank can accommodate.	Under these circumstances, multiple trips to transport eels from the OECF to the CWECF holding tanks are made. This has description has been included in text in Section 3.4.1.
42	How are the 19-L buckets loaded and transported?	The 19-L buckets are manually loaded into a custom-made bucket holder that keeps the buckets from tipping over during transport via a small cart.
	Conowingo East Eel Collection Facility	
43	How are 19-L buckets transported?	A small cart will be used to transport buckets or the 250-L transport tank from the EFL area to the CWECF holding tanks.
44	What are the plans to transport eels from CEECF to CWECF if a significant number of eels are collected? All in the 19-L bucket?	All the eels will be transported in the 19-L buckets or the 250-L transport tank with supplied oxygen.
Section 3.4.2 Operation Protocols Monitoring (1st Paragraph):		
45	Will this be an area of concern if the capacity of the holding tanks are continuously met and/or water temperatures exceed 28-degrees C?	Daily transports will occur if water temperatures exceed 28°C, and multiple daily transports could occur if holding capacity is expected to be exceeded at the CWECF.

	Comment	How Addressed
46	How are oxygen levels monitored and maintained?	At the CWECF, oxygen levels are continuously monitored by a probe. The results are automatically sent to a control panel, which is connected to the Conowingo control room. At the OECF, oxygen levels and water temperature are monitored with an Onset HOBO Probe. Oxygen levels are maintained at the CWECF and will be maintained at the CEECF with an oxygen bottle, regulator, and micro-pore diffuser. Currently, there is no oxygen bottle at OCEF, but there are two battery-powered bubblers that provide DO augmentation to the collection tank. Oxygen levels in the transport tank are maintained with oxygen bottle, regulator, and diffuser.
47	What is the calibration program for monitoring these levels?	Probes (CWECF and transport tank) and Onset HOBO Probes (OECF) are checked and calibrated weekly, and data, where applicable, are downloaded weekly.
48	Section 3.4.2 Operation Protocols Temperature Please provide additional detail on how the temperature will be monitored.	During transport events, water temperature is monitored with the same meter used to monitor DO; the probe measures both parameters.
49	Section 3.4.2 Operation Protocols Dissolved Oxygen Regarding prior note on calibration protocols – this should be addressed in the plan.	See response to Comment # 47.
50	Section 3.4.2 Operation Protocols Inspection (1st Paragraph) Please reference and provide an inspection check list.	Refer to Transport Data Sheet in Appendix E.
Section 3.4.2	Operation Protocols Inspection (2nd Paragraph)	
51	How and where is this data recorded - data logger or field form?	Refer to Transport Data Sheet in Appendix E.
52	Please define the criteria for passing inspection. This is a vague statement.	The first sentence under Inspection has been changed to read, “Prior to each trip, the transport truck and associated equipment will be inspected to confirm that all equipment is operating as intended.”
	Section 3.4.2 Operation Protocols Maintenance	
53	What is defined as the facility? Conowingo?	The term “facility” has been edited to “CWECF”.

	Comment	How Addressed
54	Clarify the meaning here. Are you saying all tanks will be cleaned weekly?	All tanks that are in use will be cleaned at least weekly.
55	Section 3.4.2 Operation Protocols American Eel Counting (1st Paragraph) Is it determined or recorded?	The text has been revised to use the term "recorded."
Section 3.4.2 Operation Protocols American Eel Counting (2nd Paragraph)		
56	What does this evaluation consider?	Mortality is not an evaluation but rather a determination. The term has been changed in the text.
57	Will all deceased eels float to the top of the tank or remain in the tank after release?	Freshly dead eels sink. They are removed by netting. Only when a small proportion of eels are left in the holding tank are they flushed. All eels are checked prior to loading into transport tank.
58	At the release site how long is the area inspected to evaluate for mortality?	The stocking location is monitored until the water returns to pre-stocking conditions (i.e. water and sediment have settled following stocking). Most eels will seek cover as soon as they are stocked. Eels that have died will be visible lying belly-up and motionless on the stream bottom. Dead eels are retrieved by the stocking crew when access allows.
59	Is the mortality evaluation process defined or is it subjective depending on the transport staff?	The word evaluated has been changed to "determined". An eel is either "alive "or "dead", hence there is no subjectivity.
60	Section 3.6 – Emergency Response Protocols Maryland advises that if 95% survival is not achieved then modifications are deemed necessary.	As stated in the plan, Exelon will meet with resource agencies to develop appropriate modifications for the facilities, if the survival goal is not met. In previous years of operation of the CWECF and OECF facilities, Exelon has met the 95% survival standard each year.
	Section 3.6.1 – Alarms and Contacts	
61	The contact list should be maintained, updated and provided in this plan.	Contact lists are updated regularly and will be distributed to resource agencies, Station staff, and contractors each season.
62	Is temperature included in the alarm system process?	There is no temperature alarm, as temperature cannot be adjusted. However, temperature is monitored continuously and recorded. Eel condition and daily water temperature are used to inform the transport schedule.

	Comment	How Addressed
Section 3.6.2 – Failed Inspections (2nd Paragraph)		Section 3.6.2 has been renamed Inspection Response, which is more accurate than Failed Inspections Protocols.
63	All inspections, passed or failed will be recorded how?	Notes detailing the issue will be recorded in the Comments section of the Daily Field Sheet or the Transport Sheet.
64	Where are the forms/sheets documenting the inspections?	The forms are included in Appendix E.
Section 3.7 – Quality Assurance and Quality Control		
65	A QA/QC plan should be developed and included as an appendix.	The QA/QC measures related to the eel program are described throughout Section 3 of this document for each facility, and inspection forms and data sheets are included as Appendices.
66	Please define training requirements and how training records will be maintained.	Supervising biologist train new staff members, who are subject to internal review. Most of the training is hands-on. A new or inexperienced staff member never leads the daily crew. Additionally, all operating personnel are required to read and understand the Conowingo Fishway Operation and Maintenance Plan.
67	Table 3.5-1: In support of stocking locations, consider adding written directions and/or maps from Conowingo Dam to each of the stocking locations. In the event a new driver is needed how will they locate the site?	All "drivers" are biologists with several seasons of experience. Maps are no longer required as most cell phones have apps for directions and rerouting capabilities when a specific road is closed due to accidents, etc.
68	Section 4 – Implementation Schedule We believe the second sentence should be both CWECF and CEECF.	This sentence has been revised for clarity. It is only referring to the CWECF. The CEECF will begin operation one year after the EFL modifications are complete.
Section 6 – Reporting and Meetings		
70	Plan should identify (and be updated) as to which emails and staff receive these reports.	Confidential contact lists including Exelon staff, consultants, and resource agencies, are kept separately from this publicly accessible report. Contact lists are updated regularly.

	Comment	How Addressed
71	Daily reports should include alarms, maintenance and cleaning operations that occurred if any	It is preferable to detail these issues if they occur in a section of the annual report. Exelon does notify the resource agencies when there is an issue with any of the eel ramps by email. The daily emails should be succinct and brief unless an unexpected situation arises.
72	Section 6.1.2 - Annual Reports Draft reports for the CWECF and CEECF are proposed to be submitted on December 1 (up to Sept 15) and December 31 (16th to end of season). Final report filing dates are February 15. While time may be short between the end of the eel passage season and December 1, it is much preferable that there be only one report for the season.	The Muddy Run Pumped Storage Project License Appendix A requires Exelon to submit draft annual reports to resource agencies for the CWECF and OECF summarizing eel facility data by December 10 each year and final reports to FERC by January 15. MDE, PADEP, SRBC, and USFWS were consulted regarding draft report submission during a meeting on October 1, 2020. Exelon stated at that time that providing a quality draft report by December 10 that covers the longer MDE-defined season at CWECF is not feasible and proposed submitting only one draft report at a later date. However, PADEP and USFWS agreed that a draft report must still be submitted by December 10 per the Muddy Run License. They acknowledged that including additional data from operations through mid-November was not feasible and it was agreed that additional September 16 through early November data should be added to the report later as an addendum. The addendum will not include additional biological data. MDE asked if the interim draft would be provided to them and Exelon agreed that all eel facility interim draft reports would be provided to all resource agencies.
Appendix I - Agency Consultation Records		

	Comment	How Addressed
73	General Comments #4 The recommended shakedown period was not intended for ramp efficiency (efficiency test) but to see if eels were attracted into the EFL and then to the ramp location. With additional attraction flow (See comment 1a below) a shakedown period will still be necessary. Tweaks are standard practice as indicated by the many tweaks and upgrades at the CWEFC and the shakedown periods for the rebuilt east and west fish lifts. Maryland would again strongly recommend a period of time when tweaks and upgrades be made and this time period not counted towards a fully functioning CEEFC evaluation period.	The CEECF is an experimental ramp. Exelon is proposing to begin operation of the ramp as outlined in this Plan. Adjustments to the attraction flow and other operational parameters can be considered at annual EPAG meetings, as necessary, after the initial installation and operation of the CEECF is evaluated.
74	General Comments #8 Maryland disagrees with Exelon in that ramp efficiency testing technology is not available. Determining the efficiency of an eel ramp is feasible and has been done at a number of other projects. As Exelon described, a ramp efficiency test is simple. Enclose a known number of eels at the bottom of the ramp, which has been cleared of eels, and count the number in the capture/holding tank at the top over a fixed period such as 6, 12, 18, 24, etc. hours. Ramp efficiency has been evaluated on three ladders at the Woronoco project (FERC # 2631) on the Westfield River in Massachusetts (Woronoco 2010 & 2012), at the Lawrence dam (FERC # 2800) on the Merrimack River in Massachusetts (Normandeau 2015), and on the Messalonskee Stream in Maine (Hickey 2012). In all cases, eelway efficiency was determined. At Woronoco the results were 99% in 96 hours at the North Ladder, 93% at the Middle Ladder in 66 hours, and 100% at the South Ladder in 18 hours. At the Lawrence Dam results after 36 hours were 55% and 32%. At the Automatic project on the Messalonskee Stream 97% efficiency was reported on the Enkamat side and 90% efficiency on the Plinko side. No times were reported. Exelon states that where ramp efficiency tests have been done the results are mixed. That is true in that in the above projects two had high efficiencies and one was poor. Exelon expressed concern that eels infiltrating the eelway might affect the result as happened at Lawrence. The report surmises that eels at Lawrence may have infiltrated the ramp due to gaps in the wooden channel where sections were joined or were not detected under the substrate which was not checked prior to the tests. Infiltration would not be an issue at the ramps at Conowingo as they are aluminum trays with a climbing material where all eels in the ramp could be observed and removed prior to the test. Any concerns with shutting down the west ramp could be mitigated by installing a temporary ramp or scheduling the test when eels movement is expected to be low.	Exelon would prefer to complete attraction efficiency and ramp efficiency testing using a single, proven technology. Proven technology for attraction efficiency (such as appropriately sized tags) is not available. Discussion of technological developments will continue at annual EPAG meetings with resource agencies. Regarding ramp efficiency only, Exelon will draft a study plan for an efficiency test in 2022, as suggested by MDE. The draft study plan will be provided to EPAG members and USFWS and will be implemented following approval of this Plan.

	Comment	How Addressed
75	Specific Comments 1a Maryland disagrees with the proposed attraction flow for the eel ramp (70 gpm) which results in 0.16 cfs. This ramp must attract eels away from the flow from the turbines and leakage from the spill and into the EFL; 70 gpm is virtually no attraction flow and therefore must be increased to a flow such that eels are attracted into the EFL.	The CWECF currently operates with the same attraction flow as proposed for the CEECF. The CWECF must also attract eels away from turbines and up the riprap on the streambank. In 2021, over 580,000 eels (as of September) were captured at the CWECF. The CEECF is an experimental ramp. Exelon is proposing to begin operation of the ramp with the 265 L-per-minute (70-gpm) attraction flow. Adjustments to the attraction flow can be considered annually at EPAG meetings, as necessary, after the initial installation and operation of the CEECF is evaluated.
76	Specific Comments 1b Night time observations are reasonable as a means of observing eels in the EFL to note concentration locations and to compare observations with captures.	Exelon is proposing that the need for nighttime observations be discussed after initial installation and operation of the CEECF. The scope and level of effort for any nighttime observations can be discussed annually at EPAG meetings and implemented accordingly.
77	Specific Comments 2a Closing diffusers would direct flow to the open channel providing a stronger signal in the open channel to guide eels to the ramp.	Exelon is proposing to begin the initial operation of the CEECF with the diffusers opened. Alternative diffuser gate settings can be considered annually at EPAG meetings, as necessary, after the initial installation and operation of the CEECF is evaluated.
78	Specific Comments 2b As noted above, 70 gal/min is insufficient to attract eels into the EFL. It is concerning that Exelon has proposed an eelway with no attraction flow beyond ramp and side splash flows.	The CWECF currently operates with the same attraction flow as proposed for the CEECF. The CWECF must also attract eels away from turbines and up the riprap on the streambank. In 2021, over 580,000 eels were captured at the CWECF by early September. The CEECF is an experimental ramp. Exelon is proposing to begin operation of the ramp with the 265 L-per-minute (70-gpm) attraction flow. Adjustments to the attraction flow can be considered annually at EPAG meetings, as necessary, after the initial installation and operation of the CEECF is evaluated.

	Comment	How Addressed
79	Specific Comment 2c That there is no provision in settlement to include bar racks is does not justify rejecting them. Many modifications to both fishways have been included as designs are developed. Adding slots for bar racks is a less than minor modification to protect eels from snakeheads and other invasives lying in wait in the EFL.	Predators will be excluded from the diffuser pits and above the crowder screen hoist by grating with 7/8-inch opening. This grating opening may change depending on the final design of the EFL modifications. Exelon will consider the need for additional predator exclusion devices (i.e., bar racks on the C gate entrance) as part of the EFL modification design process for American Shad and river herring. Any design must consider worker safety and access constraints during installation and removal of the bar racks.

APPENDIX I. AGENCY COMMENTS AND RESPONSIVENESS SUMMARY

Appendix I Table of Contents

November 2022 Draft FOMP – Resource Agency Comment Responsiveness Summary

November 2022 Draft FOMP – Resource Agency Comment Letters

November 2022 Draft FOMP – Resource Agency Comment Responsiveness Summary

Comment	Response
MDE in coordination with MDNR, dated December 16, 2022,	
Appendices- Please update the appendices and only include what is needed for the revised plan (e.g., is the Whoosh System Information still valid in 2023?)	Appendix B (Whoosh System Information has been removed.
Introduction Paragraph 6 – Last Sentence· Is it assumed that reassessment will be based on an estimate of the actual fish count? Please clarify.	Reassessment will be based on the total number of those fish transported, not on the actual fish count since some fish are sacrificed for biological information and some fish die during holding events or during lift operations. Fish transport numbers will vary throughout the season due to variations in the daily fish catch at each fish lift.
Section 3.1: Turbine Start-Up and Operation· Please provide clarifying text (i.e. give an example) that defines/explains the sequence in relation to Unit No. On and Unit No. Off. Without this description/explanation, the reader is likely to get confused as to why in the 6th Sequence Unit No. 11 is both On and Off.	The text in Section 3.1 and Table 3.1-1 have been revised to clarify the turbine operation order.
Section 4.3.1.1 West Fish Lift Third Paragraph · Please clarify that the hopper isn't lowered into the hopper bay while fish are present in the bay. · Please rephrase/define the process (i.e. state that the crowder doors have remained closed overnight since the last lift (i.e. unlikely any fish will be in the hopper bay).	Text has been added to Section 4.3.1.1. Please note that the hopper may be lowered when fish are present in the hopper pit, but the hopper door, located on the bottom of the hopper is open as it is lowered slowly to the bottom and fish can and do escape through the open door or around the sides of the hopper during its descent. The WFL crowder doors do remain closed overnight, but our experience has shown that some fish are able to enter the crowder channel with the doors closed. Divers have inspected

	the WFL several times but have not been able to determine how fish bypass the crowder doors. We anticipate that the WFL modifications will alleviate this issue.
Section 4.3.1.2 East Fish Lift Second Paragraph · This version of the report can be edited as to not reflect volitional passage (i.e., for 2023) · Refer to similar note from Section 4.3.1.1 re: potential presence of fish in the hopper bay prior to lowering the hopper. · Please clarify if there is a 'clean out' lift for the EFL? If not, please define why for the WFL and not the EFL?	Text has been edited in Section 4.3.1.2. References to volitional passage has been removed. The EFL has a crowder hoist screen which is lowered prior to the hopper being raised out of the channel. The crowder hoist screen stays down to prevent fish from entering the hopper pit area until the hopper is placed back down in the hopper pit. The crowder hoist screen is then raised allowing fish to enter hopper area. There is no "clean out" lift for the EFL because of the crowder hoist screen prevents fish from entering hopper area overnight. The current WFL does not have a crowder hoist screen and some fish have been known to get passed the closed crowder doors at the WFL.
Section 4.3.2.1 West Fish Lift · Please define how debris is removed when 'occasional cleaning is needed'?	Text has been added to Section 4.3.2.1 to define debris removal.
Section 4.5.1 First Paragraph · Please provide a time frame of when the contact list will be posted and how often it will be updated.	Text has been added to Section 4.5.1 to define time frame of the contact list and when it will be updated.
USFWS, dated December 16, 2022	
In the Introduction, it would be helpful to provide a brief bulleted list of items that have changed in this FOMP compared to the previous FOMP.	A list has been added in Section 1.0 describing major items that have changed with the annual revision of the FOMP.

Section 4.3.1.1: Although it is assumed, it may be useful to new readers to indicate that all fish not removed for transport or for AIS disposal are returned to the tailrace.	Text has been added to Section 4.3.1.1.
Section 4.6: Bullet 2 – Daily water temperature and dissolved oxygen (DO, after May 1) data are to be collected daily at the fish lifts and in the tailwater area. Those data were not fully collected/reported in the 2022 FOMP Report. In 2023, daily water temperature collection and reporting should occur for each day (including nonoperational days) of the fish passage season. In addition, if water temperatures are collected at Station 643 after May 1, please include those data in the annual report in addition to temperatures collected daily at the WFL. Temperature data from Station 643 should not replace WFL temperature monitoring unless concurrent sampling at both stations can demonstrate that similar data are collected at both locations. In addition, tracking DO concentrations in water flowing from Conowingo Pond into the WFL is critical to ensuring that sufficient DO concentrations are present for fish entering the WFL during the latter (warmer) part of the season. The Service requests collection of DO data to occur daily at the WFL location during the entire fish passage season. Monitoring of DO at the WFL could be discontinued after May 1 if concurrent sampling between the WFL and Station 643 show similar data are being collected at both locations.	Text has been added to Section 4.6 Bullet 2. Daily water temperature will be collected at 1100 hours during the fish passage season outside of the WFL in the tailrace. A continuous water temperature and dissolved oxygen logger will be installed in the WFL near the picketed barrier. The logger will record water temperature and dissolved oxygen every thirty minutes to be compared with Station 643 at the end of the fish passage season.
Section 4.6: Last Bullet - Please replace the text to reflect this updated collection protocol for river herring: River herring will also be sacrificed for biological information. Every 20th river herring of each species (Alewife and Blueback Herring) will be sacrificed with a maximum collection of 50 individuals per species from the project. River herring will be processed similar to American Shad. Additionally, any river herring mortalities resulting from lifting, sorting, handling, or transporting will be retained for analysis.	The requested revisions to Section 4.6, last bullet were made.

November 2022 Draft FOMP – Resource Agency Comment Letters

From:	David Seaborn -MDE-
To:	Kendra Gorski
Cc:	Kirk Smith; Danucalov, Andrea H:(Constellation Power); Bleistine, Ray; Mike.Cox@ERM.com; David Frazier; Eberts, Ron; Eyler, Sheila; Henning, Aaron; jesus_morales@fws.gov; Martinek, Michael; McCorkle, Richard; Miller, Jeremy; Minkkinen, Steve; Sadzinski, Robert; Seaman, Shawn; Smith, Fred; 'Steffy, Luanne'; Tryninewski, Joshua; Williamson, Scott; Heather Nelson -MDE-; Tony Prochaska -DNR-; Brett Coakley -DNR-; Donald Pugh; Matthew Jargowsky -DNR-; emily.zollweg-horan@dec.ny.gov; Joseph Petre
Subject:	EXTERNAL EMAIL -Re: Conowingo Fishway Operations and Maintenance Plan for the 2023 passage season
Date:	Friday, December 16, 2022 10:43:01 AM
Attachments:	image002.png

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Ms. Gosrki,

Thank you for the opportunity to provide comments on the 2023 Draft Conowingo FOMP. Maryland (MDE in coordination with MDNR) has the following comments:

Appendices

- Please update the appendices and only include what is needed for the revised plan (*e.g.* is the Whoosh System Information still valid in 2023?)

Introduction Paragraph 6 – Last Sentence

- Is it assumed that reassessment will be based on an estimate of the actual fish count? Please clarify.

Section 3.1: Turbine Start-Up and Operation

- Please provide clarifying text (*i.e.* give an example) that defines/explains the sequence in relation to Unit No. On and Unit No. Off. Without this description/explanation, the reader is likely to get confused as to why in the 6th Sequence Unit No. 11 is both On and Off.

Section 4.3.1.1 West Fish Lift Third Paragraph

- Please clarify that the hopper isn't lowered into the hopper bay while fish are present in the bay.

- Please rephrase/define the process (*i.e.* state that the crowder doors have remained closed overnight since the last lift (*i.e.* unlikely any fish will be in the hopper bay).

Section 4.3.1.2 East Fish Lift Second Paragraph

- This version of the report can be edited as to not reflect volitional passage (*i.e.* for 2023)

- Refer to similar note from Section 4.3.1.1 re: potential presence of fish in the hopper bay prior to lowering the hopper.

- Please clarify if there is a 'clean out' lift for the EFL? If not, please define why for the WFL and not the EFL?

Section 4.3.2.1 West Fish Lift

- Please define how debris is removed when 'occasional cleaning is needed'?

Section 4.5.1 First Paragraph

- Please provide a time frame of when the contact list will be posted and how often it will be updated.

On Fri, Nov 18, 2022 at 3:45 PM Kendra Gorski <kgorski@gomezandsullivan.com> wrote:

> Hello,
>
> Please see the attached the Constellation Conowingo Fishway Operations and Maintenance Plan for the 2023 passage season.
>
> Conowingo_FOMP_2023.pdf
>
> Constellation is requesting that comments be provided to Andrea Danucalov by December 17, 2022 so that the final report can be filed with FERC.
>
> Thank you,
>
> Kendra
>
> GOMEZ AND SULLIVAN ENGINEERS
>
> Kendra Gorski
>
> Environmental Scientist

Gomez and Sullivan Engineers, D.P.C.

1961 Wehrle Drive, Suite 12

Williamsville, NY 14221

Direct: 716-402-6811

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kgorski@gomezandsullivan.com

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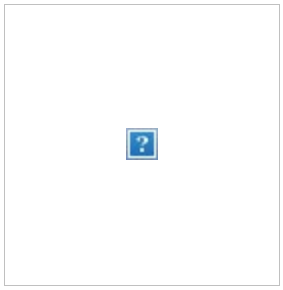

David Seaborn, Ph.D.
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443-621-1009 (C)
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Click here to complete a three question customer experience survey.

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From:	Eyler, Sheila
To:	Kendra Gorski; Kirk Smith; Danucalov, Andrea H:(Constellation Power); Bleistine, Ray; Mike.Cox@ERM.com; David Frazier; Eberts, Ron; "Henning, Aaron"; Morales, Jesus J; Martinek, Michael; McCorkle, Richard; "Miller, Jeremy"; Minkkinen, Steve; "Sadzinski, Robert"; "Seaman, Shawn"; Smith, Fred; lsteffy@srbc.net; "Tryninewski, Joshua"; "Williamson, Scott"; Heather Nelson -MDE-; tony.prochaska@maryland.gov; Brett Coakley -DNR-; David Seaborn -MDE-; don.pugh; Matthew Jargowsky -DNR-; emily.zollweg-horan@dec.ny.gov
Cc:	Joseph Petre
Subject:	EXTERNAL EMAIL -Re: [EXTERNAL] Conowingo Fishway Operations and Maintenance Plan for the 2023 passage season
Date:	Friday, December 16, 2022 10:12:42 AM
Attachments:	image002.png

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Ms. Gosrki,

Thank you for the opportunity to provide comments on the Draft Conowingo FOMP for 2023. The Service submits the following comments and recommended edits for your consideration:

- In the Introduction, it would be helpful to provide a brief bulleted list of items that have changed in this FOMP compared to the previous FOMP.
- Section 4.3.1.1: Although it is assumed, it may be useful to new readers to indicate that all fish not removed for transport or for AIS disposal are returned to the tailrace.
- Section 4.6:
    - Bullet 2 – Daily water temperature and dissolved oxygen (DO, after May 1) data are to be collected daily at the fish lifts and in the tailwater area. Those data were not fully collected/reported in the 2022 FOMP Report. In 2023, daily water temperature collection and reporting should occur for each day (including non-operational days) of the fish passage season. In addition, if water temperatures are collected at Station 643 after May 1, please include those data in the annual report in addition to temperatures collected daily at the WFL. Temperature data from Station 643 should not replace WFL temperature monitoring unless concurrent sampling at both stations can demonstrate that similar data are collected at both locations. In addition, tracking DO concentrations in water flowing from Conowingo Pond into the WFL is critical to ensuring that sufficient DO concentrations are present for fish entering the WFL during the latter (warmer) part of the season. The Service requests collection of DO data to occur daily at the WFL location during the entire fish passage season. Monitoring of DO at the WFL could be discontinued after May 1 if concurrent sampling between the WFL and Station 643 show similar data are being collected at both locations.
    - Last Bullet - Please replace the text to reflect this updated collection protocol for river herring: *River herring will also be sacrificed for biological information. Every 20th river herring of each species (Alewife and Blueback Herring) will be sacrificed with a maximum collection of 50 individuals per species from the project. River herring will be processed similar to American Shad. Additionally, any river herring mortalities resulting from lifting, sorting, handling, or transporting will be retained*

for analysis.

Let me know if you have any questions or would like a meeting to discuss these items further.

Sheila Eyler
U.S. Fish and Wildlife Service
Mid-Atlantic Fish & Wildlife Conservation Office
717-387-2117

From: Kendra Gorski <kgorski@gomezandsullivan.com>
Sent: Friday, November 18, 2022 3:45 PM
To: Kirk Smith <ksmith@gomezandsullivan.com>; Danucalov, Andrea H:(Constellation Power) <u000ahd@constellation.com>; Bleistine, Ray <rbleistine@normandeau.com>; Mike.Cox@ERM.com <Mike.Cox@ERM.com>; David Frazier <dfrazier@gomezandsullivan.com>; Eberts, Ron <reberts@pa.gov>; Eyler, Sheila <sheila_eyler@fws.gov>; 'Henning, Aaron' <ahenning@srbc.net>; Morales, Jesus J <jesus_morales@fws.gov>; Martinek, Michael <mmartinek@normandeau.com>; McCorkle, Richard <richard_mccorkle@fws.gov>; 'Miller, Jeremy' <jeremmille@pa.gov>; Minkkinen, Steve <steve_minkkinen@fws.gov>; 'Sadzinski, Robert' <bob.sadzinski@maryland.gov>; 'Seaman, Shawn' <shawn.seaman@maryland.gov>; Smith, Fred <fredp.smith@exeloncorp.com>; lsteffy@srbc.net <lsteffy@srbc.net>; 'Tryninewski, Joshua' <jtryninews@pa.gov>; 'Williamson, Scott' <scwilliams@pa.gov>; Heather Nelson -MDE- <hnelson@maryland.gov>; tony.prochaska@maryland.gov <tony.prochaska@maryland.gov>; Brett Coakley -DNR- <brett.coakley@maryland.gov>; David Seaborn -MDE- <david.seaborn@maryland.gov>; don.pugh <don.pugh@outlook.com>; Matthew Jargowsky -DNR- <matthew.jargowsky@maryland.gov>; emily.zollweg-horan@dec.ny.gov <emily.zollweg-horan@dec.ny.gov>
Cc: Joseph Petre <jpetre@gomezandsullivan.com>
Subject: [EXTERNAL] Conowingo Fishway Operations and Maintenance Plan for the 2023 passage season

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Hello,

Please see the attached the Constellation Conowingo Fishway Operations and Maintenance Plan for the 2023 passage season.
Conowingo_FOMP_2023.pdf
Constellation is requesting that comments be provided to Andrea Danucalov by December 17, 2022 so that the final report can be filed with FERC.

Thank you,
Kendra

Kendra Gorski
Environmental Scientist
Gomez and Sullivan Engineers, D.P.C.
1961 Wehrle Drive, Suite 12
Williamsville, NY 14221
Direct: 716-402-6811
Office: 716-250-4960
kgorski@gomezandsullivan.com

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From:	Eberts, Ron
To:	Danucalov, Andrea H:(Constellation Power); Kendra Gorski
Cc:	Kirk Smith; Danucalov, Andrea H:(Constellation Power); Bleistine, Ray; Mike.Cox@ERM.com; David Frazier; Sheila Eyler; Aaron Henning; jesus_morales@fws.gov; Martinek, Michael; McCorkle, Richard; Miller, Jeremy; Minkkinen, Steve; Sadzinski, Robert; Seaman, Shawn; Smith, Fred; 'Steffy, Luanne'; Tryninewski, Joshua; Williamson, Scott; Heather Nelson -MDE-; Tony Prochaska -DNR-; Brett Coakley -DNR-; Donald Pugh; Matthew Jargowsky -DNR-; emily.zollweg-horan@dec.ny.gov; Joseph Petre
Subject:	EXTERNAL EMAIL -RE: Conowingo Fishway Operations and Maintenance Plan for the 2023 passage season
Date:	Monday, December 19, 2022 2:26:40 PM
Attachments:	image001.png

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Andrea,

PA DEP has reviewed the 2023 Conowingo FOMP and does not have any suggested changes.

Thank you,

Ronald C. Eberts, Jr. | Environmental Protection Compliance Specialist
Department of Environmental Protection
Southcentral Regional Office
Waterways & Wetlands Program
909 Elmerton Avenue | Harrisburg, PA 17110
Phone: 717.705.4819| Fax: 717.705.4760
THE SOUTHCENTRAL REGIONAL OFFICE AFTER HOURS REPORTING & 24 HOUR EMERGENCY RESPONSE NUMBER: 1-800-541-2050.

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On Fri, Nov 18, 2022 at 3:45 PM Kendra Gorski <kgorski@gomezandsullivan.com> wrote:

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Kendra Gorski
Environmental Scientist
Gomez and Sullivan Engineers, D.P.C.
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--

David Seaborn, Ph.D.
Deputy Program Manager, Wetlands and Waterways Protection Program
Water and Science Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, Maryland 21230
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410-537-4465 (O)
443-621-1009 (C)
Website | Facebook | Twitter

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Attachment F

Conowingo Hydroelectric Project
(FERC Project No. 405)

Final Study Report Maryland Darter Survey Revised Study Plan
("RSP 3.10")

FINAL STUDY REPORT
MARYLAND DARTER SURVEY
RSP 3.10

CONOWINGO HYDROELECTRIC PROJECT

FERC PROJECT NUMBER 405

Prepared for:

Exelon.

Prepared by:

Normandeau Associates, Inc.

Gomez and Sullivan Engineers, P.C.

August 2012

EXECUTIVE SUMMARY

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt Conowingo Hydroelectric Project (Conowingo Project). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014. FERC issued the final study plan determination for the Project on February 4, 2010, approving the revised study plan with certain modifications.

The final study plan determination required Exelon to conduct surveys for Maryland darter (*Etheostoma sellare*), which is the subject of this report. The objective of this study was to determine if Maryland darter are present in the Susquehanna River below Conowingo Dam and/or the lower riffles of Deer and Octoraro creeks.

An initial study report (ISR) was filed on February 22, 2011, containing Exelon's 2010 and January 2011 study findings. An initial study report meeting was held on March 9, 10, and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May 27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) was filed on January 23, 2012 describing the combined results of the 2010 and 2011 Maryland darter surveys. This final study report is being filed with the Final License Application for the Project.

Maryland darter surveys were initiated in October 2010 and concluded in early December 2011. Sampling in Deer and Octoraro creeks utilized electrofishing with a seine, and snorkeling. Twenty-four locations were sampled in Deer Creek and twelve locations were sampled in Octoraro Creek. The locations in Deer Creek included the riffle under the Stafford Bridge, the only location where Maryland darter has ever been recorded in Deer Creek, as well as many locations upstream and downstream of the Stafford Bridge. Sampling in the lower Susquehanna River using an electrified benthic trawl, supplemented with snorkeling and electrofishing (backpack electrofisher), was conducted between January and early December 2011. One hundred eighty-two locations in the lower Susquehanna River were sampled during the study. No Maryland darters were recorded; however, five of the six darter species that have been recorded in the lower Susquehanna River basin were collected, including the congeners *E. blennioides, E. zonale, and E. olmstedi*.

The program was successful in collecting fish of a wide range of sizes and species. Fifty-four species representing 13 families were collected, with 49 species from Deer Creek, 46 species from Octoraro Creek, and 40 species from the Susquehanna River. A total of 9,036 darters were collected and observed during this study program. The multiple sampling techniques employed over many locations, have demonstrated that fishes of similar size, morphology, and phylogeny to Maryland darter have been readily sampled.

The objective of conducting a thorough survey for Maryland darter in the lower Susquehanna River and lower reaches of Deer Creek and Octoraro Creek was accomplished. The Maryland darter has not been recorded since 1988 even though substantial effort has been expended in those specific areas where it had been recorded historically as well as extensive adjacent areas in Deer Creek (and Swan Creek and Gashey's Run), in Octoraro Creek, and in the Susquehanna River. With 182 sites sampled over four seasons and using multiple gear types, this survey represents the major sampling effort specifically for Maryland darter in the Susquehanna River. This information supplements other recent Maryland darter surveys in the river with the same gear that were supported by USFWS and MDNR.

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LIST OF ABBREVIATIONS

cfs	cubic feet per second
FERC	Federal Energy Regulatory Commission
ft	foot/feet
ILP	Integrated Licensing Process
ISR	Initial Study Report
MDNR	Maryland Department of Natural Resources
MW	Megawatt
NOI	Notice of Intent
PAD	Pre-Application Document
PSP	Preliminary Study Proposal
RM	River mile
RSP	Revised Study Proposal
SRBC	Susquehanna River Basin Commission
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USR	Updated Study Report
W	watt

1.0 INTRODUCTION

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt (MW) Conowingo Hydroelectric Project (Project). Exelon is applying for a new license using the FERC's Integrated Licensing Process (ILP). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014.

Exelon filed its Pre-Application Document (PAD) and Notice of Intent (NOI) with FERC on March 12, 2009. On June 11 and 12, 2009, a location visit and two scoping meetings were held at the Project for resource agencies and interested members of the public. Following these meetings, formal study requests were filed with FERC by several resource agencies. Many of these study requests were included in Exelon's Proposed Study Plan (PSP), which was filed on August 24, 2009. On September 22 and 23, 2009, Exelon held a meeting with resource agencies and interested members of the public to discuss the PSP.

Formal comments on the PSP were filed with FERC on November 22, 2009 by Commission staff and several resource agencies. Exelon filed a Revised Study Plan (RSP) for the Project on December 22, 2009. FERC issued the final study plan determination for the Project on February 4, 2010, approving the RSP with certain modifications.

The final study plan determination required Exelon to conduct surveys in 2010 and 2011 for Maryland darter (*Etheostoma sellare*), which is the subject of this report. The objective of this study was to determine if Maryland darter is present in the Susquehanna River below Conowingo Dam and/or the lower riffles of Deer and Octoraro creeks.

An initial study report (ISR) was filed on February 22, 2011, containing Exelon's 2010 study findings. An initial study report meeting was held on March 9, 10, and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May 27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) was filed on January 23, 2012 describing the combined results of the 2010 and 2011 Maryland darter surveys. This final study report is being filed with the Final License Application for the Project.

2.0 BACKGROUND

The Susquehanna River below Conowingo Dam flows approximately 10 miles before entering the Chesapeake Bay. The river is tidal up to the mouth of Deer Creek (a west side tributary with confluence at river mile (RM) 7). Octoraro Creek enters the river from the east at approximately RM 10.

2.1 Conowingo Project Operations

The Conowingo Project uses limited active storage within Conowingo Pond for generation purposes. Maximum hydraulic capacity of the Conowingo powerhouse is 86,000 cubic feet per second (cfs). The current minimum flow requirements below Conowingo Dam were formally established with the signing of a settlement agreement in 1989 between the Project owners and several federal and state resource agencies (46 FERC ¶61,063) (FERC 1989). The established minimum flow regime below Conowingo Dam is the following:

March 1 – March 31	3,500 cfs or natural river flow
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
December 1 – February 28	3,500 cfs intermittent (maximum six hours off followed by equal amount on)

The downstream discharge must equal these values or the discharge (natural river flow) measured at the Susquehanna River at the Marietta United States Geological Survey (USGS) gage (No. 01576000), whichever is less. The Marietta USGS gage is located approximately 35 miles upstream of Conowingo Dam above the Safe Harbor Dam.

2.2 Historic Occurrence of Maryland Darter in the Lower Susquehanna River Basin

The Maryland darter was first collected and identified as such in 1912 from Swan Creek near Havre de Grace, Maryland. It was not found again until 1962, in Gashey's Run (Knapp 1963), a tributary to Swan Creek. The last record in Gashey's Run is from 1965 (Knapp 1976). The first record in Deer Creek is also from 1965, and the last record from any location was in Deer Creek in 1988 (Raesly 1991).

Although significant efforts since 1986 to collect Maryland darter from Deer Creek have been conducted, no Maryland darters have been recorded (Kazyak et al. 2005; Kilian et al. 2010; Raesly 1991, 1992, 2010, 2011; Stauffer and Arnold 1986).

All records of the Maryland darter are from the riffles in the lower reaches of the three small streams, Swan Creek, Gashey's Run, and Deer Creek. If the Maryland darter existed in any other streams, it was likely extirpated as the upper Chesapeake Bay area was settled and developed, resulting in degraded water quality and habitat due to land clearing and concomitant sedimentation in streams, shoreline development for towns and cities, and pollution (Stranko et al. 2010). Neely and George (2006) have documented the colonization of the Susquehanna River by the non-native greenside darter (*E. blennioides*) and state that the greenside darter may pose a serious threat to the Maryland darter.

There is evidence that the habitat in Deer Creek has deteriorated due to development (SRBC 2008). SRBC (2008) projected 25-year population increases of 23% in the lowermost Deer Creek subwatershed where the Maryland darter had been most abundant (immediately above the confluence with the Susquehanna River), and of 5 – 35% across all Deer Creek subwatersheds. Raesly (1991) reported that collections in Deer Creek reflected a significant drop in total fish collected and species richness over time during the late 1980's. In addition, he also reported increases in nitrate and chloride concentrations suggesting a deterioration of water quality (Raesly 1991). Stranko et al. (2010) concluded that effects of urbanization and non-native species were important factors in the extirpation or extinction of 13 aquatic species in Maryland, including the Maryland darter. These various studies suggest that development in the watershed may have been a significant factor in reducing numbers or eliminating Maryland darter from the basin.METHODS

As recommended by agencies, Dr. Richard L. Raesly was integrated into this study as co-principal investigator. This report includes the schedule, locations, and results for the sampling program.

3.0 SAMPLING LOCATIONS AND SEASON

The sampling occurred over 15 months from October 2010 through early December 2011 in all four seasons. Thorough coverage of the river below Conowingo Dam and the lower reaches of Deer and Octoraro creeks was accomplished (Figure 3.1-1)[1]. Stream flow during the period of study varied widely, including flood conditions, in all three bodies of water (Figure 3.1-2). During the study period the Susquehanna River varied from under 3,000 cfs to approximately 770,000 cfs. Deer Creek varied from approximately 75 cfs to approximately 5,500 cfs, and Octoraro Creek varied from approximately 55 cfs to approximately 5,500 cfs.

One hundred eighty-two locations in the Susquehanna River were sampled. Locations were selected throughout the lower river from near Conowingo Dam down to Havre de Grace and Perryville at the mouth of the river. Shallow water (e.g., just below Conowingo Dam, near the islands off of Susquehanna State Park) and deep areas downstream toward the mouth of the river were sampled. Sampling in the river occurred in all four seasons from January through early December, 2011 (Figures 3.1-3 - 3.1-6). Harsh winter conditions in January required ice-breaking at the boat launches to gain access to the main stem river. Due to access and safety considerations, winter sampling was restricted to the lowermost portion of the river (i.e., from the vicinity of Lapidum and Port Deposit downstream to Havre de Grace and Perryville, see Figure 3.1-1).

Twenty-four locations in Deer Creek and 12 locations in Octoraro Creek were sampled. Riffles, runs, backwaters, and pools (where they could be waded) were sampled. Fall (2010 and 2011), spring, and summer sampling was completed in both creeks (Figures 3.1-7 and 3.1-8). Multiple attempts to sample the creeks in December 2010 and January 2011 were unsuccessful due to ice and slush (Figure 3.1-9). The Stafford Bridge riffle (see Deer Creek figures for location of the bridge, the riffle begins just upstream of the bridge and continues for approximately 100 m downstream of the bridge) in the lower portion of Deer Creek is the only location in the Susquehanna River drainage where Maryland darter has been found (Raesly 2010). This riffle, and numerous locations upstream and downstream of the Stafford Bridge, were sampled thoroughly by electrofishing and snorkeling.

3.1 Sampling Gear

An electrified benthic trawl (Freedman et al. 2009) was the primary means used to sample the lower Susquehanna River. The power was provided by a 3,500 W generator and rectified by a Smith-Root Type

[1] Note that the river is segmented into 4 reaches. Subsequent figures of the river are presented by reach.

VI-A electrofisher. The net was set from the front of a jon boat and pulled downstream slightly faster than the current. Snorkeling and electrofishing (with backpack electrofisher) were also used in the river to sample for Maryland darter. All three of these sampling gears and techniques have been used by MDNR and USFWS to sample for Maryland darter in the lower Susquehanna River (Raesly 2011; Killian et al. 2010). All fish collected were identified to species. Darters were enumerated and the abundance of other species was recorded qualitatively.

Sampling in Deer and Octoraro creeks was conducted primarily by electrofishing along with a seine. A Smith-Root Model 12B backpack electrofisher was used along with a 5-ft by 10-ft seine with 1/8-inch mesh. At a given sampling location, the seine was cast downstream approximately 10 - 15 ft and held tight to the substrate. As soon as the seine was in place, the person carrying the electrofisher activated the unit, and with one or two other biologists, moved systematically toward the seine while kicking the substrate to chase fish into the electric field and subsequently into the seine. Fish collected in the seine were identified to species. Darter species were enumerated, and for other species a qualitative record of abundance was made. A series (approximate range of 100 - 160) of electrofishing/seine collections comprised the effort for each sampling location depicted in the figures. The backpack electrofisher (without the seine) was also used in some of the pools of the Susquehanna River where boat access was not possible.

Snorkeling was used in some portions of the Susquehanna River and in both creeks. This sampling method was conducted by a crew of 2 - 5 biologists spread across a selected reach. They moved upstream together through a reach, noting the species observed, and recording abundance. The locations sampled by gear type in the river and creeks are presented in Figures 3.2-1 - 3.2-6.

4.0 RESULTS

4.1 Sampling Schedule and Effort

The sampling objective included seasonal sampling over extensive portions of the lower Susquehanna River and lower reaches of Deer and Octoraro creeks. Sampling in the lower river was accomplished in all four seasons; sampling in the creeks was accomplished in three seasons because ice cover and flowing ice prohibited sampling in the creeks during winter months. Sampling in the river, Deer Creek, and Octoraro Creek occurred on 20, 13, and 12 days, respectively during the study period (Table 4.1-1).

4.2 Maryland Darter

All of the sampling techniques were successful in collecting or observing numerous fish. Maryland darter (Figure 4.2-1) was not collected from any of the 218 locations sampled. However, five of the possible six darter species recorded historically in this portion of the Susquehanna River basin, including three congeners of the Maryland darter, were collected from the creeks and river. The multiple sampling techniques employed over many locations demonstrated that fishes of similar size, morphology, and phylogeny to Maryland darter were readily sampled, thus this was a sound approach for finding Maryland darter in these reaches if it still exists.

4.3 Species Richness

Fifty-four species representing 13 families were collected (Table 4.3-1). The greatest species richness (49) was recorded from Deer Creek. The numbers of species collected in Octoraro Creek and the lower river were 46 and 40, respectively.

4.4 Other Darter Species

The five species of darters recorded included the three congeners of Maryland darter, *Etheostoma blennioides* (greenside darter), *E. olmstedi* (tessellated darter), and *E. zonale* (banded darter), as well as *Percina bimaculata* (Chesapeake logperch), and *P. peltata* (shield darter). Darters were collected at 74% (161) of the 218 locations sampled in all three water bodies. Darters were collected in all four seasons (Table 4.4-1) and with all three gear types (Table 4.4-2). A total of 9,036 darters were collected. Of these, the tessellated darter (6,431 total or 71%) was by far the most common.

Chesapeake logperch, threatened in Maryland (Ashton and Near 2010), was second in total numbers with 1,886 recorded. This represents 21% of the total number of darters recorded. Chesapeake logperch was also the most abundant of the darter species in Octoraro Creek with 1,260 of the 2,471 (51%) darters recorded; this total number of Chesapeake logperch is weighted by a single observation during snorkeling

(August 26, 2011 at location #8), of a school of logperch estimated at 1,220 individuals. Sampling results for all darter species recorded by season and location are presented in Table 4.4-1 and by season and gear in Table 4.4-2. The locations where all species were recorded can be found in Appendices A- C.

5.0 DISCUSSION

The objective of conducting a thorough Maryland darter survey in the lower Susquehanna River and lower reaches of Deer and Octoraro creeks was accomplished. Maryland darter was not collected during the surveys at any location.

This work complements the previous and concurrent work conducted through MDNR and USFWS in recent years (e.g., Kilian et al. 2010; Raesly 2010, 2011). Raesly (2010) stated there was a small chance that Maryland darter is present in the Susquehanna River but that the limited effort spent and gear used up to that time in sampling specifically for Maryland darter in the river may not have been adequate to find the rare species. Exelon's study used multiple gear types (electrified benthic trawl, snorkeling, backpack electrofisher) and was designed to thoroughly sample the river. With 182 river locations sampled over the four seasons, and multiple gear types used, this survey represents the major sampling effort of Maryland darter in the Susquehanna River

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TABLE 4.1-1: SAMPLING LOCATIONS IN THE LOWER SUSQUEHANNA RIVER, DEER CREEK AND OCTORARO CREEK BY DATE OF SAMPLING FROM OCTOBER 2010 – DECEMBER 2011.

Susquehanna River		Deer Creek		Octoraro Creek	
Location	**Date**	**Location**	**Date**	**Location**	**Date**
1 - 10	11-Jan-11	1	9-Oct-10	1	9-Oct-10
1 - 17	12-Jan-11	2	10-Oct-10	2	14-Nov-10
18 - 23	13-Jan-11	6	10-Oct-10	3	14-Nov-10
24 - 33	14-Jan-11	3	13-Nov-10	4	23-May-11
34 - 45	20-Feb-11	4	13-Nov-10	6	24-May-11
46 - 54	20-Jun-11	5	13-Nov-10	6	26-May-11
55 - 65	21-Jun-11	7	23-May-11	6	8-Jun-11
66 - 71	22-Jun-11	8	24-May-11	5	8-Jun-11
72 - 96	23-Jun-11	9	24-May-11	5	9-Jun-11
97 - 101	24-Jun-11	10	24-May-11	9	21-Aug-11
145 - 146	20-Aug-11	11	25-May-11	7	24-Aug-11
102 - 109	22-Aug-11	12	25-May-11	10	25-Aug-11
150 - 151	22-Aug-11	13	25-May-11	8	26-Aug-11
110 - 115	23-Aug-11	14	27-May-11	11	13-Nov-11
147 - 148	23-Aug-11	15	7-Jun-11	12	13-Nov-11
152 - 155	23-Aug-11	16	9-Jun-11		
116 - 120	24-Aug-11	17	19-Aug-11		
149	24-Aug-11	19	20-Aug-11		
156	24-Aug-11	20	20-Aug-11		
121 - 125	25-Aug-11	18	21-Aug-11		
157	26-Aug-11	21	21-Aug-11		
126 - 138	24-Oct-11	22	12-Nov-11		
139 - 144	25-Oct-11	23	12-Nov-11		
158-165	29-Nov-11	24	12-Nov-11		
166-175	30-Nov-11				
176-182	1-Dec-11				

TABLE 4.3-1: SPECIES OBSERVED IN THE LOWER SUSQUEHANNA RIVER, DEER CREEK, AND OCTORARO CREEK FROM OCTOBER 2010 – DECEMBER 2011.

Family	Genus species	Common Name	Susquehanna River	Deer Creek	Octoraro Creek	Total
Petromyzontidae	*Petromyzon marinus*	sea lamprey		x	x	
Anguillidae	*Anguilla rostrata*	American eel	x	x		
Clupeidae	*Alosa sp.*	River herrings/shad			x	
Clupeidae	*Dorosoma cepedianum*	gizzard shad	x	x	x	
Cyprinidae	*Campostoma anomalum*	central stoneroller		x	x	
Cyprinidae	*Carassius auratus*	goldfish	x	x	x	
Cyprinidae	*Clinostomus funduloides*	rosyside dace		x	x	
Cyprinidae	*Cyprinella analostana*	satinfin shiner	x	x	x	
Cyprinidae	*Cyprinella spiloptera*	spotfin shiner	x	x	x	
Cyprinidae	*Cyprinella sp.*	shiner	x	x	x	
Cyprinidae	*Cyprinus carpio*	common carp	x		x	
Cyprinidae	*Exoglossum maxillingua*	cutlips minnow		x	x	
Cyprinidae	*Hybognathus regius*	Eastern silvery minnow		x		
Cyprinidae	*Luxilus cornutus*	common shiner		x	x	
Cyprinidae	*Nocomis micropogon*	river chub		x	x	
Cyprinidae	*Notropis amoenus*	comely shiner	x	x	x	
Cyprinidae	*Notoropis hudsonius*	spottail shiner	x	x	x	
Cyprinidae	*Notropis procne*	swallowtail shiner	x	x	x	
Cyprinidae	*Notropis rubellus*	rosyface shiner	x	x	x	
Cyprinidae	*Pimephales notatus*	bluntnose minnow		x	x	
Cyprinidae	*Rhinichthys atratulus*	blacknose dace	x	x	x	
Cyprinidae	*Rhinichthys cataractae*	longnose dace	x	x	x	
Cyprinidae	*Semotilus atromaculatus*	creek chub		x	x	
Cyprinidae	*Semotilus corporalis*	fallfish		x	x	
Catostomidae	*Carpiodes cyprinus*	quillback	x	x	x	
Catostomidae	*Catostomus commersoni*	white sucker	x	x	x	
Catostomidae	*Erimyzon oblongus*	creek chubsucker	x			
Catostomidae	*Hypentelium nigricans*	northern hog sucker	x	x	x	
Catostomidae	*Moxostoma macrolepidotum*	shorthead redhorse	x	x	x	
Ictaluridae	*Ameiurus natalis*	yellow bullhead			x	
Ictaluridae	*Ameiurus nebulosus*	brown bullhead	x	x	x	
Ictaluridae	*Ictalurus punctatus*	channel catfish	x	x	x	
Ictaluridae	*Pylodictis olivaris*	flathead catfish	x	x		
Ictaluridae	*Noturus insignis*	margined madtom	x	x	x	
Salmonidae	*Salmo trutta*	brown trout		x		
Belonidae	*Strongylura marina*	Atlantic needlefish	x	x		
Fundulidae	*Fundulus diaphanus*	banded killifish	x	x	x	
Moronidae	*Morone americana*	white perch	x	x	x	
Moronidae	*Morone saxatilis*	striped bass	x	x	x	
Centrarchidae	*Amploplites rupestris*	rock bass	x	x	x	
Centrarchidae	*Lepomis auritis*	redbreast sunfish	x	x	x	
Centrarchidae	*Lepomis cyanellus*	green sunfish	x	x	x	
Centrarchidae	*Lepomis gibbosus*	pumpkinseed	x	x	x	
Centrarchidae	*Lepomis macrochirus*	bluegill	x	x	x	
Centrarchidae	*Micropterus dolomieu*	smallmouth bass	x	x	x	
Centrarchidae	*Micropterus salmoides*	largemouth bass	x	x	x	
Percidae	*Etheostoma blennioides*	greenside darter	23	4	12	39
Percidae	*Etheostoma olmstedi*	tessellated darter	2819	2647	965	6431
Percidae	*Etheostoma zonale*	banded darter	125	45	81	251
Percidae	*Percina bimaculata*	Chesapeake logperch	262	364	1260	1886
Percidae	*Percina peltata*	shield darter	46	230	153	429
Percidae	*Perca flavescens*	yellow perch	x	x	x	
Percidae	*Sander vitreum*	walleye	x			
Cottidae	*Cottus caeruleomentum*	blue ridge sculpin		x		
						9036

TABLE 4.4-1: DARTER SPECIES AND NUMBERS COLLECTED IN THE SUSQUEHANNA RIVER, DEER CREEK, AND OCTORARO CREEK BY LOCATION AND SEASON FROM OCTOBER 2010 – DECEMBER 2011.

Season	Site Nos.	*Etheostoma blennioides*	*E. olmstedi*	*E. zonale*	*E. sellare*	*Percina bimaculata*	*P. peltata*	Total
Susquehanna River								
Winter	6, 12, 13, 15, 16, 18, 22, 25, 27, 33-43	0	297	0	0	0	0	297
Spring	46-55, 60-65, 70, 71,78, 80, 83, 86, 91, 92, 97-101	0	465	4	0	36	21	526
Summer	103-106, 108-111, 113-115, 118-125, 145-157	23	1426	110	0	212	22	1793
Fall	126-144, 158-175, 178-181	0	631	11	0	14	3	659
Total	126 sites	23	2819	125	0	262	46	3275
Deer Creek								
Fall	1-6,22-24	3	2082	32	0	61	83	2261
Winter	**	**	**	**	**	**	**	**
Spring	7-16	0	315	2	0	226	76	619
Summer	18-21	1	250	11	0	77	71	410
Total	23 sites	4	2647	45	0	364	230	3290
Octoraro Creek								
Fall	1-3, 11,12	7	394	48	0	14	97	560
Winter	**	**	**	**	**	**	**	**
Spring	4-6	0	59*	0	0	11	0	70*
Summer	7-10	5	512	33	0	1235	56	1841
Total	12 sites	12	965*	81	0	1260	153	2471*
All Streams Combined								
Total	**161 Sites**	**39**	**6431**	**251**	**0**	**1886**	**429**	**9036**

*Note: During one snorkel survey *E. olmstedi* was recorded qualitatively as 'common' (defined as between 10 and 100) rather than enumerated, so the actual number for the cumulative surveys was greater by 11-99.

** No sampling done

TABLE 4.4-2: DARTER SPECIES AND NUMBERS COLLECTED IN THE SUSQUEHANNA RIVER, DEER CREEK, AND OCTORARO CREEK BY SEASON AND GEAR TYPE WITH EFFORT FROM OCTOBER 2010 – DECEMBER 2011.

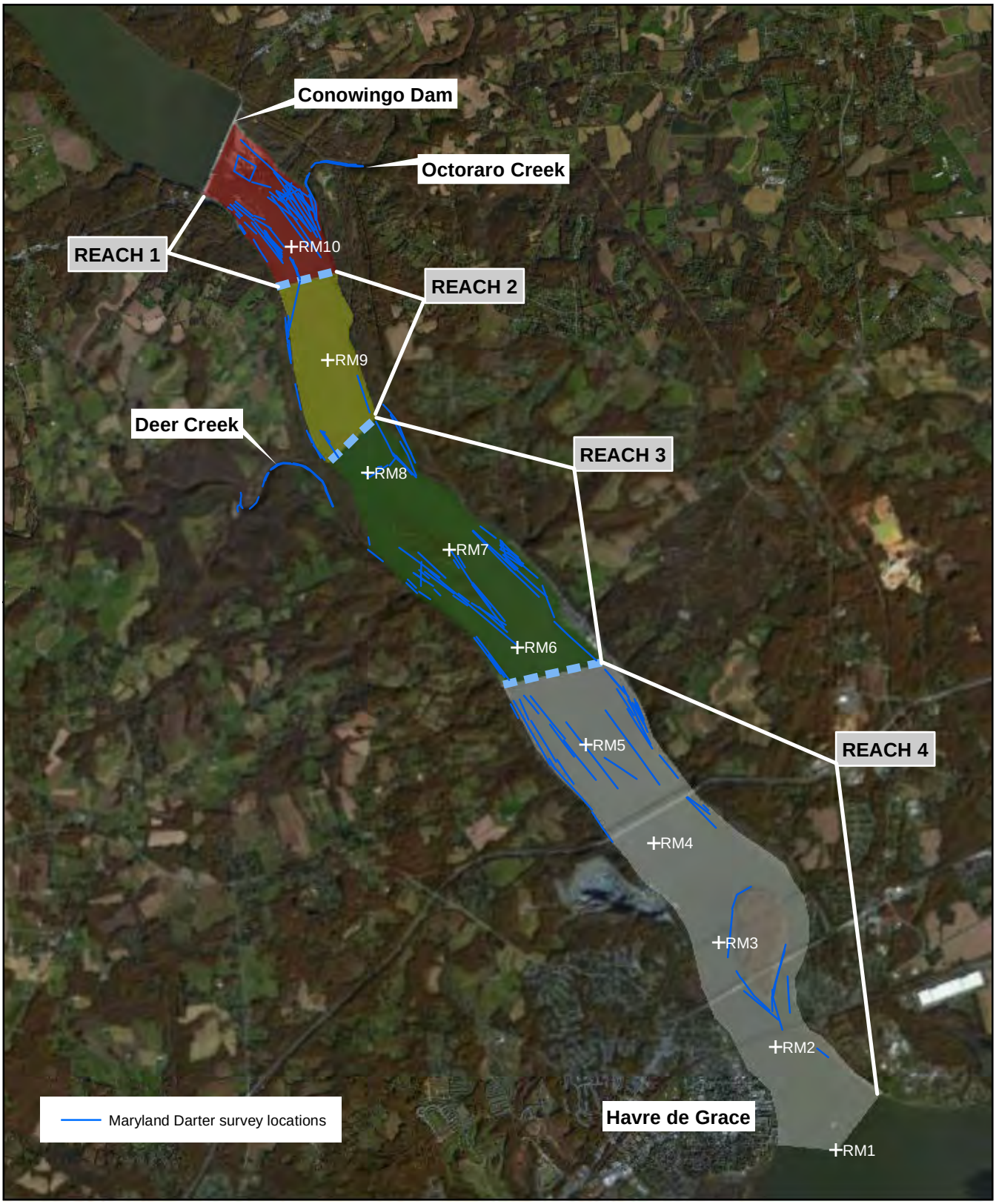
Susquehanna River	*Etheostoma blennioides*	*E. olmstedi*	*E. zonale*	*E. sellare*	*Percina bimaculata*	*P. peltata*	Row Sum	Cumulative Effort (seconds of shocking or observing)
Winter (total)	**0**	**297**	**0**	**0**	**0**	**0**	**297**	**34200**
Benthic Electric Trawl	0	297	0	0	0	0	297	34200
Backpack E-fisher								
Snorkeling								
Spring (total)	**0**	**465**	**4**	**0**	**36**	**21**	**526**	**13956**
Benthic Electric Trawl	0	465	4	0	36	21	526	13956
Backpack E-fisher								
Snorkeling								
Summer (total)	**23**	**1426**	**110**	**0**	**212**	**22**	**1793**	**140739**
Benthic Electric Trawl	2	260	10	0	17	8	297	8332
Backpack E-fisher	4	899	93	0	23	7	1026	43007
Snorkeling	17	267	7	0	172	7	470	89400
Fall (total)	**0**	**631**	**11**	**0**	**14**	**3**	**659**	**20698**
Benthic Electric Trawl	0	631	11	0	14	3	659	20698
Backpack E-fisher								
Snorkeling								
Total by Species	**23**	**2819**	**125**	**0**	**262**	**46**	**3275**	

Table 4.2-2 Continued:

Deer Creek	*Etheostoma blennioides*	*E. olmstedi*	*E. zonale*	*E. sellare*	*Percina bimaculata*	*P. peltata*	Row Sum	Cumulative Effort (seconds of shocking or observing)
Winter (total)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benthic Electric Trawl								
Backpack E-fisher								
Snorkeling								
Spring (total)	**0**	**315**	**2**	**0**	**226**	**76**	**619**	**74720**
Benthic Electric Trawl								
Backpack E-fisher	0	280	2	0	204	58	544	19520
Snorkeling	0	35	0	0	22	18	75	55200
Summer (total)	**1**	**250**	**11**	**0**	**77**	**71**	**410**	**41033**
Benthic Electric Trawl								
Backpack E-fisher	1	167	10	0	60	58	296	8333
Snorkeling	0	83	1	0	17	13	114	32700
Fall (total)	**3**	**2082**	**32**	**0**	**61**	**83**	**2261**	**50715**
Benthic Electric Trawl								
Backpack E-fisher	2	2047	31	0	46	77	2203	32715
Snorkeling	1	35	1	0	15	6	58	18000
Total by Species	**4**	**2647**	**45**	**0**	**364**	**230**	**3290**	

Table 4.2-2 Continued:

Octoraro Creek	*Etheostoma blennioides*	*E. olmstedi*	*E. zonale*	*E. sellare*	*Percina bimaculata*	*P. peltata*	Row Sum	Cumulative Effort (seconds of shocking or observing)
Winter (total)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Benthic Electric Trawl								
Backpack E-fisher								
Snorkeling								
Spring (total)	**0**	**59**	**0**	**0**	**11**	**0**	**70**	**0**
Benthic Electric Trawl								
Backpack E-fisher	0	59	0	0	7	0	66	8112
Snorkeling	0	0	0	0	4	0	4	N/A
Summer (total)	**5**	**512**	**33**	**0**	**1235**	**56**	**1841**	**61987**
Benthic Electric Trawl								
Backpack E-fisher	2	292	23	0	8	29	354	10687
Snorkeling	3	220	10	0	1227	27	1487	51300
Fall (total)	**7**	**394**	**48**	**0**	**14**	**97**	**560**	**19781**
Benthic Electric Trawl								
Backpack E-fisher	7	394	48	0	14	97	560	19781
Snorkeling								
Total by Species	**12**	**965**	**81**	**0**	**1260**	**153**	**2471**	



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PROJECT NO. 405

1 inch = 1.2 miles

0 0.5 1 2

Miles

Figure 3.1-1.
Figure Title: Maryland Darter Sampling Locations

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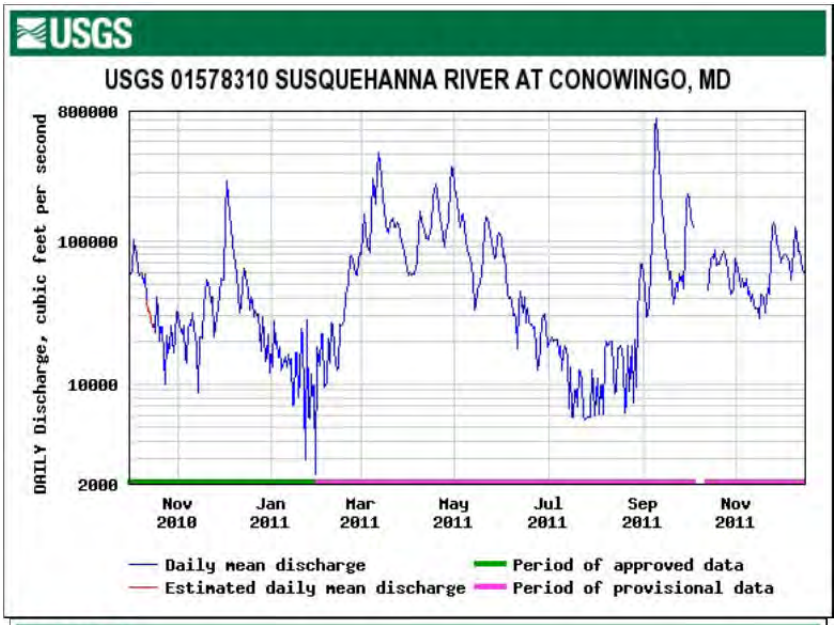
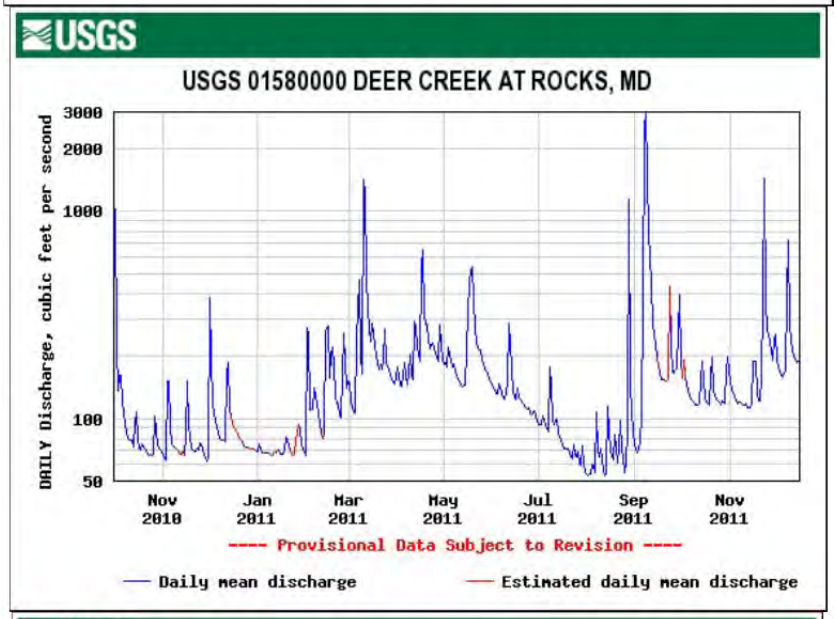
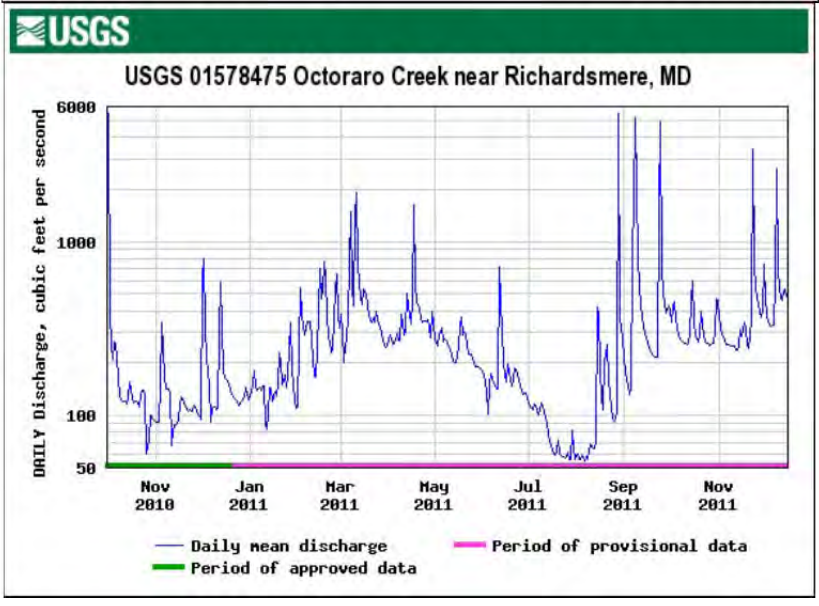
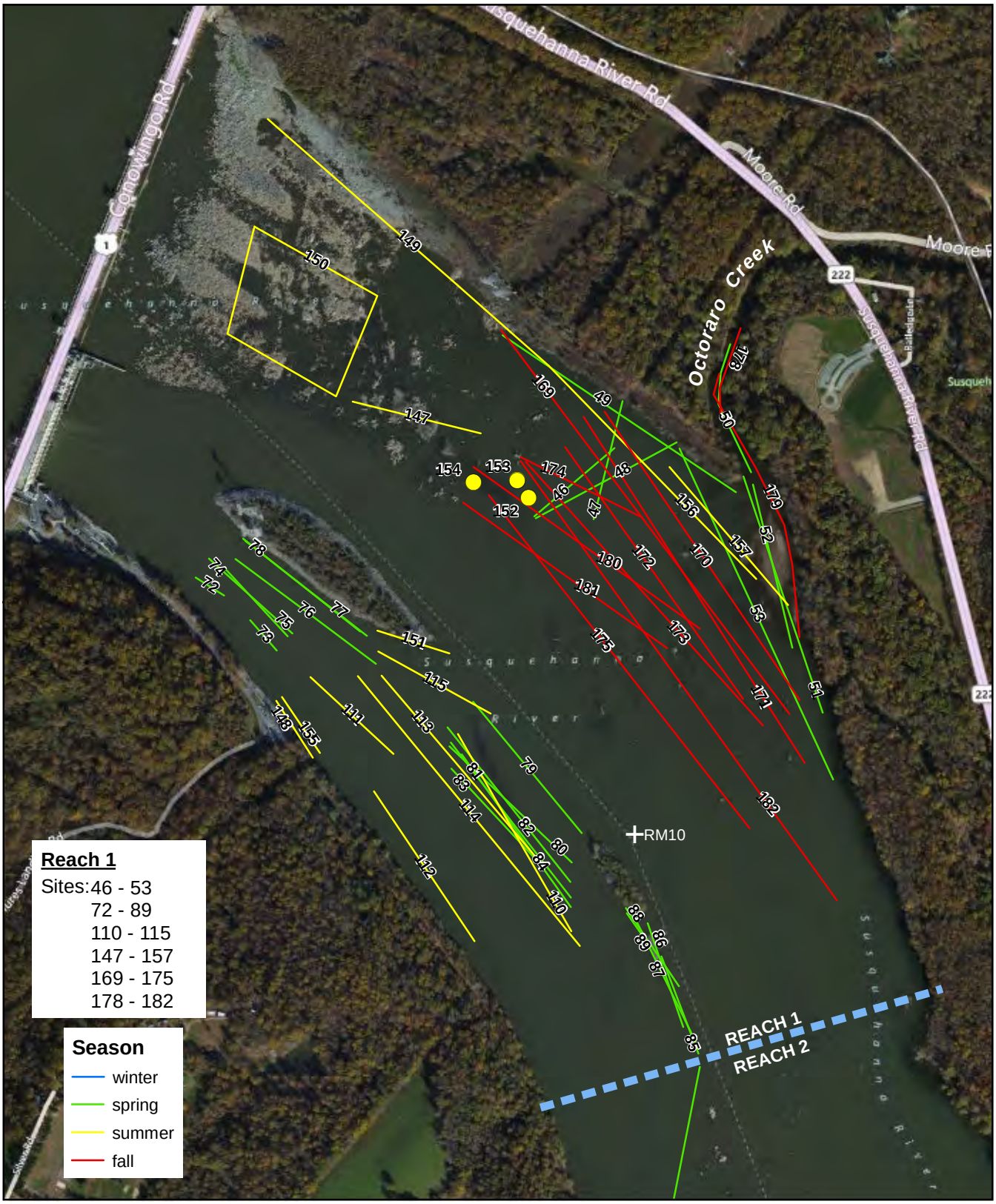
FIGURE 3.1-2: SREAMFLOW-OCTOBER 2010 TO DECEMBER 2011.









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1 inch = 0.2 miles
0 0.125 0.25
Miles

Figure 3.1-3
Figure Title: Susquehanna River - Reach 1 Sampling Locations by Season

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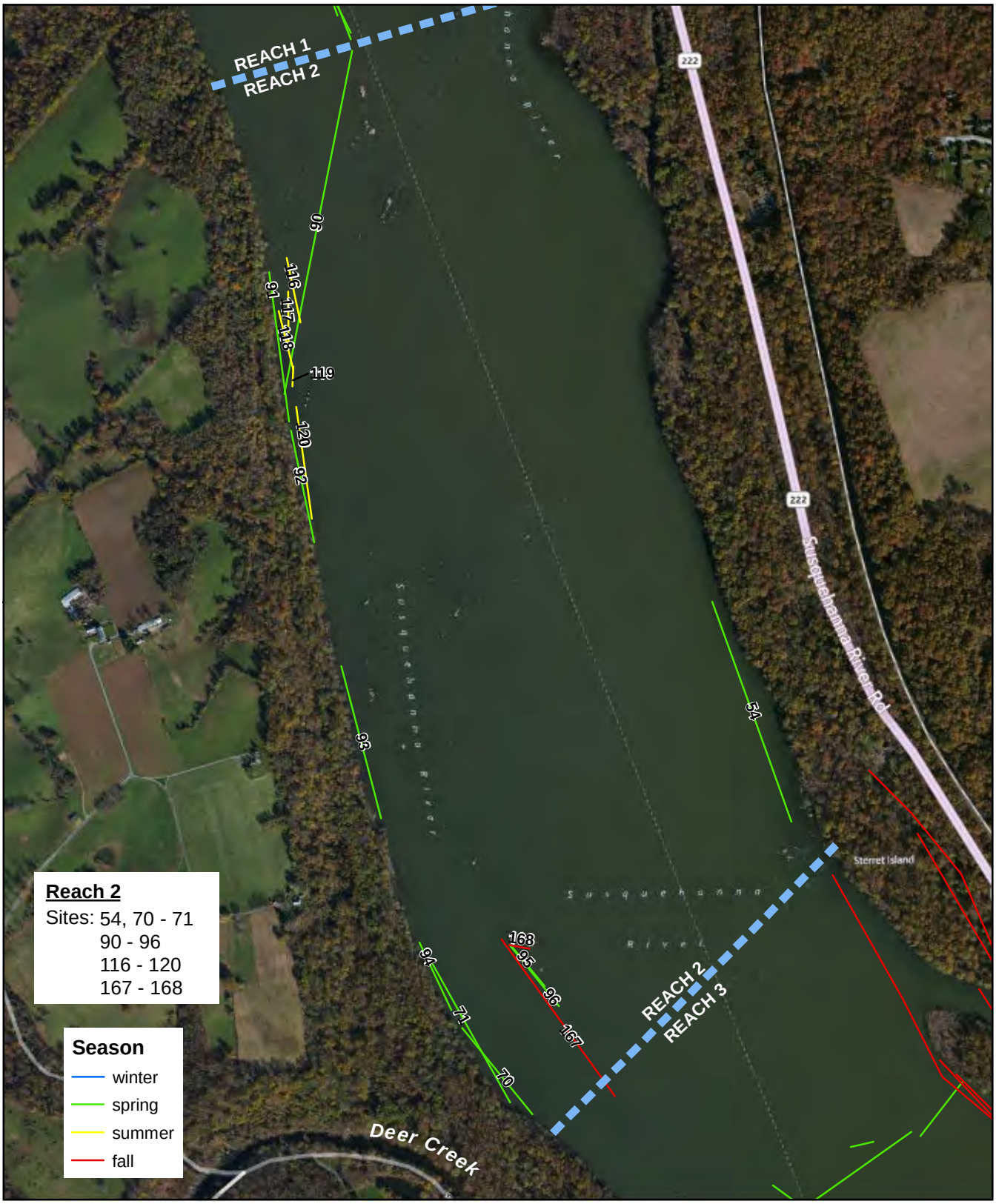

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1 inch = 0.2 miles

0 0.2 0.4 Miles

Figure 3.1-4.
Figure Title: Susquehanna River - Reach 2 Sampling Locations by Season

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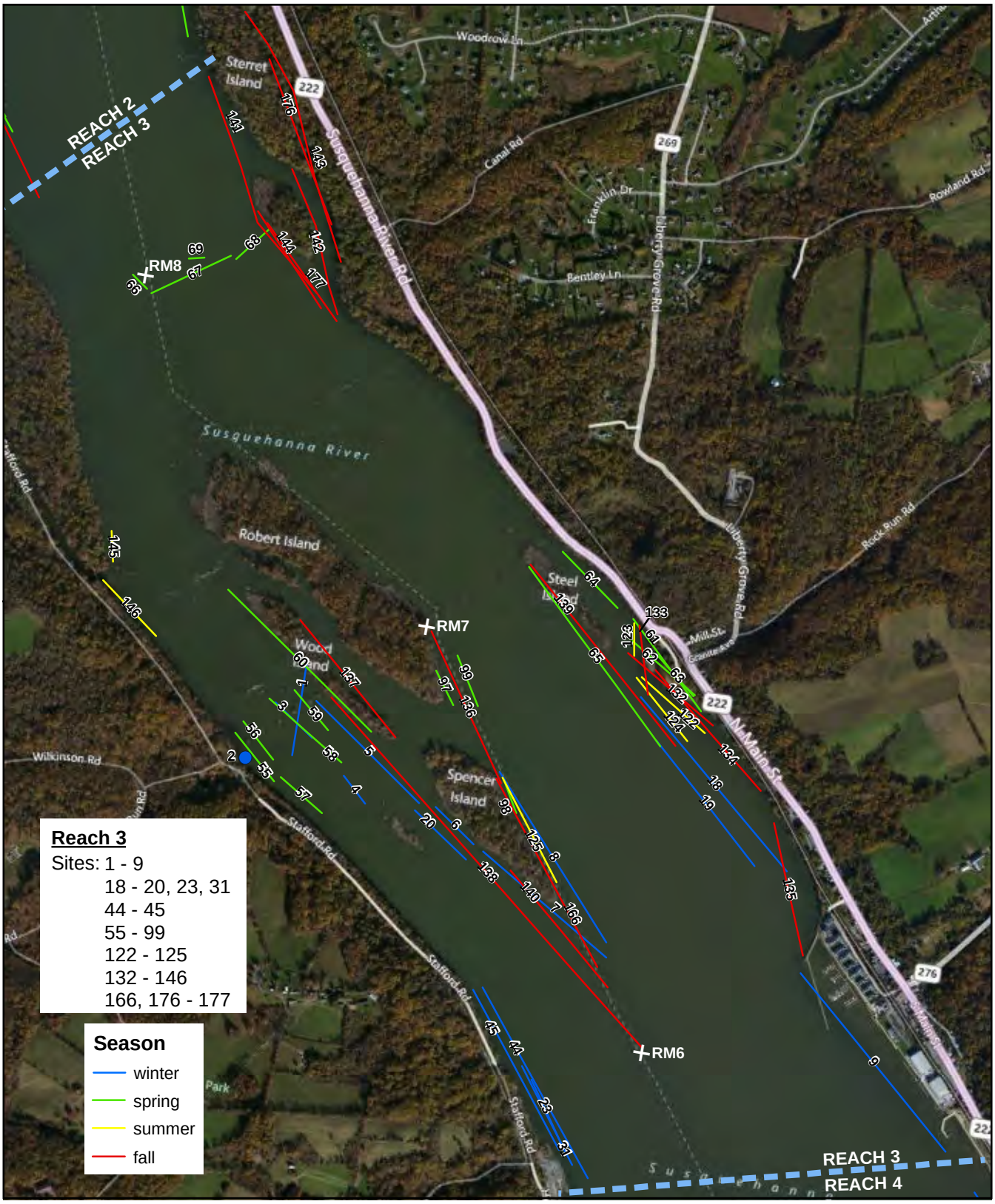

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1 inch = 0.3 miles

0 0.275 0.55 Miles

Figure 3.1- 5.
Figure Title: Susquehanna River - Reach 3 Sampling Locations by Season

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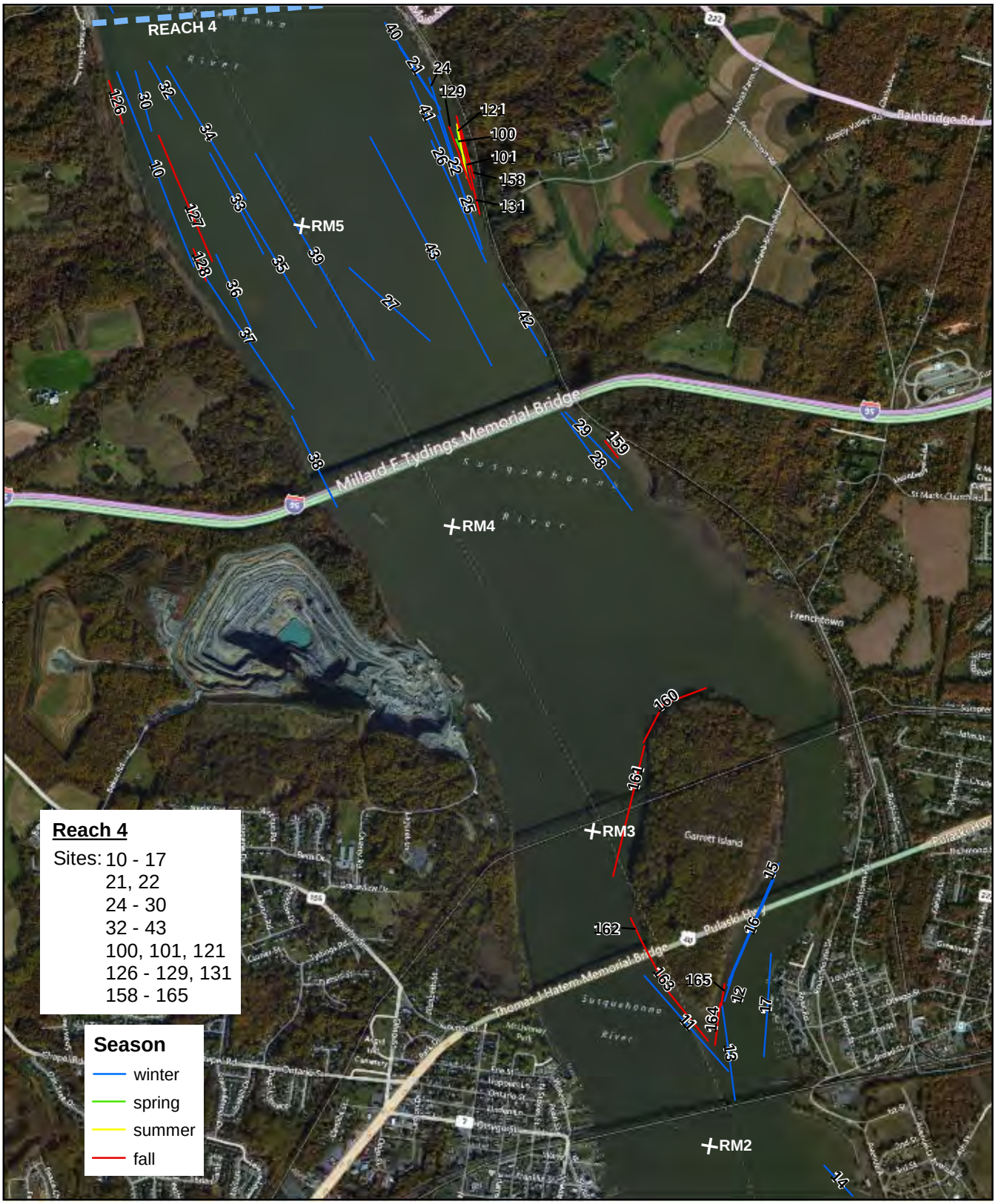

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1 inch = 0.4 miles

0 0.4 0.8
Miles

Figure 3.1- 6.
Figure Title: Susquehanna River - Reach 4 Sampling Locations by Season

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1 inch = 0.1 miles

0 0.1 0.2 Miles

Figure 3.1-7.
Figure Title: Deer Creek Sampling Locations by Season

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1 inch = 0.1 miles

0 0.1 0.2 Miles

N

Figure 3.1-8.
Figure Title: **Octoraro Creek Sampling Locations by Season**

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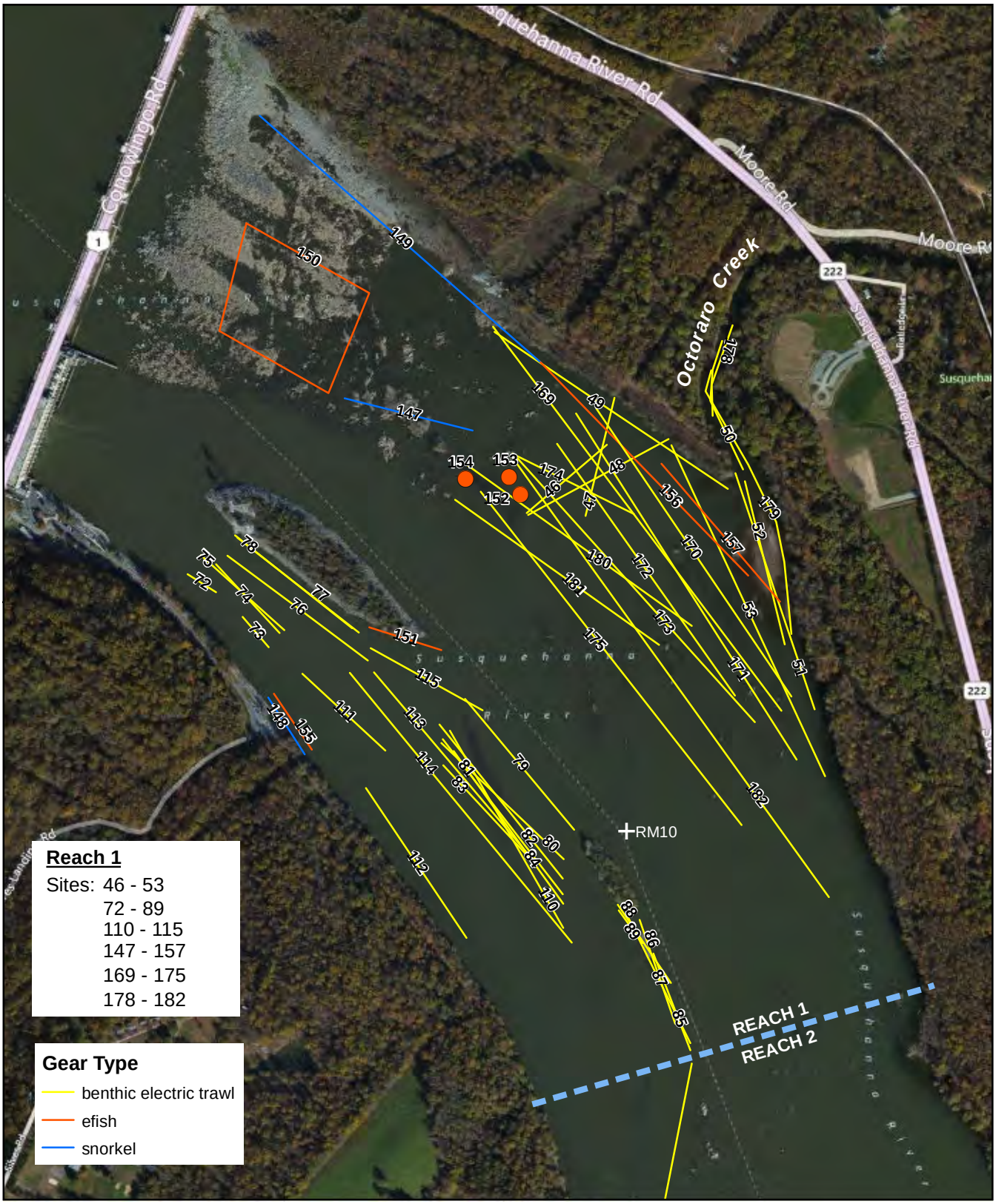
Figure 3.1-9. December 2010 Conditions on Deer Creek and Octoraro Creek



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N

1 inch = 0.2 miles

0 0.175 0.35 Miles

Figure 3.2- 1.
Figure Title: Susquehanna River - Reach 1 Sampling Locations by Gear Type

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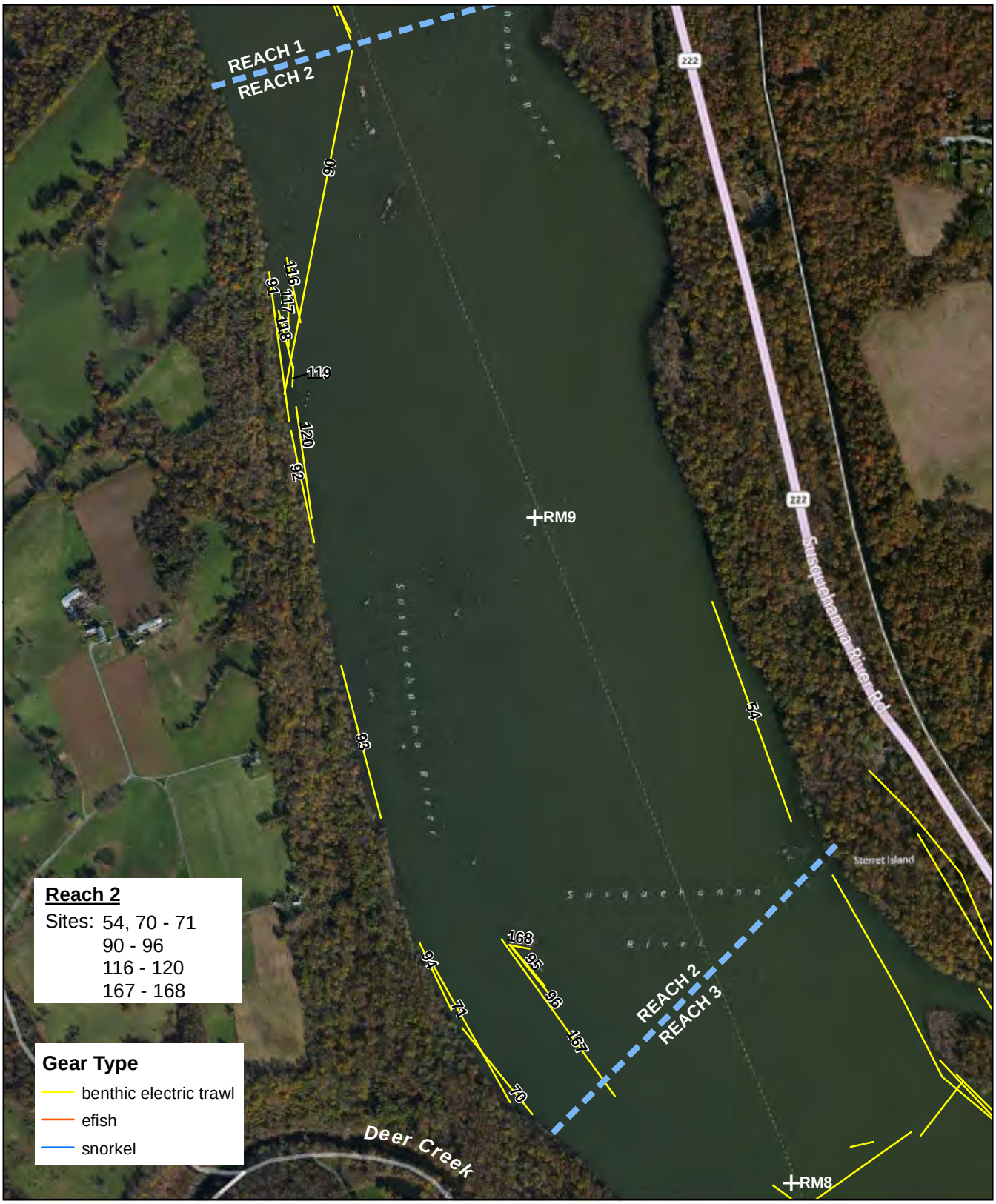

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1 inch = 0.2 miles

0 0.2 0.4 Miles

Figure 3.2 - 2.
Figure Title: Susquehanna River - Reach 2 Sampling Locations by Gear Type

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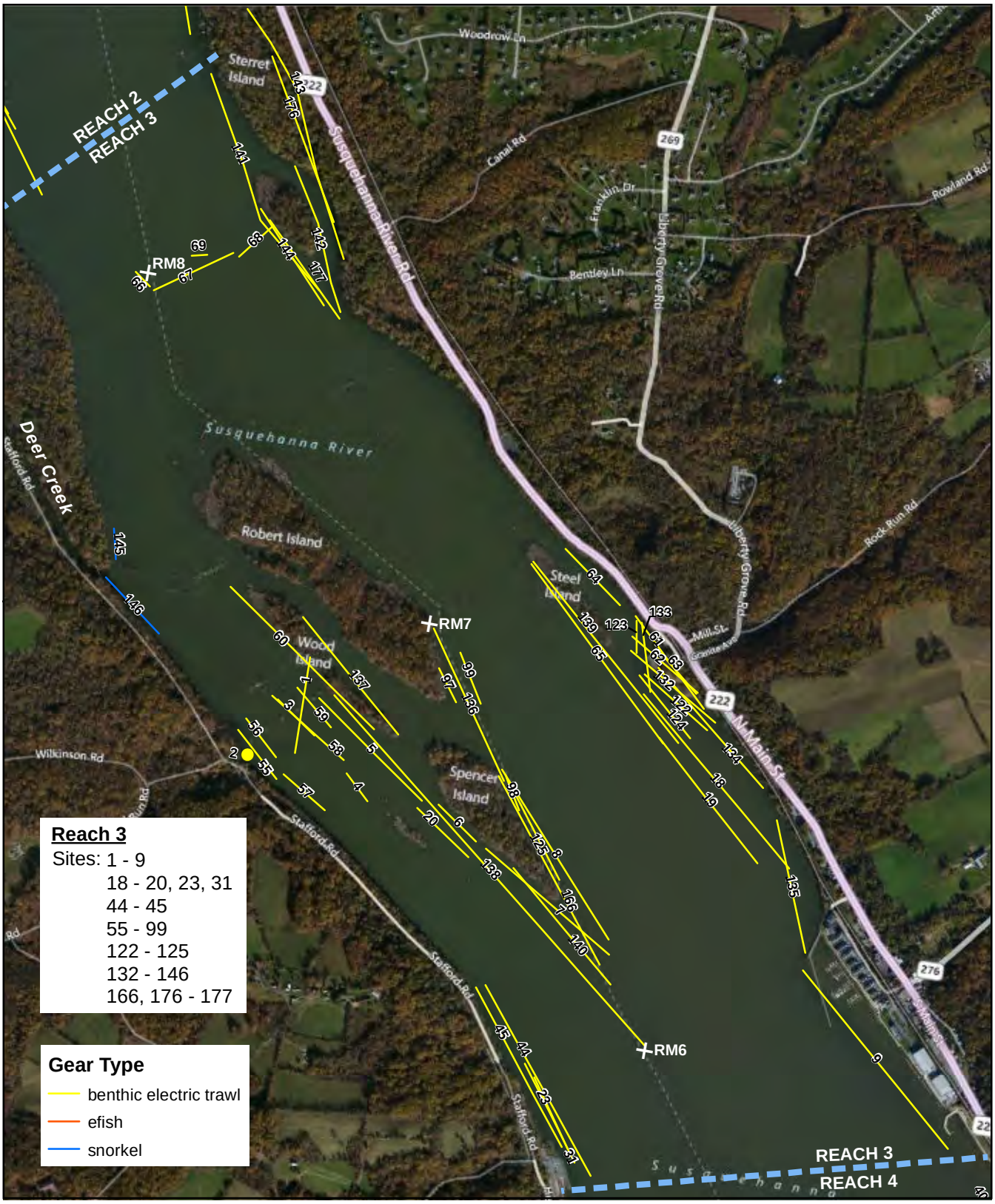

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1 inch = 0.3 miles
0 0.3 0.6
Miles

Figure 3.2- 3.
Figure Title: Susquehanna River - Reach 3 Sampling Locations by Gear Type

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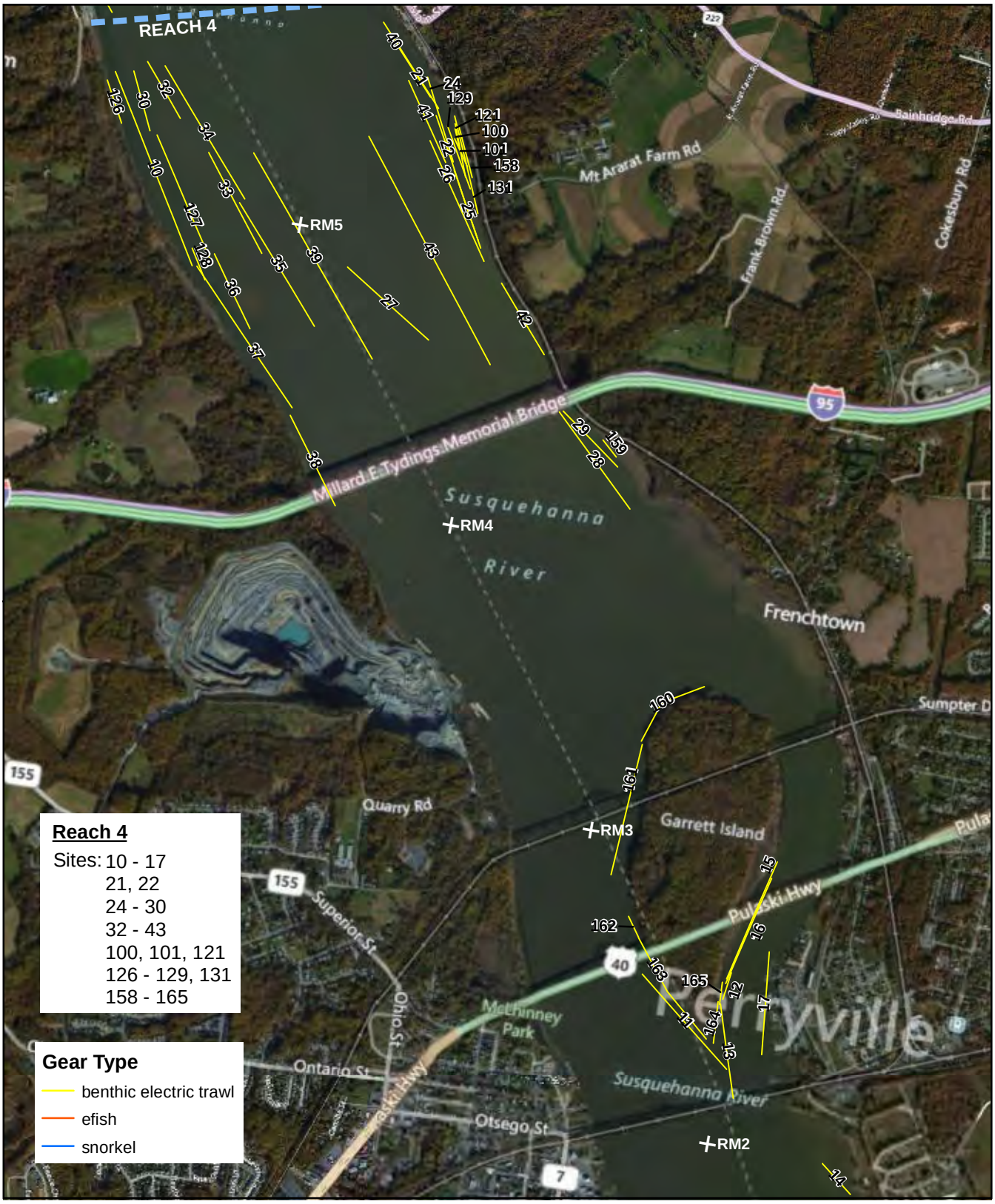

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Figure 3.2- 4.
Figure Title: Susquehanna River - Reach 4 Sampling Locations by Gear Type

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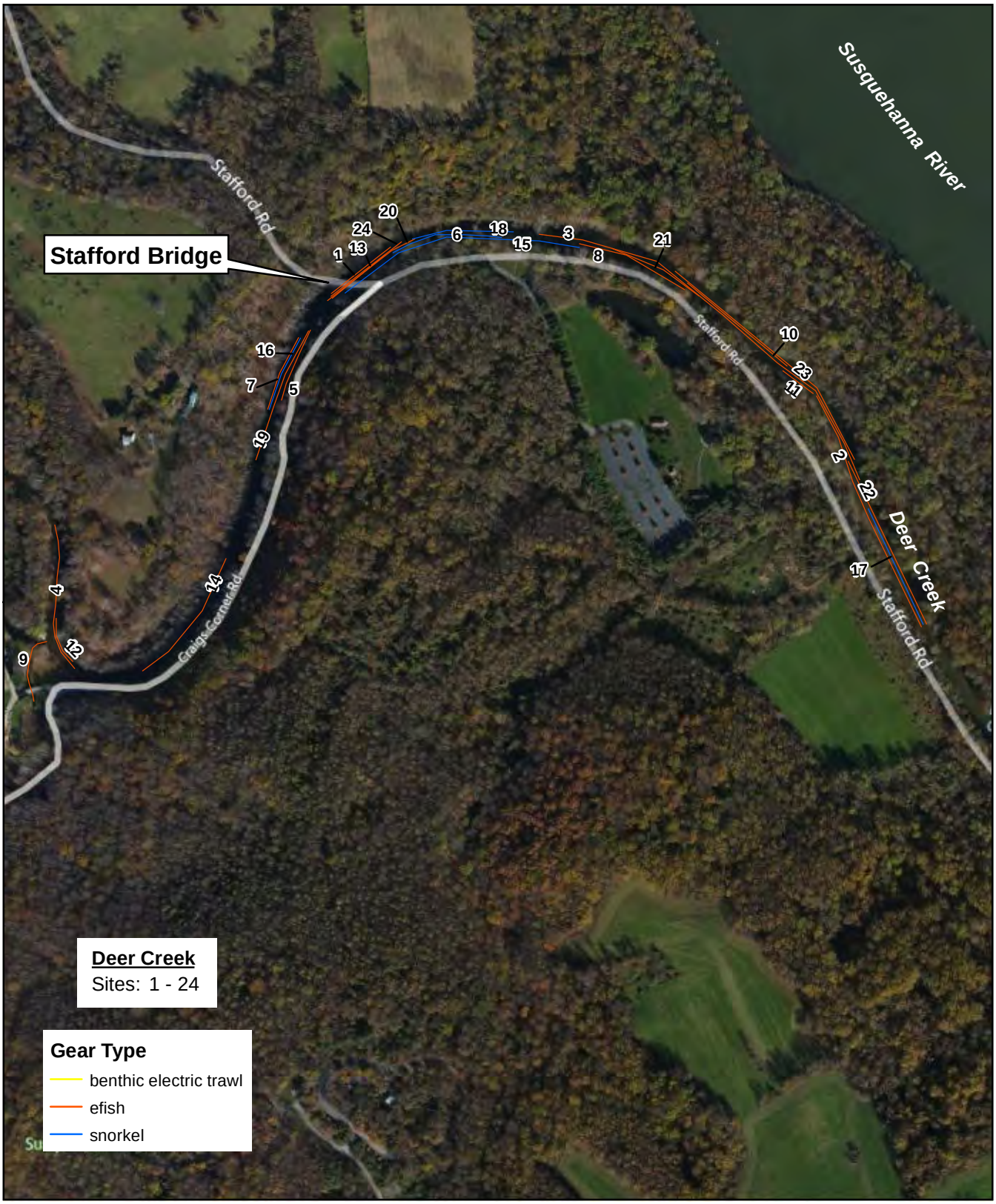

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N

1 inch = 0.1 miles

0 0.1 0.2 Miles

Figure 3.2-5.
Figure Title: Deer Creek Sampling Locations by Gear Type

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1 inch = 0.1 miles

0 0.1 0.2 Miles

Figure 3.2-6.
Figure Title: Octoraro Creek Sampling Locations by Gear Type

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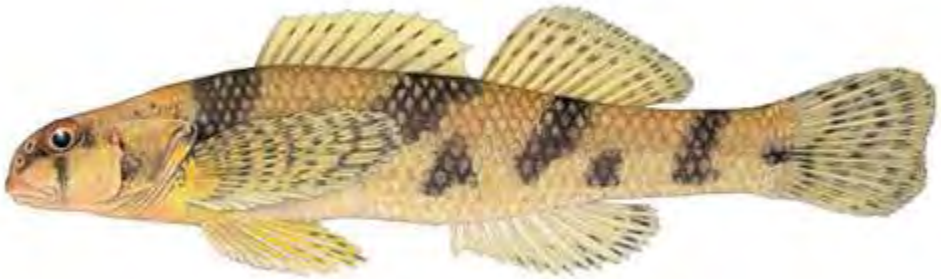

Figure 4.2-1: Maryland darter. Illustration by David Neely.

APPENDIX A: QUALITATIVE RELATIVE ABUNDACE OF SPECIES COLLECTED DURING THE SURVEY IN THE SUSQUEHANNA RIVER. DARTERS ARE ENUMERATED.

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	1	2	3	4	5	6	7	8
	Date:	1/11/11	1/11/11	1/11/11	1/11/11	1/11/11	1/11/11	1/11/11	1/11/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)*:	600	360	600	240	840	420	1140	1200
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel								
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad								
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp								
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner								
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish								
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch								
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill								
Micropterus dolomieu	smallmouth bass								
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter						1		
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter								
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	9	10	11	12	13	14	15	16
	Date:	1/11/11	1/11/11	1/12/11	1/12/11	1/12/11	1/12/11	1/12/11	1/12/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	1140	1800	900	300	660	420	1020	960
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel								1
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad				3				
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp				15				
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner				2	1		2	
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish								
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish				1			1	
Morone americana	white perch								
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish							1	
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill						1	1	1
Micropterus dolomieu	smallmouth bass								
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter				1	1		3	2
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter								
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	17	18	19	20	21	22	23	24
	Date:	1/12/11	1/13/11	1/13/11	1/13/11	1/13/11	1/13/11	1/13/11	1/14/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	660	600	600	240	480	960	480	540
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel								
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad	1	1						
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp								
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner								
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish								
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch								
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								1
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed		1						
Lepomis macrochirus	bluegill						2		
Micropterus dolomieu	smallmouth bass								
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter		1				5		
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter								
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

		Sampling Site:	25	26	27	28	29	30	31	32
		Date:	1/14/11	1/14/11	1/14/11	1/14/11	1/14/11	1/14/11	1/14/11	1/14/11
		Gear Code[a]:	1	1	1	1	1	1	1	1
		Effort *(shock or observation seconds)*:	600	720	660	780	1380	660	600	420
Petromyzon marinus	sea lamprey									
Anguilla rostrata	American eel						1		1	
Alosa sp.	River herrings/shad									
Dorosoma cepedianum	gizzard shad									
Campostoma anomalum	central stoneroller									
Carassius auratus	goldfish									
Clinostomus funduloides	rosyside dace									
Cyprinella analostana	satinfin shiner									
Cyprinella spiloptera	spotfin shiner									
Cyprinella sp.	shiner									
Cyprinus carpio	common carp									28
Exoglossum maxillingua	cutlips minnow									
Hybognathus regius	Eastern silvery minnow									
Luxilus cornutus	common shiner									
Nocomis micropogon	river chub									
Notropis amoenus	comely shiner									
Notoropis hudsonius	spottail shiner									
Notropis procne	swallowtail shiner									
Notropis rubellus	rosyface shiner									
Pimephales notatus	bluntnose minnow									
Rhinichthys atratulus	blacknose dace									
Rhinichthys cataractae	longnose dace									
Semotilus atromaculatus	creek chub									
Semotilus corporalis	fallfish									
Carpiodes cyprinus	quillback									1
Catostomus commersoni	white sucker									
Erimyzon oblongus	creek chubsucker									
Hypentelium nigricans	northern hog sucker									
Moxostoma macrolepidotum	shorthead redhorse									
Ameiurus natalis	yellow bullhead									
Ameiurus nebulosus	brown bullhead									
Ictalurus punctatus	channel catfish				29	1				
Pylodictis olivaris	flathead catfish									
Noturus insignis	margined madtom									
Salmo trutta	brown trout									
Strongylura marina	Atlantic needlefish									
Fundulus diaphanus	banded killifish									
Morone americana	white perch									
Morone saxatilis	striped bass									
Amploplites rupestris	rock bass									
Lepomis auritis	redbreast sunfish		1							
Lepomis cyanellus	green sunfish									
Lepomis gibbosus	pumpkinseed			1						
Lepomis macrochirus	bluegill		1				1			
Micropterus dolomieu	smallmouth bass									
Micropterus salmoides	largemouth bass									
Etheostoma blennioides	greenside darter									
Etheostoma olmstedi	tessellated darter		1		1					
Etheostoma zonale	banded darter									
Percina bimaculata	Chesapeake logperch									
Percina peltata	shield darter									
Perca flavescens	yellow perch									
Sander vitreum	walleye									
Cottus caeruleomentum	blue ridge sculpin									

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	33	34	35	36	37	38	39	40
	Date:	1/14/11	2/20/11	2/20/11	2/20/11	2/20/11	2/20/11	2/20/11	2/20/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	900	900	900	780	1200	720	1200	600
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel			6	2	2	3	1	1
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad								
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								1
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp	7				1	3		
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner							1	
Notoropis hudsonius	spottail shiner					31		7	7
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner							1	
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback	2							
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker					1			
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead					1		1	
Ictalurus punctatus	channel catfish					1		8	1
Pylodictis olivaris	flathead catfish							2	
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish		1			8	6		2
Morone americana	white perch								
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass						1		
Lepomis auritis	redbreast sunfish					3	1		
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed						1		
Lepomis macrochirus	bluegill						1		
Micropterus dolomieu	smallmouth bass								
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	3	3	19	3	61	8	76	29
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter								
Perca flavescens	yellow perch								2
Sander vitreum	walleye							1	
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	41	42	43	44	45	46	47	48
	Date:	2/20/11	2/20/11	2/20/11	2/20/11	2/20/11	6/20/11	6/20/11	6/20/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	1080	540	1200	600	600	220	647	415
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	1	1				*	*	
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad								
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp								
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner	3							
Notoropis hudsonius	spottail shiner	40	12						
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish	2	1					*	*
Pylodictis olivaris	flathead catfish		1						
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch							*	
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish		2					*	
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed		1						
Lepomis macrochirus	bluegill	1							
Micropterus dolomieu	smallmouth bass							*	
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	63	16	1			1	4	1
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter						1	1	
Perca flavescens	yellow perch	1	1	1					
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	49	50	51	52	53	54	55	56
	Date:	6/20/11	6/20/11	6/20/11	6/20/11	6/20/11	6/20/11	6/20/11	6/21/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)*:	647	415	608	392	538	352	519	133
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	*		**	*	*		*	
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad								
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner						*		
Cyprinella sp.	shiner				**	*			
Cyprinus carpio	common carp	*		*	*	*			
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner					*			
Notropis procne	swallowtail shiner				*				
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace			**	*	*			
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker				*				
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker	*							
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish	*	*	*	*			*	
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish					*			
Fundulus diaphanus	banded killifish			*	*	*			
Morone americana	white perch								
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish				*	*			
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill								
Micropterus dolomieu	smallmouth bass			*	*				
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	6	4	11	4	7	1	2	
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch			3					
Percina peltata	shield darter	1							
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

		Sampling Site:	57	58	59	60	61	62	63	64
		Date:	6/21/11	6/21/11	6/21/11	6/21/11	6/21/11	6/21/11	6/21/11	6/21/11
		Gear Code[a]:	1	1	1	1	1	1	1	1
		Effort *(shock or observation seconds)* **:**	289	266	114	540	430	340	423	174
Petromyzon marinus	sea lamprey									
Anguilla rostrata	American eel					*	**	*	*	*
Alosa sp.	River herrings/shad									
Dorosoma cepedianum	gizzard shad									
Campostoma anomalum	central stoneroller									
Carassius auratus	goldfish									
Clinostomus funduloides	rosyside dace									
Cyprinella analostana	satinfin shiner									
Cyprinella spiloptera	spotfin shiner									
Cyprinella sp.	shiner							*		
Cyprinus carpio	common carp						*			
Exoglossum maxillingua	cutlips minnow									
Hybognathus regius	Eastern silvery minnow									
Luxilus cornutus	common shiner									
Nocomis micropogon	river chub									
Notropis amoenus	comely shiner									
Notoropis hudsonius	spottail shiner									
Notropis procne	swallowtail shiner									
Notropis rubellus	rosyface shiner									
Pimephales notatus	bluntnose minnow									
Rhinichthys atratulus	blacknose dace									
Rhinichthys cataractae	longnose dace									
Semotilus atromaculatus	creek chub									
Semotilus corporalis	fallfish									
Carpiodes cyprinus	quillback									
Catostomus commersoni	white sucker								*	
Erimyzon oblongus	creek chubsucker									
Hypentelium nigricans	northern hog sucker									
Moxostoma macrolepidotum	shorthead redhorse					*				
Ameiurus natalis	yellow bullhead									
Ameiurus nebulosus	brown bullhead									
Ictalurus punctatus	channel catfish						*			
Pylodictis olivaris	flathead catfish									
Noturus insignis	margined madtom									
Salmo trutta	brown trout									
Strongylura marina	Atlantic needlefish									*
Fundulus diaphanus	banded killifish									
Morone americana	white perch									
Morone saxatilis	striped bass					*		*		
Amploplites rupestris	rock bass									*
Lepomis auritis	redbreast sunfish							*		
Lepomis cyanellus	green sunfish									
Lepomis gibbosus	pumpkinseed									
Lepomis macrochirus	bluegill									
Micropterus dolomieu	smallmouth bass									
Micropterus salmoides	largemouth bass									
Etheostoma blennioides	greenside darter									
Etheostoma olmstedi	tessellated darter					9	44	32	35	3
Etheostoma zonale	banded darter					1				
Percina bimaculata	Chesapeake logperch						10	5	7	1
Percina peltata	shield darter						12	1	1	
Perca flavescens	yellow perch									
Sander vitreum	walleye									
Cottus caeruleomentum	blue ridge sculpin									

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	65	66	67	68	69	70	71	72
	Date:	6/21/11	6/22/11	6/22/11	6/22/11	6/22/11	6/22/11	6/22/11	6/23/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	447	61	374	393	36	159	208	5
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	*	*			*	*	*	
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad								
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner						*	*	
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp								
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner								
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker							*	
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish	*					*	*	
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish	*							
Fundulus diaphanus	banded killifish								
Morone americana	white perch							*	
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill								
Micropterus dolomieu	smallmouth bass								
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	4		1	1		1	1	
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter								
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	73	74	75	76	77	78	79	80
	Date:	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	115	138	147	301	261	280	123	177
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	*	*		*		*	*	
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad								
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner				*	*	*		
Cyprinus carpio	common carp								
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner								
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish		*		*	*		*	
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch		*	*				*	
Morone saxatilis	striped bass								*
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill								
Micropterus dolomieu	smallmouth bass					*			
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter						1		1
Etheostoma zonale	banded darter						1		
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter								
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	81	82	83	84	85	86	87	88
	Date:	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	210	186	123	197	135	189	208	86
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel			*			*		
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad								
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner		*						
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner	*							
Cyprinus carpio	common carp		*		*	*			
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner	*					**	*	*
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish	*	*	*	*			*	
Pylodictis olivaris	flathead catfish					*			
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch	*			*	*	*		
Morone saxatilis	striped bass			*	*				
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill								
Micropterus dolomieu	smallmouth bass								*
Micropterus salmoides	largemouth bass		*					*	
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter								
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch			1			1		
Percina peltata	shield darter								
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

		Sampling Site:	89	90	91	92	93	94	95	96
		Date:	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11	6/23/11
		Gear Code[a]:	1	1	1	1	1	1	1	1
		Effort *(shock or observation seconds)* **:**	7	225	274	274	192	102	84	178
Petromyzon marinus	sea lamprey									
Anguilla rostrata	American eel			*	*					
Alosa sp.	River herrings/shad									
Dorosoma cepedianum	gizzard shad					*				
Campostoma anomalum	central stoneroller									
Carassius auratus	goldfish									
Clinostomus funduloides	rosyside dace									
Cyprinella analostana	satinfin shiner									
Cyprinella spiloptera	spotfin shiner			*		*				
Cyprinella sp.	shiner									
Cyprinus carpio	common carp				*			*	*	
Exoglossum maxillingua	cutlips minnow									
Hybognathus regius	Eastern silvery minnow									
Luxilus cornutus	common shiner									
Nocomis micropogon	river chub									
Notropis amoenus	comely shiner									
Notoropis hudsonius	spottail shiner			*	*	*				
Notropis procne	swallowtail shiner									
Notropis rubellus	rosyface shiner									
Pimephales notatus	bluntnose minnow									
Rhinichthys atratulus	blacknose dace									
Rhinichthys cataractae	longnose dace									
Semotilus atromaculatus	creek chub									
Semotilus corporalis	fallfish									
Carpiodes cyprinus	quillback									
Catostomus commersoni	white sucker				*					
Erimyzon oblongus	creek chubsucker									
Hypentelium nigricans	northern hog sucker									
Moxostoma macrolepidotum	shorthead redhorse									
Ameiurus natalis	yellow bullhead									
Ameiurus nebulosus	brown bullhead									
Ictalurus punctatus	channel catfish							*		
Pylodictis olivaris	flathead catfish									
Noturus insignis	margined madtom									
Salmo trutta	brown trout									
Strongylura marina	Atlantic needlefish									
Fundulus diaphanus	banded killifish									
Morone americana	white perch					*	*	*		*
Morone saxatilis	striped bass									
Amploplites rupestris	rock bass									
Lepomis auritis	redbreast sunfish									
Lepomis cyanellus	green sunfish									
Lepomis gibbosus	pumpkinseed									
Lepomis macrochirus	bluegill				*					
Micropterus dolomieu	smallmouth bass									
Micropterus salmoides	largemouth bass									
Etheostoma blennioides	greenside darter									
Etheostoma olmstedi	tessellated darter				1	1		3		
Etheostoma zonale	banded darter					2				
Percina bimaculata	Chesapeake logperch				1					
Percina peltata	shield darter				2					
Perca flavescens	yellow perch									
Sander vitreum	walleye									
Cottus caeruleomentum	blue ridge sculpin									

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

		Sampling Site:	97	98	99	100	101	102	103	104
		Date:	6/24/11	6/24/11	6/24/11	6/24/11	6/24/11	8/22/11	8/22/11	8/22/11
		Gear Code[a]:	1	1	1	1	1	1	1	1
		Effort *(shock or observation seconds)* **:**	349	198	359	103	201	120	173	359
Petromyzon marinus	sea lamprey									
Anguilla rostrata	American eel		*	*	*	*	*		*	*
Alosa sp.	River herrings/shad									
Dorosoma cepedianum	gizzard shad									
Campostoma anomalum	central stoneroller									
Carassius auratus	goldfish									
Clinostomus funduloides	rosyside dace									
Cyprinella analostana	satinfin shiner									
Cyprinella spiloptera	spotfin shiner									
Cyprinella sp.	shiner									
Cyprinus carpio	common carp		*	*					*	
Exoglossum maxillingua	cutlips minnow									
Hybognathus regius	Eastern silvery minnow									
Luxilus cornutus	common shiner									
Nocomis micropogon	river chub									
Notropis amoenus	comely shiner									
Notoropis hudsonius	spottail shiner									
Notropis procne	swallowtail shiner									
Notropis rubellus	rosyface shiner									
Pimephales notatus	bluntnose minnow									
Rhinichthys atratulus	blacknose dace									
Rhinichthys cataractae	longnose dace									
Semotilus atromaculatus	creek chub									
Semotilus corporalis	fallfish									
Carpiodes cyprinus	quillback									
Catostomus commersoni	white sucker									
Erimyzon oblongus	creek chubsucker									
Hypentelium nigricans	northern hog sucker									
Moxostoma macrolepidotum	shorthead redhorse								*	*
Ameiurus natalis	yellow bullhead									
Ameiurus nebulosus	brown bullhead									
Ictalurus punctatus	channel catfish							*		
Pylodictis olivaris	flathead catfish									
Noturus insignis	margined madtom									
Salmo trutta	brown trout									
Strongylura marina	Atlantic needlefish									
Fundulus diaphanus	banded killifish									
Morone americana	white perch		*							
Morone saxatilis	striped bass						*			
Amploplites rupestris	rock bass									
Lepomis auritis	redbreast sunfish		*					*	**	*
Lepomis cyanellus	green sunfish							*		*
Lepomis gibbosus	pumpkinseed					*				
Lepomis macrochirus	bluegill								*	*
Micropterus dolomieu	smallmouth bass			*						
Micropterus salmoides	largemouth bass									
Etheostoma blennioides	greenside darter								1	1
Etheostoma olmstedi	tessellated darter		19	32	1	35	198	8	37	58
Etheostoma zonale	banded darter							1	1	6
Percina bimaculata	Chesapeake logperch			3			4		1	2
Percina peltata	shield darter		1				1			
Perca flavescens	yellow perch									
Sander vitreum	walleye									
Cottus caeruleomentum	blue ridge sculpin									

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

		Sampling Site:	105	106	107	108	109	110	111	112
		Date:	8/22/11	8/22/11	8/22/11	8/22/11	8/22/11	8/23/11	8/23/11	8/23/11
		Gear Code[a]:	1	1	1	1	1	1	1	1
		Effort *(shock or observation seconds)* **:**	380	881	261	407	802	364	134	230
Petromyzon marinus	sea lamprey									
Anguilla rostrata	American eel		*	*		*	*	*		
Alosa sp.	River herrings/shad									
Dorosoma cepedianum	gizzard shad			**	*	**				
Campostoma anomalum	central stoneroller									
Carassius auratus	goldfish									
Clinostomus funduloides	rosyside dace									
Cyprinella analostana	satinfin shiner									
Cyprinella spiloptera	spotfin shiner									
Cyprinella sp.	shiner									
Cyprinus carpio	common carp			*		*	*	*		
Exoglossum maxillingua	cutlips minnow									
Hybognathus regius	Eastern silvery minnow									
Luxilus cornutus	common shiner									
Nocomis micropogon	river chub									
Notropis amoenus	comely shiner			*						
Notoropis hudsonius	spottail shiner			**		**	*			
Notropis procne	swallowtail shiner									
Notropis rubellus	rosyface shiner									
Pimephales notatus	bluntnose minnow									
Rhinichthys atratulus	blacknose dace			*			*			
Rhinichthys cataractae	longnose dace									
Semotilus atromaculatus	creek chub									
Semotilus corporalis	fallfish									
Carpiodes cyprinus	quillback						*			
Catostomus commersoni	white sucker									
Erimyzon oblongus	creek chubsucker									
Hypentelium nigricans	northern hog sucker									
Moxostoma macrolepidotum	shorthead redhorse			*	*	*	*	*		*
Ameiurus natalis	yellow bullhead									
Ameiurus nebulosus	brown bullhead									
Ictalurus punctatus	channel catfish							*	*	
Pylodictis olivaris	flathead catfish									
Noturus insignis	margined madtom									
Salmo trutta	brown trout									
Strongylura marina	Atlantic needlefish									
Fundulus diaphanus	banded killifish			*		*	*			
Morone americana	white perch		*						*	
Morone saxatilis	striped bass						*			
Amploplites rupestris	rock bass									
Lepomis auritis	redbreast sunfish		*				*			
Lepomis cyanellus	green sunfish									
Lepomis gibbosus	pumpkinseed									
Lepomis macrochirus	bluegill		*	*		*				
Micropterus dolomieu	smallmouth bass						*			
Micropterus salmoides	largemouth bass									
Etheostoma blennioides	greenside darter									
Etheostoma olmstedi	tessellated darter		23	23		1	4	20	2	
Etheostoma zonale	banded darter						1			
Percina bimaculata	Chesapeake logperch			1	1		3			
Percina peltata	shield darter			1		1	3			
Perca flavescens	yellow perch		*							
Sander vitreum	walleye									
Cottus caeruleomentum	blue ridge sculpin									

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	113	114	115	116	117	118	119	120
	Date:	8/23/11	8/23/11	8/23/11	8/24/11	8/24/11	8/24/11	8/24/11	8/24/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	462	513	183	62	95	176	232	308
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	*	*	*			*		*
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad								
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner							*	
Cyprinella spiloptera	spotfin shiner							*	
Cyprinella sp.	shiner								
Cyprinus carpio	common carp	*					*		*
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner							*	*
Notropis procne	swallowtail shiner							*	
Notropis rubellus	rosyface shiner								*
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse		*	*					*
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish	*		*					*
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch								
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill							*	
Micropterus dolomieu	smallmouth bass								*
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	6	10	1			4	1	18
Etheostoma zonale	banded darter								1
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter						1		
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	121	122	123	124	125	126	127	128
	Date:	8/25/11	8/25/11	8/25/11	8/25/11	8/25/11	10/24/11	10/24/11	10/24/11
	Gear Code[a]**:**	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	424	518	148	474	626	260	979	197
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	*	*		*	*	*	*	
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad								
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp		*						
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner					*		*	
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse							*	
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish	*						*	
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch								
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish		*						
Lepomis cyanellus	green sunfish	*	*						
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill	*	*			**			
Micropterus dolomieu	smallmouth bass								
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	1	27	1	4	11	4	174	3
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch		5			4			
Percina peltata	shield darter		2						
Perca flavescens	yellow perch							*	
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	129	130	131	132	133	134	135	136
	Date:	10/24/11	10/24/11	10/24/11	10/24/11	10/24/11	10/24/11	10/24/11	10/24/11
	Gear Code[a]:	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)*:	371	284	853	280	105	557	383	560
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	*	*		*				*
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad			*					*
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish	*							
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp				*		*		*
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner			**					*
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse		*			*		*	*
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish	**	**		*		*		*
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish			*					
Morone americana	white perch						*		
Morone saxatilis	striped bass						*		*
Amploplites rupestris	rock bass			*					
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed			*					
Lepomis macrochirus	bluegill		*	*					
Micropterus dolomieu	smallmouth bass								
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	15	38	181	17		2	2	26
Etheostoma zonale	banded darter			1	3	1			
Percina bimaculata	Chesapeake logperch			2	3		3		
Percina peltata	shield darter					1			
Perca flavescens	yellow perch			*					
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	137	138	139	140	141	142	143	144
	Date:	10/24/11	10/24/11	10/25/11	10/25/11	10/25/11	10/25/11	10/25/11	10/25/11
	Gear Code[a]**:**	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)***:**	226	1842	331	302	489	345	608	186
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	*	*	*					
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad							*	
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp	*	**	*	*		*		
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner		*						
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner							*	
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker						*		
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse	*	**				*		*
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish		*			*		*	*
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom					*	*		
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch		*	*					
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill								
Micropterus dolomieu	smallmouth bass				*	*			
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	3	18		1	5	1	1	1
Etheostoma zonale	banded darter		2		1	1	1		
Percina bimaculata	Chesapeake logperch		2			1			
Percina peltata	shield darter						1		
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	145	146	147	148	149	150	151	152
	Date:	8/20/11	8/20/11	8/23/11	8/23/11	8/24/11	8/22/11	8/22/11	8/23/11
	Gear Code[a]:	3	3	3	3	3	2	2	2
	Effort *(shock or observation seconds)* **:**	13500	13500	24000	14400	24000	6891	1449	5400a
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	*	*	*			***	**	***
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad	***	*	***		***	**		
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish						*		
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner						***		
Cyprinella sp.	shiner	**	**		***				
Cyprinus carpio	common carp			**		*	**		*
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow	**							
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub	**	*						
Notropis amoenus	comely shiner			**				*	
Notoropis hudsonius	spottail shiner				*			*	
Notropis procne	swallowtail shiner	***	**	*	*			*	
Notropis rubellus	rosyface shiner						**		
Pimephales notatus	bluntnose minnow	*							
Rhinichthys atratulus	blacknose dace				*				
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback			*	*	**	*		
Catostomus commersoni	white sucker								
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse		*	*		*	*		
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish	*		*	*	**	**	*	*
Pylodictis olivaris	flathead catfish						*		
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish	*		**		**	**		*
Morone americana	white perch								
Morone saxatilis	striped bass	*	*	*					
Amploplites rupestris	rock bass						*	*	
Lepomis auritis	redbreast sunfish	**	**	**	**	**			
Lepomis cyanellus	green sunfish	*	*	***	**		**	*	***
Lepomis gibbosus	pumpkinseed					*			
Lepomis macrochirus	bluegill	**	**	***	**	***	**	*	***
Micropterus dolomieu	smallmouth bass	**	*	**		**	*		
Micropterus salmoides	largemouth bass			**	*	**	*		*
Etheostoma blennioides	greenside darter				10	7			
Etheostoma olmstedi	tessellated darter	3	26	7	224	7	40	9	23
Etheostoma zonale	banded darter				7		1	1	1
Percina bimaculata	Chesapeake logperch	21	11	42		98	7		5
Percina peltata	shield darter	5				2	1		
Perca flavescens	yellow perch					*			
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

*<10 *Lepomis* Hybrid collected at site 150

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	153	154	155	156	157	158	159	160
	Date:	8/23/11	8/23/11	8/23/11	8/24/11	8/26/11	11/29/11	11/29/11	11/29/11
	Gear Code[a]:	2	2	2	2	2	2	2	1
	Effort *(shock or observation seconds)* **:**	2400a	4200a	7800a	6912	4355	435	281	601
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	***	**	***	***	***	*	*	
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad	*	*	*		**			
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner					*			
Cyprinella spiloptera	spotfin shiner			*		*			
Cyprinella sp.	shiner								
Cyprinus carpio	common carp		*	*	*			*	*
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow			*	**	**			
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner				**	***			
Notoropis hudsonius	spottail shiner			*	**	***	*	*	*
Notropis procne	swallowtail shiner			*	*				
Notropis rubellus	rosyface shiner			*	*	**			
Pimephales notatus	bluntnose minnow				*	**			
Rhinichthys atratulus	blacknose dace					*			
Rhinichthys cataractae	longnose dace					*			
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker				*	*			
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse								
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish			*	*	*			*
Pylodictis olivaris	flathead catfish	*							
Noturus insignis	margined madtom				*	**			
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish		**		***	**			
Morone americana	white perch								
Morone saxatilis	striped bass					*			
Amploplites rupestris	rock bass		*		*	*		*	
Lepomis auritis	redbreast sunfish			**	*	*			
Lepomis cyanellus	green sunfish	**	***	***	***	*			*
Lepomis gibbosus	pumpkinseed							*	*
Lepomis macrochirus	bluegill	**	**	***	***	*	*	**	
Micropterus dolomieu	smallmouth bass	*			*				
Micropterus salmoides	largemouth bass	*	*		*	*		*	
Etheostoma blennioides	greenside darter			3	1				
Etheostoma olmstedi	tessellated darter	18	34	100	118	557	15	7	4
Etheostoma zonale	banded darter		1	6	3	80			
Percina bimaculata	Chesapeake logperch	5	4			2			
Percina peltata	shield darter			1		5	1		
Perca flavescens	yellow perch								
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

[u] *sample time, no shock time recorded in data*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	161	162	163	164	165	166	167	168
	Date:	11/29/11	11/29/11	11/29/11	11/29/11	11/29/11	11/30/11	11/30/11	11/30/11
	Gear Code[a]**:**	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)*[u]**:**	811	141	998	368	167	568	248	73
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel	*		**	**	*	*		*
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad			*			*		
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner								
Cyprinella sp.	shiner								
Cyprinus carpio	common carp	**	*	*	*	*	**	**	**
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner								
Notoropis hudsonius	spottail shiner	**	*	**		*	**	*	
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback						*		
Catostomus commersoni	white sucker					*		*	
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse							*	
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead			*					
Ictalurus punctatus	channel catfish			*			*	**	
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish			**					
Morone americana	white perch			*	*				
Morone saxatilis	striped bass								
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish			*					
Lepomis cyanellus	green sunfish			*		*			
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill				*				
Micropterus dolomieu	smallmouth bass	*						*	
Micropterus salmoides	largemouth bass	*							
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	43	5	17	5	7	7	1	1
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter								
Perca flavescens	yellow perch	*		**	*	*			
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

[u] *sample time, no shock time recorded in data*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	169	170	171	172	173	174	175	176
	Date:	11/30/11	11/30/11	11/30/11	11/30/11	11/30/11	11/30/11	11/30/11	12/1/11
	Gear Code[a]**:**	1	1	1	1	1	1	1	1
	Effort *(shock or observation seconds)* **:**	689	544	472	642	509	284	N/A	506
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel								
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad		*						*
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner	*							
Cyprinella sp.	shiner								
Cyprinus carpio	common carp	*			*	*		*	
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner	*	*						*
Notoropis hudsonius	spottail shiner	**	*	**	*				
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback					*			
Catostomus commersoni	white sucker				*				*
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker				*				
Moxostoma macrolepidotum	shorthead redhorse	*	*	*	**	*			
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish					*			*
Pylodictis olivaris	flathead catfish								
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch								
Morone saxatilis	striped bass			*		*			
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill								
Micropterus dolomieu	smallmouth bass								
Micropterus salmoides	largemouth bass								
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter	1	1	5	1	4	1	6	
Etheostoma zonale	banded darter				1				
Percina bimaculata	Chesapeake logperch		1	1	1				
Percina peltata	shield darter							1	
Perca flavescens	yellow perch								*
Sander vitreum	walleye								
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

ᵘ *sample time, no shock time recorded in data*

Appendix A: Summary statistics & qualitative relative abundance of fishes recorded in Susquehanna River during Maryland darter survey.

	Sampling Site:	177	178	179	180	181	182		
	Date:	12/1/11	12/1/11	12/1/11	12/1/11	12/1/11	12/1/11		
	Gear Code[a]**:**	1	1	1	1	1	1		
	Effort *(shock or observation seconds)* **:**	204	595	592	842	337	633		
Petromyzon marinus	sea lamprey								
Anguilla rostrata	American eel								
Alosa sp.	River herrings/shad								
Dorosoma cepedianum	gizzard shad	*	*	*	*	*	*		
Campostoma anomalum	central stoneroller								
Carassius auratus	goldfish								
Clinostomus funduloides	rosyside dace								
Cyprinella analostana	satinfin shiner								
Cyprinella spiloptera	spotfin shiner					*			
Cyprinella sp.	shiner								
Cyprinus carpio	common carp		**	**					
Exoglossum maxillingua	cutlips minnow								
Hybognathus regius	Eastern silvery minnow								
Luxilus cornutus	common shiner								
Nocomis micropogon	river chub								
Notropis amoenus	comely shiner		*	*					
Notoropis hudsonius	spottail shiner			**		*	*		
Notropis procne	swallowtail shiner								
Notropis rubellus	rosyface shiner								
Pimephales notatus	bluntnose minnow								
Rhinichthys atratulus	blacknose dace								
Rhinichthys cataractae	longnose dace								
Semotilus atromaculatus	creek chub								
Semotilus corporalis	fallfish								
Carpiodes cyprinus	quillback								
Catostomus commersoni	white sucker		*	*			*		
Erimyzon oblongus	creek chubsucker								
Hypentelium nigricans	northern hog sucker								
Moxostoma macrolepidotum	shorthead redhorse			*	*				
Ameiurus natalis	yellow bullhead								
Ameiurus nebulosus	brown bullhead								
Ictalurus punctatus	channel catfish	*	**	*	*	*			
Pylodictis olivaris	flathead catfish					*			
Noturus insignis	margined madtom								
Salmo trutta	brown trout								
Strongylura marina	Atlantic needlefish								
Fundulus diaphanus	banded killifish								
Morone americana	white perch								
Morone saxatilis	striped bass				*				
Amploplites rupestris	rock bass								
Lepomis auritis	redbreast sunfish								
Lepomis cyanellus	green sunfish								
Lepomis gibbosus	pumpkinseed								
Lepomis macrochirus	bluegill								
Micropterus dolomieu	smallmouth bass								
Micropterus salmoides	largemouth bass			*					
Etheostoma blennioides	greenside darter								
Etheostoma olmstedi	tessellated darter		2	1	4	1			
Etheostoma zonale	banded darter								
Percina bimaculata	Chesapeake logperch								
Percina peltata	shield darter								
Perca flavescens	yellow perch								
Sander vitreum	walleye		*	*		*			
Cottus caeruleomentum	blue ridge sculpin								

[a] ***Gear codes:*** *1-benthic electric trawl; 2-backpack electrofisher; 3-snorkeling* ***Relative abundance codes:*** ** 1 - 10; ** 11-99; *** >=100*

ᵘ *sample time, no shock time recorded in data*

APPENDIX B: QUALITATIVE RELATIVE ABUNDACE OF SPECIES COLLECTED DURING THE SURVEY IN DEER CREEK. DARTERS ARE ENUMERATED.

Appendix B: Summary statistics & qualitative relative abundance of fishes recorded in Deer Creek during Maryland darter survey.

Gear Codes: 1- benthic electric trawl; 2 - backpack electrofisher; 3 snorkeling

Relative abundance codes: * - 1 - 10; ** - 11-99; *** - >=100

		Sampling Sites				Sampling Sites							Sampling Sites			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Date				Date										Date
		9-Oct-10	10-Oct-10	13-Nov-10	13-Nov-10	13-Nov-10	10-Oct-10	23-May-11	24-May-11	24-May-11	24-May-11	25-May-11	25-May-11	25-May-11	27-May-11	7-Jun-11
		Gear				Gear										Gear
		2	2	2	2	2	3	2	2	2	2	2	2	2	2	3
		Effort (shock or observation seconds)				Effort (shock or observation seconds)										Effort (shock or observatio
		4408	3510	4256	2843	1138	18000	2499	3516	1507	2203	2822	2376	2923	4173	30000
Petromyzon marinus	sea lamprey	*	*		*				*		*	*	*		*	**
Anguilla rostrata	American eel	***	***	***	***	***	*	***	***	***	***	***	***	***	***	
Alosa sp.	River herrings/shad															
Dorosoma cepedianum	gizzard shad				*	*	*									
Campostoma anomalum	central stoneroller		*													
Carassius auratus	goldfish							*					*	*	*	
Clinostomus funduloides	rosyside dace	*			*	*				***	*			*		
Cyprinella analostana	satinfin shiner		*		*				*		*	**		*	**	
Cyprinella spiloptera	spotfin shiner	**	***	*	**	*		**	**		**	**		*	**	
Cyprinella sp.	shiner						***									
Cyprinus carpio	common carp		*									*				
Exoglossum maxillingua	cutlips minnow	**	**	*	**	**	***	*	**	*	**	*	*	**	*	
Hybognathus regius	Eastern silvery minnow															
Luxilus cornutus	common shiner	*	*	*			**						*			
Nocomis micropogon	river chub	**	***	**	***	***	***	***	***		**	*	**	**		**
Notropis amoenus	comely shiner		*				***				*					
Notoropis hudsonius	spottail shiner	*		*			**	***	***		**	**	*	*	*	**
Notropis procne	swallowtail shiner		**	*			**				***	*				**
Notropis rubellus	rosyface shiner	*	**				***	**	*		*	*	*	*	*	
Pimephales notatus	bluntnose minnow	*	*				*				*					
Rhinichthys atratulus	blacknose dace	**	*	*	*					**	*			*	*	
Rhinichthys cataractae	longnose dace	***	**	**	***	***		**	**	*	**		***	***	**	
Semotilus atromaculatus	creek chub	*								***			*	*		
Semotilus corporalis	fallfish		*	*	*			*	*							
Carpiodes cyprinus	quillback															
Catostomus commersoni	white sucker	**	**	*	**	*		*	*	*		*		*	*	
Erimyzon oblongus	creek chubsucker															
Hypentelium nigricans	northern hog sucker	**	**	**	**	**	*		*			*	*			**
Moxostoma macrolepidotum	shorthead redhorse							*								
Ameiurus natalis	yellow bullhead															
Ameiurus nebulosus	brown bullhead	**	***	*				**	**	*		**	**	**	**	
Ictalurus punctatus	channel catfish		*				*		**		**	**	*	**	**	**
Pylodictis olivaris	flathead catfish															
Noturus insignis	margined madtom	***	***	***	**	**	*	***	***	*	***	**	**	***	***	**
Salmo trutta	brown trout	*								*						
Strongylura marina	Atlantic needlefish										*				*	
Fundulus diaphanus	banded killifish		**	***	***	***	*		*							
Morone americana	white perch								**		**	*	*	*		
Morone saxatilis	striped bass															
Amplophlites rupestris	rock bass	*	*			*	*	*	*	*	*	*		**	**	
Lepomis auritis	redbreast sunfish	**	***	*	*	*	***	*	**	*			*	*	**	**
Lepomis cyanellus	green sunfish	***	***	*	**	*	***	**	***	*	*	***	**	***	*	**
Lepomis gibbosus	pumpkinseed	***	***	*	**	**	***						*	*	*	**
Lepomis macrochirus	bluegill	**	***	*	**	**	***	*					*	*		**
Micropterus dolomieu	smallmouth bass	*	*				**									**
Micropterus salmoides	largemouth bass	*			*		*					*				
Etheostoma blennioides	greenside darter		2				1									
Etheostoma olmstedi	tessellated darter	193	279	501	43	35	35	29	40	26	88	46	36	13	2	20
Etheostoma zonale	banded darter	9	16	2			1		1					1		
Percina bimaculata	Chesapeake logperch	11	9	5	5	7	15	48	65		31	4	12	22	22	5
Percina peltata	shield darter	29	13	13	2	18	6	7	31		3	1	5	6	5	1
Perca flavescens	yellow perch													*		
Sander vitreum	walleye															
Cottus caeruleomentum	blue ridge sculpin	**	*	**	***	**		**	*	**	*		**	**	**	

Appendix B: Summary statistics & qualitative relative abundar

Gear Codes: 1- benthic electric trawl; 2 - backpack electrofisher; 3 snorkeling

Relative abundance codes: * - 1 - 10; ** - 11-99; *** - >=100

		Sampling Sites								
		16	17	18	19	20	21	22	23	24
		Date								
		9-Jun-11	19-Aug-11	21-Aug-11	20-Aug-11	20-Aug-11	21-Aug-11	12-Nov-11	12-Nov-11	12-Nov-11
		Gear								
		3	3	3	2	2	2	2	2	2
		on seconds)			Effort (shock or observation seconds)					
		25200	11700	21000	2317	2680	3336	5883	6883	3794
Petromyzon marinus	sea lamprey	**		*		*				
Anguilla rostrata	American eel				***	***	***	**	***	***
Alosa sp.	River herrings/shad									
Dorosoma cepedianum	gizzard shad				**					
Campostoma anomalum	central stoneroller									
Carassius auratus	goldfish				*	**				*
Clinostomus funduloides	rosyside dace					**				*
Cyprinella analostana	satinfin shiner				**	**	**	**		*
Cyprinella spiloptera	spottin shiner				**	**	**	**	***	**
Cyprinella sp.	shiner	**		**						
Cyprinus carpio	common carp			*		*				
Exoglossum maxillingua	cutlips minnow			*	**	**	**			
Hybognathus regius	Eastern silvery minnow				*					
Luxilus cornutus	common shiner									
Nocomis micropogon	river chub	**		**	**	**	**	*	*	**
Notropis amoenus	comely shiner							***	***	***
Notoropis hudsonius	spottail shiner	**		**	*	*	**	*	*	*
Notropis procne	swallowtail shiner	**		***	*	*		***	***	**
Notropis rubellus	rosyface shiner				*	**	*			*
Pimephales notatus	bluntnose minnow			**		*			*	*
Rhinichthys atratulus	blacknose dace					**				*
Rhinichthys cataractae	longnose dace	**			**	***	**			*
Semotilus atromaculatus	creek chub				*	*				*
Semotilus corporalis	fallfish			**	*	*	**		*	**
Carpiodes cyprinus	quillback									
Catostomus commersoni	white sucker			**		*	*	*	*	*
Erimyzon oblongus	creek chubsucker									
Hypentelium nigricans	northern hog sucker	**		*	*	*	*	*	*	*
Moxostoma macrolepidotum	shorthead redhorse						*		*	*
Ameiurus natalis	yellow bullhead									
Ameiurus nebulosus	brown bullhead				*	*				
Ictalurus punctatus	channel catfish			*			**	*		*
Pylodictis olivaris	flathead catfish			*						
Noturus insignis	margined madtom				**	***	***	*	*	**
Salmo trutta	brown trout									
Strongylura marina	Atlantic needlefish									
Fundulus diaphanus	banded killifish							*	*	*
Morone americana	white perch			*						
Morone saxatilis	striped bass							*		
Amplopliles rupestris	rock bass			*	*	*	*			
Lepomis auritis	redbreast sunfish	**		**	*	**	*			
Lepomis cyanellus	green sunfish	**		*	*	**	**	*	*	*
Lepomis gibbosus	pumpkinseed					*	*	*	*	**
Lepomis macrochirus	bluegill	**		***	*	*	*	**	*	**
Micropterus dolomieu	smallmouth bass	**		*	*	*	*		*	*
Micropterus salmoides	largemouth bass			*					*	
Etheostoma blennioides	greenside darter						1			
Etheostoma olmstedi	tessellated darter	15		83	27	48	92	415	397	184
Etheostoma zonale	banded darter			1	5	4	1	1	2	1
Percina bimaculata	Chesapeake logperch	17		17	19	16	25		1	8
Percina peltata	shield darter	17		13	27	13	18		1	1
Perca flavescens	yellow perch							**	***	*
Sander vitreum	walleye									
Cottus caeruleomentum	blue ridge sculpin				*	*				

APPENDIX C: QUALITATIVE RELATIVE ABUNDACE OF SPECIES COLLECTED DURING THE SURVEY IN OCTORARO CREEK. DARTERS ARE ENUMERATED.

Appendix C: Summary statistics & qualitative relative abundance of fishes recorded in Octoraro Creek during Maryland darter survey.

Gear Codes: 1- benthic electric trawl; 2 - backpack electrofisher; 3 snorkeling

Relative abundance codes: * - 1 - 10; ** - 11-99; *** - >=100

		Sampling Sites				Sampling Sites							
		1	2	3	4	5	6	7	8	9	10	11	12
		Date				Date							
		9-Oct-10	14-Nov-10	14-Nov-10	23-May-11	9-Jun-11[a]	8-Jun-11[b]	24-Aug-11	26-Aug-11	21-Aug-11	25-Aug-11	13-Nov-11	13-Nov-11
		Gear				Gear							
		2	2	2	2	2	3	3	3	2	2	2	2
		Effort (shock or observation seconds)				Effort (shock or observation seconds)							
		4234	3641	1989	4968	3144	N/A	29700	21600	4057	6630	6666	3251
Petromyzon marinus	sea lamprey					**	**	*	*	*	*		
Anguilla rostrata	American eel	***	***	***	***	***	**			***	***	***	***
Alosa sp.	River herrings/shad								***				
Dorosoma cepedianum	gizzard shad	**						***	**	**	*		
Campostoma anomalum	central stoneroller	*											
Carassius auratus	goldfish				*					*			
Clinostomus funduloides	rosyside dace		*	*	*								
Cyprinella analostana	satinfin shiner	*				**				**	***	**	***
Cyprinella spiloptera	spottin shiner	***	***	**		**				**	***	***	***
Cyprinella sp.	shiner						**	*	**				
Cyprinus carpio	common carp						**	*	*	*	*		*
Exoglossum maxillingua	cutlips minnow	**	*	*	*	*		*		*	*		
Hybognathus regius	Eastern silvery minnow							**	***	**	*		
Luxilus cornutus	common shiner	*	*	*	*		**			*			
Nocomis micropogon	river chub	**	**	***	*	*	**	**		**	*	*	*
Notropis amoenus	comely shiner	*			*			***	***	**	***	***	***
Notoropis hudsonius	spottail shiner	*	**	*	**	*	**	***	***	**	***	***	***
Notropis procne	swallowtail shiner	**	**	**	*	*	**	***	***	**	*	**	**
Notropis rubellus	rosyface shiner	***	**	***	*		**	***	**	***	***		
Pimephales notatus	bluntnose minnow	*	*		*			**	*	**			*
Rhinichthys atratulus	blacknose dace	**	*	*					*		*		
Rhinichthys cataractae	longnose dace	***	**	***			**			**	**		
Semotilus atromaculatus	creek chub				*			*			*		
Semotilus corporalis	fallfish	*					**	*		*	*		
Carpiodes cyprinus	quillback						**		*	*			
Catostomus commersoni	white sucker	*	*	*	*		**	**	*	*	*	*	*
Erimyzon oblongus	creek chubsucker												
Hypentelium nigricans	northern hog sucker	**	**	**			**	*	*	*	*	*	*
Moxostoma macrolepidotum	shorthead redhorse		*		*				*		*	*	
Ameiurus natalis	yellow bullhead									*	*		
Ameiurus nebulosus	brown bullhead	**			*								
Ictalurus punctatus	channel catfish	*			*	*	**	*	*	**	*	**	**
Pylodictis olivaris	flathead catfish												
Noturus insignis	margined madtom	***	***	***	**	**		*		**	**	**	**
Salmo trutta	brown trout												
Strongylura marina	Atlantic needlefish												
Fundulus diaphanus	banded killifish		***	***		*	**		***	*			
Morone americana	white perch				**								
Morone saxatilis	striped bass							*	*				
Amploplites rupestris	rock bass	*	*		*	*		*	*	*		*	
Lepomis auritis	redbreast sunfish	**	*	*	*	*	**	**	**	**	*	*	*

Gear Codes: 1- benthic electric trawl; 2 - backpack electrofisher; 3 snorkeling

Relative abundance codes: * - 1 - 10; ** - 11-99; *** - >=100

		Sampling Sites				Sampling Sites							
		1	2	3	4	5	6	7	8	9	10	11	12
		Date				Date							
		9-Oct-10	14-Nov-10	14-Nov-10	23-May-11	9-Jun-11[a]	8-Jun-11[b]	24-Aug-11	26-Aug-11	21-Aug-11	25-Aug-11	13-Nov-11	13-Nov-11
		Gear				Gear							
		2	2	2	2	2	3	3	3	2	2	2	2
		Effort (shock or observation seconds)				Effort (shock or observation seconds)							
		4234	3641	1989	4968	3144	N/A	29700	21600	4057	6630	6666	3251
Lepomis cyanellus	green sunfish	***	**	**	**	**	**	*	**	**	**	**	*
Lepomis gibbosus	pumpkinseed	*	*	*	*	*	**	*	*	*	*		
Lepomis macrochirus	bluegill	**	**	**	**	*	**	**	***	*	**	*	*
Micropterus dolomieu	smallmouth bass		*				**	**	**	*	*		*
Micropterus salmoides	largemouth bass	*						*	**	*			
Etheostoma blennioides	greenside darter	5		2				2	1		2		
Etheostoma olmstedi	tessellated darter	75	157	67	47	12	**	127	93	98	194	53	42
Etheostoma zonale	banded darter	15	11	19				9	1	4	19	3	
Percina bimaculata	Chesapeake logperch	5	1	4	5	2	4	7	1220	3	5	4	
Percina peltata	shield darter	19	22	52				27		6	23	3	1
Perca flavescens	yellow perch	*							*			*	*
Sander vitreum	walleye												
Cottus caeruleomentum	blue ridge sculpin												

[a] *sample taken on 8-Jun-11 and 9-Jun-11*

[b] *sample taken on 24-May-11, 26-May-11, and 8-Jun-11*

Attachment G

Conowingo Hydroelectric Project
(FERC Project No. 405)

Fish Kill Notification Plan

CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NUMBER 405

FISH KILL NOTIFICATION PLAN

Prepared for:

Constellation.

Prepared by:

GOMEZ AND SULLIVAN ENGINEERS

March 2022

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Appendix A. Correspondence on Draft Plan

Appendix B. Fish Kill Event Investigation Response Data Collection Form

LIST OF ABBREVIATIONS

COMAR	Code of Maryland Regulations
Constellation, the licensee	Constellation Energy Generation, LLC
DO	dissolved oxygen
Exelon	Exelon Generation Company, LLC
FERC, the Commission	Federal Energy Regulatory Commission
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
mg/L	milligrams per liter
PFBC	Pennsylvania Fish and Boat Commission
Project	Conowingo Hydroelectric Project
US EPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service

1 INTRODUCTION

1.1 Background

Constellation Energy Generation, LLC (Constellation, the licensee) is the licensee for the 570.15-megawatt Conowingo Hydroelectric Project (Project) (Federal Energy Regulatory Commission (FERC, the Commission) Project No. 405). The Project is located on the Susquehanna River (at river mile 10) in Pennsylvania and Maryland (Figure 1.1-1). Conowingo Dam is located in Maryland connecting Cecil and Harford counties, as is the lowermost six miles of the Project reservoir, Conowingo Pond. The remaining eight miles of Conowingo Pond are located in Pennsylvania, within York and Lancaster counties.

The Project's FERC License requires Constellation to develop and implement a plan to monitor for, investigate, and report Fish Kill Events, defined as any fish kills exceeding 50 fish, that occur in the Conowingo Pond or the tailrace.[1] Specifically, Article 411 states:

> *Article 411*. Fish Kill Notification Plan. *Within one year of license issuance, the licensee must file with the Commission for approval, a fish kill monitoring plan for any fish kills exceeding 50 fish in Conowingo Pond and/or the project tailrace. The plan must include, at a minimum: (a) data collection procedures, (b) analysis methods, (c) a provision to identify any project-related causes that could have resulted in any such reported fish kills, and (d) a schedule and procedure for reporting.*
>
> *The plan must be developed after consultation with the Maryland Department of Natural Resources, the U.S. Fish and Wildlife Service, and the Pennsylvania Fish and Boat Commission. The licensee must 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 must 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 must include the licensee's reasons, based on project-specific information.*
>
> *The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.*

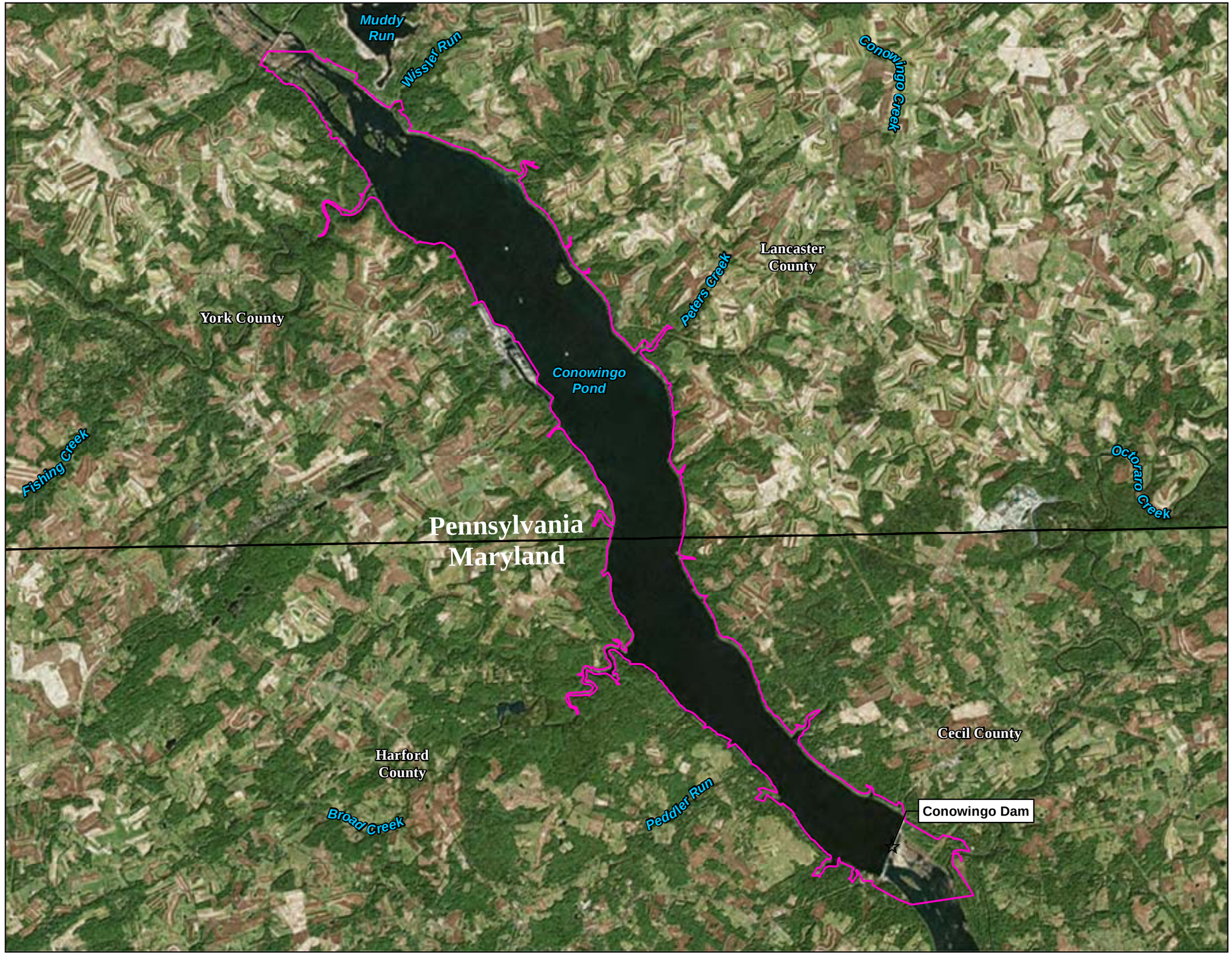
In accordance with the requirements for the contents of this plan, Constellation has developed:

- Measures to monitor for various types of potential fish kills (Section 3)
- Data collection procedures and analysis pertaining to Fish Kill Event Investigations that would be performed to identify project-related causes that could have resulted in reported or documented Fish Kill Events (Section 4)
- Schedules and procedures for Fish Kill Event notifications (Section 4.3) and reporting associated with implementing this plan (Section 5)

[1] Fish mortality in the Conowingo fish lifts and eel passage facilities will be investigated and reported separately in accordance with their relevant management plans.

1.2 Consultation Record

In accordance with Article 411 and the *Joint Offer of Settlement and Explanatory Statement Of Exelon Generation Company, LLC and the Maryland Department of the Environment* (Exelon 2019), Constellation provided a draft fish kill monitoring plan to the Maryland Department of the Environment (MDE), Maryland Department of Natural Resources (MDNR), Pennsylvania Fish and Boat Commission (PFBC), and the U.S. Fish and Wildlife Service (USFWS) on January 26, 2022, with a requested 30-day comment period. Comments were received from MDE, PFBC, and USFWS on the draft plan, and all comments are included in Appendix A. For each applicable comment, Constellation indicates whether and how the recommendation was adopted or provides justification for not adopting specific recommendations.



Fish Kill Notification Plan

Figure 1.1-1:
Project Location

Legend

Project Boundary

N

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

0 2500 5000
Feet

CONSTELLATION ENERGY GENERATION, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

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Path: X:\GISMaps\project_maps\Conowingo_FKNP\Figure_1_1_1.mxd

2 EXISTING INFORMATION

2.1 Historical Fish Kills

MDE provided historical fish kill information (1985 to present) for the Susquehanna River and major tributaries that enter the river above and below the Project dam. Several investigated fish kills had no distinguishable cause based on the results of the investigations performed. In general, the most common probable cause of fish kills identified on the Susquehanna River in Maryland has been discards from recreational and commercial fisheries. There is a high degree of fishing pressure below the Project dam, which can result in fish kills when large numbers of fish are being caught and released and subsequently succumb to angling-related injuries. Stress (e.g., seasonal, thermal, winter, migration) or disease have also been identified as probable causes in various locations. Probable causes attributed to the Project have been infrequent and have included mortalities from the fish lift and trapping facilities (e.g., gizzard shad handling stress or discards in April 1985 and July 1997), discharge of hypoxic water from the dam (July 1985), and reduction in flow releases from the dam (December 2012 and May 2015).

The most recent (December 4, 2012 and May 5, 2015) events that were attributed to the Project were both reported by members of the public with concerns about reductions in flow releases from the Project. The December 4, 2012 fish kill was attributed to stoppage of flow below the dam and was investigated at the Conowingo Fisherman's Park directly below the Project powerhouse. This fish kill included shiner species (n=200), tessellated darter (n=60), logperch (n=20), and sunfish species (n=20), for a total of around 300 fish. Flows in the Susquehanna River in the days preceding the event included baseline flows or around 4,000 cfs, along with peaking operations between 38,600 and 66,500 cfs, and periods when the flow dropped to as low as 300 cfs. Each of the peaking events were followed by rapid (e.g., nearly 17,000 cfs in half an hour) reductions in flow to the base flow level. The 2015 fish kill was located near Shures Landing and included blueback herring (n=100), gizzard shad (n=50), American shad (n=25), hickory shad (n=25), and largemouth bass (n=1) for a total of 201 fish. The complainant reported that these fish had been stranded after the gates were reportedly closed at the dam. Project operations occurring prior to this event included peaking operations on May 4th, 2015 with flows up to 59,000 cfs in the river followed by a reduction in flow to around 9,430 cfs, including a rate reduction of over 13,000 cfs in half an hour as flows fell below 30,000 cfs. The very flow flows and/or high sub-hourly rates of water level change that potentially resulted in these fish kill events will no longer occur as part of the Project's new license, which includes a minimum flow of 4,000 cfs and down-ramping rates of up to 12,000 cfs per hour when the Project discharge is less than 30,000 cfs. This will allow for fish to adapt to changes and flow and find egress from potential stranding locations.

2.2 Dissolved Oxygen Enhancement and Monitoring Requirements

Dissolved oxygen (DO) is the measure of how much oxygen is available to living aquatic organisms in water. The Conowingo Pond has been shown to exhibit DO stratification (i.e., higher DO levels in near-surface waters, and lower DO levels at depth), resulting in the potential for entrainment of lower DO level waters through low-level intakes at the Project (Exelon 2012). Constellation has implemented turbine venting as well as the installation of aerating turbine runners at the Project, which significantly improved DO levels in the tailrace relative to historic conditions.

In accordance with Article 410, Constellation must continue DO enhancement at the Project using existing turbine venting systems on Units 1 through 7 and the aerating runners on Units 2 and 5. In accordance with NPDES Permit Number 19-DP-0491 and Article 410, Constellation is required to continuously monitor DO at Station 643, located approximately 0.6 miles downstream of the power station, from May 1 through October 31 each year. The minimum hourly DO concentration to maintain compliance according to the NPDES permit is 5.0 mg/L, which is substantially higher than the lethal DO requirements for relevant

species in the Project boundary. The NPDES permit also requires grab sample collection for various scenarios.

2.3 Fish Passage Mortality Monitoring Requirements

Mortality of fish associated with the Project's East and West Fish Lifts and eel passage systems will be monitored and documented in accordance with the Fishway Operation and Maintenance Plan (FOMP).

3 FISH KILL MONITORING

3.1 Public Outreach

Though not all fish kills will be related to the Project or its operation, Constellation will provide information at the Conowingo Visitor's Center, recreation sites, and social media to inform the public about fish kills and how to report them to Constellation and the State of Maryland and Commonwealth of Pennsylvania. These measures will be installed and will be maintained and updated on an as-needed basis. Fish kills reported by members of the public to Constellation will be investigated in accordance with Section 4. The geographic extent of fish kills that Constellation will publicize includes any location with the Conowingo Project boundary (see Figure 1.1-1).

3.2 Fish Kill Reconnaissance Surveys

Fish Kill Reconnaissance Surveys are a preliminary measure for identifying potential fish kills that may not be identified by members of the public or at Project fishways. Fish Kill Reconnaissance Surveys will be triggered by:

- DO values recorded by Constellation as part of NPDES and Article 410 that do not comply with the minimum DO requirements.

- Constellation staff observations of dead fish during weekly walkthroughs: Constellation will walk the safely accessible areas on the dam along the Project forebay and tailrace areas weekly to look for dead fish. Constellation will contact contracted fisheries biologists if any dead fish are observed. Fisheries biologists will determine if a Fish Kill Reconnaissance Survey is triggered.

- Fish passage contractor observations of 50 or more dead fish or 25 or more freshly dead or dying fish. Fisheries biologists contracted by Constellation are anticipated to be on-site in the Project tailrace area daily between March and early November for various fish passage operations and will look for dead fish.

Fish Kill Reconnaissance Surveys will be performed within 24 hours of a trigger. No more than one Fish Kill Reconnaissance Survey from a specific trigger will be performed in a given day, and Fish Kill reconnaissance surveys will only be performed when it is safe to do so.

Fish Kill Reconnaissance Surveys will be performed by a fisheries biologist or technician capable of identifying the fish species in the Project vicinity. During the Fish Kill Reconnaissance Surveys, surveyors will search for dead fish visually and by using binoculars. The number and location of dead fish will be recorded. Unless the location and extent of the potential fish kill is well-defined, the surveys will be performed by walking the following locations, shown in Figure 3.2-1:

- The width of the Conowingo Project tailrace, between the East Fish Lift and West Fish Lift, where it is safe to do so.

- The width of the Conowingo Project forebay area (between the Conowingo Powerhouse and East Fish Lift), where it is safe to do so.

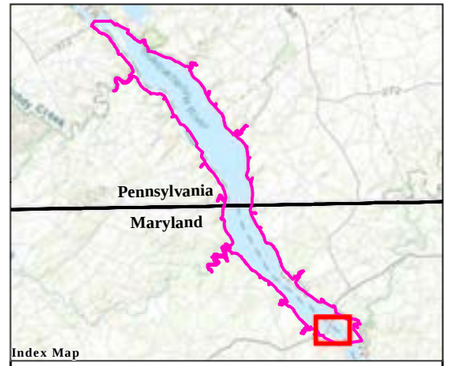
- Along the river-right shoreline from the Project powerhouse to monitoring station 643.

If Fish Kill Reconnaissance Surveys identify a fish kill[2], a Fish Kill Event Investigation will be triggered (Section 4). Even if no investigation is triggered, observations of 25 or more dead fish will trigger notification to MDE if observed in Maryland waters within the Project area (Section 4.3).

3.3 Fish Passage Mortality

Though monitoring associated with fishways (including eel passage systems) will be implemented in accordance with the FOMP, incidents involving 50 or more dead fish per day will be considered a Fish Kill Event as part of this plan and will trigger a Fish Kill Event Investigation (Section 4) and associated notification and reporting.

[2] A fish kill is defined as fifty (50) or more dead fish, except in Maryland waters where a fish kill may also be defined as at least 25 freshly dead or dying fish.



Fish Kill Notification Plan

Figure 3.2-1:
Fish Kill Reconnaissance Survey Area

Legend

- Project Boundary
- Water Quality Monitoring Station
- Fish Kill Reconnaissance Survey Walking Path

N

Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

0 250 500 1,000 Feet

CONSTELLATION ENERGY GENERATION, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

Constellation

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Path: X:\GISMaps\project_maps\Conowingo_FKNP\Figure_3_2_1.mxd

4 FISH KILL EVENT INVESTIGATION

4.1 Response

Potential Fish Kill Events within the Conowingo Project boundary (see Figure 1.1-1) reported to Constellation by members of the public or resource agencies will be responded to as soon as practicable and safe, with the goal of fisheries biologists and/or technicians performing a site visit within 24 hours to confirm and characterize the Fish Kill Event. For Fish Kill Events identified by a Fish Kill Reconnaissance Survey, a Fish Kill Event Investigation will be performed immediately.

The response to a potential Fish Kill Event will include:

- Recording the time and location of the potential Fish Kill Event
- Collecting applicable information on conditions (e.g., weather, flows, Project operations, water temperature and DO measurements) at the time of the survey
- Collecting photos of the potential Fish Kill Event, including representative photos of the area, dead fish, and individual fish
- Recording a description of the extent of the documented potential Fish Kill Event, including the upstream and downstream extent of observed fish kills,
- Identifying the dead fish to species
- Recording the number and size class (e.g., adult, juvenile, young-of-year) of each species
- Recording the freshness of specimens (e.g., moribund, freshly dead, decayed)
- Examining specimens for injuries or trauma and recording the approximate frequency
- Identifying activities in the area that may have resulted in an identified Fish Kill Event (e.g., heavy angling activity, chemical spill, signs that fish had been discarded)
- Identifying whether the event is a Fish Kill Event and if it is still occurring or progressing
- Identifying any actions taken (e.g., notifications)

The information gathered will be recorded on standardized datasheets, which are included in Appendix B. If fifty (50) or more dead fish are identified anywhere within the Project area, or if 25 freshly dead or dying fish are identified within Maryland waters within the Project area, are identified during the Fish Kill Event Investigation, it will be considered a Fish Kill Event and MDE and PFBC will be notified in accordance with Section 4.3.

4.2 Preliminary Analyses

Data gathered during a Fish Kill Event will be compiled and summarized. Operations and flow data from the Project, along with the continuous DO data from the downstream monitor, if relevant and available, will be compiled and plotted. Relevant information will be reviewed to determine if Project operations contributed to the fish kill.

4.3 Notification

Constellation will notify state agencies of confirmed Fish Kill Events as soon as feasible following an event. To ensure that contact information for notifications is up-to-date, Constellation will maintain a Fish Kill Notifications Flow Chart (Table 4.3-1). The Flow Chart will include the necessary contact information for fish kills that are identified in Pennsylvania and Maryland. Notifications provided will include the Constellation primary contact and contracted fisheries biologist responsible for performing the fish kill investigation. [3]

Table 4.3-1: Fish Kill Notifications Flow Chart Template

Contracted Fish Kill Investigation Biologist		
↓		
Constellation FERC License Compliance Manager (PRIMARY CONTACT)		
↓	↓	↓
Conowingo Visitors Center 1-410-457-2427	**Pennsylvania Fish Kills**	**Maryland Fish Kills**
	Pennsylvania Department of Environmental Protection 1-800-541-2050	Pennsylvania Fish and Boat Commission 1-855-347-4545	MDE Fish Kill Response Program 1-866-633-4686

[3] Contact information is expected to change over the lifetime of this plan; therefore, Constellation has not included specific staff contact information as part of this document. Resource agency and Constellation staff contact information will be included in the official notification table, which will be updated on an as-needed basis. Constellation will provide a current phone number and email of the primary contact to resource agencies.

5 REPORTING

5.1 Fish Kill Event Investigations

Information gathered during a Fish Kill Event Investigation will be summarized in a report, which will be provided to the Maryland Department of the Environment's Fish Kill Investigation Section and PFBC within one week of the Fish Kill Event. The report will include the details of the information gathered (see Appendix B), along with representative photographs and annotations.

5.2 Annual Summaries

Constellation will provide MDE, MDNR, PFBC, USFWS, and FERC with a summary report by February 15 of each year. The report will describe the activities performed as part of implementing this plan during the prior calendar year, and will include:

- Thresholds that triggered Fish Kill Reconnaissance Surveys[4]
- Summaries of Fish Kill Events identified, and notifications performed
- Individual Fish Kill Event Investigation Reports attached in an appendix

6 IMPLEMENTATION SCHEDULE

Implementation of this plan will be performed within one (1) year of approval of this plan by the FERC

7 PLAN UPDATES

This plan may be updated based on experiences gained and data collected during implementation of this plan. Any modifications would be developed in consultation with MDE, MDNR, PFBC, USFWS and would be subject to approval by the agencies and the FERC.

[4] DO monitoring will be reported separately from this plan on an annual basis, in accordance with Article 410 of the license and the NPDES permit. However, instances of DO thresholds triggering Fish Kill Reconnaissance Surveys will be included as part of reporting for this plan.

8 REFERENCES

Exelon Generation Company, LLC (2012). Seasonal and Diurnal Water Quality in Conowingo Pond and Below Conowingo Dam – RSP 3.1, Final Study Report. Prepared for Exelon by Normandeau Associates, Inc. and Gomez and Sullivan Engineers. August 2012.

Exelon Generation Company, LLC. (2016). *Conowingo Hydropower Project Settlement Agreement Between Exelon Generation Company, LLC and the United States Department of the Interior Fish & Wildlife Service.*

Exelon Generation Company, LLC and the Maryland Department of the Environment. (2019). *Joint Offer of Settlement and Explanatory Statement Of Exelon Generation Company, LLC and the Maryland Department of the Environment.*

Federal Energy Regulatory Commission. (2015). *Final Multi-Project Environmental Impact Statement For Hydropower Licenses.* Federal Energy Regulatory Commission, Office of Energy Projects, Division of Hydropower Licensing. Washington, DC: Federal Energy Regulatory Commission.

U.S. Environmental Protection Agency (US EPA). (1986). Ambient Water Quality Criteria for Dissolved Oxygen (Freshwater). U.S. EPA. Office of Research and Development, Environmental Research Laboratories. Duluth, MN and Narragansett, RI.

APPENDIX A. CORRESPONDENCE ON DRAFT PLAN

Erin Redding

From: Erin Redding
Sent: Wednesday, January 26, 2022 9:40 PM
To: Heather Nelson, MDE; David Seaborn. MDE; Brett Coakley, MDNR; Tony Prochaska; Bob Sadzinski; Shawn Seaman, MDNR; Josh Tryninewski; Aaron Henning, SRBC; Sheila Eyler, USWFS; Richard McCorkle; Steve Minkkinen; Jesus Morales
Cc: David Frazier; Kirk Smith; Ian Kiraly; Danucalov, Andrea
Subject: Fish Kill Notification Plan
Attachments: 20220126_Fish_Kill_Notification_Plan_Draft.pdf

Hello,

Exelon has prepared the attached Fish Kill Notification Plan Draft in accordance with Conowingo Hydroelectric Project Federal Energy Commission License Article 411. Please review this plan and provide any comments to Andrea Danucalov and me by February 25, 2021.

Sincerely,

Erin Redding (she/her)
Certified Senior Ecologist, ESA
Gomez and Sullivan Engineers, D.P.C.
1961 Wehrle Dr.
Suite 12
Williamsville, NY 14221
eredding@gomezandsullivan.com
Please note, I do not work on Wednesdays.

Erin Redding

From: Eyler, Sheila <sheila_eyler@fws.gov>
Sent: Thursday, January 27, 2022 12:41 PM
To: Erin Redding; Heather Nelson, MDE; David Seaborn. MDE; Brett Coakley, MDNR; Tony Prochaska; Bob Sadzinski; Shawn Seaman, MDNR; Tryninewski, Joshua; Aaron Henning, SRBC; McCorkle, Richard; Minkkinen, Steve; Morales, Jesus J
Cc: David Frazier; Kirk Smith; Ian Kiraly; Danucalov, Andrea
Subject: EXTERNAL EMAIL -Re: [EXTERNAL] Fish Kill Notification Plan

CAUTION: This email originated from outside of GSE. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Andrea,

Thank you for the opportunity to review the Fish Kill Notification Plan for the Conowingo Project.

The USFWS recommends adding surveys of the spillway area of the tailrace for potential fish kills. Fish mortality has been observed in this area previously due to rapid dewatering of the spillway and warrants future surveying to ensure project operations do not provide conditions where fish kills may occur.

Please reach out if you have any questions or would like to discuss this comment further.

Sheila Eyler
U.S. Fish and Wildlife Service
Mid-Atlantic Fish & Wildlife Conservation Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
717-387-2117

Constellation Fish Kill Plan - Comment Document February 23, 2022

Second Paragraph page 1. The State of Maryland defines a reportable fish kill as 25 dead fish, not 50.

Article 411, second paragraph, should also include Maryland Department of Environment. This agency (MDE) has responsibility for investigating Fish Kill events in Maryland in a timely fashion.

The geographical extent of "tailrace" needs to be expanded upon. Any event occurring downstream of and within a mile (monitoring station 643 is 0.6 miles) of the dam "could" be related to discharge quantity or quality at the dam and needs to be investigated.

Section 2.1. MDE has records of 20 fish kills that have occurred either in the Conowingo Pool or downstream of the Conowingo Dam (in close proximity to the dam) since 1985. Several of them involved either dam discharge flows or the concentration of migratory fish attempting to pass through the fish lifts. Others involved disease and fishing discards. In several cases the cause was unknown.

Section 2.2. Should also include blueback herring (*Alosa aestivalis*), blue catfish *(Ictalurus furcatus*), flathead catfish (*Pylodictis olivari*s), walleye (*Sander vitreum*), Rock Bass (*Ambloplites rupestris*), largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis* sp.), and sunfish (*Lepomis* spp.). Also within the project area, but downstream of the dam, are striped bass (*Morone saxatilus*) and yellow perch (*Perca flavescens*). Other species, particularly benthic species (e.g. tessellated darter, chesapeake logperch), are more susceptible to localized water quality issues due to their small home ranges and, therefore, require immediate investigation if they are observed.

Section 2.2.2 (American Shad), add blueback herring

Section 2.2.3 (Gizzard Shad), add "increasing or "….decreasing water temperatures

Section 2.3 should be 25 minimum dead fish observed

Section 4.1 should be 25 minimum dead fish observed

Section 4.3 (Notification). It will be necessary for MDE to have timely communication with the lead biologist who is investigating noteworthy events leading up to generation of a report later in the week. If an event generates significant public interest, MDE's office of Communications may need timely updates from MDE and/or Constellation's designated biologists as well.

We suggest Constellation add the degree of observed freshness to fish kill events. Small numbers of fish that die for a variety of natural and anthropogenic reasons from the vicinity may tend to congregate either above or below the dam in various stages of decomposition. Twenty-five moribund or freshly dead fish should take precedence for a timely investigation.

Add emails for timely fish kill reporting to MDE Charles.Poukish@maryland.gov, Chris.Luckett@maryland.gov

MDE Fish Kill personnel need contacts for Constellation in case a fish kill incident is reported to the hotline and an investigation is initiated by the state of Maryland.

What are the geographic boundaries established for Constellation to perform autonomous fish kill investigations? The Susquehanna River is considered “Waters of the State”. Hence, any fish kill that occurs near Conowingo Dam should be reported to MDE as soon as possible.

“A special responsibility mandated by Environmental Article Section 4-405C requires management and control agencies to investigate the occurrence of damage to aquatic resources, including but not limited to, mortality of fish and other aquatic life. The investigation should determine the nature and extent of the event and attempt to establish a cause and source if applicable. If appropriate, findings shall be acted upon to require the repair of any damage done and the restoration of water resources to a degree necessary to protect the best interests of the people of the state.”

“This responsibility requires that management and control agencies deal promptly and effectively with the investigation of fish kills. Many people are aware of the problems caused by pollution. The presence of dead fish may indicate that a toxic substance has entered the waterway. For this reason, it is very important that the responsible agencies quickly ascertain the facts, announce the findings, and institute corrective measures if practical.”

Erin Redding

From: Tryninewski, Joshua <jtryninews@pa.gov>
Sent: Friday, February 25, 2022 4:08 PM
To: Erin Redding; Danucalov, Andrea
Cc: David Frazier; Kirk Smith; Ian Kiraly; Heather Nelson, MDE; David Seaborn. MDE; Brett Coakley, MDNR; Tony Prochaska; Bob Sadzinski; Shawn Seaman, MDNR; Aaron Henning; Sheila Eyler; McCorkle, Richard; Steve Minkkinen; Jesus Morales
Subject: EXTERNAL EMAIL -RE: [External] Fish Kill Notification Plan

CAUTION: This email originated from outside of GSE. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Erin & Andrea,

The PFBC has reviewed the "FISH KILL NOTIFICATION PLAN DRAFT" dated January 2022 and offers the following comments for your consideration.

- Section 1.1 Background (page 1)
  - Conowingo Pond and/or Tailrace reference in the Article 411 excerpt
    - Is the entire Conowingo Pond included in fish kill surveillance?
    - Does "project tailrace" include the spillway?
    - Recommend adding a figure delineating the area(s) included within the fish kill surveillance area.
    - There is no discussion about fish kills resulting from fish lift malfunctions. Should these infrequent events be captured in this plan?

- Section 2.1 Fish Kill Events within the Conowingo Project (page 2)
  - Does the "Conowingo Project boundary" referenced in the first sentence of this section differ from the "Conowingo Pond and/or Tailrace" referenced in the Article 411 excerpt of section 1.1?

- Section 3.2 Fish Kill Reconnaissance Surveys (Page 4)
  - Second Bullet – Exelon will walk the safely accessible areas on the dam along the Project forebay and tailrace areas weekly to look for dead fish.
    - For areas that are not safely accessible or too distant or removed from direct observation (e.g. the spillway) or not safely accessible via routine walk-throughs, could remote control drone surveillance be considered?
  - Second paragraph and subsequent bullets:
    - Please provide definition(s) for the phrases "when safe to do so" and "where safe to do so" and what conditions will preclude surveillance
    - Will the surveillance area between the East and West fish lifts and the width of the forebay area be constant or influenced by plant operations?
    - Recommend including a figure that delineates the surveillance areas addressed in these three bullets.

- Section 4.1 Response (Page 6)
  - 4th Bullet, Recording a description of the extent of the documented potential Fish Kill Event
    - Recommend including the statement "the upstream and downstream extent of observed fish kills" to this bullet

- Section 4.3 Notification
  - During Normal Working Hours (Page 6)

        - Please included: “and the Pennsylvania Fish and Boat Commission at 1-855-347-4545 (1-855-Fish-Kil).” to the end of sentence: Calls for incoming fish kill reports in Pennsylvania should be directed to the Pennsylvania Department of Environmental Protection at 1-800-541-2050.
    - During Evenings, Weekends and Holidays (Page 6)
        - Please included: “and the Pennsylvania Fish and Boat Commission at 1-855-347-4545 (1-855-Fish-Kil).” to the end of sentence: Calls for incoming fish kill reports in Pennsylvania should be directed to the Pennsylvania Department of Environmental Protection at 1-800-541-2050.
    - During any notification process of a Fish Kill event with in PA’s jurisdictionally waters, please include a contact name and number for a local point of contact per fish kill event. Doing so will facilitate effective and efficient communications that may need to occur between PFBC Law Enforcement and Conowingo’s fish kill response team.

- Appendix B, Fish Kill Investigation Response Sheet
    - Recommend adding a column to the *Fish Involved in Fish Kill Event table* that captures photo documentation. Column header could be as simple as “Photo Taken (Y/N)”
    - Recommend providing photo(s) with annotations as attachments to the Response Sheet.
    - Recommend adding a space on the form to collect information regarding resource agency contact(s) (documenting who and when)

Thank you for the opportunity to review and provide comments.

Regards,
-Josh

Joshua D. Tryninewski
Anadromous Fish Restoration Unit
Pennsylvania Fish & Boat Commission
1735 Shiloh Rd.
State College, PA 16801
Office: 814-353-2239
Cell: 814-424-0985
Fax: 814-355-8264
Email: jtryninews@pa.gov

From: David Seaborn -MDE- <david.seaborn@maryland.gov>

Sent: Friday, March 18, 2022 2:53 PM

To: Danucalov, Andrea H:(Constellation Power) <Andrea.Danucalov@constellation.com>

Subject: [EXTERNAL]Fish Kill Monitoring Plan - one item

EXTERNAL MAIL. Do not click links or open attachments from unknown senders or unexpected Email.

Andrea,

We have a hang up over whether 50 or 25 dead fish triggered certain responses. The current Plan being written provides for 50 as being the threshold to initiate an investigation. Perhaps there is a compromise. Specifically, we would like to have two things considered:

1. Notify MDE of accumulations greater than 25 even though it doesn't trigger your investigation. This is because you are not assessing outside the project zone, and in some cases there could be more dead fish downstream. It would fall on MDE to follow up or not. It may dovetail with an ongoing investigation or a priori information we have. Another reason for notification is that MDE houses the fish kill records for all events in Waters of the State.

2. Another change would be to investigate for "50 dead fish or 25 freshly dead or actively dying fish". The dam has a natural propensity to concentrate all forms of flotsam and jetsam, including fish that died over extended times and in different places. Twenty five mostly old fish in varying stages of decay should not concern them, but 25 fish that are actively dying or freshly dead within sight of the dam (which is our protocol for response) should.

Please let me know your thoughts. Everything else is fine.

--

David Seaborn, Ph.D.

Deputy Program Manager, Wetlands and Waterways

Water and Science Administration

Maryland Department of the Environment

1800 Washington Boulevard

Baltimore, Maryland 21230

david.seaborn@maryland.gov

410-537-4465 (O)

443-621-1009 (C)

Website | Facebook | Twitter

Comments and Responses

Comment	Response
USFWS comments, received January 27, 2022	
The USFWS recommends adding surveys of the spillway area of the tailrace for potential fish kills. Fish mortality has been observed in this area previously due to rapid dewatering of the spillway and warrants future surveying to ensure project operations do not provide conditions where fish kills may occur.	Constellation is required to operate in accordance with Article 407 of the Project license, which includes down-ramping rates that were designed to prevent rapid dewatering of the spillway area and associated stranding effects. Additionally, the spillway area is a difficult to access and dangerous location to send personnel for performing fish kill reconnaissance surveys and it is unlikely that remote survey technology (e.g., drones) would be able to identify small dead fish, as would be required by this plan. Therefore, fish kill reconnaissance surveys in the spillway area have not been included as part of this plan.
MDE and MDNR comments, received February 23, 2022	
Second Paragraph page 1. The State of Maryland defines a reportable fish kill as 25 dead fish, not 50.	The threshold for investigations has been changed to 25 freshly dead or dying fish (for Maryland waters within the Project area) in accordance with this and other comments received from MDE/MDNR.
Article 411, second paragraph, should also include Maryland Department of Environment. This agency (MDE) has responsibility for investigating Fish Kill events in Maryland in a timely fashion.	Constellation has included MDE in consultation for development of this plan. This license article has been written by FERC as part of the Conowingo Hydroelectric Project license. Constellation is not able add MDE to the language of Article 411.
The geographical extent of "tailrace" needs to be expanded upon. Any event occurring downstream of and within a mile (monitoring station 643 is 0.6 miles) of the dam "could" be related to discharge quantity or quality at the dam and needs to be investigated.	The geographic extent of this plan includes locations within the Conowingo Project boundary. This includes Conowingo Pond and the river downstream past monitoring station 643. Water from the various Project structures becomes largely mixed by the time it reaches monitoring station 643. Fish kills resulting from water quantity or quality at the Project would occur upstream of monitoring station 643 and this location is an appropriate downstream extent. The extent of Fish Kill Reconnaissance Surveys has been revised to include downstream areas extending to monitoring station 643 (see Figure 3.2-1).

Comment	Response
Section 2.1. MDE has records of 20 fish kills that have occurred either in the Conowingo Pool or downstream of the Conowingo Dam (in close proximity to the dam) since 1985. Several of them involved either dam discharge flows or the concentration of migratory fish attempting to pass through the fish lifts. Others involved disease and fishing discards. In several cases the cause was unknown.	Since obtaining this comment, Constellation has requested and received records of fish kills in the area since 1985 and has incorporated a general discussion of the records into Section 2.1 of this plan.
Section 2.2. Should also include blueback herring (*Alosa aestivalis*), blue catfish (*Ictalurus furcatus*), flathead catfish (*Pylodictis olivaris*), walleye (*Sander vitreum*), Rock Bass (*Ambloplites rupestris*), largemouth bass (*Micropterus salmoides*), crappie (*Pomoxis* sp.), and sunfish (*Lepomis* spp.). Also within the project area, but downstream of the dam, are striped bass (*Morone saxatilus*) and yellow perch (*Perca flavescens*). Other species, particularly benthic species (e.g. tessellated darter, Chesapeake logperch), are more susceptible to localized water quality issues due to their small home ranges and, therefore, require immediate investigation if they are observed.	Section 2.2 was informative in nature and was not meant to preclude any species from investigation as part of this plan. Upon review of this plan and comments received, Constellation has removed the species-specific information in this section.
Section 2.2.2 (American Shad), add blueback herring	Upon review of this plan and comments received, Constellation has removed the species-specific information in this section.
Section 2.2.3 (Gizzard Shad), add “increasing or ”….decreasing water temperatures	Upon review of this plan and comments received, Constellation has removed the species-specific information in this section.
Section 2.3 should be 25 minimum dead fish observed Section 4.1 should be 25 minimum dead fish observed	This plan has been developed to address the FERC license Article 411 requirements, which calls for monitoring of fish kills of 50 or more fish.
Section 4.1 should be 25 minimum dead fish observed	This plan has been developed to address the FERC license Article 411 requirements, which calls for monitoring of fish kills of 50 or more fish.
Section 4.3 (Notification). It will be necessary for MDE to have timely communication with the lead biologist who is investigating noteworthy events leading up to generation of a report later in the week. If an event generates significant public interest, MDE’s office of Communications may need timely updates from MDE and/or Constellation’s designated biologists as well.	Section 4.3 has been revised to clarify that notifications regarding confirmed fish kill events will include contact information for the biologist performing the fish kill investigation. Constellation will rely on MDE’s identified contact to update their Office of Communications and to determine whether an event generates significant public interest.

Comment	Response
We suggest Constellation add the degree of observed freshness to fish kill events. Small numbers of fish that die for a variety of natural and anthropogenic reasons from the vicinity may tend to congregate either above or below the dam in various stages of decomposition. Twenty-five moribund or freshly dead fish should take precedence for a timely investigation.	Section 4.1 and Appendix B have been revised to include recorded observations of fish freshness.
Add emails for timely fish kill reporting to MDE Charles.Poukish@maryland.gov, Chris.Luckett@maryland.gov	Contact information is expected to change over the lifetime of this plan; therefore, Constellation has not included specific contact information as part of this plan. Section 4.3 has been revised to include a Fish Kill Notification Flow Chart template, which will be maintained and updated by Constellation. The initial contact information to be included in the flow chart will be confirmed with MDE and PA DEP in a timely manner after FERC approval of this plan.
MDE Fish Kill personnel need contacts for Constellation in case a fish kill incident is reported to the hotline and an investigation is initiated by the state of Maryland.	Contact information is expected to change over the lifetime of this plan; therefore, Constellation has not included specific contact information as part of this plan. Constellation's FERC License Compliance Manager will be responsible for implementing this plan. Contact information will be provided to MDE, PADEP, and PFBC and updates will be provide by Constellation as necessary.
What are the geographic boundaries established for Constellation to perform autonomous fish kill investigations? The Susquehanna River is considered "Waters of the State". Hence, any fish kill that occurs near Conowingo Dam should be reported to MDE as soon as possible.	The geographic boundaries of this plan require fish kill investigations to be performed by Constellation within the Conowingo Project area, which includes Conowingo Pond and the Susquehanna River downstream to the approximate location of monitoring station 643. Section 4.3 has been modified to include a flow chart for the notification process, and to state that confirmed fish kill events will be reported as soon as feasible. The flow chart notification process provided by Constellation will ensure timely reporting of fish kills.

Comment	Response
"A special responsibility mandated by Environmental Article Section 4-405C requires management and control agencies to investigate the occurrence of damage to aquatic resources, including but not limited to, mortality of fish and other aquatic life. The investigation should determine the nature and extent of the event and attempt to establish a cause and source if applicable. If appropriate, findings shall be acted upon to require the repair of any damage done and the restoration of water resources to a degree necessary to protect the best interests of the people of the state."	Constellation acknowledges the responsibilities of the management and control agencies.
"This responsibility requires that management and control agencies deal promptly and effectively with the investigation of fish kills. Many people are aware of the problems caused by pollution. The presence of dead fish may indicate that a toxic substance has entered the waterway. For this reason, it is very important that the responsible agencies quickly ascertain the facts, announce the findings, and institute corrective measures if practical.	Constellation acknowledges the responsibilities of the management and control agencies.
PFBC comments, February 25, 2022	
Section 1.1 Background (page 1), Conowingo Pond and/or Tailrace reference in the Article 411 excerpt	
Is the entire Conowingo Pond included in fish kill surveillance?	The entirety of Conowingo Pond has been included within the area where fish kill investigations will be performed if reported by members of the public. Public outreach efforts are a fish kill monitoring component of this plan.
Does "project tailrace" include the spillway?	Constellation is required to operate in accordance with Article 407 of the Project license, which includes down-ramping rates that were designed to prevent rapid dewatering of the spillway area and associated stranding effects. Additionally, the spillway area is a difficult to access and dangerous location to send personnel for performing fish kill reconnaissance surveys and it is unlikely that remote survey technology (e.g., drones) would be able to identify small dead fish, as would be required by this plan. Therefore, fish kill reconnaissance surveys in the spillway area have not been included as part of this plan.

Comment	Response
Recommend adding a figure delineating the area(s) included within the fish kill surveillance area.	Figure 3.2-1 has been added to the plan.
There is no discussion about fish kills resulting from fish lift malfunctions. Should these infrequent events be captured in this plan?	This has been clarified by adding Sections 2.3 and 3.3 to this plan.
Section 2.1 Fish Kill Events within the Conowingo Project (page 2), Does the "Conowingo Project boundary" referenced in the first sentence of this section differ from the "Conowingo Pond and/or Tailrace" referenced in the Article 411 excerpt of Section 1.1?	Conowingo Pond and the tailrace are both located within the Conowingo Project Boundary.
Section 3.2 Fish Kill Reconnaissance Surveys (Page 4)	
Second Bullet – Exelon will walk the safely accessible areas on the dam along the Project forebay and tailrace areas weekly to look for dead fish. For areas that are not safely accessible or too distant or removed from direct observation (e.g. the spillway) or not safely accessible via routine walk-throughs, could remote control drone surveillance be considered?	It is unlikely that remote survey technology (e.g., drones) would be able to identify small dead fish, as would be required by this plan.
Second paragraph and subsequent bullets:	
Please provide definition(s) for the phrases "when safe to do so" and "where safe to do so" and what conditions will preclude surveillance	Safety will depend upon a number of factors including location, spill and river conditions, and weather. These factors will dictate Constellation's ability to safely launch a boat, launch a drone, or access from the shoreline. Environmental conditions such as these will be noted and a decision will be coordinated with the FERC License Compliance and Recreation Manager, Plant Manager, and Safety Specialist along with response team. Safety decisions will be documented as part of Fish Kill Event Investigations. As soon conditions improve, Constellation will re-assess and deploy a response team.
Will the surveillance area between the East and West fish lifts and the width of the forebay area be constant or influenced by plant operations?	The reconnaissance evaluations performed in these areas would occur over the entirety of those aeras and would not be influenced by plant operations.
Recommend including a figure that delineates the surveillance areas addressed in these three bullets.	Figure 3.2-1 has been added to the plan.
Section 4.1 Response (Page 6)	

Comment	Response
4th Bullet, Recording a description of the extent of the documented potential Fish Kill Event, Recommend including the statement "the upstream and downstream extent of observed fish kills" to this bullet	"Including the upstream and downstream extent of the observed fish kill event" has been added to the fourth bullet. A place for this information has also been added to Appendix B.
Section 4.3 Notification	
During Normal Working Hours (Page 6), Please included: "and the Pennsylvania Fish and Boat Commission at 1-855-347-4545 (1-855-Fish-Kil)." to the end of sentence: Calls for incoming fish kill reports in Pennsylvania should be directed to the Pennsylvania Department of Environmental Protection at 1-800-541-2050.	PFBC has been added to the revised notification section. Phone numbers will be kept on a current notification workflow that is maintained by Constellation's FERC License Compliance Manager.
During Evenings, Weekends and Holidays (Page 6), Please included: "and the Pennsylvania Fish and Boat Commission at 1-855-347-4545 (1-855-Fish-Kil)." to the end of sentence: Calls for incoming fish kill reports in Pennsylvania should be directed to the Pennsylvania Department of Environmental Protection at 1-800-541-2050.	PFBC has been added to the revised notification workflow.
During any notification process of a Fish Kill event within PA's jurisdictionally waters, please include a contact name and number for a local point of contact per fish kill event. Doing so will facilitate effective and efficient communications that may need to occur between PFBC Law Enforcement and Conowingo's fish kill response team.	This request has been incorporated in the revised Section 4.3
Appendix B, Fish Kill Investigation Response Sheet	
Recommend adding a column to the Fish Involved in Fish Kill Event table that captures photo documentation. Column header could be as simple as "Photo Taken (Y/N)"	This column has been added.
Recommend providing photo(s) with annotations as attachments to the Response Sheet.	Representative photographs and annotations have been added to the report outlined in Section 5.1 (Fish Kill Event Investigation Reporting)
Recommend adding a space on the form to collect information regarding resource agency contact(s) (documenting who and when)	This has been added.

MDE and MDNR comments, received March 18, 2022	
Comment	**Response**
…We would like to have two things considered: 1. Notify MDE of accumulations greater than 25 even though it doesn't trigger your investigation. This is because you are not assessing outside the project zone, and in some cases there could be more dead fish downstream. It would fall on MDE to follow up or not. It may dovetail with an ongoing investigation or *a priori* information we have. Another reason for notification is that MDE houses the fish kill records for all events in Waters of the State. 2. Another change would be to investigate for "50 dead fish or 25 **freshly dead or actively dying** fish". The dam has a natural propensity to concentrate all forms of flotsam and jetsam, including fish that died over extended times and in different places. Twenty five mostly old fish in varying stages of decay should not concern them, but 25 fish that are actively dying or freshly dead within sight of the dam (which is our protocol for response) should.	These comments have been addressed in various sections of the plan, with reporting of at least 25 dead fish observed to MDE for areas within Maryland waters that are within the Project area. Additionally, investigations will be performed if 25 or more freshly dead or dying fish are observed in Maryland waters within the Project area.

APPENDIX B. FISH KILL EVENT INVESTIGATION RESPONSE DATA COLLECTION FORM

Fish Kill Event Investigation Response Sheet

Surveyor(s):	
Date:	Time:
Location/GPS Coordinates:	
Weather:	
Description of Trigger for Fish Kill Investigation:	
Flow/Project Operations:	
Temperature and DO measurements:	
Description of Fish Kill Event:	
Upstream extent:	
Downstream extent:	

Fish Involved in Fish Kill Event

Species	Number	Size Class (Adult, Juvenile, YOY)	Freshness (e.g., moribund, freshly dead, decayed)	Injuries or Trauma and approximate frequency	Photo

Activities in the area that may have resulted in the Fish Kill Event:
Is Fish Kill Event still in progress? (Yes/No)
Action taken:
Description of Agency Notifications (e.g., contacts, date/time)

Attachment H

Conowingo Hydroelectric Project
(FERC Project No. 405)

American Eel Passage and Restoration Plan
("EPRP")

CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NUMBER 405

AMERICAN EEL PASSAGE AND RESTORATION PLAN

Prepared for:

Exelon.

Prepared by:

GOMEZ AND SULLIVAN ENGINEERS

and

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

September 2021

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LIST OF ABBREVIATIONS

CEECF	Conowingo East Eel Collection Facility
cfs	cubic feet per second
Conowingo Project or Project	Conowingo Hydroelectric Project
CWA	Chester Water Authority
CWECF	Conowingo West Eel Collection and Holding Facility
DO	dissolved oxygen
EFL	East Fish Lift
EPAG	Eel Passage Advisory Group
EPRP	American Eel Passage and Restoration Plan
Exelon	Exelon Generation Corporation, LLC
FERC or Commission	Federal Energy Regulatory Commission
hp	horsepower
L	Liter
MD	Maryland
MDE	Maryland Department of the Environment
MDE Settlement	Joint Offer of Settlement and Explanatory Statement of Exelon Generation Company, LLC and The Maryland Department of the Environment
m	meter
mL	milliliter
mm	millimeter
MRPSP	Muddy Run Pumped Storage Project
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
OECF	Octoraro Creek Eel Collection Facility
PA	Pennsylvania
ppm	parts per million
rpm	revolutions per minute
SRBC	Susquehanna River Basin Commission
USFWS	United States Fish and Wildlife Service
WQC	Water Quality Certificate

1 BACKGROUND

Exelon Generation Company, LLC (Exelon) is the licensee for the 570.15-megawatt Conowingo Hydroelectric Project (Conowingo Project or Project). The Project is located on the Susquehanna River (at river mile 10) in Pennsylvania and Maryland. Conowingo Dam is in Maryland, connecting Cecil and Harford counties, as are the lowermost six miles of the Project reservoir, Conowingo Pond. The remaining eight miles of Conowingo Pond are in Pennsylvania, within York and Lancaster counties.

The Conowingo Project Federal Energy Regulatory Commission (FERC or Commission) License requires Exelon to develop and submit an American Eel Passage and Restoration Plan (EPRP). Specifically, Article 415 states:

> *Within six months of license issuance, the licensee must file with the Commission for approval, an eel passage and restoration plan. The plan must include:*
>
> *a) detailed plans for modifications to the East Fish Lift to specifically accommodate a temporary eel trapping facility at a location within the East Fish Lift stilling basin in the vicinity of the foot of the spillway;*
>
> *b) details regarding the annual operation and maintenance of all current and proposed eel fishways; and*
>
> *c) proposed attraction flow velocity and volume, slopes of the ramps, matting, and methods to reduce predation.*
>
> *Within 30 days of license issuance, the licensee must submit the plan to the Maryland Department of the Environment (MDE), the Pennsylvania Department of Environmental Protection (Pennsylvania DEP), the Pennsylvania Fish and Boat Commission (Pennsylvania Fish and Boat), the Susquehanna River Basin Commission (SRBC), the U.S. Fish and Wildlife Service (FWS), and the Maryland Department of Natural Resources (Maryland DNR), for review. In the event that MDE, in consultation with the Pennsylvania DEP, the Pennsylvania Fish and Boat, SRBC, FWS, or the Maryland DNR, determines that additional information, revisions, modifications, or amendments are necessary to the eel passage and restoration plan, then within 60 days of receipt of written notice, the licensee must submit such information, revisions or amendments to the above-listed agencies.*
>
> *The licensee must 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 must 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 must include the licensee's reasons, based on project-specific information.*
>
> *The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.*

The Joint Offer of Settlement and Explanatory Statement of Exelon Generation Company, LLC and The Maryland Department Of The Environment (MDE Settlement) (2019) also requires the development of an Eel Passage and Restoration Plan that will:

> *(i) provide for modification of the EFL to accommodate a temporary eel trapping facility in the EFL stilling basin (the "Temporary Eel Trapping Facility"); (ii) contain details regarding the operation and maintenance of all existing and proposed eel fishways at the Project, including continued use of the EFL for eel passage after shad and herring season has ended; and (iii) establish attraction flow speed and volume, slopes of ramps, matting, and methods to reduce predation.*

Exelon also operates the Muddy Run Pumped Storage Project (MRPSP) on the Susquehanna River in Pennsylvania (PA). The MRPSP FERC license includes an American Eel Passage Plan that requires Exelon to trap, transport, and stock eels in the Susquehanna River watershed from the Octoraro Eel Collection Facility (OECF) located at the Chester Water Authority (CWA) facility (located in Nottingham, PA) and the Conowingo West Eel Collection Facility (CWECF) located on the west bank at Conowingo Dam. Under the MRPSP License, the eel collection season starts May 1 and ends September 15 at the OECF. The CWECF will begin operation on May 1 and continue until the mean daily water temperature, as determined by hourly readings at Exelon's monitoring station 643 (located 0.6 miles downstream of Conowingo Dam) or by manual readings taken at an alternative location within the Project tailrace, is 10 degrees Celsius or less for three consecutive days. The Conowingo East Eel Collection Facility (CEECF)[1] will commence operation 10 days following the end of EFL operation and will continue to operate until the mean daily water temperature is 10 degrees Celsius or less for three consecutive days, as determined by hourly readings at Exelon's monitoring station 643 (located 0.6 miles downstream of Conowingo Dam) or by manual readings taken at an alternative location within the Project tailrace.

[1] The temporary eel collection facility at the East Fish Lift stilling basin will be installed within twelve (12) months of completing the East Fish Lift modifications described in the FERC License, Appendix 1.

2 PROJECT CONFIGURATION

The Project consists of 1) a main dam, 2) a spillway, 3) a reservoir (Conowingo Pond), and 4) an intake and powerhouse.

The Conowingo Dam is a concrete gravity dam with a maximum height of approximately 94 feet and a total length of 4,648 feet. The dam consists of four distinct sections from east to west: a 1,190-foot long non-overflow gravity section with an elevation of 115.7 feet[2]; an ogee shaped spillway, the major portion of which is 2,250 feet long with a crest elevation of 86.7 feet, and the minor portion of which is 135 feet long with a crest elevation of 98.7 feet; an intake-powerhouse section which is 950 feet long; and a 100-foot long abutment section (Figure 2.0-1). The dam and powerhouse also support US Highway Route No. 1, which passes over the top of Conowingo Dam. The East and West Fish Lifts are located at opposite ends of the powerhouse.

Flow over the Conowingo Main Dam spillway is controlled by 50 stony-type crest gates with crest elevations of 86.7 feet and two regulating gates with crest elevations of 98.7 feet. Each of the crest gates are 22.5 feet high by 38 feet wide and have a discharge capacity of approximately 16,000 cubic feet per second (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 approximately 5,000 cfs per gate at a reservoir elevation of 109.2 feet.

Conowingo Pond extends approximately 14 miles upstream from Conowingo Dam to the lower end of the Holtwood Project tailrace. The Conowingo Pond is generally maintained at an elevation of 109.2 feet, with a surface area of approximately 8,500 acres and a total impoundment design volume of 310,000 acre-feet at that elevation.

The Project powerhouse contains eleven main turbines, as well as two house turbines (Table 2.0-1). The house units are located on the far western end of the powerhouse, whereas the larger units are arranged in order such that Unit 1 discharges near the western end of the dam, and Unit 11 discharges near the eastern end of the dam. Units 2 and 5 are equipped with aerating runners, which serve to increase dissolved oxygen (DO) levels in the turbine discharge water. The Project intakes for each turbine are individually protected by seven trash racks; five are entirely steel (clear spacing of 5.375 inches) and two are steel framed with wood racks (clear spacing of 4.75 inches). The top two racks are constructed of wood due to frazzle ice accumulations on the steel sections.

[2] Unless noted otherwise, elevations are in the National Geodetic Vertical Datum of 1929 (NGVD 1929), as opposed to Conowingo Datum. There is 0.702-foot difference between Conowingo Datum and NGVD 1929 Datum (i.e. El. 100.00 Conowingo Datum = 100.702 NGVD 1929 Datum).

Table 2.0-1: Conowingo Project Turbine Specifications

Unit	Type	Runner Speed (rpm)	Rated Output (hp)	Approx. Rated Discharge (cfs)
House #1	Francis	360	1,900	247
House #2	Francis	360	1,900	247
1	Francis	81.8	64,500	6,749
2	Francis	81.8	54,000	6,320
3	Francis	81.8	64,500	6,749
4	Francis	81.8	64,500	6,749
5	Francis	81.8	54,000	6,320
6	Francis	81.8	64,500	6,749
7	Francis	81.8	64,500	6,749
8	Mixed-Flow Kaplan	120	85,000	9,352
9	Mixed-Flow Kaplan	120	85,000	9,727
10	Mixed-Flow Kaplan	120	85,000	9,727
11	Mixed-Flow Kaplan	120	85,000	9,727

EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405
Eel Passage and Restoration Plan

N

0 250 500 1,000 Feet

1 inch = 500 feet

Figure 2.0-1:
Project Configuration

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Path: X:\GISMaps\project_maps\eel_passage_and_restoration\figure_2_0-1_configuration.mxd

3 UPSTREAM TRAPPING, TRANSPORT, AND STOCKING FOR AMERICAN EEL

Exelon will trap and hold American Eels and then transport them to designated stocking locations in the Susquehanna River watershed in compliance with Article 414 and FERC License Appendix 1. Article 414 reads:

> *Upon license issuance, in addition to complying with U.S. Department of the Interior's section 18 prescription (Appendix 1), the licensee must:*
>
> *a) Operate all current and proposed eel fishways on the west side of the Conowingo Dam from May 1 until mean daily water temperature, as determined by hourly readings at Exelon's monitoring station 643 (located 0.6 mile downstream of Conowingo Dam), is 10 degrees Celsius or less for three consecutive days.*
>
> *b) Operate all current and proposed eel fishways on the east side of Conowingo Dam from 10 days after the date that American shad operations cease at the East Fish Lift until mean daily water temperature, as determined by hourly readings at Exelon's monitoring station 643 (located 0.6 mile downstream of Conowingo Dam), is 10 degrees Celsius or less for three consecutive days*[3].
>
> *c) Maintain the upstream eel passage trap and transport program through 2035 .*
>
> *d) During the 10 years of operating the East Fish Lift with the eel temporary modifications (12.6.1 of the section 18 prescription), if the number of eels exceeds the maximum capacity of eels per unit of ramp area, redesign and construct the East Fish Lift - Eel Temporary Modifications to reduce crowding.*
>
> *e) If, after 10 years of operating the East Fish Lift with the eel temporary modifications (12.6.1 of the section 18 prescription), the 10-year average annual catch of the East Fish Lift is greater than or equal to 50% of the comparable 10-year average catch of eels at the eel trapping facility at the West Fish Lift, design, install, and operate a permanent eel trapping facility at the location of the East Fish Lift, in accordance with a schedule agreed upon by the Maryland Department of the Environment (MDE) and the U.S. Fish and Wildlife Service (FWS), and approved by the Commission. The 10-year average must be based on comparable dates of operation, as the East Fish Lift eel temporary modifications will operate a shorter period than the eel trapping facility at the West Fish Lift. The licensee must maintain and operate the eel trapping facility at the West Fish Lift for the term of the new license, but is not required to maintain and operate more than two permanent eel traps (e.g., the eel trapping facility at the West Fish Lift and either an eel trapping facility at the location of the East Fish Lift or Octoraro Creek, or comparable facility required under the Muddy Run Project License (FERC No. 2355) at any time, unless otherwise directed by the Commission.*
>
> *Unless otherwise directed by the Commission, the licensee must not make any modifications, undertake any construction, or make any changes to the operation of any eel fishway without the agreement of the MDE and FWS and approval from the Commission.*

[3] Station 643 will operate through October 31 each year. Beginning November 1, water temperature readings will be taken manually at the CWECF.

> *The Commission reserves the right to require changes to any proposed modification. Modifications must not begin until the licensee is notified by the Commission that the modifications are approved. Upon Commission approval, the licensee must implement proposed modifications, including any changes required by the Commission.*

All activities addressed in this EPRP that occur in Maryland waters are subject to any permits, licenses, or authorizations that may be required by the State of Maryland. All activities addressed in this EPRP that occur in Pennsylvania waters are subject to any permits, licenses, or authorizations that may be required by the Commonwealth of Pennsylvania.

3.1 Description of Facilities

Per MRPSP FERC license requirements, Exelon currently operates two American Eel collection facilities, the CWECF on the west shore of the Susquehanna River near Conowingo Dam and the OECF on Octoraro Creek below the Pine Grove Dam in Chester County, Pennsylvania. In addition to these two collection facilities, Exelon will design, construct, and operate a temporary eel collection facility in the vicinity of the Conowingo EFL, the CEECF. Features of each collection facility are detailed below.

3.1.1 Conowingo West Eel Collection Facility

The CWECF is located on the right (west) bank of the Conowingo Dam tailrace (Figure 3.1.1-1). Beginning in 2005, US Fish and Wildlife Service (USFWS) began collecting eels near the base of the Conowingo Dam at various locations. Information from these initial studies assisted in directing restoration efforts in the Susquehanna watershed above Conowingo Dam. During 2005 and 2006 exploratory efforts were conducted to determine the best placement and design of a temporary trapping facility. In 2007, elvers were observed climbing up the riprap where water was spilling over from pumps operated to supply water for the West Fish Lift operations. Since 2008, eels have been trapped and transported near this area on the west side of the Conowingo Dam in some capacity. From 2008 through 2016, excess water from the West Fish Lift operations was used as attraction flow over riprap. Elvers that found this attraction flow would crawl up the riprap to the trap and they were then transported and stocked in tributaries to the Susquehanna River and the Susquehanna River mainstem. In 2013, the USFWS increased the number of holding tanks and water supply and drainpipe sizes to improve holding capability. From 2005 to 2016, annual eel captures ranged from 19 to 293,141, with a total of 839,120 eel captures during the entire 2005-2016 period. The current facility was constructed in 2017 per USFWS design criteria and consists of four main elements: (1) a water supply line; (2) a ramp; (3) a collection tank; and (4) multiple holding tanks.

3.1.2 Octoraro Creek Eel Collection Facility[4]

The OECF is located on the left bank of Octoraro Creek immediately downstream of the CWA's Pine Grove Low-Head Dam (Figure 3.1.2-1). The facility was constructed in 2015 and consists of three main elements: (1) a water supply line and a submersible pump; (2) two ramps; and (3) a collection tank. Eels collected at the OECF are transported directly to, and held at, the CWECF at Conowingo Dam prior to transport upstream.

3.1.3 Conowingo East Eel Collection Facility

The CEECF will be located at the stilling basin dissipation wall within the EFL at Conowingo Dam, as called for in the MDE Settlement (2019) (Figure 3.1.1-1). The CEECF is an experimental facility that will operate for 10 years on a temporary basis to determine its suitability as a potential permanent location for the collection of eels. The location of the facility within the EFL was recommended by MDE to evaluate the feasibility of capturing eels on the easterly side of Conowingo Dam, as the American Eel Passage Plan

[4] Details governing the Octoraro Creek Eel Collection Facility are contained in the MRPSP American Eel Passage Plan.

contained in the MRPSP FERC license as well as the Conowingo FERC license, Appendix 1 precludes the construction of any American Eel collection facilities below the Conowingo spillway. The facility will consist of three main elements: (1) a water supply line; (2) a ramp; and (3) a collection tank. Eels collected at the CEECF will be transported directly to, and held at, the CWECF prior to transport upstream. This facility will be installed and put in service 12 months after modifications related to upstream American Shad and river herring passage at the EFL are completed. Operation of the facility will start each season ten (10) days following the end of the operation of the East Fish Lift.[5]

3.2 Trapping and Collection

3.2.1 Design

For the purposes of this plan, "trapping" includes the operation of a ramp-style trap and "collection" refers to operation of the collection tank where juvenile eels are temporarily held after ascending the ramp. All facilities are a flow-through system and no recirculation of any water is used except for attraction flow.

Conowingo West Eel Collection Facility

This facility was put in service on May 1, 2017 upon approval by FERC and the Muddy Run Eel Passage Advisory Group (EPAG)[6]. Under Conowingo License Article 414, the CWECF will operate through 2035. The CWECF contains one collection tank, which is 1.02 meter (m) wide with a length of 1.83 m. The depth of the water in the collection tank is about 686 millimeters (mm), with a volume of approximately 1,274 liters (L). With a maximum density of 10 eels per L, the collection tank can hold up to 12,740 eels at once. The collection tank has 203 mm of freeboard to keep eels from climbing out of the tank. The main flow into the collection tank is provided from the 51-mm fill line with the terminus of the pipe about 51 mm above the waterline providing a constant flow of freshwater to the tank. Also, some water from the spray bar flow also enters the collection tank from the backside of the ramp. The upper end of the ramp is custom fitted into the collection tank and ends about 102 mm above the high-water mark in the tank. The collection tank contains a drain comprised of a 102-mm diameter PVC pipe with holes drilled through it and wrapped in 1-mm mesh to prevent juvenile eel escapement. The 102-mm collection tank drain line contains a 25-mm gravity drain line with a ball valve that is directed to the highest point possible (gravity feed) of the ramp, thus providing eel scent from the eels in the collection tank to the ramp. The collection tank also contains a 76-mm drain line, positioned about 76 mm off the bottom. The drain line attaches to a gate valve that remains closed until eels are removed. The 76 and 102-mm flexible drain lines empty into the overflow tank. The collection tank was custom fitted with a lid made from 6-mm polycarbonate sheet. In addition to the in-line flow meter, the collection tank contains a water temperature and DO probe.

The juvenile eel ramp is constructed of an aluminum cable tray. The cable tray contains landscape fabric climbing substrate (Enkamat 7010) attached to the tray bottom. This substrate consists of a dense three-dimensional mesh of fused filaments, which provides a climbing surface for the juvenile eels. The ramp consists of an approximately 8.75 m long by 457 mm wide cable tray positioned at a 42.5° angle, plus a continuous length of tray that is bent and shaped at a 90° angle over a 25 mm radius at the top of the ramp to convey juvenile eels into the collection tank. The entrance of the ramp is at elevation 29 feet, which is above the normal high-water line (elevation ±21 feet), with a smooth transition to the existing rip-rap shoreline. The facility is designed so that eels ascend the riprap between the tailwater surface and the entrance of the ramp. This portion of the riprap is wetted from the attraction flow exiting the eel ramp and the overflow tank down to the tailwater level. Once eels ascend the rip-rap portion, they enter the eel ramp

[5] The East Fish Lift operation will operate until river temperatures rise above 72 degrees Fahrenheit for four consecutive days, but ending no earlier than June 1 and no later than June 15.

[6] EPAG is a requirement under the MRPSP License and is chaired by Exelon with membership consisting of representatives of Pennsylvania Department of Environmental Protection, Pennsylvania Fish and Boat Commission, USFWS, the Maryland Department of Natural Resources, and the SRBC.

and can ascend to the collection tank. The ramp is held in place by six metal braces, evenly spread across the length of the ramp, and attached to large substrate along the shoreline. The ramp is covered from the top down to near the entrance to protect juvenile eels when ascending. The large 60% shade cloth[7] is installed below the entrance to help protect juvenile eels between the tailrace and the entrance of the ramp.

The facility uses up to 265 L per minute of water to provide attraction flow to the eel ramp and for use within the collection tank. A 203-mm diameter gravity feed line supplies water for the CWECF. The water line forms a manifold at elevation 46 feet and contains four 51 mm globe valves for the Conowingo West Fish Lift and one 76 mm gate valve for the CWECF. The main water line for the CWECF is 76 mm in diameter, but each fill line for each tank is 51 mm in diameter. Each fill line has one 51 mm gate valve and one 51 mm angle valve along with an inline flow meter between these valves. A separate 25 mm line with a ball valve continuously discharges water down the ramp and into the collection tank via a spray bar, keeping the substrate moist and creating a flow to attract juvenile eels. Climbing ramp flow is augmented by a 25-mm diameter scent line from a tap and ball valve from the collection tank drain providing additional attraction flow via this gravity feed hose. The overflow tank collects the water from the collection tank and the holding tanks that are in service. Two 102-mm diameter additional attraction flow pipes drain the overflow tank and are discharged near the entrance of the ramp. These additional flow pipes are discharged above the shade cloth allowing the water to disperse over a larger area and provide additional attraction. All water from the ramp and the additional attraction pipes provides the overall attraction flow down the shoreline riprap to the tailrace. Engineering drawings for the facility are in Appendix A.

Octoraro Creek Eel Collection Facility

The OECF collection tank is 660 mm wide with a length of 1,575 mm. The depth of the water in the collection tank is about 299 mm, with a volume of approximately 310.4 L. With a maximum density of 10 eels per L, the collection tank can hold up to 3,104 eels at once. The collection tank has 209 mm of freeboard to keep eels from climbing out of the tank. The collection tank is filled by allowing some of the spray bar flow to enter the collection tank, thus providing a constant flow of freshwater to the tank. The collection tank contains two drains that are comprised of a 76-mm PVC pipe with holes drilled through it and wrapped in 1-mm mesh to prevent juvenile eels from escaping. The drain line is directed to the highest point possible (gravity feed) to the cover of the ramp to add the scent of the eels into the ramp. The upper end of the ramp is custom fitted into the collection tank and ends about 50 mm above the high-water mark in the tank. The collection tank is custom fitted with a lid that is held down by clamps.

Each ramp consists of approximately 12.34 m x 305 mm wide cable trays positioned at approximately a 30° angle, plus a continuous length of tray that was bent and shaped at a 90° angle over a 25 mm radius at the top to convey juvenile eels into the collection tank. The entrance of each ramp is located underwater, during all tailwater elevations, with a smooth transition to the existing riverbed adjacent to a quiescent pool located in the creek. Ramps are held in place by a scaffold structure located approximately mid-length and four T-shaped solid metal braces, evenly spread across the length of the ramp and driven into the ground beneath the ramps. Ramps are covered from the top down to near the tailwater median flow height to protect juvenile eels when ascending. One cable tray contains a landscape fabric climbing substrate (Enkamat 7010) attached to the tray bottom. The other cable tray contains Milieu small substrate, with staggered vertical tubes.

Water flow to the ramps is supplied from a one horsepower (hp) submersible pump that is installed in a 114-L barrel in the forebay above CWA's Pine Grove Low-Head Dam. The barrel contains about 50, 38 mm holes that are covered with 1 mm mesh screen to prevent any material from entering the pump, lines

[7] The percentage listed refers to the percentage of sunlight and corresponding UV rays that is blocked by the shade cloth.

and manifold that could cause clogging. The barrel is deployed in the forebay about 1.2 m below the water surface. The underground 51 mm water line is encased in 203-mm PVC, to protect the line. The 51 mm water line is attached to a 51 mm manifold with seven 25 mm ball valves that supply water to the spray bars and additional attraction flow lines. Water is continuously discharged down the ramp and into the collection tank via a spray bar, keeping the substrates moist and creating a flow to attract juvenile eels. Climbing ramp flow is augmented by additional attraction flow from the overflow of the collection tank via a gravity feed 25 mm scent line hose. Two additional 25 mm hoses are attached to the cover of each ramp near the water's edge to create splashing and additional attraction flow for the juvenile eels. The facility uses up to 265 L per minute of water to provide attraction flow to the eel ramp and for use within the collection tank. Each ramp has one spray bar and two attraction flow lines. Engineering drawings for the facility are in Appendix B.

Conowingo East Eel Collection Facility [8]

The temporary CEECF will be installed each year ten (10) days after the completion of the upstream anadromous fish migration season, beginning the first eel season after the completion of the modifications to the EFL under the FERC License, Appendix 1, Section 12.6.1[9], and will be located in the EFL stilling basin in the vicinity of the spillway.[10] The temporary CEECF will be operated for ten (10) years, beginning after the EFL modifications are completed. If, after 10 years of operating the CEECF, the 10-year average annual catch of the CEECF is greater than or equal to 50% of the comparable 10-year average catch of eels at the CWECF, Exelon will design, install, and operate a permanent eel trapping facility at the location of the CEECF, in accordance with a schedule agreed upon by MDE and USFWS and approved by FERC. The 10-year average must be based on comparable dates of operation, as the CEECF will operate a shorter period than the CWECF. Exelon will maintain and operate the CWECF and either an eel trapping facility at the location of the CEECF or Octoraro Creek, or comparable facility required under the MRPSP FERC License at any time, unless otherwise directed by FERC. No modifications, construction, or other changes will be made to the operation of any eel fishway at the Conowingo Dam without the agreement of MDE and USFWS and approval of FERC.

The CEECF will contain one collection tank positioned on a platform, which is 660 mm wide with a length of 1,575 mm. The depth of the water in the collection tank is about 299 mm, with a volume of approximately 310.4 L. With a maximum density of 10 eels per L, the collection tank can hold up to 3,104 eels at once. The collection tank has 209 mm of freeboard to keep eels from climbing out of the tank. The collection tank is filled by a 25-mm fill line and also filled by allowing some of the spray bar flow to enter the collection tank, thus providing a constant flow of freshwater to the tank. The top end of the ramp is custom fitted into the collection tank and ends about 50 mm above the high-water mark in the tank. The 76-mm collection tank drain line contains a 25-mm gravity drain line with a ball valve that is directed to the highest

[8] The attached drawings for the temporary eel facility at the EFL are based upon the most current EFL designs and will be resubmitted to the Resource Agencies and FERC for approval, if there are any changes to the EFL designs resulting from FERC License Appendix 1, Section 12.6.1. The Fishway Operations and Maintenance Plan will also be updated to reflect any changes in flows, unit operation, or other aspects with respect to eel collection facilities at Conowingo.

[9] The construction schedule for the EFL modifications for river herring and American Shad has not been finalized. The CEECF will be installed after the EFL modifications are complete. Exelon will provide schedule updates at a minimum during the annual EPAG meetings and will also update this plan accordingly and submit it to the resource agencies for review and FERC for approval. Exelon also participates in monthly design-planning meetings with resource agencies, and schedule is discussed during these meetings.

[10] Due to safety concerns, no equipment will be placed in the spillway. This is confirmed in the MDE Settlement, Draft Article XX. Eel Passage, i, "…in no case, shall any temporary or permanent eel ramps be required to be constructed in the Conowingo Dam spillway area. Additionally, the MRPSP FERC License requirements also exclude the spillway as a potential location for an eel facility due to safety concerns.

point possible (gravity feed) of the ramp, thus providing eel scent from the eels in the collection tank to the ramp. The collection tank also contains a 76-mm drain line, positioned near the bottom of the collection tank. The drain line attaches to a knife valve that remains closed until eels are removed. The collection tank is custom fitted with a lid that is held down by clamps. The EFL gravity-feed water supply, which withdraws water from approximately elevation 100.7 feet from Conowingo Pond, will provide water for the attraction flow for the CEECF. (Attraction flow will be approximately 265 L-per-minute). Proper operation of the components will be ensured through daily inspections and recording of water temperature and DO levels and weekly calibration of the water supply systems.

The juvenile eel ramp is constructed of an aluminum cable tray. The cable tray contains landscape fabric climbing substrate (Enkamat 7010) attached to the tray bottom. This substrate consists of a dense three-dimensional mesh of fused filaments, which provides a climbing surface for the juvenile eels. The ramp consists of an approximately 5 m long by 457 mm wide cable tray positioned at a 30° angle, plus a continuous length of tray that is bent and shaped at a 90° angle over a 25 mm radius at the top of the ramp to convey juvenile eels into the collection tank. The base of the ramp is at approximately elevation 17.8 feet, which is above the minimum tailwater line of approximately 12.9 feet (elevation at a flow of 4,000 cfs), with a smooth transition to the existing concrete stilling basin/east fish lift area floor. The facility is designed so that eels ascend the concrete floor between the tailwater surface and the end of the ramp. This portion of the concrete is wetted from the attraction flow exiting the eel ramp down to the tailwater level. Once eels ascend the concrete portion, they enter the eel ramp and can ascend to the collection tank. The ramp is held in place by metal braces, evenly spread across the length of the ramp, and attached to the existing concrete structures. The ramp is covered with a metal plate from the top down to near the normal high-water line (elevation ±21 feet) to protect juvenile eels from avian predators when ascending. A large 60% shade cloth is installed below the entrance to help protect juvenile eels between the tailrace and the entrance of the ramp.

A gravity feed water line supplies at least 265 L per minute to the collection tank and ramp for eel attraction. A 51-mm diameter gravity feed line supplies water for the CEECF. The water line forms a manifold at elevation 48 feet and contains one 51-mm ball valve and two 25-mm ball valves for the CEECF (i.e., supply water to the spray bars and additional attraction flow lines). The main water line for the CEECF is 25 mm in diameter. The fill line has one 25-mm ball valve. A separate 25-mm line with a ball valve continuously discharges water down the ramp and into the collection tank via a spray bar, keeping the substrate moist and creating a flow to attract juvenile eels. Climbing ramp flow is augmented by additional attraction flow from the overflow of the collection tank via a gravity feed 25-mm scent line hose and 25 -mm ball valve. Two additional 25-mm hoses are attached to the cover of each ramp near the water's edge to create splashing and additional attraction flow for the juvenile eels. All water from the ramp and the additional attraction pipes provides the overall attraction flow down the concrete to the tailrace. Engineering drawings for the facility are in Appendix C and an annotated presentation of the drawings is included in Appendix D.

During the 10 years of operation, if the number of American Eels attempting to migrate to the CEECF exceeds 90,000 eels per day, which is the maximum capacity of American Eels per unit of ramp area[11], or if densities in the collection tank exceed 10 eels per L, the facility will be modified, or operational protocols adjusted to reduce crowding, in consultation with MDE, USFWS, and EPAG.

[11] The maximum capacity of American Eels per unit of ramp area is based on the USFWS Fish Passage Engineering Design Criteria (USFWS, 2019), which gives a guideline of 5,000 eels per day per inch of ramp width, assuming that the mean eels are a size of 150 mm, total length.

3.2.2 Construction

Both the CWECF and OECF are constructed and have been in operation since 2017 and 2015, respectively. Modifications to the EFL to improve passage of American shad and river herring will be constructed as required by the Conowingo License, Appendix 1. The CEECF will be constructed, to be operational within 12 months of completion of construction of the EFL American shad and river herring improvements.

3.2.3 Operational Protocols

All trapping and collection facilities will be operated in accordance with the schedule outlined in Section 5 and the following protocols.

The CEECF will be operated using the following gate position downstream of the facility inside the EFL[12].

- Downstream Weir Gate C: 100% open
- Downstream Weir Gate B: 0% open
- Upstream Weir Gate A: 0% open (to keep debris out of EFL)
- Diffuser Gate A: 100% open
- Diffuser Gate B: 100% open
- Crowder Area Gate: 100% open
- Crowder doors: fully open
- Crowder Screen Hoist: fully lowered (to keep debris out of hopper area)
- Crowder Dividing Screen: fully raised
- Crowder Channel Screen: fully raised
- Trash Rack A: fully raised
- Trash Rack B: raised a few feet (bottom of rack at full generation elevation)

Attraction flows for the CEECF will be from the gravity-fed water system from the headpond only. The Spillway Gates A and B along with the Spillway Trough Gate will be fully closed and locked out for safety measures prior to and during eel passage season at the CEECF.

The ramp will be removed when flows are forecast to exceed 113,000 cfs and will be reinstalled when flows have receded to a level that will allow for safe access.

Monitoring

At each facility, proper operation of the components will be ensured either through the continuous monitoring of water flow supplied to the ramp and collection tank with an alarm system triggered by low flows or low DO conditions that are not within design parameters (CWECF), or by daily inspections and continuous recording of water temperature and DO levels and weekly calibration of the water supply systems (OECF and CEECF). If an alarm at the CWECF is triggered by low DO or flow, an alarm sounds in the Station control room and a text message/email is sent to Exelon's contractor. If Exelon station personnel are unable to resolve the issue, the contractor will come to the site to troubleshoot and correct the issue. Daily Field Sheets are included in Appendix E. The collection tanks hold American Eel at densities not exceeding 10 elvers per L unless otherwise agreed to by Exelon, MDE, and the USFWS. If deemed necessary by MDE, USFWS, or FERC, Exelon will provide aeration to the collection tanks.

During any instance when alarms indicate or daily inspections suggest that attraction or ramp flow is not within design parameters and cannot be adjusted to operate within these parameters within 24 hours, it will

[12] This section will be updated if there are if there are any changes to the CEECF operation required by updated EFL designs per from Appendix 1 Section 12.6.1 of the Conowingo License. Any changes to operation protocols will be resubmitted to the Resource Agencies and FERC for approval.

be considered an emergency, and operators must follow the Emergency Response Protocols outlined in Section 3.6.

Verification and Testing

The main flow and spray bar flow will be independently measured once per week to verify that the flow meters are providing accurate measurements. If a flow meter provides measurements that differ from the design parameters the main flow meter will be re-calibrated or replaced.

Similarly, the temperature and DO meter will be tested once each week using an independent meter(s) to verify that they are accurate. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, or outside the designed parameters, then it will be re-calibrated, repaired, or replaced.

The alarm systems monitoring flow rates will be tested once per week. Monitors will be tested against deliberate deviations from the design range to ensure that these deviations trigger the alarms. The Conowingo Control Room will be contacted prior to any testing of the alarms.

Inspection

The ramp, cover, substrate, attraction flow, spray bar, and ramp flow will be visually inspected daily to ensure proper operation. If any component is not functioning properly, corrections and/or repairs will be made as soon as practicable. Results of any inspection items that require further action will be recorded on a Daily Field Sheet (Appendix E).

If an inspection suggests that any structure or flow component is not performing properly and no alarm has been triggered, verification of this potential deviation will be performed as described above and corrective action will be taken as soon as possible. If equipment function cannot be immediately repaired, inspectors will refer to Inspection Response Protocols outlined in Section 3.6.

Maintenance

The collection tanks will be drained daily to ensure all eels have been removed. At least once per week, the collection tank(s) will be scrubbed. Scrubbing the tanks is performed with water, a brush, and scouring pad. No chemicals are used.

Debris that would block or hinder passage of eels that is observed on the ramp and substrate during visual inspections will be removed at the time of the inspection. If the debris cannot be removed upon inspection for any reason, it will be removed as soon as practicable thereafter.

At the end of each sampling season, and if determined to be necessary during the season, the ramp will be cleaned. During this cleaning process the substrate will be inspected for any degradation or damage. Sections of substrate will be replaced if necessary. Maintenance activities are recorded on a Daily Field Sheet (Appendix E).

American Eel Counting

Juvenile eels will be counted during each daily check upon removal from the collection tank. When small numbers of eels (fewer than 1,000) are observed in the collection tank, actual counts will be performed. Large quantities of eels will be counted volumetrically. Volumetric estimates will be performed by placing 200 mL of water in a graduated container and then placing anesthetized juvenile eels in the graduated container until it is filled to the 400 mL mark. These juvenile eels will be counted to determine the number of eels displaced by 200 mL of water. Four Ls of water will be added into a 20-L graduated bucket, the

remaining eels from the collection tank will be added to the 20-L bucket, and the resulting displacement of water will indicate the number of eels[13]. This process will be repeated until all juvenile eels have been removed from the collection tank. Length measurements, weight, and condition factor will be taken from a maximum of 25 eels on a bi-weekly basis. Eels will be measured to the nearest mm and weighed to the nearest 0.1 grams after being anesthetized.

All data collected will be recorded on the Daily Field Sheet (Appendix E). Any dead eels will be removed, enumerated, and recorded on the Daily Field Sheet. At the CWECF, the number of eels added to a given holding tank will be recorded, and at the other facilities, the number transferred to the holding tank(s) at the CWECF will be recorded.

3.3 Holding

For this plan, "holding" refers to the retention of eels in holding tanks after removal from the collection tank.

Conowingo West Eel Collection Facility

The only facility with holding capabilities other than in a collection tank is the CWECF. Eels from the OECF and CEECF are transported daily to the CWECF for holding. At the CWECF, there are three holding tanks positioned along a concrete pad. Juvenile eels captured in the collection tank(s) are counted and transferred to one of the three holding tanks. Eel that are transferred to holding tanks are recorded on the Daily Field Sheet (Appendix E).

3.3.1 Design

The CWECF contains three stainless steel holding tanks, with a total holding capacity of 51,660 juvenile eels at a maximum density of 10 eels per L of water. Each holding tank is 1.68 m wide and 1.68 m long. The depth of the water in each collection tank is 0.61 m, providing approximately 1,722 L of water in each tank. A freeboard of 203 mm is provided to prevent eels from climbing and escaping. The bottom of each holding tank is sloped to the center drain to help flush all water and eels from the tank. The top of the center drainpipe is fitted with a 457-mm square screen drain that has a height of 203 mm. The screen drain is constructed of 1-mm mesh to prevent eels from escaping and allows consistent water exchange. This screened box is attached to a 102-mm PVC pipe fitted into a 102-mm bulkhead fitting that is removed to drain the tank completely. The bulkhead fitting is attached to a 90° PVC fitting and attached to a 102-mm flexible hose by a cam fitting that drains into an overflow tank. The main flow into a holding tank is supplied by the 51-mm fill line with the terminus of the pipe about 51-mm above the waterline, providing a constant flow of freshwater to the tank.

An overflow tank holds the overflow water discharged from the holding tank system, where it is discharged to the bottom of the ramp to provide attraction flow and eel scent. The overflow tank is a 568-L tank containing three 76 mm bulkhead fittings. These bulkhead fittings are attached to 76-mm PVC solid wall pipe that is used to provide the additional attraction flow near the entrance of the ramp. The overflow tank is filled by the collection tank and all in-service holding tank drain lines. Prior to any tank being drained, a very fine mesh bag is hose clamped to the end of the drain hose to ensure that no eels are released into the overflow tank. The drain hose with the mesh bag attached is placed into the overflow, which acts as a water cushion for the eels being collected in the bag.

[13] For example, if 100 eels were counted in the displaced 200 mL graduated container, the resulting ratio would be 500 eels per L. If the displacement of water in the 20-L bucket is four L, then 2,000 eels are in the 20-L bucket.

3.3.2 Operational Protocols

The number of holding tanks operating at any time will be determined by the number of eels being held at the CWECF. The number of juvenile eels in each holding tank will not exceed 17,222 eels, which is 10 juvenile eels per L. Juvenile eels may be held in holding tanks for a maximum of seven days prior to transport unless conditions (water temperature above 28.0°C or air temperature above 32.0°C on consecutive days) warrant transports to be conducted on multiple days throughout the week. Specifically, EPAG agreed that transports should occur at least twice per week starting in mid-June and continue through September 15. Additionally, daily transports are also conducted pre-emptively as water temperatures near 28°C or eels become crowded in the holding tanks. The CWECF is maintained daily and decisions to transport are made in real-time based on eel condition, environmental conditions, and the number of eels in holding. A transport vehicle is left on-site to facilitate the ability to conduct transports as needed.

Monitoring

Proper operation of the holding facility will be ensured through the continuous monitoring of flow and water quality parameters, weekly verification of monitors, and daily inspections.

Water Exchange: The amount of water flowing into each operational holding tank will be monitored continuously. If measured flows are not within the design parameters flow (19 to 151 L per minute per tank in service), a sensor will trigger an alarm that will alert the Conowingo Control Room. Also, in the event of an alarm, an e-mail notification will be sent immediately to operational personnel. Contact lists are updated regularly and will be distributed to resource agencies, Station staff, and contractors each season.

Temperature: Water temperature in each operational holding tank will be monitored continuously. If measured temperature is not within the design parameters (10-35° C), a sensor will trigger an alarm that will alert the Conowingo Control Room. Also, in the event of an alarm, an e-mail notification will be sent immediately to operational personnel.

Dissolved Oxygen: Concentration of DO in each operational holding tank will be monitored continuously. If measured concentrations are not within the design parameters (5-20 ppm), a sensor will trigger an alarm that will alert the Conowingo Control Room. Also, in the event of an alarm, an e-mail notification will be sent immediately to operational personnel.

Verification and Testing

The flow into each holding tank will be measured once per week to verify that the flow meters are providing accurate flow measurements. If a flow meter provides measurements that differ from the design parameters, then the holding tank flow meter will be re-calibrated or replaced.

Similarly, the temperature and DO meters will be tested once each week using an independent meter(s) to verify that they are accurate. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, or outside the designed parameters, then it will be re-calibrated, repaired, or replaced.

Alarm systems for holding tanks will be tested once per week. Monitors of flow, temperature, and DO will be tested against deliberate deviations from the design ranges to ensure that these deviations trigger the alarms. The Conowingo Control Room will be contacted prior to any testing of the alarms.

Inspection

The holding tanks in use will be inspected daily to ensure proper operation. Results of any inspection items that require further action will be recorded on a Daily Field Sheet. If the flow through the holding tanks,

water temperature, or DO is suspected of operating outside of design parameters, investigation of this suspected deviation will be performed via verification measuring, as described above, and, if found to be operating outside of design parameters, immediate action will be taken to find a solution. Upon a failed inspection, inspectors will refer to Failed Inspection protocols outlined in Section 3.6.

Maintenance

Every week, the holding tank(s) that were used will be scrubbed and air dried, and this cleaning will be recorded on the associated Daily Field Sheet. Eels will be removed from the holding tanks prior to scrubbing, and every effort will be made to coordinate cleaning with transport so that the tanks are cleaned after eels are removed for transport.

The holding tanks will be drained and cleaned at the end of the trapping season, after operations at the ramp have ceased and all juvenile eels have been transported.

American Eel Counting

During daily inspections of holding tanks, and immediately prior to transfer to transport tanks, any dead eels will be removed, enumerated, and recorded on the Daily Field Sheets.

3.4 Transport

For the purpose of this plan, "transport" refers to movement of eels from holding tanks to transport tanks and transport to the upstream stocking locations.

3.4.1 Design

Conowingo West Eel Collection Facility

When fewer than 150 eels are collected during a sampling event, transport will occur using aerated 19-L buckets with lids, containing the maximum amount of water to prevent sloshing, with no more than 50 eels in each bucket. When counts of juvenile eels are greater than 150 but less than 2,500 individuals, a small, enclosed transport tank (250 L) with supplemental oxygen capability will be used to transport eels to designated locations. When large loads (more than 2,500) of American Eels are transported, a custom-made transport truck and tank unit will be used to deliver eels efficiently and safely to designated stocking locations.

The transport truck is a non-CDL licensed, Department of Transportation truck with a 2,498-L two-chambered transport tank (1,249 L = 12,490 eels per compartment)[14] permanently centered on a flat bed. Each compartment contains a micro pore oxygen diffuser and an oxygen manifold connected to an oxygen bottle by a regulator. A monitor in the cab of the truck attached to a water quality probe that reads water temperature and DO concentration continuously is installed in each compartment. Each compartment has a 968-mm screen drain to release water prior to eels being released to check for any mortality. A 102-mm hose is connected to the 102-mm knife valve that is flush with the floor of the tank to ensure all eels and water are flushed from the tank. Engineering drawings for the transport facility are in Appendix F.

Octoraro Creek Eel Collection Facility

All juvenile eels that are captured at the OECF will be transported to the CWECF at Conowingo Dam daily where they will be held before subsequent transport and release at designated locations in the Susquehanna River watershed. When less than 150 eels are collected at the OECF during a sampling event, the eels will be transported in aerated 19-L buckets with lids that contain the maximum amount of water to prevent sloshing, with up to 50 eels in each bucket. When counts of juvenile eels are greater than 150 individuals,

[14] Transport tanks are designed to hold eels at densities less than 10 juvenile eels per liter.

a small, enclosed transport tank (250 L) filled completely to prevent sloshing and equipped with supplemental oxygen to maintain DO levels in the tank, will be used. When more eels are collected in a single day than the OECF collection tank or the transport tank can accommodate, multiple trips to transport eels from the OECF to the CWECF holding tanks are made.

Conowingo East Eel Collection Facility

All juvenile eels that are captured at the CEECF will be transported to the CWECF at Conowingo Dam daily where they will be held before subsequent transport and release at designated locations in the Susquehanna River watershed. Eels collected at the CEECF during a sampling event will be transported in aerated 19-L buckets with lids that contain the maximum amount of water to prevent sloshing, with no more than 50 eels in each bucket.

3.4.2 Operation Protocols

Monitoring

Transport of juvenile eels will occur at least once per week. Eels will be trucked to appropriate release locations on the same day of removal from holding. The frequency of transport will be increased if the capacity of the holding tanks is approached or if water temperatures are above 28°C. Specifically, EPAG agreed that transports should occur at least twice per week starting in mid-June and continue through September 15. Additionally, daily transports are also conducted pre-emptively as water temperatures near 28°C or eels become crowded in the holding tanks. Multiple daily transports could occur if holding capacity is expected to be exceeded at the CWECF. The number of juvenile eels placed in the transport tank(s) will not exceed 10 juvenile eels per L, and each transport tank will be equipped with supplemental oxygen for aeration. The tank will be fully enclosed during transport.

Temperature: Water temperature in the transport tank(s) will be monitored with the same meter used to monitor DO; the probe measures both parameters.

Dissolved Oxygen: A continuous supply of DO is provided with an oxygen bottle, regulator, and diffuser. Concentration of DO in the transport tank(s) will be monitored. If measured concentrations fall below 5 ppm, the transport crew will pull over at a safe location to quickly resolve the issue (adjust regulator pressure, hook up spare oxygen bottle, etc.).

Verification and Testing

Temperature and DO meters in the transport tanks will be tested once each week using an independent meter(s) to verify that they are accurate. The independent meter(s) will be calibrated according to manufacturer instructions and recommendations. If any continuous monitor provides measurements different than verification measurements, then it will be re-calibrated, repaired, or replaced.

Inspection

Prior to each trip, the transport truck and associated equipment will be inspected to confirm that all equipment is operating as intended. The initial inspection will be done before any eels are transferred to a transport tank. Any necessary adjustments will be made, and the tank will then be filled approximately three-quarters full, immediately prior to inspection and subsequent transfer of eels to the transport tank. All drains and tanks will be secured and examined for leaks. Water quality parameters will be recorded prior to eels being added to the tank. The supplemental oxygen system will be checked to verify that it is functioning properly. A final inspection will be conducted after the eels are transferred to the transport tank. The transport tank will be completely filled to prevent sloshing when driving. All drains and tanks will again be examined for leaks again and water quality parameters will be recorded.

Water quality data during transports will be recorded. The transport system must pass initial inspection before any eels are transferred to the transport tank and final inspection before transport begins. If the transport system does not pass inspection, it may not be used for transport until all issues are resolved and it passes a subsequent inspection. These data are recorded on the Transport Data Sheet located in Appendix E.

Maintenance

Upon return to the CWECF, the transport tank will be opened to the air until the next transport. Transport tanks will be cleaned weekly.

American Eel Counting

The number of eels transferred to the transport tank from holding tanks will be recorded on the Daily Field Sheets and will be recorded as the total number of live eels currently present in the holding tanks.

Transport mortality will be determined by visually inspecting the transport tanks prior to and after the eels are released. Additionally, release areas will be inspected prior to leaving the stocking site. The stocking location is monitored until the water returns to pre-stocking conditions (i.e. water and sediment have settled following stocking). Most eels will seek cover as soon as they are stocked. Eels that have died will be visible lying belly-up and motionless on the stream bottom. Dead eels are retrieved by the stocking crew when access allows. Any dead eels observed during transport and release will be considered transport mortality. Eel mortalities from collection, holding, and transport will be reported to MDE, USFWS, and EPAG in the final report.

3.5 Stocking

Proposed stocking locations are summarized on Table 3.5-1 and shown in Figure 3.5-1. Stocking locations will be finalized and the amount stocked at each location will be determined in consultation with MDE, USFWS, and EPAG by February 1 each year. Progress in stocking these locations will be reported to MDE and EPAG after each transport trip and will be summarized during the annual eel passage meeting, during which input will be received on future stocking locations.

In addition to these stocking locations, which are focused on stocking eels to areas upstream of the Conowingo Project in the Susquehanna River watershed, MDE, USFWS, and EPAG will consider requests for eels to support research or alternative stocking projects (Appendix G). All requests are subject to approval from Exelon, MDE, USFWS, and EPAG. Requests for research or alternate stocking projects within New York State are also subject to approval from the New York State Department of Conservation. No more than 20% of the average annual catch will be provided in a given year for research or alternate stocking projects and transport of eels will be provided by the entity requesting the eels.

Each year, prior to April 1, 60 juvenile eels will be sampled randomly from tributaries below Conowingo Dam and sent to the USFWS or another resource agency for wild fish health screening. Protocols for selecting, preserving, and handling these eels will be developed in consultation with the receiving entity. Results of the wild fish health screening will be shared with MDE, USFWS, and EPAG.

3.6 Emergency Response Protocols

The goal of the restoration program is to achieve a minimum annual survival rate of 95% for juvenile eel during collection and holding processes. If these survival rates are not met in a given year, Exelon will, in consultation with MDE, USFWS, and EPAG, review the reasons that the 95% survival rates were not achieved and, if necessary, develop modifications that will be implemented prior to the start of the eel passage program in the following year.

3.6.1 Alarms and Contacts

For emergency purposes, a contact list with multiple emergency contacts will be developed for the Conowingo Control Room. These individuals will be responsible for responding to and resolving emergency situations at the facilities if station personnel cannot resolve the problem. Alarm systems, where applicable by facility, for flows, and DO in the collection and holding facilities, will be linked to the Conowingo Control Room for immediate alarm notification. Also, in the event of an alarm, an e-mail notification or text message will be sent to operational personnel five minutes after the Control Room has been notified. The operational personnel will contact the Conowingo Control Room and determine the appropriate action to be taken to correct the problem.

3.6.2 Inspection Response Protocols

As indicated in the previous sections, routine inspections will be performed at the facilities. Equipment that is not functioning as intended will be repaired or corrected immediately, if possible. If a facility is not functioning as intended and there is the potential for increased eel mortality (e.g., low flow to collection or holding tanks, high ambient river water temperatures, low DO concentrations), all eels in the facility will be transported to the next scheduled stocking location as soon as possible and, if necessary, the facility temporarily shut down until the issue is resolved. If there is no potential for increased eel mortality (e.g., attraction flow is not operating within design parameters), then it may not be required to temporarily shut down or immediately transport eels.

If an initial inspection determines that a transport tank or associated equipment are not functioning as intended prior to having eels transferred to it, no eels will be transferred to it until repairs have been completed and the equipment has been tested for proper function. If eels are transferred to a transport tank that then fails the final inspection, all eels must be transferred back to a holding tank unless the cause of failure can be addressed immediately, or to another transport tank if one is immediately available that has already passed initial inspection. Inspection forms are included in Appendix E.

3.7 Quality Assurance and Quality Control

As detailed in previous sections, 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 MDE, USFWS, and EPAG.

Various alarms and inspections, along with regular and seasonal maintenance, will ensure that the facilities are operating properly. All staff responsible for operating and maintaining trapping, holding, and transport components of the facilities will be trained and familiar with the specifications and operational parameters of applicable facilities/components. Supervising biologists will be responsible for training new staff members. Additionally, all operating personnel will be required to read and understand the Conowingo Fishway Operation and Maintenance Plan, as well as this Plan. Pertinent equipment and parts that are critical to operation of the facilities will be obtained and securely stored, to reduce the probability and extent of potential eel passage facility shutdowns.

Table 3.5-1: Stocking Locations for Juvenile Eel in the Susquehanna River Watershed

Site Number	Location	Water Body	County	Driving Distance (Miles)	Minimum Transport Time (hr:min)[15]
1	Conowingo Pool	Susquehanna River	Lancaster	< 20	< 0:30
2	Between Holtwood and Safe Harbor	Susquehanna River	Lancaster/York	25	0:40
3	Between Safe Harbor and York Haven Dam	Susquehanna River	Lancaster	36	0:55
4	Upstream of York Haven Dam	Susquehanna River	Dauphin	55	1:20
5	West Fairview Access (Route 11/15)	Susquehanna River	Cumberland	72	1:30
6	Fort Hunter Access	Susquehanna River	Dauphin	75	1:30
7	Shikellamy State Park	Susquehanna River	Northumberland	125	2:25
8	Route 487 Bloomsburg	N. Br. Susquehanna River	Columbia	130	2:40
9	Route 29 Bridge (Wilkes Barre) Nesbitt Park, (Kingston)	N. Br. Susquehanna River	Luzerne	142	2:50
10	Upstream of Hepburn Street Dam (Williamsport)	W. Br. Susquehanna River	Lycoming	155	3:00
11	Upstream of Grant Street Dam	W. Br. Susquehanna River	Clinton	180	3:10
12	City Island	Susquehanna River	Dauphin	70	1:30

[15] Actual transport times may be longer, due to slower driving with a loaded vehicle and multiple stocking locations per trip.

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CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405
Eel Passage and Restoration Plan

N

0 250 500 1,000 Feet

1 inch = 500 feet

Figure 3.1.1-1:
Locations of Conowingo West Eel Collection and Holding Facility and Conowingo East Eel Collection Facility

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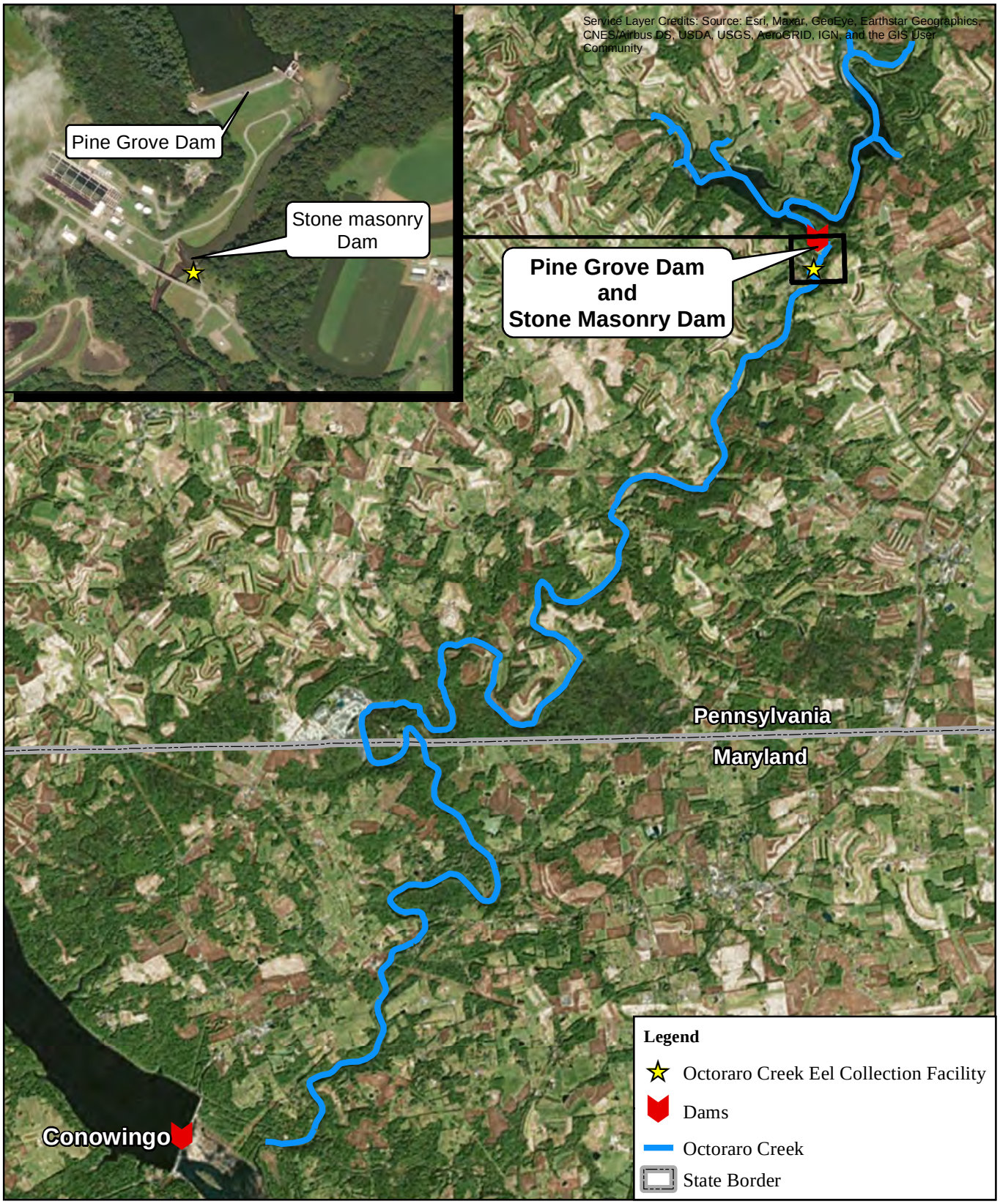

EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405
Eel Passage and Restoration Plan

N

0 0.75 1.5 3 Miles

1 inch = 1.5 miles

Figure 3.1.2-1:
Location of Octoraro Creek Eel Collection Facility

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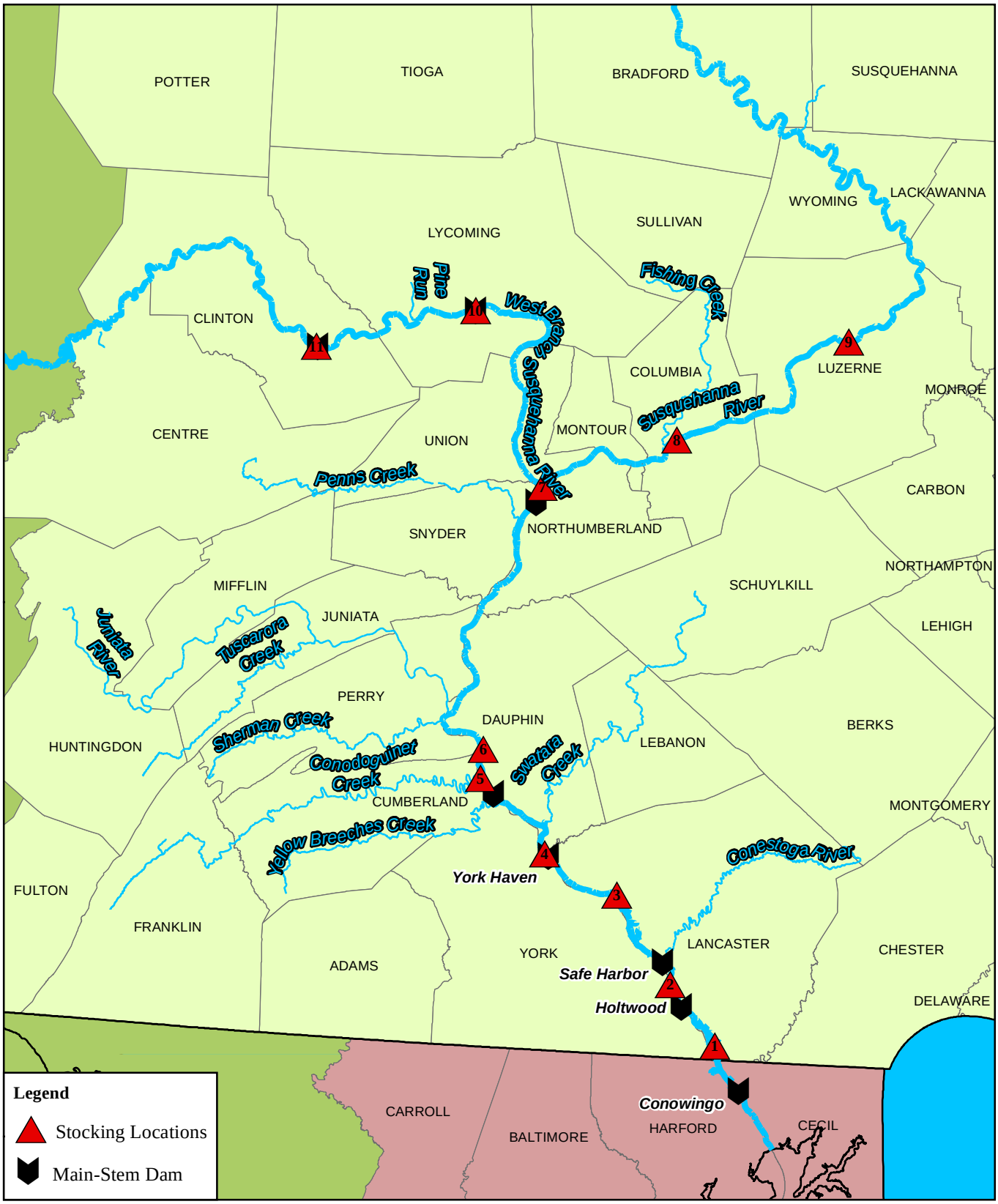

EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405
Eel Passage and Restoration Plan

N

0 10 20 40 Miles

1 inch = 20 miles

Figure 3.5-1:
Stocking Locations for Eel in the Susquehanna River Watershed

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Path: X:\GISMaps\project_maps\eel_passage_and_restoration\figure_3_5-1_stocking_locations.mxd

4 IMPLEMENTATION SCHEDULE

This Eel Passage and Restoration Plan will be implemented following FERC approval. The CWECF operated has operated since 2017. It is anticipated that this plan will be approved prior to the 2022 eel passage season. and the CWECF will begin operation per this plan on May 1, 2022.

Preliminary drawings for the CEECF have been developed (Appendix C). Design, including all reviews, will be further developed as the EFL modification designs are completed and approved. Permitting and other consultations will begin when the design is at least 60% finalized. Installation and operation of the temporary eel collection tank and eel ramp will occur no later than twelve (12) months following the completion of the EFL modifications.

5 ANNUAL SCHEDULES AND DURATION OF OPERATIONS

Each facility will operate annually in accordance with the schedule outlined below. During periods of operation, the facilities will each be operated 24 hours per day, seven days per week.

Facility	Start	End*
CWECF	May 1	Mean Daily Water Temperature < 10°C for three (3) consecutive days in the fall
CEECF	No more than ten (10) days after ceasing EFL shad passage operations	Mean Daily Water Temperature < 10°C for three (3) consecutive days in the fall
OECF	May 1	September 15

*Water temperatures will be monitored hourly at Station 643, approximately 0.6 miles downstream of Conowingo Dam, or by manual readings taken at an alternative location within the Project tailrace unless MDE, USFWS, EPAG, and FERC require a different location.

The operational schedule of the facilities may also be temporarily modified due to extreme hydrological conditions, as defined below, or by agreement between Exelon, MDE, USFWS, and EPAG. "Extreme Hydrologic Conditions" means the occurrence of events beyond Exelon's control that may potentially damage the facility(s) such as, but not limited to, abnormal precipitation, extreme runoff, flood conditions, or other hydrologic conditions such that the operation of the eel facilities is impractical or is inconsistent with the safe operation of the Project.

The trap and transport program will continue through the year 2035 at the Conowingo Project, at a minimum, prior to development of volitional passage structures. However, trapping operations at these specific facilities could change. Exelon is required to maintain and operate the CWECF for the term of the new license but is not required to maintain and operate more than two permanent eel traps (this includes the CWECF and either the CEECF or OECF (or comparable facility required under the MRPSP License) at any time and, in no case, shall any temporary or permanent eel ramps be required to be constructed in the Conowingo Dam spillway area. The OECF is required to be run through 2030 consistent with the MRPSP FERC License.

6 REPORTING AND MEETINGS

6.1.1 Daily Operation Summaries

Throughout the collection facilities' operational season, Exelon will email daily summaries of American Eel collection, holding, transport, and stocking to representatives from MDE, USFWS, and EPAG and any other interested resource agencies. Daily reports will include:

- The estimated number of juvenile eel captured (i.e., number of eels in collection tank).
- The estimated number of eels in the holding tanks.
- The number of eels transported or moved.
- The disposition (location and status) of any transported eels, and
- The count of any mortalities encountered at the CWECF and during transport.

6.1.2 Annual Reports

Due to different season requirements and different reporting requirements between the Conowingo and Muddy Run License requirements, annual reports will include, but not be limited to, the following information:

- The estimated number of juvenile eel captured each day (i.e., number of eels in collection tank).
- The estimated number of eels in the holding tanks.
- The number and dates of eels transported to each stocking location or moved.
- The number of mortalities observed during collection, holding, and transport.
- Statistics (average, maximum, minimum) showing operational parameters for the main components (i.e., flows, temperatures, DO concentrations).
- A description of any significant problem encountered with the trapping, collecting, and holding systems including results of weekly verification efforts and any repair/maintenance actions taken.

Draft annual reports will be submitted to MDE, USFWS, and EPAG by December 1 each year. The draft reports will detail eel collection, holding, and transport from May 1 through September 15 of each year. For the CWECF and the CEECF, eel collection, holding, and transport counts from September 16 through the close of the season will be added to this report as an addendum, and a draft updated report will be submitted to MDE, USFWS, and EPAG for review and comment by December 31[16]. Following review by MDE, USFWS, and EPAG, the final OECF report will be submitted to MDE, USFWS, and EPAG as well as filed with FERC by January 15 of the following year. The final CWECF and CEECF reports will be submitted to MDE, USFWS, and EPAG as well as filed with FERC by February 15 of the following year.

Report	Draft Report Submission Date	Final Report Filing Date
CWECF and CEECF annual reports (May 1 to Sept 15 period)	December 1	February 15
CWECF and the CEECF annual report addendum (Sept 16 to end of season period)	December 31	February 15
OECF annual report (May 1 to Sept 15 period)	December 1	January 15
Fishway Operation and Maintenance Plan annual report	---	December 31

[16] The Fishway Operation and Maintenance Plan annual report will be filed on December 31 and will include daily counts of American eel collected at each facility.

6.1.3 Teleconferences and Remote Meetings

Monthly remote meetings with MDE, USFWS, and EPAG will include discussions of each operating eel passage facility, and also be used to administer implementation of this EPRP.

6.1.4 Meetings

Exelon will meet with MDE, USFWS, and EPAG annually to discuss this EPRP. This meeting will occur no later than January 31 each year unless Exelon and MDE, USFWS, and EPAG agree on a different date. The purpose of the meeting will be to discuss the eel passage results from the previous year and discuss any modifications for the upcoming eel passage season.

7 VOLITIONAL UPSTREAM PASSAGE FOR AMERICAN EEL

License Article 414 requires Exelon to maintain the upstream eel passage trap and transport program for American Eels through 2035.[17] Exelon will work with the Resource Agencies to resolve the timing issues between the two licenses related to volitional and/or trap and transport of American eels.

[17] This date differs from the Offer of Settlement and Explanatory Statement between Exelon and the US Department of Interior (2016), which states, "The Licensee shall conduct trap and transport of American eels until 2030, and will implement volitional American eel passage starting in the 2031 season," and, "Consistent with the Eel Passage Plan established by the Muddy Run license, construction of the volitional passage facility will eliminate the Licensee's obligation to participate in the trap and transport program once the volitional upstream eel passage facility is operational. However, if the upstream eel trap and transport and periodic evaluation program continues beyond 2030, the Licensee will continue to provide access to the Conowingo eel collection facilities for as long as the program continues. The Licensee, however, shall bear no cost responsibility for the trap and transport and periodic evaluation program until 2046, at which time cost responsibility shall be shared among all participants in the program."

8 REFERENCES

Exelon Generation Company, LLC. (2016). *Conowingo Hydropower Project Settlement Agreement Between Exelon Generation Company, LLC and the United States Department of the Interior Fish & Wildlife Service.*

Exelon Generation Company, LLC and the Maryland Department of the Environment. (2019). *Joint Offer of Settlement and Explanatory Statement Of Exelon Generation Company, LLC and the Maryland Department of the Environment.*

Federal Energy Regulatory Commission. (2015). *Final Multi-Project Environmental Impact Statement For Hydropower Licenses.* Federal Energy Regulatory Commission, Office of Energy Projects, Division of Hydropower Licensing. Washington, DC: Federal Energy Regulatory Commission.

USFWS. (2019). *Fish Passage Engineering Design Criteria.* Fish and Aquatic Conservation, Fish Passage Engineering Ecological Services, Conservation Planning Assistance. Northeast Region: USFWS. Retrieved from https://www.fws.gov/northeast/fisheries/pdf/USFWS-R5-2019-Fish-Passage-Engineering-Design-Criteria-190622.pdf

APPENDIX A. CONOWINGO WEST EEL COLLECTION FACILITY DRAWINGS

PROJECT OWNER:

Exelon®
EXELON GENERATION COMPANY, LLC

CONOWINGO HYDROELECTRIC PROJECT FERC NO. 405

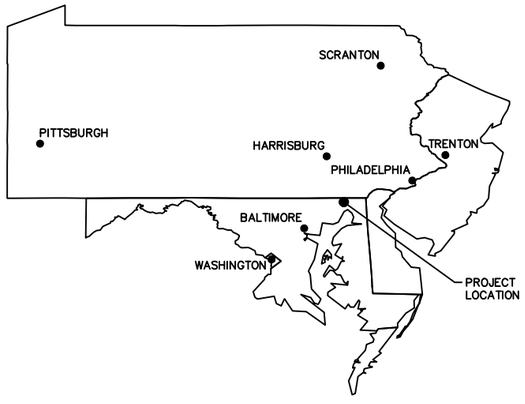
PROJECT TITLE:

CONOWINGO EEL PASSAGE

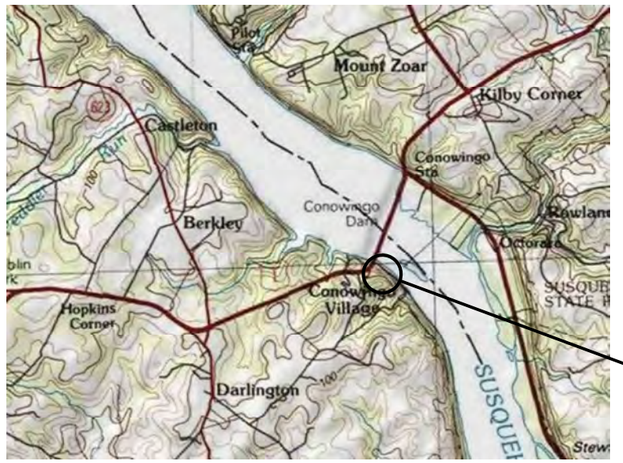
PROJECT ENGINEER:

GOMEZ AND SULLIVAN ENGINEERS

DRAWING INDEX	
DRAWING NO.	DRAWING TITLE
CS	COVER SHEET AND LOCATION PLAN
1	GENERAL NOTES
GP–1	SITE ACCESS PLAN
2	PROPOSED PIPE LAYOUT
3	EEL FACILITY PIPING CONFIGURATION
4	8" PIPELINE 3D PROFILE (INSIDE)
5	8" AND 3" PIPELINES 3D PROFILE (OUTSIDE)
6	EEL FACILITY PIPELINE 3D PROFILE
7	DETAILED PIPE LAYOUT PLANS, SHEET 1
8	DETAILED PIPE LAYOUT PLANS, SHEET 2
9	SECTIONS AND DETAILS
10	EXCAVATION AND CONCRETE ENCASEMENT PLAN
11	EXCAVATION, CONCRETE ENCASEMENT, AND ROAD SECTIONS
12	PIPE SUPPORTS
13	EEL FACILITY PLAN LAYOUT
14	TYPICAL TANK SECTIONS
15	HOLDING TANK PLAN AND SECTIONS
16	HOLDING TANK SECTIONS AND DETAILS
17	COLLECTION TANK PLAN AND SECTIONS
18	EEL RAMP SECTIONS AND DETAILS
19	EEL RAMP ELEVATION AND PIPE SUPPORT DETAILS
20	SITE AND SEDIMENT AND EROSION CONTROL PLAN AND DETAILS
21	MISCELLANEOUS DETAILS



1 CS LOCUS PLAN
NOT TO SCALE



2 CS LOCATION PLAN
NOT TO SCALE

DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG
GSE PROJECT NO.: 1714 DATE: 2/17/2017

Exelon®
EXELON GENERATION COMPANY, LLC

CONOWINGO EEL PASSAGE

GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

COVER SHEET AND LOCATION PLAN

SCALE: AS NOTED DRAWING NO.: CS

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

STRUCTURAL DESIGN DATA NOTES

1. DESIGN REFERENCES
   AMERICAN SOCIETY OF CIVIL ENGINEERS 7–10
   UNITED STATES GEOLOGICAL SURVEY EARTHQUAKE HAZARDS PROGRAM 2014 MAPPING
   AMERICAN SOCIETY OF CIVIL ENGINEERS MANUAL 79
   AMERICAN IRON AND STEEL INSTITUTE WELDED STEEL PIPE
   AMERICAN WATER WORKS ASSOCIATION C208–12
   AMERICAN WATER WORKS ASSOCIATION M11
   AMERICAN SOCIETY OF MECHANICAL ENGINEERS B16.9
   AMERICAN SOCIETY OF MECHANICAL ENGINEERS PRESSURE VESSEL CODE
   US BUREAU OF RECLAMATION WELDED STEEL PENSTOCKS MONOGRAPH NO.3
   AMERICAN CONCRETE INSTITUTE 318
   AMERICAN WELDING SOCIETY D.1.1
   AMERICAN INSTITUTE OF STEEL CONSTRUCTION STEEL CODE
2. RISK CATEGORY: III
3. TERRAIN/EXPOSURE CATEGORY: D
4. DEAD LOAD
   UNIT WEIGHT OF CONCRETE: 150PCF
   UNIT WEIGHT OF STEEL: 490PCF
   UNIT WEIGHT OF WATER: 62.4PCF
5. WIND LOADS
   BASIC WIND SPEED (3 SECOND GUST): 120 MPH
   DIRECTIONALITY FACTOR (Kd): 0.95
   TOPOGRAPHIC FACTOR (Kzt): 1.0
   HEIGHT OF STRUCTURE: 0–15' ABOVE FIN. GRADE
   DESIGN WIND PRESSURE: 37 PSF
6. HYDROSTATIC
   NORMAL POOL: EL. 108.5
   MAX POOL (IDF): EL. 116.5
   WATER HAMMER: 140% STATIC HEAD
   STATIC HEAD: ±71.1 FT
   ASSUMED TRANSIENT/SURGE PRESSURE: 52 PSI
   DESIGN PRESSURE: 150 PSI
7. HYDRODYNAMIC
   TOTAL FLOW IN SYSTEM = 1400 GPM (3.08 CFS)
   DESIGN FLOW TO EEL FACILITY = 145 GPM (0.319 CFS)
   ADDITIONAL FLOW CAPACITY (FOR WEST FISH LIFT & FUTURE USE) = 1255 GPM (2.76 CFS)
8. THERMAL
   ΔTmax = 48° F (BETWEEN INSTALLATION AND EXTREME ANNUAL AIR/WATER TEMPERATURES)
9. DAM HAZARD CLASSIFICATION: HIGH

EROSION AND SEDIMENT CONTROL NOTES:

1. THE LIMIT OF DISTURBANCE SHALL BE CLEARLY DELINEATED IN THE FIELD PRIOR TO THE PRE–CONSTRUCTION MEETING AND ANY GRADING ACTIVITIES TO ENSURE COMPLIANCE WITH THE APPROVED PLAN.
2. THE APPROVED EROSION AND SEDIMENT CONTROL PLAN MUST BE KEPT AT THE PROJECT SITE.
3. THE SOIL CONSERVATION DISTRICT (SCD) RESERVES THE RIGHT TO MODIFY THE EROSION AND SEDIMENT CONTROL PLANS.
4. THE SCD MAY REVOKE THE APPROVAL OF THE EROSION AND SEDIMENT CONTROL PLAN IF WORK PERFORMED AT THE PROJECT SITE DOES NOT CONFORM TO THE PROVISIONS OF THE GRADING PERMIT, TO THE APPROVED PLAN OR TO ANY WRITTEN INSTRUCTIONS FROM MDE, COUNTY DPW OR THE SCD.
5. THE CONTRACTOR SHALL CONSTRUCT ALL EROSION AND SEDIMENT CONTROL MEASURES PER THE APPROVED PLAN AND CONSTRUCTION SEQUENCE AND SHALL HAVE THEM INSPECTED AND APPROVED BY THE SEDIMENT CONTROL INSPECTOR PRIOR TO BEGINNING ANY OTHER LAND DISTURBANCES.
6. THE CONTRACTOR SHALL ENSURE THAT ALL RUNOFF FROM DISTURBED AREAS IS DIRECTED TO THE SEDIMENT CONTROL DEVICES AND SHALL NOT REMOVE ANY EROSION OR SEDIMENT CONTROL MEASURE WITHOUT PRIOR PERMISSION FROM THE SEDIMENT CONTROL INSPECTOR.
7. THE FOLLOWING MINOR PLAN MODIFICATIONS MAY BE APPROVED BY THE SEDIMENT CONTROL INSPECTOR IN THE FIELD:
   A. SEDIMENT CONTROL STRUCTURES (EXCEPT BASINS AND TRAPS) MAY BE MOVED TO MEET THE EXISTING CONTOURS AND FIELD CONDITIONS, WHEN MOVING THESE STRUCTURES WOULD HAVE NO IMPACT ON THEIR FUNCTION OR DESIGN CRITERIA.
   B. SUBSTITUTION OF PERIMETER CONTROL MEASURES MAY BE MADE PROVIDED THE MEASURE SUBSTITUTED IS EQUIVALENT (I.E., SILT FENCE FOR STRAW BALES) OR IS AN UPGRADE OF THE ORIGINAL MEASURE (I.E., SILT FENCE TO A PERIMETER BERM WITH PROPERLY SIZED OUTLET).
   C. ADDITION AND EXTENSION OF PERIMETER CONTROLS (INCLUDING STONE CONSTRUCTION ENTRANCES) MAY BE MADE TO MEET FIELD CONDITIONS.
8. THE CONTRACTOR SHALL PROTECT ALL POINTS OF CONSTRUCTION INGRESS AND EGRESS TO PREVENT THE DEPOSITION OF MATERIALS ONTO PUBLIC ROADS. ALL MATERIALS DEPOSITED ONTO PUBLIC ROADS SHALL BE REMOVED IMMEDIATELY.
9. ON–SITE TEMPORARY STOCKPILE AREAS MUST BE PLACED AS SHOWN ON THE APPROVED PLAN. IF THE CONSTRUCTION SCHEDULE IS TO EXCEED 3 DAYS, THE STOCKPILE AREAS MUST BE STABILIZED. STOCKPILE AREAS SHOULD NOT EXCEED FIFTEEN FEET IN HEIGHT. IF A STOCKPILE IS TO EXCEED FIFTEEN FEET IN HEIGHT, IT MUST BE SHOWN ON THE PLAN TO BE TERRACED WITH PIPE SLOPE DRAINS INSTALLED AND APPROVED BY SCD. UPON THE COMPLETION OF THE USE OF THE STOCKPILE AREA, EXISTING GROUND SURFACES SHALL BE RESTORED TO THEIR ORIGINAL CONDITIONS AND PERMANENTLY STABILIZED.

EROSION AND SEDIMENT CONTROL NOTES CONTINUED:

10. VARIOUS STEPS IN THE SEQUENCE OF CONSTRUCTION MAY REQUIRE THE CONTRACTOR TO REMOVE EXCESS EXCAVATED MATERIAL TO AN APPROVED LOCATION OR TO IMPORT MATERIAL FROM AN APPROVED LOCATION. FOR PURPOSES OF THIS PLAN, AN APPROVED LOCATION SHALL BE ONE WHICH IS OPERATING UNDER AN APPROVED EROSION AND SEDIMENT CONTROL PLAN AND AN ACTIVE GRADING PERMIT AT THE TIME OF CONSTRUCTION.
11. THE CONTRACTOR SHALL INSPECT DAILY AND MAINTAIN CONTINUOUSLY IN AN EFFECTIVE OPERATING CONDITION ALL EROSION AND SEDIMENT CONTROL MEASURES UNTIL SUCH TIME AS THEY ARE REMOVED WITH PRIOR PERMISSION FROM THE SEDIMENT CONTROL INSPECTOR.
12. FOLLOWING INITIAL SOIL DISTURBANCE OR RE–DISTURBANCE, PERMANENT OR TEMPORARY STABILIZATION SHALL BE COMPLETED WITHIN:
   A. THREE (3) CALENDAR DAYS AS TO THE SURFACE OF ALL PERIMETER CONTROLS, DIKES, SWALES, DITCHES, PERIMETER SLOPES, AND ALL SLOPES EQUAL TO OR GREATER THAN 3 HORIZONTAL TO 1 VERTICAL (3:1), AND
   B. SEVEN (7) DAYS AS TO ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT SITE.
   THE ABOVE REQUIREMENTS DO NOT APPLY TO THOSE AREAS WHICH ARE SHOWN ON THE PLAN AND ARE CURRENTLY BEING USED FOR MATERIAL STORAGE OR FOR THOSE AREAS ON WHICH ACTUAL CONSTRUCTION ACTIVITIES ARE CURRENTLY BEING PERFORMED OR TO INTERIOR AREAS OF A SURFACE MINE SITE WHERE THE STABILIZATION MATERIAL WOULD CONTAMINATE THE RECOVERABLE RESOURCE.
   MAINTENANCE SHALL BE PERFORMED AS NECESSARY TO ENSURE THAT THE STABILIZED AREAS CONTINUOUSLY MEET THE APPROPRIATE REQUIREMENTS OF THE MOST CURRENT MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL.
13. SEDIMENT CONTROL PRACTICES WILL BE MAINTAINED UNTIL THE ENTIRE CONTRIBUTING AREA TO THE PRACTICE HAS BEEN PERMANENTLY STABILIZED AND MEETS THE SATISFACTION OF THE SEDIMENT CONTROL INSPECTOR. SEDIMENT CONTROLS MAY ONLY BE REMOVED WITH THE AUTHORIZATION OF THE SEDIMENT CONTROL INSPECTOR.
14. ALL AREAS DISTURBED BY THE REMOVAL OF SEDIMENT CONTROL DEVICES MUST BE IMMEDIATELY STABILIZED.
15. SURFACE DRAINAGE FLOWS OVER UNSTABILIZED CUT AND FILL SLOPES SHALL BE CONTROLLED BY EITHER PREVENTING DRAINAGE FLOWS FROM TRAVERSING THE SLOPES OR BY INSTALLING PROTECTIVE DEVICES TO CONVEY THE WATER DOWNSLOPE WITHOUT CAUSING EROSION. DIKES SHALL BE INSTALLED AND MAINTAINED AT THE TOP OF CUT OR FILL SLOPES UNTIL THE SLOPE AND DRAINAGE AREA TO IT ARE FULLY STABILIZED, AT WHICH TIME THE DIKES MUST BE REMOVED AND FINAL GRADING DONE TO PROMOTE SHEET FLOW DRAINAGE. EROSION CONTROL MEASURES MUST BE IMPLEMENTED AT POINTS OF CONCENTRATED FLOW WHERE EROSION IS LIKELY TO OCCUR.
16. SEDIMENT REMOVED SHALL BE PLACED AND STABILIZED IN APPROVED AREAS, BUT NOT WITHIN A FLOODPLAIN, WETLAND OR FOREST RETENTION AREA. WHEN PUMPING SEDIMENT LADEN WATER, THE DISCHARGE MUST BE DIRECTED TO A SEDIMENT TRAPPING DEVICE PRIOR TO RELEASE FROM THE SITE.
17. FOR APPROVED DEWATERING STRATEGIES FOR TRAPS AND BASINS, SEE SECTION F OF THE 2011 MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL. PUMPING SEDIMENT LADEN WATER INTO THE WATERS OF THE STATE WITHOUT FILTRATION IS STRICTLY FORBIDDEN.
18. THE DEVELOPER IS RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS PRIOR TO ANY CONSTRUCTION ACTIVITIES. FURTHER, THE ISSUANCE OF A GRADING PERMIT DOES NOT RELIEVE THE DEVELOPER OF THE RESPONSIBILITY TO OBTAIN ANY ADDITIONAL LOCAL, STATE OR FEDERAL PERMITS.

GENERAL NOTES:

1. THESE DRAWINGS DO NOT INCLUDE NECESSARY COMPONENTS FOR CONSTRUCTION SAFETY. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR CONSTRUCTION SAFETY AND FOR COMPLIANCE WITH ALL OSHA REGULATIONS DURING CONSTRUCTION.
2. CONTRACTOR SHALL DETERMINE LOCATION OF EXISTING UTILITIES BEFORE COMMENCING WORK. CONTRACTOR AGREES TO BE FULLY RESPONSIBLE FOR DAMAGES WHICH MAY OCCUR BY FAILURE TO LOCATE AND PRESERVE EXISTING UTILITIES.
3. CONTRACTOR SHALL CONTACT THE LOCAL CALL BEFORE YOU DIG CENTER TWO FULL WORKING DAYS IN ADVANCE OF DIGGING. THE CONTACT NUMBER FOR MARYLAND IS 811.
4. THE LOCATIONS AND INFORMATION ABOUT UNDERGROUND PIPES, UTILITIES OR OTHER STRUCTURES ARE COMPILED FROM AVAILABLE RECORD DATA AND VISIBLE FIELD OBSERVATIONS AND ARE NOT REPRESENTED AS BEING EXACT OR COMPLETE.
5. THE CONTRACTOR SHALL RECORD TIE MEASUREMENTS, DEPTHS, DIMENSIONS, MATERIALS, FIELD CONDITIONS AND OTHER PERTINENT DATA ABOUT ALL UNDERGROUND PIPES, UTILITIES AND STRUCTURES ENCOUNTERED DURING THE WORK, BOTH EXISTING AND CONSTRUCTED. CONTRACTOR SHALL SUBMIT RECORD DRAWINGS WITH THIS INFORMATION TO THE CONSTRUCTION MANAGER WHO WILL SUBMIT TO THE ENGINEER, UPON COMPLETION OF THE WORK.
6. THE CONTRACTOR SHALL TAKE PRECAUTIONS TO PROTECT AND PREVENT DAMAGE TO ELECTRICAL AND MECHANICAL EQUIPMENT, CONTROLS, AND OTHER EXISTING STRUCTURES FROM CONSTRUCTION ACTIVITIES.
7. DIMENSIONS AND EXISTING CONDITIONS SHALL BE VERIFIED IN FIELD BY CONTRACTOR.
8. DO NOT SCALE DRAWINGS. CONTRACTOR SHALL NOTIFY CONSTRUCTION MANAGER WHO SHALL NOTIFY ENGINEER OF ANY DISCREPANCIES IN THE DRAWINGS.
9. DO NOT CHANGE SIZE OR SPACING OF STRUCTURAL ELEMENTS WITHOUT PRIOR APPROVAL FROM ENGINEER.
10. DETAILS SHOWN ARE TYPICAL; SIMILAR DETAILS APPLY TO SIMILAR CONDITIONS UNLESS OTHERWISE INDICATED.
11. THE CONTRACTOR SHALL PROVIDE AND DESIGN TEMPORARY BRACING/SHORING OF STRUCTURES AND EQUIPMENT DURING CONSTRUCTION AS REQUIRED UNTIL FINAL STRUCTURAL ELEMENTS NEEDED FOR STABILITY ARE INSTALLED..
12. CONTRACTOR SHALL NOTIFY THE CONSTRUCTION MANAGER WHO SHALL NOTIFY THE ENGINEER IN WRITING OF PROPOSED DEVIATIONS OR SUBSTITUTIONS OF DIMENSIONS, MATERIALS, OR EQUIPMENT SHOWN ON THE DRAWINGS AND MAKE ONLY THOSE DEVIATIONS OR SUBSTITUTIONS ACCEPTED BY ENGINEER.
13. IF CONTRACTOR OBSERVES FIELD CONDITIONS WHICH VARY SIGNIFICANTLY FROM WHAT IS SHOWN ON THESE PLANS, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE CONSTRUCTION MANAGER WHO SHALL NOTIFY THE ENGINEER FOR RESOLUTION OF THE CONFLICTING INFORMATION.
14. THE CONTRACTOR SHALL NOT BEGIN DEMOLITION UNTIL AFTER RECEIVING WRITTEN AUTHORIZATION FROM THE OWNER TO BEGIN DEMOLITION.
15. THE OWNER SHALL BE RESPONSIBLE FOR HAZARDOUS MATERIAL ABATEMENT AND PROTECTION OF WORKERS. MEASURES SHALL BE TAKEN, AS REQUIRED, PRIOR TO AND DURING CONSTRUCTION TO IDENTIFY, EVALUATE, AND REMOVE ANY ENCOUNTERED HAZARDOUS MATERIALS.
16. ALL ELECTRICAL WORK TO BE DESIGNED AND CONSTRUCTED BY OTHERS.
17. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING WITH THE OWNER AND OTHER CONTRACTORS (AS NECESSARY) FOR ISOLATION AND DRAINAGE OF THE EXISTING HEADER PIPE.
18. PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION, EXELON SHALL CONSULT AND COOPERATE WITH THE STATE HISTORIC PRESERVATION OFFICER (SHPO) TO DETERMINE THE NEED FOR, AND EXTENT OF ANY ARCHEOLOGICAL OR HISTORIC SURVEYS, AND MITIGATION MEASURES THAT MAY BE NECESSARY. IF ANY PREVIOUSLY UNRECORDED ARCHAEOLOGICAL OR HISTORIC SITES ARE DISCOVERED DURING THE COURSE OF CONSTRUCTION, CONSTRUCTION ACTIVITY IN THE VICINITY SHALL BE HALTED, AND A QUALIFIED ARCHEOLOGIST SHALL BE CONSULTED TO DETERMINE THE SIGNIFICANCE OF THE SITES.

SURVEY NOTES

1. EXISTING PROJECT DRAWINGS AND FIELD MEASUREMENTS WERE USED TO DEVELOP THIS DRAWING SET.
2. HORIZONTAL DATUM IS NAD83 MARYLAND STATE PLANE US FEET.
3. THE VERTICAL DATUM IS CONOWINGO DATUM (0.7 FEET LOWER THAN NGVD29 AND .14 FEET HIGHER THAN NAVD88).

GENERAL CONCRETE NOTES:

1. THE FOLLOWING STANDARDS SHALL BE USED
   - CONCRETE DESIGN STANDARD: ACI 318;
   - CONCRETE DETAILING STANDARD: ACI 315;
   - CONCRETE SPECIFICATION STANDARD: ACI 301;
   - CONCRETE FIELD REFERENCE MANUAL: ACI MNL–15
2. ALL CORNERS, INTERSECTIONS, AND ENDS IN CONCRETE STRUCTURES SHALL BE REINFORCED WITH ADDITIONAL BARS. REFER TO SECTIONS AND DETAILS ON SHEET 11.
3. REINFORCEMENT STEEL SHALL EXTEND THROUGH CONCRETE CONSTRUCTION JOINTS AT LEAST A FULL DEVELOPMENT LENGTH ON EITHER SIDE OF JOINT.
4. ALL REINFORCING STEEL SHALL CONFORM WITH ASTM A615, GRADE 60 UNLESS GRADE 75 IS SPECIFIED. ALL REINFORCING SHALL BE PLAIN DEFORMED BARS.
5. PROTECT CONCRETE FROM PREMATURE DRYING IMMEDIATELY AFTER PLACEMENT. CURING OF CONCRETE SHALL START WITHIN TWO HOURS AFTER FINISHING OPERATIONS ARE COMPLETE. REFER TO THE PROJECT SPECIFICATIONS FOR ADDITIONAL CURING, THERMAL, AND MOISTURE RETENTION REQUIREMENTS.
6. CONCRETE FINISHES SHALL BE AS REQUIRED BY ACI 301, UNLESS OTHERWISE NOTED. ALL CONCRETE REMAINING EXPOSED TO VIEW AT THE COMPLETION OF CONSTRUCTION SHALL RECEIVE A BROOM FINISH. THE FINISH SHALL BE INSTALLED IMMEDIATELY UPON FORM REMOVAL.
7. THE CONTRACTOR SHALL COORDINATE THE SIZE OF ALL OPENINGS, PENETRATIONS, JOINTS AND UTILITIES WITH THE OWNER. THE FINAL SIZE AND LOCATION OF ALL ITEMS AFFECTING THE CONCRETE WORK SHALL BE INDICATED ON THE CONCRETE REINFORCING DRAWINGS AT THE TIME OF SUBMISSION TO THE ENGINEER FOR REVIEW. IF ADDITIONAL OPENINGS ARE REQUIRED THAT ARE NOT SHOWN, CONTRACTOR SHALL IDENTIFY SUCH OPENINGS TO THE OWNER'S PROJECT MANAGER WHO SHALL NOTIFY THE ENGINEER.
8. ALL EXPOSED EDGES SHALL HAVE A 3/4" CHAMFER UNLESS OTHERWISE NOTED.
9. CONCRETE COVER SHALL BE AS FOLLOWS:

COVER	DESCRIPTION
3"	CONCRETE IN CONTACT WITH THE GROUND.
2"	CONCRETE GREATER THAN 12" THICK OR EXPOSED TO WEATHER.
*	CONCRETE LESS THAN OR EQUAL TO 12" THICK SHALL USE COVER REQUIREMENTS IN ACI 318.

10. ALL CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 4500PSI AT 28 DAYS.

GENERAL EARTHWORK NOTES:

1. PLACE FOUNDATIONS ON COMPETENT BEDROCK OR ON A SUITABLE SUBGRADE UNLESS OTHERWISE APPROVED. IF PLACED ON BEDROCK, REMOVE ORGANICS, DEBRIS, AND LOOSE SOIL/ROCK AND PRESSURE WASH PRIOR TO PLACING CONCRETE. IF ON SOIL; OVER EXCAVATE ±1FT AND REPLACE WITH COMPACTED STRUCTURAL FILL.
2. NO BORINGS ARE AVAILABLE.
3. PROVIDE BACKFILL WITH POSITIVE DRAINAGE AWAY FROM STRUCTURES.

GENERAL STEEL NOTES:

1. STRUCTURAL STEEL:
   - STEEL PLATE, SHAPES, AND BARS – ASTM A36
   - STAINLESS STEEL PLATE AND SHAPES – ASTM A276, TYPE 304
   - STEEL PIPE – ASTM A106, GRADE B (Fy=35KSI, Fu=50KSI)
   - STEEL FITTINGS – ASTM A105 (Fy=36KSI, Fu=70KSI)
2. DESIGN, FABRICATION, AND ERECTION SHALL BE AS PER SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS (AISC 360–10).
3. WHERE STEEL MEMBERS ARE WELDED AND NO SIZE IS SPECIFIED, PROVIDE FULL LENGTH FILLET WELDS BOTH SIDES OF MEMBER. WELD SIZES SHALL BE AS FOLLOWS UNLESS NOTED OTHERWISE:

MEMBER THICKNESS	WELD SIZE
3/16"	3/16"
1/4"	3/16"
5/16"	3/16"
3/8"	1/4"
7/16"	1/4"
1/2"	5/16"
9/16"	3/8"
5/8"	7/16"

4. SPLICING OF STRUCTURAL STEEL MEMBERS IS PROHIBITED WITHOUT PRIOR APPROVAL OF THE ENGINEER AS TO LOCATION AND TYPE OF SPLICE TO BE MADE. ANY MEMBER HAVING A SPLICE NOT SHOWN AND DETAILED ON SHOP DRAWINGS WILL BE REJECTED.
5. ALL WELDING SHALL CONFORM TO THE AMERICAN WELDING SOCIETY CODE. USE E70 SERIES ELECTRODES FOR ALL STRUCTURAL STEEL WELDS.
6. UNLESS OTHERWISE SPECIFIED, ALL STRUCTURAL STEEL SHALL BE HOT–DIP GALVANIZED AFTER FABRICATION, INCLUDING BOLTS, WASHERS, AND SHIMS.
7. ULTRASONIC INSPECTION OR OTHER APPROVED METHOD, BY THE TESTING LABORATORY SHALL BE PROVIDED FOR ALL WELDS CALLED FOR ON THE STRUCTURAL DRAWINGS OR SHOP DRAWINGS AS FULL PENETRATION OR COMPLETE JOINT PENETRATION WELDS.
8. ALL BOLTED CONNECTIONS SHALL CONFORM TO ASTM F3125, GRADE A325, UNLESS NOTED OTHERWISE.
9. REFER TO THE CONSTRUCTION SPECIFICATIONS FOR PIPE COATING REQUIREMENTS.
10. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL PRIOR TO STARTING FABRICATION

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DATE	#		BY	APP

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG
GSE PROJECT NO.: 1714 DATE: 2/17/2017

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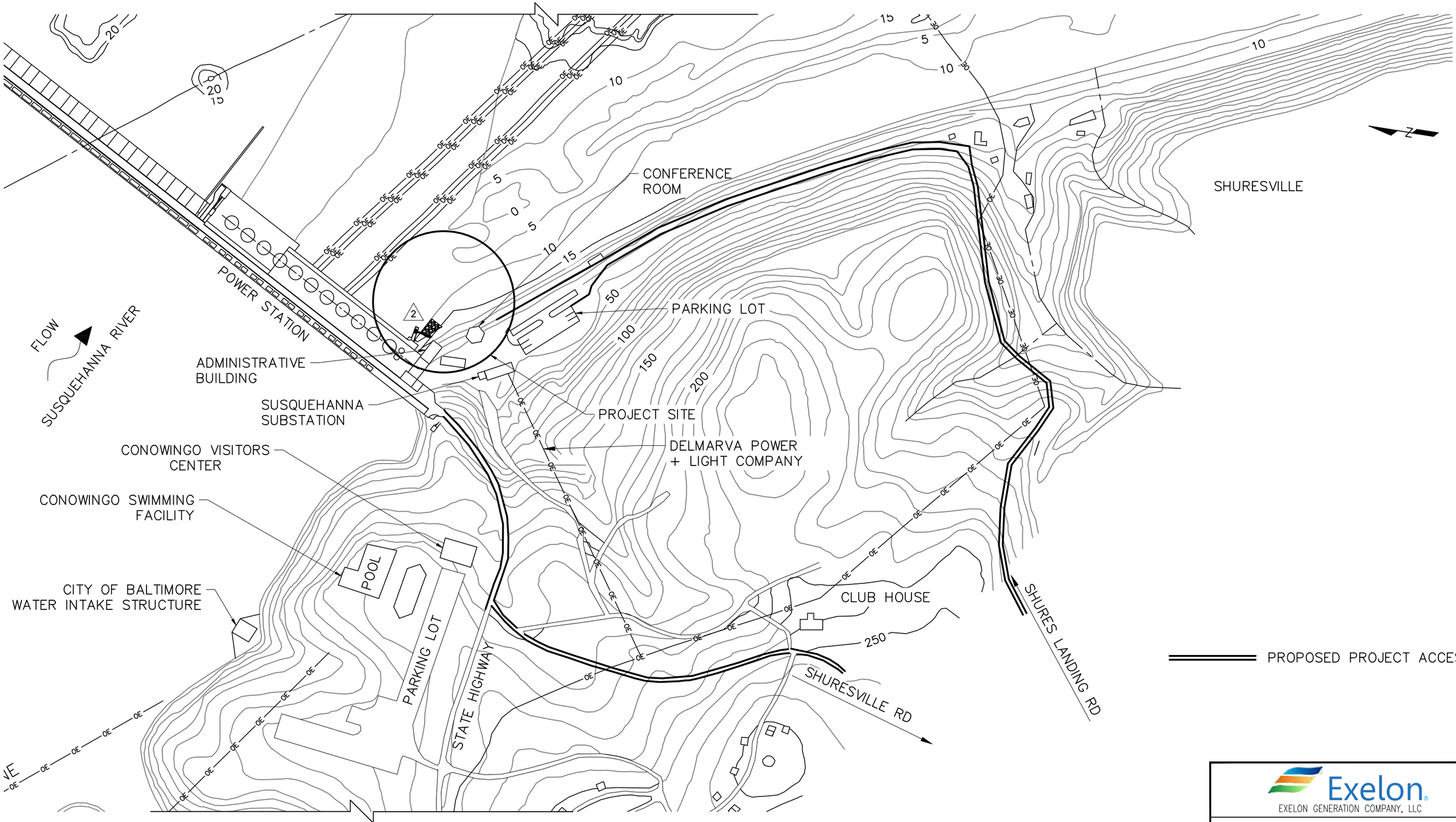
GENERAL NOTES

SCALE: AS NOTED DRAWING NO.: 1



2000' 0 2000' 4000'

SCALE: 1" = 2000'–0"

NOTE: THIS DRAWING REFERENCES CONOWINGO DATUM, IN CONTRAST TO THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29). CONOWINGO ELEVATIONS ARE 0.7 FT LOWER THAN NGVD 29 ELEVATIONS SUCH THAT 108.5 FT CONOWINGO DATUM EQUALS ELEVATION 109.2 FT NGVD 29. CONOWINGO DATUM IS 0.14 FT HIGHER THAN NAVD 88.

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SITE ACCESS PLAN

SCALE: AS NOTED DRAWING NO.: GP–1

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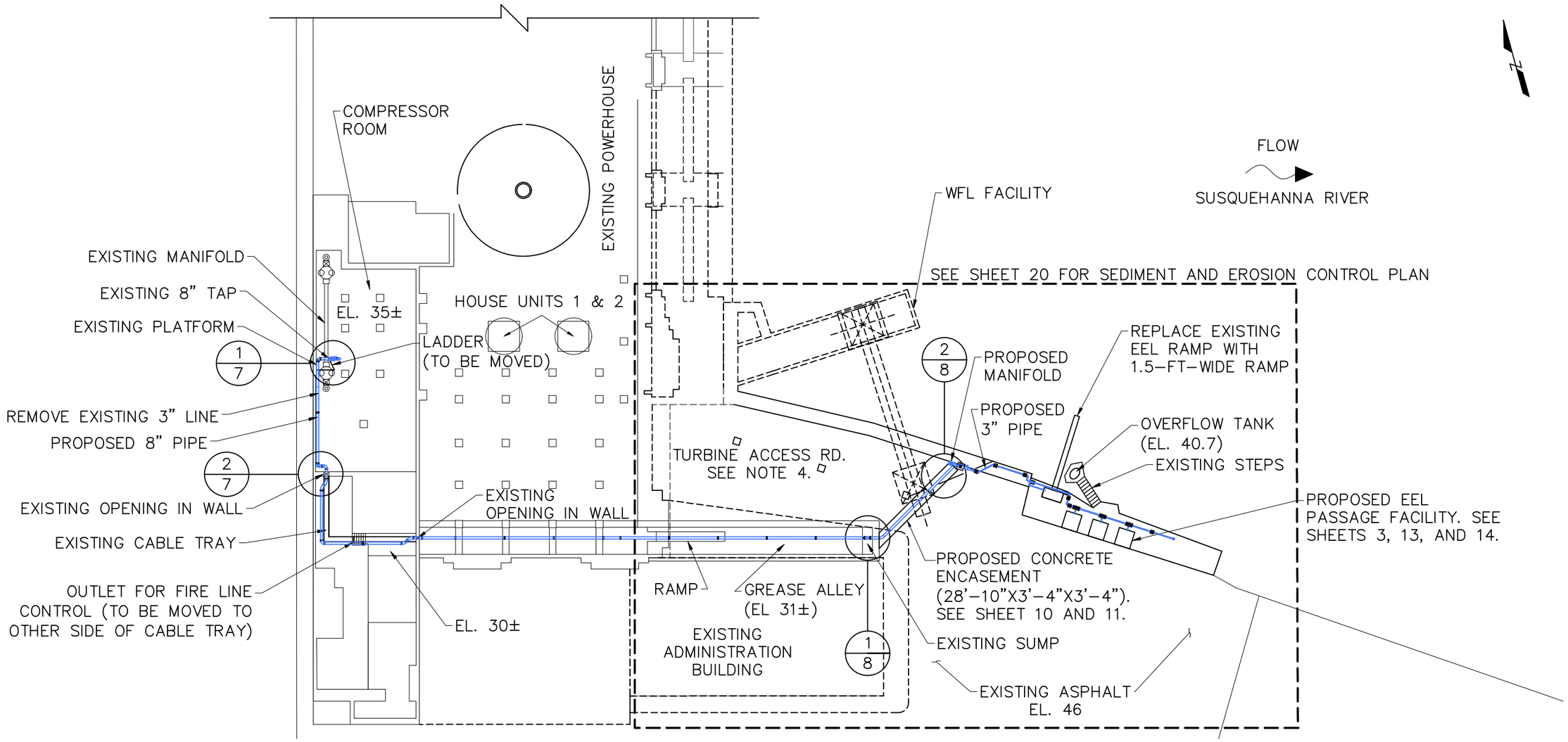

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29 AND 0.14 FEET HIGHER THAN NAVD88)
2. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB. SEE SHEET 12 FOR TYPICAL SUPPORT DETAILS.
3. CONTRACTOR SHALL REMOVE EXISTING 3" PIPE THAT EXISTS ALONG THE ALIGNMENT OF THE PROPOSED 8" PIPE. AVOID OR MOVE OTHER PIPES UPON EXELON'S APPROVAL.
4. LOCATE AND PROTECT EXISTING BURIED DRAINS BENEATH TURBINE ACCESS ROAD (SEE EXISTING P.E. CO. DRAWING H-80531). RAILROAD TIES AND TRACKS MAY ALSO BE BURIED UNDER TURBINE ACCESS ROAD. IF ENCOUNTERED, AND PENDING SHPO CONSULTATION, THE RAILS AND TIES SHALL BE PRESERVED IN PLACE.

16' 0 16' 32'

SCALE: 1" = 16'-0"

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PROPOSED PIPE LAYOUT

SCALE: AS NOTED DRAWING NO.: 2

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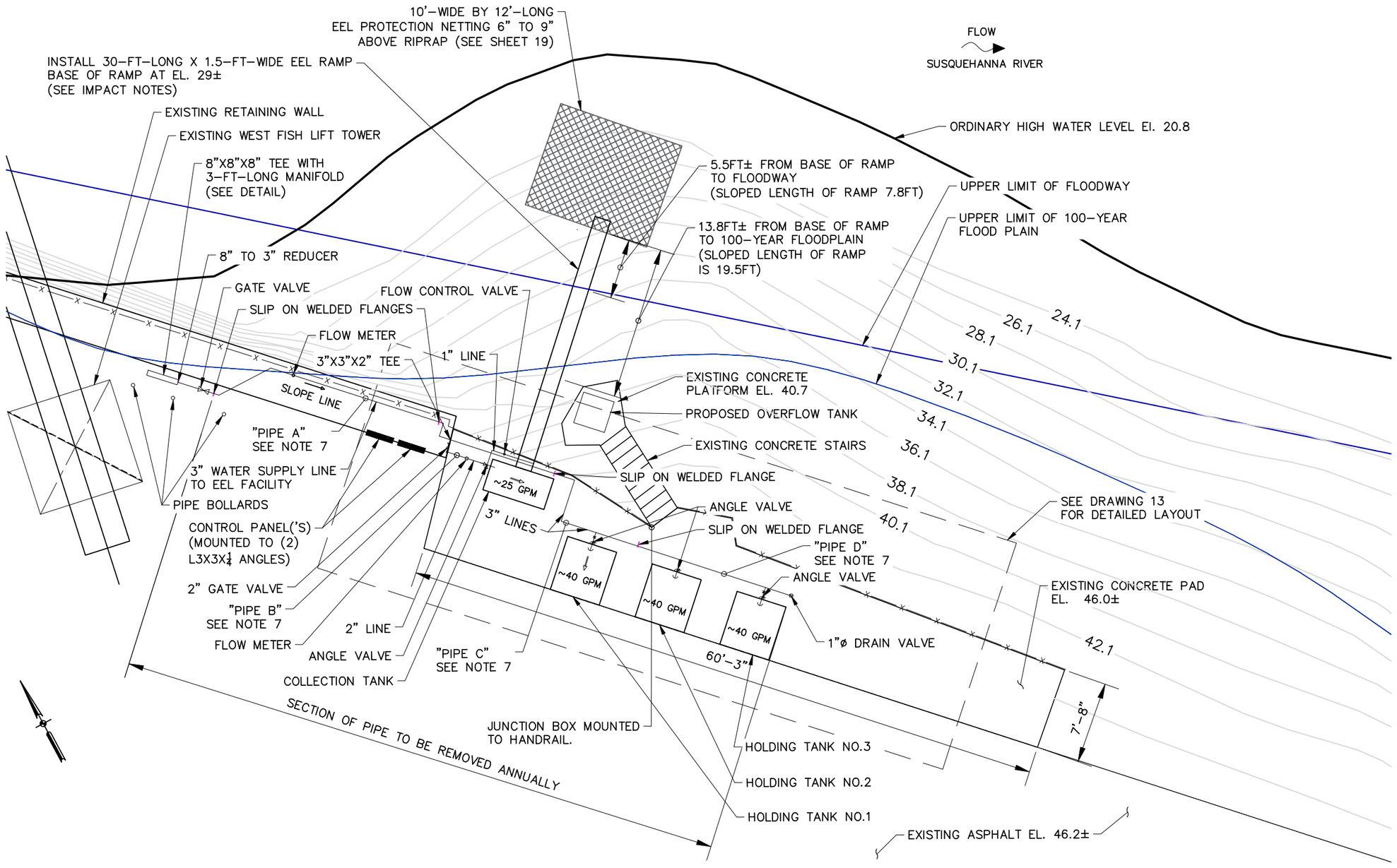

IMPACTS TO FLOODPLAIN

1. LINEAR FEET OF EEL RAMP WITHIN 100–YEAR FLOODPLAIN IS 13.8 FT.
2. AREA OF EEL RAMP WITHIN 100–YEAR FLOOD PLAIN IS 20.7 FT^2.
3. AREA OF EEL RAMP PIPE SUPPORT IS 2 FT^2.
4. AREA OF TWO FLEXIBLE DRAINAGE HOSES IS 9.2 FT^2.
5. AREA OF ANTI–PREDATOR NETTING IS 120 FT^2.

NOTES

1. ELEVATIONS SHOWN ARE IN CONOWINGO DATUM.
2. CONTOUR DATA WAS OBTAINED FROM THE HARFORD COUNTY GIS AND RECORDS MANAGEMENT. CONTOURS WERE DEVELOPED FROM LIDAR DATA COLLECTED ON 3/9/2013 AND 4/6/2013 WITH VERTICAL ACCURACY OF 0.223 FEET.
3. FLOODWAY AND 100–YEAR FLOODPLAIN LINES WERE OBTAINED FROM FEMA'S NATIONAL FLOOD HAZARD LAYER.
4. SEE DRAWING 6 FOR ADDITIONAL PIPING INFORMATION.
5. SEE DRAWING 13 FOR DETAILED LAYOUT.
6. SEE DRAWING 14 FOR TYPICAL TANK SECTIONS.
7. PIPES SHALL BE CLEARLY MARKED AND LABELED WITH 1" HIGH LETTERS.

5' 0 5' 10'

SCALE: 1" = 5'–0"

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EEL FACILITY PIPING CONFIGURATION

SCALE: AS NOTED DRAWING NO.: 3

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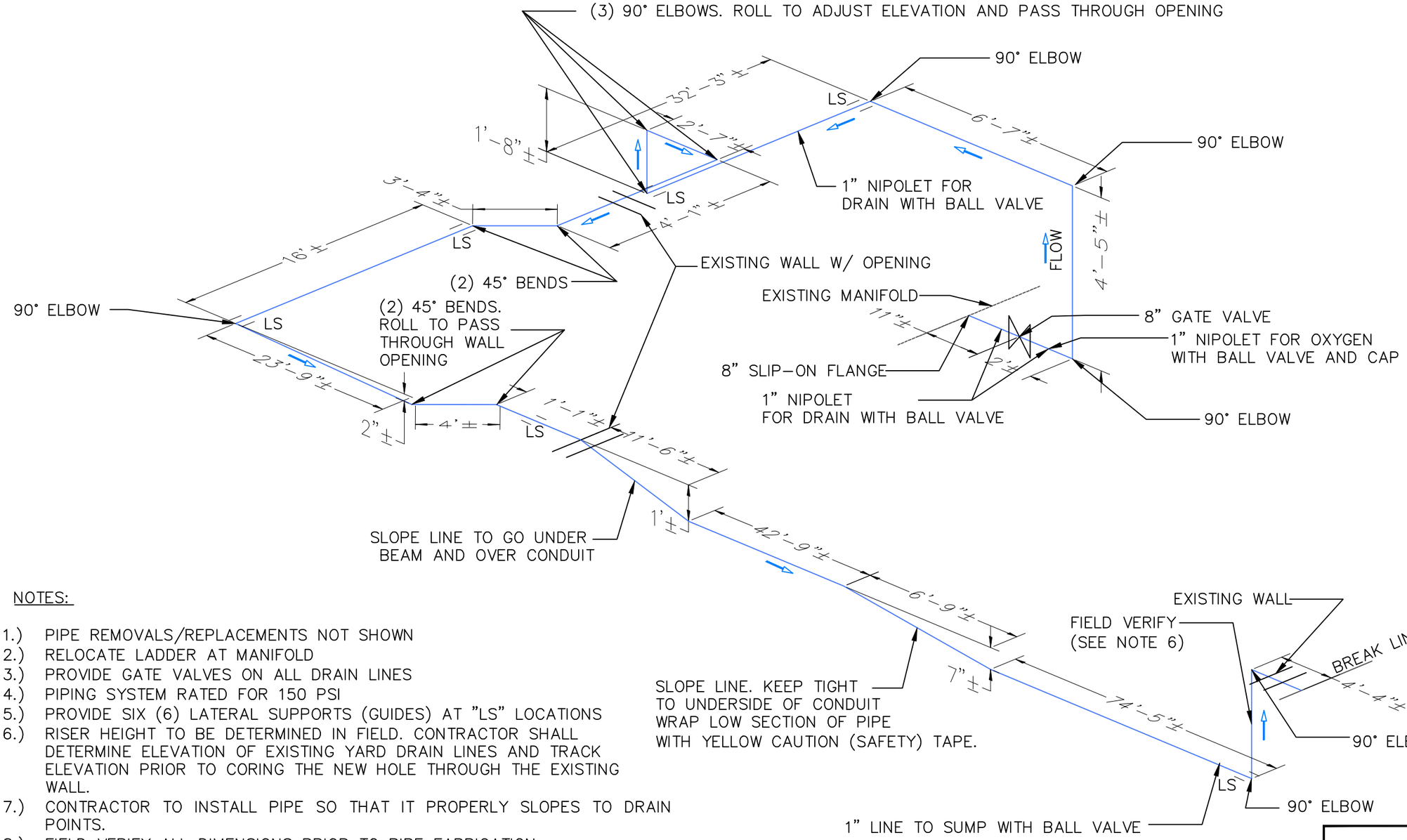

NOTES:

1.) PIPE REMOVALS/REPLACEMENTS NOT SHOWN
2.) RELOCATE LADDER AT MANIFOLD
3.) PROVIDE GATE VALVES ON ALL DRAIN LINES
4.) PIPING SYSTEM RATED FOR 150 PSI
5.) PROVIDE SIX (6) LATERAL SUPPORTS (GUIDES) AT "LS" LOCATIONS
6.) RISER HEIGHT TO BE DETERMINED IN FIELD. CONTRACTOR SHALL DETERMINE ELEVATION OF EXISTING YARD DRAIN LINES AND TRACK ELEVATION PRIOR TO CORING THE NEW HOLE THROUGH THE EXISTING WALL.
7.) CONTRACTOR TO INSTALL PIPE SO THAT IT PROPERLY SLOPES TO DRAIN POINTS.
8.) FIELD VERIFY ALL DIMENSIONS PRIOR TO PIPE FABRICATION.
9.) REFER TO NOTES 4 & 5 ON DRAWING 7 REGARDING ISOLATION OF THE PRESSURIZED MANIFOLD.

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

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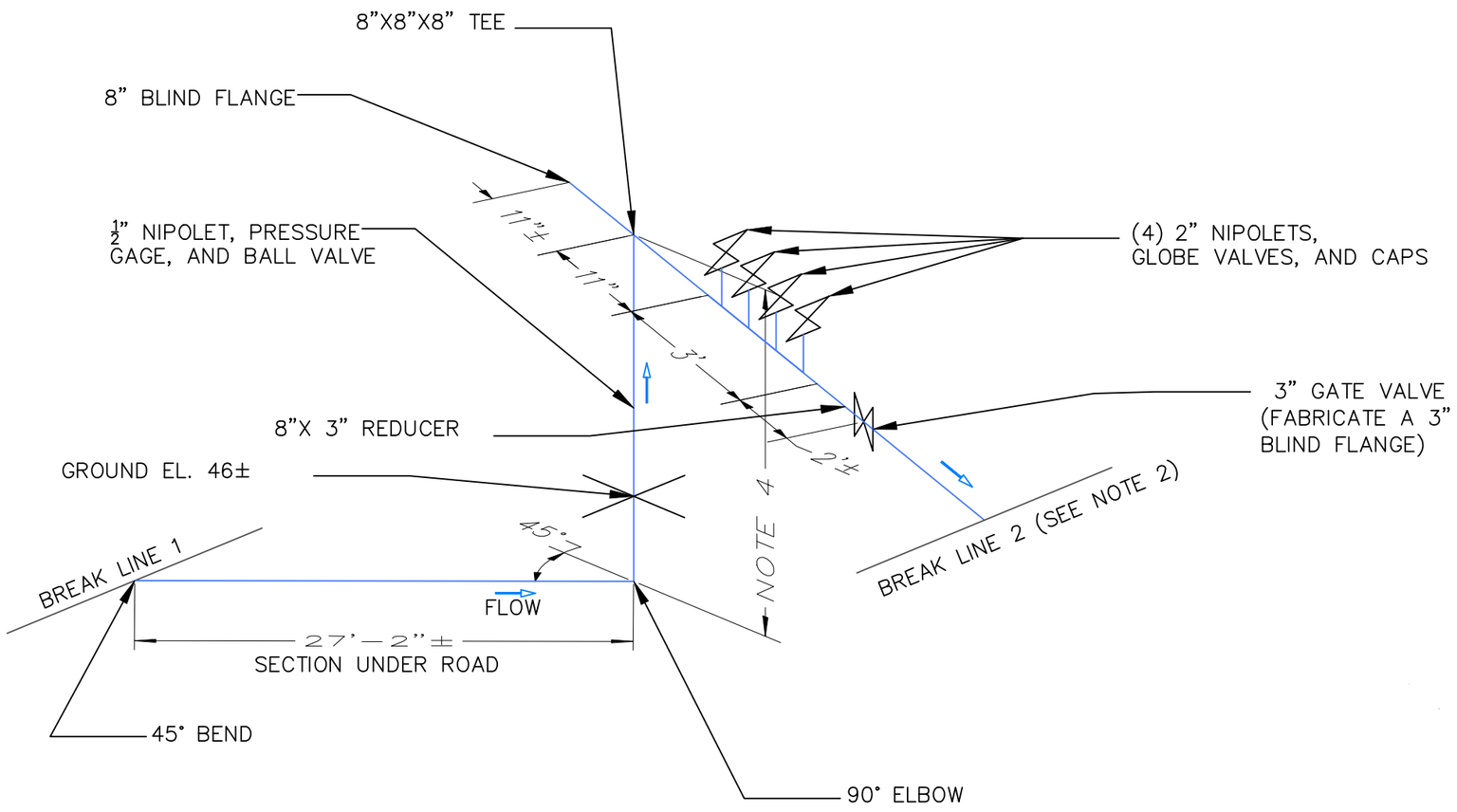
8" PIPELINE 3D PROFILE (INSIDE)

SCALE: AS NOTED DRAWING NO.: 4



NOTES:

1.) PIPING SYSTEM RATED FOR 150 PSI
2.) SEE ATTACHED SHEET 6 FOR CONTINUED PIPE PROFILE TO EEL PASSAGE STORAGE TANKS
3.) PIPING UNDER ROAD TO BE ENCASED IN CONCRETE.
4.) RISER HEIGHT TO BE DETERMINED IN FIELD. CONTRACTOR SHALL DETERMINE ELEVATION OF EXISTING YARD DRAIN LINES AND TRACK ELEVATION. CENTERLINE OF MANIFOLD SHALL BE AT ELEVATION 48±.
5.) 3-INCH SCHEDULE 40 STEEL CONDUIT (ELECTRICAL) TO BE INSTALLED ABOVE PIPE. SEE DRAWING 11.
6.) LENGTH OF PIPING IN BILL OF MATERIALS ASSUMES 10% CONTINGENCY. ALL LENGTHS OF PIPE TO BE FIELD VERIFIED PRIOR TO FABRICATION.
7.) BILL OF MATERIALS DOES NOT INCLUDE VALVES AND PIPING ATTACHED TO OR DOWNSTREAM OF THE EEL FACILITY TANKS. REFER TO SHEET 18 FOR EEL FACILITY SUPPLIES.

BILL OF MATERIALS

Piping

Item Description	Total Length
8-inch Schedule 40 Steel Pipe	±282 ft.
3-inch Schedule 40 Steel Pipe	±110 ft.
2-inch Schedule 40 PVC Pipe	±19 ft.
1-inch Schedule 40 Steel Pipe	±2 ft.

Valves

# of Item	Item Description
1	8-inch Steel Gate Valve
6	1-inch Steel Ball Valve
1	1/2-inch Steel Ball Valve
4	2-inch Steel Globe Valve
1	3-inch Steel Gate Valve
4	2-inch PVC Gate Valve
4	2-inch PVC Angle Valve

Fittings

# of Item	Item Description
3	8-inch Class D Slip-on Steel Flange
6	1-inch Steel Nipolet
6	1-inch Steel Threaded Cap
10	8-inch, 90-degree, Short Radius, Steel Elbow
5	8-inch, 45-degree Steel Bend
1	1/2-inch Steel Nipolet
1	1/2-inch Steel Threaded Cap
1	8"x8"x8" Steel Tee
1	8-inch Steel Blind Flange
4	2-inch Steel Nipolet
4	2-inch Steel Threaded Cap
1	8"x3" Steel Reducer (2' Long)
4	3-inch Slip-on Steel Flange
2	3-inch, 45-degree Steel Bend
4	3-inch, 90-degree, Short Radius Steel Elbow
4	3"x3"x2" Steel Tee
2	3-inch Steel Blind Flange
9	2-inch, 90-degree, PVC Elbow
4	Steel to PVC Adaptor
2	3-inch Steel Threaded Cap

Instruments

# of Item	Item Description
1	1/2-inch Pressure Gage
1	3-inch Flow Meter
4	2-inch Flow Meter

BILL OF MATERIALS, CONT'D

Pipe Supports

# of Item	Item Description
5	2-inch Pipe Stand
15	3-inch Pipe Stand
5	Type A Lateral Support
1	Type B Lateral Support
4	Type C Lateral Support
3	Type A Vertical Hanger Support
14	Type B Vertical Hanger Support
2	Type C Vertical Hanger Support

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8" & 3" PIPELINES 3D PROFILE (OUTSIDE)

SCALE: AS NOTED DRAWING NO.: 5

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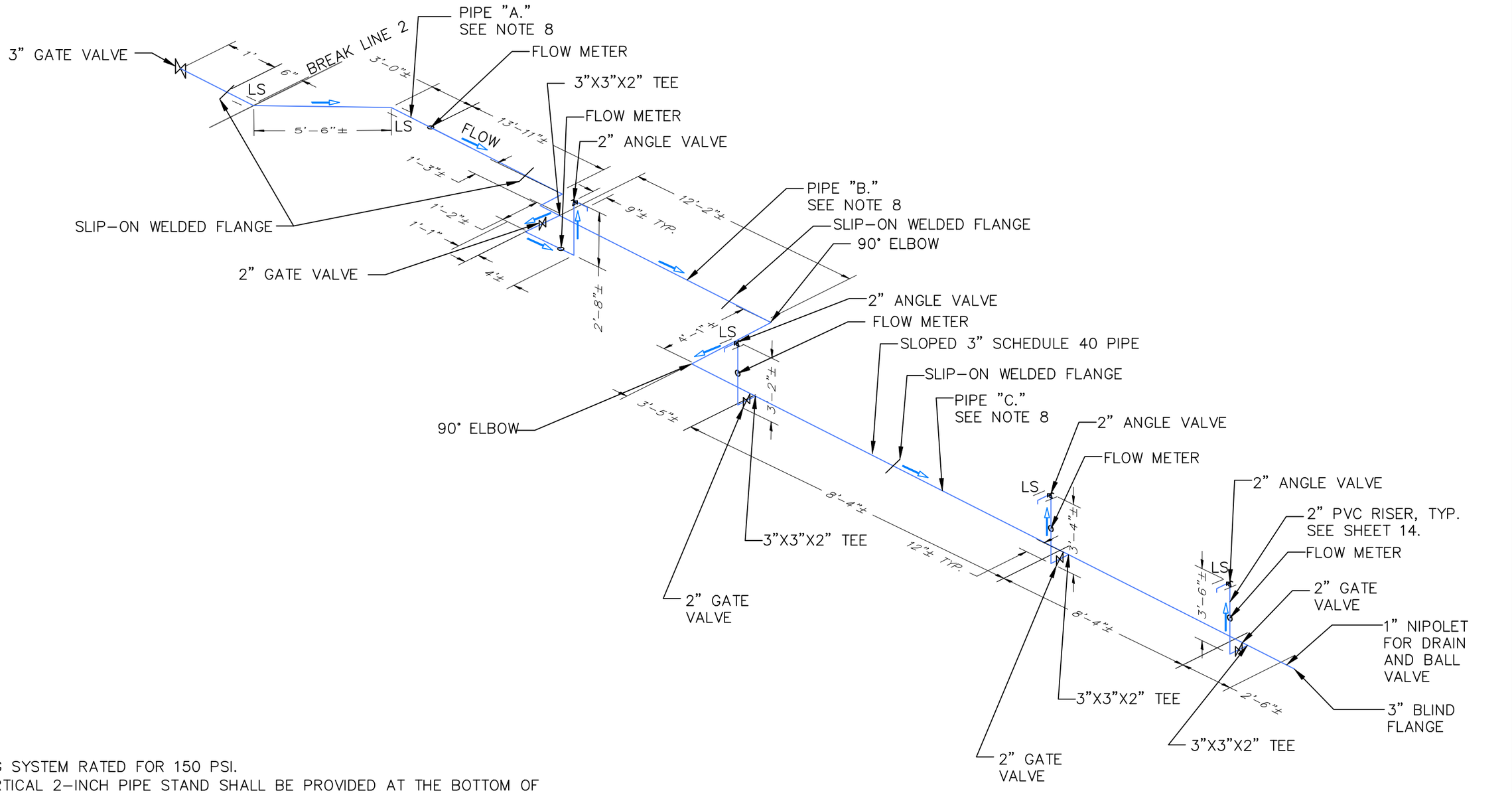

NOTES:

1.) PIPING SYSTEM RATED FOR 150 PSI.
2.) A VERTICAL 2–INCH PIPE STAND SHALL BE PROVIDED AT THE BOTTOM OF EACH 2–INCH RISER.
3.) SLOPE PIPE TO DRAIN WITH DOWNSTREAM END 6" ABOVE GRADE.
4.) PROVIDE VERTICAL PIPE STANDS AT "LS" LOCATIONS SHOWN ON DRAWING.
5.) MAXIMUM SPACING OF PIPE STANDS SHALL BE 12 FEET FOR 3–INCH PIPING.
6.) PROVIDE LATERAL SUPPORT, TYPE C AT THE TOP OF EACH 2–INCH RISER.
7.) LABEL PIPE SEGMENTS AS SPECIFIED ON DRAWING 3.
8.) FIELD VERIFY ALL DIMENSIONS PRIOR TO FABRICATION.

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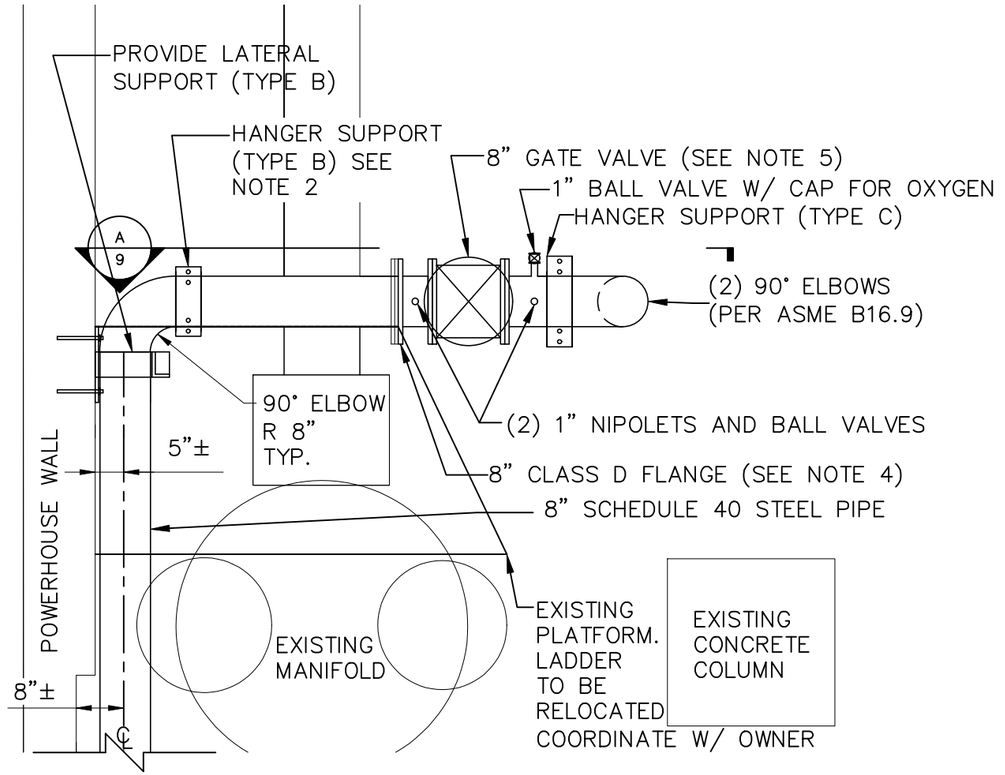
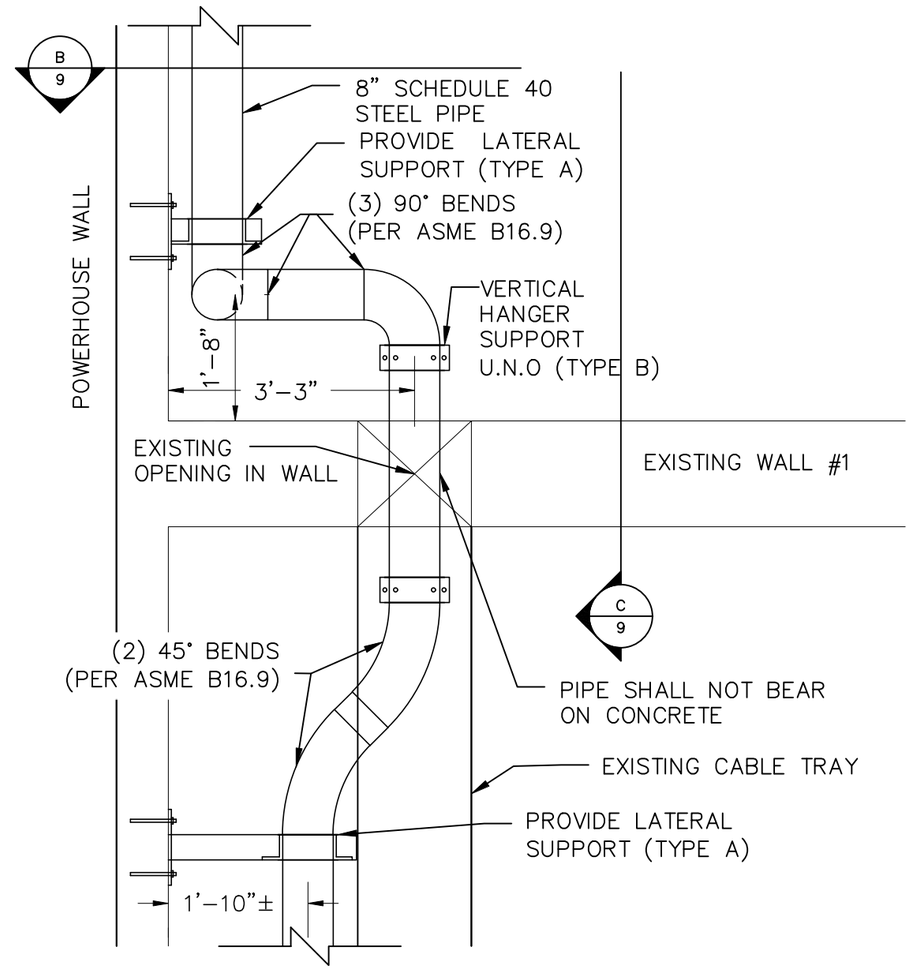
EEL FACILITY PIPELINE 3D PROFILE

SCALE: AS NOTED DRAWING NO.: 6



1/7 PLAN OF PIPE AT EXISTING MANIFOLD
Scale: 1"=1'



2/7 PLAN OF PIPE THROUGH WALL #1
Scale: 1"=1'

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29)
2. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB. SEE SHEET 12 FOR TYPICAL SUPPORT DETAILS.
3. CONTRACTOR SHALL REMOVE EXISTING 3" PIPE THAT EXISTS ALONG THE ALIGNMENT OF THE PROPOSED 8" PIPE. AVOID OR MOVE OTHER PIPES UPON EXELON'S APPROVAL.
4. EXISTING MANIFOLD IS UNDER PRESSURE AND MUST BE ISOLATED (DOUBLE ISOLATED PREFERRED) PRIOR TO COMMENCING ANY WORK. BLIND FLANGE IS TO BE CAREFULLY REMOVED IN SUCH A MANNER TO CHECK LINE IS NOT PRESSURIZED.
5. THE NEW GATE VALVE IS TO BE INSTALLED AND CLOSED WITHIN 2 HOURS OF THE REMOVAL OF THE EXISTING BLIND FLANGE. TEMPORARILY SUPPORT THE VALVE UNTIL NEW SUPPORTS ARE INSTALLED.

1' 0 1' 2'
SCALE: 1" = 1'-0"

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DETAILED PIPE LAYOUT PLANS, SHEET 1

SCALE: AS NOTED DRAWING NO.: 7

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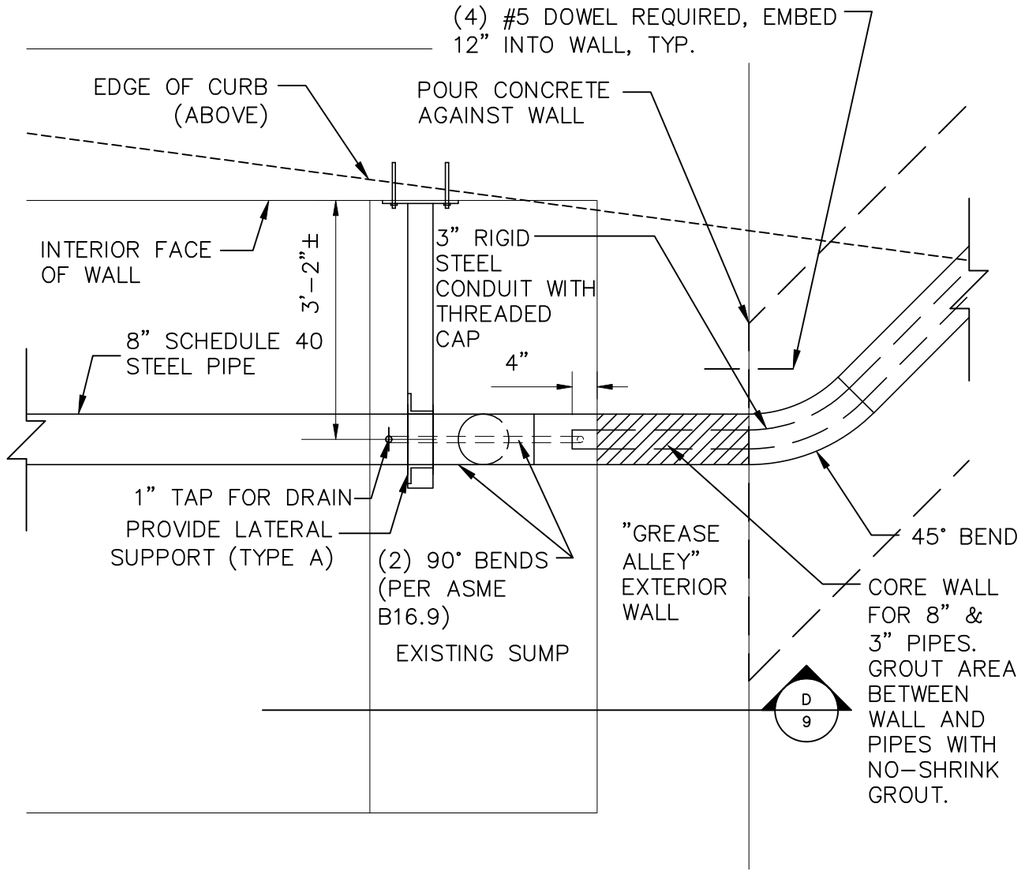
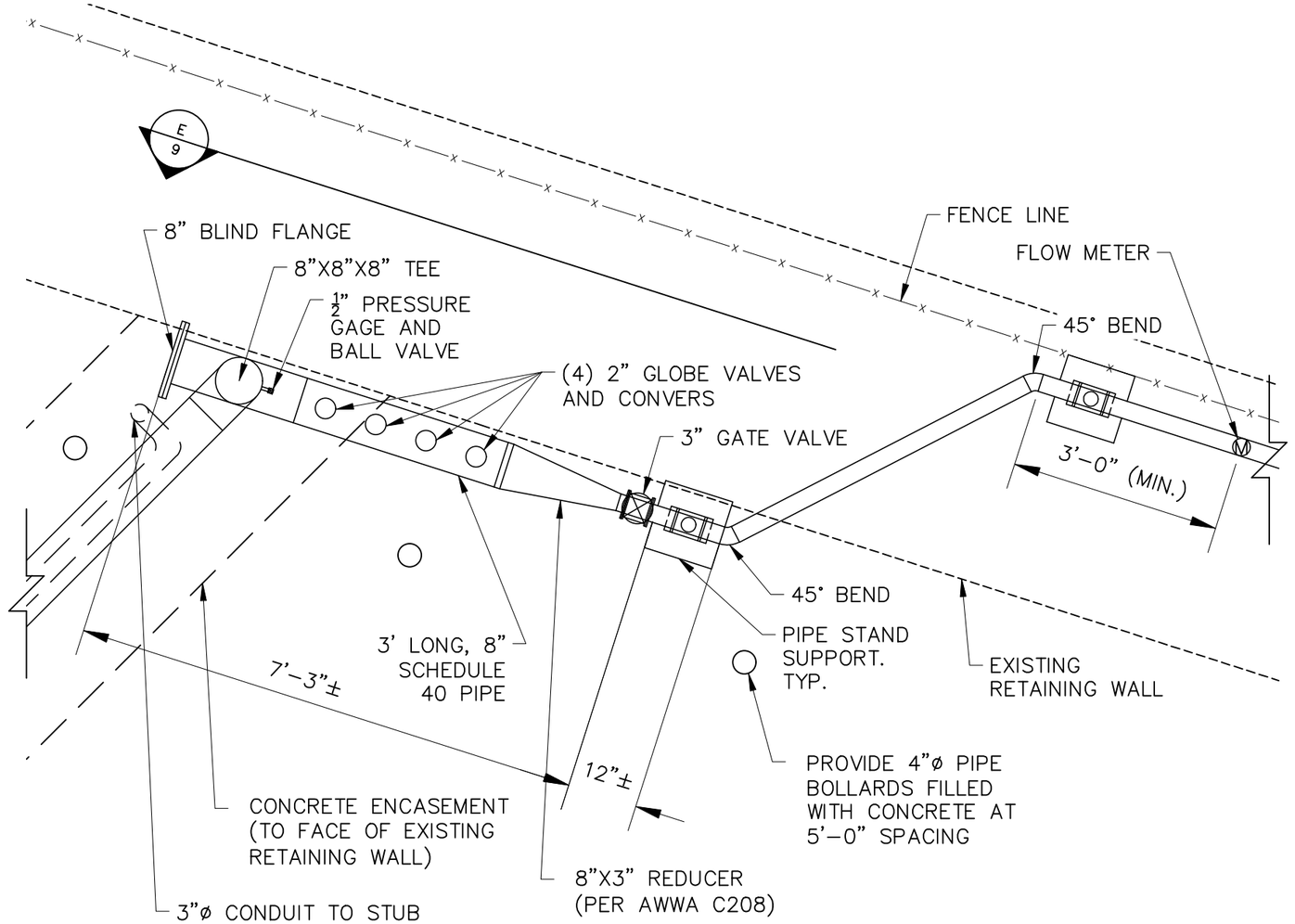


1/8 PLAN OF PIPE AT END OF ALLEY
Scale: 1"=1'



2/8 PLAN OF PROPOSED MANIFOLD
Scale: 1"=1'

NOTE: 3" RIGID STEEL CONDUIT TO STUB UP 4" ABOVE FINISH GRADE. PLACE 12" AWAY FROM MANIFOLD.

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29)
2. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB. SEE SHEET 12 FOR TYPICAL SUPPORT DETAILS.

1' 0 1' 2'
SCALE: 1" = 1'-0"

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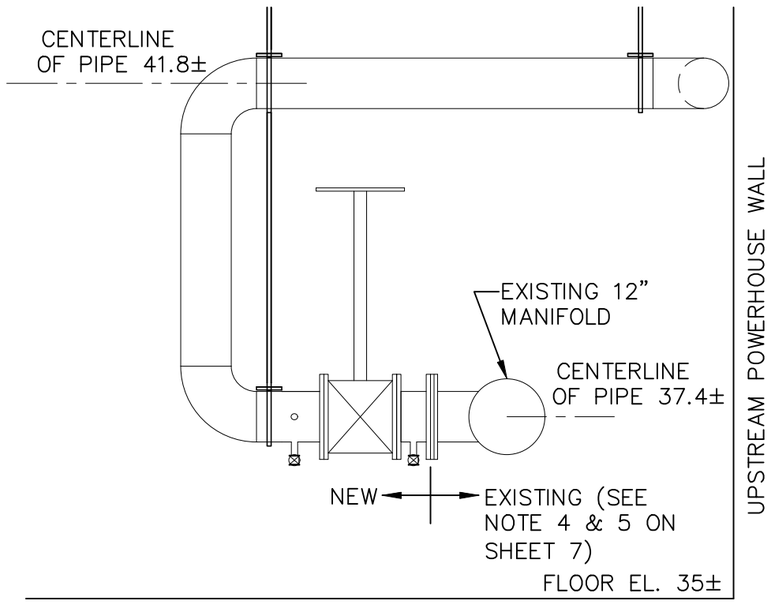
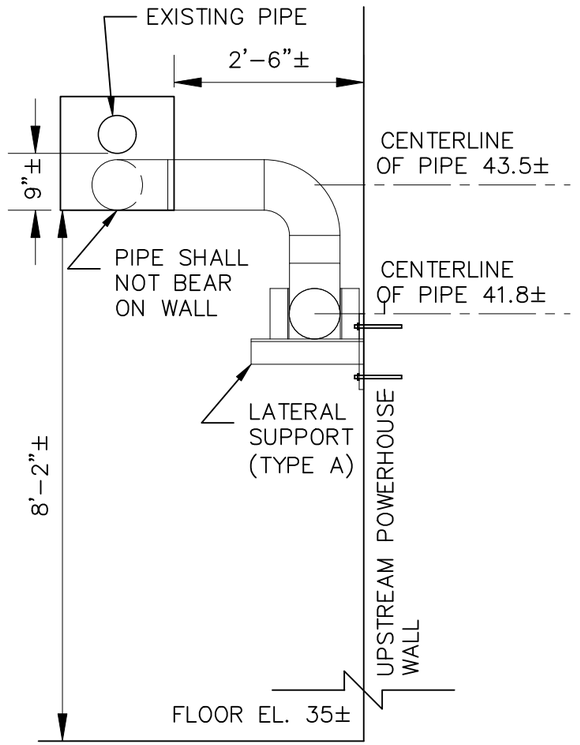
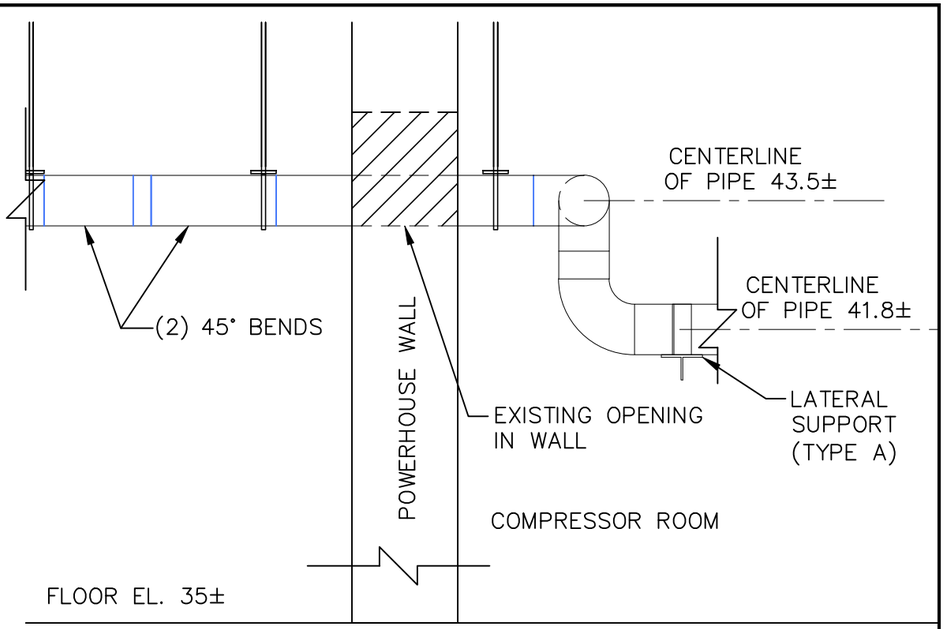
DETAILED PIPE LAYOUT PLANS, SHEET 2

SCALE: AS NOTED DRAWING NO.: 8

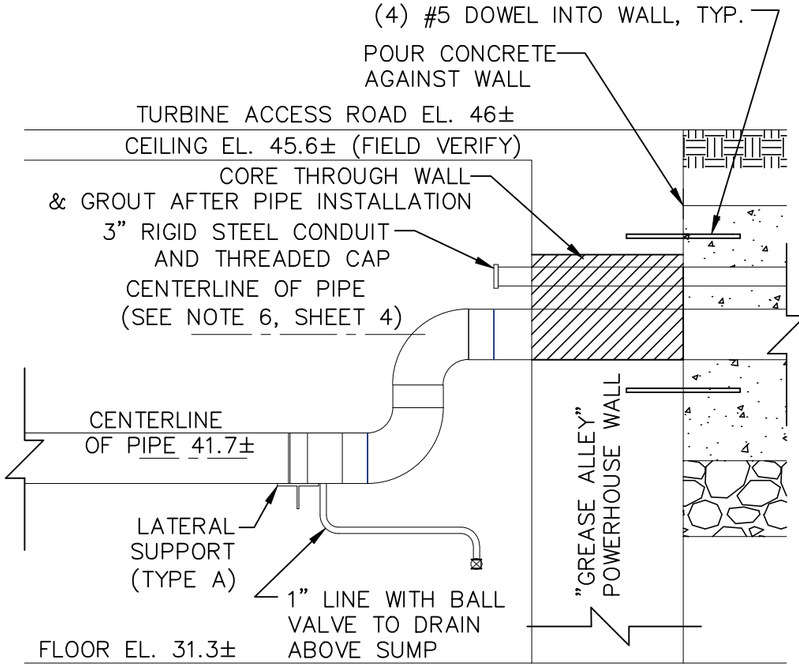


A/9 ELEVATION AT EXISTING MANIFOLD
Scale: 1"=1'



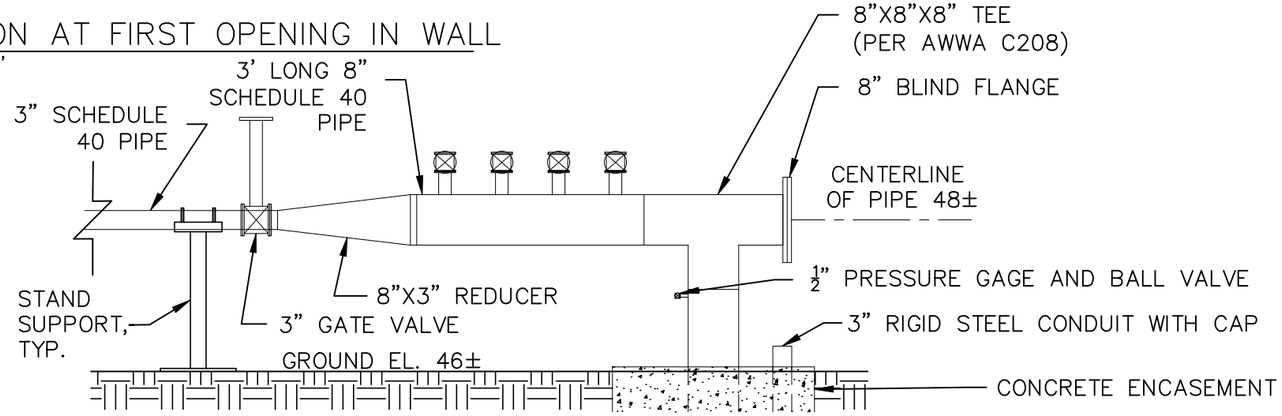


C/9 ELEVATION AT FIRST OPENING IN WALL
Scale: 1"=1'



D/9 ELEVATION AT END OF "GREASE ALLEY"
Scale: 1"=1'

B/9 SECTION AT FIRST OPENING IN WALL
Scale: 1"=1'



E/9 MANIFOLD DETAIL ELEVATION
Scale: 1"=2'

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29)

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SECTIONS AND DETAILS

SCALE: AS NOTED DRAWING NO.: 9

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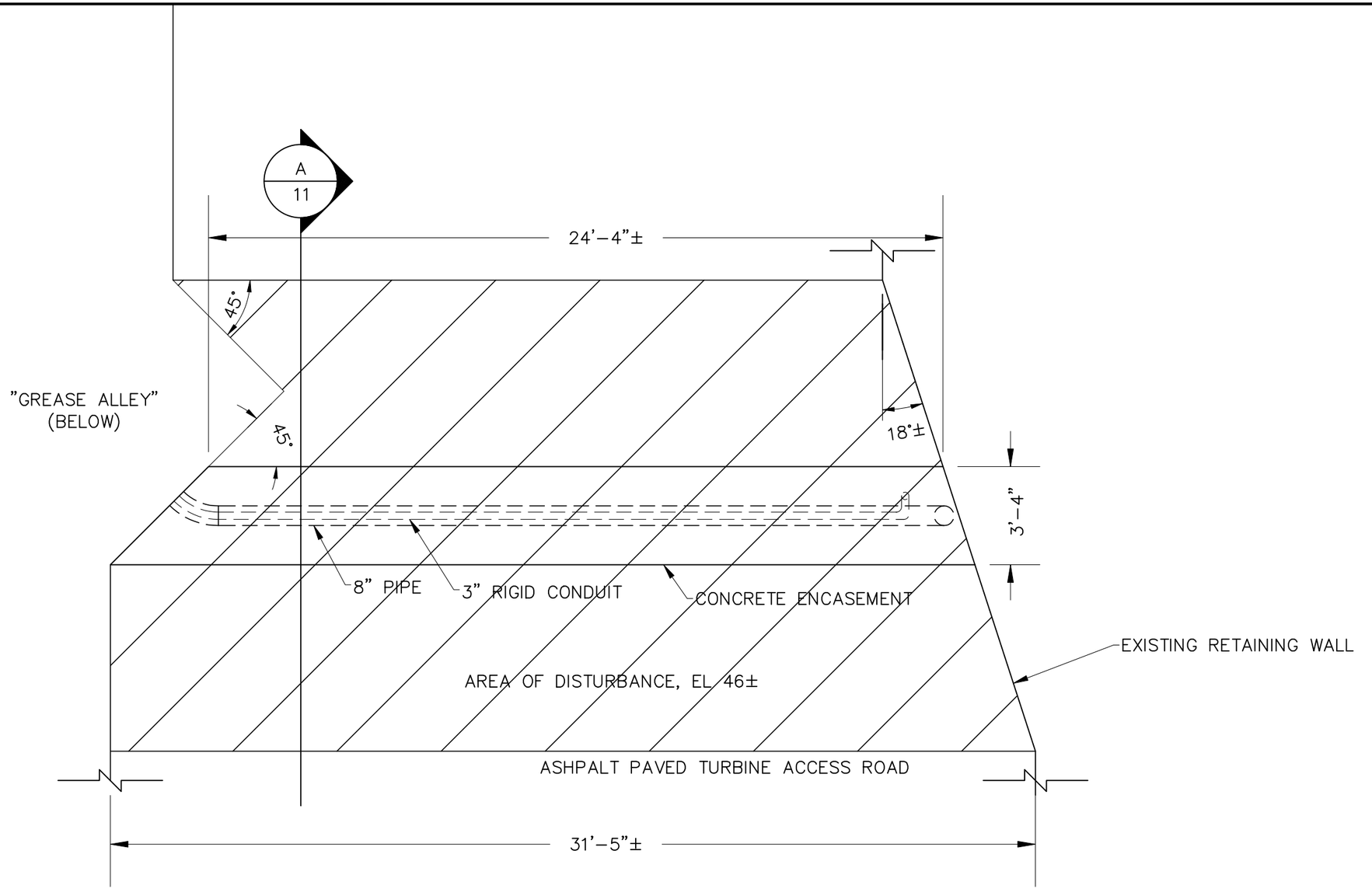

NOTES:

1. THE 8" PIPE SHALL RUN UNDER THE EXISTING YARD DRAINAGE LINES. EXCAVATE BY HAND TO LOCATE DRAIN LINES AND TO ENSURE LINES ARE NOT DAMAGED OR DISTURBED DURING INSTALLATION OF NEW PIPE. ELEVATION ACROSS DRIVEWAY WILL BE DEPENDENT ON LOCATION OF DRAIN LINES AND RAILROAD TRACKS.
2. MAXIMUM AREA OF DISTURBANCE EQUAL TO 507 SQ. FT.

2' 0 2' 4'

SCALE: 1" = 2'–0"

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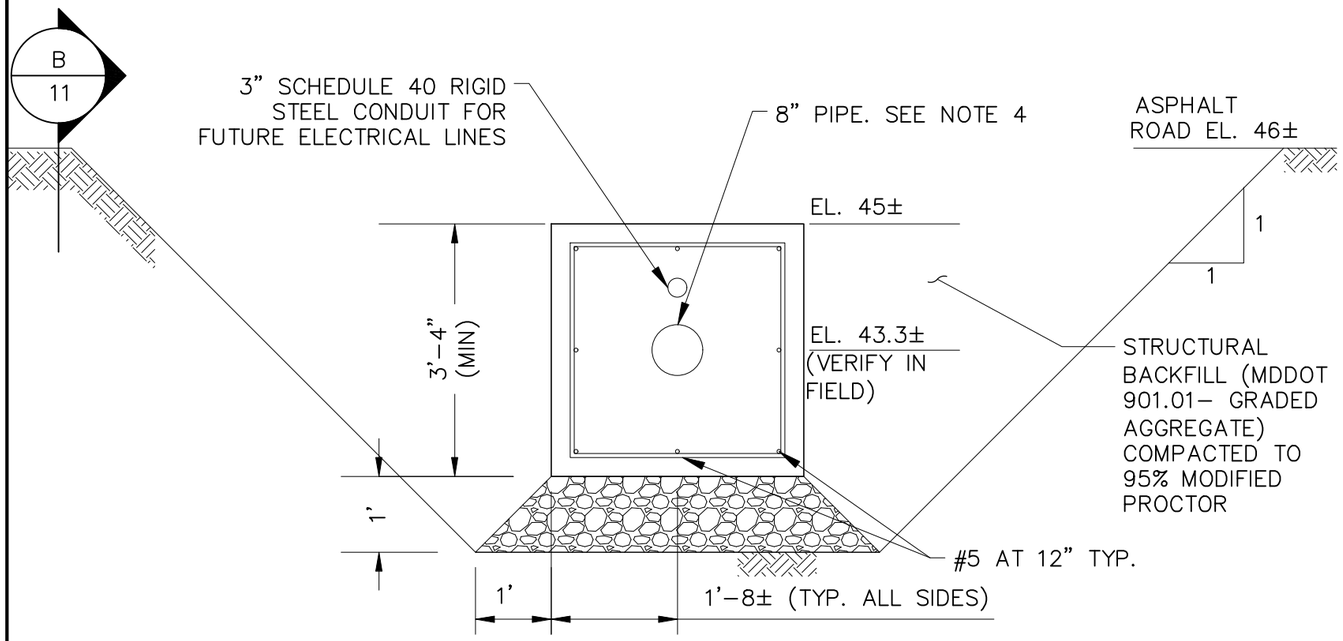
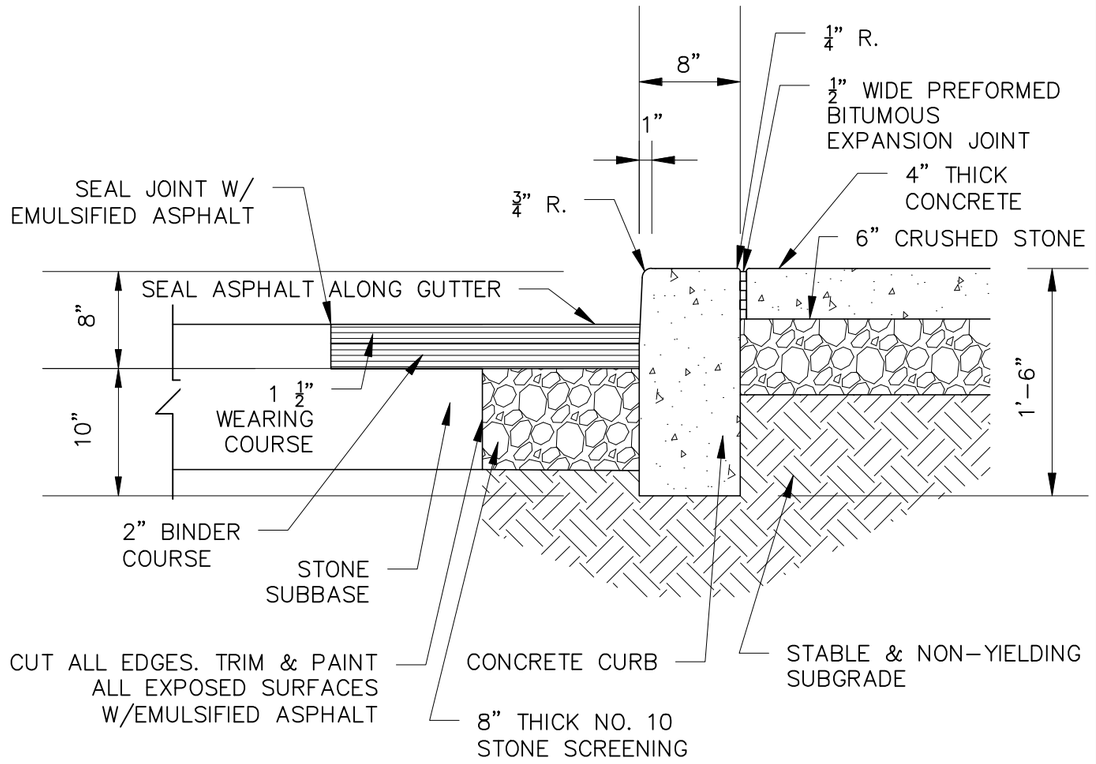
EXCAVATION AND CONCRETE ENCASEMENT PLAN

SCALE: AS NOTED DRAWING NO.: 10

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



A/11 CONCRETE ENCASEMENT SECTION AND EXCAVATION DETAIL
Scale: 1"=1'



B/11 ROAD BASE DETAIL TYP.
Scale: 1"=6"

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29)
2. A BUOYANT FORCE OF 950 LB MUST BE RESISTED DURING POUR AND CURING OF CONCRETE
3. GROUND SHALL BE COMPACTED TO ASTM D 1557 (95% MODIFIED PROCTOR).
4. THE 8" PIPE SHALL RUN UNDER THE EXISTING YARD DRAINAGE LINES. EXCAVATE BY HAND TO LOCATE DRAIN LINES, TO LOCATE POSSIBLE RAILROAD TRACKS, AND TO ENSURE LINES ARE NOT DAMAGED OR DISTURBED DURING INSTALLATION OF NEW PIPE.
5. ASPHALT ROAD TO BE REPLACED PER SECTION B.
6. EROSION AND SEDIMENT CONTROL REQUIREMENTS ARE SHOWN ON DRAWING 20.

DATE	#		BY	APP

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EXCAVATION, CONCRETE ENCASEMENT AND ROAD SECTIONS

SCALE: AS NOTED DRAWING NO.: 11

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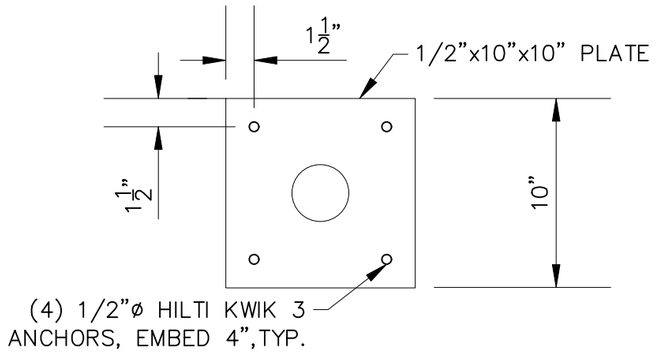
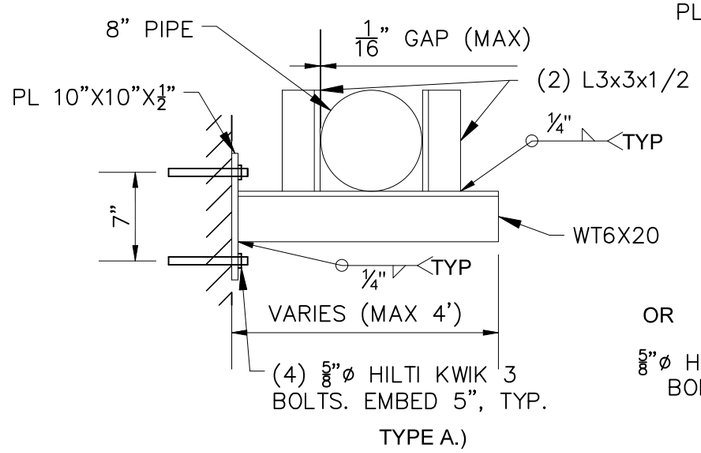
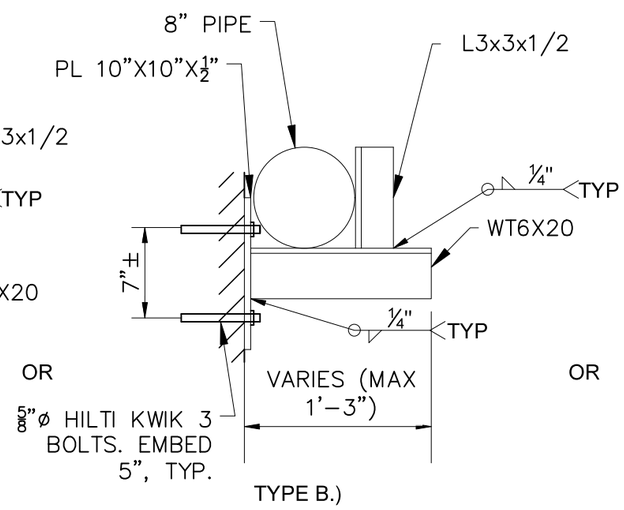


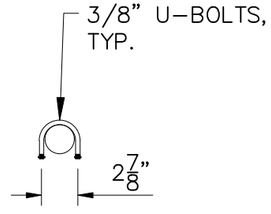
B/12 STAND PIPE SUPPORT BASE (TYP.)
Scale: 3"=1'



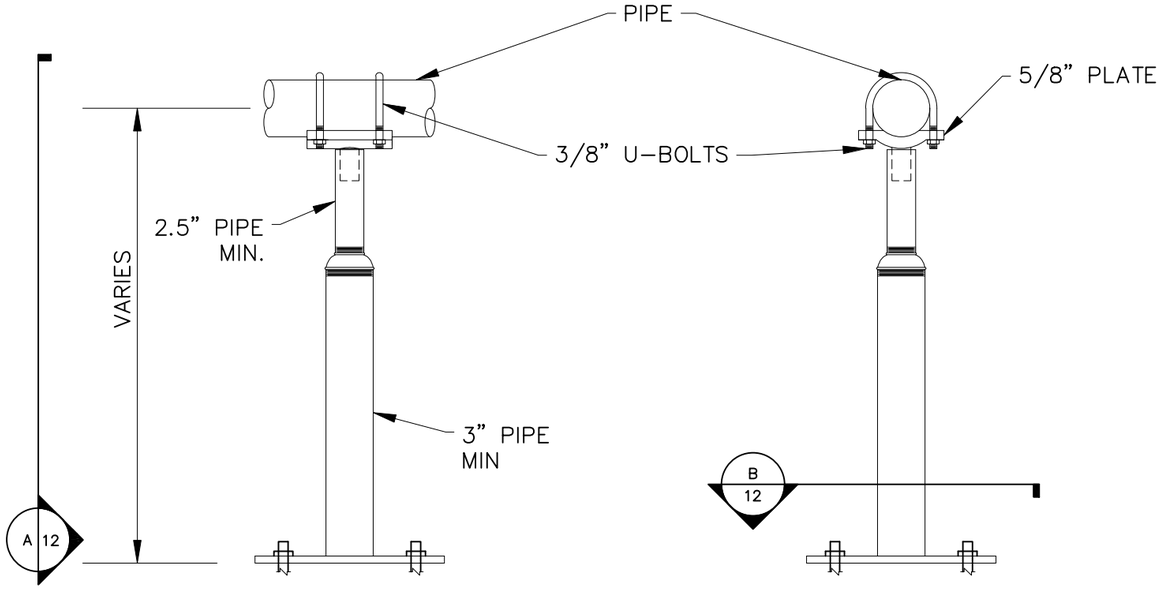


OR

OR

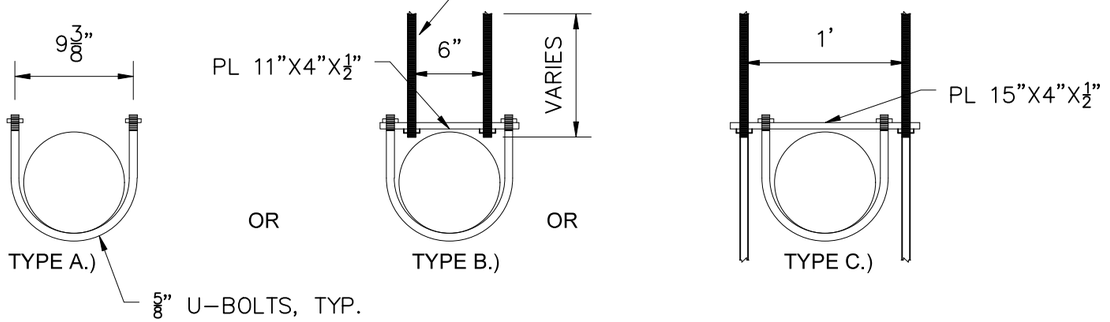


2/12 8" LATERAL PIPE SUPPORT (TYP.)
Scale: 2"=1'



ADJUSTABLE STAND
1/12 VERTICAL PIPE SUPPORT (TYP.)
Scale: 3"=1'

A/12 ELEVATION STAND PIPE SUPPORT
Scale: 3"=1'



3/12 8" HANGER (VERTICAL) PIPE SUPPORTS (TYP.)
Scale: 2"=1'

NOTES

1. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB.
2. LATERAL SUPPORTS MUST BE CAPABLE OF SUPPORTING 1000 LB HORIZONTAL LOAD AND 1500 POUND VERTICAL LOAD.

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PIPE SUPPORTS

SCALE: AS NOTED DRAWING NO.: 12

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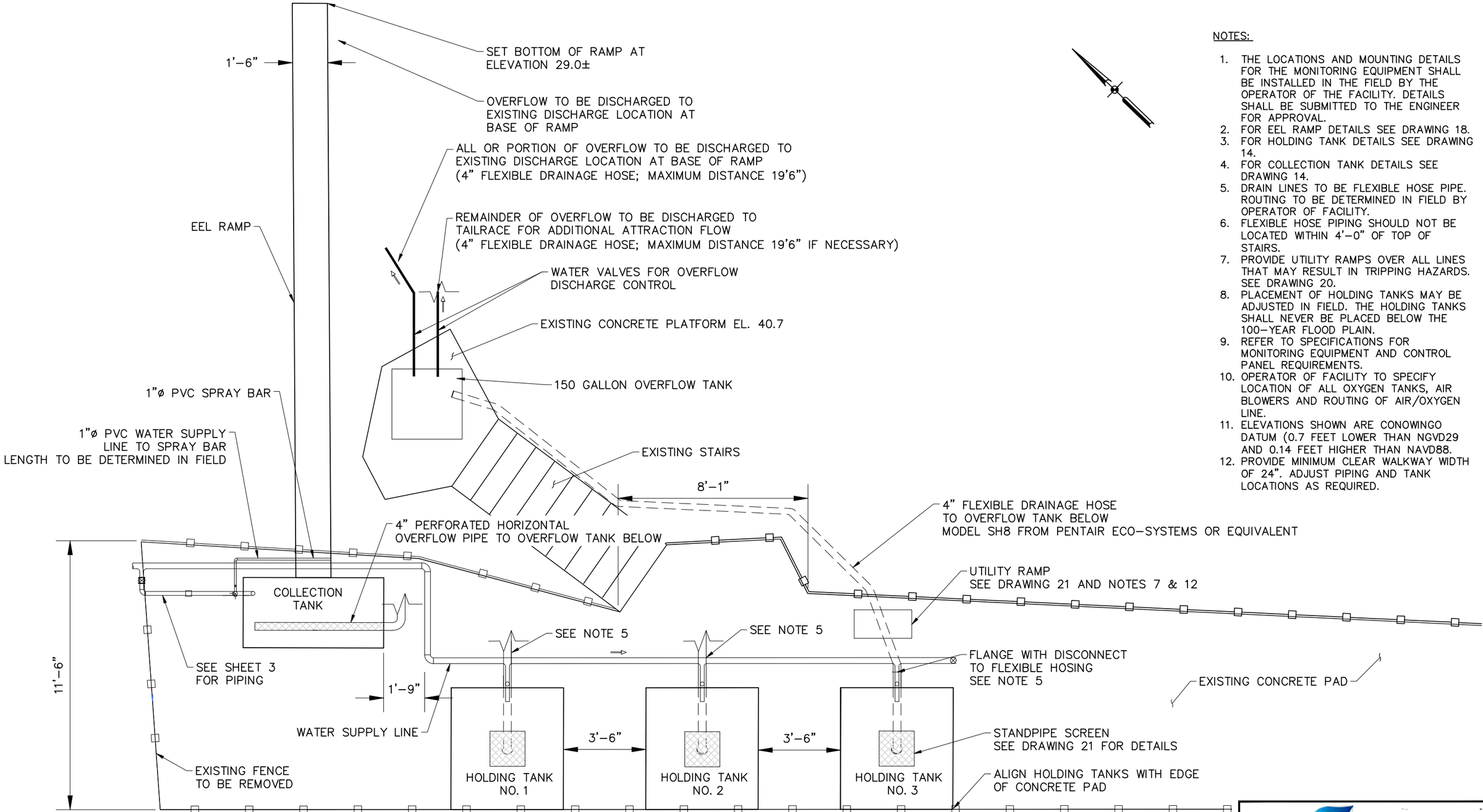

NOTES:

1. THE LOCATIONS AND MOUNTING DETAILS FOR THE MONITORING EQUIPMENT SHALL BE INSTALLED IN THE FIELD BY THE OPERATOR OF THE FACILITY. DETAILS SHALL BE SUBMITTED TO THE ENGINEER FOR APPROVAL.
2. FOR EEL RAMP DETAILS SEE DRAWING 18.
3. FOR HOLDING TANK DETAILS SEE DRAWING 14.
4. FOR COLLECTION TANK DETAILS SEE DRAWING 14.
5. DRAIN LINES TO BE FLEXIBLE HOSE PIPE. ROUTING TO BE DETERMINED IN FIELD BY OPERATOR OF FACILITY.
6. FLEXIBLE HOSE PIPING SHOULD NOT BE LOCATED WITHIN 4'–0" OF TOP OF STAIRS.
7. PROVIDE UTILITY RAMPS OVER ALL LINES THAT MAY RESULT IN TRIPPING HAZARDS. SEE DRAWING 20.
8. PLACEMENT OF HOLDING TANKS MAY BE ADJUSTED IN FIELD. THE HOLDING TANKS SHALL NEVER BE PLACED BELOW THE 100–YEAR FLOOD PLAIN.
9. REFER TO SPECIFICATIONS FOR MONITORING EQUIPMENT AND CONTROL PANEL REQUIREMENTS.
10. OPERATOR OF FACILITY TO SPECIFY LOCATION OF ALL OXYGEN TANKS, AIR BLOWERS AND ROUTING OF AIR/OXYGEN LINE.
11. ELEVATIONS SHOWN ARE CONOWINGO DATUM (0.7 FEET LOWER THAN NGVD29 AND 0.14 FEET HIGHER THAN NAVD88.
12. PROVIDE MINIMUM CLEAR WALKWAY WIDTH OF 24". ADJUST PIPING AND TANK LOCATIONS AS REQUIRED.

2' 0 2' 4'

SCALE: 1/2" = 1'–0"

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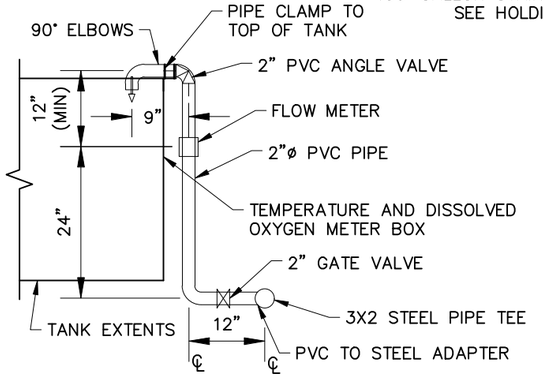
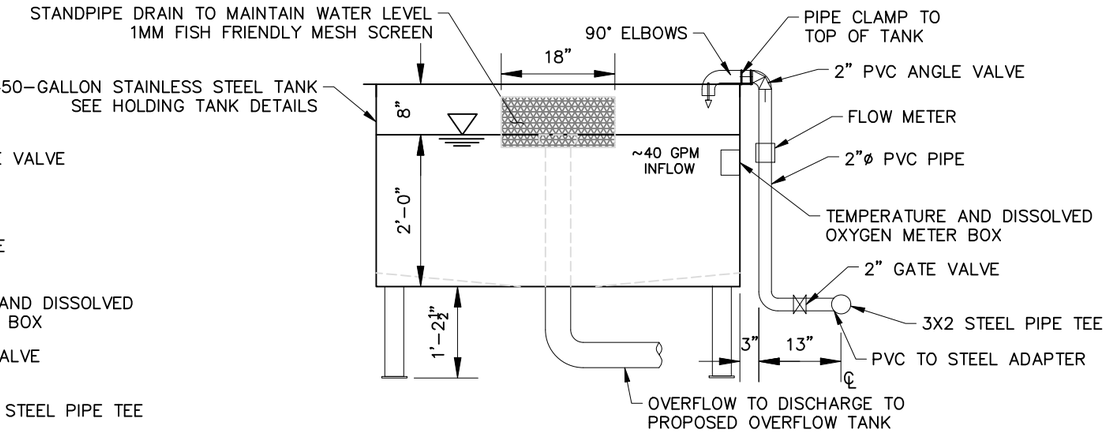
EEL FACILITY PLAN LAYOUT (FIGURE 2.2.3-1)

SCALE: AS NOTED DRAWING NO.: 13



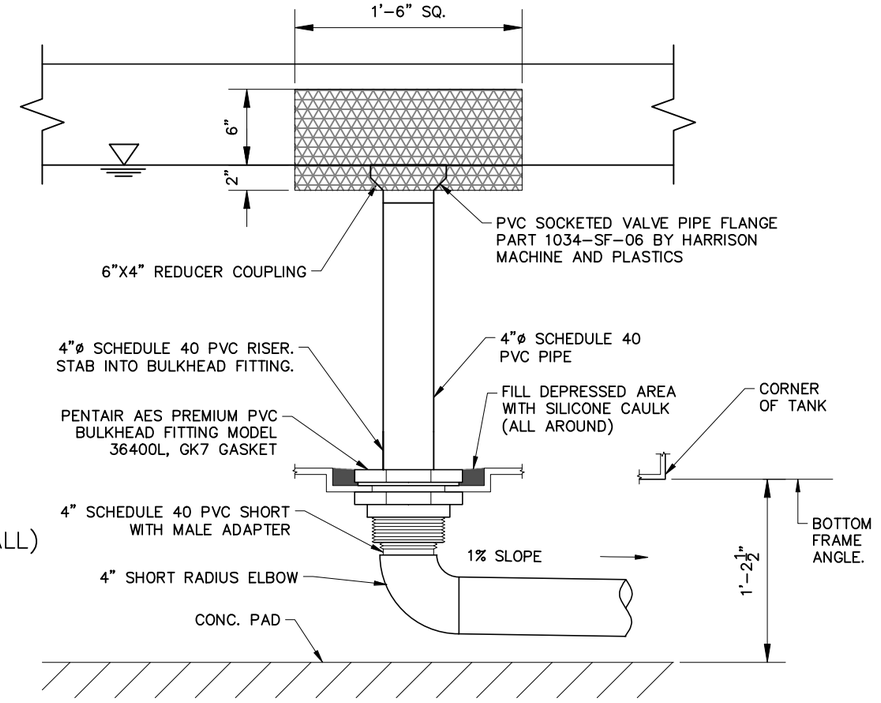
1 TYPICAL RISER DETAIL – HOLDING TANK

Scale: 1" = 1'–0"



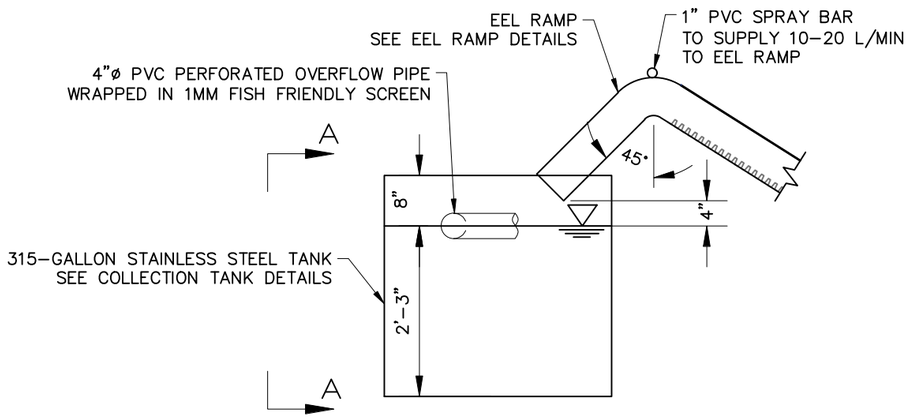
1/14 SECTION OF HOLDING TANK

1" = 1'–0" (APPROXIMATE TANK SIZE 5'6"X5'6"X2'8" TALL)



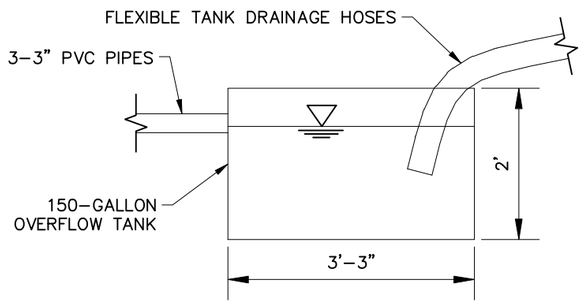
2 STANDPIPE DETAIL – HOLDING TANK

Scale: 1" = 1'–0"



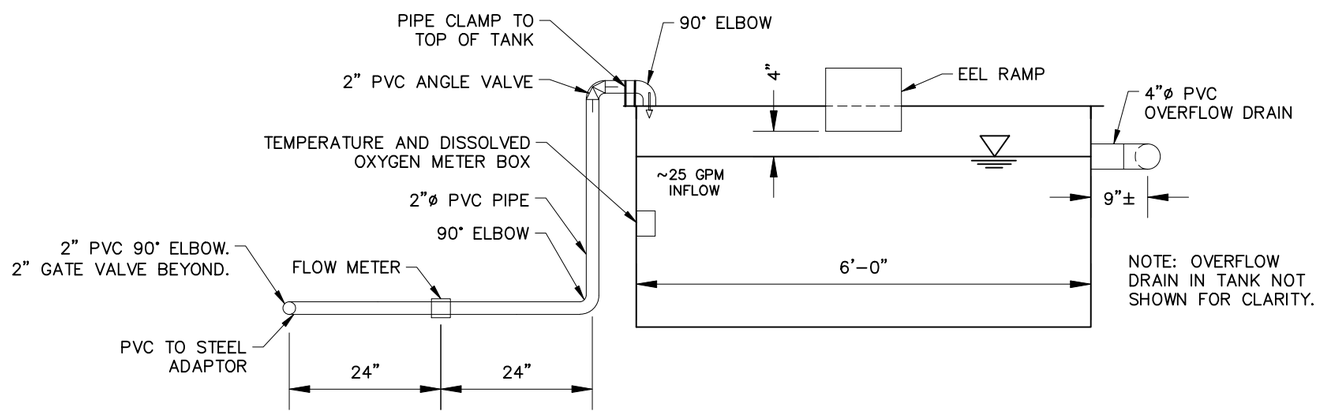
2/14 SECTION OF COLLECTION TANK

1" = 1'–0" (APPROXIMATE TANK SIZE 6'X3'4"X3'1" TALL)



3/14 SECTION OF OVERFLOW TANK

1" = 1'–0" (APPROXIMATE TANK SIZE 39"X58"X24" TALL)



A/14 ELEVATION OF COLLECTION TANK

1" = 1'–0"

NOTES

1. REFER TO SPECIFICATIONS FOR MONITORING EQUIPMENT AND CONTROL PANEL REQUIREMENTS.
2. HOLES IN TANK COVERS FOR DISSOLVED OXYGEN AND AERATION LINES TO BE DRILLED IN FIELD.
3. OPERATOR OF FACILITY TO SPECIFY LOCATION OF ALL OXYGEN TANKS, AIR BLOWERS AND ROUTING OF AIR/OXYGEN LINE.
4. ELEVATIONS SHOWN ARE CONOWINGO DATUM (0.7 FEET LOWER THAN NAGVD 29 AND 0.14 FEET HIGHER THAN NAVD88).

1' 0 1' 2'

SCALE: 1" = 1'–0"

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TYPICAL TANK SECTIONS (FIGURE 2.2.3-2)

SCALE: AS NOTED DRAWING NO.: 14

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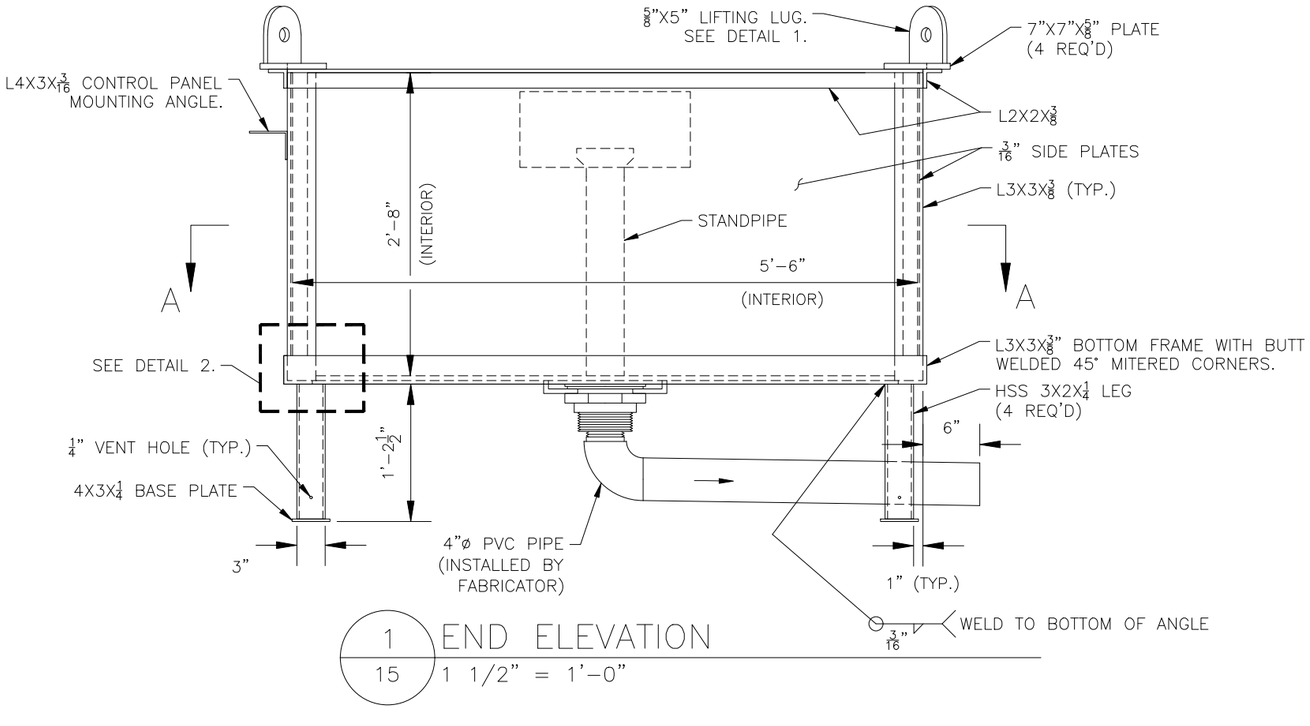
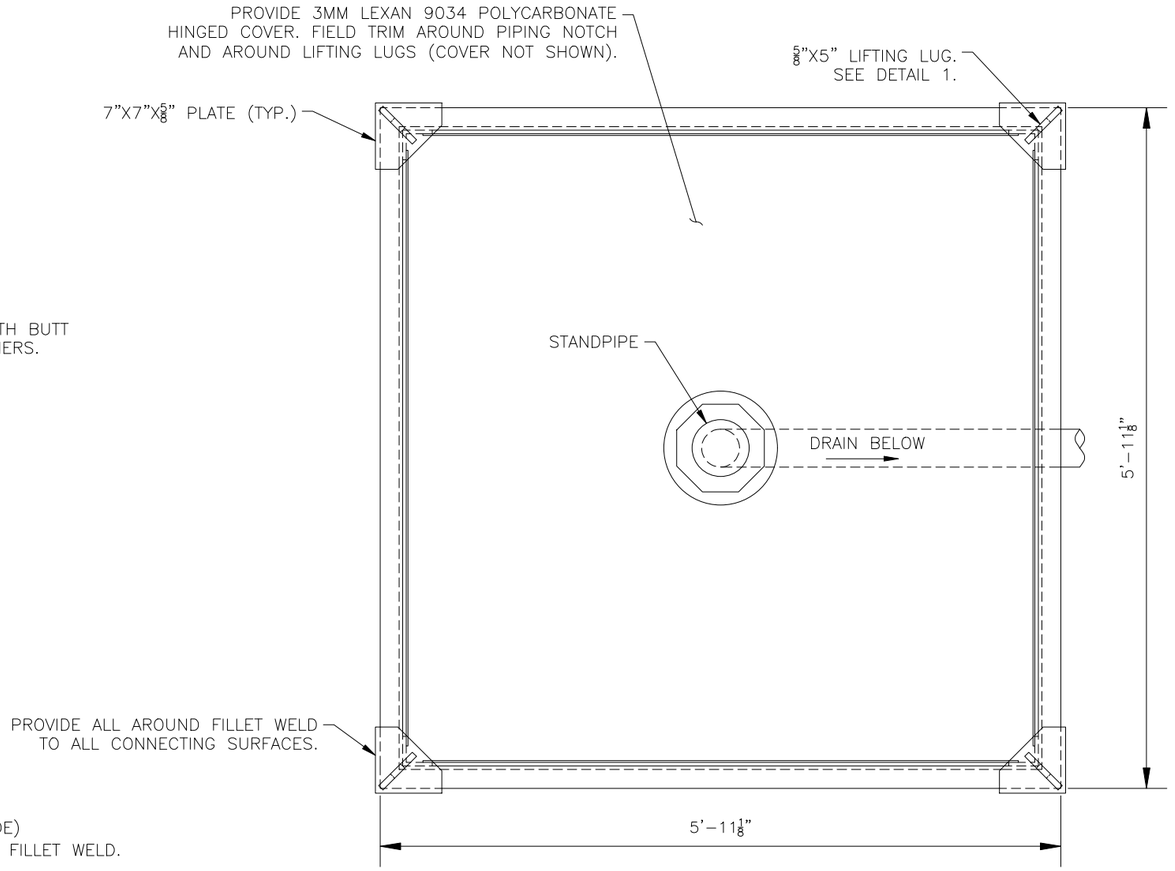


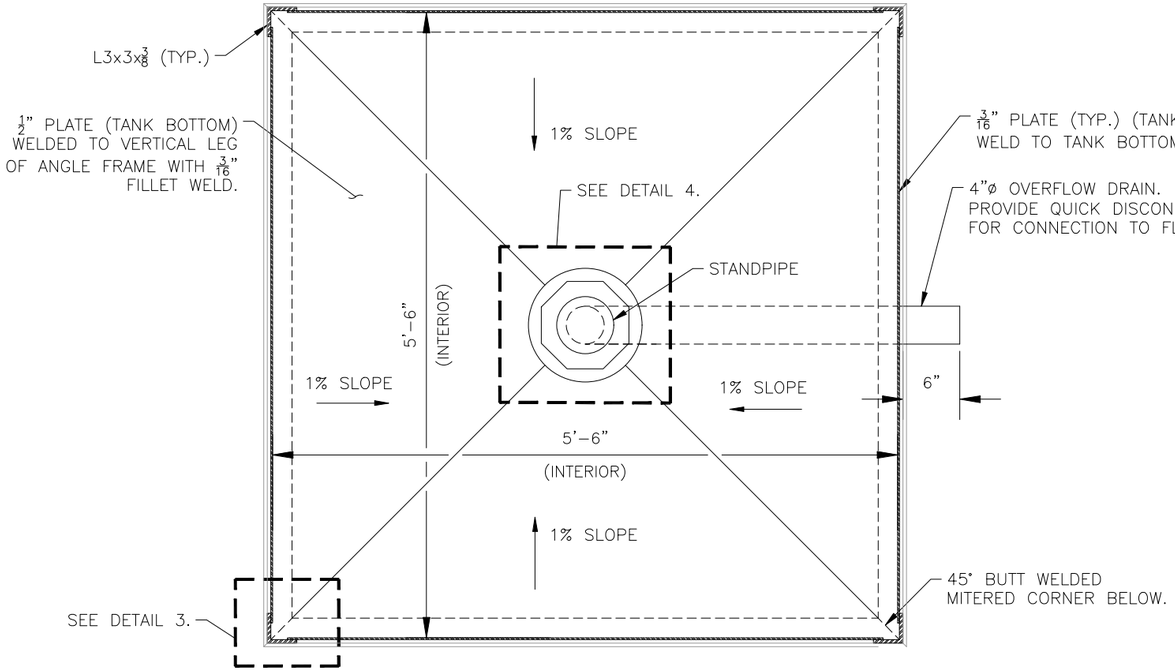
1/15 END ELEVATION

1 1/2" = 1'-0"



2/15 PLAN – TOP OF TANK

1 1/2" = 1'-0"



A/15 PLAN THROUGH TANK

1 1/2" = 1'-0"

8" 0 8" 16"

SCALE: 1 1/2" = 1'-0"

NOTES:

1. USE STAINLESS STEEL ELECTRODES.
2. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE CONTINUOUS.
3. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE 3/16" FILLET WELDS.
4. ALL OVERLAPPING SURFACES TO BE FULLY WELDED WITH 3/16" FILLET WELDS.
5. LIFTING LUGS ARE DESIGNED TO LIFT TANK ASSUMING TANK IS COMPLETELY DRAINED.
6. SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL.
7. TANK FABRICATOR SHALL DRILL/CUT HOLES IN TANK SIDES FOR MONITORING EQUIPMENT (TEMPERATURE AND OXYGEN METERS). LOCATIONS AND SIZES TO BE DETERMINED DURING MEETING WITH OWNER'S REPRESENTATIVE(S) AND ENGINEER.
8. LOCATION OF CONTROL PANEL MOUNTING ANGLE TO BE DETERMINED DURING THE SITE MEETING WITH OWNER, OWNER'S REPRESENTATIVE, AND ENGINEER.
9. FITTINGS ATTACHED TO TANKS TO BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.

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HOLDING TANK PLAN AND SECTIONS

SCALE: AS NOTED DRAWING NO.: 15

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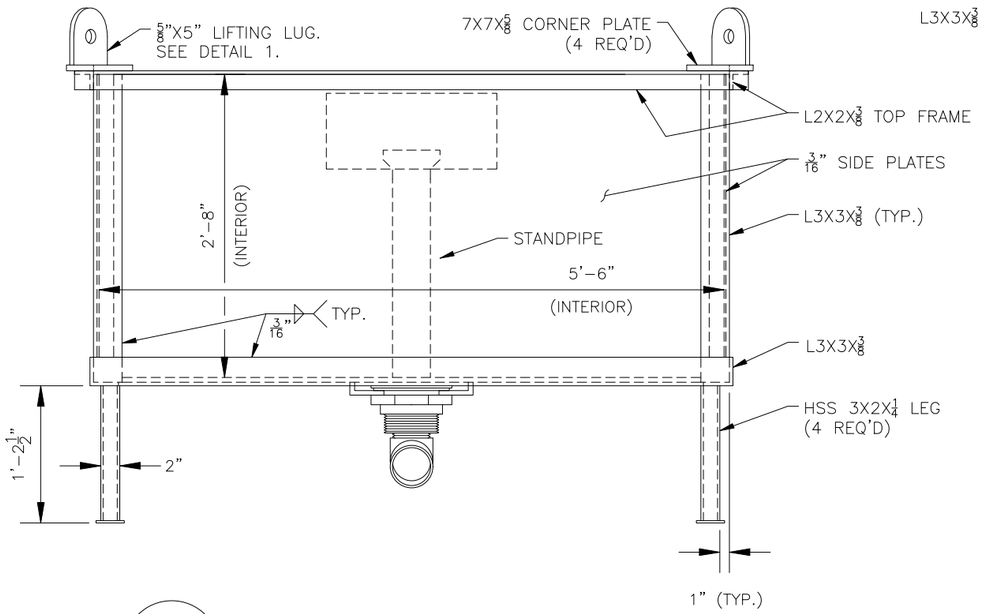
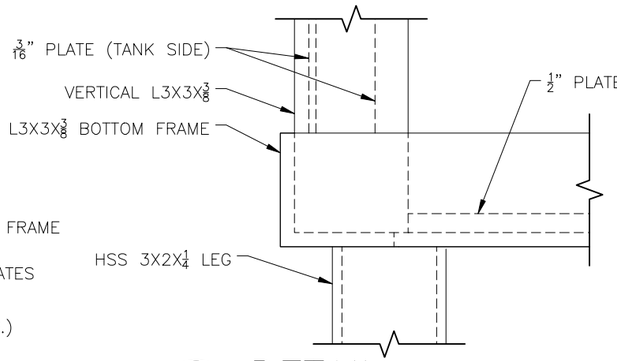
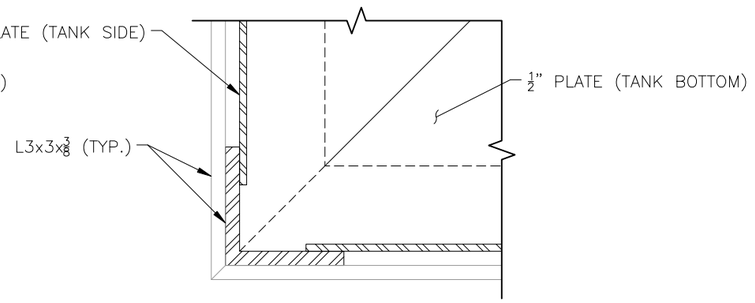


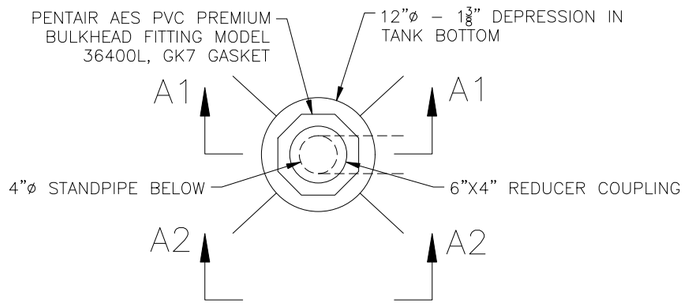
1/16 SIDE ELEVATION
3/4" = 1'-0"



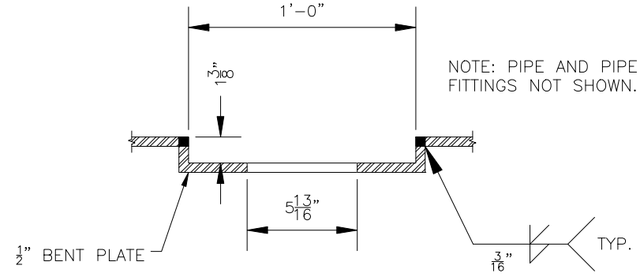
2 DETAIL
Scale: 6" = 1'-0"



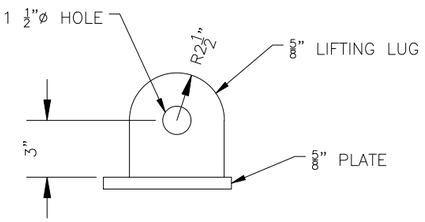
3 DETAIL
Scale: 6" = 1'-0"



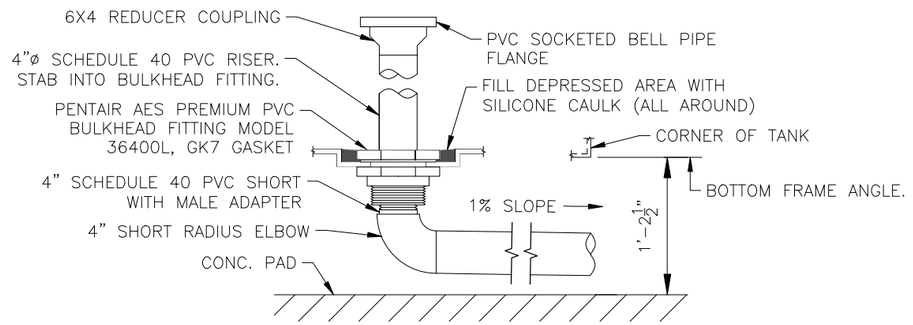
4 DETAIL
Scale: 1 1/2" = 1'-0"



A1/16 SECTION THROUGH TANK BOTTOM
3" = 1'-0"



1 DETAIL
Scale: 3" = 1'-0" (SEE NOTE 8)



A2/16 SECTION OF TANK BOTTOM
1 1/2" = 1'-0"

NOTES:

1. USE STAINLESS STEEL ELECTRODES.
2. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE CONTINUOUS.
3. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE 3/16" FILLET WELDS.
4. ALL OVERLAPPING SURFACES TO BE FULLY WELDED WITH 3/16" FILLET WELDS.
5. SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL.
6. BULKHEAD FITTINGS TO BE PROVIDED AND INSTALLED BY THE FABRICATOR AT THE FABRICATION PLANT.
7. TANK FABRICATOR SHALL DRILL/CUT HOLES IN TANK SIDES FOR MONITORING EQUIPMENT (TEMPERATURE AND OXYGEN METERS). LOCATIONS AND SIZES TO BE DETERMINED DURING MEETING WITH OWNER'S REPRESENTATIVE AND ENGINEER.
8. LIFTING LUGS ARE DESIGNED TO LIFT TANK ASSUMING TANK IS COMPLETELY DRAINED.

4" 0 4" 8"
SCALE: 3" = 1'-0"

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GSE PROJECT NO.: 1714 DATE: 2/17/2017

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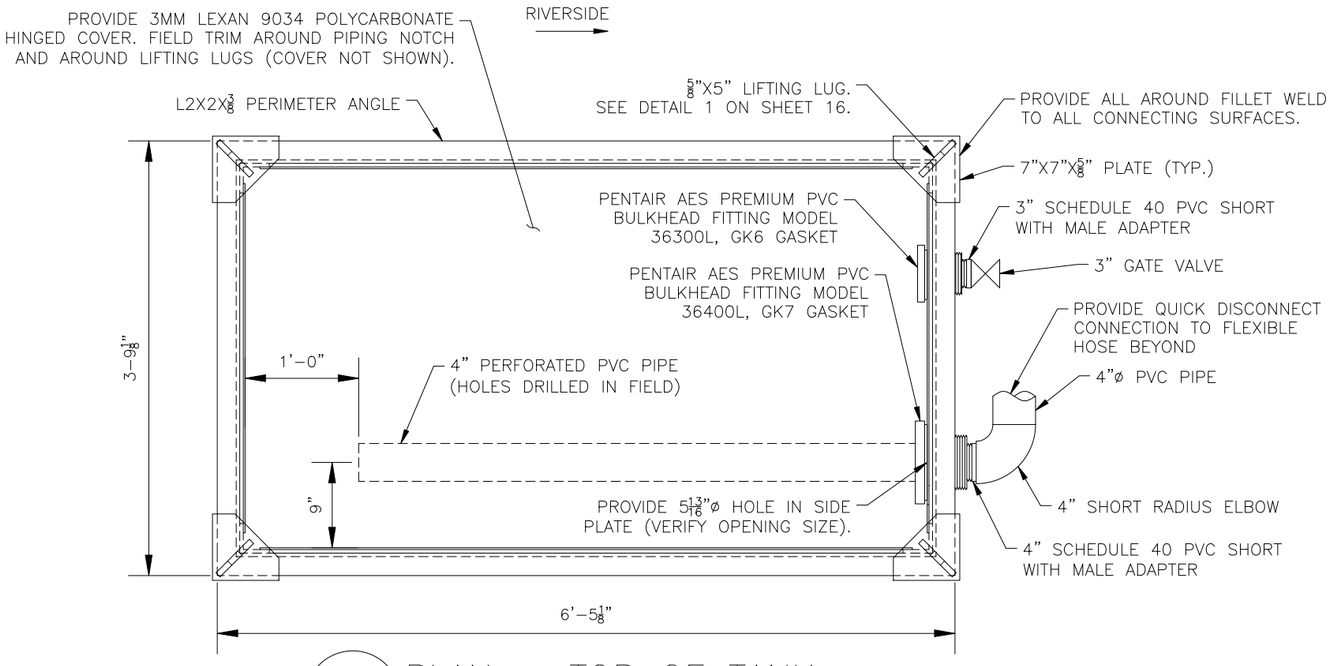
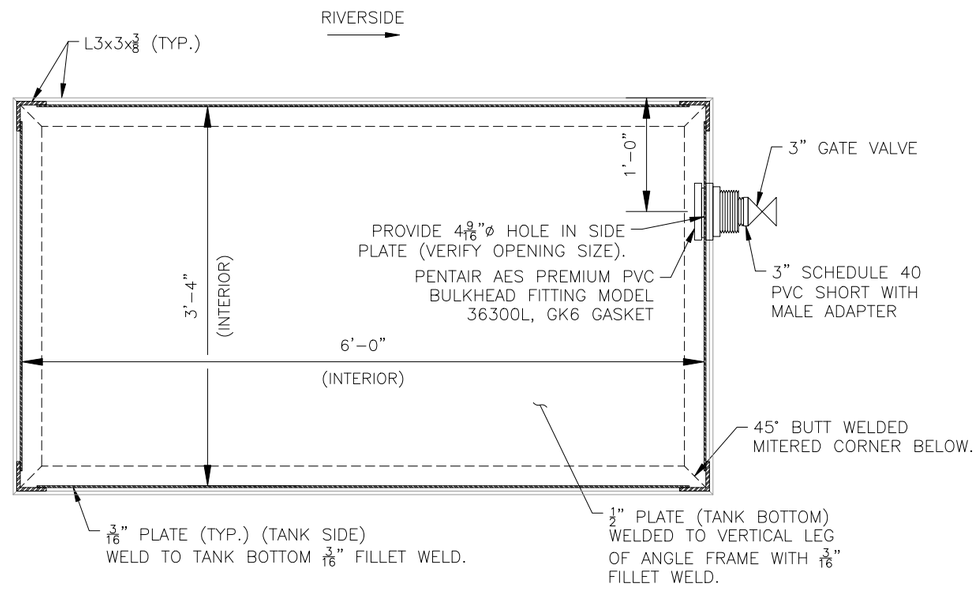
HOLDING TANK SECTIONS AND DETAILS

SCALE: AS NOTED DRAWING NO.: 16

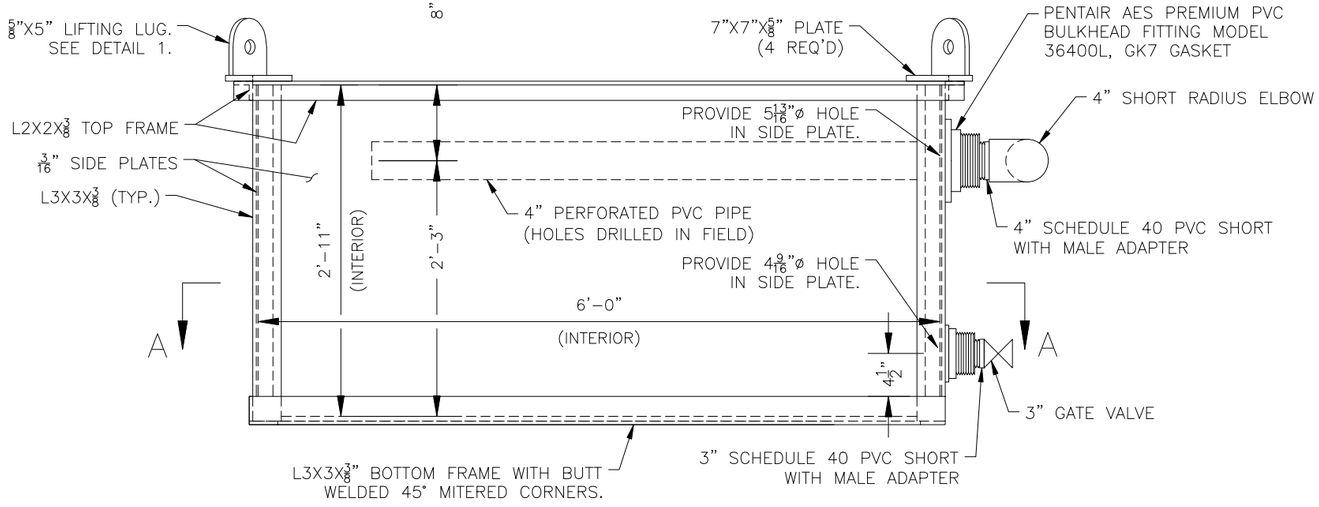
IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LISCENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



1/17 PLAN – TOP OF TANK
1 1/2" = 1'-0"



A/17 PLAN THROUGH TANK
1 1/2" = 1'-0"



2/17 SIDE ELEVATION
1 1/2" = 1'-0"

NOTES:

1. USE STAINLESS STEEL ELECTRODES.
2. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE CONTINUOUS.
3. UNLESS OTHERWISE SPECIFIED, ALL WELDS TO BE 3/16" FILLET WELDS.
4. ALL OVERLAPPING SURFACES TO BE FULLY WELDED WITH 3/16" FILLET WELDS.
5. SUBMIT SHOP DRAWINGS TO ENGINEER FOR APPROVAL.
6. FABRICATION DETAILS SHALL BE SIMILAR TO THOSE SHOWN FOR THE FABRICATION TANK.
7. TANK FABRICATOR SHALL DRILL/CUT HOLES IN TANK SIDES FOR MONITORING EQUIPMENT (TEMPERATURE AND OXYGEN METERS). LOCATIONS AND SIZES TO BE DETERMINED DURING MEETING WITH OWNER'S REPRESENTATIVE AND ENGINEER.
8. LIFTING LUGS ARE DESIGNED TO LIFT TANK ASSUMING TANK IS COMPLETELY DRAINED.
9. FITTINGS ATTACHED TO TANKS TO BE SUPPLIED AND INSTALLED BY TANK MANUFACTURER.

8" 0 8" 16"
SCALE: 1 1/2" = 1'-0"

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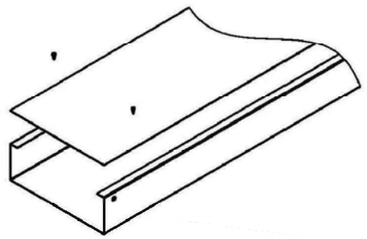
COLLECTION TANK PLAN AND SECTIONS

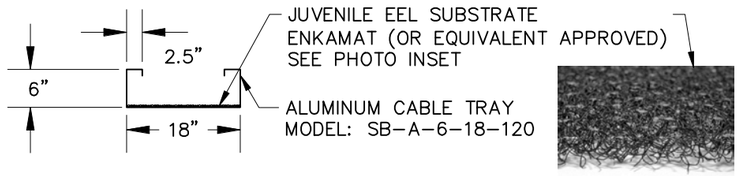
SCALE: AS NOTED DRAWING NO.: 17



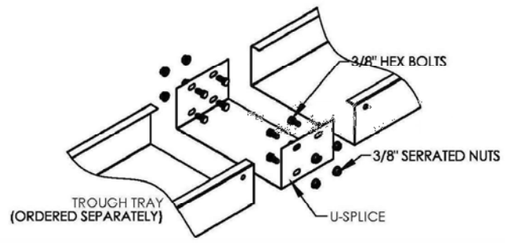
NOTES

1. PROVIDE COVER WITH (10) #8 SELF DRILLING TEK SCREWS FOR MOUNTING. RECOMMENDED ATTACHMENT LOCATIONS: 3/8" FROM EDGES WIDTH WISE AND 1" FROM END LENGTH WISE, FOLLOWED BY 29–1/2" O.C.

1/18 COVER DETAIL
NOT TO SCALE



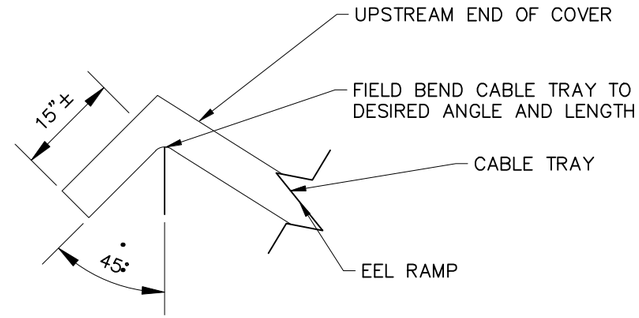
2/18 EEL RAMP ELEVATION
Scale: 1"=1'



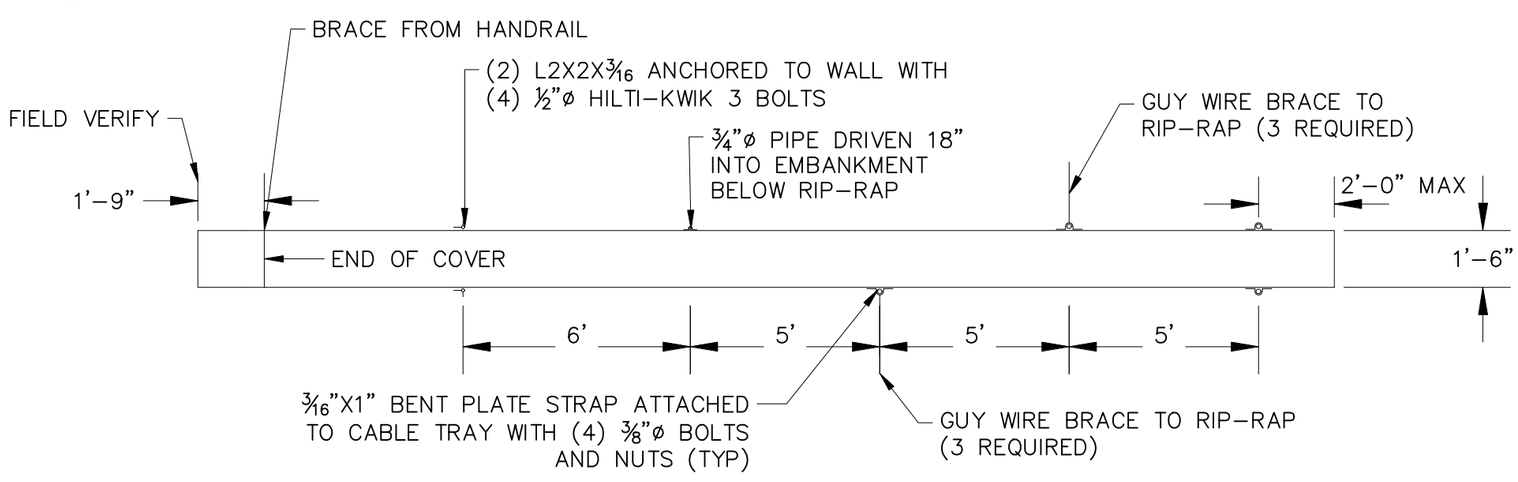
NOTES:

1. USE TO JUNCTION TRAY SECTIONS TOGETHER.
2. FEED PROVIDED 3/8"X3/4" HEX HEAD BOLT THRU TRAY AND U–SPLICE AND ATTACH 3/8" SERRATED NUTS ON OUTSIDE OF U–SPLICE.
3. RECOMMENDED TORQUE: FOR 3/8" FASTENERS: 25–35 FT–LBS.
4. IF DESIRED, ADDITIONAL HOLES MAY BE FIELD DRILLED IN THE BOTTOM OF THE TRAY THRU THE C–SPLICE AND ADDITIONAL HARDWARE (BY OTHERS) ATTACHED.

4/18 U–SPLICE DETAIL
NOT TO SCALE



5/18 BENT SECTION OF EEL RAMP
Scale: 1"=1'



3/18 EEL RAMP PLAN
Scale: 1"=2'

2' 0 2' 4'
SCALE: 1" = 2'–0"

1' 0 1' 2'
SCALE: 1" = 1'–0"

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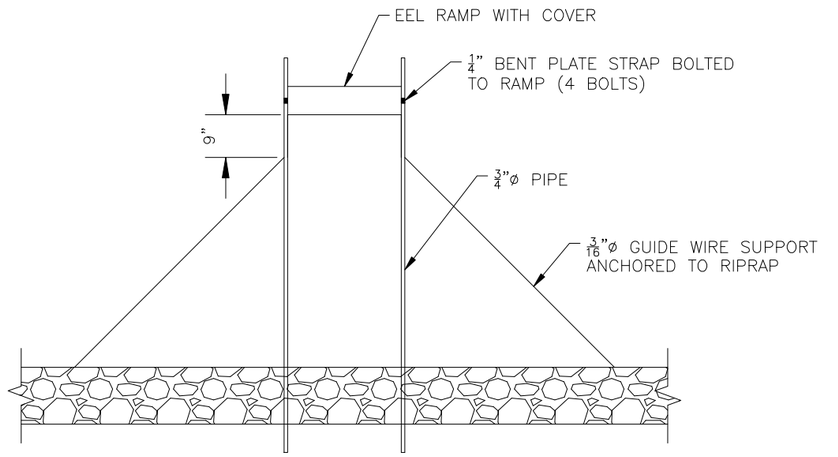
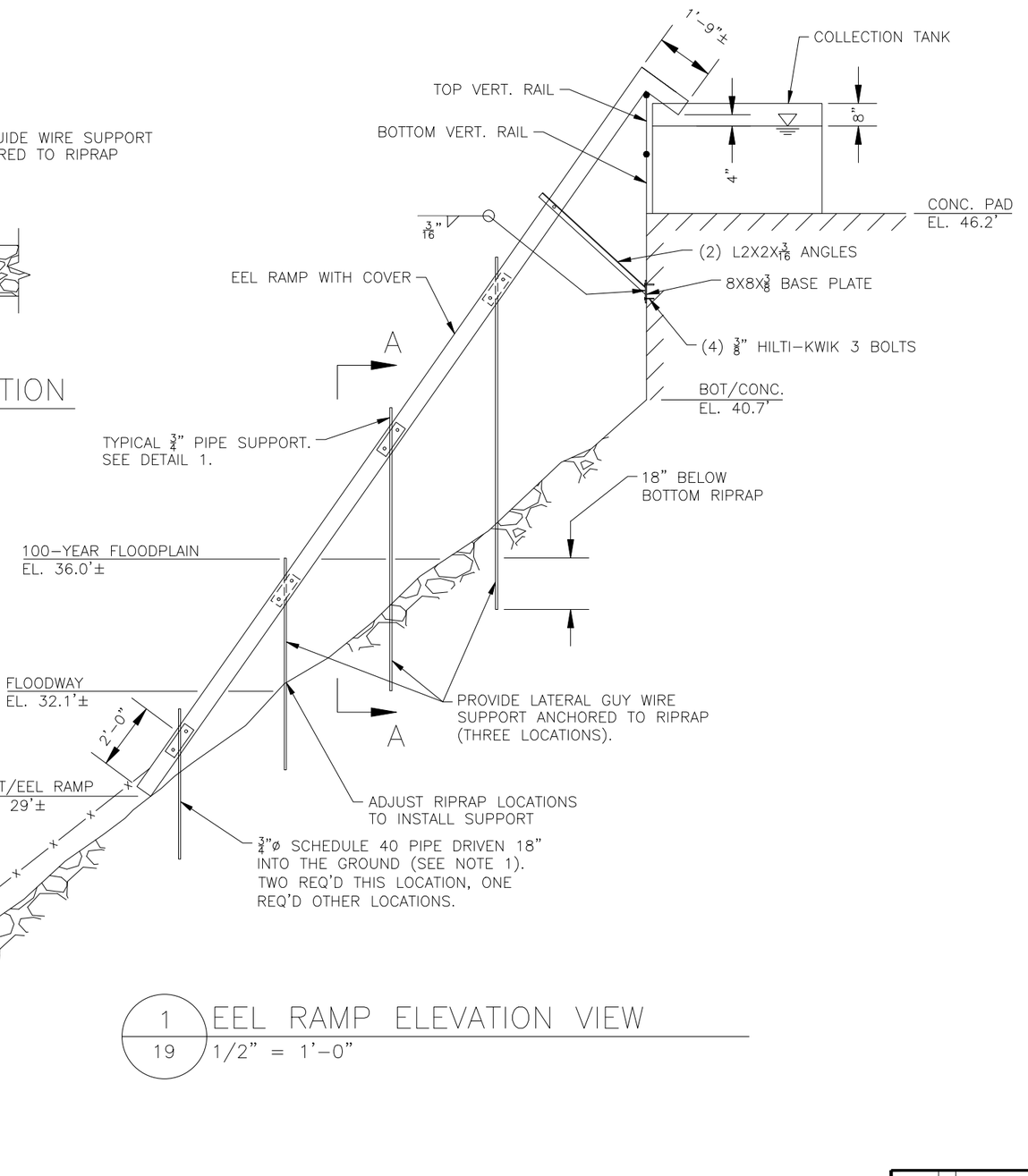
EEL RAMP SECTIONS AND DETAILS

SCALE: AS NOTED DRAWING NO.: 18



A 19 EEL RAMP SUPPORT SECTION
3/4" = 1'–0"



NOTES:

1. IF PIPE SUPPORTS CANNOT BE DRIVEN INTO ROCK, PIPE CAN BE WELDED TO AN L3X3X3/16"x12"LG ANGLE AND ANCHORED TO TOP OF RIPRAP WITH TWO 3/4"ø HILTI–KWIK 3 BOLTS.
2. EEL RAMP NETTING TO BE ENKAMAT 7010 TURF REINFORCEMENT MAT OR EQUAL.

1 19 EEL RAMP ELEVATION VIEW
1/2" = 1'–0"

2' 0 2' 4'
SCALE: 1/2" = 1'–0"

EEL FACILITY EQUIPMENT LIST

QUANTITY	ITEM DESCRIPTION	MANUFACTURER
60 feet	Eel Ramp cable tray	Monosystems
1	200-foot roll of Enkamat 7010 Substrate	
1	Overflow tank	Plastic Mart
150 sq-ft	Lexan for tank covers	
4	Dock Ramp	
8	Dock ramp panels	
	TANK DRAINAGE	
4	PVC socketed valve pipe flange	
6	6" X 4" Reducer Coupling	Pentair Ecosystems
30 feet	4" Schedule 40 PVC pipe	Pentair Ecosystems
6	4" Schedule 40 PVC short radius elbow	Pentair Ecosystems
6	4" diameter aluminum quick disconnect fitting	Pentair Ecosystems
6	4" schedule 40 PVC short with male adapter	Pentair Ecosystems
2	3" PVC Bulkhead fitting	Pentair Ecosystems
2	3" PVC gate valve	Pentair Ecosystems
60 feet	4-inch Schedule 40 PVC Pipe	Pentair Ecosystems
10 feet	1-inch Schedule 40 PVC Pipe	Pentair Ecosystems
300 feet	4" Suction Discharge Hose (Model SH8)	Pentair Ecosystems
	OXYGEN/AIR DIFFUSER PIPING	
3	linear piston air pump (SL44B)	Pentair Ecosystems
200 feet	3/4" Vinyl clear tubing for air lines	Pentair Ecosystems
200 feet	1/4" vinyl clear tubing for air lines	Pentair Ecosystems
250 feet	1/4" thick walled rubber tubing for O2	Pentair Ecosystems
50	3/4" polyethylene tubing for airlines	Pentair Ecosystems
200	3/4" hose clamps	Pentair Ecosystems
100	1/4" hose clamps	Pentair Ecosystems
4	O2 bottle regulators	Pentair Ecosystems
4	Reducer from 3/4" to 1/4", prior to splitter	Pentair Ecosystems
3	three way splitters for air lines (needle valves)	Pentair Ecosystems
3	O2 flow meter manifold	Pentair Ecosystems
2	Pump blower boxes with louvers	Pentair Ecosystems
12	Fine pore diffusers (AS300)	Pentair Ecosystems
	SPRAY BAR AND OVERFLOW PIPE	
10 feet	1" PVC solid wall pipe (spray bar)	Pentair Ecosystems
10	1" PVC cap, adapter, ball valve	Pentair Ecosystems
5	3" PVC bulkhead fitting for overflow tank drains	Pentair Ecosystems
	SHADING/EEL PROTECTION	
2	12' X 10' shade cloth (SC70) for eel protection	Pentair Ecosystems
1,250 sq-ft	60% black UV shade cloth over eel facilty	GreenhouseMegastore
	MONITORING EQUIPMENT	
2	3" flow meter	PDIR
6	2" flow meter	PDIR
5	Temperature/DO sensor	PDIR
1	cellular modem	PDIR
2	controller	PDIR
	ADDITIONAL SUPPLIES FOR EEL PROCESSING	
2	Fish measuring board (FMB2)	Pentair Ecosystems
1	Dissecting microscope	Pentair Ecosystems
2	Dissection kit	Pentair Ecosystems
	Digital scale	Pentair Ecosystems
	zip ties	
100	spat bags	Pentair Ecosystems
	Nets of various sizes, small to large	Pentair Ecosystems
2	1,000 ml graduated container	Pentair Ecosystems
2	2,000 ml graduated container	Pentair Ecosystems
5	brushes, bottle, hose, pipe, long handle	Pentair Ecosystems

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EEL RAMP ELEVATION AND PIPE SUPPORT DETAILS

SCALE: AS NOTED DRAWING NO.: 19

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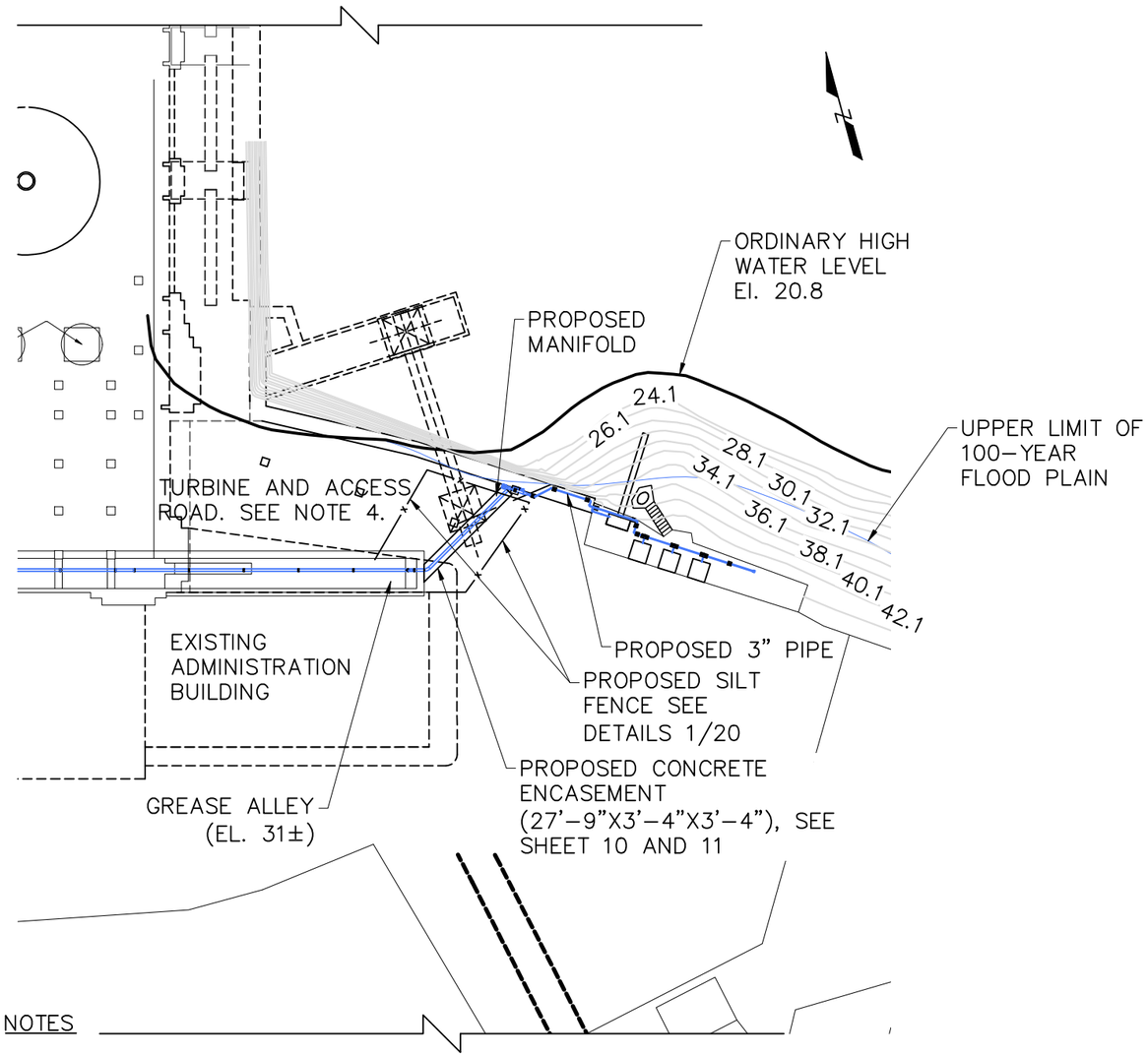
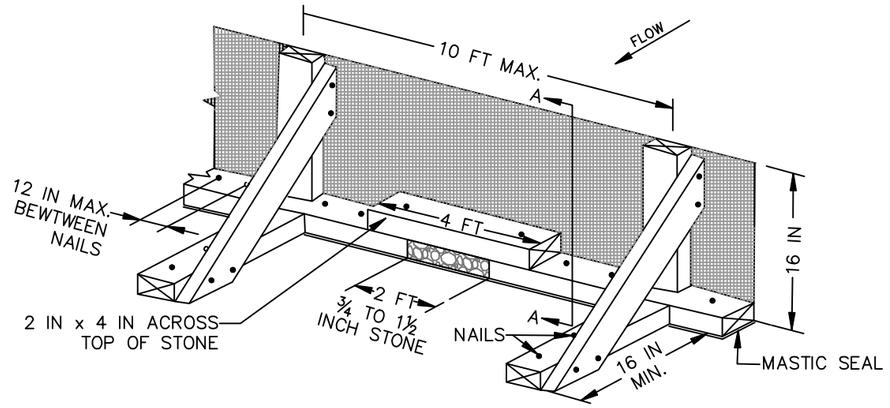


NOTES

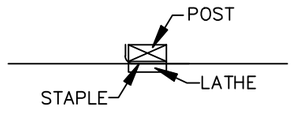
1. ELEVATIONS SHOWN ARE CONOWINGO DAM DATUM (0.7 FEET LOWER THAN NGVD 29 AND 0.14 FEET HIGHER THAN NAVD 88)
2. MAXIMUM SUPPORT SPACING SHALL BE 18 FEET FOR 8" PIPE AND 12 FEET FOR 3" PIPE. WHERE POSSIBLE THERE SHALL BE A SUPPORT AT EACH END OF AN ELBOW/BEND. ALL VERTICAL SUPPORTS SHALL BE SADDLE-SHAPED AND SHALL HAVE A MINIMUM CAPACITY OF 1500 LB. SEE SHEET 12 FOR TYPICAL SUPPORT DETAILS.
3. CONTRACTOR SHALL REMOVE EXISTING 3" PIPE THAT EXISTS ALONG THE ALIGNMENT OF THE PROPOSED 8" PIPE. AVOID OR MOVE OTHER PIPES UPON EXELON'S APPROVAL.
4. LOCATE AND PROTECT EXISTING BURIED DRAINS BENEATH TURBINE ACCESS ROAD (SEE EXISTING P.E. CO. DRAWING H-80531). RAILROAD TIES AND TRACKS MAY ALSO BE BURIED UNDER TURBINE ACCESS ROAD. IF ENCOUNTERED, AND PENDING SHPO CONSULTATION, THE RAILS AND TIES SHALL BE PRESERVED IN PLACE.

20' 0 20' 40'

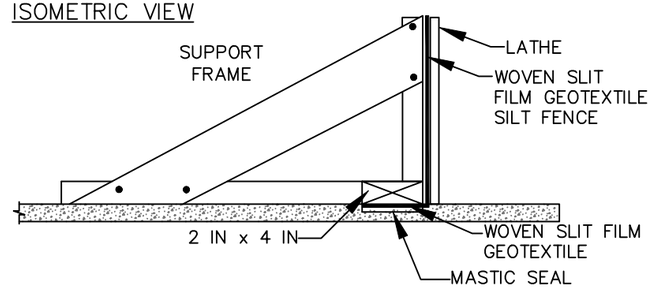
SCALE: 1" = 20'-0"



ISOMETRIC VIEW



JOINING ADJACENT SECTIONS OF GEOTEXTILE



SECTION A-A

1/20 SILT FENCE
Scale: 1"=1'

CONSTRUCTION SPECIFICATIONS

1. USE NOMINAL 2 INCH X 4 INCH LUMBER.
2. USE WOVEN SLIT FILM GEOTEXTILE, AS SPECIFIED IN SECTION H-1 MATERIALS.
3. PROVIDE MANUFACTURER CERTIFICATION TO THE AUTHORIZED REPRESENTATIVE OF THE INSPECTION/ENFORCEMENT AUTHORITY SHOWING THAT THE GEOTEXTILE USED MEETS THE REQUIREMENTS IN SECTION H-1 MATERIALS.
4. SPACE UPRIGHT SUPPORTS NO MORE THAN 10 FEET APART.
5. PROVIDE A TWO FOOT OPENING BETWEEN EVERY SET OF SUPPORTS AND PLACE STONE IN THE OPENING OVER GEOTEXTILE.
6. KEEP SILT FENCE TAUT AND SECURELY STAPLE TO THE UPSLOPE SIDE OF UPRIGHT SUPPORTS. EXTEND GEOTEXTILE UNDER 2x4.
7. WHERE TWO SECTIONS OF GEOTEXTILE ADJOIN: OVERLAP, FOLD, AND STAPLE TO POST IN ACCORDANCE WITH THIS DETAIL. ATTACH LATHE.
8. PROVIDE A MASTIC SEAL BETWEEN PAVEMENT, GEOTEXTILE, AND 2x4 TO PREVENT SEDIMENT-LADEN WATER FROM ESCAPING BENEATH SILT FENCE INSTALLATION.
9. SECURE BOARDS TO PAVEMENT WITH 40D 5 INCH MINIMUM LENGTH NAILS.
10. REMOVE ACCUMULATED SEDIMENT AND DEBRIS WHEN BULGES DEVELOP IN SILT FENCE OR WHEN SEDIMENT REACHES 25% OF FENCE HEIGHT. REPLACE GEOTEXTILE IF TORN. MAINTAIN WATER TIGHT SEAL ALONG BOTTOM. REPLACE STONE IF DISPLACED.

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SITE AND SEDIMENT AND EROSION CONTROL PLAN AND DETAILS

SCALE: AS NOTED DRAWING NO.: 20

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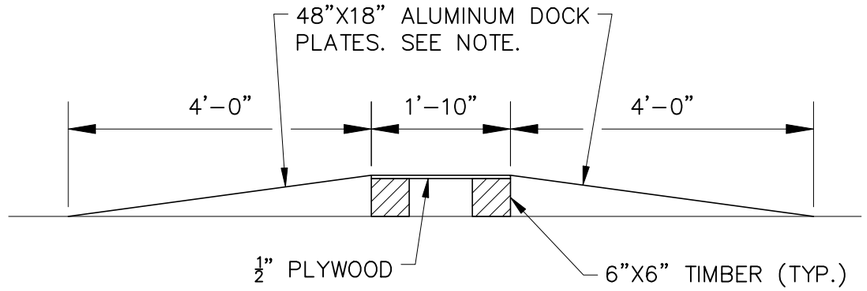
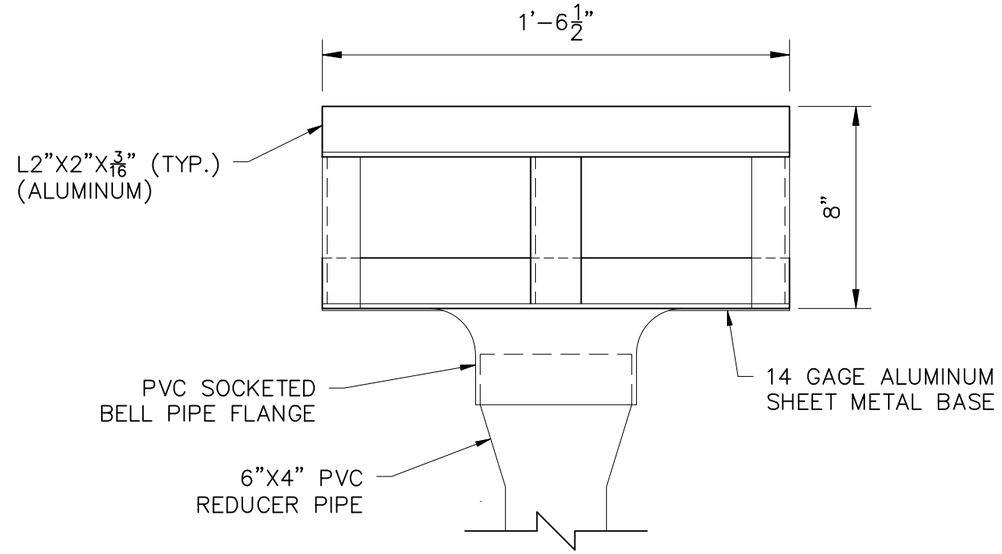


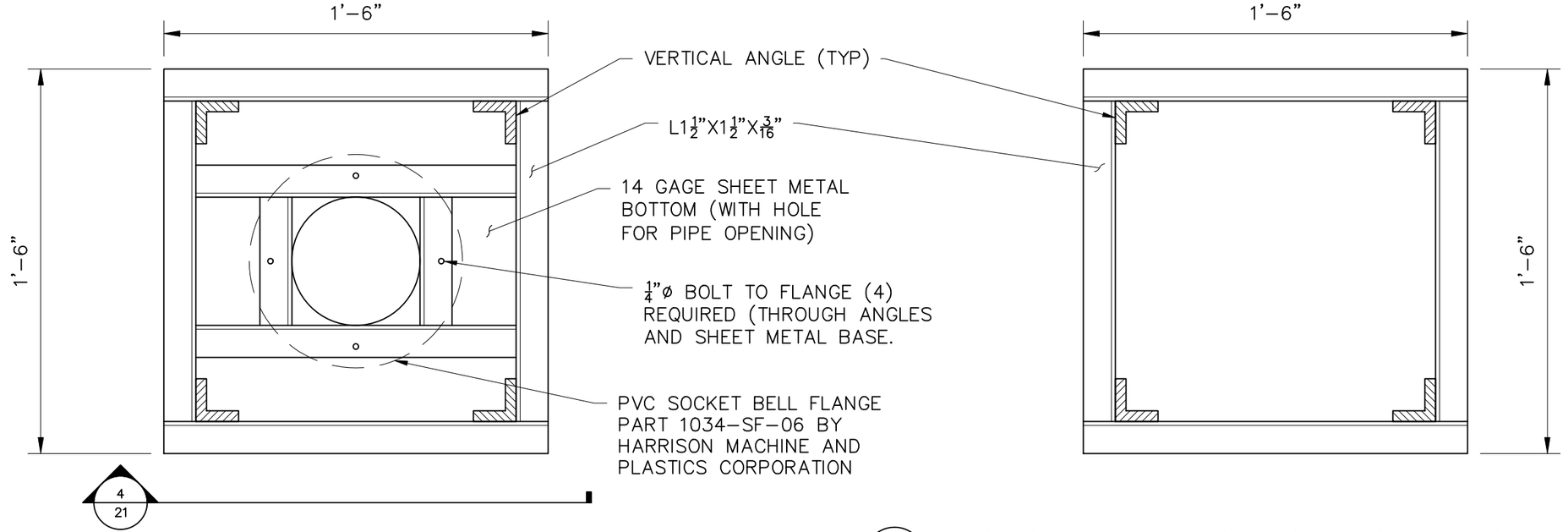
NOTE: PROVIDE 48"X18"X7" ALUMINUM HAND TRUCK DOCK PLATE RATED 500 LBS BY GLOBAL INDUSTRIES OR OR EQUAL. ANCHOR TO 6X6 TIMBERS WITH (4) ¼"ø ROUND HEADED LAG SCREEN. (PROVIDE 4 RAMPS – 8 PANELS.)

1 / 21 DETAIL
Scale: 1" = 1 '– 0"

1' 0 1' 2'
SCALE: 1" = 1'–0"



4 / 21 HOLDING TANK FILTER ELEVATION VIEW
Scale: 4" = 1 '– 0"



2 / 21 HOLDING TANK FILTER LOWER FRAMING PLAN
Scale: 4" = 1 '– 0"

3 / 21 HOLDING TANK FILTER UPPER FRAMING PLAN
Scale: 4" = 1 '– 0"

NOTES:
1. 1MM FILTER SCREEN TO BE WRAPPED AROUND AND FASTENED TO THE FILTER FRAME.
2. DO NOT LIFT OR PRY FRAME FROM EXTERIOR EDGES. LIFT FROM SOCKETED BELL PIPE FLANGE.
3. PROVIDE (4) FRAME STRUCTURES.

3' 0 3' 6'
SCALE: 4" = 1'–0"

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MISCELLANEOUS DETAILS

SCALE: AS NOTED DRAWING NO.: 21

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APPENDIX B. OCTORARO CREEK EEL COLLECTION FACILITY DRAWINGS

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LANCASTER COUNTY

APPROX. MUNICIPAL BOUNDARY LINE

LOWER OXFORD TWP.
CHESTER COUNTY

OCTORARO CREEK

Existing Dam

EXIST. 1 HP SUBMERSIBLE PUMP CONTAINED WITHIN 1MM MESH SCREENED BARREL

EDGE OF WATER

APPROX. ORDINARY HIGH WATER MARK

Stone Steps

Top Steps
Elev.=253.99

100-YEAR FLOOD PLAIN (ZONE A)

Existing 1 ½ Story Stone Art Building

Wood Ramp

Shed

APPROX. QUIESCENT POOL

APPROX. SHORELINE EL. 237.0
(SURVEYED MAY 2019)

EXIST. FENCE

ELECTRICAL PANEL

FIRST FLOOR EL. 254.55±

Steps

Survey Control Point
Traverse Nail
Elev.=264.17

EXISTING EEL RAMP (SEE R1)

17'-6"

3'-4"

17'-2"

5'-7"

1'-4"

1'-10"

1'-5"

2"

1'-3"

5'

(2) VERTICAL 45° BENDS

Conc. Pad With Art Piece

45° BEND

EXIST. 6" PVC

EXIST. BURIED 2" WATER LINE WITH ADJACENT 2" CONDUIT FOR ELECTRIC (INSIDE PVC PIPING)

SEE BENCHMARK NOTES

APPROX. ORDINARY HIGH WATER MARK EL. 238.5

Exist. Eroded Area

Sign
Danger
Dam

EXIST. 8" PVC (TO BE REROUTED TO PROPOSED LOCATION)

SCAFFOLDING STRUCTURE

Guy Wire

Underground Electric

EXIST. UTILITY POLES

EXIST. EEL COLLECTION TANK
(APPROX. 85 GALLONS) SEE R1

SCAFFOLDING STRUCTURE

BURIED TAILRACE CENTERLINE

15' BURIED TAILRACE BUFFER

EXIST. GRAVEL DRIVE

OH

UE

240

245

250

255

260

265

NOTES:
1. THE DIMENSIONS NOTED ARE AS MEASURED IN THE FIELD.

BENCHMARK NOTES:
SOUTHEAST CORNER OF CONCRETE PAD
ELEV. = 252.64 FT
NORTHING = 172329.0 FT
EASTING = 2447865.2 FT
VERTICAL DATUM: NAVD88
HORIZONTAL DATUM: NAD83
PA SOUTH ZONE

LEGEND

- MINOR CONTOUR
- MAJOR CONTOUR
- EDGE OF WATER
- ORDINARY HIGH WATER MARK
- FEMA 100-YEAR FLOODPLAIN
- OH — OVERHEAD ELECTRIC LINE
- UE — UNDERGROUND ELECTRIC LINE
- x — FENCE
- SURVEY CONTROL POINT
- UTILITY POLE
- BENCHMARK

5' 0 5' 10'
SCALE: 1" = 5'

ISSUE	DESCRIPTION	BY	APP

DRAWN BY: JSC
CHECKED BY: HNN
APPROVED BY:
PROJECT NO. 1714 DATE: 4/6/2021

OCTORARO CREEK EEL COLLECTION FACILITY

TEMPORARY FACILITY PLAN

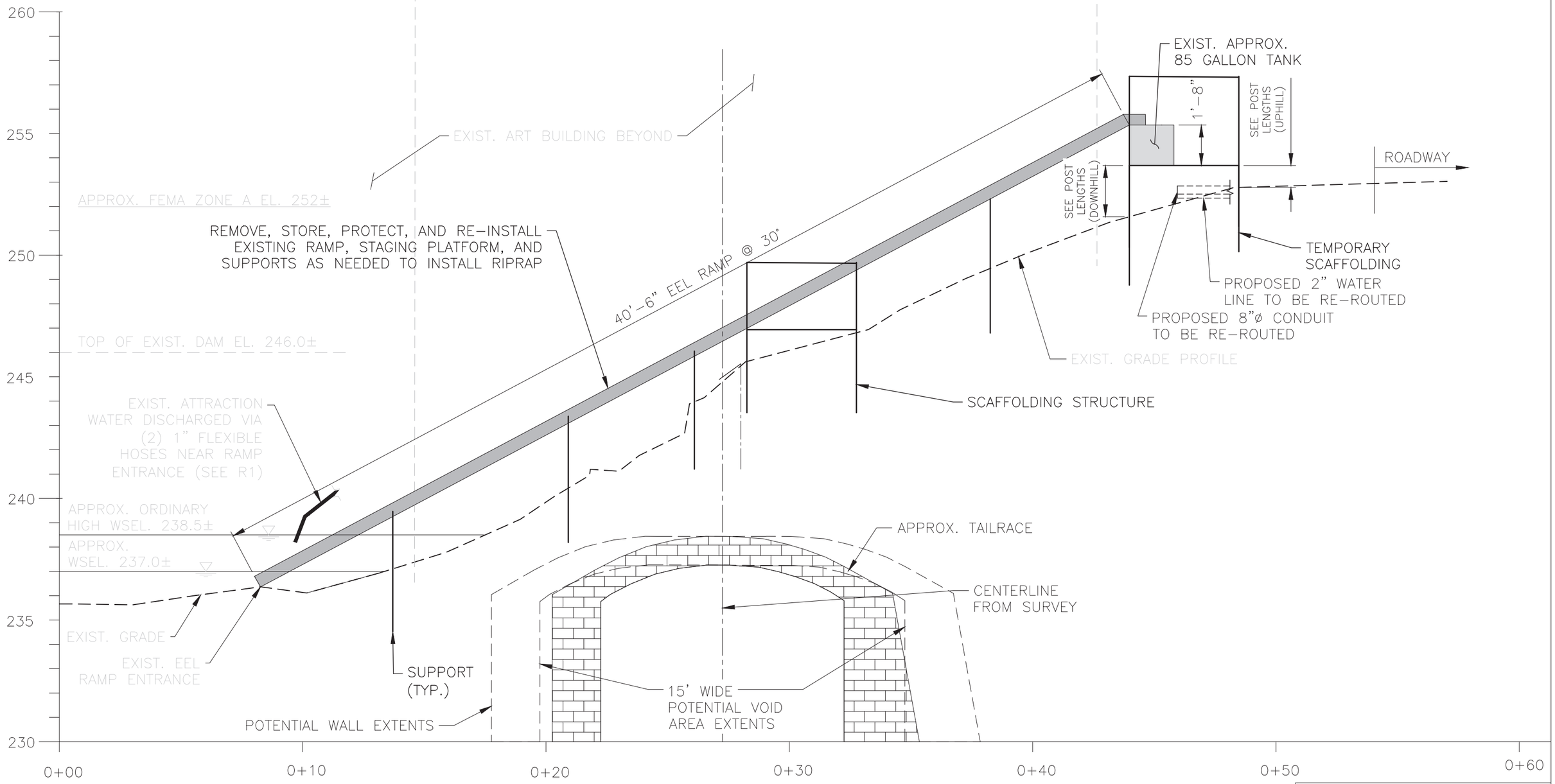
Exelon Generation Company, LLC
300 Exelon Way
Kennett Square, PA 19348

Gomez and Sullivan Engineers, D.P.C.
288 Genesee Street
Utica, NY 13502

SCALE: 1" = 5' (34"x22")

DRAWING: OCTORARO

IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.



1/2 PROFILE
Scale: 1" = 2'-0"

NOTES:
1. THE DIMENSIONS NOTED ARE AS MEASURED IN THE FIELD.

SCAFFOLDING POST LENGTHS:
1. UPSTREAM DOWNHILL = 1'-4"
2. DOWNSTREAM DOWNHILL = 3'-6"
3. UPSTREAM UPHILL = 2'-3"
4. DOWNSTREAM UPHILL = 11"

2' 0 2' 4'
SCALE: 1" = 2'

OCTORARO CREEK EEL COLLECTION FACILITY

TEMPORARY FACILITY PROPOSED PROFILE

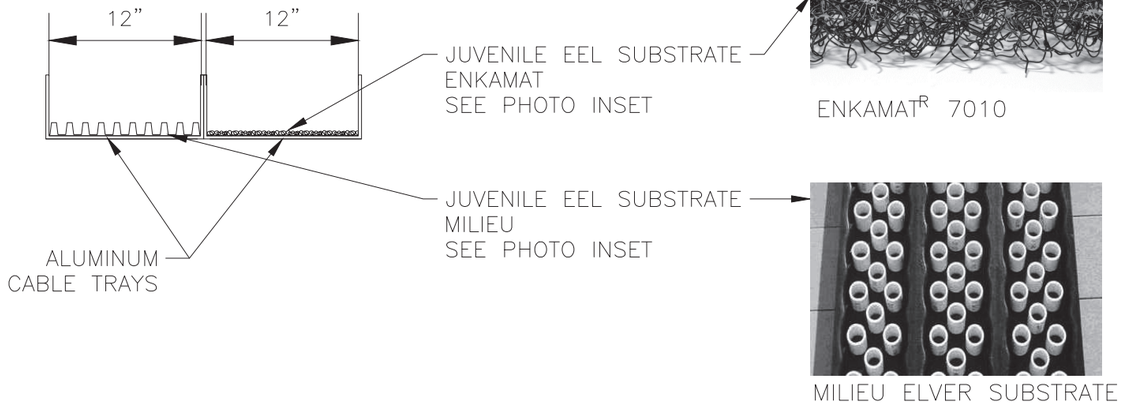
ISSUE	DESCRIPTION	BY	APP

DRAWN BY: JSC
CHECKED BY: HNN
APPROVED BY:
PROJECT NO. 1714 DATE: 4/6/2021

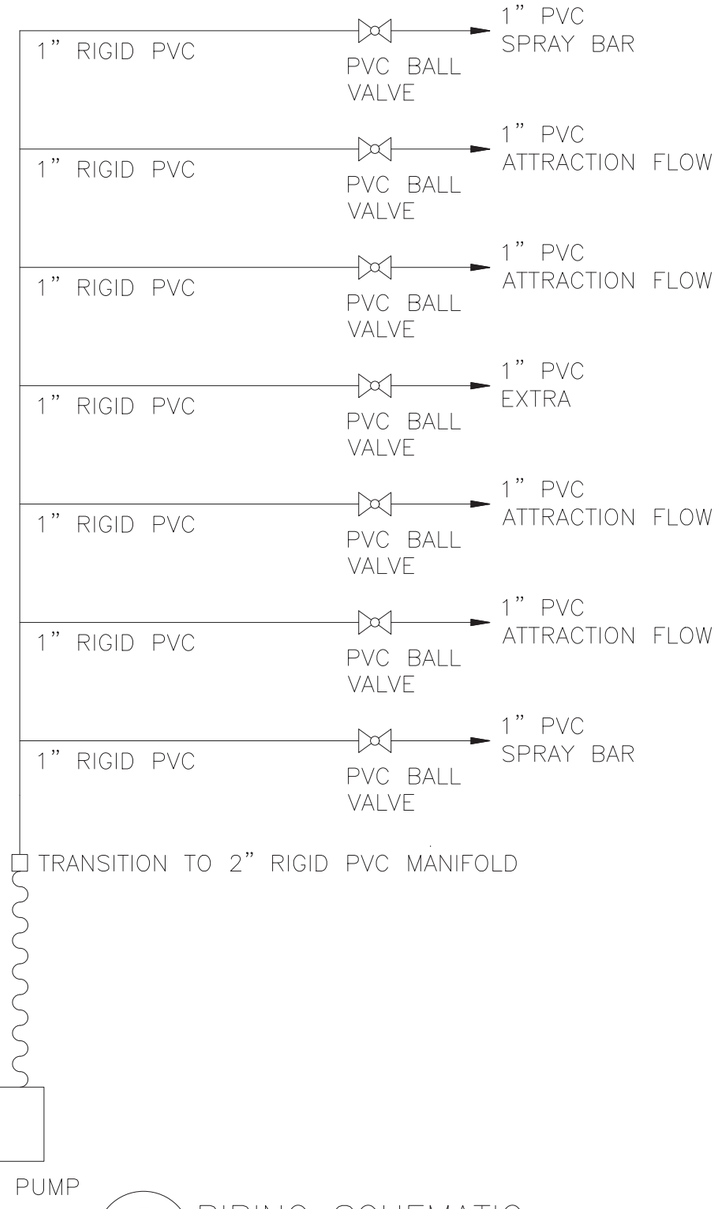
Exelon Generation Company, LLC
300 Exelon Way
Kennett Square, PA 19348

Gomez and Sullivan Engineers, D.P.C.
288 Genesee Street
Utica, NY 13502

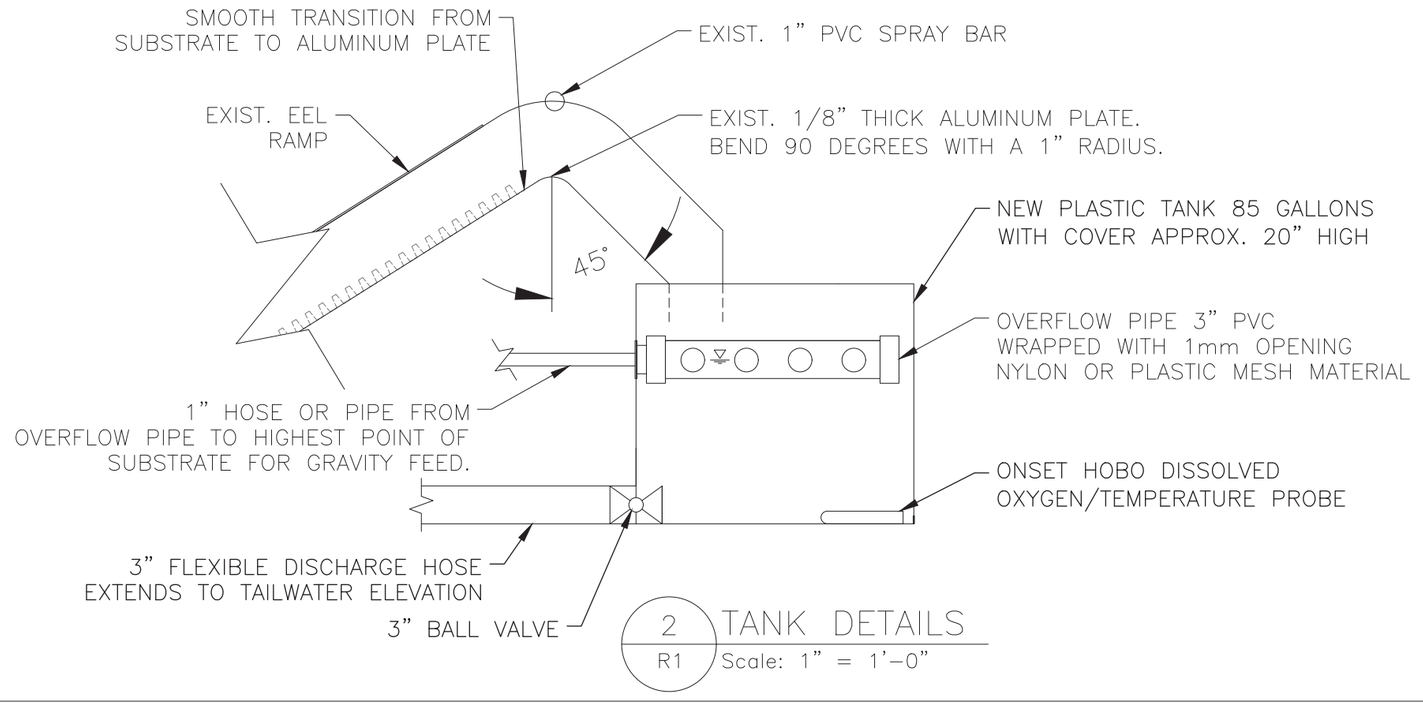
SCALE: 1" = 2' (34"x22")
DRAWING: OCTORARO 2 OF 2



1 / R1 EEL RAMP SECTION (TYPICAL)
Scale: 1" = 1'-0"



3 / R1 PIPING SCHEMATIC
Scale: NTS



2 / R1 TANK DETAILS
Scale: 1" = 1'-0"

2' 0 1' 2'
SCALE: 1" = 1'

OCTORARO CREEK EEL COLLECTION FACILITY

TYPICAL EEL LADDER SECTION AND DETAILS (DONE BY OTHERS)

ISSUE	DESCRIPTION	BY	APP

DRAWN BY: JSC
CHECKED BY: HNN
APPROVED BY:
PROJECT NO. 1714 DATE: 4/6/2021

Exelon Generation Company, LLC
300 Exelon Way
Kennett Square, PA 19348

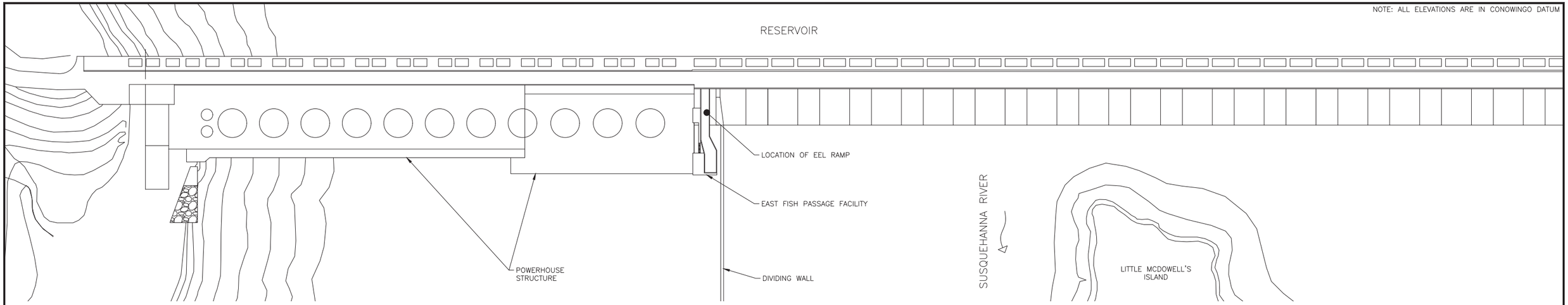
Gomez and Sullivan Engineers, D.P.C.
288 Genesee Street
Utica, NY 13502

SCALE: AS SHOWN (34"X22") DRAWING: OCTORARO R1

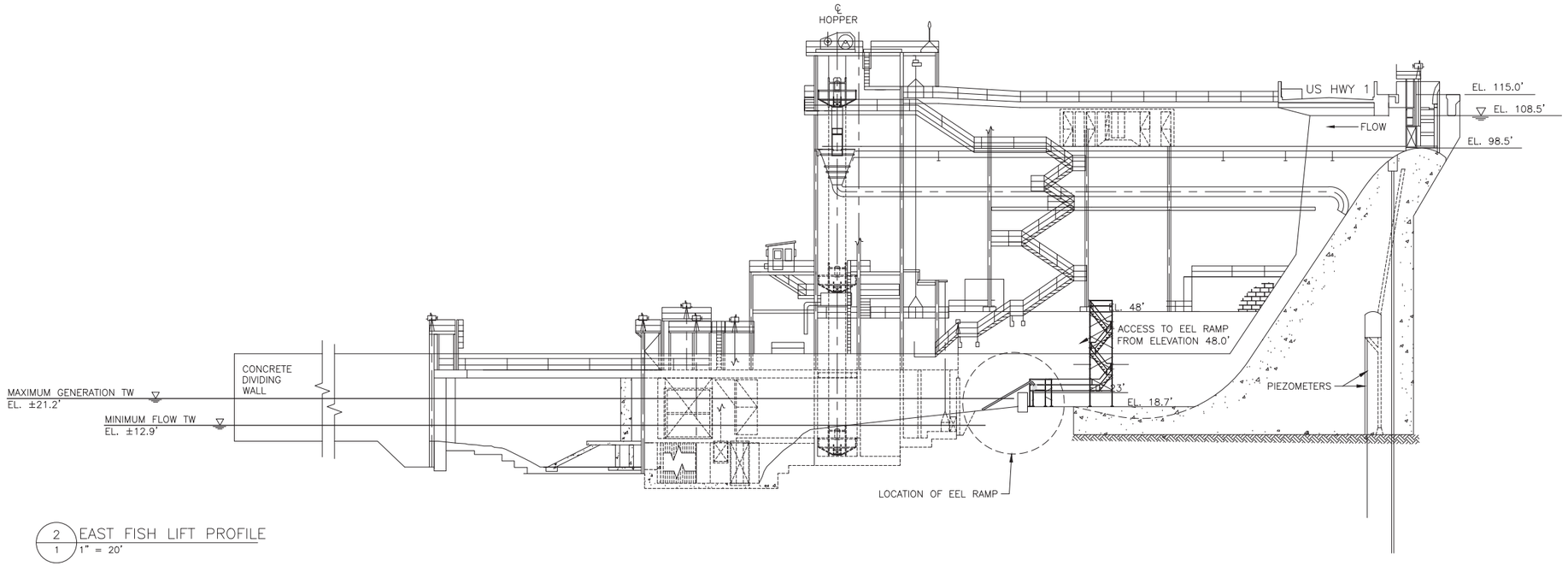
IT IS A VIOLATION OF THE LAW FOR ANY PERSON TO ALTER THIS DRAWING IN ANYWAY UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. ALTERATIONS MUST HAVE THE ENGINEER'S SEAL AFFIXED ALONG WITH A DESCRIPTION OF THE ALTERATION, THE SIGNATURE AND DATE.

APPENDIX C. CONOWINGO EAST EEL COLLECTION FACILITY DRAWINGS

NOTE: ALL ELEVATIONS ARE IN CONOWINGO DATUM



1/1 CONOWINGO DAM PLAN
1" = 1000'



2/1 EAST FISH LIFT PROFILE
1" = 20'

PRELIMINARY DRAWINGS
TO BE REVISED PENDING FINALIZATION OF EAST FISH LIFT MODIFICATIONS FOOTPRINT

NO.	DATE	DESCRIPTION	BY	APP
1	5/22/20	CONCEPTUAL CONOWINGO EFL EEL FACILITIES	BAS	-

FOR: Exelon, EXELON GENERATION COMPANY, LLC
BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY:	BAS
DRAWN BY:	BAS
CHECKED BY:	HNN
APPROVED BY:	-
PROJECT NO.:	2132
DATE:	4/15/2021

CONOWINGO EAST EEL COLLECTION FACILITY

PROPOSED EEL RAMP LOCATION AND PROFILE

SCALE: AS NOTED

DRAWING NO.: 1

NOTE: ALL ELEVATIONS ARE IN CONOWINGO DATUM

EXISTING STATION WATER GRAVITY FEED MANIFOLD

2" CAM LOCK FITTING AND VALVE ON EXISTING MANIFOLD FOR CONNECTION TO 2" FLEX SUPPLY HOSE. PROVIDE SIZE ADAPTER IF NECESSARY.

2" FLEX SUPPLY HOSE

SEE DETAIL 2/C3 FOR TYPICAL GUY WIRE ANCHOR

EXISTING HOPPER

CROWDER AREA GATE

LANDING AT ELEV. 48.0'

ADD'L 5 FT. X 7 FT. SCAFFOLD W/ LEVELING JACKS.

CROWDER

UP

6"

3'

45°

45°

GUY WIRES TYP.

13'-6"

3'

ACCESS PLATFORM TO EEL FACILITY W/ OSHA COMPLIANT HANDRAILS

OSHA COMPLIANT MODULAR 5 FT X 7 FT. SCAFFOLDING TOWER WITH STAIRS AND LEVELING JACKS. METALTECH OR APPROVED EQUAL.

TOE OF SPILLWAY

NEW EEL RAMP WATER GRAVITY FEED MANIFOLD

EEL RAMP

4'

TOE OF BUCKET (BELOW)

TRASH RACK B

NOTE: SEAL SPILLWAY GATES DURING EEL PASSAGE SEASON TO PREVENT LEAKAGE INTO STILLING BASIN.

1/2 ACCESS PLAN
1/4" = 1'-0"

4' 0 4' 8'
SCALE:1/4"=1'-0"

EL. 58.8'

REMOVE EXISTING HANDRAILS AS NEEDED FOR ACCESS

7'-0"

3'-6"

EL. 48.0'

EL. 46.0'

8'-2"

OSHA COMPLIANT MODULAR 5 FT X 7 FT. SCAFFOLDING TOWER WITH STAIRS AND LEVELING JACKS. METALTECH OR APPROVED EQUAL.

D-PLATE WALL ANCHORS FOR TIE-OFF TYP. SEE 2/C3 FOR DETAILS

8'-2"

2/C3

GUY WIRES TYP.

OSHA COMPLIANT HANDRAIL FOR TEMPORARY STAGING PLATFORM

ADD'L 5 FT. X 7 FT. SCAFFOLD W/ LEVELING JACKS.

8'

MIN 13'

ACCESS PLATFORM TO EEL FACILITY

6"

EL. 23.0'

5'-0"

1/C3

EL. 18.7'

EL. 35.0'

2/2 ACCESS PROFILE
1/4" = 1'-0"

PRELIMINARY DRAWINGS
TO BE REVISED PENDING FINALIZATION OF EAST FISH LIFT MODIFICATIONS FOOTPRINT

NO.	DATE	DESCRIPTION	BY	APP
1	5/22/20	CONCEPTUAL CONOWINGO EFL EEL FACILITIES	BAS	-

FOR: Exelon
EXELON GENERATION COMPANY, LLC

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY:	BAS
DRAWN BY:	BAS
CHECKED BY:	HNN
APPROVED BY:	-
PROJECT NO.:	2132
DATE:	4/15/2021

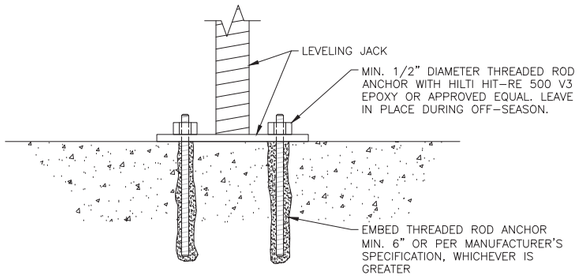
CONOWINGO EAST EEL COLLECTION FACILITY

PROPOSED EEL RAMP ACCESS

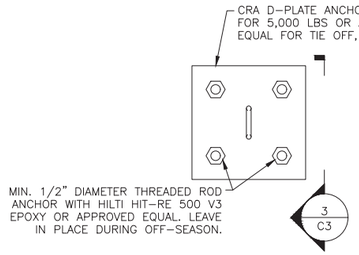
SCALE: 1/4" = 1'-0"

DRAWING NO.: 2

NOTE: ALL ELEVATIONS ARE IN CONOWINGO DATUM

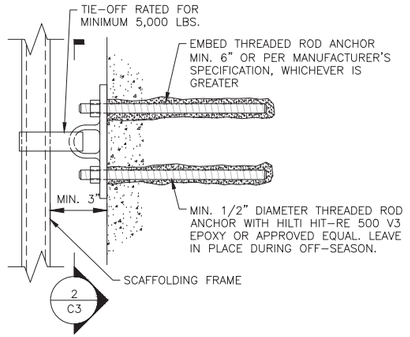


1 / C3 LEVELING JACK ANCHORS
NOT TO SCALE

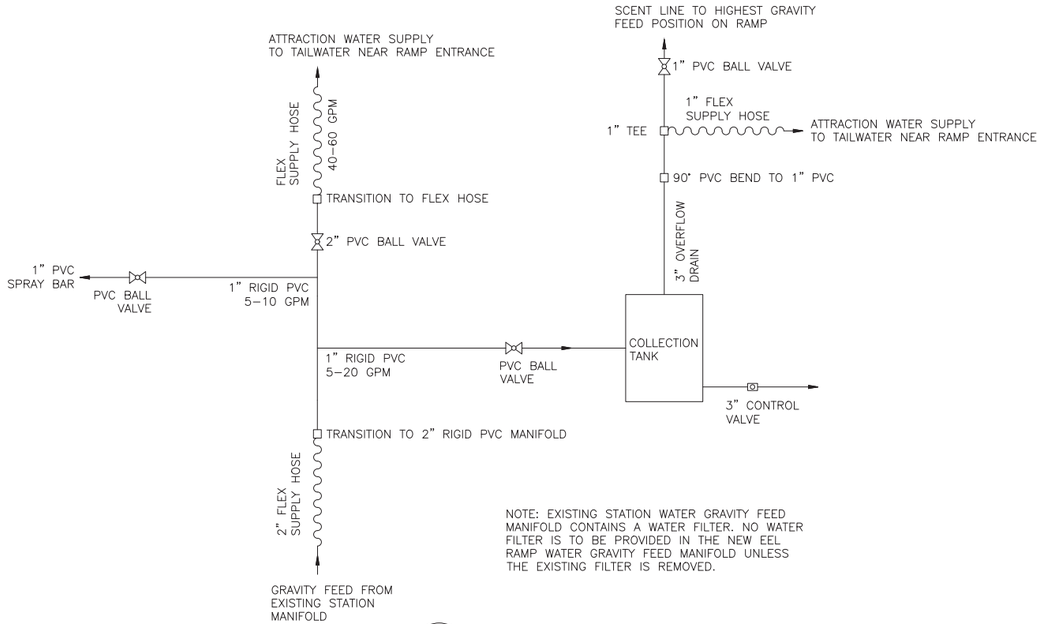


2 / C3 D–PLATE ANCHOR ELEVATION
NOT TO SCALE

NOTE: PROVIDE SIMILAR ANCHOR POINT FOR GUY WIRES



2 / C3 D–PLATE ANCHOR SECTION
NOT TO SCALE



4 / C3 PIPING SCHEMATIC
NO SCALE

PRELIMINARY DRAWINGS
TO BE REVISED PENDING FINALIZATION OF EAST FISH LIFT MODIFICATIONS FOOTPRINT

NO.	DATE	DESCRIPTION	BY	APP
1	5/22/20	CONCEPTUAL CONOWINGO EFL EEL FACILITIES	BAS	-

FOR: Exelon, EXELON GENERATION COMPANY, LLC

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY:	BAS
DRAWN BY:	BAS
CHECKED BY:	HNN
APPROVED BY:	-
PROJECT NO.:	2132
DATE:	4/15/2021

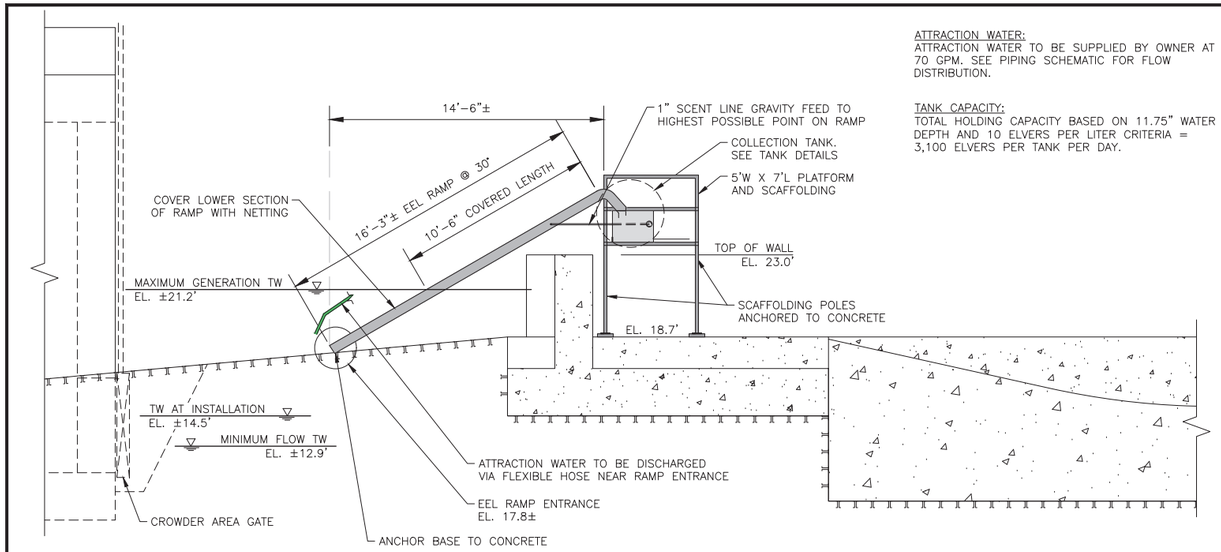
CONOWINGO EAST EEL COLLECTION FACILITY

ANCHORING AND PIPING DETAILS

SCALE: AS NOTED

DRAWING NO.: 3

NOTE: ALL ELEVATIONS ARE IN CONOWINGO DATUM

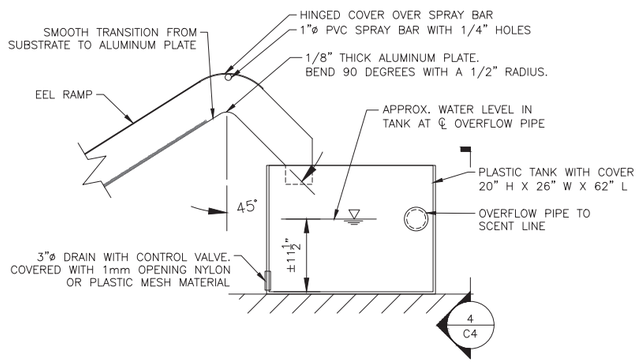


1 / C4 EEL RAMP PROFILE
1/4" = 1'-0"

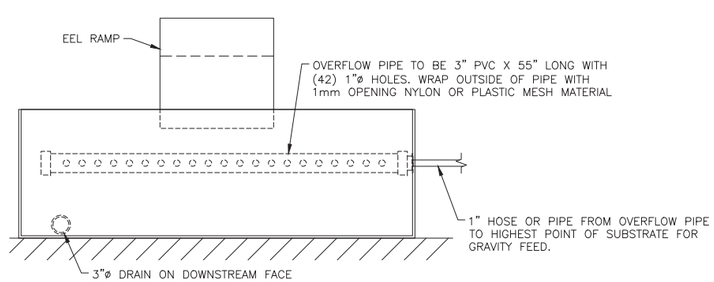
ATTRACTION WATER:
ATTRACTION WATER TO BE SUPPLIED BY OWNER AT 70 GPM. SEE PIPING SCHEMATIC FOR FLOW DISTRIBUTION.

TANK CAPACITY:
TOTAL HOLDING CAPACITY BASED ON 11.75" WATER DEPTH AND 10 ELVERS PER LITER CRITERIA = 3,100 ELVERS PER TANK PER DAY.

2 / C4 EEL RAMP SECTION
1"=1'-0"



3 / C4 COLLECTION TANK DETAILS
1" = 1'-0"



4 / C4 COLLECTION TANK SECTION
1" = 1'-0"

PRELIMINARY DRAWINGS
TO BE REVISED PENDING FINALIZATION OF EAST FISH LIFT MODIFICATIONS FOOTPRINT

NO.	DATE	DESCRIPTION	BY	APP
1	5/22/20	CONCEPTUAL CONOWINGO EFL EEL FACILITIES	BAS	-

FOR: EXELON GENERATION COMPANY, LLC
BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Honniker, NH
www.gomezandsullivan.com

DESIGNED BY:	BAS
DRAWN BY:	BAS
CHECKED BY:	HNN
APPROVED BY:	-
PROJECT NO.:	2132
DATE:	4/15/2021

CONOWINGO EAST EEL COLLECTION FACILITY

EEL RAMP DETAILS

SCALE: AS NOTED

DRAWING NO.: 4

APPENDIX D. ANNOTATED CONOWINGO EAST EEL COLLECTION FACILITY DESIGN PRESENTATION

Conowingo Hydroelectric Facility
and
Muddy Run Pumped Storage Project

FERC Project Nos. 405 and 2355

Eel Passage Advisory Group (EPAG) Teleconference

Remote Meeting
October 15, 2020, 2:00 pm to 3:30 pm

Exelon Generation®

Agenda

Review East Fish Lift (EFL) Temporary Eel Facility Design

Review EFL Temporary Eel Facility Drawings and photos of existing structure

Questions and 3D model presentation

Source: NYSDEC Wiki Commons

EFL Eel Facility Design

Water Levels (Conowingo Datum)

- Based on 5% and 95% exceedance flows during passage season (June 1 – November 30)
- Minimum Tailwater (95% exceedance) = El. 12.79’
- Maximum Tailwater (5% exceedance) = El. 21.17’

Eel Ramp

- 18-inches wide, 30° slope, approx. 16’-3” length
- Enkamat substrate, throughout ramp and along concrete to low water level
- Solid cover above max. water level and netting along the remainder
- Ramp entrance elevation = El. 17.8’ +/-

Exelon Generation
Gomez and Sullivan Engineers

EFL Eel Facility Design (cont.)

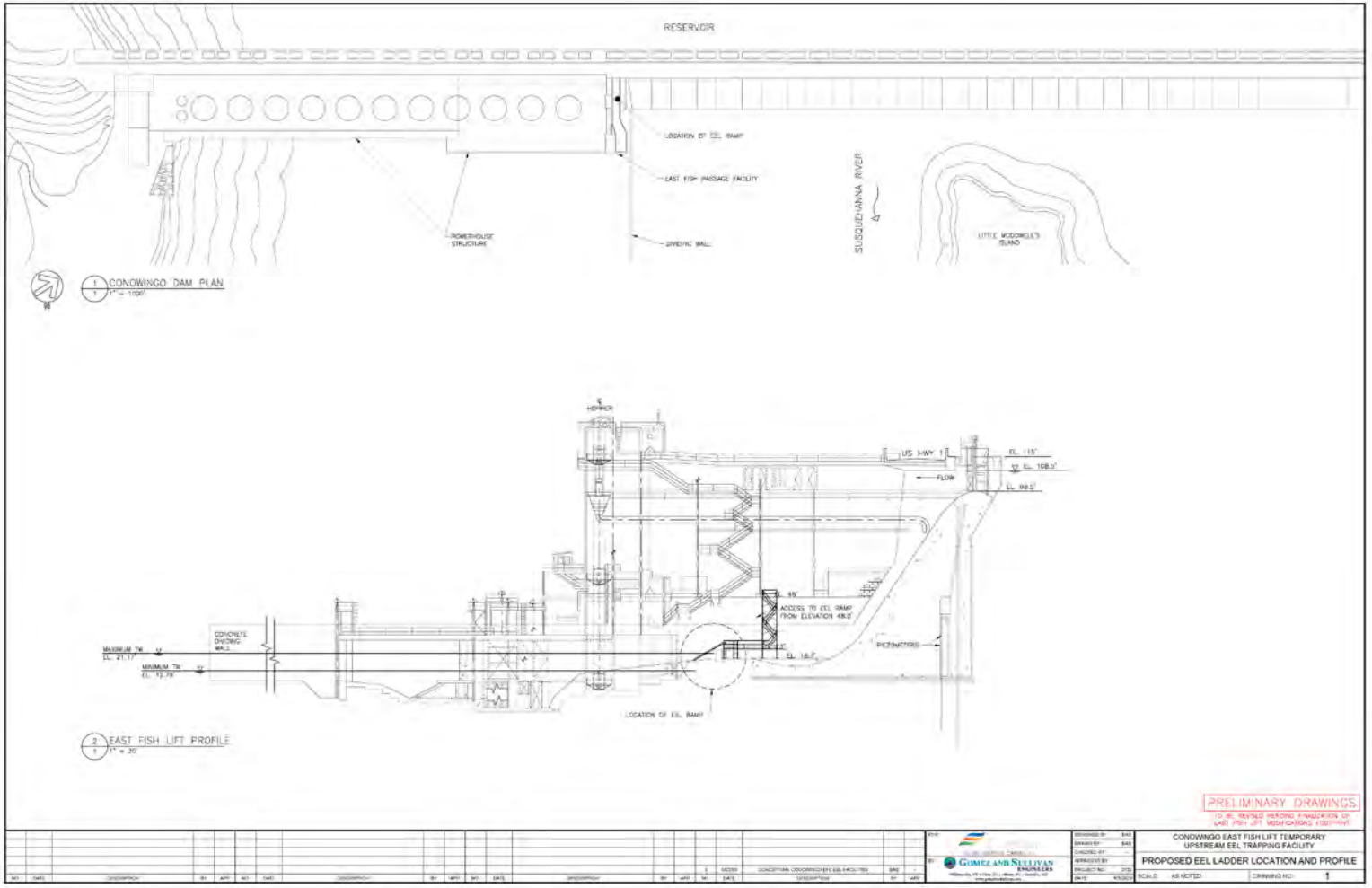
Collection Tank

- Approximately 80-gallon capacity (3100 eels @ 10 eels per liter)
- 11.75-inch +/- water depth

Water Supply

- 1-inch PVC spray bar
- Scent line from tank to highest gravity fed position on ramp
- Overflow line from tank to base of ramp.

EFL Eel Facility Drawings (pg. 1)



Exelon Generation

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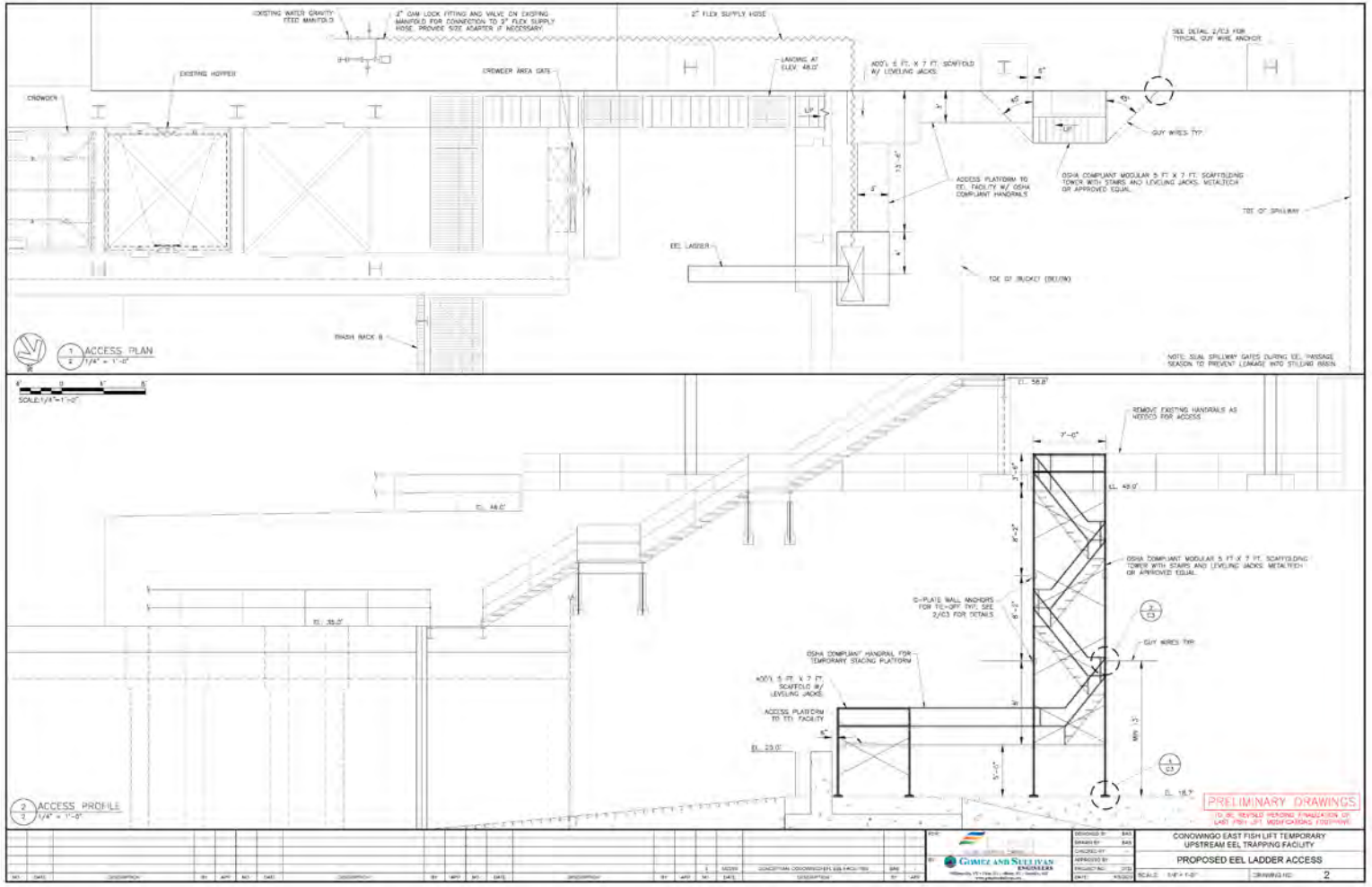
EFL Eel Facility Drawings (pg. 2)



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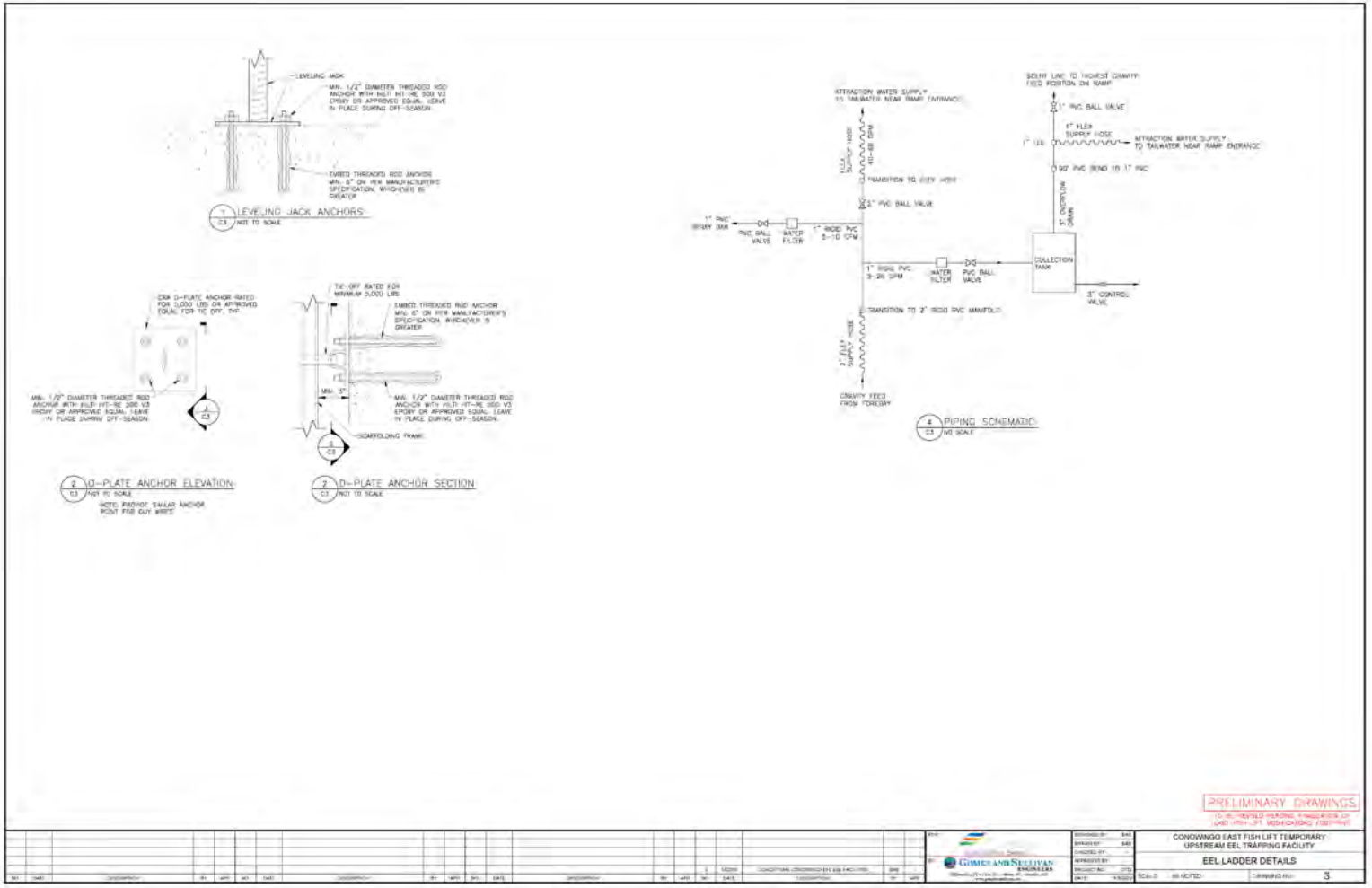
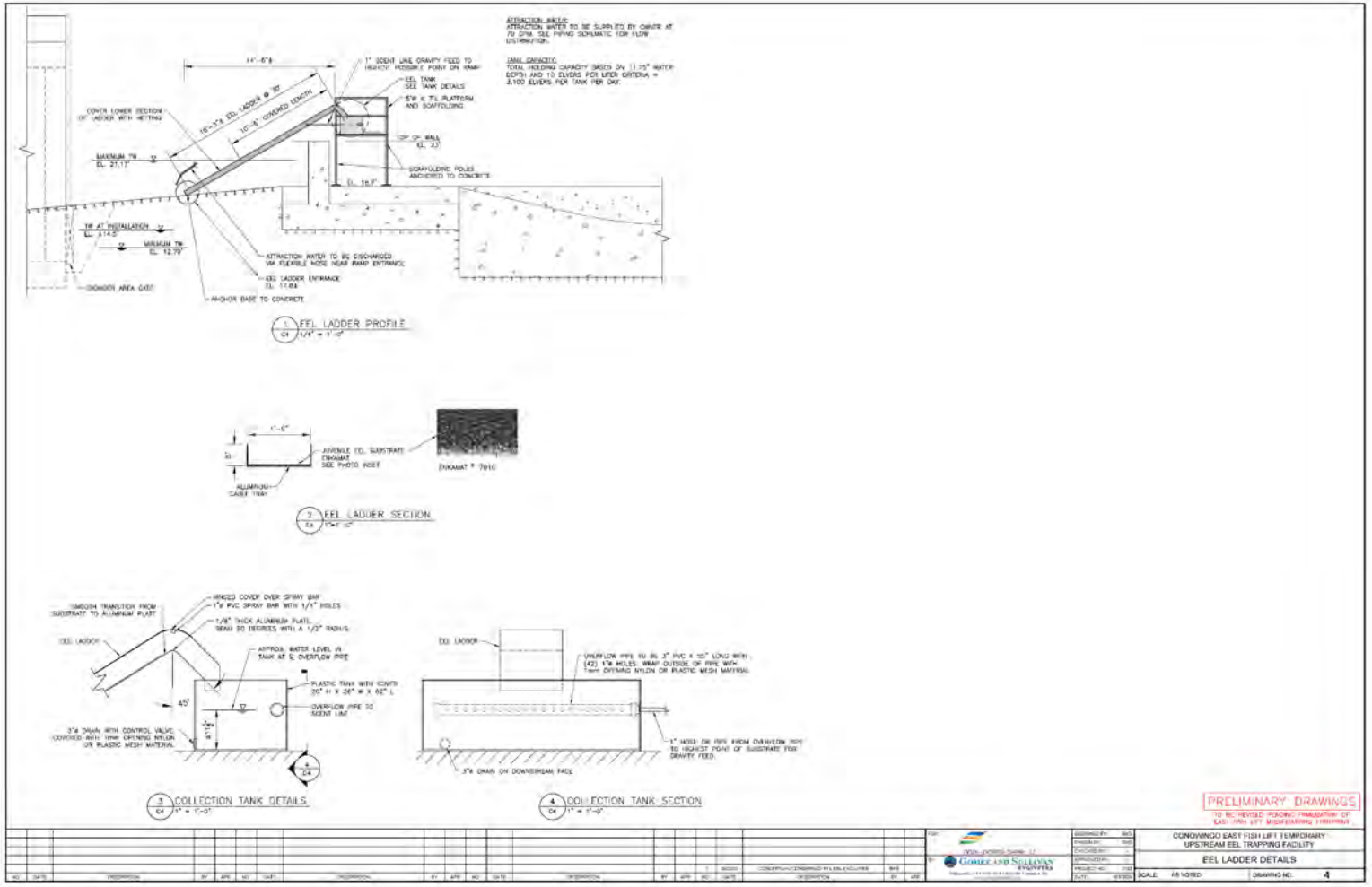
EFL Eel Facility Drawings (pg. 3)



Exelon Generation

Gomez and Sullivan Engineers

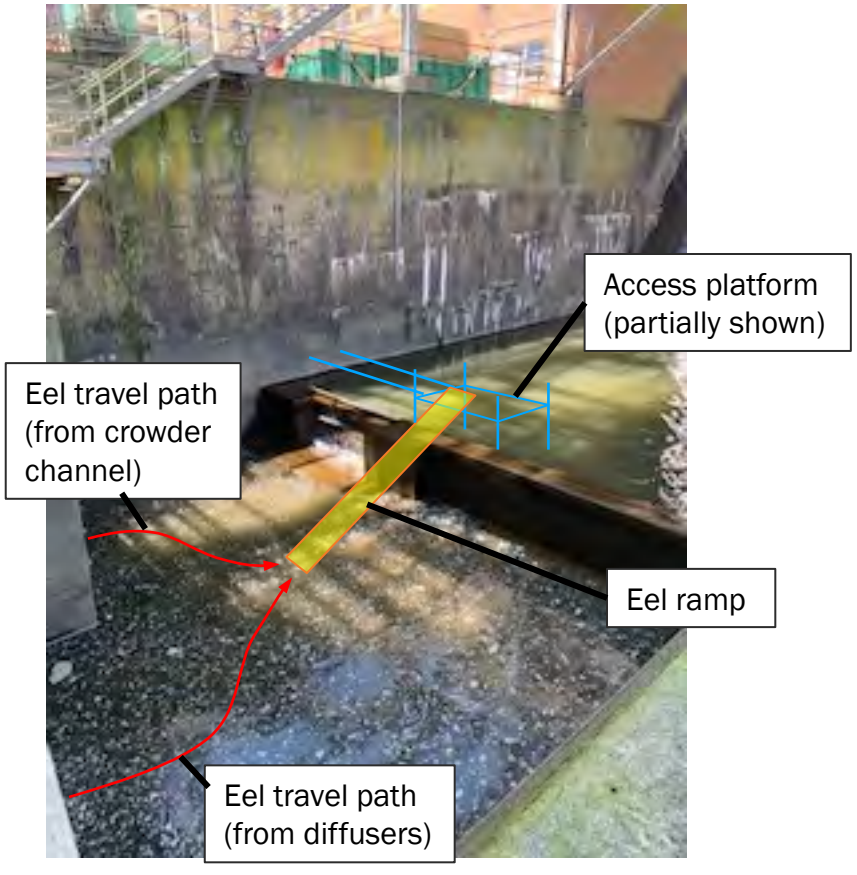
EFL Eel Facility Drawings (pg. 4)



Exelon Generation

GOMEZ AND SULLIVAN ENGINEERS

East Fish Lift Photos



Dissipation Wall

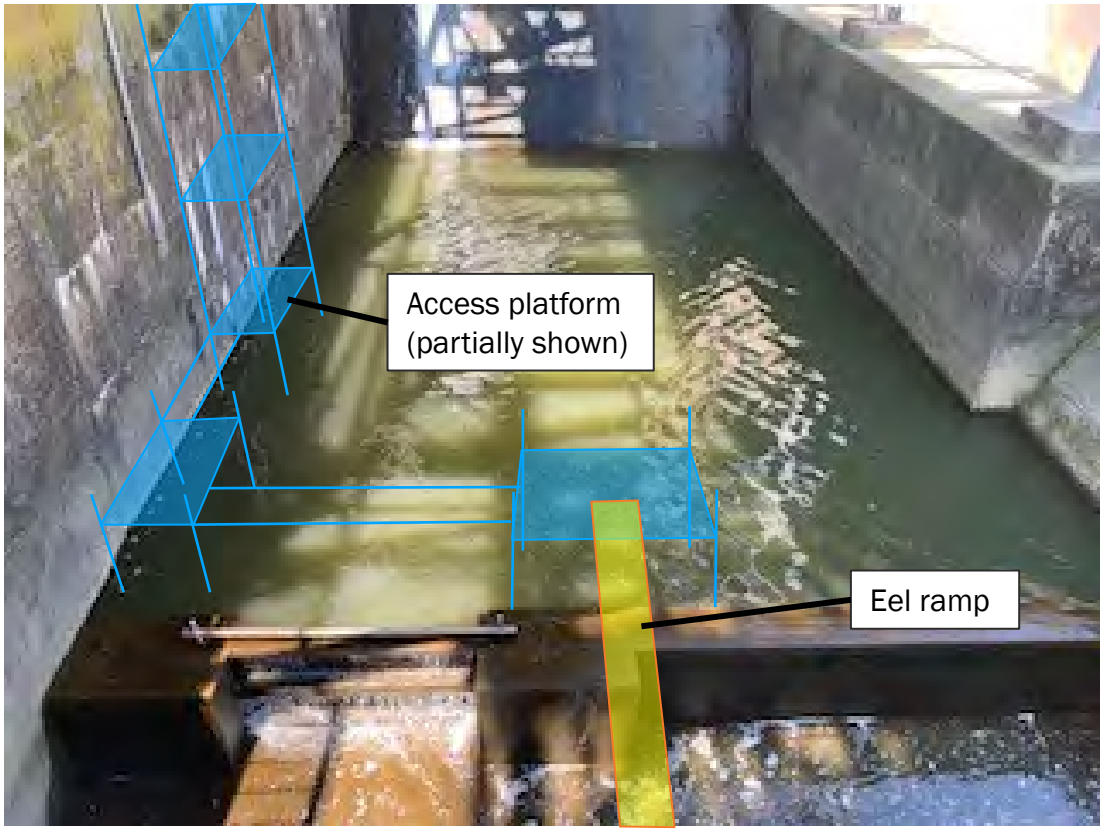
Exelon Generation

Gomez and Sullivan Engineers

East Fish Lift Photos

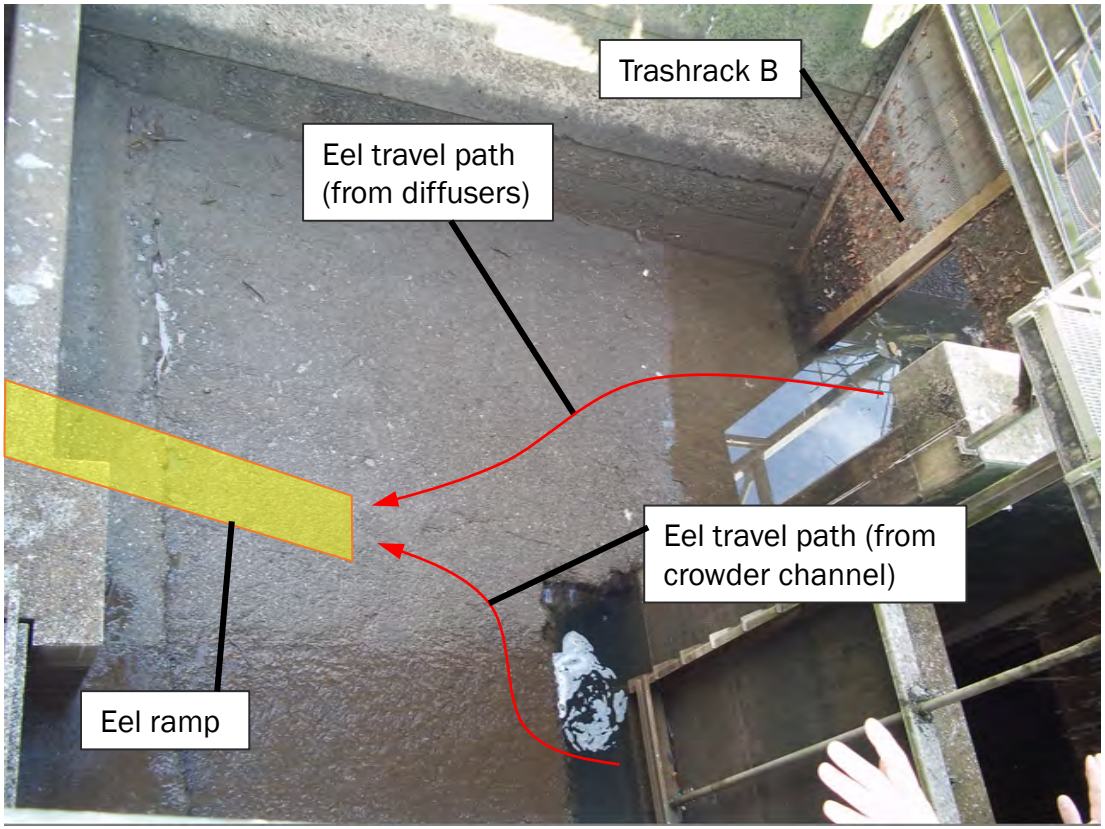
Trashrack B from Crowder Area Gate

East Fish Lift Photos



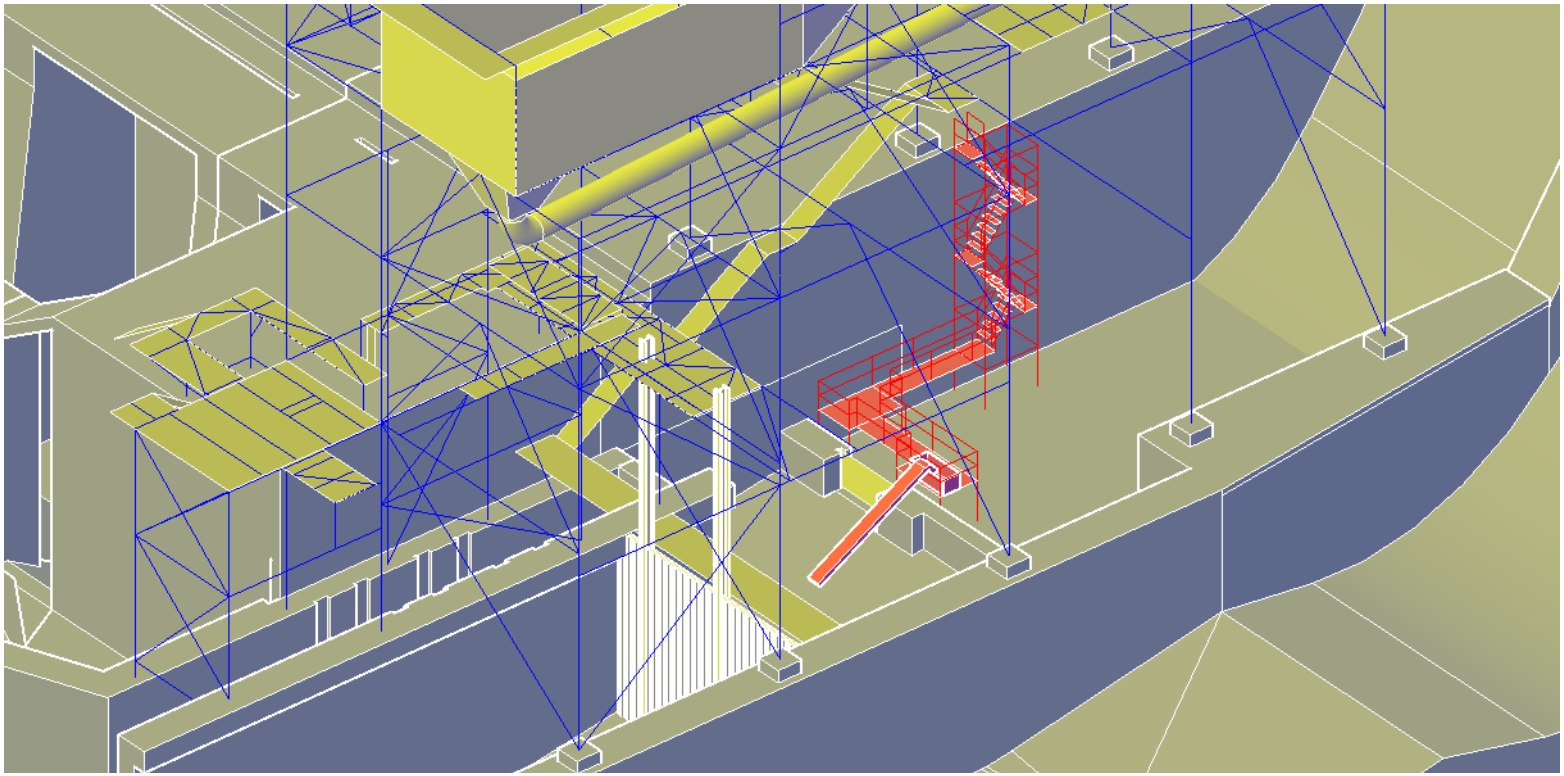
Upper Basin from Crowder Area Gate

East Fish Lift Photos



Stilling Basin Wall to Trashrack B and Crowder Area Gate

3D Model



3D model of EFL with proposed Eel Facilities shown in red

Exelon Generation
Gomez and Sullivan Engineers

APPENDIX E. DAILY AND WEEKLY DATA SHEETS

Conowingo West Eel Collection Facility Daily Field Sheet

Project Number:	Crew:
Collection Number:	Generation:
Date:	***Control Room DO reading***:
Weather:	

	Collection Tank	Holding Tank # 1	Holding Tank # 2	Holding Tank # 3	Main Flow
Time:					
Flow Meter (gpm):					
Total Flow Volume:					
Temperature (°C):					
Dissolved Oxygen (mg/L):					
In Operation:					

Actual Counted # of Eels:	**Volumetric Estimates**
Dead eels in collection tank #:	Actual # of eels in 200 mL:
Sacrificed #:	# of eels in 1 Liter:
Eels released into holding tank #:	Displacement of water (L):
# Eels released into tank:	Estimated # of eels:
Dead eels in tank #:	**Total estimated:**
Total # of eels in tank: (not to exceed 17,000	(total estimated equals number estimated plus eels in the 200 mL subsample)
	Estimate Check (QA) (if necessary):
	Actual:
	Estimate:
Holding Tank #:	Holding Tank #:
Total alive:	Total alive:
Dead #:	Dead #:
New total:	New total:

Comments:

Octoraro Creek Eel Collection Facility at Pine Grove Daily Field Sheet

Biological Data, Monday and Thursday (sheet 2)
Calibration, Wednesday

Project Number:			Collection Number:
Date:			Time:
Weather:			Rain Gauge Amount (tenths of inch):
	Collection Tank	Head pond	
Temp (°C):			
DO (mg/L):			

Number of eels collected:	**Dissolved Oxygen Probe Download**		
Number of eels transported:		Before	After
Location transported to:	Date:		
Number of dead eels:	Time:		
Answer following questions with YES or NO	DO (mg/L):		
Water running down ramp?	Temp (°C):		
Was the spray bar cleaned?	**Dissolved Oxygen Probe Reading** (inserted later)		
Was the ramp vandalized?		Before	After
Is end of ramp underwater?	DO (mg/L):		
Was the hydro operating?	Temp (°C):		
Was the probe cleaned?	Time:		

Design Parameters - Calibration (Weekly checks, Wednesday)

	Enkamat	Milieu	
Spray bar:			gallons/min
Collection tank:			gallons/min
Top Attraction:			gallons/min
Bottom Attraction:			gallons/min
TOTAL:			gallons/min

Estimate	
Number in 200 ml:	**Estimate check:**
Volumetric estimate:	Actual count:

Equation for estimating number of eel volumetrically: E = 5XD

Where, E = Estimated number of eels in collection X = number of eels in displaced 200 ml sample D = Displaced amount of 2 liter water in bucket when all eels have been added.

Comments

Conowingo East Eel Collection Facility Daily Field Sheet

Project Number:	Crew:
Collection Number:	Generation:
Date:	***Control Room DO reading***:
Weather:	

	Collection Tank
Time:	
Flow Meter (gpm):	
Total Flow Volume:	
Temperature (°C):	
Dissolved Oxygen (mg/L):	

Actual Counted # of Eels:	**Volumetric Estimates**
# dead eels in collection tank:	Actual # of eels in 200 mL:
Eels released into holding tank #:	# of eels in 1 Liter:
# Eels released into tank:	Displacement of water (L):
Yes/No	Estimated # of eels:
Was the end of the ramp underwater?	**Total estimated:**
Was water flowing down the ramp?	(total estimated equals number estimated plus eels in the 200 mL subsample)
	Estimate Check (QA) (if necessary):
	Actual:
	Estimate:

Comments:

American Eel Transport Sheet	
Facility (circle) CWECF CEECF OECF	Transport Tank (circle) Large Small

Prior to transport, while in holding (H1)		Prior to transport, while in holding	
Date	Time	Date	Time
DO	Temp	DO	Temp
No. eels being held		No. eels being held	
No. dead eels in holding prior to transport		No. dead eels in holding prior to transport	
No. eels being transported		No. eels being transported	

After eels have been loaded (in tank)		Prior to releasing eels (in tank)	
Date	Time	Date	Time
DO	Temp	DO	Temp
No. eels transported			
No. of eel dead during transport			
No. eels released			

Release Location			
Date	Time	Creek DO	Creek Temp

Release Locations
A – Muddy Creek Forks (York County)
B – Conewago Creek, Aberdeen PA (Lancaster County)
C – Beaver Creek, Hummelstown, PA

Susquehanna River
1 – Conowingo Pond, Conowingo Creek (Cecil County)
2 – Lake Aldred (York/Lancaster County)
3 – Lake Clarke (Lancaster County)
4 – Etters Boat Ramp, Goldboro, PA
5 – West Fairview Access, Route 11/15 (Cumberland County)
6 – For Hunter Access (Perry County)
7 – Shikellamy State Park (Northumberland County)
8 – Route 487 (Bloomsburg, PA (Columbia County)
9 – Route 29 Bridge (Luzerne County)
10 – Upstream of Hepburn Street Dam, Williamsport PA (Lycoming County)
11 – Upstream of Grant Street Dam (Clinton County)
12 – City Island (Dauphin County)

Daily Conowingo West Eel Collection Facility Email Template

PROVISIONAL DATA SUBJECT TO REVISION

Collection

Today ____ American Eel were collected at the Conowingo West Eel Collection Facility. The season total is now ____.

New collection tank mortalities:

Transport

Today ____ American Eel were transported to _____. The season total transported is now ____.

New transport tank mortalities: ____.

Holding

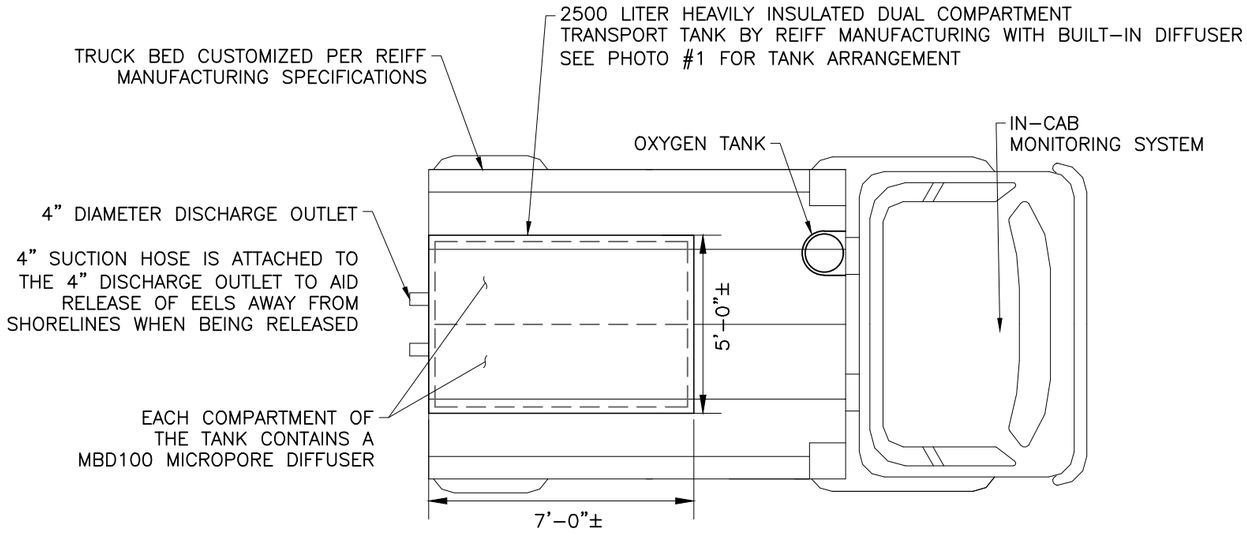
____ American Eel are in holding.

New holding tank mortalities: ____.

Meter and Probe Maintenance

Probe/Meter No.	Date Services	Maintenance Items Performed	Status	By

APPENDIX F. CONOWINGO TRANSPORT FACILITY DRAWINGS



TRANSPORT TRUCK PLAN
SCALE: 1/4" = 1'

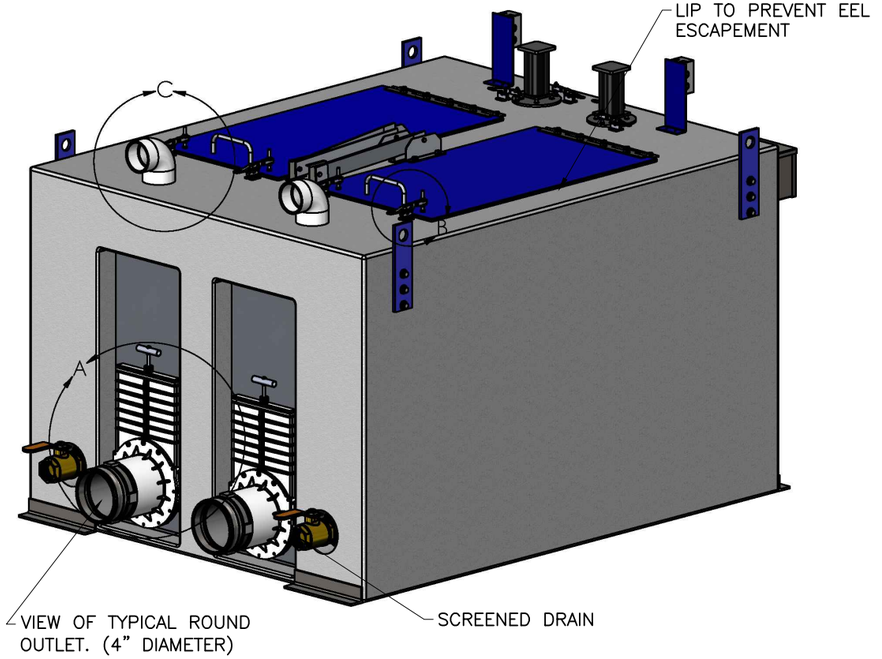


PHOTO 1: ISOMETRIC VIEW OF REIFF MANUFACTURING TRANSPORT TANK

REIFF MANUFACTURING
TRANSPORT TANK ARRANGEMENT

NOTES:

TRANSPORT TRUCK AND MONITORING

1. TRANSPORT TRUCK HAS CAPACITY TO TRANSPORT 25,000 EELS (2,500 LITERS) IN ONE TRIP.
2. TRANSPORT TRUCK INCLUDES CONTINUOUS IN–CAB MONITORING SYSTEM FOR INSUFFICIENT WATER TEMPERATURE AND DISSOLVED OXYGEN PARAMETERS. NO BACK–UP PUMP AND NO ALARMS (FLOW IS NOT NEEDED FOR EELS AND THE TECHNICIAN MONITORS THE IN–CAB MONITORING SYSTEM).

TRANSPORT TANK

1. TANK HAS CAPACITY TO HOLD 25,000 EELS (2,500 LITERS) WITH 4" OF FREEBOARD.
2. TANK INCLUDES LIP TO PREVENT EEL ESCAPEMENT.
3. TANK MANUFACTURED BY REIFF MANUFACTURING.
4. EELS WILL BE EMPTIED DIRECTLY FROM TANK VIA 4" SUCTION HOSE ATTACHED TO THE 4" DRAIN (KNIFE VALVE) TO AID RELEASE OF EELS AWAY FROM SHORELINES AT DESIRED STOCKING LOCATIONS.
5. TANK INCLUDES $1\frac{1}{2}$" SCREENED DRAIN TO LOWER WATER LEVELS AS NEEDED.
6. OTHER DETAILS OF THE TANK CAN BE FOUND ON THE REIFF MANUFACTURING DRAWINGS.

FINAL

NO.	DATE	DESCRIPTION	BY	APP
0	4/15/19	CONOWINGO EEL TRANSPORT FACILITIES	KBS	-

FOR: Exelon
EXELON GENERATION COMPANY, LLC

BY: GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

DESIGNED BY:	CRS
DRAWN BY:	CRS
CHECKED BY:	-
APPROVED BY:	-
PROJECT NO.:	1385
DATE:	

CONOWINGO AMERICAN EEL TRANSPORT FACILITY

PLAN, SECTION, DETAILS - EEL TRANSPORT

SCALE:

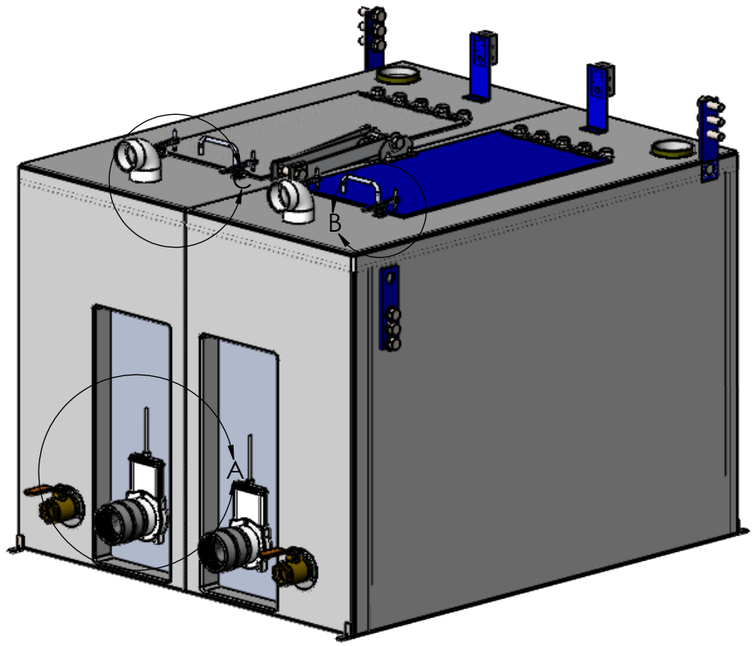
SHEET 1 of 4

Tank Notes:

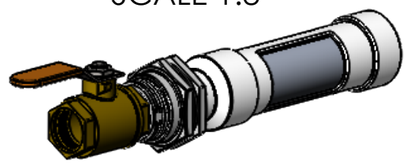
- Inner Tank structure to be built out of 0.19" thick 5025-H32 Aluminum 2 Tank Insulation 2lb. density El Foam P200 or equal (7.9 Rs per in.).
- External Tank to be made of 0.125" thick FRP with additional in corners and bottom for reinforcement.
- Urethane clear coat over outer gelcoal layer for durability and ease of cleaning.
- [2] 4" Round outlet with external mount Valterra 4" Knife gates. (1) per compartment. Gates are mounted to Tank with machined Alum plate.
- (2) - 24 Point Four Systems microbubble diffuser. (1) per compartment.
    - Each diffuser stone is countersunk in tank bottom.
    - Stones have removable alum covers for maintenance and repair.
    - Countersunk pockets have drainline for water drainage of pockets.
    - (2) Oxygen Flowmeter, (1) per stone.
    - (1) Oxygen Regulator.
- (2) Ventilation scoop. SCH 40 PVC elbow with Alum perforated screening. (1) per compartment mounted on access hatch doors.
- (2) Access hatch 18" x 36" with 21" x 39" signle hinge doors. (1) per compartment.
    - Each door has heavy duty Stainless Steel piano style hinge.
    - (1) Alum fabricated jack knife door lock hinge. Hinge holds door in open position to keep accidental closure from occuring.
- Details NOT shown in Submittal drawings include: Point Four oxygen stones and internal oxygen lines. (placement pocket and flush mount cover is shown.

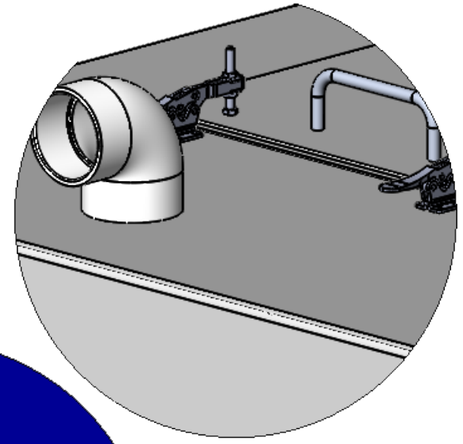
External Valterra Gate Notes

- Gate is double sealed with easily replacable seals.
- Gate is double flanged with full gate able to be removed easily for maintenance or repair.
- Gate seal when gate is closed to be drip ligt, and leak proof, when properly adjusted.
- Bolts for mounting of flanges to allow for seal tension adjustment.
- Outer removable flange has threaded pipe slub in slip flange for mounting threaded 4". Female thread to Male camlock quick coupler.

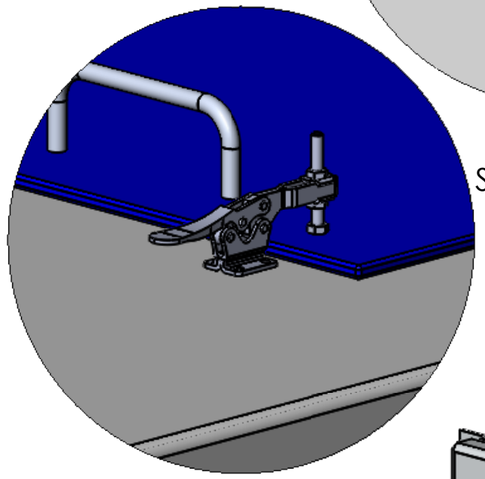


SCREENED TEMPERING VALVE
DETAIL
SCALE 1:8

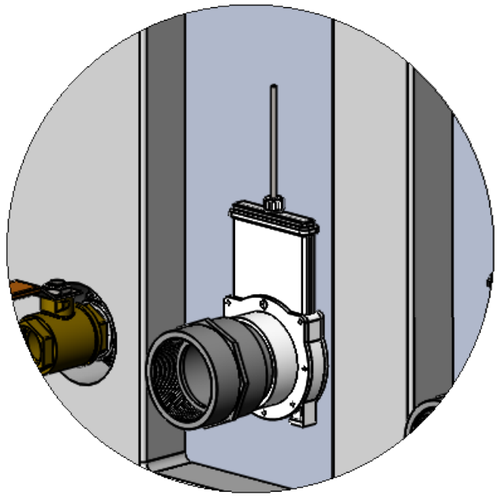




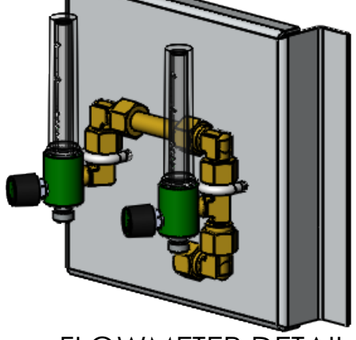
DETAIL C
SCALE 1 : 6



DETAIL B
SCALE 1 : 4



DETAIL A
SCALE 1 : 8



FLOWMETER DETAIL
SCALE 1:4

FINAL

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CUSTOMER SUBMITTAL APPROVAL
Signature or Initial: (upon approval)

Date Signed: (MM/DD/YYYY)

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ± 1/32"
ANGULAR: MACH ±
BEND ±
TWO PLACE DECIMAL ± 0.01
THREE PLACE DECIMAL ±
REIFF Mfg. ACCURACY TOLERANCE (Job Specific): ±
MATERIAL
FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	CA	3/23/2016
CHECKED		

Reiff Manufacturing
www.reiffusa.com
670 B Street, Walla Walla, WA 99362 (509) 525-1081

Reiff MFG.
CITY/COUNTY AIRPORT
670 B Street
WALLA WALLA,WA.99362
PHONE: 509-525-1081

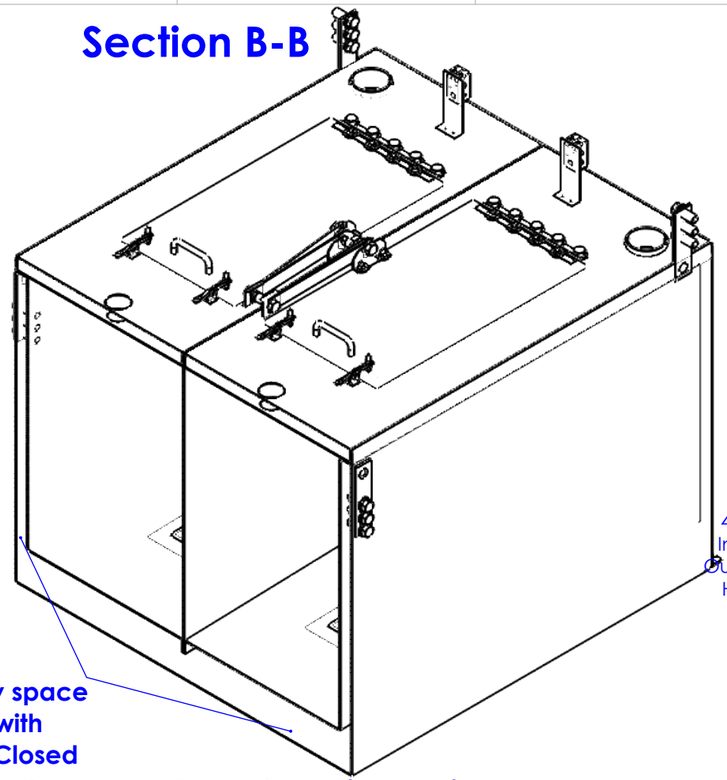
CUSTOMER:
Normandeau - PA

TITLE:
660gal 2 comp fish trans

SIZE	JOB. NO.	REV
B	650gal 2 Comp	1

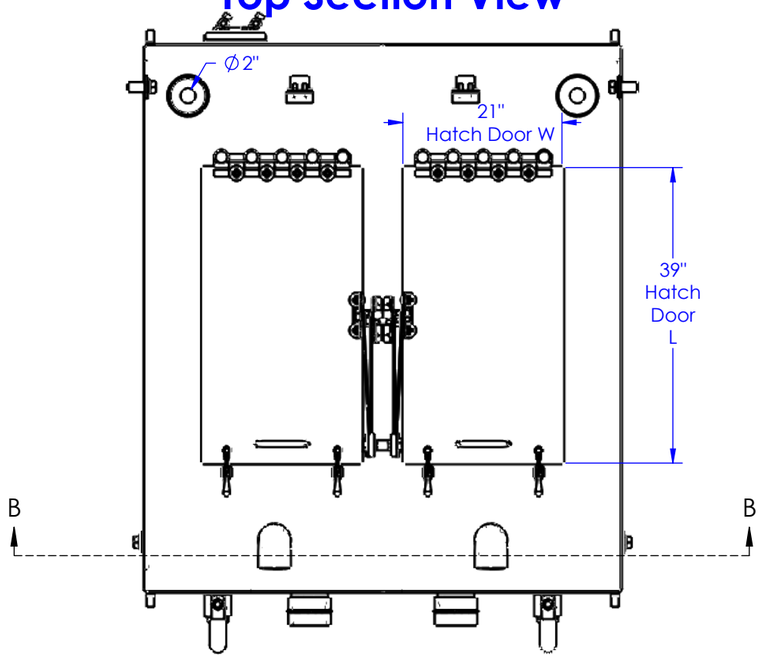
SCALE: 1:20 WEIGHT: SHEET 2 OF 4

Section B-B

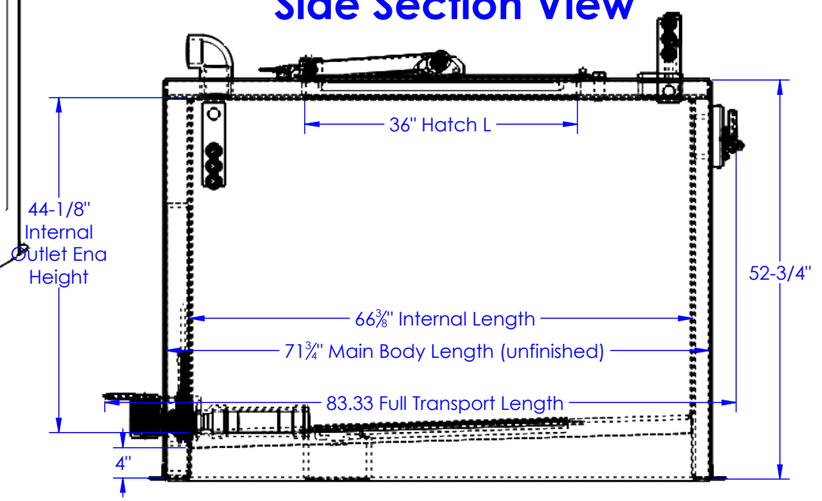


Empty space filled with P200 Closed Cell Foam

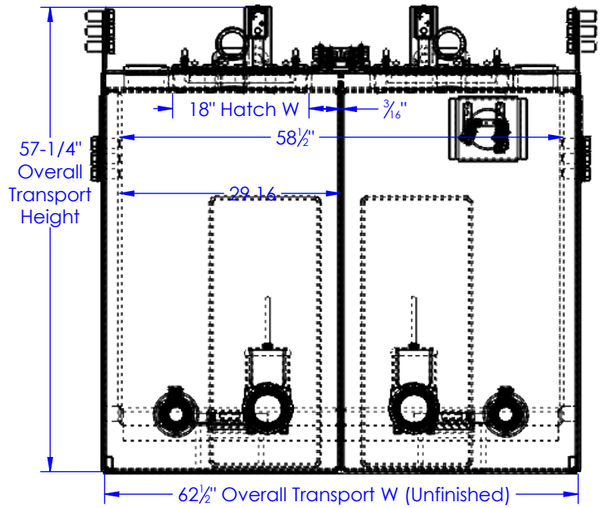
Top Section View



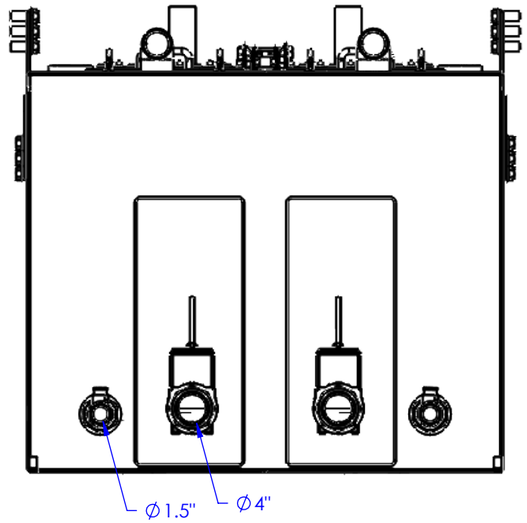
Side Section View



Cab End Section View



Outlet End Section View



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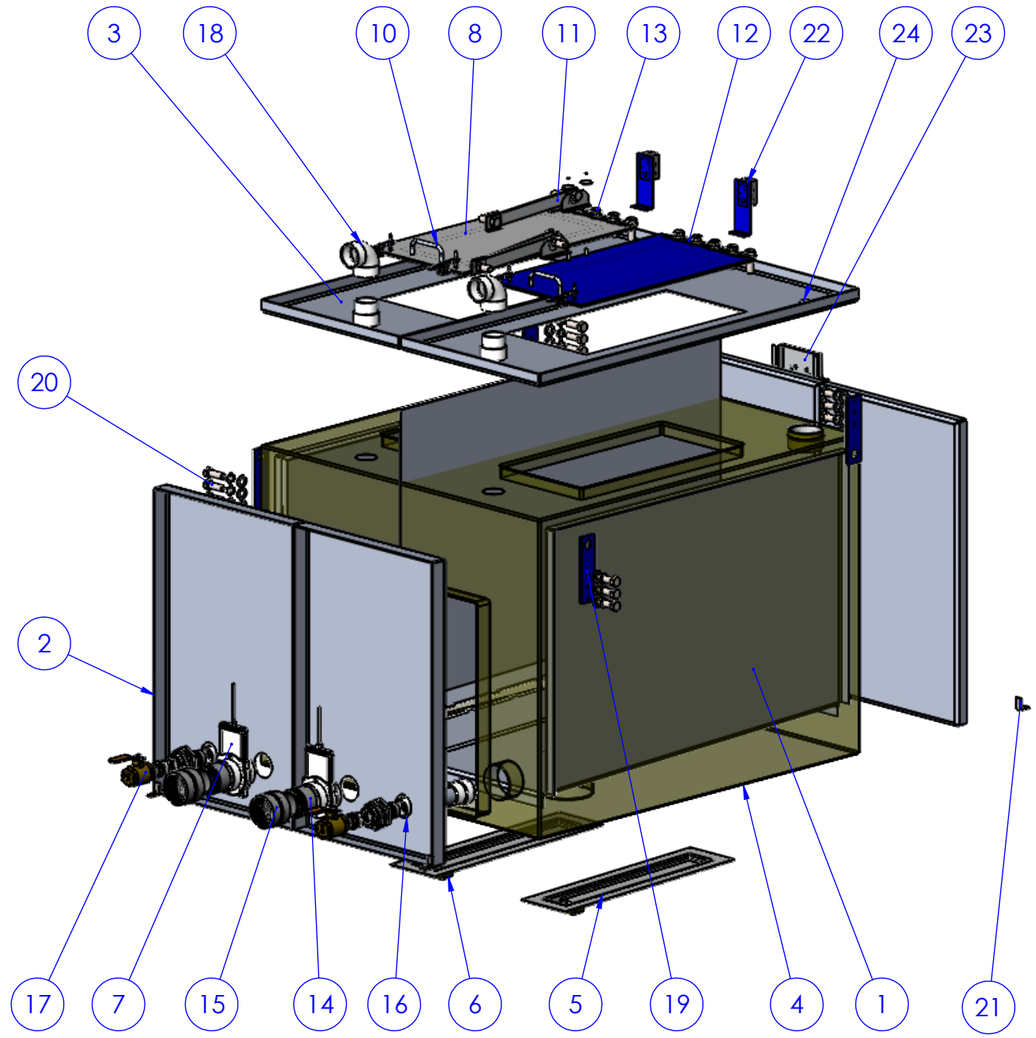
CUSTOMER SUBMITTAL APPROVAL Signature or Initial: (upon approval) Date Signed: (MM/DD/YYYY)	Reiff Manufacturing 670 B Street, Walla Walla, WA 99362 (509) 525-1081	CUSTOMER: Normandeau - PA
	Reiff MFG. CITY/COUNTY AIRPORT 670 B Street WALLA WALLA,WA.99362 PHONE: 509-525-1081	TITLE: 660gal 2 comp fish trans
		SIZE B · JOB. NO. 650gal 2 Comp · REV 1
		SCALE: 1:20 WEIGHT: SHEET 3 OF 4

NOTE #	PART	QTY.	DESCRIPTION
1	660 gal Alum Interior Body Piece	2	Tank Body made from 0.19" thick 5052-H32 fabricated Alum Sheet.
2	660 gal Alum Interior Ends	4	Tank Body made from 0.19" thick 5052-H32 fabricated Alum Sheet.
3	660 gal Alum Interior Top	2	Tank Body made from 0.19" thick 5052-H32 fabricated Alum Sheet.
4	Fiberglass Outer Shell	1	White and Clear gel coated, Chop Applicated 0.15" FRP Outer Shell.
5	Point Four System's 24" O2 diffuser stone FRP pockets	2	Pockets are recess mounted to allow flush mounting of O2 stone cover.
6	0.125" 5052-H32 flush mount O2 stone covers	2	Flush Alum covers secured with removable hardware for servicing of O2 stones.
7	4" Valterra External Mount ABS Plastic KnifeGate	2	Valterra 4" ABS Plastic, Alum plate flange mounted exterior fish release knife gate valve.
8	15" x 32" un-insulated 0.25" thick Alum hatchway access door	2	Alum Angle reinforced large access top door for loading fish into transport tank.
9	USS DeStaCo 225 horizontal toggle clamps	4	Toggle clamps for seccuring top hatch door and appling gasket seal pressure. 500 lbs. pressure per clamp.
10	Alum 6" access door handle	2	
11	Reiff Jack-Knife Door Hinge	2	Hinge that is installed to hold door in open position and prevent injury due to accidental closing.
12	18" L Heavy Duty 3" stainless steel hinge	2	18" length Heavy Duty 3" Stainless Stell Piano Style Hinge for Hatch Door.
13	0.25" Bolt hardware		Used to mount hatch door, toogle clamps, other non-load bearing items.
14	4" Male NPT PVC Pipe Stub	2	4" Male NPT PVC pipe stub for attaching camlock fitting to 4" gate valve flange.
15	4" Female NPT to Male Camlock quick connector	2	Female NPT end is threaded onto male pipe stub for attachment of hose with camlock fitting.
16	1.5" PVC screened bulkhead fitting	2	PVC tank wall threaded bulkhead fitting for mounting tempering valve, screened internally.
17	1.5" Tempering and Dewatering ball valve	2	Threaded manual operated ball valve mounted to bulkhead.
18	3" SCH40 90 Elbow Vent	2	Screened Vent elbow for air circulation and keep tank from over pressurization.
19	0.375" thick powder coated Alloy Steel Tank lifting Bracket	4	**Lifting backets that can be used for lifting tank WHILE EMPTY.**
20	0.375" Stainless Steel lifting eye Hardware	12	Hardware for securing lifting eye to backing on tank (3 per lifting eye).
21	3" x 3" x 0.25" Alum Angle	4	Alum Angle for bolting or mounting Transport to bed of truck
22	0.125" thick Alum Outlet Box Bracket Mount and Electric J Box	4	1 Bracket per Aerator with mounted Aerator plug in electrical J box.
23	Oxygen Flow Meters and Mount	2	**(1) Alum mounting bracket, (2) O2 flow meter, Brass fittings connected to green O2 lines.**
24	2" Bulkhead	2	
Extra	Hardware not shown on tank		EI Foam Insulation, Diffuser Stone (MBD100), O2 regulator, Plumbing for O2 delivery, and internal wire routing



FINAL

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CUSTOMER SUBMITTAL APPROVAL
Signature or Initial: (upon approval)

Date Signed: (MM/DD/YYYY)

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ± 1/32"
ANGULAR: MACH ±
BEND ±
TWO PLACE DECIMAL ± 0.01
THREE PLACE DECIMAL ±
REIFF Mfg. ACCURACY TOLERANCE (Job Specific): ±
MATERIAL
FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	CA	3/23/2016
CHECKED		

Reiff Manufacturing
www.reiffmfg.com
670 B Street, Walla Walla, WA 99362 (509) 525-1081

Reiff MFG.
CITY/COUNTY AIRPORT
670 B Street
WALLA WALLA,WA.99362
PHONE: 509-525-1081

CUSTOMER:
Normandeau - PA

TITLE:
660gal 2 comp fish trans

SIZE	JOB. NO.	REV
B	650gal 2 Comp	1

SCALE: 1:24 WEIGHT: SHEET 4 OF 4

Conowingo 250-L Transport Tank

Conowingo 19-L Transport Buckets

APPENDIX G. SUSQUEHANNA RIVER AMERICAN EEL ELVER REQUEST FORM

Susquehanna River American Eel Elver Request Form

Submit requests to Aaron Henning of the Susquehanna River Basin Commission (ahenning@srbc.net) by November 15 to be considered for eel distribution the following calendar year. Approval of this request is not a binding contract for the agencies or Exelon to provide eels.

Principal Investigator:_____

Organization Affiliation:_____

Email Address:_____ **Phone Number:**_____

Project Title:_____

Brief Project Description (a project proposal can be attached to this form):_____

_____

_____

_____

Total # Eels requested (by calendar year):_____

Estimated Duration of Holding:_____

Ultimate Disposition of Eels (released or other):_____

Proposed release location, including waterbody, county, municipality, and state:_____

_____

An 8.5"x11" map of the stocking location should be attached to this request

Project Start and End Dates:_____

Have scientific collection and/or stocking permits been secured?:_____

Is this a new or ongoing request?:_____

Has sufficient funding been secured to implement the project?:_____

Has a transport mechanism been approved by the agencies?:_____

Additional Information:

For projects requesting large numbers of eels (i.e. >500/yr), the agencies may require the requestor to give a presentation of the proposed study plan at the annual SRAFRC/Hydro Meeting in December or at another time agreed to by the Resource Agencies.

Annual study reports must be filed with the Resource Agencies each year prior to November 15. Study reports should include the number of eels received by date, the disposition of eels (stocked, retained, died in transport, etc.), the conditions monitored during transport, latitude, longitude, and number of elvers released at each stocking event, and any available information related to the project results. Future eel requests may be denied if annual study reports are not filed in a timely manner.

All requests are subject to approval from the following agencies: Susquehanna River Basin Commission, U.S. Fish and Wildlife Service, Pennsylvania Fish and Boat Commission, Pennsylvania Department of Environmental Protection, New York State Department of Environmental Conservation, and Maryland Department of Natural Resources. No more than 20% of the average annual catch will be provided in a given year for research or alternate stocking projects.

All proposed transport procedures will need to be submitted to the agencies for approval no later than April 1. Procedures need to include details on vehicle, transport tank size, mechanism to continuously monitor temperature and dissolved oxygen during transport, and ability to provide supplemental oxygen during transport. Water quality measurements for transport will need to be reported in the annual report along with number of eels transported and number of mortalities during transport. An inspection of the transport vehicle and water quality monitoring mechanisms may be required by a resource agency staff or Exelon representative prior to approving transport procedures.

All parties receiving eels must comply with Exelon's standard operating procedures for eel transfer and also complete a Chain of Custody form (attached).

Standard Operating Procedures for American Eel Transfer from Exelon

The purpose of this protocol is to ensure the health of the eels removed from and transported to locations as designated by the eel request form. Exelon's ability to hold eels for longer than 24-hours may be limited during the summer due to the increased stress and mortality related to high water temperatures.

A minimum notice of 24 hours is required for an anticipated pickup. No pickups will be facilitated by Exelon on weekends or holidays.

Pickup personnel should be limited to 1-2 people and the names of those individuals must be provided to Exelon prior to arrival, ideally when the pickup is scheduled. For anyone arriving on

station, proper PPE must be worn including closed toe shoes, long pants, and short sleeve shirts. Hard hats and safety glasses will need to be worn on site, but can be provided temporarily by Exelon if notified prior to arrival on station.

Planned pickup time should be around 7:30 a.m. No transfers will occur after 5:00 pm.

Exelon reserves the right to deny transfer of eels if they believe the transport vehicle and supporting equipment could jeopardize safety and survival of eels.

Exelon will notify resource agency staff if the requested eels are (or anticipated to be) available. Agency staff will approve transfer and coordinate with the requestor and Exelon to arrange pickup details for the next day.

ATTACH CHAIN OF CUSTODY FORM

CHAIN OF CUSTODY SHEET: JUVENILE EELS PROVIDED TO RESOURCE AGENCY PERSONNEL FROM THE CONOWINGO EEL COLLECTION FACILITY

Date: _____ **Time:** _____

NUMBER OF EELS PROVIDED:

CECF Collection Tank: _____

Holding Tank # 1: _____

Holding Tank # 2: _____

Holding Tank # 3: _____

Total number of eels provided for Transport: _____

WATER TEMPERATURE:

Collection/Holding Tank: _____

Transport Truck: _____

SIGNATURES:

Normandeau/Exelon Representative: _____

Agency Representative: _____

Agency Rep. Printed Name and Agency: _____

APPENDIX H. FINAL STUDY REPORT: BIOLOGICAL AND ENGINEERING STUDIES OF AMERICAN EEL AT CONOWINGO PROJECT 2011 EEL SAMPLING BELOW CONOWINGO DAM

FINAL STUDY REPORT
BIOLOGICAL AND ENGINEERING STUDIES OF AMERICAN EEL AT CONOWINGO PROJECT
2011 Eel Sampling below Conowingo Dam

RSP 3.3

CONOWINGO HYDROELECTRIC PROJECT

FERC PROJECT NUMBER 405

Prepared for:

Exelon.

Prepared by:

Normandeau Associates, Inc.

Gomez and Sullivan Engineers, P.C.

August 2012

EXECUTIVE SUMMARY

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt Conowingo Hydroelectric Project (Conowingo Project). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014. FERC issued the final study plan determination for the Conowingo Project on February 4, 2010, approving the revised study plan with certain modifications.

The final study plan determination required Exelon to conduct biological and engineering studies of American eel (*Anguilla rostrata*). The objectives of the study are to: 1) summarize available scientific and commercial information regarding the American eel; 2) identify suspected factors affecting American eel abundance; 3) describe the spatial distribution and size characteristics of American eels in the Conowingo tailrace; 4) examine the engineering feasibility and costs of upstream and downstream passage options, including consideration of potential fallback of eels after exiting an upstream passage device; (5) examine the potential impact of upstream and downstream passage of American eels on the Susquehanna River; (6) assess the cumulative impacts to the biodiversity of the Susquehanna River ecosystem of upstream and downstream passage of American eel; and (7) if deemed beneficial to American eel abundance, identify potential locations for an upstream eel passage facility at Conowingo Dam.

An initial study report (ISR) was filed on February 22, 2011 that covered study objective 3, containing Exelon's 2010 study findings. An initial study report meeting was held on March 9, 10 and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May 27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) describing the results of the 2011 biological sampling at the spillway side of the dam was filed on January 23, 2012. This final study report detailing the 2011 sampling is being filed with the Final License Application for the Project. A separate report was developed to address the remaining study objectives 1, 2, and 4 thru 7.

The 2011 study began June 24, 2011 and ended on September 5, 2011. Heavy rainfall in the spring of 2011 delayed implementation of the study. Construction and deployment of the spillway elver ramps could not be completed until spillway water levels stabilized to safely allow work crews access to the

spillway. During the May 2011 relicensing meeting, the potential impacts of a delayed study start were discussed and it was felt that the heavy rainfall and high river flows probably hindered the upstream elver migration, thus indicating that a late start may not significantly impact the 2011 study results. The USFWS sampling area, (West bank), is accessible at higher river flows which allowed them to start on May 20, 2011 as planned. The spillway area sampled by Normandeau Associates is not accessible during spill conditions, which delayed the set-up and start of sampling. Heavy rainfall associated with Hurricane Irene and Tropical Storm Lee forced both studies, (USFWS and Normandeau), to conclude early.

Two capture methods were deployed for eels. Elver ramps and associated collection facilities were placed on the west and east sides of the spillway below Conowingo Dam. In 2011, two ramps per sample location, each with a different substrate, were deployed. Additional attraction water was provided to each set of ramps which appeared to attract more elvers to the ramp locations and improved upon the elver catch observed in 2010. On the west side a submersible pump provided water which drained down the East Lift wing wall creating water movement at the base of the ramps. The east side ramps were placed downstream of a creek which provided natural water movement and potential attractant. In addition, both sample areas had PVC pipes placed between the dual ramps, which were fed with water provided from a gravity-flow system within Conowingo Dam creating more attraction flow than previously used in 2010.

In concert with the substrate utilized in the 2010 study, (Enkamat®), a second substrate (AkwaDrain™) was placed in a separate parallel ramp. Two different mesh-sized baited eel pots that targeted larger yellow eels were situated adjacent to the two ramps. Both gear types (excluding the new AkwaDrain™ ramp) were consistent with those used in 2010 and previous years by USFWS to enhance data comparability between the two sampling areas.

Elvers and yellow eels were sampled between June 24 and September 5, 2011. A total of 1,159 eels were collected. Of these, 1,100 were elvers collected from the ramps. The east ramps collected 539 elvers, with 133 harvested in the Enkamat® substrate and 406 captured from the AkwaDrain™ substrate. The west ramps collected 561 elvers, with 405 harvested in the Enkamat® substrate and 156 collected in the AkwaDrain™ substrate. Elver lengths ranged from 87 to 188 mm total length (TL), with an average size of 124.9 mm. Yellow eels harvested from the eel pots totaled 59; all yellow eels were collected from the west side. The length range of eels collected in pots ranged from 300 to 689 mm TL, with an average length of 515.4 mm.

Hourly water temperatures were recorded throughout the study period. Water temperatures typically rose and fell three to four degrees Fahrenheit (°F) every day. The water temperature in the Conowingo

spillway ranged from a low of 73.7° F on September 3 to a high of 90.8° F on July 24. A comparison of water temperatures to elver catch at the ramps revealed no apparent relationship.

The study period encompassed three new moon periods and two full moon periods. A possible, but weak and limited relationship between the number of elvers collected and moon periods was observed during part of the study period.

Normandeau Associates also conducted three nighttime surveys to document areas of elver congregation in the spillway. During these surveys, elvers were only observed in abundance below crest gate #30.

Seventy-seven eels were preserved for otolith ageing. A total of 73 of the 77 otoliths preserved were aged successfully. The majority of elvers were split at age I or II, and III to V years of age, at 30% for each group. A large gap in age at years VI to VIII is apparent due to a lack of specimens in the 189 to 299 mm size range. Larger eels were aged IX to XVII, plus one at age XIX.

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LIST OF ABBREVIATIONS

Exelon	Exelon Generation Company, LLC
F	Fahrenheit
FERC	Federal Energy Regulatory Commission
ft	feet
h	hour
in	inch
ISR	Initial Study Report
L	liter
min	minute
mm	millimeter
MW	megawatt
PIT	Passive Integrated Transponder
RSP	Revised Study Plan
TL	total length
USFWS	United States Fish and Wildlife Service
USR	Updated Study Report

1.0 INTRODUCTION

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt Conowingo Hydroelectric Project (Conowingo Project). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014. FERC issued the final study plan determination for the Conowingo Project on February 4, 2010, approving the revised study plan with certain modifications.

The final study plan determination required Exelon to conduct biological and engineering studies of American eel (*Anguilla rostrata*). The objectives of the study are to: 1) summarize available scientific and commercial information regarding the American eel; 2) identify suspected factors affecting American eel abundance; 3) describe the spatial distribution and size characteristics of American eels in the Conowingo tailrace; 4) examine the engineering feasibility and costs of upstream and downstream passage options, including consideration of potential fallback of eels after exiting an upstream passage device; (5) examine the potential impact of upstream and downstream passage of American eels on the Susquehanna River; (6) assess the cumulative impacts to the biodiversity of the Susquehanna River ecosystem of upstream and downstream passage of American eel; and (7) if deemed beneficial to American eel abundance, identify potential locations for an upstream eel passage facility at Conowingo Dam.

An initial study report (ISR) was filed on February 22, 2011 that covered study objective 3, containing Exelon's 2010 study findings. An initial study report meeting was held on March 9, 10 and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May 27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) describing the results of the 2011 biological sampling at the spillway side of the dam was filed on January 23, 2012. This final study report detailing the 2011 sampling is being filed with the Final License Application for the Project. A separate report was developed to address the remaining study objectives 1, 2, and 4 thru 7.

2.0 METHODS

The 2011 study objectives were to acquire; 1) eel spatial distribution data in the tailrace and spillway pool, and 2) collect associated biological and physical data (Appendix A). In order to maximize elver and yellow eel catch, (the life stages targeted by this study), we utilized two capture methods. Elver ramps and associated collection facilities were placed on the west and east sides of the spillway below Conowingo Dam (Figure 2-1). Baited eel pots that targeted larger yellow eels were fished adjacent to these two ramp locations.

During the 2010 study, we had utilized one elver ramp per site containing Enkamat® substrate. In 2011, two ramps per site, each with different substrates (Figure 2-2) were deployed. In addition to the Enkamat® substrate utilized in 2010, a second substrate, AkwaDrain™, was placed in a separate ramp adjacent to the Enkamat® ramp.

The west ramps were constructed and placed parallel to the wing wall near the East Fish Lift on June 23, 2011 (Figures 2-3 and 2-4), with additional water cascading down from the top of the wing wall to create disturbance and additional flow for attraction purposes. The west spillway ramps operated for nearly two weeks prior to the installation of the east spillway ramps.

The east side spillway sampling location used in 2010 was structurally damaged by heavy spring rainfall. Therefore, on July 1, 2011, the east spillway ramps (Figure 2-5) were deployed at a location adjacent to the location used in 2010. The east ramps were constructed on scaffolding located near the mouth of a small intermittent stream entering the Susquehanna River near the base of the dam (Figure 2-6). This provided natural water flow patterns that may have attracted elvers to the ramp.

The ramps were constructed with galvanized ductwork, and Enkamat® or AkwaDrain™ substrate was attached to the tray bottom with industrial grade adhesive (Figure 2-7). These substrates allowed elvers to climb the ascending section of the ramps. As advised by USFWS personnel, the substrate did not extend to the top of the ramp so the climbing elvers were forced to swim the final section of the ascending ramp; this configuration prevented them from using the substrate to pull themselves back up the descending section of the ramp to avoid capture. Each ramp unit was supported by scaffolding, which provided a sturdy base. The angle of each ramp was measured, the east ramp angle was 40°, and the west ramp angle was 35°. Each ramp consisted of approximately 20 ft. of cable tray, 12 in. wide, plus tray and sheet metal curved at the top to convey elvers into secure mesh bags which were housed in holding containers which were medium sized plastic trash cans. All ramps were fastened to scaffolding and located at or near spillway drainage or overflow.

Water flow to each ramp was supplied from a gravity-flow system within Conowingo Dam (Figure 2-8). Water was continuously released down the ramp via a spray bar to provide even sheet flow across the entire width of the ascending and descending sections of the ramps (Figure 2-9), keeping the substrate moist and creating a small amount of flow to attract elvers. The spray bars also directed water into each holding container and played a role in keeping the collected elvers aerated and alive.

Climbing ramp flow was augmented by an additional attraction flow directed to the bottom of the ramp and released between the ramps at each location (Figure 2-9). This attraction water was provided to each set of ramps which appeared to attract more elvers to the ramp locations and improved upon the elver catch observed in 2010.

On the west side a submersible pump provided water which drained down the East Lift wing wall creating water movement at the base of the ramps. The east side ramps were placed downstream of a creek which provided natural water movement and potential attractant.

In addition, both sample areas had PVC pipes placed between the dual ramps which were fed with water from a gravity-flow system within Conowingo Dam providing more attraction flow. Attraction flow volumes from the PVC pipes on both sets of ramps were measured. The west ramp was nearly 57 L/min (15 gpm), while the estimated attraction flow volume on the east ramps was 45 L/min (12 gpm). These volumes were a slight increase to the amounts used in 2010, due in part to the distance of the ramps from the water source. In addition to added attraction flow, water was siphoned from the holding containers where elvers were collected and redirected down each ramp to provide a scent trail to potentially attract elvers to the ramps.

Holding containers were checked for elvers on Mondays, Wednesdays and Fridays during the entire 2011 study with exceptions on holidays, (July 4, Labor Day), when the holding containers were checked the following day. Wednesday and Friday samples represented a 48 h fishing effort while Monday samples included the weekend days and represented a 72 h effort.

Yellow eels were collected with two different size mesh eel pots. The mesh of the pots was 0.25 in. (modified pot) and 0.5 in. (cloth pot). (Figure 2-10). These two sized mesh pots were fished adjacent to each set of elver ramps. Two pots at each end of the spillway were baited and fished for a 48-h period every other week.

Once captured, eels were sedated with MS-222, counted and measured (Figure 2-11). All captured eels were scanned for PIT tags previously inserted by USFWS (Figure 2-12). At the request of USFWS

personnel, PIT tags were implanted into yellow eels captured during the 2011 study period. These tags were provided by USFWS, and the corresponding PIT tag numbers were recorded. After PIT tagging, yellow eels were released back into the Susquehanna River at the point of capture. A subsample of captured elvers and yellow eels was frozen for otolith analysis. All remaining elvers were placed in the USFWS tank located near the West Fish Lift facility for upstream transport.

Water temperature was determined by an ONSET Water Temp Pro2 recording device which was located in the Conowingo spillway at the west ramp. (Figure 2-13). This device measured water temperature on an hourly basis throughout the entire study. Data were retrieved monthly. Data on daily rainfall (measured at Conowingo Dam) and percent lunar fractions at Havre de Grace, MD (www.usno.navy.mil/USNO/astronomical-applications/data-services/lunar-ecl-us) were also collected throughout the study period.

A representative sample of elvers and yellow eels were frozen for otolith removal and aging. Otoliths were removed from the eels, embedded in clear epoxy, and dried for 12 hours. Utilizing a double-bladed, slow speed saw, a 0.2-mm thick transverse section was cut through the nucleus perpendicular to the sulcus. Adhesive was applied to the cut otolith which was then placed on a glass slide. The sample was polished using a series of fine grade lapping films, which were periodically inspected to insure no damage to the polished otolith. After polishing, Toluidine Blue stain was applied to the sample to assist readers when counting the annular rings. All otolith samples were read by two readers. If the two readers agreed on the analysis, the age estimate was accepted. If readers of the slides weren't in agreement on an age, that slide was re-analyzed. If no consensus was met, the otolith was rejected. The age reported herein is the freshwater age (*i.e.*, the numbers of annuli outside the transition mark - the end of larval growth in salt water).

During the 2011 study period, three nighttime surveys were conducted below the Conowingo spillway area to examine potential evening movements of elvers. Correlating with full and new moon periods, two boat crews utilizing headlamps, and LED marine rechargeable spotlights with night vision covers, (red lenses), traversed the spillway area looking for elver abundance. A fourth survey was scheduled but was cancelled due to heavy rains that created unsafe conditions in the spillway area.

3.0 RESULTS

Elvers and yellow eels were sampled between June 24 and September 5, 2011. Heavy rains from Hurricane Irene and Tropical Storm Lee forced the early termination of this year's study. A major spill event at Conowingo Dam was imminent so all equipment was removed on 6 September.

A total of 1,159 eels were collected from the Conowingo Dam spillway in 2011 (Table 3-1). Of these, 1,100 were elvers collected from all elver ramps combined. This represents a substantial increase in the number collected in 2010, when the east elver ramp collected 158 elvers and the west elver ramp collected 8. In 2011, the east elver ramps collected 539 elvers, with 133 harvested in the Enkamat® substrate and 406 captured from the AkwaDrain™ substrate (Table 3-1). Generally, the east ramps collected elvers evenly throughout the study period. However, on July 11, the AkwaDrain™ substrate collected 239 elvers, with none collected in the adjacent Enkamat® ramp. The west elver ramps collected 561 elvers, with 405 harvested in the Enkamat® substrate and 156 collected in the AkwaDrain™ substrate (Figure 3-1). Overall, the majority of elvers were collected in the Enkamat® substrate on the west side (405), and the AkwaDrain™ substrate (406) on the east side. Both of these ramps were located adjacent to walls suggesting that elvers may utilize structures to help orientate them upstream. Elver lengths ranged from 87 to 188 mm TL, with an average size of 124.9 mm (Figure 3-2).

A subsample of elvers (N = 46) and yellow eels (N = 31) caught was frozen for ageing by otolith analysis. All remaining elvers not used for otolith research (1,007) were placed in the USFWS tank located near the West Fish Lift facility for upstream transport (Table 3-2). Yellow eels harvested from the eel pots totaled 59, all of which were collected on the west side. The size of eels collected in the pots ranged from 300 to 689 mm TL, with an average length of 515.4 mm (Figure 3-3). Twenty-seven of the 59 yellow eels were PIT tagged and released back at the point of capture. No recaptures were encountered during the study period.

Water temperature was recorded on an hourly basis throughout the study period. Water temperatures typically rose and fell three to four degrees Fahrenheit each day at all ramps. The water temperature in the Conowingo spillway ranged from a low of 73.7° F on September 3 to a high of 90.8° F on July 24 (Table 3-3). A comparison of water temperature to elver catch revealed no apparent relationships (Figure 3-4).

The 2011study period encompassed three new moon periods (0% lunar phase) and two full moon periods (100% lunar phase). Eels have been observed to move in abundance during new moon periods or periods of little illumination. During the 2010 survey, a correlation between full moon periods and elver collection was observed. The 2011 survey had little data to support any association with movement and

lunar illumination. However, when moon phase is plotted against the number of elvers collected; a slight positive relationship was observed on July 11. (Figure 3-4). July 11 was also the largest single day collection of elvers during 2011.

Three nighttime surveys were conducted in the Conowingo spillway to document locations of elver congregation (Figure 3-5). Elvers were only observed in abundance below crest gate #30 (Figures 2-1 and 3-6). Located immediately downstream of crest gate #30 is a plateau of concrete or macadam. Elvers were observed at this location during all three nighttime surveys. Elvers were also observed, (although not in abundance) near seeps, or areas where water trickled over the spillway sill , and when water cascaded down bedrocks associated near these seeps. In these areas where elvers were observed, predatory fish such as channel catfish, and striped bass also were observed.

Rainfall occurred on 25 of the 74 days during the 2011 elver study. Daily rainfall at Conowingo Dam plotted against the number of elvers collected does not show any relationship between rainfall events and elver movement (Figure 3-7).

Seventy-seven eels were preserved for otolith research. A sample from each size range was collected in the 2011 study. Four otoliths were deemed unreadable. Seventy-three eels were aged successfully. The dominate age group collected (I to V years of age) comprised 60% of the otoliths examined. A large gap in age at years VI to VIII is apparent due to lack of specimens in the 189 to 299 mm size range. Larger eels were aged IX to XVII, plus one eel aged at XIX years (Table 3-4).

The 2011 study ended abruptly due to heavy rainfall from Hurricane Irene and Tropical Storm Lee that forced Conowingo Dam to spill water through forty-three of its fifty crest gates (Figure 3-8).

4.0 DISCUSSION

The low elver catch in 2010 and agency comments provided on that study report prompted some changes for the 2011 study. An additional ramp with a different substrate was added to each spillway sampling location. Additional attraction flow was also provided for both sets of ramps. The west side ramps were located in the same general position as in the 2010 study, but were oriented parallel to the river in 2011 rather than perpendicular in 2010. The east side ramps were relocated due to structural damage at the 2010 sampling location from heavy spring rains. The new location was constructed close to the 2010 placement.

Although the 2011 study period was bookended by heavy rains that attributed to a late start and early finish, the overall elver catch was significantly higher in 2011 (1,159), than in 2010 (258) . Once the study was underway, the elver ramps collected eels for 74 days as compared to 106 days in 2010. Collection of elvers and yellow eels was consistent throughout the entire study period with a few exceptions. The east spillway facility collected 239 elvers from a single ramp on July 11, 2011.

Predation from both land-based animals and birds was not directly observed but may have occurred at the east side. On several collection days, animal tracks were present in the muddy areas near the ramps. This same area exhibited an abundance of avian fecal matter and feathers littered on and around the ramp platform. Predation may have been an issue, but evidence does not exist to quantify. The 2011 catch of elvers was much higher than the total collected in 2010. An increase in elver catch during the 2011 study period may be attributed to additional ramps, (four in 2011, as opposed to two in 2010), additional attraction water and the addition of scent attraction.

In contrast to 2010, both sides of the spillway captured nearly equal numbers of elvers, with the west side collecting slightly more than the east. The absence of eels from ~189 to 299 mm is generally similar to previous year's collections by Normandeau Associates and USFWS. Attempts to collect this size range of yellow eels with smaller-mesh pots (.25 inch) failed. Enkamat® is reportedly size-selective for eels less than 260 mm (Soloman and Beach 2004), but neither Enkamat® nor either type of pot deployed was successful catching eels in the 189 to 299 mm size range.

Elvers were observed during the 3 night surveys below crest gate #30 near the macadam plateau. The macadam and the water cascading over it is an attractant to elvers migrating upstream. Water trapped in the spillway sill after the cessation of full generating conditions, and water seeping from the crest gate provided this attraction flow. Without these two water sources, particularly the leakage from crest gate

#30, water would not flow over the macadam plateau and would likely not attract large numbers of elvers to this particular location.

5.0 2011 USFWS SAMPLING RESULTS

The 2011 USFWS report on elver sampling on the West bank of the Conowingo tailrace is contained in Appendix B. During the 2011 sampling season, USFWS reported that approximately 85,000 elvers were collected from their West side facility and some 62,000 elvers were transported to upstream tributaries of the Susquehanna River in Pennsylvania.

REFERENCES

Soloman, D.J. and M.H. Beach. 2004. Manual for provision of upstream migration facilities for eel and elver. Science Report SC020075/SR2. Environment Agency, Bristol, UK.

TABLE 3-1: DAILY COLLECTION OF YELLOW EELS AND ELVERS FROM EAST AND WEST SPILLWAY AREAS IN 2011.

Date	E. Ramp Enka Mat	E. Ramp Akwa Drain	E. Ramp Cloth Pot	E. Ramp Modified Pot	W. Ramp Enka Mat	W. Ramp Akwa Drain	W. Ramp Cloth Pot	W. Ramp Modified Pot	Lunar %	Rain
6/24	-	-	-	-	-	-	-	-	39	0
6/25	-	-	-	-	-	-	-	-	30	0
6/26	-	-	-	-	-	-	-	-	21	0
6/27	-	-	-	-	0	0	0	0	14	0.01
6/28	-	-	-	-	-	-	-	-	8	0
6/29	-	-	-	-	7	1	5	0	3	0
6/30	-	-	-	-	-	-	-	-	1	0
7/1	-	-	-	-	15	16	0	0	0	0
7/2	-	-	-	-	-	-	-	-	2	0
7/3	-	-	-	-	-	-	-	-	6	0.05
7/4	-	-	-	-	-	-	-	-	13	0
7/5	0	2	0	0	0	0	0	0	22	0
7/6	-	-	-	-	-	-	-	-	32	0
7/7	-	-	-	-	-	-	-	-	43	0
7/8	0	2	0	0	58	2	14	5	50	0.05
7/9	-	-	-	-	-	-	-	-	66	0.8
7/10	-	-	-	-	-	-	-	-	76	0
7/11	0	239	0	0	18	21	0	0	85	0
7/12	-	-	-	-	-	-	-	-	92	0.82
7/13	2	11	0	0	3	17	6	0	97	0
7/14	-	-	-	-	-	-	-	-	100	0
7/15	2	1	0	0	59	18	0	0	100	0
7/16	-	-	-	-	-	-	-	-	98	0
7/17	-	-	-	-	-	-	-	-	94	0
7/18	3	2	0	0	3	13	0	0	88	0
7/19	-	-	-	-	-	-	-	-	81	0
7/20	3	8	0	0	12	7	8	1	73	0.02
7/21	-	-	-	-	-	-	-	-	64	0
7/22	36	11	0	0	5	11	0	0	55	0
7/23	-	-	-	-	-	-	-	-	45	0
7/24	-	-	-	-	-	-	-	-	36	0.04
7/25	3	13	0	0	15	13	0	0	27	0
7/26	-	-	-	-	-	-	-	-	19	0.99
7/27	21	0	0	0	0	0	0	0	11	0
7/28	-	-	-	-	-	-	-	-	5	0
7/29	10	22	0	0	6	2	0	0	2	0.03
7/30	-	-	-	-	-	-	-	-	0	0.02
Totals	**80**	**311**	**0**	**0**	**201**	**121**	**33**	**6**	**1598**	**2.83**

TABLE 3-1: CONTINUED.

Date	E. Ramp Enka Mat	E. Ramp Akwa Drain	E. Ramp Cloth Pot	E. Ramp Modified Pot	W. Ramp Enka Mat	W. Ramp Akwa Drain	W. Ramp Cloth Pot	W. Ramp Modified Pot	Lunar %	Rain
7/31	-	-	-	-	-	-	-	-	1	0
8/1	2	0	0	0	6	0	0	0	5	0
8/2	-	-	-	-	-	-	-	-	11	0.04
8/3	0	5	0	0	6	3	2	0	20	0
8/4	-	-	-	-	-	-	-	-	30	0.12
8/5	1	0	0	0	9	3	0	0	41	0
8/6	-	-	-	-	-	-	-	-	50	0
8/7	-	-	-	-	-	-	-	-	63	0.37
8/8	2	3	0	0	0	0	0	0	74	1.8
8/9	-	-	-	-	-	-	-	-	83	0
8/10	0	0	0	0	5	0	5	5	90	0.33
8/11	-	-	-	-	-	-	-	-	95	0
8/12	4	0	0	0	3	6	0	0	99	0
8/13	-	-	-	-	-	-	-	-	100	0
8/14	-	-	-	-	-	-	-	-	99	1.05
8/15	5	4	0	0	3	3	0	0	96	1.83
8/16	-	-	-	-	-	-	-	-	92	0.07
8/17	3	0	0	0	28	7	5	1	86	0
8/18	-	-	-	-	-	-	-	-	79	0.13
8/19	10	18	0	0	5	1	0	0	71	0.32
8/20	-	-	-	-	-	-	-	-	62	0
8/21	-	-	-	-	-	-	-	-	50	0
8/22	3	7	0	0	47	7	0	0	43	0.22
8/23	-	-	-	-	-	-	-	-	33	0
8/24	2	4	0	0	12	2	2	0	24	0
8/25	-	-	-	-	-	-	-	-	15	0
8/26	9	6	0	0	28	0	0	0	8	0.47
8/27	-	-	-	-	-	-	-	-	3	0
8/28	-	-	-	-	-	-	-	-	0	4.8
8/29	5	36	0	0	13	2	0	0	1	0.014
8/30	-	-	-	-	-	-	-	-	4	0
8/31	5	3	0	0	5	1	0	0	9	0
9/1	-	-	-	-	-	-	-	-	18	0
9/2	2	4	0	0	31	0	0	0	27	0
9/3	-	-	-	-	-	-	-	-	38	0
9/4	-	-	-	-	-	-	-	-	50	0
9/5	0	4	0	0	3	0	0	0	60	0.7
Totals	**53**	**94**	**0**	**0**	**204**	**35**	**14**	**6**	**1730**	**12.26**

TABLE 3-2: NUMBER OF ELVERS PROVIDED TO USFWS FOR UPSTREAM TRANSPORTATION IN 2011.

Date	No. of Elvers
5-Jul-11	16
8-Jul-11	74
11-Jul-11	268
13-Jul-11	29
15-Jul-11	81
22-Jul-11	63
25-Jul-11	47
27-Jul-11	21
29-Jul-11	45
1-Aug-11	7
3-Aug-11	14
5-Aug-11	13
8-Aug-11	19
10-Aug-11	5
12-Aug-11	13
15-Aug-11	15
17-Aug-11	39
19-Aug-11	17
22-Aug-11	62
24-Aug-11	20
26-Aug-11	43
29-Aug-11	39
31-Aug-11	14
2-Sep-11	35
6-Sep-11	8
Total	**1007**

TABLE 3-3: MEAN DAILY WATER TEMPERATURES RECORDED AT THE SPILLWAY ELVER RAMPS, 2011.

Date	Water Temp.
24-Jun-11	80.5
25-Jun-11	81.1
26-Jun-11	80.8
27-Jun-11	80.6
28-Jun-11	80.5
29-Jun-11	81.2
30-Jun-11	81.2
1-Jul-11	80.9
2-Jul-11	81.3
3-Jul-11	81.3
4-Jul-11	82.1
5-Jul-11	83.1
6-Jul-11	83.2
7-Jul-11	83.6
8-Jul-11	83.7
9-Jul-11	83.8
10-Jul-11	84.2
11-Jul-11	84.5
12-Jul-11	85.5
13-Jul-11	85.7
14-Jul-11	84.4
15-Jul-11	84.3
16-Jul-11	84.2
17-Jul-11	84.4
18-Jul-11	84.9
19-Jul-11	86.1
20-Jul-11	87
21-Jul-11	87.9
22-Jul-11	89.1
23-Jul-11	89.8
24-Jul-11	90.8
25-Jul-11	89.7
26-Jul-11	88.8
27-Jul-11	88
28-Jul-11	87.1
29-Jul-11	87.9
30-Jul-11	88.6

Date	Water Temp.
31-Jul-11	88.2
1-Aug-11	88.6
2-Aug-11	88.1
3-Aug-11	86.5
4-Aug-11	85.2
5-Aug-11	85.9
6-Aug-11	85.4
7-Aug-11	85.6
8-Aug-11	86.1
9-Aug-11	86
10-Aug-11	85.5
11-Aug-11	84.8
12-Aug-11	84.1
13-Aug-11	83.2
14-Aug-11	82.2
15-Aug-11	82.4
16-Aug-11	81.8
17-Aug-11	82.2
18-Aug-11	81.9
19-Aug-11	82.1
20-Aug-11	82.2
21-Aug-11	81.9
22-Aug-11	81.7
23-Aug-11	80.8
24-Aug-11	81.2
25-Aug-11	80.9
26-Aug-11	81.2
27-Aug-11	81.1
28-Aug-11	79.5
29-Aug-11	78.3
30-Aug-11	76.6
31-Aug-11	75.3
1-Sep-11	74.6
2-Sep-11	73.9
3-Sep-11	73.7
4-Sep-11	74.2
5-Sep-11	74.8

TABLE 3-4: AGES OF 73 AMERICAN EELS COLLECTED IN THE CONOWINGO DAM SPILLWAY BY SIZE GROUP.

Elver Size Range (mm)										Elver Totals		
75-99		100-124		125-149		150-174		175-274				
Age	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	No.	Percent
I	9	I	2	–	–	–	–	–	–	I	11	25.0
II	1	II	7	II	3	–	–	–	–	II	11	25.0
–	–	–	–	III	5	III	2	–	–	III	7	15.9
–	–	–	–	IV	1	IV	7	IV	6	IV	14	31.8
–	–	–	–	–	–	V	1	–	–	V	1	0.2
											44	

Yellow Eel Size Range (mm)										Yellow Eel Totals		
275-349		350-449		450-549		550-649		650+				
Age	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	No.	Percent
IX	1	–	–	–	–	–	–	–	–	IX	1	3.4
X	1	X	3	–	–	–	–	–	–	X	4	13.7
–	–	XI	1	XI	1	–	–	–	–	XI	2	6.8
–	–	XII	1	XII	4	XII	1	–	–	XII	6	20.7
–	–	–	–	XIII	2	XIII	2	–	–	XIII	4	13.7
–	–	–	–	XIV	2	XIV	2	–	–	XIV	4	13.7
–	–	–	–	XV	1	XV	1	–	–	XV	2	6.8
–	–	–	–	–	–	XVI	2	XVI	1	XVI	3	10.3
–	–	–	–	–	–	XVII	1	XVII	1	XVII	2	6.8
–	–	–	–	–	–	–	–	XVIII	–	XVIII	–	0.0
–	–	–	–	–	–	–	–	XIX	1	XIX	1	3.4
											29	

FIGURE 2-1: LOCATION OF ELVER RAMPS, AND EELS POTS FISHED IN SPILLWAY REACH BELOW CONOWINGO DAM.

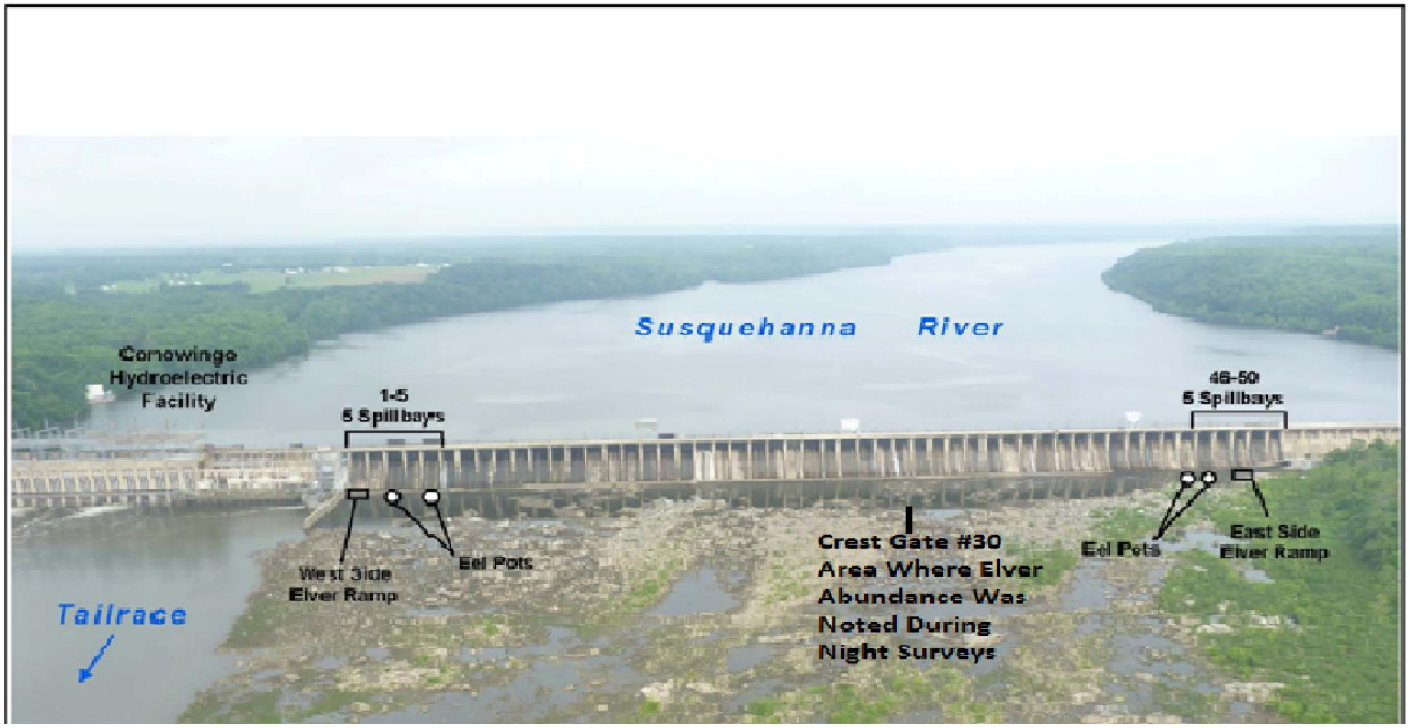

FIGURE 2-2: ENKAMAT® AND AKWADRAIN™ SUBSTRATE.

FIGURE 2-3: WEST SIDE ELVER RAMPS WITH ADDITIONAL ATTRACTION WATER.

FIGURE 2-4: COMPARISON AND SAMPLING LOCATIONS OF 2010 AND 2011 WEST SPILLWAY RAMP LOCATION.

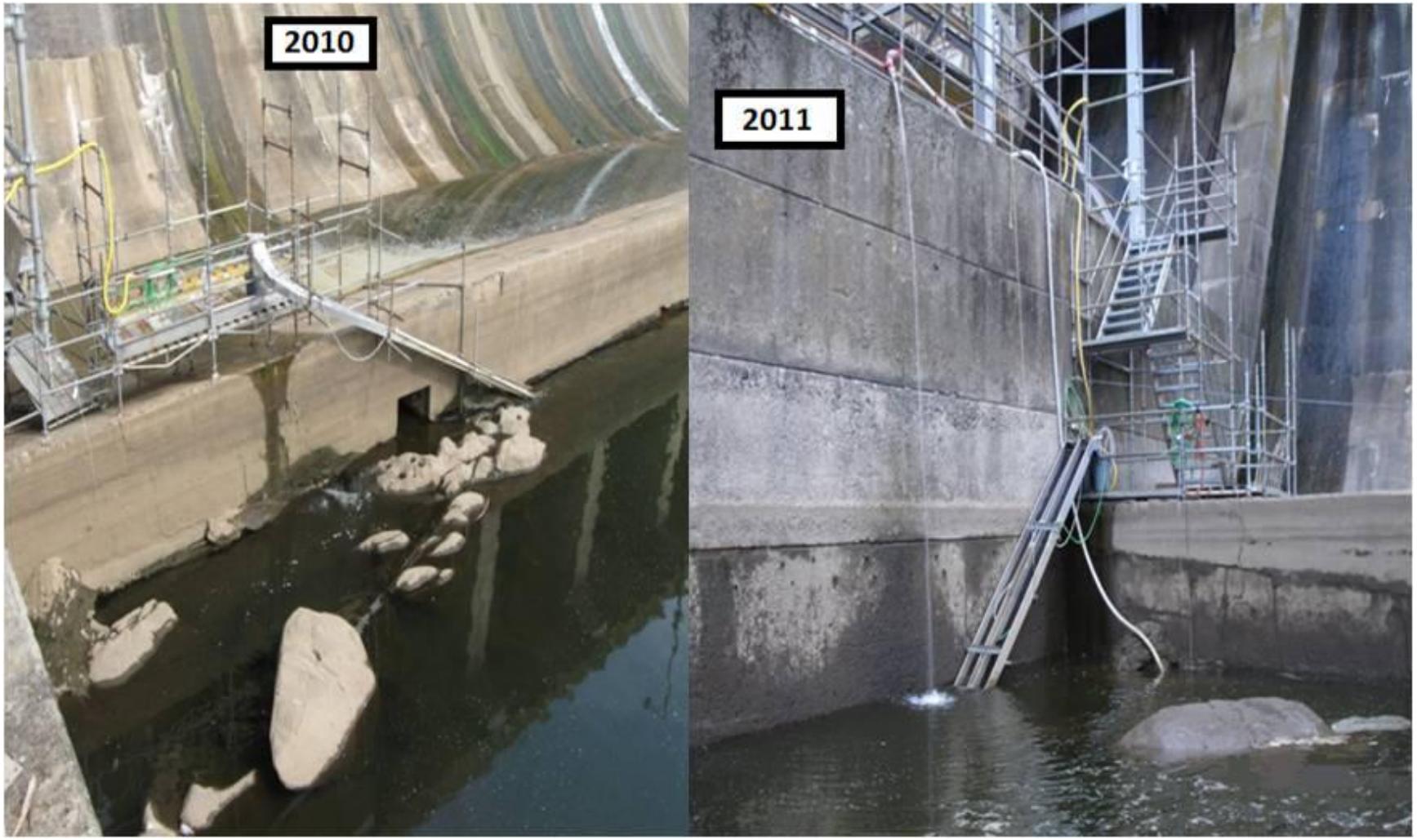

FIGURE 2-5: LOCATION AND CONFIGURATION OF EAST SIDE ELVER RAMPS IN 2010 AND 2011.

FIGURE 2-6: EAST RAMP WITH NATURAL ATTRACTION FLOW FROM INTERMITTENT STREAM.

FIGURE 2-7: CONSTRUCTION OF ELVER RAMPS USING TWO DIFFERENT SUBSTRATES.

FIGURE 2-8: WATER SUPPLY MANIFOLD, SPRAY BARS, AND HOLDING CONTAINERS.

FIGURE 2-9: PHOTO OF SPRAY BAR AND ADDITIONAL FLOW.

FIGURE 2-10: BAITING AND SETTING EEL POTS.

FIGURE 2-11: PROCESSING OF COLLECTED SPECIMENS.

FIGURE 2-12: COLLECTION OF YELLOW EELS AND PITT TAG SCANS.

FIGURE 2-13: WATER QUALITY MEASURING DEVICE, HOBO.

FIGURE 3-1: COMPARISON OF ELVER CATCH TO ENKAMAT® AND AKWADRAIN™ SUBSTRATES.

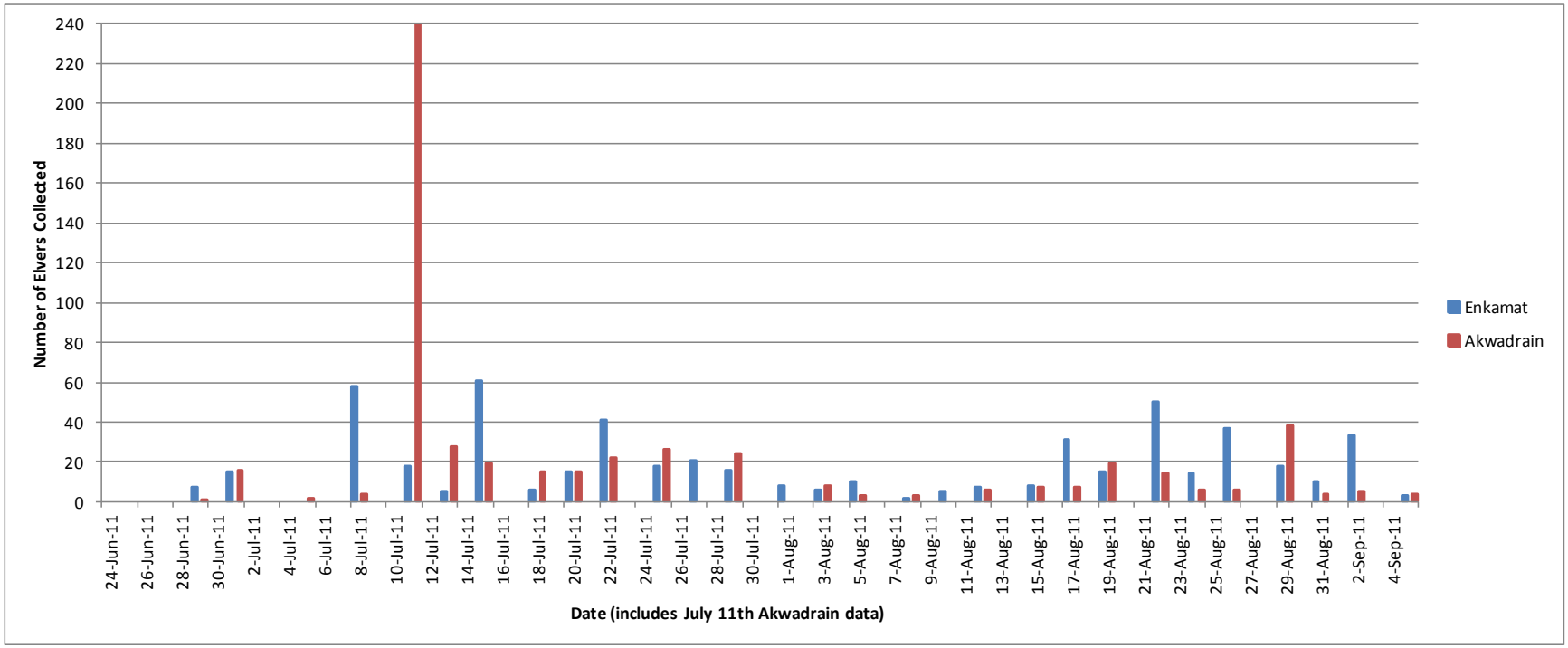

FIGURE 3-1: CONTINUED.

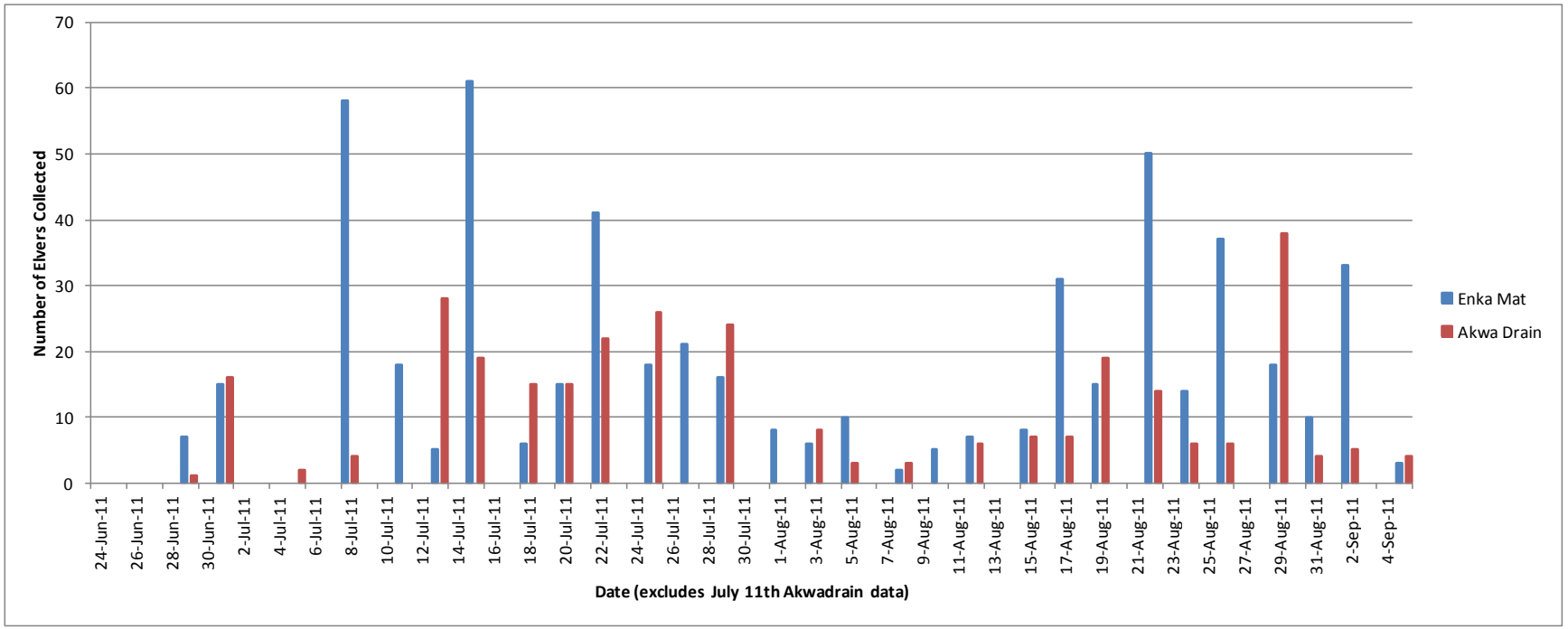

FIGURE 3-2: SIZE RANGE OF ELVERS CAUGHT IN SPILLWAY RAMPS.

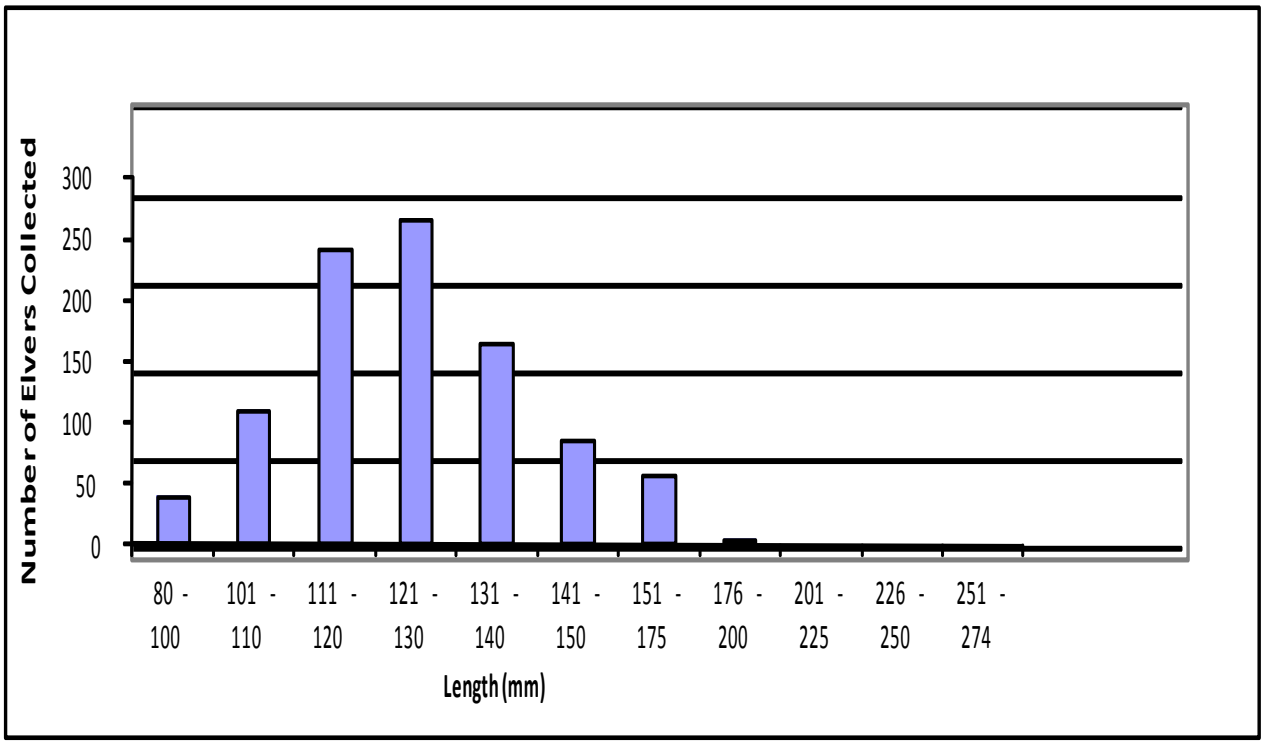

FIGURE 3-3: SIZE RANGE OF YELLOW EELS CAUGHT IN SPILLWAY POTS.

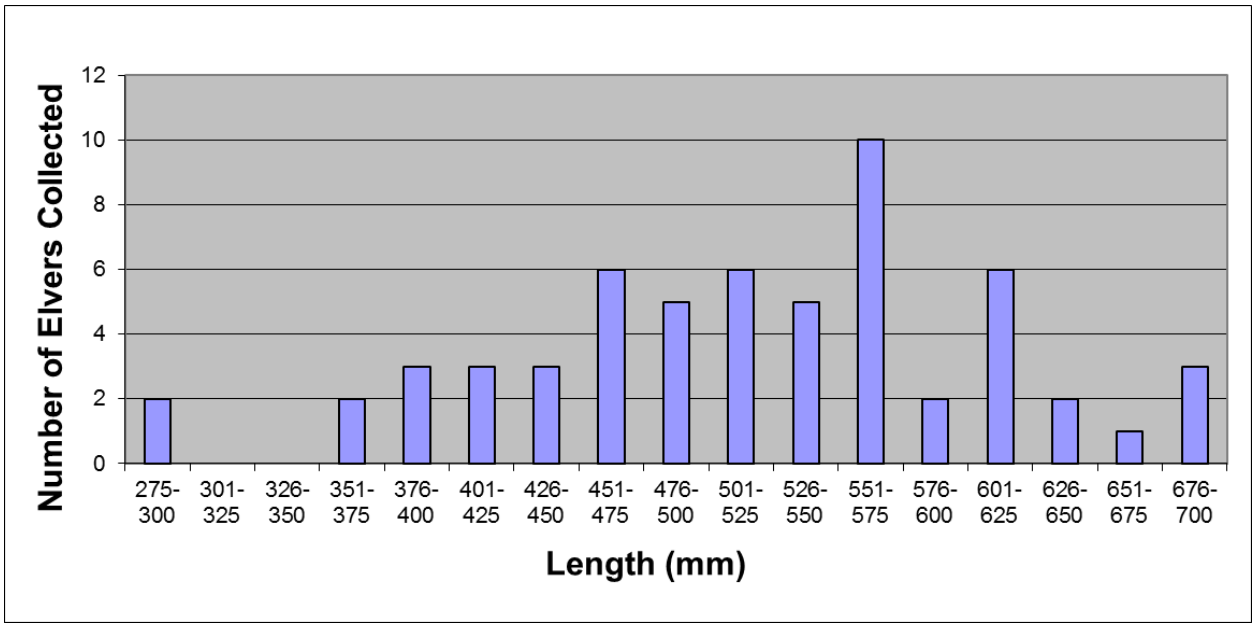

FIGURE 3-4: ELVERS COLLECTED IN RELATION TO WATER TEMPERATURE (°F) AND LUNAR CYLCE IN THE CONOWINGO SPILLWAY.

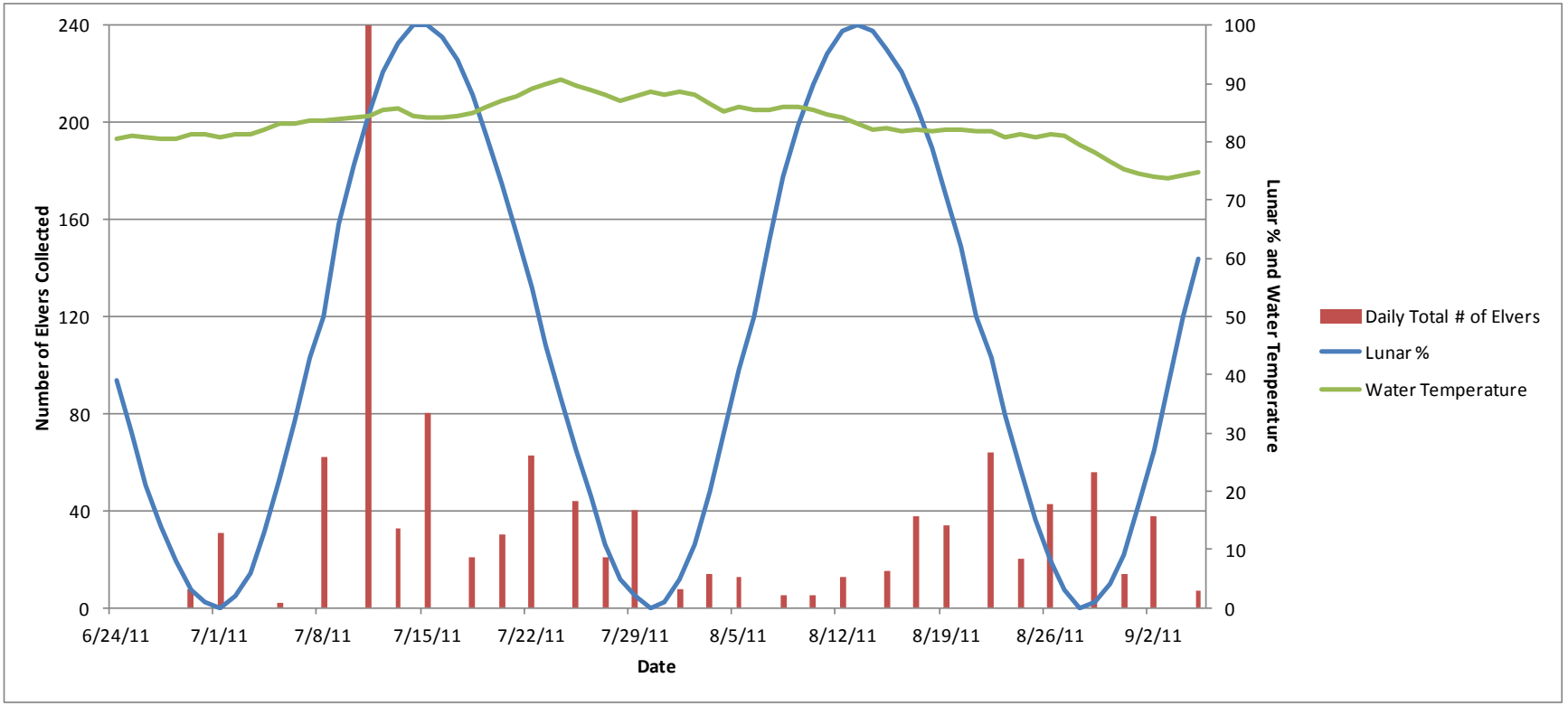

FIGURE 3-5: EVENING ASSESSMENT OF ELVER MOVEMENT.

FIGURE 3-6: AREA IN FRONT OF SPILLBAY 30 WHERE ELVERS WERE OBSERVED.

FIGURE 3-7: NUMBER OF ELVERS COLLECTED IN SPILLWAY RAMPS IN RELATION TO RAINFALL (INCHES) AT CONOWINGO DAM. EXCLUDES DAYS OF NO RECORDED RAINFALL.

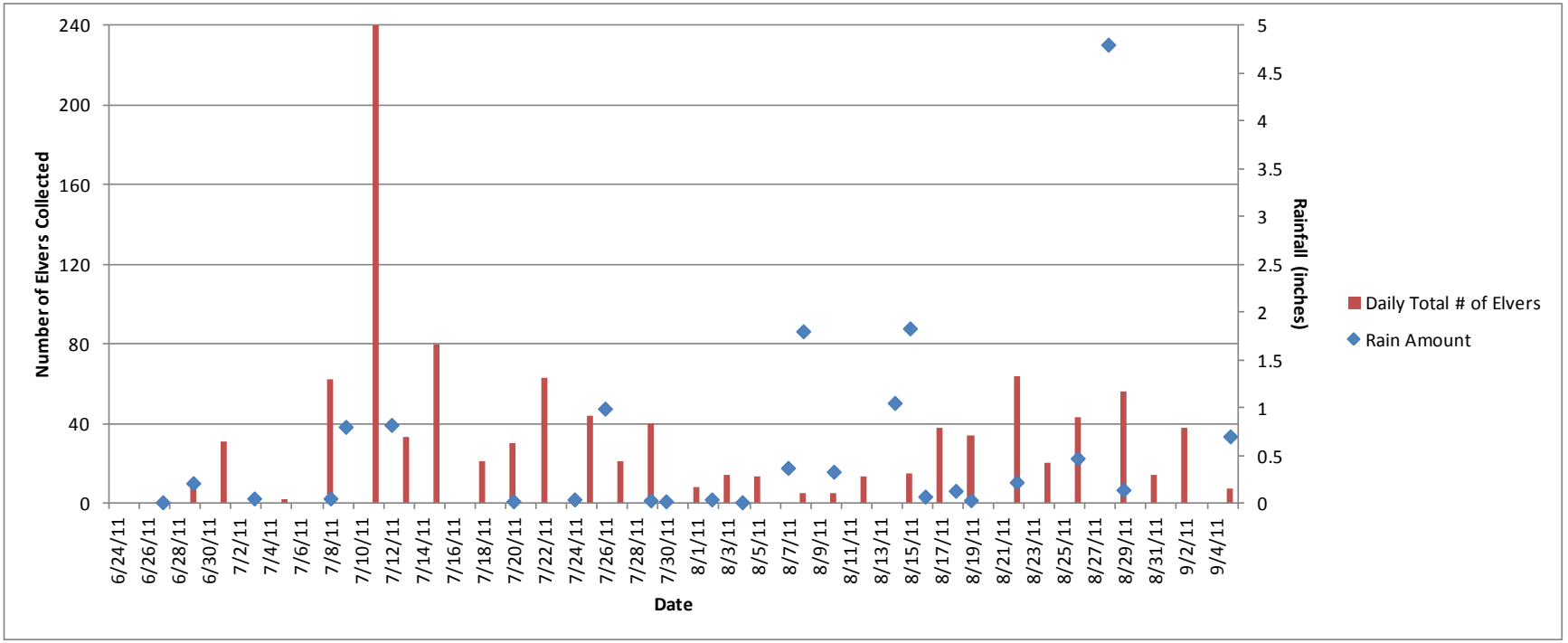

FIGURE 3-8: HURRICANE IRENE AND TROPICAL STORM LEE ENDED THE 2011 SEASON.

APPENDIX A -2011 STUDY PLAN

2011 STUDY WORK PLAN
CONOWINGO HYDROELECTRIC PROJECT

May 13, 2011

3.3 Biological and Engineering Studies of American Eel at the Conowingo Project

3.3.1 Study Request

The FERC, Lower Susquehanna Riverkeeper, MDNR, PaDEP, PFBC, SRBC, and USFWS have requested engineering and biological studies to assess the passage of American eel over the Conowingo Dam. The study requests generally recommend the following elements: (1) assessment of the optimal location for an upstream American eel passage facility; (2) an assessment of the rate of drop-back of migrating American eels; and (3) documentation of seasonal eel abundance and size/age distribution below the Conowingo Dam. Exelon does not plan to address Study Request Component 2 (drop-back study) during the field studies that gather siting and biological data, per the recommendation by MDNR to defer this aspect in their study request letter. Rather, this field study would be more appropriate pre-construction during evaluations of potential design and exit location for an upstream eel passage facility.

In section 5.0 of the Conowingo PAD, Exelon proposed to complete a literature based study on American eel to: (1) summarize available scientific and commercial information; (2) identify suspected factors affecting the American eel population; (3) examine the engineering feasibility of upstream and downstream passage options for American eel; and (4) examine the potential impact of upstream and downstream passage of American eels in the Susquehanna River on the American eel population.

3.3.2 Existing Information (18 CFR § 5.11(d)(3))

Results of 2010 elver and yellow eel biological studies performed in the tailrace (by USFWS) and spillway (by Exelon) below Conowingo Dam were submitted to FERC and participating agencies for review on February 22, 2011. Elvers and yellow eels were sampled between June 14 and September 30, 2010**.** A total of 258 eels were collected on the spillway side of Conowingo Dam. Of these, 166 were elvers collected from the elver ramps. The east elver ramp collected 158 elvers, while the west elver ramp collected eight. Elver lengths ranged from 92 to 154 mm TL. Baited eel pots yielded 91 yellow eels and one elver. The east-side eel pots collected one yellow eel, while the west-side pots collected 90 yellow eels. The length range of yellow eels collected in pots ranged from 301 to 640 mm TL. Seven yellow eels were fin-clipped recaptures from the location where tagged.

Otoliths from 65 eels were aged. Most elvers were age I or II, although 15% had spent four years in fresh water. Most yellow eels were aged VII, VIII, or IX. However, ages IV through VI were likely under sampled by the gears utilized since no eels were collected between 155-300 mm.

The findings in 2010 suggested that the comparatively low numbers of elvers collected in the spillway (relative to 24,000 elvers collected by USFWS in the tailrace) may have resulted from a delayed start, or possibly from additional factors including attraction flow volume, ramp substrate material, and/or ramp location. Consequently, Exelon plans to repeat the spillway study in 2011 to acquire additional information while adjusting for, to the extent feasible, any effects of those factors identified above. For example, different substrate material may allow collection of small yellow eels between 150-300 mm that eluded capture in 2010. Section 3.3.6 below presents plans to collect additional biological information in the spillway area in 2011.

3.3.2 Resource Management Goals (18 CFR § 5.11(d)(2))

The SRAFRC Alosid Management and Restoration Plan for the Susquehanna River Basin was completed November 15, 2010 and provides for restoration of American eels to their historical habitats above dams. ASMFC's eel management plan calls for provision of upstream eel passage facilities at dams throughout the Atlantic coast of the United States.

3.3.3 Purpose (18 CFR § 5.11(d)(1))

The purpose of the 2011 study is to: 1) describe the spatial distribution and size characteristics of American eels in the Conowingo tailrace; 2) identify potential locations for an upstream eel passage facility at Conowingo Dam. Thus, the goals are to refine and improve upon the information learned during the 2010 study.

3.3.4 Project Nexus (18 CFR § 5.11(d)(4))

Conowingo Dam is an impediment to upstream passage of American eel.

3.3.5 Investigation Area

The study area for the desktop portion of this study plan includes the lower Susquehanna River from Conowingo Dam upstream to above the York Haven Dam. The field biological studies will occur in the Conowingo tailrace and below the spillway.

3.3.6 Methodology (18 CFR § 5.11(b)(1), (d)(5)-(6))

Task 1: Field Studies in 2011

Task 1A—Collect Eel Spatial distribution data in the tailrace and spillway pool

Spatial distribution and abundance data will be collected from the tailrace and from below the spillway. Recent USFWS methodology in the tailrace has utilized separate gear types to capture elver-stage eels and larger yellow eels. Exelon will utilize both elver ramps and baited eel pots to collect a broad range of eel sizes within the spillway pool.

Elvers in the tailrace will be collected using the USFWS ascent ramp(s) and collection facility on the west bank. The USFWS west bank facility is typically deployed in May and will be sampled regularly (2-3 times per week) through late summer. This is already a known location where elvers congregate in sizeable numbers. Seasonal abundance and biological data may be obtained from this location.

Historical observations of elver use of the spillway pool exist from the 1960s to the 1980s. Elvers in the spillway pool will be collected by a system of self-contained devices consisting of elver ascent ramps and collection buckets. One station will be located on the spillway lip, adjacent to the east fish lift, and a second station located on the spillway lip adjacent to the eastern river shore. Similar systems have been used below the Roanoke Rapids (NC) Project and others to collect eels in a spillway area. Exelon safety standards will be followed for these locations. The spillway pool collection ramps will be fished from late May through October 2011. This study period is contingent upon the termination of spill conditions at the Project. Upon start-up of ramp and attraction flows, elver ramps will fish continuously and be visited each Monday-Wednesday-Friday each sampling week. If elver numbers dictate, more frequent visits to tend collection tanks or larger collection tanks will be utilized as necessary. This component will determine seasonal use of the spillway pool by elvers as well as contrast spatial abundance with the tailrace.

In 2010, Enkamat substrate was used in the elver ramps, conforming by study design to techniques used over several years in the tailrace ramps utilized by the USFWS. In March 2011, Normandeau biologists attended an eel symposium in Gloucester, MA and intend to incorporate ideas gleaned from the meeting into the design of the elver ramps for the 2011study. Alternate substrate materials will be examined and one selected for use in combination with Enkamat. For example, an alternate substrate such as Akwadrain or equivalent will be fitted to an elver ramp used in tandem with a ramp with Enkamat to compare efficacy. Moreover, such a substrate ideally would pass elvers as well as yellow eels. For this study, attraction flow will be provided simultaneously to both ramps, if the water source is able to provide sufficient flow volume. Substrate coverage will be refined to better lead eels to the collection facilities, as will ramp flow through the substrate.

Among other potential modifications to increase the efficacy of the ramps, further research prior to 2011 start-up will examine appropriate ramp angles for the length of ramp used and the amount of attraction flow. Attraction flow is important and the volume achieved in 2010 may have been too little to attract elvers, given the volume and number of spillway lip overflows available. Attraction flow will be increased as feasible given the in-house supply capability. Periodic review of catch results and ramp performance may also lead to changes to ramp structure throughout the study period. Periodic nighttime observations of the study equipment and surrounding spillway area may be necessary to help ascertain best placement of the catch-gear in the spillway area. Such observations may lead to mid-season relocation of ramp entrances if feasible. Exelon will conduct up to four night surveys of the spillway lip/pool area, timed to match high/peak catch rates of elvers in the spillway and the USFWS WFL facility (June/July 2011). Exelon is currently establishing safety protocols for field crews when conducting these nighttime surveys.

Yellow eels in the tailrace and spillway pool will be collected with baited eel pots. Spillway pool eel pots will be fished at intervals along the spillway lip where lock-out and safety protocol permits. Typically, about 0.5 pound of bait is adequate for a 48-h set. Eel pots will be modified to catch a broader range of size classes. The eel pots will be fished bi-weekly from May through October or as tailrace and spillway pool conditions permit.

Task 1B—Collect Biological and Physical Data

Captured eels will be counted, measured, and scanned for PIT tags. Large counts of elvers may be estimated volumetrically. Yellow eels from both locations will be measured. The first ten specimens from six representative size ranges will be sacrificed for age analysis via otoliths. All remaining yellow eels will have pectoral fins clipped; right pectoral fin for eels captured in east spillway pots, left pectoral for west, then provided to the USFWS for insertion of PIT tags (personal communication with Steve Minkkinen (USFWS). Representative samples of tailrace and spillway pool elvers will be measured. A representative sample from a variety of predetermined size classes will be sacrificed for otolith analysis, including those in the 151 to 300 mm size range that have been uncommon in sampling to date. All other elvers will be placed into the USFWS west bank facility for transport if desired.

Daily and weekly catch data will describe temporal occurrence in relation to several physical variables. Physical data recorded for each sample will include: water temperature, rainfall during the sample period, and percent lunar fraction. Tailrace water temperatures will be obtained from the Exelon tailrace continuous monitor (Station 643). Spillway pool temperatures will be monitored with two ONSET temperature loggers, one at each end of the spillway pool. Percent lunar fraction for a nearby location will be obtained from the Naval Observatory website.

Size structure from each gear type will be determined, including how size structure changes during the sampling season. Size structure informs the choice of substrate material for any upstream passage device.

Task 2: Develop Study Report

Study results will be summarized in a report that will include the study methodology, results of the desktop and field studies, and conclusions. The report will be distributed to interested stakeholders and submitted to the FERC.

3.3.7 Level of Effort and Cost (18 CFR § 5.11(d)(6))

Exelon believes that the proposed level of effort is adequate to analyze this issue. The estimated total cost for the field study outlined in this plan is approximately $100,000.

3.3.8 Study Reporting and Schedule

In accordance with 18 CFR § 5.15(c)(1), a Study Report will be prepared and submitted to FERC and resource agencies by January 21, 2012.

APPENDIX B - USFWS 2011 EEL COLLECTION REPORT, CONOWINGO DAM TAILRACE

American Eel sampling at Conowingo Dam 2011

Steve Minkkinen, Ian Park, Maryland Fishery Resources Office, 1/25/2012

Background

Eels are a catadromous species that ascend freshwater environments as juveniles then reside in riverine habitats until reaching maturity at which time they migrate to the Sargasso Sea where they spawn once and die. Larval eels are transported by ocean currents to rivers along the eastern seaboard of the continent. Unlike anadromous shad and herring, they have no particular homing instinct. Historically, American eels were abundant in East Coast streams, comprising more than 25 percent of the total fish biomass in many locations. However, Atlantic coast commercial landings have been declining sine the 1970's.

The Atlantic States Marine Fishery Commission Fishery Management Plan for American Eel lists access to freshwater habitat as a priority for protecting the population. Although the Chesapeake Bay and tributaries support a large portion of the coastal eel population, eels have been essentially extirpated from the largest Chesapeake tributary, the Susquehanna River. The Susquehanna River basin comprises 43% of the Chesapeake Bay watershed. Construction of Conowingo Dam in 1928 effectively closed the river to upstream migration of elvers at river mile ten (Figure 1).

Mainstem Susquehanna fish passage facilities (lifts and ladder) were designed and sized to pass adult shad and herring and are not effective (due to attraction flow velocities and operating schedules) in passing juvenile eels (elvers) upriver. Specialized passages designed to accommodate elvers are needed to allow them access to the watershed above dams.

Survey methods and Equipment Placement

To determine the best method to reintroduce eels into the Susquehanna River above Conowingo Dam, we have collected baseline information on eel abundance, migration timing, catch efficiency, and attraction parameters at the base of the Conowingo Dam since the spring of 2005. Information from the study will assist in determining the potential for reintroducing eels into the Susquehanna watershed above Conowingo Dam.

The 2011 American eel sampling below Conowingo took place on the west side of the dam adjacent to the West Fish Lift. This sampling served as an attempt to further survey the population of juvenile eels (elvers) at the base of Conowingo Dam. In 2007, elvers were observed climbing up the rip rap where water was spilling over from pumps operated to supply water for the West fish lift operations. From 2008 through 2011 we used this excess water as attraction flow for our elver trap, constructed from industrial cable tray with landscape fabric attached to the bottom (Figure 2). Elvers that found this attraction flow would crawl up the rip rap to the trap and then climb into the trap. The top of the cable tray emptied into a fine mesh collection bag placed in collection tanks (Figure 3). Aerated water was supplied to the collection and holding tanks using a 1/8 HP Sweetwater™ Blower. In 2009 and 2010 we made an attempt

to attract elvers directly from the Susquehanna River at the base of the riprap as well. In 2011 we discontinued the experimental trap going down to the river's edge. Elvers were sedated with, Finquel Tricane Methanesulfonate (MS-222), measured for total length (TL), and individually counted. Large numbers of eels were counted volumetrically. The collection of substantial numbers of eels allowed for the experimental stocking of elvers into Buffalo Creek, Pine Creek and Conowingo Creek. Stocking in Buffalo Creek and Pine Creek is part of a compensatory mitigation for the Sunbury Riverfront Stabilization Project for the City of Sunbury (DA Permit Application Number: NAB 2005-02860-PO5) (attachment 1).

All of the elvers stocked were marked with a 6 hour immersion in buffered oxytetracycline (OTC) at a concentration of 550 ppm prior to release. A subsample of elvers captured was also sent to the Lamar Fish Health Center (Lamar, PA) for disease testing before any stocking occurred.

In previous years, eel pots with a 6 mm square mesh were set around the base of the West Fish Lift to catch larger eels. In 2011, we changed our collection device from a cylindrical eel pot to a double throated rectangular trap with a 25 mm by 13 mm mesh that is more consistent with local commercial gear. Yellow eels captured in eel pots were sedated with a concentrated solution of MS-222 (450g/L), measured, fin clipped, and had a Passive Integrated Transponder (PIT) tag inserted in the dorsal musculature and released.

In 2011, young-of-year (glass eels) were collected by Maryland Department of Natural Resources (Maryland DNR) in Turville Creek, MD. These eels were then transported to the United State Geological Survey lab in Wellsboro, Pennsylvania. The glass eels were held in the lab until June, and then released in Buffalo and Pine Creek (Table 1).

Results

Eels were sampled between 23 May and 8 September 2011 and elvers were collected throughout the sampling timeframe (Table 2). A total of 85,000 elvers were collected during 2011 with the majority collected in two pulses. The first wave occurred in the month of July and the second wave occurred at the end of August through the beginning of September during high flows associated with hurricane Irene and tropical storm Lee. Sampling ended abruptly due to flooding subsequently caused by tropical storm Lee. The seasonal pattern of migration in 2011 was similar to that observed in 2008 when a majority of the eel collection occurred in the end of June through the end of July. During 2009 the migration was later and more protracted with the majority of elvers being collected in the end of July through August. In 2008, 2010 and 2011 we saw multiple waves of elvers throughout our sampling efforts; where as in 2009 there did not appear to be spikes in collections, but more of a steady level of migration through the sampling period (Figure 4).

Juvenile eel lengths ranged from 84 to 225 mm TL (Figure 5), slightly larger than previous years sampling. In 2011, 75%of elvers measured were between 110 and 149 mm, and from 2005-2009 56% of elvers measured were between 110 and 149 mm.

Yellow and silver eel collections in eel pots have taken place from 2007 - 2011. In 2011, we caught 224 yellow and silver eels that ranged from 333 to 659 mm TL. Of the 224 captures, 127 eels had new PIT tags inserted, 55 were recaptures from tagging done in 2011 or in previous year, and the rest were released without being tagged. This year we caught significantly more yellow and silver eels than in previous years. The largest number of yellow and silver eels previously caught was in 2009, when we had 68 new captures (Table 3). The addition of the 127 new captures brings the total number of PIT-tagged yellow eels in the study to 289. We are tracking annual growth rates of the 31 PIT tagged eels that have been recaptured after at least one year after tagging (Table 4).

A total of ten stockings from elvers captured at Conowingo Dam were conducted, with an estimated total of 62,000 elvers being stocked in Buffalo, Pine and Conowingo Creek (Table 1).

To evaluate stocking success at Buffalo and Pine Creek, we conducted electrofishing surveys using 3 backpack shockers and a barge shocker in August 2011. We duplicated methods used by the Maryland Biological Stream Survey (2007) to quantify the catch per unit effort (CPUE) and the biomass of eels. Two sites, bracketing the eel release sites, in each creek were surveyed (Table 1). At each site, 75 meters of stream were blocked off using ¼" mesh block net. In order to quantify the fauna in the stream, two passes with the electrofishing units were conducted and all species of fish collected were enumerated. Captured eels were measured to assess growth and a subsample of the eels collected was brought back to confirm previous marking of otoliths by OTC. In August of 2011, 441 elvers were recaptured in Buffalo Creek. All but 9 of these were recaptured at the Strawbridge Rd site. An attempt was made to sample at the foot bridge on Rte. 1003 but high flows prevented a depletion study from being conducted. The average TL of stocked elvers from Conowingo was 127 mm, and the average TL of glass eels stocked was 80mm, while the average TL of recaptured eels in Buffalo Creek was 137 mm (Figure 6). Sampling Pine Creek in 2011 provided 20 recaptured elvers, 12 of which were recaptured at the Darling Run site, and the rest were caught at the Ansonia Bridge site. The average TL of recaptured eels in Pine Creek was 143 mm. In addition to eels, 4,854 individuals of 30 fish species were collected in Buffalo Creek and 3,663 individuals of 23 fish species were collected in Pine Creek during electrofishing surveys. (Minkkinen et al. 2011)

Maryland DNR conducts an American eel young of year (glass eel) survey to characterize trends in American eel recruitment over time (ASMFC 2000). Sampling takes place at Turville Creek, MD using a modified Irish elver ramp. We compared estimated recruitment of glass eels from Turville Creek to captures of elvers below Conowingo dam one year later. Based on four years of data it appears that the glass eel recruitment index at Turville Creek does predict elver abundance the following year at Conowingo Dam (Figure 7).

A subsample of elvers was sacrificed to evaluate the presence of the parasite *Anguillicola crassus*. A total of 46 eels were euthanized using MS-222, then examined for the presence of *Anguillicola crassus* in the swim bladder. The samples were collected in 2010 and 2011, with 19 samples from 2010 and 27 samples from 2011. *Anguillicola crassus* was found in 22 of the samples, with the highest infection rate of 6 being found in one eel. There does not appear to be any relation between the length of an eel and the infection rate (Figure 8) or an increase in infection rate from one year to the next.

Discussion

Throughout the project we have compared elver captures to several environmental factors. This year we increased the environmental factors analyzed. The factors we looked at were lunar fraction, river flow in Havre De Grace MD, barometric pressure, air temperature, daily precipitation levels, and the average daily values of dissolved oxygen, salinity, water temperature, pH, turbidity, and chlorophyll. In years past we have not been able to determine what environmental factors control the timing of the elver migration below Conowingo Dam. Typically elvers reach the dam between the first week of May through the end of June and peak captures usually occur in June and July. Using Pearson correlation it appears that turbidity, river flow and precipitation have the largest correlation value and these three values are directly related to one another (Table 5). With an increase of rain, for example the tropical storm that was observed this year, there was an increase in elver collection.

Interruptions in power supply to our pumps have impacted elver catch on several occasions. We have implemented several sampling design changes in an attempt to ensure that we would have an uninterrupted supply of water throughout the sample period. We have also increased the size of our collection and holding tanks in an effort to increase survival and decrease stress while holding the elvers for stocking. These measures have improved our ability to capture and hold larger numbers of elvers for stocking above the dam.

In 2012 we will attempt to release an additional 36,000 elvers in Pine Creek. We also will attempt to release elvers into Conowingo Creek in Maryland and Buffalo Creek in Pennsylvania. Elvers will be marked with OTC before being released. The Maryland Biological Stream Survey plans on conducting surveys in Conowingo Creek to evaluate the stocking effort. The Maryland Fishery Resources Office will survey elvers released in Buffalo Creek and Pine Creek using methods identical to those used in 2010 and 2011.

Figure 1. Map of the Maryland Biological Stream Survey (MBSS) sampling sites of tributaries to the Susquehanna River in Maryland. The numbers in boxes indicates eel counts at each sampling site. Note the difference in densities of eels in tributaries below Conowingo Dam compared to above the Dam.

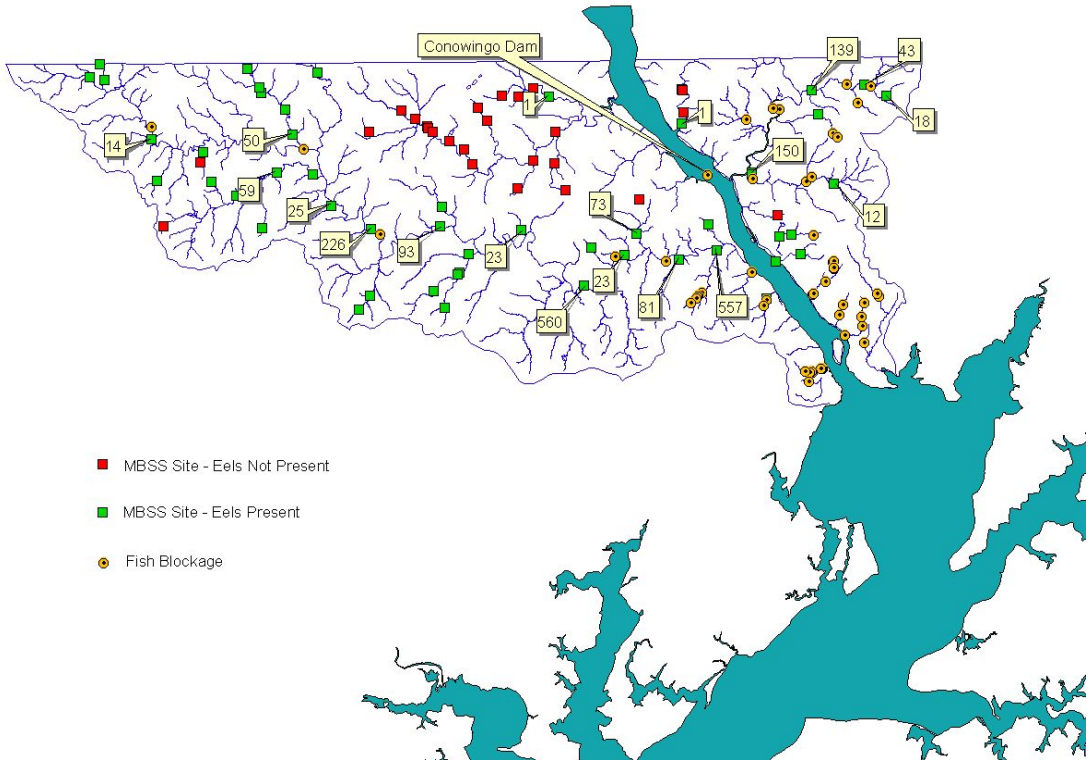

Figure 2. Eel trap constructed of industrial cable tray and landscape fabric.

Figure 3. The cable tray emptying into a collection bag in a holding tank.

Figure 4 Elver capture in relation to date for 2008 – 2011.

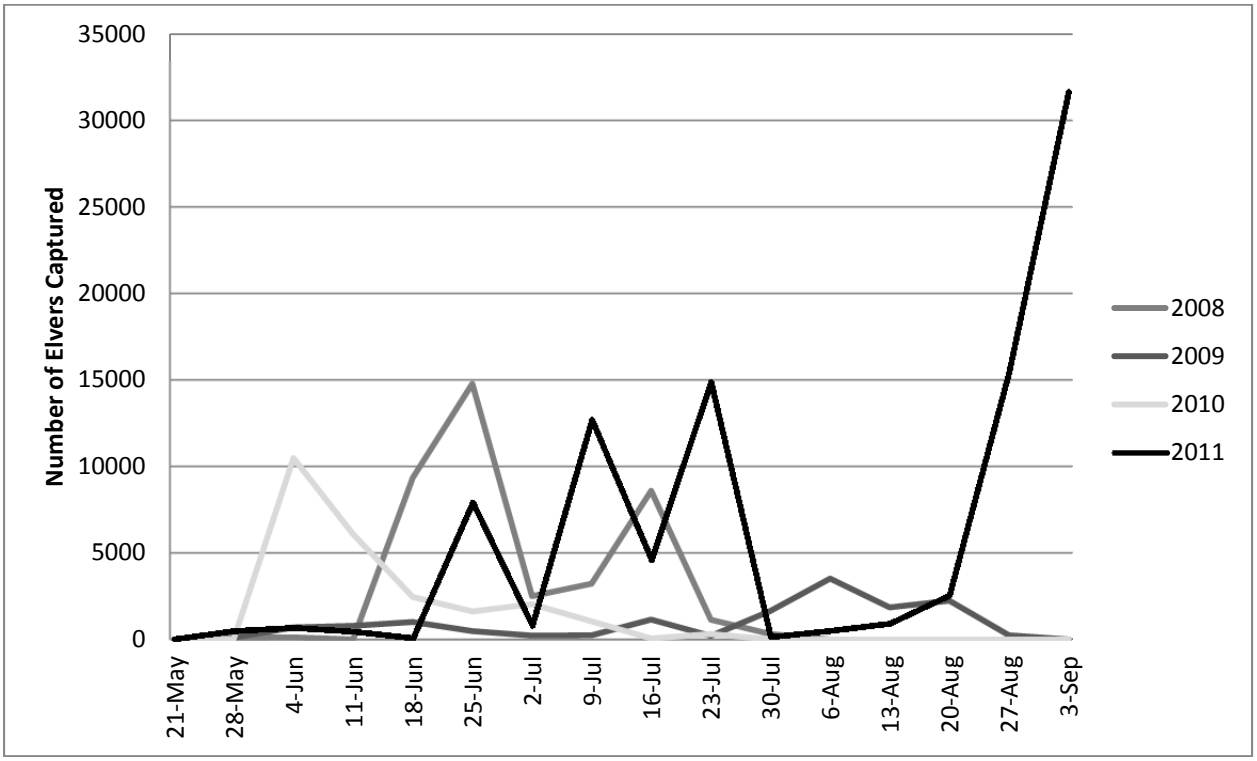

Figure 5 Length frequency of elvers captured below Conowingo Dam 2005-2011.

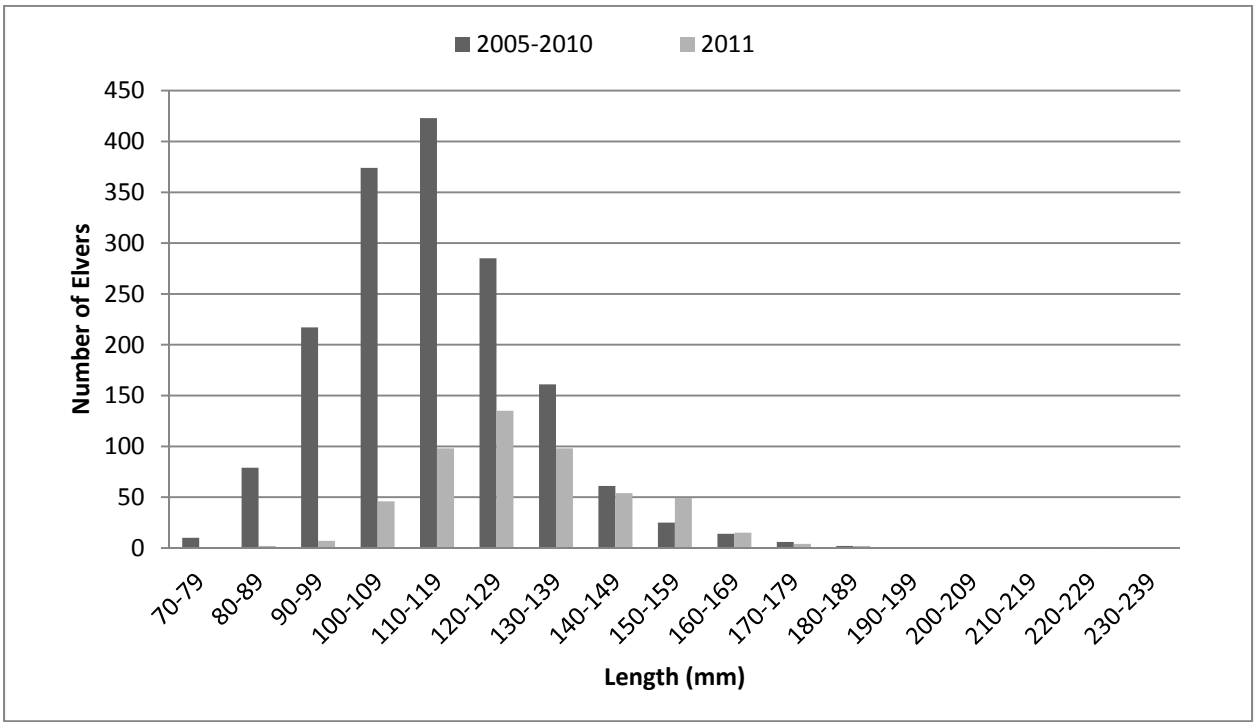

Figure 6 Length frequency of elvers recaptured in Buffalo Creek 2011

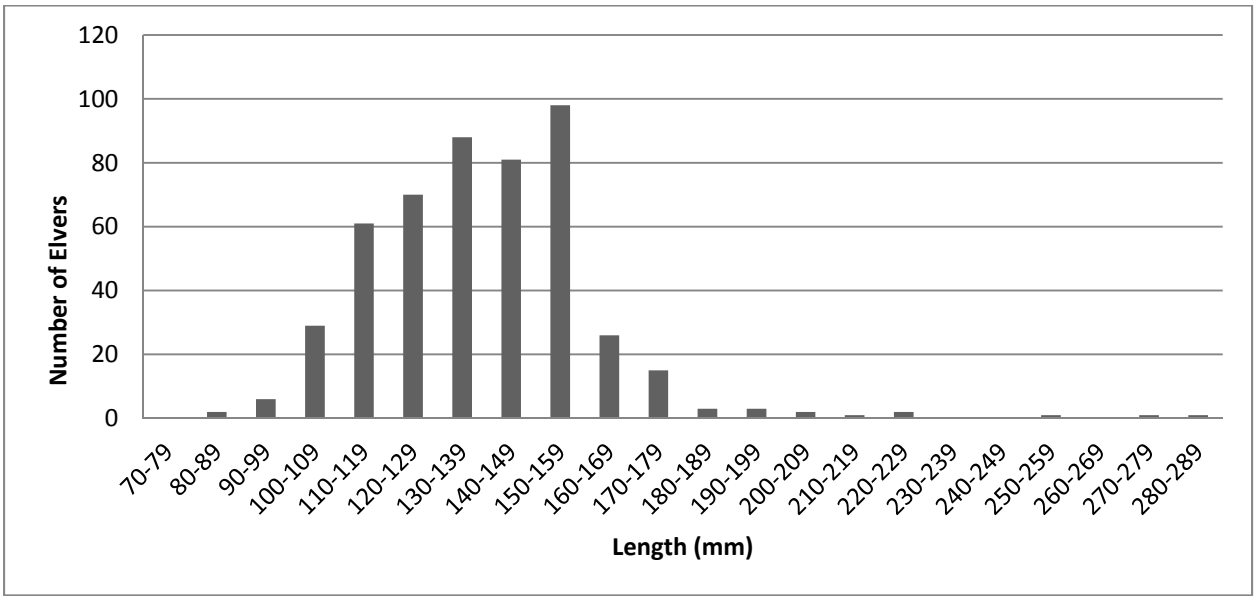

Figure 7 Yearly catch rates of glass eels from Turville Creek and elvers from Conowingo Dam

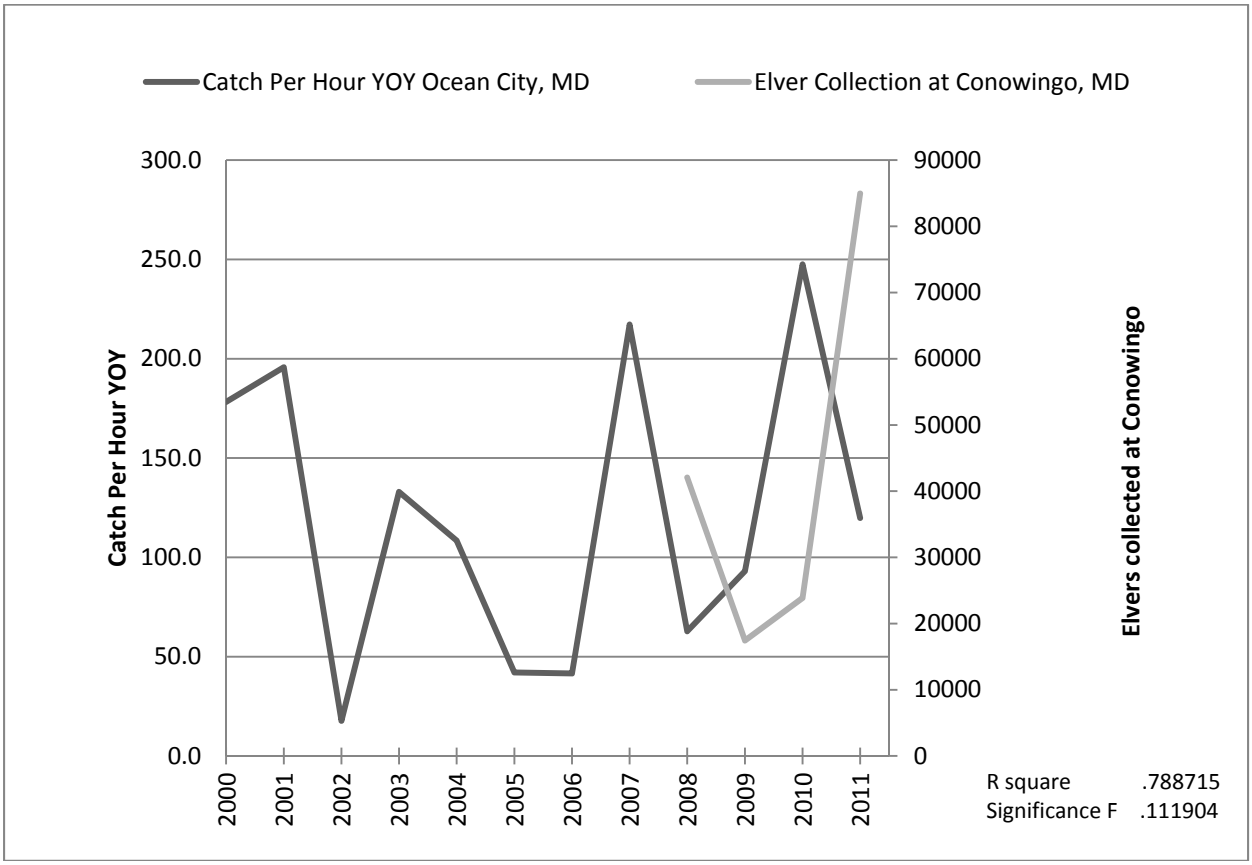

Figure 8 The number of *Anguillicola crassus* present in different lengths of elvers.

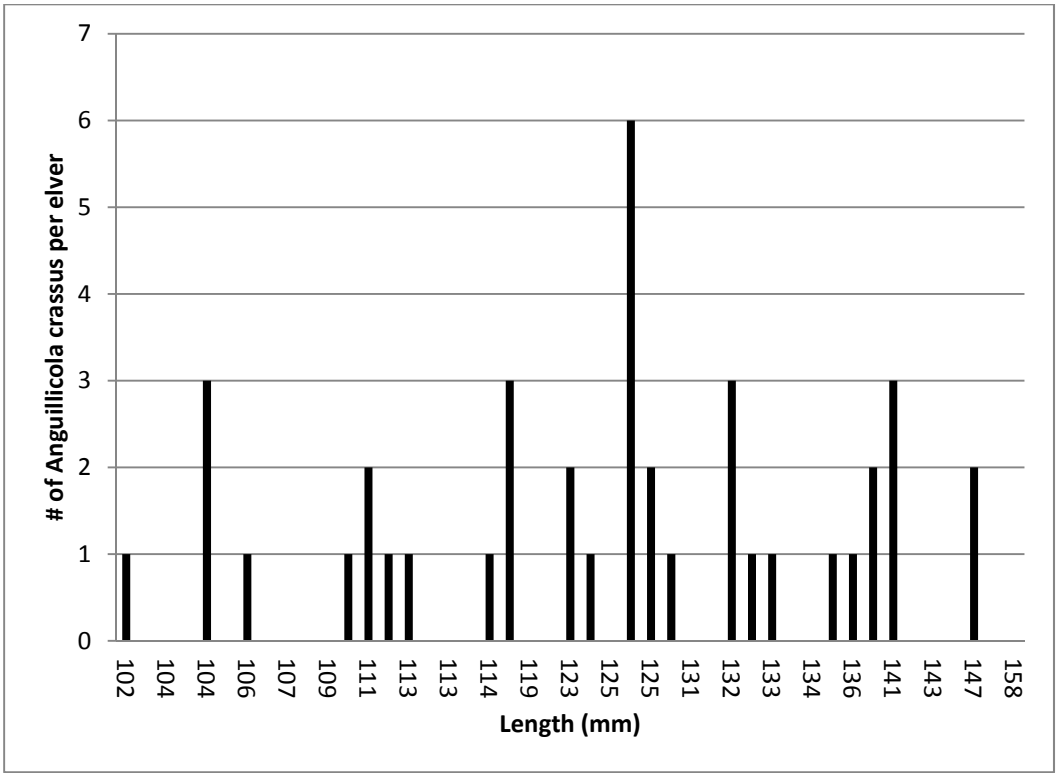

Table 1. Date, location, and number of elvers collected and stocked in 2011

STOCKING DATE	TOTAL ELVERS	STOCKING SITE	Latitude	Longitude	Origin
6/21/2011	16110	Buffalo Creek	40 58.864' N	76.57.081' W	Turville Creek
6/21/2011	16109	Buffalo Creek	40 59.139' N	76 55.930' W	Turville Creek
6/22/2011	10666	Pine Creek	41 44.633' N	77 26.031' W	Turville Creek
6/22/2011	10666	Pine Creek	41 16.285' N	77 19.894' W	Turville Creek
6/22/2011	10666	Pine Creek	41 44.203' N	77 25.822' W	Turville Creek
6/22/2011	1797	Conowingo Creek	39 43.852' N	76 10.701' W	Conowingo Dam
6/30/2011	7222	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
7/14/2011	6326	Buffalo Creek	40 59.139' N	76 55.930' W	Conowingo Dam
7/18/2011	4390	Buffalo Creek	40 59.139' N	76 55.930' W	Conowingo Dam
7/28/2011	3603	Buffalo Creek	40 59.139' N	76 55.930' W	Conowingo Dam
8/22/2011	1528	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
8/31/2011	8940	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
9/2/2011	8084	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
9/7/2011	12205	Pine Creek	41 44.633' N	77 26.031' W	Conowingo Dam
9/8/2011	7844	Conowingo Creek	39 43.852' N	76 10.701' W	Conowingo Dam

Table 2. Number of eels caught at the base of Conowingo Dam on the West side of the dam during 2011.

Date	# of Elvers		Date	# of Elvers
5/23/2011	34		7/20/2011	282
5/25/2011	8		7/22/2011	1380
5/27/2011	1		7/25/2011	2013
5/31/2011	41		7/27/2011	3603
6/3/2011	476		7/29/2011	34
6/6/2011	511		8/1/2011	87
6/8/2011	70		8/2/2011	16
6/10/2011	121		8/5/2011	58
6/13/2011	382		8/8/2011	250
6/15/2011	79		8/10/2011	126
6/17/2011	21		8/12/2011	149
6/20/2011	71		8/15/2011	257
6/22/2011	6		8/17/2011	184
6/24/2011	21		8/19/2011	506
6/27/2011	1217		8/22/2011	928
6/29/2011	4467		8/24/2011	850
6/30/2011	1817		8/26/2011	797
7/1/2011	439		8/29/2011	1344
7/3/2011	378		8/30/2011	2648
7/5/2011	162		8/31/2011	3358
7/7/2011	288		9/1/2011	3548
7/11/2011	1132		9/2/2011	4573
7/12/2011	5514		9/3/2011	3880
7/13/2011	1660		9/4/2011	7250
7/14/2011	2074		9/6/2011	6275
7/15/2011	2340		9/7/2011	6424
7/16/2011	2187		9/8/2011	7844
7/18/2011	780			

Table 3. Number of Passive Integrated Transponder Tags (PIT) applied to yellow eels by year.

Year	# of Tags Applied
2007	51
2008	32
2009	68
2010	11
2011	127

Table 4. Growth of yellow eels caught and recaptured in pots at the base of Conowingo dam by year.

	Average Length (mm)					*Average Annual Growth Increase (mm)*
ID	**2007**	**2008**	**2009**	**2010**	**2011**	
257C63E092	594	617	*	*	*	23
257C6534CA	733	770	*	*	*	37
257C6526C0	463	474	*	*	*	11
257C65EB48	404	510	521	*	*	58.5
257C655F24	426	445	*	*	*	19
257C65F2F2	338	390	505	*	*	83.5
257C63E581	551	589	*	*	*	38
257C65F8B0	475	511	*	*	*	36
257C65E87B	405	471	510	*	*	55
257C65FBAB	377	405	440	*	*	31.5
257C652B3A	466	490	*	*	*	24
257C63C580	391	520	*	557	*	55.3
257C660193	386	428	*	*	*	21
257C63CE9A	458	*	565	*	*	53.5
257C63CF54	484	*	624	*	*	70
257C652735	457	*	590	*	*	66.5
257C6534A4	386	*	478	*	*	46
257C66192F	447	*	580	*	*	66.5
257C63D36E	*	419	433	*	*	14
257C652BF4	*	364	383	395	449	28.3
257C65342C	*	393	516	*	*	123
257C65B1E0	*	479	543	*	*	64
257C660279	*	497	575	*	*	78
257C65E54F	*	454	*	550	*	48
1C2D05239A	*	*	612	626	*	14
1C2D0529B9	*	*	495	578	*	83
257C63D39B	*	*	432	462	470	19
257C6553FB	*	335	*	*	446	37
257C655957	*	321	*	*	377	18.6
1C2D05286B	*	*	476	*	508	16
1C2D052453	*	*	368	*	465	48.5

Table 5 Pearson Correlation performed on number of elvers captured and environmental variables

	# eels	*Lunar Fraction*	*Avg. Att Flow*	*Barrometric Pressure*	*Air Temp*	*Precipitation Sum*	*AVG of DO (conc.)*	*AVG of Salinity (ppt)*	*AVG of Temp (°C)*	*AVG of pH*	*AVG of Turbidity (NTU)*	*AVG of Chlorophyll a (µg/l)*
# eels	1											
Lunar Fraction	0.0260	1										
AVG Flow	0.4241	0.0330	1									
Barrometric Pressure	0.1454	-0.2805	0.1595	1								
Air Temp	-0.2163	0.0302	-0.2621	-0.4116	1							
Precipitation	0.3088	0.0424	0.2415	0.0207	-0.3217	1						
AVG of DO	-0.0735	-0.1243	0.2647	0.2474	0.0248	-0.1219	1					
AVG of Salinity	-0.2894	-0.0734	-0.5819	-0.1535	0.1199	-0.1368	-0.5397	1				
AVG of Temp	-0.2502	0.0874	-0.6924	-0.2893	0.5639	-0.1738	-0.3882	0.6475	1			
AVG of pH	-0.5675	-0.1282	-0.3780	-0.0321	0.2888	-0.2476	0.6206	-0.0170	0.3254	1		
AVG of Turbidity	0.6111	0.1400	0.8525	0.0083	-0.1800	0.2524	0.0581	-0.4502	-0.4174	-0.4150	1	
AVG of Chlorophyll a	-0.1177	-0.4422	0.2031	0.1431	-0.0758	-0.0637	0.6783	-0.3313	-0.2645	0.6269	0.1055	1

REFERENCES

ASMFC (Atlantic States Marine Fisheries Commission). 2000. Standard procedures for American eel young of the year survey.

Maryland DNR. 2007. Maryland Biological Stream Survey: Sampling Manual Field Protocols. 65 pp.

Minkkinen S.P., Devers J.L. & W.A. Lellis. 2011. Experimental Stocking of American Eels in the Susquehanna River Watershed. Report of U.S. Fish and Wildlife Service to City of Sunbury, Pennsylvania.

APPENDIX I. AGENCY CONSULTATION RECORDS

From: Danucalov, Andrea H:(Exelon Power) <Andrea.Danucalov@exeloncorp.com>
Sent: Friday, April 16, 2021 4:52 PM
To: denise.keehner@maryland.gov; Heather Nelson -MDE-; David Seaborn -MDE-; 'Eyler, Sheila'; 'McCorkle, Richard'; jesus_morales@fws.gov; 'Minkkinen, Steve'; 'Henning, Aaron'; 'McCollum, Allyson'; 'Miller, Jeremy'; 'Williamson, Scott'; Eberts, Ron; Tony Prochaska -DNR-; Brett Coakley -DNR-; 'Seaman, Shawn'; Bob Sadzinski - MD DNR; 'Steffy, Luanne'; 'Tryninewski, Joshua'
Cc: Bleistine, Ray; David Frazier; Ian Kiraly; Erin Redding; Kirk Smith; Martinek, Michael; 'Slowik, Adam'
Subject: Conowingo Eel Passage and Restoration Plan
Attachments: Conowingo_Eel_Passage_and_Restoration_Plan (MDE Version).pdf

All,

On March 19, 2021, the Federal Energy Regulatory Commission issued a new license for the Conowingo Hydroelectric Project (P-405) to Exelon Generation, LLC (Exelon). Article 415 of the license requires Exelon to develop an *American Eel Passage and Restoration Plan* and submit the Plan to the Maryland Department of the Environment (MDE), the Pennsylvania Department of Environmental Protection (PADEP), the Pennsylvania Fish and Boat Commission (PFBC), the Susquehanna River Basin Commission (SRBC), the U.S. Fish and Wildlife Service (USFWS), and the Maryland Department of Natural Resources (MDNR) within 30 days of license issuance (April 18, 2021). Accordingly, please find attached to this email a copy of the Plan for your review and comment.

Please send your comments to me at andrea.danucalov@exeloncorp.com by May 18, 2021.

The approval of the Plan by MDE will also be completed pursuant to Section 2.5(g), Procedure for Approval of Plans, of the Conowingo Dam Water Quality Settlement Agreement between MDE and Exelon, dated October 29, 2019. In addition, the document will be posted on our web portal on Monday, April 19, 2021. I will send the link separately.

Article 415 of the license also requires Exelon to file a final version of the Plan with FERC within 6 months of license issuance (September 19, 2021).

Please let me know if you have any questions, comments, or concerns.

Have a good weekend!

Andrea

Andrea Danucalov
FERC License Compliance Manager
Exelon.
Exelon Generation
Conowingo Hydroelectric Generating Station
2569 Shures Landing Road
Darlington, MD 21034
Skype: 267.533.1125
Cell: 610.301.1664
andrea.danucalov@exeloncorp.com

From: Eyler, Sheila <sheila_eyler@fws.gov>
Sent: Thursday, May 6, 2021 8:53 AM
To: Danucalov, Andrea; denise.keehner@maryland.gov; Heather Nelson -MDE-; David Seaborn -MDE-; McCorkle, Richard; Morales, Jesus J; Minkkinen, Steve; 'Henning, Aaron'; 'Miller, Jeremy'; Eberts, Ron; 'Seaman, Shawn'; Bob Sadzinski - MD DNR; 'Tryninewski, Joshua'
Cc: Bleistine, Ray; David Frazier; Ian Kiraly; Erin Redding; Kirk Smith; Martinek, Michael; 'Slowik, Adam'
Subject: Re: [EXTERNAL] Conowingo Eel Passage and Restoration Plan

Andrea,

FWS has reviewed the Conowingo Eel Passage and Restoration Plan. Generally, we have no significant concerns with the document. We recommend the following edits and additions be included in the final version of the Plan:

1. Background, Page 2: Exelon states that the Conowingo East Eel Collection Facility (CEECF) (the temporary eel facility to be placed in the vicinity of the stilling basin at the East Fish Lift (EFL) will begin operation on May 1. This is inconsistent with the license and EFL operations. According to the license, operation of the CEECF will not commence until 10 days following the end of the operation of the EFL, as correctly stated in section 3.1.3.
2. Reporting and Meetings, Page 23: Regarding eel transport in Sections 6.1.1 and 6.1.2, Exelon describes reporting on transport in the text but does not include the reporting on transport in the bulleted list of items to be included in the daily and annual reports. Transport information (i.e. number transported by date and location) should be included in bulleted lists for both sections.
3. Appendix D: Daily datasheets for transport efforts should be included in this section or added as a separate appendix item.

Thank you for the opportunity to review.

Sheila Eyler
U.S. Fish and Wildlife Service
Mid-Atlantic Fish & Wildlife Conservation Office
177 Admiral Cochrane Dr.
Annapolis, MD 21401
717-387-2117

From: Henning, Aaron <ahenning@srbc.net>
Sent: Friday, May 7, 2021 7:53 AM
To: Danucalov, Andrea; denise.keehner@maryland.gov; Heather Nelson -MDE-; David Seaborn -MDE-; 'Eyler, Sheila'; 'McCorkle, Richard'; jesus_morales@fws.gov; 'Minkkinen, Steve'; 'McCollum, Allyson'; 'Miller, Jeremy'; 'Williamson, Scott'; Eberts, Ron; Tony Prochaska -DNR-; Brett Coakley -DNR-; 'Seaman, Shawn'; Bob Sadzinski - MD DNR; Steffy, Luanne; 'Tryninewski, Joshua'
Cc: Bleistine, Ray; David Frazier; Ian Kiraly; Erin Redding; Kirk Smith; Martinek, Michael; 'Slowik, Adam'
Subject: RE: Conowingo Eel Passage and Restoration Plan

Andrea,

Thank you for the opportunity to comment on the eel plan. The Susquehanna River Basin Commission submits the following comments for consideration:

- In Table 3.5-1, Site 9 refers to rt. 29 bridge in Wilkes Barre. Rt. 29 crosses the Susquehanna River in Nanticoke and does not offer a safe offload point. Consider Nesbitt Park, Kingston PA for comparable alternative access (-75.8851, 41.2513)
- In Table 6.1.1 Daily Operations Summary, in addition to the two listed items please include the following in daily reports: The number of eels transported or moved from the CECF (even if zero), disposition (location and status) of any eels transported from the CECF, any mortalities encountered at the CECF or during transport
- On page 10, paragraph two the document states: “During the 10 years of operation if the number of American Eels attempting to migrate to the CEECF exceeds the maximum capacity of American Eels per unit of ramp area, or if densities exceed 10 eels per L, the facility will be modified….” The “maximum capacity of American eels per unit of ramp area” needs a clear definition and determination on how this will be measured, by who and when.

Aaron Henning
Fisheries Biologist
Susquehanna River Basin Commission
4423 North Front St.
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Office: (717) 238-0423 ext.1184
Mobile: (717) 884-5937
ahenning@srbc.net

Maryland
Department of
the Environment

Larry Hogan, Governor
Boyd K. Rutherford, Lt. Governor

Ben Grumbles, Secretary
Horacio Tablada, Deputy Secretary

May 14, 2021

Via electronic mail
Ms. Andrea Danucalov
FERC License Compliance Manager
Exelon Generation
Conowingo Dam
2569 Shures Landing Road
Darlington, MD 21034
Andrea.Danucalov@exeloncorp.com

Re: Conowingo Dam, Draft American Eel Passage and Restoration Plan

Dear Ms. Danucalov:

The Maryland Department of the Environment, Wetlands and Waterways Program, (MDE) has consulted with the Maryland Department of Natural Resources, Power Plant and Research Program, (MDNR) to review and comment on the Draft American Eel Passage and Restoration Plan (Plan) submitted by Exelon Generation Company, LLC (Exelon) on April 16, 2021 in accordance with the Federal Energy and Regulatory Commission (FERC) License, specifically License Article 415. A requirement of License Article 415 is that the Plan be submitted to MDE within 30 days of the FERC License issuance for the operation of the hydropower facility at the Conowingo Dam. Exelon has prepared the Plan and is seeking initial agency comments prior to a formal submission by a requisite due date per the FERC License. MDE and MDNR are offering the attached comments requesting additional information, revisions and modifications to the Plan. MDE and MDNR are not approving in whole or in part the Plan. Please see Attachment I for comments regarding the Plan.

If you would like to discuss these comments further, please contact David Seaborn, Deputy Program Manager, MDE, Wetlands and Waterways Program via email at david.seaborn@maryland.gov to arrange a time to discuss with the appropriate MDE and MDNR staff.

Sincerely,

Heather L. Nelson, Manager
Wetlands and Waterways Program
Water and Science Administration

Attachment

(Via electronic mail)
cc: Bob Sadzinski, MDNR
Shawn Seaman, MDNR
Sheila Eyler, USFWS

Attachment I

General Comments:

1) The history of the WFL eel ramp does not include the time when U.S. Fish and Wildlife Service (USFWS) setup the ramp and operated it. Please include the complete history of the ramp.

2) Regarding FERC Article 414: The trigger for the eel ramp to operate within the East Fish Lift (EFL) is based on the closing of the EFL after the shad season. The Plan should describe what happens if the EFL does not operate or operates intermittently. We anticipate the Conowingo East Eel Collection Facility (CEECF) would operate during those extended periods when the EFL is not operating and after 1 May of any year.

3) The east side eel ramp is based on "modifications" of the new EFL. The Plan should include a construction timeline for the rebuilding of the EFL and any provisions to capture eels during this period. Interim eelway collections during construction or modifications to the eelway or EFL should not be considered as years to be compared between the CEECF and the west side eelway.

4) Maryland recommends including an eelway shakedown period that does not affect the ten-year comparison clock for the ramp to become permanent.

5) Small "tweaks" (*e.g.*, flow changes, gate openings/closings, ramp substrate(s)) should not be considered as modifications and should be differentiated from modifications requiring approval from the FERC. This needs to be defined in the Plan.

6) The Plan should address how the parties resolve disagreements regarding modifications to the eel collection facilities. (see Page 90 of the FERC Order)

7) Significant numbers of eels were observed during nighttime observations below the spillway during an Exelon study conducted in 2011. These eels could be redirected to the new eel ramp if access including attraction water could be provided through the wing wall. Exelon should consider this option (or other alternatives) to provide passage to eels attracted to the spill gate area? Since the EFL is being redesigned, this may be a minor modification to significantly improve the catchability of eels on the east side of the river.

8) Studies to determine ramp efficiency should be implemented during the first full season of operation and any time the ramp substrate is changed, or ramp flows are significantly changed by using a known number of eels released at the base of the ramp versus the number captured in the holding tank. Identified problems with the ramp must be addressed immediately.

Specific Comments:

1) 3.2.1 Design Conowingo East Eel Collection Facility (CEECF)

a. The Plan states that the CEECF be supplied with at least 265 liters per minute (70 gal/min, 1.2 gal/sec) of water. This flow may be insufficient to attract eels past the diffuser's flow and to the ramp. Additional attraction water may need to be provided such that it does not spill or sheet across the concrete pad creating false attraction when tailwater is low.

b. Nighttime observations should also be made of the concrete pad to ensure no eels are congregating toward this flow.

c. How does Exelon plan to determine if ramp density (overcrowding) is an issue?

2) 3.2.3 Operational Protocols

The plan states that:

- Weir gate C open 100% open.
- Weir gates B 0% open.
- Weir gates A 0% open
- Diffuser gates A 100% open
- Diffuser gates B 100% open

a. The plan should describe the amount of flow from diffusers. How will this configuration affect internal EFL flow patterns, and the amount of flow at Weir Gate C?

i. Exelon should also include diffuser Gate C into the operation plan along with options for the operation of entrance Gate A.

ii. Sufficient flow from the weir gate(s) is necessary to attract eels while maintaining velocities suitable for entry. The plan should also address the potential for attraction of eels into flow from the diffuser(s).

b. Prior to initial operation of the CEECF, operation flows should be observed and agreed to by agency representatives/personnel. Any subsequent modifications to flows or gate operations should also be observed and agreed to by agency representatives/personnel.

c. Entrance gates should be constructed with bar racks to reduce the number of predators accessing the EFL during the operation of the eel ramp.

d. Internal and zone-of-passage (ZOP) flow modeling should be conducted at the CEECF to ensure no velocity barriers exist for American Eels.

e. Monitoring- aeration of the collection tanks at the CEECF and CWECF should be performed unless DO is continuously monitored in those tanks.

3) 3.4 Transport, 3.4.1 Design

a. The plan should include density of eels in 19-liter buckets and 250-liter tank during transport to stocking locations.

b. If density is same as in large tanks (10 eels per liter) then continuous DO monitoring is needed.

EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT (FERC NO. 405)
EEL PASSAGE AND RESTORATION PLAN REMOTE MEETING SUMMARY
JULY 9, 2021, 1:00 PM TO 2:30 PM EST
Call-in Number: Microsoft Teams Call-in 716-402-6612, passcode 20670122

Attendees

Attendee	Affiliation	Email
Andrea Danucalov	Exelon	andrea.danucalov@exeloncorp.com
Erin Redding	Gomez and Sullivan Engineers	eredding@gomezandsullivan.com
Ben Sawyer	Gomez and Sullivan Engineers	bsawyer@gomezandsullivan.com
Kirk Smith	Gomez and Sullivan Engineers	ksmith@gomezandsullivan.com
Heather Nelson	Maryland Department of the Environment	hnelson@maryland.gov
David Seaborn	Maryland Department of the Environment	David.seaborn@maryland.gov
Shawn Seaman	Maryland Dept. of Natural Resources	shawn.seaman@maryland.gov
Ray Bleistine	Normandeau Associates, Inc.	rbleistine@normandeau.com
Mike Martinek	Normandeau Associates, Inc.	mmartinek@normandeau.com
Jeremy Miller	PA Dept of Environmental Protection	jeremmille@pa.gov
Josh Tryninewski	PA Fish and Boat Commission	jtryninews@pa.gov
Aaron Henning	Susquehanna River Basin Commission	ahenning@srbc.net
Sheila Eyler	US Fish and Wildlife Service	sheila_eyler@fws.gov
Rick McCorkle	US Fish and Wildlife Service	richard_mccorkle@fws.gov
Jesus Morales	US Fish and Wildlife Service	jesus_morales@fws.gov
Don Pugh	Consultant for Maryland	don.pugh@outlook.com

Meeting Purpose

Andrea Danucalov began the meeting. The focus of this meeting will be to review the resource agencies' comments on Exelon's Draft Eel Passage and Restoration Plan (EPRP). Exelon would like to finalize the EPRP and submit it to FERC. Following this meeting, an updated draft EPRP will be distributed to resource agencies for a final review.

Conowingo East Eel Collection Facility Design and Planned Operation

Ben Sawyer shared a 3-D model of the Conowingo East Eel Collection Facility (CEECF) on his screen. Major features were highlighted to show how the facility will be laid out.

The CEECF is in the stilling basin. A scaffolding stairway leads down from the dam to a walkway that allows for access to the collection tank, positioned at the top of the ramp. The ramp runs from the stilling basin down over the dissipation wall.

Eels may access the ramp via multiple routes. Once they reach and ascend the ramp, they are collected from the tank and carried out of the facility in buckets. The EPRP discusses which gates will be open or closed.

Ben showed the model in low and in high water level conditions. The model can show approximate low and high water levels.

Attraction flow for the CEECF is sourced from the dam. Water is supplied via the same pipe that feeds the stilling basin. The pipe is from the forebay located between Unit 11 and the EFL. Flow will be tapped off that pipe and sent to the CEECF via pipes or hoses. A manifold is located on top of the concrete at the powerhouse level. All the provided flow comes off the existing manifold, and all the flow will eventually come out the bottom of the ramp. The flow will then continue out the crowder channel or the diffuser channel.

There will be no water upstream of the dissipation wall where the scaffolding is placed. The scaffolding area will be dry, even during high water conditions.

The attraction flow will be 70 gallons per minute (0.16 cfs). Jesus Morales asked the manifold's flow capacity. Ben did not have this information available. Ray Bleistine said that the pipe that feeds the manifold is a six-inch pipe and previously provided water for the east lift. There is sufficient flow for the 70 gpm. Mike Martinek said that there is a two-inch hose called out for this facility, so flows will be very similar to flow at the Conowingo West Eel Collection Facility.

Jesus asked which gates will be open for eels to enter the East Fish Lift. He noted that most of the time, more water will be coming into the East Fish Lift than 70 gpm. He asked what the expectation is for how fish will find their way through the gates to the ramp. He also asked if the gates be completely open, screened, or covered. Gate C will be fully open. Mike said that there are no plans for screening the entrances to the channels; however, areas susceptible to avian predation will be screened. Jesus asked for confirmation that when the water level is dry, the attraction flow will be the only water coming down the concrete slab. Mike confirmed that this statement is correct.

Don Pugh asked how much flow will pass through the diffuser gates. Mike said that the attraction flow of 70 gpm will pass through the diffuser gates. Don expressed doubt that the eels would be able to locate the 70 gpm attraction flow where there would also be potentially thousands of gallons of flow coming downstream from the Conowingo operating units. Don thinks that the eels will instead be attracted to the flow from the dam. Jesus agreed and said that there would be more water going into Gate A than water coming out. Jesus said that he thinks some eels will eventually locate the ramp; however, he is wondering what will draw eels into the east fish lift to begin with. He acknowledged that they may follow the wall on that leads to Gate C and enter the fish lift there. Ray said that there are historic observations of eels in this area, before the east fish lift was built. Eels were observed coming through leakage from the regulating gate. An eel ramp at this location is in response to agency requests. The ramp cannot be put into the spillway due to safety and operation concerns. Ray said that there is no guarantee that there are eels here; this is an experiment. Benefits of the site include access and water availability.

Jesus agreed that this location is experimental and agreed that there are positive aspects of this location. He said he still wonders if something else could be done to improve the attraction flow for eels as the 70 gpm will be competing with the flow from the powerhouse. Ray said that the specifications for the CEECF are aligned with the CWECF as Exelon is required to compare the two facilities after ten years of operation. Ray said that he is concerned that having a different set up in the CEECF may bias the required comparisons. Don said the CEECF's purpose is to collect eels, not to replicate the CWECF for comparison. Conditions on the west side of the river are different; eels come up the edge of the river into an open area. This area is not open. Ray said that the eels could come up the wingwall. Don said that that the attraction flow is not sufficient to bring eels into the fish lift. They may wander into the fish lift, but could still miss the attraction flow due to water movement within the lift. Mike said that when the units are operating, flow from the dam will be too great for eels to swim up to the dam. The flow will push eels toward the wingwall where they will find Gate C. Don said that the eels will only be pushed to the wingwall

and Gate C if units 10 and 11 are running. Otherwise they could swim up to Gate A, which will be closed. Mike said that if unit 5 is on, the eels will be throughout the tailrace. Don said that this makes his point that collecting on the west side does not collect all the eels in the river that are trying to pass upstream of Conowingo Dam. The locations of the eels in the river downstream of the dam are unknown as they are too small for tracking studies.

Regarding diffuser flows, Don asked if the water could go through the diffusers and down the channel. It can.

Don said that predators entering the east fish lift may also be an issue. He asked if there will be bar racks in front of the gate. Bar racks are not currently planned for in front of the gates. Ray said there is an eddy below the CWECF where predatory fish rest; however, there is no evidence that it is impacting the CWECF catch. Don said that it is not possible to know if predatory fish are impacting the CWECF catch or not because no one knows how many eels are available. It is known that the species of predatory fish in the eddy do like to eat eel. Aaron Henning said that there were eels in the stomachs of some of the snakeheads caught this summer.

Conowingo Eel Passage and Restoration Plan – Agency Comments and Exelon's Responses

A comments response matrix was shared on the meeting screen and Kirk Smith led the group through a discussion. For each comment, Kirk summarized Exelon's response and solicited further comments or questions from the resource agencies. The matrix and meeting discussion begin on the next page.

	Comment	How Addressed
MDE & MDNR		
General Comments		
	Meeting Discussion: Ray said that the C-channel will be narrowed with supports and steel plates, making it even more challenging to create a hole for attraction flow here.	
8	Studies to determine ramp efficiency should be implemented during the first full season of operation and any time the ramp substrate is changed, or ramp flows are significantly changed by using a known number of eels released at the base of the ramp versus the number captured in the holding tank. Identified problems with the ramp must be addressed immediately.	FERC License, Appendix 1, Section 12.7.3 requires that upstream American Eel effectiveness testing be completed in the year immediately following license issuance unless Exelon and the USFWS agree that effective technology is not available. Based on the available scientific literature, Exelon and USFWS agree that the appropriate, proven tagging technology does not currently exist to conduct ramp efficiency studies for the size range of eels currently collected at Conowingo Dam (mean length 125 mm). Per the FERC License, Appendix 1, Section 12.7.3, available technology will be reconsidered and the potential for tests of upstream passage efficiency will be discussed at annual meetings with USFWS. In addition, Section 12.7.3 requires that when technology is available and following any modifications to the operation or physical structure an upstream efficiency study will be conducted to evaluate the relative success of the modifications. This language has been added to the Eel Passage and Restoration Plan. Additionally, to perform a comparative analysis with the CWECF, substantial modifications such as changing ramp substrate or attraction flow should be avoided during the 10-year comparative period so as not bias results.
	Meeting Discussion: Don said that Maryland is requesting a ramp efficiency study, rather than a passage efficiency study. The requested study would involve containing a fixed number of eels at the base of the eel ramp and then, over a set time-period, seeing what percentage of the eels reach the collection tank. Ray said that, at Conowingo, it would be a challenge to keep other eels from entering the ramp via the sides of the ramp, as the eels climb up the rip-rap. Ray also noted that closing off the ramp for a day to eels that are trying to move upstream could result in not passing thousands of eels. Don agreed that this type of study would be difficult at the CWECF, but it could be possible at the CEECF. Exelon now understands Don's request and will consider it further.	

	Comment	How Addressed
Specific Comments		
1	**3.2.1** Design Conowingo East Eel Collection Facility (CEECF) a. The Plan states that the CEECF be supplied with at least 265 liters per minute (70 gal/min, 1.2 gal/sec) of water. This flow may be insufficient to attract eels past the diffuser's flow and to the ramp. Additional attraction water may need to be provided such that it does not spill or sheet across the concrete pad creating false attraction when tailwater is low. b. Nighttime observations should also be made of the concrete pad to ensure no eels are congregating toward this flow. c. How does Exelon plan to determine if ramp density (overcrowding) is an issue?	a. There will be no flow provided through the EFL diffusers. The weir and diffuser gates are open to allow eels the opportunity to enter the EFL via multiple locations, but there will be no flow provided through the gates via the conventional operation of the EFL. Attraction flow to the CEECF will be provided from a separate water source. This flow will consist of 70 gpm of water discharged through the ramps attraction flow system as described in Section 3.2.1. Therefore, there is no potential for the creation of false attraction by the EFL diffusers when the tailwater is low. b. Nighttime observations are not necessary, since the EFL will not be providing flow through diffusers; thus, eliminating the potential for false attraction. c. The proposed eel ramp is 18 inches wide. Using the USFWS Fish Passage Engineering Design Criteria (2019) of a maximum capacity of 5,000 eels/day per inch of ramp width, assuming a mean eel size of 150 mm total length, the proposed ramp will have a capacity of 90,000 eels/day. During the 10 years of operation, if the number of American Eels attempting to migrate through the CEECF exceeds 90,000 eels per day, based on volumetric estimates, or if densities in the collection tank exceed 10 eels per L, the facility will be modified, or operational protocols adjusted to reduce crowding, in consultation with MDE, USFWS, and EPAG, and following approval from FERC. This information has been added to page **Error! Bookmark not defined.**.
	Meeting Discussion: Don asked where the maximum ramp capacity metric comes from, other than the USFWS' guidelines. Jesus suggested that Alex Haro may know the source of this metric. Don said that he has asked Alex Haro, and Alex did not know either. (At the end of the meeting, Jesus typed in the chat that the maximum capacity metric was taken from the UK Environment Agency's eel manual.)	

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	Comment	How Addressed
2	**3.2.3** Operational Protocols The plan states that: Weir gate C open 100% open. Weir gates B 0% open. Weir gates A 0% open Diffuser gates A 100% open Diffuser gates B 100% open	Appendix D has been added to provide additional information regarding operations.
	e. Monitoring- aeration of the collection tanks at the CEECF and CWECF should be performed unless DO is continuously monitored in those tanks.	Daily DO checks and weekly downloads of continuous monitoring data will be performed. Aeration will be provided if DO monitoring indicates that it is necessary. See Section 3.2.1 for details.
	Meeting Discussion: Don asked for confirmation that there will be a daily check as well as logged continuous monitoring. Ray confirmed that Normandeau will perform manual daily checks of water quality and a HOBO is also in place to collect continuous monitoring data. These data are downloaded on an established schedule. This approach is similar to how monitoring is completed at the Octoraro Creek Eel Collection Facility.	
3	3.4 Transport, 3.4.1 Design a. The plan should include density of eels in 19-liter buckets and 250-liter tank during transport to stocking locations. b. If density is same as in large tanks (10 eels per liter) then continuous DO monitoring is needed.	a. The density of eels in the transport buckets and transport tank are less than less than 10 juvenile eels per liter. Section 3.4 has been revised to clarify this. b. Eels are transported with continuous DO supply. This has been clarified in Section 3.4.2.
	Meeting Discussion: Don asked if Normandeau has ever transported eels in 5-gallon buckets. Mike said yes; this is done when eel numbers are low. No more than 50 eels are placed in a 5-gallon bucket. Normandeau puts a blower in the bucket during transport to ensure there is sufficient oxygen.	

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Agency Comments on April 16, 2021 Draft and Exelon Responses

	Comment	How Addressed
MDE & MDNR		
General Comments		
1	The history of the WFL eel ramp does not include the time when U.S. Fish and Wildlife Service (USFWS) setup the ramp and operated it. Please include the complete history of the ramp.	A brief history of the WFL eel ramp has been incorporated into Section 3.1.1.
2	Regarding FERC Article 414: The trigger for the eel ramp to operate within the East Fish Lift (EFL) is based on the closing of the EFL after the shad season. The Plan should describe what happens if the EFL does not operate or operates intermittently. We anticipate the Conowingo East Eel Collection Facility (CEECF) would operate during those extended periods when the EFL is not operating and after 1 May of any year.	Exelon does not anticipate any periods when the EFL would not be operating in some capacity from May 1 to June 15. Exelon must operate the EFL, as required by the FERC license. Not operating the EFL or operating the EFL intermittently would require FERC to approve a variance request in advance of any changes to operation of the EFL. Also, per the MDE Settlement the temporary eel facility is to start operating twelve months after the EFL modifications required under Appendix 1 of the FERC license (i.e., the DOI Fishway Prescription) in order to allow for the construction of the upgrades required by the license to occur. Exelon does not anticipate a scenario where the EFL will not be operated in either trap and transport or volitional mode after the EFL initial modifications are complete. Given this, there does not appear to be any circumstance where the CEECF would operate prior to the closing of the typical American Shad passage season.
3	The east side eel ramp is based on “modifications” of the new EFL. The Plan should include a construction timeline for the rebuilding of the EFL and any provisions to capture eels during this period. Interim eelway collections during construction or modifications to the eelway or EFL should not be considered as years to be compared between the CEECF and the west side eelway.	Exelon is developing a schedule to complete the upgrades to the EFL. Per the MDE Settlement, Exelon and MDE agreed to initiate operation of the CEECF 12 months after completion of the EFL upgrades. Due to safety concerns and the required EFL upgrade requirement, collection of eels will not occur until completion of the EFL upgrades. There are no specific requirements in the MDE Settlement or FERC License to capture eels on the east side of the dam during the EFL construction period. However, operation of the CWECF and the

		OECF will continue during the EFL construction period and will continue to provide a source of eels for upstream transport.
4	Maryland recommends including an eelway shakedown period that does not affect the ten-year comparison clock for the ramp to become permanent.	The current CEECF design follows USFWS's Fish Passage Engineering Design Criteria (2019) in relation to attraction flow, general design configuration, and substrate material. The design has also been discussed with EPAG, USFWS, and MDE. The CWECF and OECF did not require shakedown periods after their initial construction and have not required any substantive modifications since operation began. As part of the normal operating procedure before the start of the eel passage season, each ramp undergoes a series of pre-season checks as well. Exelon anticipates the same for the proposed CEECF and therefore is not proposing a shakedown period.
5	Small "tweaks" (*e.g.*, flow changes, gate openings/closings, ramp substrate(s)) should not be considered as modifications and should be differentiated from modifications requiring approval from the FERC. This needs to be defined in the Plan.	Article 414 has been added to Section 3 for reference. The language of Article 414 does not suggest that small changes or "tweaks" to design or operation may be made without MDE, USFWS, and FERC approval; therefore, Exelon considers it appropriate to have all changes to the design or operation approved by FERC before they are implemented to ensure license compliance.
6	The Plan should address how the parties resolve disagreements regarding modifications to the eel collection facilities. (see Page 90 of the FERC Order)	Exelon maintains regular consultation with MDE, USFWS and EPAG through monthly virtual meetings, emails and phone calls, and annual meetings, and meeting records are maintained. Exelon will attempt to resolve any disagreements regarding modifications to the eel collection facilities through conversations held during these meetings, phone calls, and emails. In the case of unresolved disagreements between MDE, USFWS, and EPAG regarding modifications, FERC will maintain and exercise its decision authority based upon the consultation record.
7	Significant numbers of eels were observed during nighttime observations below the spillway during an Exelon study conducted in 2011. These eels could be redirected to the new eel ramp if access including attraction water could be provided through the wing wall. Exelon should consider this option (or other alternatives) to provide	Three nighttime surveys were conducted in 2011. Elvers were observed in the same area below Crest gate #30 during all three surveys, which is located approximately 1,200 feet away from the EFL.

	passage to eels attracted to the spill gate area? Since the EFL is being redesigned, this may be a minor modification to significantly improve the catchability of eels on the east side of the river.	However, crest gate #30 was leaking a significant amount of water since it had been opened during high spring river flows that resulted in spill, and it had not been resealed prior to the survey. It was concluded that eels would not have been attracted to that location if the crest gate had not been leaking. A copy of the 2011 study is attached as Appendix H. Exelon is not proposing any modifications to the EFL wingwall as it serves to regulate the tailwater elevation in the vicinity of Gate C of the EFL as generation and spillway flows change. In addition, there is a channel at the terminus of the wingwall that maintains connectivity between the spillway and tailrace under nearly all flow conditions experienced at the Project.
8	Studies to determine ramp efficiency should be implemented during the first full season of operation and any time the ramp substrate is changed, or ramp flows are significantly changed by using a known number of eels released at the base of the ramp versus the number captured in the holding tank. Identified problems with the ramp must be addressed immediately.	FERC License, Appendix 1, Section 12.7.3 requires that upstream American Eel effectiveness testing be completed in the year immediately following license issuance unless Exelon and the USFWS agree that effective technology is not available. Based on the available scientific literature, proven tagging technology does not currently exist to conduct ramp efficiency studies for the size range of eels currently collected at Conowingo Dam (mean length 125 mm). Per the FERC License, Appendix 1, Section 12.7.3, available technology will be reconsidered and the potential for tests of upstream passage efficiency will be discussed at annual meetings with USFWS. In addition, Section 12.7.3 requires that when technology is available and following any modifications to the operation or physical structure an upstream efficiency study will be conducted to evaluate the relative success of the modifications. This language has been added to the Eel Passage and Restoration Plan. Testing of ramp efficiency by placing a known number of unmarked eels at the bottom of an eel ramp to determine the percentage of eels that successfully ascend the ramp has had mixed results. A method for marking juvenile eels (size range 70 to 130 mm) needs to be developed in

		order to detect eels as they enter, ascend, and exit the eel ramp. This would allow testing to occur without shutting down the ramp for some length of time and eliminate concerns of eels not in the test group infiltrating the ramp and skewing the results. Until a marking technique is developed for small eels that provides reliable detectability to ensure accurate results, it is our consensus that this type of study be delayed. Exelon will continue to work with the resource agencies to address this issue.
Specific Comments		
1	3.2.1 Design Conowingo East Eel Collection Facility (CEECF) a. The Plan states that the CEECF be supplied with at least 265 liters per minute (70 gal/min, 1.2 gal/sec) of water. This flow may be insufficient to attract eels past the diffuser's flow and to the ramp. Additional attraction water may need to be provided such that it does not spill or sheet across the concrete pad creating false attraction when tailwater is low. b. Nighttime observations should also be made of the concrete pad to ensure no eels are congregating toward this flow. c. How does Exelon plan to determine if ramp density (overcrowding) is an issue?	a. There will be no flow provided through the EFL diffusers. The weir and diffuser gates are open to allow eels the opportunity to enter the EFL via multiple locations, but there will be no flow provided through the gates via the conventional operation of the EFL. Attraction flow to the CEECF will be provided from a separate water source. This flow will consist of 70 gpm of water discharged through the ramps attraction flow system as described in Section 3.2.1. Therefore, there is no potential for the creation of false attraction by the EFL diffusers when the tailwater is low. b. Nighttime observations are not necessary, since the EFL will not be providing flow through diffusers; thus, eliminating the potential for false attraction. c. The proposed eel ramp is 18 inches wide. Using the USFWS Fish Passage Engineering Design Criteria (2019) of a maximum capacity of 5,000 eels/day per inch of ramp width, assuming a mean eel size of 150 mm total length, the proposed ramp will have a capacity of 90,000 eels/day. During the 10 years of operation, if the number of American Eels attempting to migrate through the CEECF exceeds 90,000 eels per day, based on volumetric estimates, or if densities in the collection tank exceed 10 eels per L, the facility will be modified, or operational protocols adjusted to reduce crowding, in consultation with MDE, USFWS, and EPAG, and following approval from

		FERC. This information has been added to page 11.
2	3.2.3 Operational Protocols The plan states that: Weir gate C open 100% open. Weir gates B 0% open. Weir gates A 0% open Diffuser gates A 100% open Diffuser gates B 100% open	Appendix D has been added to provide additional information regarding operations.
	a. The plan should describe the amount of flow from diffusers. How will this configuration affect internal EFL flow patterns, and the amount of flow at Weir Gate C? i. Exelon should also include diffuser Gate C into the operation plan along with options for the operation of entrance Gate A. ii. Sufficient flow from the weir gate(s) is necessary to attract eels while maintaining velocities suitable for entry. The plan should also address the potential for attraction of eels into flow from the diffuser(s).	The weir and diffuser gates are open to allow eels the opportunity to enter the EFL via multiple locations; however, there will be no flow provided through the EFL diffusers or through the gates via the conventional operation of the EFL. Attraction flow to the CEECF will be provided from a separate water source. This flow will consist of 70 gpm of water discharged through the ramps attraction flow system as described in Section 3.2.1. Note that items have been added to the Operational Protocols list on page 12. Exelon has attached a copy of the PowerPoint presented at the October 15, 2020 EPAG meeting, which provides additional information regarding the operation of the temporary eel facility at the EFL (Appendix D).
	b. Prior to initial operation of the CEECF, operation flows should be observed and agreed to by agency representatives/personnel. Any subsequent modifications to flows or gate operations should also be observed and agreed to by agency representatives/personnel.	As described above, there will be no attraction flow provided through conventional operation of the EFL. Therefore, observation of flows is not necessary, aside from regular inspections made by the ramp operating staff. The magnitude (70 gpm) of attraction flow water for the eel ramp itself is provided based on the USFWS Fish Passage Engineering Design Criteria (2019).
	c. Entrance gates should be constructed with bar racks to reduce the number of predators accessing the EFL during the operation of the eel ramp.	The proposed eel ramp design does not require bar racks on the EFL entrance gates. The only EFL entrance gate that will be open during operation of

		the eel ramp will be Gate C. There is no provision within the MDE Settlement to modify the current EFL entrance gates with bar racks.
	d. Internal and zone-of-passage (ZOP) flow modeling should be conducted at the CEECF to ensure no velocity barriers exist for American Eels.	There will be no attraction flow provided through conventional operation of the EFL. The 70-gpm magnitude of attraction flow water for the eel ramp itself is provided based on the USFWS Fish Passage Engineering Design Criteria (2019). The 70-gpm (0.16 cfs) attraction flow is not expected to form any velocity barriers within the EFL, so flow modeling is unnecessary.
	e. Monitoring- aeration of the collection tanks at the CEECF and CWECF should be performed unless DO is continuously monitored in those tanks.	Daily DO checks and weekly downloads of continuous monitoring data will be performed. Aeration will be provided if DO monitoring indicates that it is necessary. See Section 3.2.1 for details.
3	3.4 Transport, 3.4.1 Design a. The plan should include density of eels in 19-liter buckets and 250-liter tank during transport to stocking locations. b. If density is same as in large tanks (10 eels per liter) then continuous DO monitoring is needed.	a. The density of eels in the transport buckets and transport tank are less than less than 10 juvenile eels per liter. Section 3.4 has been revised to clarify this. b. Eels are transported with continuous DO supply. This has been clarified in Section 3.4.2.
PADEP		
1	Page 10, Paragraph 2: Please provide description of maximum capacity of American Eels per unit of ramp area for CEECF.	The proposed eel ramp is 18 inches wide. Using the USFWS Fish Passage Engineering Design Criteria (2019) of a maximum capacity of 5,000 eels/day per inch of ramp width, assuming a mean eel size of 150 mm total length, equates to a capacity of 90,000 eels/day. This information has been added to page 11.
2	Table 3.5-1 Stocking Locations for Juvenile Eel in the Susquehanna River Watershed: Site #6 Fort Hunter should be Dauphin County not Perry County.	The county has been corrected in the table.
SRBC		

1	In Table 3.5-1, Site 9 refers to Rt. 29 bridge in Wilkes Barre. Rt. 29 crosses the Susquehanna River in Nanticoke and does not offer a safe offload point. Consider Nesbitt Park, Kingston PA for comparable alternative access (-75.8851, 41.2513).	Comment noted. This alternative access point has been added to Table 3.5-1.
2	In Table 6.1.1 Daily Operations Summary, in addition to the two listed items please include the following in daily reports: The number of eels transported or moved from the CECF (even if zero), disposition (location and status) of any eels transported from the CECF, any mortalities encountered at the CECF or during transport.	These items are now included in the list of items for daily reports. (Note, this comment refers to Section 6.1.1, not Table 6.1.1.)
3	On page 10, paragraph two the document states: "During the 10 years of operation if the number of American Eels attempting to migrate to the CEECF exceeds the maximum capacity of American Eels per unit of ramp area, or if densities exceed 10 eels per L, the facility will be modified…." The "maximum capacity of American eels per unit of ramp area" needs a clear definition and determination on how this will be measured, by who and when.	The proposed eel ramp is 18 inches wide. Using the USFWS Fish Passage Engineering Design Criteria (2019) of a maximum capacity of 5,000 eels/day per inch of ramp width, assuming a mean eel size of 150 mm total length, the proposed ramp will have a capacity of 90,000 eels/day. This information has been added to page 11. During the 10 years of operation, if the number of American Eels attempting to migrate through the CEECF exceeds 90,000 eels per day, based on volumetric estimates, or if densities in the collection tank exceed 10 eels per L, the facility will be modified, or operational protocols adjusted to reduce crowding, in consultation with MDE, USFWS, and EPAG, and following approval from FERC.
USFWS		
1	Background, Page 2: Exelon states that the Conowingo East Eel Collection Facility (CEECF) (the temporary eel facility to be placed in the vicinity of the stilling basin at the East Fish Lift (EFL) will begin operation on May 1. This is inconsistent with the license and EFL operations. According to the license, operation of the CEECF will not commence until 10 days following the end of the operation of the EFL, as correctly stated in section 3.1.3.	The text in the Section 1. Background has been corrected.
2	Reporting and Meetings, Page 23: Regarding eel transport in Sections 6.1.1 and 6.1.2, Exelon describes reporting on transport in the text but does not include the reporting on transport in the bulleted list of items to be included in the daily and annual reports. Transport information (i.e. number transported by date and location) should be included in bulleted lists for both sections.	Transport information has been added to the list of items to be included in the daily and annual reports on page 25.
3	Appendix E: Daily datasheets for transport efforts should be included in this section or added as a separate appendix item.	Daily transport sheets have been added to what is now Appendix E.

From: Kirk Smith
Sent: Wednesday, August 18, 2021 10:33 AM
To: Erin Redding; Danucalov, Andrea; Bleistine, Ray; Brett Coakley; Mike.Cox@ERM.com; David Frazier; Eberts, Ron; 'Eyler, Sheila'; 'Henning, Aaron'; denise.keehner@maryland.gov; Ian Kiraly; jesus_morales@fws.gov; Martinek, Michael; 'McCollum, Allyson'; 'McCorkle, Richard'; 'Miller, Jeremy'; 'Minkkinen, Steve'; Heather Nelson -MDE-; Tony Prochaska; 'Sadzinski, Robert'; David Seaborn -MDE-; 'Seaman, Shawn'; 'Slowik, Adam'; Smith, Fred; 'Steffy, Luanne'; 'Tryninewski, Joshua'; 'Williamson, Scott'
Subject: Exelon EPAG July Meeting Summary and August Meeting Agenda
Attachments: EPAG_Meeting_Summary_20210715.pdf; EPAG_Meeting_Agenda_20210819.pdf; Conowingo_Eel_Passage_and_Restoration_Plan_2021.pdf

Hello,

Please see the attached Exelon EPAG July 2021 Meeting Summary and August 2021 Meeting Agenda.

Also attached is a revised version of the *American Eel Passage and Restoration Plan* required by Article 415 of the new license. The plan was previously distributed in April 2021 and has been revised based on resource agency comments.

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Maryland DNR / Power Plant Research Program

Comments, Questions and Recommendations

Exelon's Proposed American Eel Passage and Restoration Plan

9/1/21

Received 9/2/2021

Section 2 – Project Configuration:

- 2nd Paragraph: Be consistent with acronym definitions (i.e. define WFL. Use of both WFL and West Fish Lift is below).
- 2nd Paragraph: Figure 2.0-1 should depict all that is described in the text (i.e. spillway, abutment sections, etc.)

Section 3.2.1 - Conowingo West Eel Collection Facility

- 2nd Paragraph: Suggest including the elevation of the normal high-water line in the text.
- 3rd Paragraph: What is defined as 'large 60% shade cloth'. Additional clarification is needed.

Section 3.2.1 - Octoraro Creek Eel Collection Facility

- 2nd Paragraph: Add angle to 90-degrees.
- 3rd Paragraph: Define L as Liter and use consistently throughout.

Section 3.2.1 - Conowingo East Eel Collection Facility

- How was the location of the ramp determined?
- Does the attraction water come off the top of the pond?
- What is the general difference in water temperatures during the summer? Water temperatures in the tailrace compared to the CEECF attraction water should be recorded.
- The plan should describe how predators prevented from entering the EFL?
- Clarify the amount of attraction water coming out of the entrance gate C and how that will be a signal for eels to enter the EFL
- The plan should describe the flows when the eel ramp will be pulled.
- Provide an approximate year of project initiation/operation startup. We realize this is defined in the schedule section but mention of it here is recommended.
- 2nd Paragraph last sentence: Sentenced needs to be edited. Use of with versus will.
- 3rd Paragraph:
    - Include elevation of normal high-water line.
    - 7th sentence: is it 'tailwater level', or 'existing tailwater elevation'.

Section 3.2.2 – Construction

- Provide an estimated construction date.

Section 3.2.3 – Operational Protocols: Intro

- Re: Operation of CEECF - Diffuser gates A & B are to be open. With only 70 gal/min 'attraction flow' it might be better to close them off to get max guidance in the open channel for any eels that enter the EFL.

- Section 3.2.3 references a schedule outlined in Section 4. Section 4 needs more detailed information detailing actual operation and monitoring schedules at all three facilities.

Section 3.2.3 – Operational Protocols: Monitoring

- Are there specific monitoring forms? If so, please include in the plan
- Continuous monitoring / alarm systems at both the OECK and CEECF should be considered for replacement instead of daily inspections.

Section 3.2.3 – Operational Protocols: Inspection

- Page 12 states: *if an inspection suggests that any structure or flow component is not performing properly and no alarm has been triggered, verification of this potential deviation will be performed as described above and corrective action will be taken as soon as possible.* The plan should define this process.
- Alarms are mentioned but not discussed in enough detail.
- Please reference or clarify use, operation, etc. of alarms.
- What defines a failed inspection?

Section 3.2.3 – Operational Protocols: Maintenance

- Will the CEECF ramp be accessible for daily clearing obstructions?
- Is there a process or specific procedure for scrubbing the collection tank?
- What triggers a determination that the ramp needs to be cleaned?
- Are there specific maintenance logs/sheets?
- Are they provided in this plan and where will they be stored?
- Is anyone qualified to conduct the monitoring and maintenance activities or will this be a requirement?

Section 3.3 – Holding (Conowingo West Eel Collection Facility)

- Include a reference that all eels transferred to holding tanks will be recorded on the daily inspection sheet.
- Maryland is concerned that the plan continues to recommend holding eels for seven days until water temperatures exceed 28°C on consecutive days. Eels in crowded conditions can become stressed and develop fungus, as has been observed. Eels should be transported within 48 hours of capture. A recommended alternative would be the transportation and stocking to the Conowingo Pond and Lake Aldred eels that, held 48 hours, when the number held does not meet the threshold for stocking at upriver locations.

Section 3.3.2 – Operational Protocols

- What is the QA/QC process associated with the inspection sheets such that holding time and temperatures are met for transport?

Section 3.3.2 – Operational Protocols / Monitoring

- What defines continuous? Operation is noted later as 24 hours a day 7 days a week. This implies that monitoring will be conducted non-stop during the collection season/operation.
- 2nd Paragraph: Please reference and maintain/update a contact list including operational personnel in the plan.
- 4th Paragraph: Is there an elevated concentration that will trigger an alarm or just the minimum?

Section 3.3.2 – Operational Protocols / Inspection

- Once per day? Continuous measurements on other systems and only daily for holding tanks? Please clarify.

Section 3.4.1 – Design

Conowingo West Eel Collection Facility

- How often is the water quality probe calibrated and maintained?
- Where are the calibration and maintenance forms located in this plan?

  GLOBAL note for calibration forms as it is discussed in other sections of the plan
- Appendix F references engineering drawings for transport facility. Are there drawings for the 19-L buckets and enclosed transport tank?

Octoraro Creek Eel Collection Facility

– the holding tank has a capacity of 3,140 eels. The transport truck for more than 150 eels is a 250 liter tank which can transport 2,500 eels. In 2021, more than 2,500 eels were collected on July 13 – 3,474, 14 – 4,738 and 15 – 6,168. The plan should describe operations when more eels are collected in a single day than the holding tank or the transport tank can accommodate.

- How are the 19-L buckets loaded and transported?

Conowingo East Eel Collection Facility

- How are 19-L buckets transported?
- What are the plans to transport eels from CEECF to CWECF if a significant number of eels are collected? All in the 19-L bucket?

Section 3.4.2 Operation Protocols Monitoring (1st Paragraph):

- Is there a maximum amount of trips that are prohibitive per week based on staff or equipment limitations?
- Will this be an area of concern if the capacity of the holding tanks are continuously met and/or water temperatures exceed 28-degrees C?
- How are oxygen levels monitored and maintained?
- What is the calibration program for monitoring these levels?

Section 3.4.2 Operation Protocols Temperature

- Please provide additional detail on how the temperature will be monitored.

Section 3.4.2 Operation Protocols Dissolved Oxygen

- Regarding prior note on calibration protocols – this should be addressed in the plan.

Section 3.4.2 Operation Protocols Inspection (1st Paragraph)

- Please reference and provide an inspection check list.

Section 3.4.2 Operation Protocols Inspection (2nd Paragraph)

- How and where is this data recorded - data logger or field form?
- Please define the criteria for passing inspection. This is a vague statement.

Section 3.4.2 Operation Protocols Maintenance

- What is defined as the facility? Conowingo?
- Clarify the meaning here. Are you saying all tanks will be cleaned weekly?

Section 3.4.2 Operation Protocols American Eel Counting (1st Paragraph)

- Is it determined or recorded?

Section 3.4.2 Operation Protocols American Eel Counting (2nd Paragraph)

- What does this evaluation consider?
- Will all deceased eels float to the top of the tank or remain in the tank after release?
- At the release site how long is the area inspected to evaluate for mortality?
- Is the mortality evaluation process defined or is it subjective depending on the transport staff?

Section 3.6 – Emergency Response Protocols

- Maryland advises that if 95% survival is not achieved then modifications are deemed necessary.

Section 3.6.1 – Alarms and Contacts

- The contact list should be maintained, updated and provided in this plan.
- Is temperature included in the alarm system process?

Section 3.6.2 – Failed Inspections (2nd Paragraph)

- All inspections, passed or failed will be recorded how?
- Where are the forms/sheets documenting the inspections?

Section 3.7 – Quality Assurance and Quality Control

- A QA/QC plan should be developed and included as an appendix.
- Please define training requirements and how training records will be maintained.
- Table 3.5-1: In support of stocking locations, consider adding written directions and/or maps from Conowingo Dam to each of the stocking locations. In the event a new driver is needed how will they locate the site?

Section 4 – Implementation Schedule

- We believe the second sentence should be both CWECF and CEECF.

Section 6 – Reporting and Meetings

- Plan should identify (and be updated) as to which emails and staff receive these reports.
- Daily reports should include alarms, maintenance and cleaning operations that occurred if any

Section 6.1.2 - Annual Reports

- Draft reports for the CWECF and CEECF are proposed to be submitted on December 1 (up to Sept 15) and December 31 (16th to end of season). Final report filing dates are February 15. While time may be short between the end of the eel passage season and December 1, it is much preferable that there be only one report for the season.

Appendix I - Agency Consultation Records

General Comments #4

The recommended shakedown period was not intended for ramp efficiency (efficiency test) but to see if eels were attracted into the EFL and then to the ramp location. With additional attraction flow (See comment 1a below) a shakedown period will still be necessary. Tweaks are standard practice as indicated by the many tweaks and upgrades at the CWEFC and the shakedown periods for the rebuilt east and west fish lifts. Maryland would again strongly recommend a period of time when tweaks and upgrades be made and this time period not counted towards a fully functioning CEEFC evaluation period.

General Comments #8

Maryland disagrees with Exelon in that ramp efficiency testing technology is not available. Determining the efficiency of an eel ramp is feasible and has been done at a number of other projects. As Exelon described, a ramp efficiency test is simple. Enclose a known number of eels at the bottom of the ramp, which has been cleared of eels, and count the number in the capture/holding tank at the top over a fixed period such as 6, 12, 18, 24, etc. hours.

Ramp efficiency has been evaluated on three ladders at the Woronoco project (FERC # 2631) on the Westfield River in Massachusetts (Woronoco 2010 & 2012), at the Lawrence dam (FERC # 2800) on the Merrimack River in Massachusetts (Normandeau 2015), and on the Messalonskee Stream in Maine (Hickey 2012). In all cases, eelway efficiency was determined. At Woronoco the results were 99% in 96 hours at the North Ladder, 93% at the Middle Ladder in 66 hours, and 100% at the South Ladder in 18 hours. At the Lawrence Dam results after 36 hours were 55% and 32%. At the Automatic project on the Messalonskee Stream 97% efficiency was reported on the Enkamat side and 90% efficiency on the Plinko side. No times were reported.

Exelon states that where ramp efficiency tests have been done the results are mixed. That is true in that in the above projects two had high efficiencies and one was poor. Exelon expressed concern that eels infiltrating the eelway might affect the result as happened at Lawrence. The report surmises that eels at Lawrence may have infiltrated the ramp due to gaps in the wooden channel where sections were joined or were not detected under the substrate which was not checked prior to the tests. Infiltration would not be an issue at the ramps at Conowingo as they

are aluminum trays with a climbing material where all eels in the ramp could be observed and removed prior to the test. Any concerns with shutting down the west ramp could be mitigated by installing a temporary ramp or scheduling the test when eels movement is expected to be low.

Specific Comments 1a

Maryland disagrees with the proposed attraction flow for the eel ramp (70 gpm) which results in 0.16 cfs. This ramp must attract eels away from the flow from the turbines and leakage from the spill and into the EFL; 70 gpm is virtually no attraction flow and therefore must be increased to a flow such that eels are attracted into the EFL.

Specific Comments 1b

Night time observations are reasonable as a means of observing eels in the EFL to note concentration locations and to compare observations with captures.

Specific Comments 2a

Closing diffusers would direct flow to the open channel providing a stronger signal in the open channel to guide eels to the ramp.

Specific Comments 2b

As noted above, 70 gal/min is insufficient to attract eels into the EFL. It is concerning that Exelon has proposed an eelway with no attraction flow beyond ramp and side splash flows.

Specific Comment 2c

That there is no provision in settlement to include bar racks is does not justify rejecting them.. Many modifications to both fishways have been included as designs are developed. Adding slots for bar racks is a less than minor modification to protect eels from snakeheads and other invasives lying in wait in the EFL.

References

Hickey, S.J. January 26, 2012. Letter to Mr. Steven Shepard, USFWS. Kennebec Water District Upstream and Downstream Proposal. Pg. 4.

Normandeau. 2015. Assessment of eel pass effectiveness at the Lawrence hydroelectric project (FERC No. 2800), Merrimack River, Lawrence, MA.

Woronoco Hydro. 2010. Report on the 2009 testing of the upstream passage for juvenile American eels phase i – passability testing and site observations. FERC # 2631. Accession No. 20110131-5111.

Woronoco Hydro. 2012. Report on the 2011 testing of the upstream passage of juvenile eels, Phase 1 Passability tests of all eel ladders and repeat of Phase II attractiveness testing and observations –article 404. FERC # 2631. Accession No. 20120229-5139.

From: Miller, Jeremy <jeremmille@pa.gov>
Sent: Friday, September 3, 2021 6:32 AM
To: Danucalov, Andrea H:(Exelon Power) <Andrea.Danucalov@exeloncorp.com>
Cc: Eberts, Ron <reberts@pa.gov>; Williamson, Scott <scwilliams@pa.gov>
Subject: RE: [External] American Eel Passage and Restoration Plan

Andrea,

DEP has reviewed the revised Conowingo American Eel Passage and Restoration Plan dated August 2021 and have no further comments or questions.

Thank you for the opportunity to review.

Jeremy

Jeremy Miller | Aquatic Biologist
Department of Environmental Protection | Clean Water Program
Southcentral Regional Office
909 Elmerton Ave | Harrisburg, PA 17110
Phone: 717.705.4777 | Fax: 717.705.4760
www.dep.pa.gov
DEP's 24-hour Emergency Response Number is 1.800.541.2050

Agency Comments on August 18, 2021 Draft and Exelon Responses

	Comment	How Addressed
MDE & MDNR, Received September 2, 2021		
Section 2 – Project Configuration		
1	2nd Paragraph: Be consistent with acronym definitions (i.e. define WFL. Use of both WFL and West Fish Lift is below).	WFL has been removed from the document.
2	2nd Paragraph: Figure 2.0-1 should depict all that is described in the text (i.e. spillway, abutment sections, etc.)	This figure has been updated.
Section 3.2.1 - Conowingo West Eel Collection Facility		
3	2nd Paragraph: Suggest including the elevation of the normal high-water line in the text.	The elevation of the normal high-water line has been added to the text.
4	3rd Paragraph: What is defined as 'large 60% shade cloth'. Additional clarification is needed.	The percentage listed refers to the percentage of sunlight and corresponding UV rays that are blocked by the shade cloth. This explanation has been added as a footnote to the text.
Section 3.2.1 - Octoraro Creek Eel Collection Facility		
5	2nd Paragraph: Add angle to 90-degrees.	The word "angle" has been added to the text.
6	3rd Paragraph: Define L as Liter and use consistently throughout.	L is defined as liter in Section 3.2.1, the first paragraph under Conowingo West Eel Collection Facility. The document has been checked for consistency as liter has been replaced with L in one location within the document.
Section 3.2.1 - Conowingo East Eel Collection Facility		

	Comment	How Addressed
7	How was the location of the ramp determined?	The MDE Settlement Joint Explanatory Statement, Section A.2.a.i says, "Exelon will develop an 'Eel Passage and Restoration Plan' that will (i) provide for modification of the EFL to accommodate a temporary eel trapping facility in the EFL stilling basin (the 'Temporary Eel Trapping Facility')". The MDE Settlement Draft License Article Eel Passage says, "The Eel Passage and Restoration Plan shall include (i) detailed plans for modifications to the East Fish Lift to specifically accommodate a temporary eel trapping facility at a location within the East Fish Lift stilling basin in the vicinity of the foot of the spillway ('EFL Eel Temporary Modifications')". Due to the language of the MDE Settlement draft license article, Article 415 then specifically calls for a temporary eel trapping facility at a location within the East Fish stilling basin. The MDE Settlement is referenced in Section 3.1.3. The stilling basin location allows for a water source, power source, and safety from vandalism. No facility can be placed below the spillway itself due to safety concerns. The CEECF is considered experimental and temporary. The design for the CEECF is not finalized and will be developed further, as necessary, in consultation with the resource agencies, after the design of the EFL modifications for American Shad and river herring are complete.
8	Does the attraction water come off the top of the pond?	Attraction flow water to the CEECF comes from a 6-inch gravity feed water line from the headpond near elevation 100.7 feet (full pond elevation is 109.2 feet) to valve located near the EFL. Then the water line is reduced to a 2-inch line to feed the CEECF.

	Comment	How Addressed
9	What is the general difference in water temperatures during the summer? Water temperatures in the tailrace compared to the CEECF attraction water should be recorded.	Available data from Exelon's 2010 water quality study[18] conducted during relicensing indicates there is little to no thermal stratification during summer in Conowingo Pond at sampling locations near the dam. In addition, a comparison of water temperatures measured at monitoring locations throughout the water column just upstream of the dam indicated that temperatures were comparable to those measured in the tailrace at monitoring station 643. Water temperature from the continuous monitor located in the collection tank can be compared to temperature data recorded in the tailrace at monitoring station 643.
10	The plan should describe how predators prevented from entering the EFL?	Predators will not be excluded from the EFL but will be excluded from the diffuser pits and above the crowder screen hoist by grating with 7/8-inch opening. This grating opening may change depending on the final design of the EFL modifications.
11	Clarify the amount of attraction water coming out of the entrance gate C and how that will be a signal for eels to enter the EFL	The attraction flow out of entrance gate C will be 265 L-per-minute. This is the same amount of attraction flow used at the CWECF, which as of September 2021 had captured over 580,000 moving along the west side of the tailrace, along the margin of the main generation flow. The CEECF is intended to collect eels that may move along the east side of the tailrace to the EFL entrances along the margin of the main generation flow. The amount of attraction flow has been added to Section 3.2.1.
12	The plan should describe the flows when the eel ramp will be pulled.	The ramp should be pulled when flows are forecasted to exceed 113,000 cfs. This has been added to Section 3.2.3. The ramp will be redeployed once flows have receded to a level that allow for safe access.

[18] Normandeau Associates, Inc. and Gomez and Sullivan Engineers, P.C., 2012. Seasonal and Diurnal Water Quality in Conowingo Pond and Below Conowingo Dam.

	Comment	How Addressed
13	Provide an approximate year of project initiation/operation startup. We realize this is defined in the schedule section but mention of it here is recommended.	The construction schedule for the EFL modifications for river herring and American Shad has not been finalized. The CEECF will be installed after the EFL modifications are complete. Exelon will provide schedule updates at a minimum during the annual EPAG meetings and will also update this plan accordingly and submit it to the resource agencies for review and FERC for approval. Exelon also participates in monthly design-planning meetings with resource agencies, and schedule is discussed during these meetings. This has been added to Section 3.2.1.
14	2nd Paragraph last sentence: Sentenced needs to be edited. Use of with versus will.	This sentence has been corrected.
15	3rd Paragraph: Include elevation of normal high-water line. 7th sentence: is it 'tailwater level', or 'existing tailwater elevation'.	This sentence has been revised to reference the elevation of the base of the ramp (+/-17.8 ft) relative to the minimum tailwater elevation (+/-12.9 ft) expected to occur during the operational season for the CEECF (mid-June to early November).
Section 3.2.2 – Construction		
16	Provide an estimated construction date.	The construction schedule for the EFL modifications for river herring and American Shad has not been finalized. The CEECF will be installed after the EFL modifications are complete. Exelon will provide schedule updates at a minimum during the annual EPAG meetings and will also update this plan accordingly and submit it to the resource agencies for review and FERC for approval. Exelon also participates in monthly design-planning meetings with resource agencies, and schedule is discussed during these meetings.
Section 3.2.3 – Operational Protocols: Intro		

	Comment	How Addressed
17	Re: Operation of CEECF - Diffuser gates A & B are to be open. With only 70 gal/min 'attraction flow' it might be better to close them off to get max guidance in the open channel for any eels that enter the EFL.	If eels are near the bottom of the channel, having the Diffuser C open will help guide eels into the stilling basin, otherwise they could become trapped in this area and have no way out. The situation is similar at the Crowder Area Gate. Leaving Diffuser Gate A and B open along with Crowder Area Gate will allow eels to reach the CEECF, without becoming isolated and trapped in these passages.
18	Section 3.2.3 references a schedule outlined in Section 4. Section 4 needs more detailed information detailing actual operation and monitoring schedules at all three facilities.	Section 3.2.3 should refer to Section 5, which outlines the annual schedule and duration of operation at each of the facilities. The text has been revised to reflect this. Monitoring schedules are outlined in Section 3.2.3 under the monitoring subheading.
Section 3.2.3 – Operational Protocols: Monitoring		
19	Are there specific monitoring forms? If so, please include in the plan	The CWECF Daily Field Sheet is included in Appendix E.
20	Continuous monitoring / alarm systems at both the OECF and CEECF should be considered for replacement instead of daily inspections.	30-minute readings of temperature and DO will be recorded using an Onset HOBO Probe in the collection tanks at both the CEECF and OECF. These data are downloaded and reviewed regularly to identify any water quality related issues with the operation of the facilities. Daily inspections by operation staff are an important component of maintaining the proper functioning of each facility, and Exelon does not believe discontinuing these procedures would be appropriate.
Section 3.2.3 – Operational Protocols: Inspection		
21	Page 12 states: if an inspection suggests that any structure or flow component is not performing properly and no alarm has been triggered, verification of this potential deviation will be performed as described above and corrective action will be taken as soon as possible. The plan should define this process.	Items such as faulty or incorrectly positioned attraction flow hoses or components such as a spray bar incorrectly spraying water due to blockages of the holes, etc. are examples of items included in the visual inspection. These items are not identifiable by the alarm system and must be covered during the daily inspections. Observed anomalies are recorded on the Daily Field Sheet. The CWECF Daily Field Sheet is included in Appendix E.

	Comment	How Addressed
22	Alarms are mentioned but not discussed in enough detail.	Text has been added to Section 3.2.3 (Monitoring).
23	Please reference or clarify use, operation, etc. of alarms.	Refer to text in Section 3.2.3 (Monitoring).
24	What defines a failed inspection?	The term failed inspection refers to when a facility is not operating as intended. This term and Section 3.6.2 have been revised for clarity.
Section 3.2.3 – Operational Protocols: Maintenance		
25	Will the CEECF ramp be accessible for daily clearing obstructions?	The ramp will be accessible; however, very few obstructions are anticipated to be found near the ramp area due to trash racks preventing debris from entering through the gravity feed line and no debris are expected to enter the stilling basin due to the elevation of the EFL walls that surround it.
26	Is there a process or specific procedure for scrubbing the collection tank?	Scrubbing the tanks is performed with water, a brush, and scouring pad. No chemicals are used.
27	What triggers a determination that the ramp needs to be cleaned?	The ramp will need to be cleaned if debris block or hinders passage of eels at the entrance or on the ramp.
28	Are there specific maintenance logs/sheets?	The Daily Field Sheet is used to record all information including any issues that might be observed. There is also a weekly calibration sheet that is used to verify that the eel ramp equipment is working properly.
29	Are they provided in this plan and where will they be stored?	Data sheets are in Appendix E. They are stored in files at Normandeau's office and data are digitized.
30	Is anyone qualified to conduct the monitoring and maintenance activities or will this be a requirement?	The eel ramps are checked daily by experienced personnel. If a new employee is used to assist with the ramp checks, that employee is always teamed and trained by an experienced member of the maintenance staff.
Section 3.3 – Holding (Conowingo West Eel Collection Facility)		
31	Include a reference that all eels transferred to holding tanks will be recorded on the daily inspection sheet.	This reference has been added.

	Comment	How Addressed
32	Maryland is concerned that the plan continues to recommend holding eels for seven days until water temperatures exceed 28°C on consecutive days. Eels in crowded conditions can become stressed and develop fungus, as has been observed. Eels should be transported within 48 hours of capture. A recommended alternative would be the transportation and stocking to the Conowingo Pond and Lake Aldred eels that, held 48 hours, when the number held does not meet the threshold for stocking at upriver locations.	Health of eels in holding is a top priority. The Muddy Run Eel Passage Plan call for weekly transport, but EPAG agreed that transports should occur twice per week starting in mid-June and continue through September 15. Daily transports are conducted pre-emptively before water temperatures exceed 28°C or eels become crowded. SRBC has traditionally suggesting stocking locations and the locations are approved by EPAG. Alternative stocking approaches can be discussed during annual meetings with EPAG and MDE. Exelon would propose 100 eels in holding over a 48-hour period as a threshold to determine transport to Conowingo Pond and Lake Aldred versus locations further upstream.
Section 3.3.2 – Operational Protocols		
33	What is the QA/QC process associated with the inspection sheets such that holding time and temperatures are met for transport?	The CWECF is maintained daily and decisions to transport are made in real-time based on eel condition, environmental conditions, and the number of eels in holding. A transport vehicle is on-site to facilitate the ability to conduct transports as needed.
	Section 3.3.2 – Operational Protocols / Monitoring	
34	What defines continuous? Operation is noted later as 24 hours a day 7 days a week. This implies that monitoring will be conducted non-stop during the collection season/operation.	Flow, DO, and temperature are monitored and recorded continuously at the CWECF holding tanks. These meters are in place throughout the entire collection season and operate 24/7.
35	2nd Paragraph: Please reference and maintain/update a contact list including operational personnel in the plan.	Contact lists are updated regularly and will be distributed to resource agencies, Station staff, and contractors each season.
36	4th Paragraph: Is there an elevated concentration that will trigger an alarm or just the minimum?	The upper DO threshold is 20 ppm. This has been added to the text.
37	Section 3.3.2 – Operational Protocols / Inspection Once per day? Continuous measurements on other systems and only daily for holding tanks? Please clarify.	Eel tanks are typically checked every morning. Continuous measurements of temperature, flow and DO are recorded for the holding tanks, as well as the collection tank.
Section 3.4.1 – Design		

	Comment	How Addressed
	Conowingo West Eel Collection Facility	
38	How often is the water quality probe calibrated and maintained?	Water quality data are downloaded weekly. The probe is checked weekly versus a calibrated meter, and then the probe is calibrated, as necessary.
39	Where are the calibration and maintenance forms located in this plan? *GLOBAL note for calibration forms as it is discussed in other sections of the plan*	This form has been added to Appendix E.
40	Appendix F references engineering drawings for transport facility. Are there drawings for the 19-L buckets and enclosed transport tank?	There are no engineering drawings for the 19-L buckets or the smaller enclosed transport tank. Pictures of these have been provided in Appendix F.
	Octoraro Creek Eel Collection Facility	
41	The holding tank has a capacity of 3,140 eels. The transport truck for more than 150 eels is a 250 liter tank which can transport 2,500 eels. In 2021, more than 2,500 eels were collected on July 13 – 3,474, 14 – 4,738 and 15 – 6,168. The plan should describe operations when more eels are collected in a single day than the holding tank or the transport tank can accommodate.	Under these circumstances, multiple trips to transport eels from the OECF to the CWECF holding tanks are made. This has description has been included in text in Section 3.4.1.
42	How are the 19-L buckets loaded and transported?	The 19-L buckets are manually loaded into a custom-made bucket holder that keeps the buckets from tipping over during transport via a small cart.
	Conowingo East Eel Collection Facility	
43	How are 19-L buckets transported?	A small cart will be used to transport buckets or the 250-L transport tank from the EFL area to the CWECF holding tanks.
44	What are the plans to transport eels from CEECF to CWECF if a significant number of eels are collected? All in the 19-L bucket?	All the eels will be transported in the 19-L buckets or the 250-L transport tank with supplied oxygen.
Section 3.4.2 Operation Protocols Monitoring (1st Paragraph):		
45	Will this be an area of concern if the capacity of the holding tanks are continuously met and/or water temperatures exceed 28-degrees C?	Daily transports will occur if water temperatures exceed 28°C, and multiple daily transports could occur if holding capacity is expected to be exceeded at the CWECF.

	Comment	How Addressed
46	How are oxygen levels monitored and maintained?	At the CWECF, oxygen levels are continuously monitored by a probe. The results are automatically sent to a control panel, which is connected to the Conowingo control room. At the OECF, oxygen levels and water temperature are monitored with an Onset HOBO Probe. Oxygen levels are maintained at the CWECF and will be maintained at the CEECF with an oxygen bottle, regulator, and micro-pore diffuser. Currently, there is no oxygen bottle at OCEF, but there are two battery-powered bubblers that provide DO augmentation to the collection tank. Oxygen levels in the transport tank are maintained with oxygen bottle, regulator, and diffuser.
47	What is the calibration program for monitoring these levels?	Probes (CWECF and transport tank) and Onset HOBO Probes (OECF) are checked and calibrated weekly, and data, where applicable, are downloaded weekly.
48	Section 3.4.2 Operation Protocols Temperature Please provide additional detail on how the temperature will be monitored.	During transport events, water temperature is monitored with the same meter used to monitor DO; the probe measures both parameters.
49	Section 3.4.2 Operation Protocols Dissolved Oxygen Regarding prior note on calibration protocols – this should be addressed in the plan.	See response to Comment # 47.
50	Section 3.4.2 Operation Protocols Inspection (1st Paragraph) Please reference and provide an inspection check list.	Refer to Transport Data Sheet in Appendix E.
Section 3.4.2 Operation Protocols Inspection (2nd Paragraph)		
51	How and where is this data recorded - data logger or field form?	Refer to Transport Data Sheet in Appendix E.
52	Please define the criteria for passing inspection. This is a vague statement.	The first sentence under Inspection has been changed to read, “Prior to each trip, the transport truck and associated equipment will be inspected to confirm that all equipment is operating as intended.”
	Section 3.4.2 Operation Protocols Maintenance	
53	What is defined as the facility? Conowingo?	The term “facility” has been edited to “CWECF”.

	Comment	How Addressed
54	Clarify the meaning here. Are you saying all tanks will be cleaned weekly?	All tanks that are in use will be cleaned at least weekly.
55	Section 3.4.2 Operation Protocols American Eel Counting (1st Paragraph) Is it determined or recorded?	The text has been revised to use the term "recorded."
Section 3.4.2 Operation Protocols American Eel Counting (2nd Paragraph)		
56	What does this evaluation consider?	Mortality is not an evaluation but rather a determination. The term has been changed in the text.
57	Will all deceased eels float to the top of the tank or remain in the tank after release?	Freshly dead eels sink. They are removed by netting. Only when a small proportion of eels are left in the holding tank are they flushed. All eels are checked prior to loading into transport tank.
58	At the release site how long is the area inspected to evaluate for mortality?	The stocking location is monitored until the water returns to pre-stocking conditions (i.e. water and sediment have settled following stocking). Most eels will seek cover as soon as they are stocked. Eels that have died will be visible lying belly-up and motionless on the stream bottom. Dead eels are retrieved by the stocking crew when access allows.
59	Is the mortality evaluation process defined or is it subjective depending on the transport staff?	The word evaluated has been changed to "determined". An eel is either "alive "or "dead", hence there is no subjectivity.
60	Section 3.6 – Emergency Response Protocols Maryland advises that if 95% survival is not achieved then modifications are deemed necessary.	As stated in the plan, Exelon will meet with resource agencies to develop appropriate modifications for the facilities, if the survival goal is not met. In previous years of operation of the CWECF and OECF facilities, Exelon has met the 95% survival standard each year.
	Section 3.6.1 – Alarms and Contacts	
61	The contact list should be maintained, updated and provided in this plan.	Contact lists are updated regularly and will be distributed to resource agencies, Station staff, and contractors each season.
62	Is temperature included in the alarm system process?	There is no temperature alarm, as temperature cannot be adjusted. However, temperature is monitored continuously and recorded. Eel condition and daily water temperature are used to inform the transport schedule.

	Comment	How Addressed
Section 3.6.2 – Failed Inspections (2nd Paragraph)		Section 3.6.2 has been renamed Inspection Response, which is more accurate than Failed Inspections Protocols.
63	All inspections, passed or failed will be recorded how?	Notes detailing the issue will be recorded in the Comments section of the Daily Field Sheet or the Transport Sheet.
64	Where are the forms/sheets documenting the inspections?	The forms are included in Appendix E.
Section 3.7 – Quality Assurance and Quality Control		
65	A QA/QC plan should be developed and included as an appendix.	The QA/QC measures related to the eel program are described throughout Section 3 of this document for each facility, and inspection forms and data sheets are included as Appendices.
66	Please define training requirements and how training records will be maintained.	Supervising biologist train new staff members, who are subject to internal review. Most of the training is hands-on. A new or inexperienced staff member never leads the daily crew. Additionally, all operating personnel are required to read and understand the Conowingo Fishway Operation and Maintenance Plan.
67	Table 3.5-1: In support of stocking locations, consider adding written directions and/or maps from Conowingo Dam to each of the stocking locations. In the event a new driver is needed how will they locate the site?	All “drivers” are biologists with several seasons of experience. Maps are no longer required as most cell phones have apps for directions and rerouting capabilities when a specific road is closed due to accidents, etc.
68	Section 4 – Implementation Schedule We believe the second sentence should be both CWECF and CEECF.	This sentence has been revised for clarity. It is only referring to the CWECF. The CEECF will begin operation one year after the EFL modifications are complete.
Section 6 – Reporting and Meetings		
70	Plan should identify (and be updated) as to which emails and staff receive these reports.	Confidential contact lists including Exelon staff, consultants, and resource agencies, are kept separately from this publicly accessible report. Contact lists are updated regularly.

	Comment	How Addressed
71	Daily reports should include alarms, maintenance and cleaning operations that occurred if any	It is preferable to detail these issues if they occur in a section of the annual report. Exelon does notify the resource agencies when there is an issue with any of the eel ramps by email. The daily emails should be succinct and brief unless an unexpected situation arises.
72	Section 6.1.2 - Annual Reports Draft reports for the CWECF and CEECF are proposed to be submitted on December 1 (up to Sept 15) and December 31 (16th to end of season). Final report filing dates are February 15. While time may be short between the end of the eel passage season and December 1, it is much preferable that there be only one report for the season.	The Muddy Run Pumped Storage Project License Appendix A requires Exelon to submit draft annual reports to resource agencies for the CWECF and OECF summarizing eel facility data by December 10 each year and final reports to FERC by January 15. MDE, PADEP, SRBC, and USFWS were consulted regarding draft report submission during a meeting on October 1, 2020. Exelon stated at that time that providing a quality draft report by December 10 that covers the longer MDE-defined season at CWECF is not feasible and proposed submitting only one draft report at a later date. However, PADEP and USFWS agreed that a draft report must still be submitted by December 10 per the Muddy Run License. They acknowledged that including additional data from operations through mid-November was not feasible and it was agreed that additional September 16 through early November data should be added to the report later as an addendum. The addendum will not include additional biological data. MDE asked if the interim draft would be provided to them and Exelon agreed that all eel facility interim draft reports would be provided to all resource agencies.
Appendix I - Agency Consultation Records		

	Comment	How Addressed
73	General Comments #4 The recommended shakedown period was not intended for ramp efficiency (efficiency test) but to see if eels were attracted into the EFL and then to the ramp location. With additional attraction flow (See comment 1a below) a shakedown period will still be necessary. Tweaks are standard practice as indicated by the many tweaks and upgrades at the CWEFC and the shakedown periods for the rebuilt east and west fish lifts. Maryland would again strongly recommend a period of time when tweaks and upgrades be made and this time period not counted towards a fully functioning CEEFC evaluation period.	The CEECF is an experimental ramp. Exelon is proposing to begin operation of the ramp as outlined in this Plan. Adjustments to the attraction flow and other operational parameters can be considered at annual EPAG meetings, as necessary, after the initial installation and operation of the CEECF is evaluated.
74	General Comments #8 Maryland disagrees with Exelon in that ramp efficiency testing technology is not available. Determining the efficiency of an eel ramp is feasible and has been done at a number of other projects. As Exelon described, a ramp efficiency test is simple. Enclose a known number of eels at the bottom of the ramp, which has been cleared of eels, and count the number in the capture/holding tank at the top over a fixed period such as 6, 12, 18, 24, etc. hours. Ramp efficiency has been evaluated on three ladders at the Woronoco project (FERC # 2631) on the Westfield River in Massachusetts (Woronoco 2010 & 2012), at the Lawrence dam (FERC # 2800) on the Merrimack River in Massachusetts (Normandeau 2015), and on the Messalonskee Stream in Maine (Hickey 2012). In all cases, eelway efficiency was determined. At Woronoco the results were 99% in 96 hours at the North Ladder, 93% at the Middle Ladder in 66 hours, and 100% at the South Ladder in 18 hours. At the Lawrence Dam results after 36 hours were 55% and 32%. At the Automatic project on the Messalonskee Stream 97% efficiency was reported on the Enkamat side and 90% efficiency on the Plinko side. No times were reported. Exelon states that where ramp efficiency tests have been done the results are mixed. That is true in that in the above projects two had high efficiencies and one was poor. Exelon expressed concern that eels infiltrating the eelway might affect the result as happened at Lawrence. The report surmises that eels at Lawrence may have infiltrated the ramp due to gaps in the wooden channel where sections were joined or were not detected under the substrate which was not checked prior to the tests. Infiltration would not be an issue at the ramps at Conowingo as they are aluminum trays with a climbing material where all eels in the ramp could be observed and removed prior to the test. Any concerns with shutting down the west ramp could be mitigated by installing a temporary ramp or scheduling the test when eels movement is expected to be low.	Exelon would prefer to complete attraction efficiency and ramp efficiency testing using a single, proven technology. Proven technology for attraction efficiency (such as appropriately sized tags) is not available. Discussion of technological developments will continue at annual EPAG meetings with resource agencies. Regarding ramp efficiency only, Exelon will draft a study plan for an efficiency test in 2022, as suggested by MDE. The draft study plan will be provided to EPAG members and USFWS and will be implemented following approval of this Plan.

	Comment	How Addressed
75	Specific Comments 1a Maryland disagrees with the proposed attraction flow for the eel ramp (70 gpm) which results in 0.16 cfs. This ramp must attract eels away from the flow from the turbines and leakage from the spill and into the EFL; 70 gpm is virtually no attraction flow and therefore must be increased to a flow such that eels are attracted into the EFL.	The CWECF currently operates with the same attraction flow as proposed for the CEECF. The CWECF must also attract eels away from turbines and up the riprap on the streambank. In 2021, over 580,000 eels (as of September) were captured at the CWECF. The CEECF is an experimental ramp. Exelon is proposing to begin operation of the ramp with the 265 L-per-minute (70-gpm) attraction flow. Adjustments to the attraction flow can be considered annually at EPAG meetings, as necessary, after the initial installation and operation of the CEECF is evaluated.
76	Specific Comments 1b Night time observations are reasonable as a means of observing eels in the EFL to note concentration locations and to compare observations with captures.	Exelon is proposing that the need for nighttime observations be discussed after initial installation and operation of the CEECF. The scope and level of effort for any nighttime observations can be discussed annually at EPAG meetings and implemented accordingly.
77	Specific Comments 2a Closing diffusers would direct flow to the open channel providing a stronger signal in the open channel to guide eels to the ramp.	Exelon is proposing to begin the initial operation of the CEECF with the diffusers opened. Alternative diffuser gate settings can be considered annually at EPAG meetings, as necessary, after the initial installation and operation of the CEECF is evaluated.
78	Specific Comments 2b As noted above, 70 gal/min is insufficient to attract eels into the EFL. It is concerning that Exelon has proposed an eelway with no attraction flow beyond ramp and side splash flows.	The CWECF currently operates with the same attraction flow as proposed for the CEECF. The CWECF must also attract eels away from turbines and up the riprap on the streambank. In 2021, over 580,000 eels were captured at the CWECF by early September. The CEECF is an experimental ramp. Exelon is proposing to begin operation of the ramp with the 265 L-per-minute (70-gpm) attraction flow. Adjustments to the attraction flow can be considered annually at EPAG meetings, as necessary, after the initial installation and operation of the CEECF is evaluated.

	Comment	How Addressed
79	Specific Comment 2c That there is no provision in settlement to include bar racks is does not justify rejecting them. Many modifications to both fishways have been included as designs are developed. Adding slots for bar racks is a less than minor modification to protect eels from snakeheads and other invasives lying in wait in the EFL.	Predators will be excluded from the diffuser pits and above the crowder screen hoist by grating with 7/8-inch opening. This grating opening may change depending on the final design of the EFL modifications. Exelon will consider the need for additional predator exclusion devices (i.e., bar racks on the C gate entrance) as part of the EFL modification design process for American Shad and river herring. Any design must consider worker safety and access constraints during installation and removal of the bar racks.

Attachment I

Conowingo Hydroelectric Project
(FERC Project No. 405)

Chlorophyll-A Monitoring Plan

CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NO. 405

CHLOROPHYLL-A MONITORING PLAN

Prepared for:

Constellation.

Prepared by:

GOMEZ AND SULLIVAN ENGINEERS

Submitted to Maryland Department of the Environment

FINAL PLAN: ~~November 2021~~

Revised: March 2023

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LIST OF ABBREVIATIONS

CBL	Chesapeake Biological Laboratory
COC	Chain-of-Custody
COMAR	Code of Maryland Regulations
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
IR	Integrated Report
MD	Maryland
MDE	Maryland Department of the Environment
ml	milliliter
NTU	Nephelometric Turbidity Units
PA	Pennsylvania
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Checks
RPD	Relative Percent Deviation
The Reservoir	Conowingo Reservoir
TMDL	Total Maximum Daily Load
ug/L	Microgram/Liter

1 INTRODUCTION

This document proposes a plan to monitor chlorophyll-a for three (3) years in the Maryland portion of the Conowingo Dam impoundment between May 1 and September 30, as required by Section 2.4 (g) of the Joint Offer of Settlement and Explanatory Statement of Exelon Generation Company, LLC) and the Maryland Department of the Environment (MDE) (i.e., the Settlement Agreement, Exelon, 2019). The Settlement Agreement states the monitoring plan "shall be designed to determine with a high level of statistical confidence whether chlorophyll-a water quality standards are exceeded in the Maryland portion of the Reservoir between May 1 and September 30 in any particular year."

The impoundment created by Conowingo dam is known as Conowingo Pool, Conowingo Reservoir, Conowingo Lake and Conowingo Pond. For the purposes of this document, it will be referred to as Conowingo Reservoir (or the Reservoir) to stay consistent with the wording of the Settlement Agreement. The Maryland portion of the Reservoir ends approximately five (5) miles above the dam and provides recreational opportunities such as boating and fishing and is the source of drinking water to the City of Baltimore and Harford County (Conowingo pond management plan, SRBC, 2006).

A draft of this plan was provided to MDE on July 23, 2021 for review in advance of Constellation's sampling program proposed to start in 2022[1]. Prior to submittal of the draft plan, Constellation and MDE held a conference call on June 10, 2021 to discuss the intent and commitments of the sampling requirement as well as previous monitoring performed by MDE and potential methods for Constellation's sampling program. MDE provided comments on the draft plan to Constellation on August 4, 2021 and Constellation and MDE subsequently held another conference call to discuss MDE's comments. On August 31, 2021, the monitoring plan was submitted to MDE and MDE provided additional comments on September 20, 2021.

Constellation revised the monitoring plan to address MDE's September 2021 comments and provided a revised plan to MDE on October 4, 2021. Constellation also provided additional information regarding the costs to implement the plan to MDE on October 15, 2021. MDE provided one additional comment to Constellation regarding the sampling time of day via email dated October 27, 2021. Constellation responded on November 1, 2021, and MDE accepted Constellation's proposed sampling times. Appendix A contains a responsiveness summary describing how Constellation addressed MDE's comments and copies of related correspondence.

Constellation has proposed to amend the Chlorophyll-a Monitoring Plan following the completion of the 2022 monitoring effort. In 2022, the analytical methodology to determine chlorophyll-a deviated from what was specified in the monitoring plan. Analytical testing of chlorophyll-a was performed using the fluorometric method (EPA 445.0, SM10200H.3) instead of the spectrophotometric method (EPA 446.0, SM10200H). The fluorometric method is the University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory (CBL) default method for analyzing chlorophyll-a in water and sediment of fresh, estuarine, and coastal areas, as it provides slightly more sensitivity than the spectrophotometric method (J. Frank, CBL, to J. Petre,

[1] The Settlement Agreement limits the study to an annual budget of $40k.

Gomez and Sullivan Engineers, D.P.C., personal communication, November 3, 2022). The laboratory calculated method detection limits (MDL) are similar between both methods. Under the fluorometric method, CBL has determined a MDL of 0.68 µg/L for chlorophyll-a and a MDL of 0.46 µg/L for phaeophytin (CBL, 2022). In comparison, the spectrophotometric method has a MDL of 0.62 µg/L for chlorophyll-a and a MDL of 0.74 µg/L for phaeophytin (CBL, 2022). All sample preservation procedures, extraction methods, and holding times are identical between the fluorometric and spectrophotometric methods. Additionally, the measuring and reporting of chlorophyll-a done by CBL is comparable between both methods.To retain consistency through the remainder of the three-year monitoring program, Constellation proposes to continue performing chlorophyll-a analysis using the fluorometric method in 2023 and 2024.

1.1 Water Quality Background

1.1.1 Standards and Guidelines

The Maryland water quality standards are found in the Code of Maryland regulations (COMAR) at 26.08.01 – 26.08.02. Chlorophyll-a is a parameter regarded as a supporting factor for the characterization of water quality conditions (MD, 2009). Chlorophyll-a concentrations indicate the amount of algae growing in a waterbody and are measured in part to determine nutrient loading in impoundments in MD since algal growth generally increases with nutrients. A chlorophyll-a concentration of 10 ug/L is recognized as the threshold between mesotrophic and eutrophic conditions (per guidance from Carlson, 1977).

Maryland's chlorophyll-a numeric criteria for public water-supply reservoirs (COMAR 26.08.02.03-3(H)) are as follows. The following criteria apply in freshwater reservoirs designated Class I-P, III-P or IV-P:

1) The arithmetic mean of a representative number of samples of chlorophyll a concentrations, measured during the growing season (May 1 to September 30) as a 30-day moving average may not exceed 10 micrograms per liter; and
2) The 90th-percentile of measurements taken during the growing season may not exceed 30 micrograms per liter.

1.1.2 Designated Uses

The reach of the Susquehanna River from the north side of the Conowingo dam to the Maryland/Pennsylvania border, is a Use I-P[2] waterbody, whose designated uses include water contact recreation, protection of aquatic life, and public water supply. A waterbody is considered "impaired" if it does not meet established water quality thresholds/criteria or if it does not support a designated use. Certain water quality criteria are used to determine if a designated use is not being met (narrative or numeric) (MDE, 2019).

Maryland's current Impaired Surface Waters 303(d) list is included in Maryland's Final 2018 Integrated Report (IR) of Surface Water Quality, submitted in accordance with Sections 303(d), 305(b), and 314 of the Clean Water Act. The IR categorizes waterbody-designated use-pollutant combinations as to whether water quality standards are being met and whether a TMDL has been

[2] "-P" signifies a waterbody is designated for public water supply.

completed or other solution has been initiated. This categorization system can thus lead to having a single waterbody (e.g., Conowingo Reservoir) being captured under different categories for different designated use-pollutant combinations.

In this manner, Conowingo Reservoir is listed under Category 2 (waters attaining standards for which they have been assessed), Category 3 (waters with insufficient information to determine if water quality standards are attained) and Category 5 (303(d) list of impaired waters for which a Total Maximum Daily Load (TMDL) is required) for different designated use-pollutant combinations. Total phosphorus is listed under Category 5 for impairing the designated use of public water supply for the reservoir, as indicated by chlorophyll-a concentrations. Nutrients tend to increase chlorophyll-a production.

1.1.3 Historical Data

Historical chlorophyll-a data within the Reservoir are limited. However, in 2017, the MDE conducted a monitoring study at eight (8) sampling locations between May and October. Chlorophyll-a concentrations from the eight (8) sample locations monitored during MDE's 2017 chlorophyll monitoring study ranged from 1.28 ug/L to 23.92 ug/L, with an average of 9.23 ug/L and a median of 8.09 ug/L[3].

According to data collected from the Environmental Protection Agency (EPA) Water Quality Portal (https://www.waterqualitydata.us/) for the Conowingo Reservoir in Maryland, before the MDE study for chlorophyll-a there was just one study conducted within the Reservoir for three (3) days in 2012. Other studies to note not directly within the Reservoir include a study conducted in 1999 at Funk's Pond which is connected to the Reservoir less than two (2) miles above Conowingo Dam, as well as data collected by the USGS at the gage on the dam (USGS Gage No. 01578310) via the dam catwalk off the tailrace[4].

[3] Data received via email from MDE (Matthew Stover) June 11, 2021.
[4] Specifically, sampling occurs at Unit #8, a Kaplan turbine that does not have aeration capabilities.

2 SAMPLING METHODS AND PROCEDURES

Constellation is committed to conducting chlorophyll-a monitoring for three (3) years in the Maryland portion of the Conowingo Reservoir, starting in 2022. Sampling methods are primarily based on procedures described in the MDE Water Quality Assessment Quality Assurance Project Plan (QAPP): Conowingo Impoundment Nutrient and Chlorophyll Sampling Component (MDE, 2021, "Conowingo QAPP") and summarized in this plan. MDE stated that Constellation's sampling method would be surface grab samples in various locations throughout the Maryland portion of the Conowingo Reservoir. The method for surface grab samples deviates slightly from the MDE QAPP which contains methods for both surface and deeper samples.

Due to the budget limitation specified in the Settlement Agreement[5], Constellation is proposing to conduct sampling two (2) times per month during May through September for three (3) years.

2.1 Sample Locations

Samples will be collected at a total of eight (8) locations within the MD portion of Conowingo Reservoir. Four (4) locations are consistent with the 2017 MDE sites (i.e., XLG0091, XLG0880, XLG2166 and XLG3360) with one location (Conowingo-5) being repositioned slightly downstream so that it lies within Maryland portion of the Reservoir (see Table 2.1-1 and Figure 2.1-1 for the proposed sampling locations). MDE sample locations from 2017 (i.e., XLG0091, XLG0880, XLG2166 and XLG3360) had chlorophyll-a concentrations ranging from 1.50 ug/L to 23.92 ug/L with an average of 10.38 ug/L and a median of 10.57 ug/L[6].

The MDE requested four (4) additional sampling locations within the Maryland portion of Conowingo Pond for a total of eight (8) sampling locations (see Table 2.1-1). The four (4) additional sampling locations suggested by MDE include Conowingo-1, Conowingo-2, Conowingo-3 and Conowingo-4 (see Figure 2.1-1). Note that Conowingo-1 was repositioned slightly upstream due to Constellation's 400-yard exclusion zone from the dam. The actual sampling locations may vary slightly based on site-specific conditions encountered upon sampling initiation.

2.2 Sample Collection

2.2.1 Field Parameters

At each sampling site, measurements of pH, temperature, dissolved oxygen, and conductivity will be collected *in situ* using a multiparameter water quality instrument. If the instrument has a turbidity sensor, a turbidity measurement in NTU will also be recorded. Prior to each sampling event, the instrument will be calibrated in accordance with the manufacturer's protocols. Calibration date, time and results will be recorded.

At each sampling site, a vertical profile of physical parameters will be measured throughout the water column at a maximum of 3-meter intervals. The top readings will be taken at approximately

[5] The Settlement Agreement limits the study to an annual budget of $40k.
[6] Data received via email from MDE (Matthew Stover) June 11, 2021.

0.3 meters from the surface and bottom readings will be taken at approximately 0.3 meters from the bottom without disturbing the bottom sediment.

Secchi readings will be taken at each sampling station when feasible. A 20-cm standard Secchi disc attached to a graduated rope will be used. The disc will be lowered into the water and the depth at which the disc just disappears is noted. The disc is then raised and the depth at which the disc reappears is noted. The average of these two readings will be recorded as the "Secchi disc reading". Optimal conditions for uses of the disc are: clear sky, sun directly overhead, lowered on the shaded protected side of the boat, under a sun shade, and minimal waves or ripples. Any departure from these conditions will be specifically recorded.

On each sampling day, weather observations will be documented (cloud cover, air temperature, wind conditions, etc.)

2.2.2 Chlorophyll-a Sample Collection and Filtration

Per discussions with MDE, surface grab samples for Chlorophyll-a will be collected. Sample methods described here are slightly different than the MDE QAPP, which focused on surface and deeper sample methods. Surface water samples will be collected by boat at each sampling location during daylight hours (between 8 am and 5 pm). Samples will be collected approximately 0.3 m below the surface of the water with a labeled brown, 1 L plastic bottle or a white 1 L plastic bottle. The bottle will be primed prior to collection at each location by rinsing with ambient water (by closing it and shaking) three (3) times. The primed bottle will then be used to collect water in a different location than that which was disturbed during the priming process (i.e., a different side of the boat, for example). The sample bottle will then be completely immersed with the opening faced down until a depth of approximately 0.3 m is reached (about elbow deep). Water will be allowed to fill the bottle by slowly tipping the bottle top up, avoiding aeration. The sample will be capped underwater, so no air is left at the top, labeled, and placed immediately on bagged ice in a cooler[7]. Sample labels will include Station ID, sample date and sample time (OWRB, 2018).

Filtering kits will be provided by the subcontracting laboratory, University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory (CBL). Filtering equipment will be inspected for leaks or cracks prior to field use. Samples will be filtered by the end of the day on which samples were collected, and out of direct sunlight (and incandescent light) if possible[8].

Filtration will be done as follows (adapted from Appendix B of MDE, 2021 and CBL protocol: CBL, 2021):

1. Connect tubing to filtration flask and hand pump.

2. Rinse the 250 ml filter unit (bell and collection flask) with de-ionized water three (3) times. [Do not use sample water, as this can bias results.]

[7] Any white sample bottles will be wrapped in aluminum foil and labeled on the outside before placing in a cooler.
[8] The holding time for unfiltered chlorophyll samples is 24 hours from collection.

3. Place a 47 mm GF/F Whatman pad on the filter unit, using clean forceps. Avoid touching the pad with hands and minimize pad contact with the forceps.

4. Gently shake and invert the sample water container at least three (3) times, to mix the sample water and prevent the settling of materials.

5. Rinse a 100 ml and/or 250 ml graduated cylinder three (3) times with sample water. [Use a graduated cylinder closer in volume to the anticipated filtration volume for greatest accuracy.]

6. Use the hand pump to filter 50 ml of the sample at a time, being sure to maintain a pressure below ten (10) inches of Hg so chlorophyll is not damaged.

7. If the filter pad does not show slight coloration, continue filtering up to 1000 ml of sample water until a solid coloration has been achieved.

8. Keep filtration apparatus under pressure until the filter appears dry.

9. Release the vacuum. Fold the filter in half, keeping the sample material inside the fold, and transfer the filter to a labeled foil pouch[9]. Close the foil pouch.

10. Label the foil pouch with a sticker or thick permanent marker (thin may pierce hole) with the following information:

    - Location ID, sample collection date & time, volume filtered.

11. Transfer pouch to plastic bag. Place plastic bag in additional plastic bag or plastic container to prevent water from entering from the cooler.

Sample collection date and time and filtration date, time and volume filtered will all be recorded in a field log or field data sheet, along with the weather, personnel present, and any other pertinent information. A Chain-of-Custody (COC, see Attachment 1) will also be completed with sample collection date and time and filtration date and time and volume filtered.

Equipment used to process chlorophyll-a samples will be cleaned after each sampling event with a critical cleaning detergent such as Alconox, Liquinox, or similar, rinsed with de-ionized water and air-dried.

2.2.3 Laboratory Analysis

The University of Maryland Center for Environmental Science, Chesapeake Biological Laboratory (CBL) will conduct the chlorophyll-a analysis. The methods used for chlorophyll-a analysis and quality control activities are described in the Nutrient Analytical Services Laboratory Standard Operating Procedures (CBL, 2022). As an added precaution for turbid locations needing less than 150 ml of filtrate, a total of three (3) filters will be provided for analysis at CBL. Each filter will have had the same volume of water filtered. Official chlorophyll-a results for these locations will

[9] To make a pouch, fold an aluminum square into thirds, like a letter.

be the average of the three (3) filters and flagged as such. Filtration replicates will ensure consistency between filtration technique and chlorophyll-a results. See Table 2.2.3-1 for holding times and detection limits.

Expected field sampling days will be discussed with the contracting laboratory for planning purposes prior to sampling. Samples and a COC are to be hand-delivered or shipped overnight on bagged wet ice to the contracting laboratory each week of sampling to:

Jerry Frank
Chesapeake Biological Laboratory
146 Williams Street
Solomons, MD 20688

The COC will be relinquished upon delivery.

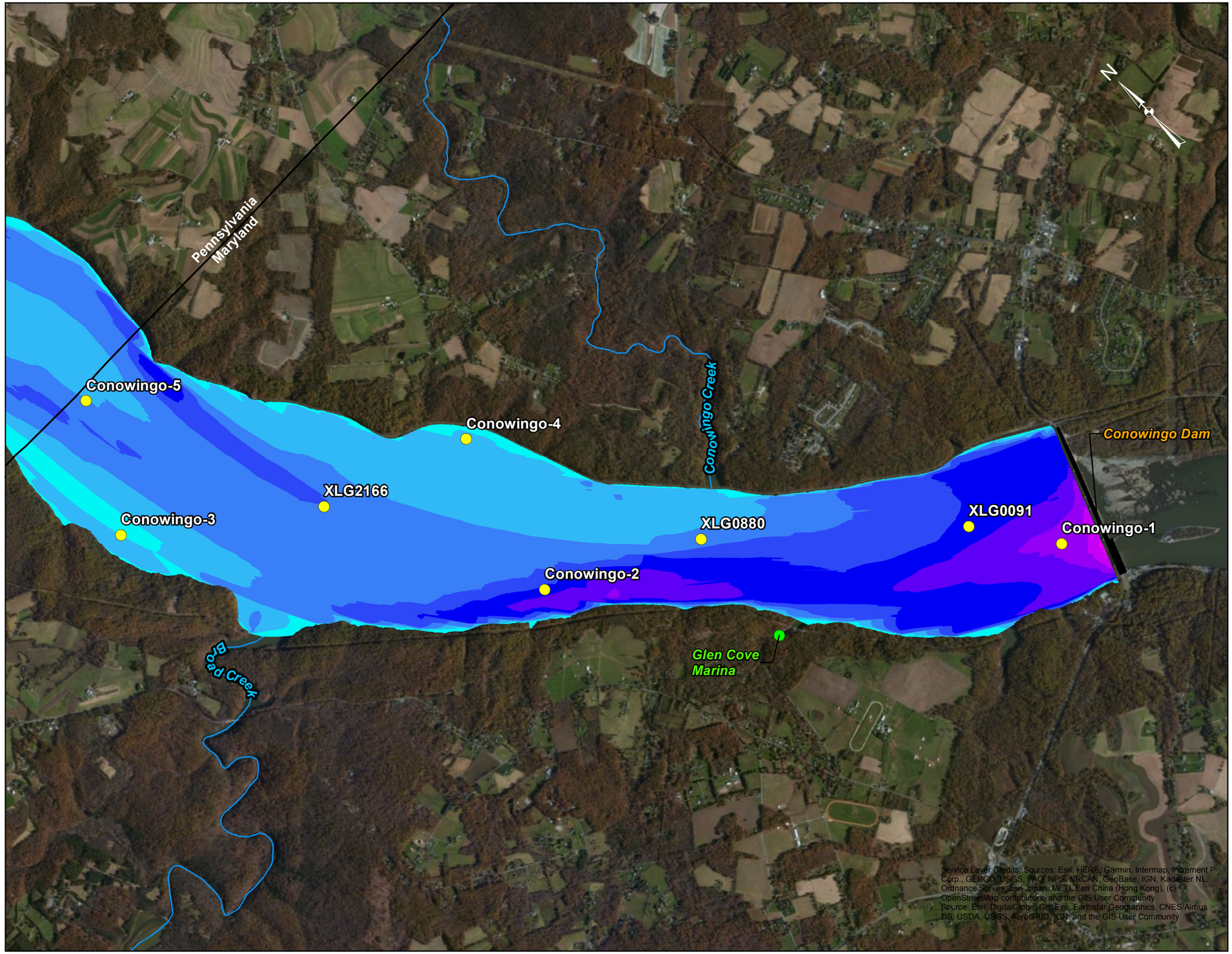
Table 2.1-1. Proposed Conowingo Reservoir Chlorophyll-a Monitoring Locations

Station ID	Latitude	Longitude	Description
XLG0091	39.667000	-76.182700	Mid-Channel. Close to Conowingo dam.
XLG0880	39.680600	-76.201400	Mid-Channel. Across from Conowingo Creek.
XLG2166	39.702400	-76.224300	Mid-Channel. Across from Broad Creek.
Conowingo-5	39.72051	-76.23288	Mid-Channel. Just below MD/PA border
Conowingo-1	39.65994	-76.17675	New station, nearest dam (at least 400 yards upstream of the dam for safety)
Conowingo-2	39.68635	-76.21532	New station, upstream of Glen Cove Marina
Conowingo-3	39.71175	-76.23978	New station, west side of Conowingo Reservoir, upstream of Broad Creek confluence
Conowingo-4	39.69828	-76.21016	New station, east side of Conowingo Reservoir, upstream of Conowingo Creek confluence

Table 2.2.3-1. CBL Chlorophyll-a Analysis Information

Parameter	Abbr.	Detection Limit	Method/Reference	Maximum Holding Time
Chlorophyll-a	CHLA	0.74 ug/l	EPA Method 445.0	30 days at -20°C

CBL, 2022



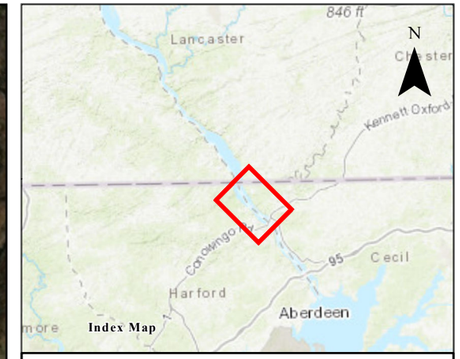


Figure 2.1-1:
Proposed Chlorophyll-a Monitoring Locations

Legend

- Proposed Station Location
- Boat Access
- Named Tributaries

Conowingo Pond Bathymetry (2020)

Bathymetry Elevation (NGVD29)

- 100' to 109.2'
- 90' to 100'
- 80' to 90'
- 70' to 80'
- 60' to 70'
- 50' to 60'
- 40' to 50'
- 30' to 40'
- <30'

1 inch = 0.5 miles

0 0.25 0.5 1 Miles

EXELON GENERATION COMPANY, LLC
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

Exelon.

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Path: X:\GISMaps\project_maps\chlorophyll_plan\figure_2_1-1_proposed_monitoring_locations(8).mxd

2.3 QA/QC Methods

A duplicate field sample will be collected for every ten (10) chlorophyll-a samples. The duplicate will be collected in water undisturbed by the first sample within fifteen (15) minutes. Duplicate and sample filtrations will be done one after the other. Filtration time will be recorded for both the sample and field duplicate.

Field logs and/or field sheets will be reviewed for completeness and accuracy at the end of each field day. Anything appearing unusual or out of range will be investigated and addressed by qualified staff.

2.4 Data Management and Data QA/QC

The Relative Percent Deviation (RPD) will be included in the report for field duplicates. Laboratory Quality Assurance/Quality Checks (QA/QC) will be included in the laboratory reports attached with each monitoring report.

2.5 Reporting

Deliverables for chlorophyll-a monitoring (per the Settlement Agreement) will include:

1. An annual report with all measured chlorophyll-a levels, field parameters, sampling dates and monitoring locations by December 31 of each monitoring year (2022 – 2024).
2. A final report that provides an analysis of all the results of all the chlorophyll-a monitoring completed by June 30 of the year after the final year of monitoring (i.e., June 30, 2025).

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egrated_Report_Section_PDFs/IR_2018/2018IR_Parts_A-E_Final.pdf Date Accessed: 7/20/2020

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UMCES CHESAPEAKE BIOLOGICAL LABORATORY
NUTRIENT ANALYTICAL SERVICES

146 Williams St.
Solomons, MD 20688
(410) 326-7252
(410) 326-7209 fax

Contract#/Billing Reference

Page _____ of _____.

Project:						# of Containers									
Client:						Container type									
Send Results to:						Parameters to be Analyzed/ Volumes Filtered									Client Comments
Address:															
Phone:															
CBL ID #	Sample ID#	Date Sampled	Time Sampled	Sample Matrix	Sampler's Initials										
Relinquished by:		Date/Time	Received by:			Relinquished by:			Received for Laboratory by:				Date/Time		
Relinquished by:		Date/Time	Received by:			Date/Time	Shipper:		Airbill No.:						
Relinquished by:		Date/Time	Received by:			Laboratory Comments:							Temp.		

APPENDIX A. AGENCY CONSULTATION

	MDE Comment	Comment Date	How Addressed
General Comments			
1	Collection of Physical Water Quality Parameters - The collection of in situ physical water parameters -such as dissolved oxygen, pH, salinity, water clarity, and temperature - is standard protocol in a monitoring regime such as this. The physical data provide valuable insight into the condition of the water at the given locations. This is also relatively inexpensive and can be done rather quickly at each location during sample collection since a sampling crew will already be present at each station to collect the Chlorophyll-A samples. Collection of these physical WQ parameters in situ during the monitoring program should be included as part of your plan.	August 4, 2021	The collection of physical parameters was added as recommended. Exelon is not proposing to collect salinity as previous results from MDE's 2017 sampling effort show that salinity was always 0.2 ppt or less.
2	Number and Locations of Stations - We have suggested monitoring at eight (8) locations on the Maryland portion of the Susquehanna River upstream from Conowingo Dam. The Monitoring Plan you provided shows just six sites. Can you please provide a justification for the decrease in sites from our recommendation? Is this a smaller number of stations due to cost? MDE realizes that there is a limited and capped annual budget associated with this monitoring effort however, eight stations would seem to be a reasonable number and provide the best data.	August 4, 2021	Exelon's draft plan limited the sampling to six (6) locations due to budget limitations and built-in contingencies for unexpected events related to the sampling program. Exelon revised the final plan to include sampling at the eight (8) locations generally proposed by MDE.
3	Budget - Since the sampling regime is directly associated with a capped budget, can you please provide the bid costs for this monitoring in an itemized fashion for MDE to review?	August 4, 2021	Exelon plans to obtain updated cost proposals for the sampling program upon MDE's final approval of the sampling plan. Exelon will submit a budget tracker to MDE at the end of each sampling period with the annual reports due on December 31 from 2022-2024.
Specific Comments			
1	Standards and Guidelines Correction: Maryland does have numeric water quality criteria for chlorophyll a, specifically for public water supply reservoirs. This can be found at COMAR 26.08.02.03-3.	August 4, 2021	Edits made to final plan.
2	Designated Uses MDE would add the clarification that "A waterbody is considered impaired if it does not meet established water quality thresholds/criteria or if it does not support a designated use."	August 4, 2021	Edits made to final plan.
3	Designated Uses Suggest rewording this sentence *The IR includes assessments of waterbodies throughout the state in such a way that categorizes if or how designated uses are being met; and if designated uses are not being met, what pollutant(s) or cause(s) are hindering the designated uses from being met.*	August 4, 2021	Suggested edits made to final plan.

	MDE Comment	Comment Date	How Addressed
	to something like "The IR categorizes waterbody-designated use-pollutant combinations as to whether water quality standards are being met and whether a TMDL has been completed or other solution has been initiated.		
4	Designated Uses Another addition: This categorization system can thus lead to having a single waterbody (e.g., Conowingo Reservoir) being captured under different categories for different designated use-pollutant combinations.	August 4, 2021	Suggested edits made to final plan.
5	Designated Uses Suggest rewording this sentence: *Conowingo Reservoir is listed under Category 2 (waters attaining standards for which they have been assessed), Category 3 (waters with insufficient information to determine if water quality standards are attained) and Category 5 (303(d) list of impaired waters for which a Total Maximum Daily Load (TMDL) is required).* to something like "In this manner, Conowingo Reservoir is listed under....(TMDL) is required) for different designated use-pollutant combinations."	August 4, 2021	Edits made to final plan.
6	Historical Data Correction: Sampling was started in May of 2017.	August 4, 2021	Edits made to final plan.
7	Sampling Methods and Procedures If any sampling methods deviate from the MDE QAPP, please highlight them in this section.	August 4, 2021	Deviations from the MDE QAPP were explained in the final plan. The method for surface grab samples deviates slightly from the MDE QAPP which focuses on surface and deeper samples.
8	Sample Locations If only 6 stations are possible we'd prefer that Conowingo-2 and Conowingo-3 are the ones that do not get sampled. And instead sample Conowingo-1 and Conowingo-4 along with the original 4 locations.	August 4, 2021	Exelon revised the final plan to include sampling at the eight (8) locations generally proposed by MDE.
9	Sample Locations This statement was written in the context largely of sampling small (1st-4th order) flowing streams, not impounded water. In this case we do want to sample an area with likely lower surface flow which is why we are prioritizing Conowingo-4.	August 4, 2021	Exelon revised the final plan to include sampling at the eight (8) locations generally proposed by MDE.
10	Sample Filtration #7 First bullet typo on work “locations”	August 4, 2021	Edits made to final plan.
11	In Section 2.2.1, if the sonde unit used for recording physical water parameters has a turbidity sensor, the turbidity should be documented as well and recorded in NTU. Update the Plan to reflect this note.	September 20, 2021	The requested edits have been made in the October 2021 REV 1 plan.
12	On page 2-3, point #7 describes filtering the sample to collect and save a filtrate. We were under the impression you were not collecting the filtrate. If you are not, this bullet point is not necessary.	September 20, 2021	The requested edits have been made in the October 2021 REV 1 plan.

	MDE Comment	Comment Date	How Addressed
13	Include a provision in the Monitoring Plan that if the $40,000 annual budget is not exceeded once a contract is awarded, Exelon will seek to amend the plan to increase the frequency of sampling from twice monthly to three or four times a month (per station) as originally requested by MDE.	September 20, 2021	Response provided to MDE in separate letter dated October 15, 2021.
14	Include a statement that Exelon will supply MDE with the bid costs for the Chlorophyll-A monitoring in an itemized fashion for review. It is requested that Exelon provide both the low and high bid for the three different frequencies of sampling (2x/month, 3X/month, 4X/month).	September 20, 2021	Response provided to MDE in separate letter dated October 15, 2021.
15	Requested language in the plan to better define the sampling window each day.	October 27, 2021	Response provided to MDE via email on November 1, 2021. Sampling window of 8 am to 5 pm added to the final plan. MDE concurred via email dated November 2, 2021.

Copies of Correspondence

From: Danucalov, Andrea H:(Exelon Power) <Andrea.Danucalov@exeloncorp.com>
Sent: Friday, July 23, 2021 4:36 PM
To: Denise Keehner -MDE-; Heather Nelson -MDE-; David Seaborn -MDE-; Gregory Busch -MDE-; allison.ohanlon@maryland.gov; Matthew Stover -MDE-
Cc: David Frazier; Bethany Belmonte; Jason George
Subject: EXTERNAL EMAIL -Conowingo Hydroelectric Project (P-405) - Chlorophyll-A Levels in the Reservoir - Draft Monitoring Plan
Attachments: Conowingo Chlorophyll-a_Monitoring_Plan_Agency_Draft.pdf

CAUTION: This email originated from outside of GSE. Do not click links or open attachments unless you recognize the sender and know the content is safe.

All,

Pursuant to Section 2.4 paragraph (g) of the Joint Offer of Settlement signed on October 29, 2019, Exelon is providing a draft of the Chlorophyll-A Monitoring Plan for your review and comment.

We would like to setup a meeting the week of August 16, 2021 to review any comments or questions. Pending your approval of the plan, monitoring will start May 1, 2022.

Please let me know if you have any questions.

Thanks you and have a good weekend!

Andrea

Andrea Danucalov
FERC License Compliance Manager

Exelon.

Exelon Generation
Conowingo Hydroelectric Generating Station
2569 Shures Landing Road
Darlington, MD 21034
Skype: 267.533.1125
Cell: 610.301.1664
andrea.danucalov@exeloncorp.com

From: David Seaborn -MDE- <david.seaborn@maryland.gov>
Sent: Wednesday, August 4, 2021 2:51 PM
To: Danucalov, Andrea H:(Exelon Power) <Andrea.Danucalov@exeloncorp.com>
Cc: Heather Nelson -MDE- <hnelson@maryland.gov>
Subject: [EXTERNAL] Comments on draft Chlorophyll-A Monitoring Plan

Hello Andrea,

Thank you for providing a draft of the Chlorophyll-A Monitoring Plan, pursuant to Section 2.4(g) of the Settlement Agreement on July 23, 2021 for MDE to review and comment upon.

We have reviewed the draft Monitoring Plan and have provided specific comments embedded digitally in the pdf document (see attached). Let us know if you have trouble accessing those comments.

Additionally, we have two overarching items to discuss:

1) Collection of Physical Water Quality Parameters - The collection of in situ physical water parameters - such as dissolved oxygen, pH, salinity, water clarity, and temperature - is standard protocol in a monitoring regime such as this. The physical data provide valuable insight into the condition of the water at the given locations. This is also relatively inexpensive and can be done rather quickly at each location during sample collection since a sampling crew will already be present at each station to collect the Chlorophyll-A samples. Collection of these physical WQ parameters in situ during the monitoring program should be included as part of your plan.

2) Number and Locations of Stations - We have suggested monitoring at eight (8) locations on the Maryland portion of the Susquehanna River upstream from Conowingo Dam. The Monitoring Plan you provided shows just six sites. Can you please provide a justification for the decrease in sites from our recommendation? Is this a smaller number of stations due to cost? MDE realizes that there is a limited and capped annual budget associated with this monitoring effort however, eight stations would seem to be a reasonable number and provide the best data.

3) Budget - Since the sampling regime is directly associated with a capped budget, can you please provide the bid costs for this monitoring in an itemized fashion for us to review?

You had suggested in your transmittal email that we have a meeting the week of 8/16 to discuss comments, so please let us know after your review of our comments, if you still find a meeting is necessary in order for you to send in your "final" plan by the prescribed due date.

Thank you,

David Seaborn
--

David Seaborn, Ph.D.
Deputy Program Manager, Wetlands and Waterways
Water and Science Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, Maryland 21230
hezm2wiefsvrD q evjgerh2ksz
410-537-4465 (O)
443-621-1009 (C)
Website | Facebook | Twitter

August 31, 2021

Heather L. Nelson
Program Manager
Federal Consistency Coordinator
Wetlands and Waterways Program
Water and Science Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, Maryland 21230
hnelson@maryland.gov

Sent Via Email

RE: Conowingo Hydroelectric Project (FERC Project No. 405) Chlorophyll-a Monitoring Plan

Dear Ms. Nelson:

On October 29, 2019, Exelon Generation Company, LLC (Exelon) and the Maryland Department of the Environment (MDE) submitted a Joint Offer of Settlement (the Settlement) to the Federal Energy Regulatory Commission (FERC) regarding the new hydropower license for the Conowingo Hydroelectric Project, FERC Project No. 405. On March 19, 2021, the FERC issued a new 40-year license to the Exelon for the continued operation and maintenance of the Conowingo Hydroelectric Project.

Section 2.4(g) of the Settlement specifies that Exelon will submit to MDE for approval a plan for monitoring chlorophyll-a levels in the Maryland portion of Conowingo Reservoir within 180 days of the effective date of the new license. In accordance with this requirement, Exelon is providing herein its Chlorophyll-A Monitoring Plan for MDE approval.

A draft of this plan was provided to MDE on July 23, 2021 for review. Prior to submittal of the draft plan, Exelon and MDE held a conference call on June 10, 2021 to discuss the intent and commitments of the sampling requirement as well as previous monitoring performed by MDE and potential methods for Exelon's sampling program. MDE provided comments on the draft plan to Exelon on August 4, 2021 and Exelon and MDE subsequently held another conference call to discuss MDE's comments on August 20, 2021. The attached Chlorophyll-A Monitoring Plan addresses the comments received by MDE and Appendix A contains a response summary.

Regarding MDE's request for Exelon to submit an itemized budget for this effort, Exelon will submit a budget tracker to MDE at the end of each sampling period with the annual reports due on December 31. The budget tracker will list the amount spent by Exelon towards this effort in relation to the annual maximum of $40,000 as specified in the Settlement.

Exelon is prepared to implement the Chlorophyll-A Monitoring Plan upon approval from MDE. If you have any questions regarding this information, please contact me at 267.533.1125 or by email at Andrea.Danucalov@exeloncorp.com.

Sincerely Yours,

Andrea Danucalov
FERC License Compliance Manager
Exelon Generation
Conowingo Hydroelectric Dam
2569 Shures Landing Road
Darlington, MD 21034

Enclosure

cc: David Seaborn, MDE

September 20, 2021

via electronic mail
Andrea Danucalov
FERC License Compliance Manager
Exelon Generation Company, LLC
Conowingo Hydroelectric Generating Station
2569 Shures Landing Road
Darlington, MD 21034
Andrea.Danucalov@exeloncorp.com

Re: Conowingo Dam Water Quality Settlement Agreement, by and between the State of Maryland, Department of the Environment, and Exelon Generation Company, LLC, Chlorophyll-A Monitoring Plan

Ms. Danucalov,

The Maryland Department of the Environment (MDE), Wetlands and Waterways Program, acknowledges receipt of the Chlorophyll-A Monitoring Plan (Plan) sent by Jason George of Gomez and Sullivan Engineers on August, 31, 2021 in accordance with Section 2.4(g)(1) of the Conowingo Dam Water Quality Settlement Agreement, by and between the State of Maryland, Department of the Environment, and Exelon Generation Company, LLC (Settlement Agreement). MDE has reviewed the Plan and has the following comments:

1. In Section 2.2.1, if the sonde unit used for recording physical water parameters has a turbidity sensor, the turbidity should be documented as well and recorded in NTU. Update the Plan to reflect this note.

2.On page 2-3, point #7 describes filtering the sample to collect and save a filtrate. We were under the impression you were not collecting the filtrate. If you are not, this bullet point is not necessary.

3. Include a provision in the Monitoring Plan that if the $40,000 annual budget is not exceeded once a contract is awarded, Exelon will seek to amend the plan to increase the frequency of sampling from twice monthly to three or four times a month (per station) as originally requested by MDE.

4. Include a statement that Exelon will supply MDE with the bid costs for the Chlorophyll-A monitoring in an itemized fashion for review. It is requested that Exelon provide both the low and high bid for the three different frequencies of sampling (2x/month, 3X/month, 4X/month).

Please amend the Plan and resubmit within the next fourteen (14) days. If you have any questions, please contact David Seaborn, Deputy, Wetlands and Waterways Program at david.seaborn@maryland.gov or call 410-537-4465.

Sincerely,

Heather L. Nelson, Manager
Wetlands and Waterways Program
Maryland Department of the Environment

(via electronic mail)
cc: Jason George, Gomez and Sullivan Engineers
Matthew Stover, Chief, Water Quality Standards Section, MDE

October 4, 2021

Heather L. Nelson
Program Manager
Federal Consistency Coordinator
Wetlands and Waterways Program
Water and Science Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, Maryland 21230
hnelson@maryland.gov

Sent Via Email

RE: Conowingo Hydroelectric Project (FERC Project No. 405)
MDE Offer of Settlement - Chlorophyll-a Monitoring Plan

Dear Ms. Nelson:

On October 29, 2019, Exelon Generation Company, LLC (Exelon) and the Maryland Department of the Environment (MDE) submitted a Joint Offer of Settlement (the Settlement) to the Federal Energy Regulatory Commission (FERC) regarding the new hydropower license for the Conowingo Hydroelectric Project, FERC Project No. 405. On March 19, 2021, the FERC issued a new 50-year license to Exelon for the continued operation and maintenance of the Conowingo Hydroelectric Project.

Section 2.4(g) of the Settlement specifies that Exelon will submit to MDE for approval a plan for monitoring chlorophyll-a levels in the Maryland portion of Conowingo Reservoir within 180 days of the effective date of the new license. In accordance with this requirement, Exelon provided its Chlorophyll-A Monitoring Plan for MDE approval on August 31, 2021. MDE provided subsequent comments in a letter to Exelon dated September 20, 2021. The attached Chlorophyll-A Monitoring Plan addresses the September 20, 2021 comments with the exception of comments #3 and #4 which pertain to Exelon's consultant procurement process, budgets and potential increases in sample frequencies. As noted in *Appendix A – Agency Consultation*, Exelon is requesting additional time to discuss these comments with MDE. In addition, we are currently working with our vendor to obtain a proposal to support this work and request an extension until November 4, 2021.

In addition to the MDE comments, Exelon also made a minor change to the August 31, 2021 monitoring plan. This change is in *Section 2.2.2 Chlorophyll-a Sample Collection and Filtration*; in the 1st paragraph the clause "between 9:00 AM and 3:00 PM" was replaced with "during daylight hours." This change was made to address concerns of field sampling staff who requested more flexibility with respect to field work starting and ending time.

If you have any questions regarding this information, please contact me at 267.533.1125 or by email at Andrea.Danucalov@exeloncorp.com.

Sincerely Yours,

Andrea Danucalov
FERC License Compliance Manager
Exelon Generation
Conowingo Hydroelectric Dam
2569 Shures Landing Road
Darlington, MD 21034

Enclosure

cc: David Seaborn, MDE

October 15, 2021

Heather L. Nelson
Program Manager
Federal Consistency Coordinator
Wetlands and Waterways Program
Water and Science Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, Maryland 21230
hnelson@maryland.gov

Sent Via Email

RE: Conowingo Hydroelectric Project (FERC Project No. 405) Chlorophyll-A Monitoring Plan

Dear Ms. Nelson:

Thank you for allowing us extra time to gather additional data concerning the estimated costs to implement the Chlorophyll-A Monitoring Plan submitted to MDE on August 31, 2021 (and revised on October 4, 2021). We believe that the plan meets the requirements of the Offer of Settlement dated October 29, 2019. Paragraph 2.4(g) states the following:

> *(g) Chlorophyll-A Levels in the Reservoir.*
>
> > *(1) No later than one hundred eighty (180) days after the Effective Date, Exelon shall submit to MDE for approval a plan for monitoring chlorophyll-A levels in the Maryland portion of the Reservoir (the "Chlorophyll-A Monitoring Plan"). The Chlorophyll-A Monitoring Plan shall provide for collection of three (3) years of data on chlorophyll-A levels in the Maryland portion of the Reservoir between May 1 and September 30, in accordance with a monitoring protocol to be provided by MDE no later than thirty days after approval of the Chlorophyll-A Monitoring Plan by MDE, and shall be designed to determine with a high level of statistical confidence whether chlorophyll-A WQS are exceeded in the Maryland portion of the Reservoir between May 1 and September 30 in any particular year. Exelon shall be required to expend no more than a maximum of $40,000 per year in connection with the costs of the Chlorophyll-A Monitoring Plan and any associated annual reporting as described below. Exelon shall comply with the Chlorophyll-A Monitoring Plan after it is approved by MDE.*
> >
> > *(2) Pursuant to the Chlorophyll-A Monitoring Plan, Exelon shall provide MDE with (a) annual reports of all measured chlorophyll-A levels and dates and locations of monitoring in the Maryland portion of the Reservoir by December 31 of the year in which the monitoring occurred; and (b) a final report that analyzes and presents the results of all chlorophyll-A monitoring completed by June 30 of the year after the final year of monitoring.*

The plan that we have provided was designed to determine with a high level of statistical confidence whether chlorophyll-A water quality standards are exceeded in the Maryland portion of the Conowingo Pond between May 1 and September 30 in any particular year. We have obtained a quote from Normandeau to do the field work and also a quote from Gomez and Sullivan who will provide project management support and complete the annual reports due each year as well as the final report due in 2025. Both vendors bring expertise in the area, along with extensive familiarity of Conowingo Pond, and a proven track record of completing work on time and within budget. Both vendors will contract directly with Exelon in order to avoid any additional charges by having Normandeau subcontracted to Gomez and Sullivan. Both vendors have been vetted by our procurement team and meet our requirements concerning safety.

Below is a table showing tasks and estimated costs broken out by reporting and project management, field work, and laboratory services.

Cost Estimate to Complete Conowingo Chlorophyll-a Monitoring 2022-2024 - Eight Sites, 2X/Month

Task No.	Task Description	Reporting and PM	Field Component	Laboratory Services	TOTAL COST
1	Chlorophyll-a Monitoring 2022	$10,414	$25,277	$1,630	$37,321
1.1	Planning, Mobilization, and Safety Training	$1,638			$1,638
1.2	Field Sampling - 8 sites, 10 events	$730	$25,277		$26,007
1.3	Data Analysis and Compilation (includes lab costs)	$1,799		$1,630	$3,429
1.4	Reporting and Project Management	$6,246			$6,246
2	Chlorophyll-a Monitoring 2023	$10,722	$26,035	$1,720	$38,477
2.1	Planning, Mobilization, and Safety Training	$1,689			$1,689
2.2	Field Sampling - 8 sites, 10 events	$730	$26,035		$26,765
2.3	Data Analysis and Compilation (includes lab costs)	$1,858		$1,720	$3,578
2.4	Reporting and Project Management	$6,444			$6,444
3	Chlorophyll-a Monitoring 2024	$11,030	$26,816	$1,800	$39,646
3.1	Planning, Mobilization, and Safety Training	$1,740			$1,740
3.2	Field Sampling - 8 sites, 10 events	$730	$26,816		$27,546
3.3	Data Analysis and Compilation (includes lab costs)	$1,918		$1,800	$3,718
3.4	Reporting and Project Management	$6,642			$6,642
4	Final Report (Due 2025)	$11,863	$0	$0	$11,863
	TOTAL	**$44,028**	**$78,128**	**$5,150**	**$127,306**

The estimated cost to complete the work that Exelon committed to in the Offer of Settlement meets the requirement of the settlement in that we are not expending more than a maximum of $40,000 per year and we are implementing a plan that will provide statistical confidence regarding chlorophyll-A levels relative to MDE water quality standards. Costs in the table above have been escalated with a cost of living adjustment and do not reflect any contingency, which we normally assume 10% in order to account for delays due to weather or mechanical issues with a boat, etc.

In Year 1, Exelon estimates that the cost to perform the study and prepare the annual report will cost $37,321; Year 2 a cost of $38,477; and Year 3 a cost of $39,646. Costs to prepare the final report in 2025 are estimated at about $12,000. Given our experience with Normandeau and their proximity to the

Conowingo Project and lack of additional charges for travel and mobilization and the expertise provided by Gomez and Sullivan, Exelon is not bidding this work. In addition, we do not believe additional language is required in the plan concerning the budget agreed to by both MDE and Exelon as specified in the Offer of Settlement. Due to how close the costs are to the $40,000 cap, especially in Year 2 and Year 3, Exelon does not recommend any additional sampling sites or sampling events in any of the years as that will result in an increase in the budget that was agreed to.

Proposals and invoices are business confidential. However, if MDE would like to see a summary of annual invoices to verify that we have not exceeded the $40,000 budget specified in the Offer of Settlement, we will need to work through confidentiality requirements to ensure that such information is kept confidential.

We respectfully request that MDE approve the plan that we submitted on August 31, 2021 with changes submitted on October 4, 2021, and that MDE indicate that we have satisfactorily addressed the comments in your September 20, 2021 letter.

Sincerely Yours,

Andrea Danucalov
FERC License Compliance Manager
Exelon Generation
Conowingo Hydroelectric Dam
2569 Shures Landing Road
Darlington, MD 21034

cc: David Seaborn, MDE

From: David Seaborn -MDE- <david.seaborn@maryland.gov>
Sent: Tuesday, November 2, 2021 2:40 PM
To: Jason George
Cc: Danucalov, Andrea; Heather Nelson; David Frazier
Subject: Re: Exelon's Chlorophyll-A Monitoring Plan for Conowingo

Jason,

We would be fine with a sampling window of 8-5. That sounds reasonable.

Dave

On Mon, Nov 1, 2021 at 4:15 PM Jason George <jgeorge@gomezandsullivan.com> wrote:

> Hi Dave,
>
> The chlorophyll sampling plan initially specified the 9 am to 3 pm sampling window. However, after talking with the field sampling crew and further refining the work plan and budget, we felt the sampling window was too narrow for a few reasons:
>
> - Our intent is to complete sampling at all 8 sites within one day, so the 9 am start time may be too late, especially in the spring/fall months when darkness sets in earlier.
> - We agreed to collect vertical profile data along with the chlorophyll sampling. With the boat travel time between sites on the reservoir, and potential for stronger winds in the afternoon hours, we have assumed that each site would take about one hour to complete.
> - The chlorophyll samples need to be filtered within 24 hours of collection. The later start time may affect this should the crew run into any issues on the water.
> - A wider window of say 8 am to 5 pm will allow for more time for contingencies if unforeseen issues arise in the field.
>
> Therefore, we suggest that the sampling window be from 8 am to 5 pm. Our intention is not to start at dawn and be off the water by mid-morning. We simply wanted to make sure we had enough time to complete the sampling tasks at all sites within one day.
>
> Please let us know if you have any concerns or if you would like to have a quick call to come to an agreement on this.

Jason George

Gomez and Sullivan Engineers

PO Box 2179

Henniker, NH 03242

Direct: (716) 402-6791

Cell: (603) 340-7666

From: David Seaborn -MDE- <david.seaborn@maryland.gov>
Sent: Wednesday, October 27, 2021 2:43 PM
To: Danucalov, Andrea <Andrea.Danucalov@exeloncorp.com>; Heather Nelson <hnelson@mde.state.md.us>
Cc: Jason George <jgeorge@gomezandsullivan.com>; David Frazier <dfrazier@gomezandsullivan.com>
Subject: Re: [EXTERNAL]Re: Exelon's Chlorophyll-A Monitoring Plan for Conowingo

Andrea,

Thank you for the reply. I'm glad to hear you don't see the addition of this 'time of day sampling' language as a problem.

Dave

On Wed, Oct 27, 2021 at 2:32 PM Danucalov, Andrea H:(Exelon Power) <Andrea.Danucalov@exeloncorp.com> wrote:

> Hi Dave,
>
> We will take a look – I don’t see this as a problem. We will work on the language and get back to you.

Thanks,

Andrea

From: David Seaborn -MDE- <david.seaborn@maryland.gov>
Sent: Wednesday, October 27, 2021 8:41 AM
To: Jason George <jgeorge@gomezandsullivan.com>
Cc: Danucalov, Andrea H:(Exelon Power) <Andrea.Danucalov@exeloncorp.com>; David Frazier <dfrazier@gomezandsullivan.com>
Subject: [EXTERNAL]Re: Exelon's Chlorophyll-A Monitoring Plan for Conowingo

EXTERNAL MAIL. Do not click links or open attachments from unknown senders or unexpected Email.

Jason/Andrea,

Thank you for the opportunity to read over the Revised Chlorophyll-A Monitoring Plan. We have one last item to discuss, and I assure you this is the last one. We would like to see some language as to the sampling time for this monitoring. We would like to see the samples collected around a window of something like 9-3. Since Chlorophyll-A can exhibit diurnal patterns, we just want to make certain all the samples are not collected from sunrise to 9:00 AM. Could you please add language to better define the sampling window each day?

Thank you,

Dave Seaborn

From:	Joseph Petre
To:	David Seaborn. MDE
Cc:	Danucalov, Andrea H:(Constellation Power); David Frazier; Vines, Gregg A:(Constellation Power - TSA)
Subject:	RE: Conowingo Chlorophyll-a Monitoring Program - Revised Monitoring Plan for MDE Review
Date:	Monday, May 15, 2023 3:52:00 PM
Attachments:	image001.png image002.png

Hello David,

As requested, here is a new link to the revised Conowingo Chlorophyll-a Monitoring Plan.

Conowingo Chlorophyll-a_Monitoring_Plan_2023_update_MDE_draft.docx

Please let me know if I can assist with anything else,

Joe

Joseph Petre
Environmental Scientist
Gomez and Sullivan Engineers, DPC
1961 Wehrle Dr, Ste 12 | Williamsville, NY 14221
O: (716) 250-4960 | D: (716) 402-6809
jpetre@gomezandsullivan.com

30th GOMEZ AND SULLIVAN ESTABLISHED 1993

From: Joseph Petre
Sent: Monday, March 27, 2023 12:08 PM
To: David Seaborn. MDE <david.seaborn@maryland.gov>
Cc: Danucalov, Andrea H:(Constellation Power) <u000ahd@constellation.com>; David Frazier <dfrazier@gomezandsullivan.com>; Vines, Gregg A:(Constellation Power - TSA) <Gregg.Vines@constellation.com>
Subject: Conowingo Chlorophyll-a Monitoring Program - Revised Monitoring Plan for MDE Review

Hello,

On behalf of Constellation, the following link contains a draft of the revised Conowingo Chlorophyll-a Monitoring Plan for MDE review.

Conowingo Chlorophyll-a_Monitoring_Plan_2023_update_MDE_draft.docx

As you are aware, during the first season of chlorophyll-a monitoring (between May 1 and

September 30, 2022) the analytical methodology to determine chlorophyll-a deviated from what was specified in the plan. As requested during the December 16, 2022, conference call, Constellation has revised the monitoring plan to retain consistency through the remainder of the three-year monitoring program. In addition to the change in methodology, the plan has been updated to reflect the name change from Exelon to Constellation that occurred following the plan being finalized in November 2021. All changes to the document are provided in track-changes for your review.

Constellation is requesting comments by April 26, 2023 (30 days). Please send all comments to Andrea Danucalov and me.

Sincerely,

Joe

Joseph Petre
Environmental Scientist
Gomez and Sullivan Engineers, DPC
1961 Wehrle Dr, Ste 12 | Williamsville, NY 14221
O: (716) 250-4960 | D: (716) 402-6809
jpetre@gomezandsullivan.com

Attachment J

Quality Assurance Project Plan for Lake Nutrient Monitoring for Integrated Report Assessment and Total Maximum Daily Load Development

FINAL Quality Assurance Project Plan

Lake Nutrient Monitoring for Integrated Report Assessment and Total Maximum Daily Load Development

Water and Science Administration

Watershed Protection, Restoration, and Planning Program

Field Services Program

Prepared Date	September 2024
Effective Date	April 21, 2025
Period of Applicability	April 21, 2025- April 21, 2030
Revision/version control information	0.0
Grant Number	

MARYLAND DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard | Baltimore, MD 21230

A2. Approval Page

Concurrence

Project/Operations Manager

Name: Melinda Cutler Title: Natural Resources Planner Organization: Maryland Department of the Environment	Signature: Date: 13/05/25

Author (if different than Project Manager)

Name: Melinda Cutler Title: Natural Resources Planner Organization: Maryland Department of the Environment	Signature: Date: 13/05/25

Author (if different than Project Manager)

Name: Becky Monahan Title: Natural Resources Planner Organization: Maryland Department of the Environment	Signature: Becky Monahan Date: 13/05/25

Senior Manager

Name: Matthew Stover Title: Division Chief, WQS&A Organization:Maryland Department of the Environment	Signature: Date: 13/05/25

Project Quality Assurance Manager

Name: Melissa Stefun Title: Natural Resources Planner Organization: Maryland Department of the Environment	Signature: Date: 13/05/25

EPA Designated Project Manager

Name: Samantha Stanchak Title: EPA R3 MD 106 Project Officer Organization: EPA Region 3	Signature: Date: 05/15/25

Approval

EPA Region 3 Delegated Approving Official

Name: Organization:	Signature: Date:

A3. Table of Contents, Document Format, and Document Control

Document Format

This Quality Assurance Project Plan (QAPP) was developed by the Watershed Protection, Restoration, and Planning Program (WPRPP) and Field Services Program (FSP) in accordance with the U.S. EPA Quality Assurance Project Plan Standard (U.S. EPA, 2023). This QAPP documents the water quality monitoring activities, and quality control and quality assurance procedures developed for impoundment (hereafter called "lakes") eutrophication related monitoring for Integrated Report (IR) and Total Maximum Daily Load (TMDL) programs. The order of the elements in this QAPP follows the U.S. EPA Standard, as seen in the Table of Contents. The QAPP is also consistent with the applicable recommendations and requirements of the U.S. EPA Region 3 Quality Management Plan (2020; DCN R3QMP001-20200601) and MDE's Quality Management Plan (2020).

Document Control

This table shows changes to this controlled document over time. The Lake Nutrient Monitoring for Integrated Report Assessment and Total Maximum Daily Load Development QAPP is represented by the document control number (DCN) of LNMQAPP(i.e. "Lake Nutrient Monitoring QAPP").

Questions regarding this QAPP should be addressed to:

Allison O'Hanlon – Chemical and Biological Monitoring Division
Maryland Department of the Environment - Field Services Program
416 Chinquapin Round Road
Annapolis, MD 21401
443-482-2724

Table 1 QAPP Versions

DCN Version	Changes	Effective Date
Lake Nutrient Monitoring QAPP- DCN LNMQAPP Version 0.0	Original Document Prepared By: Melinda Cutler and Becky Monahan-MDE	April 2025

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List of Acronyms

Ambient Water Quality Monitoring System	AWQMS
Chesapeake Biological Laboratory	CBL
Data Quality Indicator	DQI
Delegated Approving Official	DAO
Document Control Number	DCN
Field Data Manager	FDM
Field Services Program	FSP
Integrated Report	IR
Laboratory Data Manager	LDM
Lake Nutrient Monitoring	LNM
Maryland Department of the Environment	MDE
Project Manager	PM
Quality Assurance	QA
Quality Assurance Manager	QAM
Quality Assurance Project Plan	QAPP
Quality Control	QC
Quality Management Plan	QMP
Standard Operating Procedure	SOP
Total Maximum Daily Load	TMDL
United States Environmental Protection Agency	EPA
University of Maryland Center for Environmental Science	UMCES
Water Quality Exchange	WQX
Water Quality Portal	WQP
Watershed Protection, Restoration and Planning Program	WPRPP

A4. Project Purpose, Problem Definition, and Background

This section provides an overview of the Maryland Department of the Environment's (MDE) role in the execution of the Integrated Report (IR) and Total Maximum Daily Load (TMDL) water-quality monitoring program for assessing nutrients within Maryland's impoundments. It briefly states the project goals, describes the participants and discusses the general approach used to provide water quality monitoring support for the IR and TMDL programs.

Purpose and Problem Definition

This QAPP documents the water quality monitoring activities and quality control procedures developed for the Lake Nutrient Monitoring Project. This project establishes a water-quality monitoring program to identify and address eutrophication in Maryland's impoundments. The project provides direct measurements of water quality to compare against state regulatory standards and criteria to determine if Maryland's impoundments are impaired for nutrients (eutrophic). These data will be evaluated for assessments in Maryland's Integrated Report of Surface Water Quality (IR) and, if determined to be impaired, will be utilized in the subsequent development of a Total Maximum Daily Load (TMDL). This process allows Maryland to identify waters with impaired conditions and establish a plan to improve these waters. These operations fulfill sections 303(d), 305(b), and 314 requirements of the Clean Water Act.

MDE coordinates this effort, conducting data collection and analysis. Within MDE, the Watershed Protection, Restoration and Planning Program (WPRPP) and the Field Services Program (FSP) are the chief divisions responsible for the data collection, analysis, and implementation of this QAPP.

The purpose of the Lake Nutrient Monitoring QAPP is to document the environmental decision(s) that need to be made and the level of information quality needed to ensure that those decisions are based on sound environmental information. The QAPP describes the data collection process and the data acceptance and performance criteria determine if the data is of high quality. High quality data can be used to meet programmatic needs.

Background

Maryland's impoundments (hereafter referred to as "lakes") are valuable natural resources that provide numerous recreational and ecological benefits such as bathing beaches, fishing and boating opportunities, freshwater aquatic life habitat, and drinking water to Maryland citizens. Maryland Department of the Environment (MDE) and the Maryland Department of Natural Resources (MDDNR) have recognized the need for continued lake monitoring and partnered to address known sampling gaps and to coordinate sampling protocols. One of the primary goals is to monitor and assess all significant (> 5 acres surface area), publicly-owned lakes in Maryland for impacts due to nutrients. To inform current and future lake monitoring efforts, MDE and MDDNR jointly developed a prioritization strategy[1] to identify an order in which lakes will be sampled. MDE plans to sample 3-5 lakes per year according to the list and MDDNR will assist with other targeted sampling of State-owned Lakes. The data from these efforts will inform the Integrated Report (IR) assessment process to determine impairment status, as well as address any impairments through development of TMDLs.

The IR is a combined biennial report under sections 305(b) and 303(d) of the federal Clean Water Act, requiring states, territories and authorized tribes to perform annual water quality assessments to determine the status of

[1]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/2021%20Final%20Prioritization%20Strategy%20for%20Monitoring%20Maryland%20Lakes.pdf

jurisdictional waters and to identify waters assessed as not meeting water quality standards (as specified in Code of Maryland Regulations 26.08.02). Waters that do not meet standards may require a TMDL to determine the maximum amount of an impairing substance or pollutant that a particular water body can assimilate and still meet water quality criteria. Please see MDE's assessment methodologies webpage[2] and The Assessment Methodology for Dissolved Oxygen and Chlorophyll a Criteria in Maryland's Seasonally Stratified Water-Supply Reservoirs[3] for information on how impairment status is determined. For information on water quality standards, see MDE's water quality standards webpage[4] or COMAR 26.08.02.03-3[5]. Nutrient data from this project will be used to inform future TMDL development, if necessary.

If a waterbody impairment is identified for a monitored lake, data from the Lake Nutrient Monitoring project will also assist with informing the WPRPP's TMDL development process. Under the direction of the U.S. Environmental Protection Agency (EPA), States are required to develop TMDLs for their impaired waters that do not meet or are not expected to meet designated State water quality standards. This process serves as a mechanism to determine limits and waste load allocations on allowable point and non-point source loadings to a waterbody in order to bring a waterbody back into compliance with the applicable water quality standards. MDE develops and implements TMDLs for the impaired-listed waters of the state of Maryland. This is accomplished through targeting and scheduling high priority impaired waters from the IR's impaired waters list (as identified on the 303(d) list), developing TMDLs to achieve State water quality standards, and ultimately implementing and assessing prescribed control actions to bring water bodies back into attainment of water quality standards.

Other QA Documents

Other quality assurance documents, including standard operating procedures (SOPs), that may be related to this project are listed in Table A4-1.

Table A4-1 Other QA Planning Documents that have Relevant Requirements

Document Title	Directive #, DCN, or Revision	Effective Date	Pertinence to this QAPP
MDE Standard Operating Procedure: Lake Nutrient Monitoring (LNM) Project-Data Management and QA/QC[6]	LNM01-	September 2024	SOP to be followed during data management
MDE Standard Operating Procedure: Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies[7]	WQ01	September 2024	Field SOP to be followed

[2] https://mde.maryland.gov/programs/water/tmdl/integrated303dreports/pages/ir_listing_methodologies.aspx
[3]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/DOandCHLa_Lakes_AM_2012_final.pdf
[4] https://mde.maryland.gov/programs/water/tmdl/waterqualitystandards/pages/index.aspx
[5] https://dsd.maryland.gov/regulations/Pages/26.08.02.03-3.aspx
[6] https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Lakes/LNM01_DataManagement_SOP.pdf
[7]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Lakes/WQ01_SamplingStationSelectionName_SOP.pdf

Document Title	Directive #, DCN, or Revision	Effective Date	Pertinence to this QAPP
MDE Standard Operating Procedure: Water Quality Equipment Maintenance and Calibration SOP[8]	WQ02	September 2024	Field SOP to be followed
MDE Standard Operating Procedure: Collection and Handling of Water Samples[9]	WQ03	September 2024	Field SOP to be followed
Maryland Department of the Environment (MDE) Quality Management Plan. [10]		September 2020	QAPP developed in accordance with MDE Quality Management Plan
Chesapeake Biological Laboratory. Nutrient Analytical Services Laboratory: Quality Assurance/Quality Control[11]			Lab data QA/QC procedures to be followed
Chesapeake Biological Laboratory. Nutrient Analytical Services Laboratory: Methods[12]	TDN and TN - Revision 2023-1	May 15, 2023	Lab methods to be followed
	NO3+NO2 - Revision 2023-1	May 1, 2023	
	NO3 + NO2 Cd reduction - Revision 2023-1	May 1, 2023	
	NH4 - Revision 2023-1	May 1, 2023	
	PO4 - Revision 2023-1	May 1, 2023	
	Chla - Revision 2023-1	May 1, 2023	
U.S. EPA Quality Assurance Project Plan Standard[13]	CIO 2105-S-02.0	July 18, 2023	QAPP developed in accordance with EPA QAPP standard.
U.S. EPA Records Management Policy[14]	CIO 2155.5	June 9, 2020	Records managed in accordance with EPA's Record Management Policy.

[8]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Lakes/WQ02_EquipmentMaintenanceandCalibration_SOP.pdf

[9]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Lakes/WQ03_CollectionofWaterSamples_SOP.pdf

[10] https://mde.maryland.gov/Documents/MDE%20QMP%20Mgmt%20Plan%20Signed.pdf

[11] https://www.umces.edu/quality-assurancequality-control

[12] https://www.umces.edu/nasl/methods

[13] https://www.epa.gov/system/files/documents/2024-04/quality_assurance_project_plan_standard.pdf

[14] https://www.epa.gov/system/files/documents/2021-08/records_management_policy.pdf

Document Title	Directive #, DCN, or Revision	Effective Date	Pertinence to this QAPP
U.S. EPA Region 3 Quality Management Plan[15]	R3QMP001-20200601	June 1, 2020	QAPP developed in accordance with EPA Region 3 Quality Management Plan.
U.S. EPA Region 3 QAPP Template			Example QAPP Template developed in accordance with EPA Region 3 QAPP Template.

[15] https://www.epa.gov/quality/quality-management-plan-region-3

A5. Project Task Description

The Lake Nutrient Monitoring project will focus on the collection and quality assurance/ quality control (QA/QC) of water quality data within designated Maryland lakes. Quality data collected as part of the project will inform impairment status decisions on the IR for designated lakes. Additionally, for TMDL development, data collected as part of the project will help to identify spatial and temporal distribution of eutrophication related constituents, as well as the contribution of flow inputs under varying hydrological conditions for the waters listed as impaired.

The FSP is responsible for designing the Lake Nutrient Monitoring study, including selecting sampling locations and laboratories; conducting fieldwork; and sending documentation of final results to the WPRPP office in Baltimore. FSP and WPRPP work in coordination to establish appropriate QA/QC procedures for the project. All of these efforts, provided by the FSP with support from WPRPP, are structured to meet the data quality objectives that were set forth to support the data requirements for IR assessments and TMDLs.

Water quality at designated stations will be sampled twice a month from April to October. From November through March, sampling will be conducted once a month. The increased frequency of sampling during the summer season (April through October) was established with the intent to capture summer conditions of Maryland's lakes under varying hydrodynamic and meteorological scenarios.

Best efforts will be made to keep to the sampling schedule and frequency outlined; however, this schedule is subject to change due to unsafe sampling conditions or other competing Program objectives. In the event of canceled surveys, efforts to reschedule will be made by the Field Data Manager. However, the viability of rescheduling will be dependent on competing tasks at the FSP and laboratories, as well as the projected usefulness of the replacement data to the data users. All canceled surveys will be noted as appropriate in a centrally accessible data tracking spreadsheet.

All field data and sample collection will be completed by FSP personnel. All collected water samples will be analyzed by the appropriate laboratory, checked for completeness by FSP personnel and submitted to Baltimore headquarters. All data collected and analyzed through this project will be entered and stored in MDE's Ambient Water Quality Monitoring System (AWQMS) database and shared with the EPA's Water Quality Exchange (WQX) and Water Quality Portal (WQP). Following verification and validation, the data will be made available to the assessment staff for IR decisions and the modeling staff to support the development of TMDLs as applicable.

Following the procedures outlined in this QAPP, data will be of quality for regulatory decision-making.

To achieve this goal of high quality nutrient monitoring data, a variety of smaller work products will be produced as a result of the project. These work products include:

- A list of selected impoundments for monitoring (Excel format)
- A map of stations to be sampled (Excel and .mxd ArcGIS file)

- A Quality Assurance Project Plan (Word / PDF format)
- Field measurements (Hard copy field sheets, Scanned PDFs, AWQMs / database uploads)
- Laboratory analysis (Excel format, AWQMS / database uploads)
- Data tracking spreadsheet (Excel format)
- Quarterly QA/QC and duplicate reports (Word format / email communications)

The following table describes the progression and schedule of the Lake Nutrient Monitoring project with associated products and duties.

Table A5-1 Task Schedule and Products

Project Year	Task	Lead	Final Task Deliverable(s)	J	F	M	A	M	J	J	A	S	O	N	D
Year One	Selection of impoundments	PM	List of selected impoundments (Excel sheet)									X	X	X	X
	QAPP review	PM	QAPP (Word / PDF)									X	X	X	X
	Station selection	PM / FDM	Map of stations (Excel and .mxd ArcGIS file)									X	X	X	X
Year Two	QAPP Review	PM	QAPP (Word / PDF)	X	X	X									
	Station selection	PM	Map of stations (.mxd ArcGIS file)	X	X	X									
	Monitoring surveys and field data upload	FDM	Field data (Hard copy field sheets, Scanned PDFs, Excel data tracking sheet AWQMS uploads)				X	X	X	X	X	X	X	X*	X*
	Laboratory analysis	LDM	Laboratory data (Excel sheets, AWQMS uploads)							X			X		
	Quarterly QA/QC checks of data submissions & data upload	QAM	Quarterly data quality report (Word / Email)							X			X		
Year Three	Monitoring surveys and field data upload	FDM	Field data (Hard copy field sheets, Scanned PDFs, Excel data tracking sheet AWQMS uploads)	X*	X*	X*	X	X	X	X	X	X	X		
	Laboratory analysis	LDM	Laboratory data (Excel sheets, AWQMS uploads)	X			X			X			X		X
	Quarterly QA/QC checks of data submissions	QAM	Quarterly data quality report (Word / Email)	X			X			X			X		X

*Sampling will occur once per month from November - March

PM = Project Manager, FDM = Field Data Manager, LDM = Laboratory Data Manager

A6. Information/Data Quality Objectives and Performance/Acceptance Criteria

Data quality objectives are established to evaluate the quality of the data collected and ensure that it is suitable for its intended users. This section describes the quality objectives developed for the project and the measurement performance criteria used to achieve these objectives.

This element describes quality specifications at two levels:

1) at the level of the decision or study question (Quality Objectives)

2) at the level of the information/data used to support the decision or study question (Performance/Acceptance Criteria).

Data Quality Objectives

In-situ field water quality data and nutrient laboratory data collected under the Lake Nutrient Monitoring QAPP is intended for use by MDE staff in IR assessments and any future TMDL development needs. Data collected will be compared to regulatory standards to determine if an impoundment is impaired for nutrients. Data will be assessed following the Assessment Methodology for Dissolved Oxygen and Chlorophyll a Criteria in Maryland's Seasonally Stratified Water-Supply Reservoirs[16]. This methodology typically requires two summers and one winter season of data in order to inform a regulatory IR assessment decision. If there is evidence of impairment with less data, a decision may be made according to the best professional judgment of IR staff.

Data may also be utilized by MDE's TMDL modeling staff for any needed TMDL development; this process requires at least two years of available data to inform model development. If additional data are necessary for TMDL development, TMDL staff will organize an additional field sampling project to collect the additional information. The information collected for TMDL development will be used in mathematical models that simulate environmental conditions in non-tidal waters/impoundments and predict water quality concentrations in the watershed being studied.

The IR assessments and TMDL models typically require other input data such as meteorological and field monitoring parameters to characterize environmental conditions in the watershed. The majority of this data will be collected by the FSP as in-situ field measurements, field observations reported by the field scientists, and water samples to be analyzed by the laboratories.

MDE is committed to collecting primary lake nutrient data and obtaining existing data of the highest quality possible within the constraints of project resources. A system of performance criteria has been established to ensure that this data is of good quality and that it will be suitable for use by the IR assessment and TMDL modeling staff. The project will comply with the data quality policies outlined in Maryland Department of the Environment's Quality Management Plan (MDE, 2020). All

[16]https://mde.maryland.gov/programs/water/TMDL/Integrated303dReports/Documents/Assessment_Methodologies/DOandCHLa_Lakes_AM_2012_final.pdf

data used for analysis within the IR and/or TMDL development will also be reviewed first using the quality procedures outlined in this QAPP and within the LNM Project-Data Management and QA/QC SOP. The involved laboratories (i.e. Chesapeake Biological Laboratory, CBL) will follow their internal quality procedures and perform all necessary quality assurance as required for each parameter's method (see section B2 - Methods for Environmental Information Acquisition) . QA/QC'ed data will be reviewed and stored in MDE's internal Ambient Water Quality Monitoring System (AWQMS) database and final data will be submitted to the Water Quality Exchange (WQX) where it will be considered in data analysis for the IR and TMDL development as appropriate.

Performance and Acceptance Criteria

Performance Criteria

Performance criteria address the adequacy of information that is to be collected for the project. These criteria often apply to new information collected for a specific use. The performance criteria that the data will need to achieve to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates to within acceptable levels based on the quality objectives include:

- Field and lab quality requirements- as discussed throughout this QAPP and as described in the SOPs such as:
    - Sample collections will be made under all weather conditions, if necessary (i.e., rain, snow).
    - Collections will be made at the approximate same time of day (mornings) using the techniques and equipment described in Section B.
    - Field filtering and preparation of samples will be conducted using the techniques and equipment described in the MDE Standard Operating Procedure: Collection and Handling of Water Samples SOP
    - Consistent reporting and data verification techniques will be employed.
    - Consistent laboratory analyses will be conducted for specified suites of parameters at predetermined sampling sites.
    - Field scientists will note comments regarding unusual weather conditions or any other factors that may influence the integrity of the data collected.
    - The Program Manager and QA/QC team will be responsible for ensuring the adherence of project quality objectives.
- Table B2-1: In-situ Field Parameters provide the accuracy and acceptable measurement ranges for all in-situ field parameters.
- Table B2-2: Water Quality Parameters Analyzed for the Lake Monitoring Program provide the acceptable detection limits for laboratory analyzed parameters for the project.
- Data Quality Indicators, as outlined below.

Acceptance Criteria

Acceptance criteria address the adequacy of existing information proposed for inclusion in the project. These criteria often apply to information drawn from existing sources. Existing data to be collected for this project, their intended uses, and their limitations/acceptance criteria are described in Table A6-1. When appropriate, data will be uploaded or manually entered into the project database using the same quality protocols described for primary data. Primary data collected for this project will meet acceptance criteria through specific quality control activities described in Table B4-1.

Table A6-1 Existing Data

Existing Data Type	Source	Intended Use	Limitations/ Acceptance Criteria
Hydrological data	USGS Website-Water Data for the Nation https://waterdata.usgs.gov/nwi	To provide hydrological data for a site if needed for TMDL development purposes.	USGS's website notes on the stream gage's page when data are provisional and subject to revision until they have been thoroughly reviewed and received final approval. USGS's website also may indicate data quality for periods of time or certain parameters in the site's "Remarks". Data users should note in metadata upon data submission if the data is marked as provisional or has other QA notes on the USGS website. Additional follow-up to the website should occur to determine if there are any status changes to the data.

Data Quality Indicators

Data quality indicators (DQIs) are important in determining total measurement and sampling uncertainty, and thus assist in determining if performance (and acceptance) criteria were met for quality objectives. To ensure that data collected are of sufficient quality for the intended use, a system of qualitative and quantitative DQIs will be used to assess the level of acceptability: precision, accuracy, representativeness, comparability, completeness, and sensitivity (US EPA, 2023a). The following text describes these DQIs and practices used to assess data quality for each. Please see section B4 and Table B4-1 QC Activities for a more comprehensive description of quantitative quality control (QC) checks.

Precision

Precision is the measure of agreement among repeated measurements of the same property under identical or substantially similar conditions. This project meets data precision goals by completing the appropriate field duplicate frequencies found in section B4. The methods for collecting the duplicate samples can be found in the LNM Project-Data Management and QA/QC SOP. These duplicate samples will be processed by the CBL following the same procedures as non-duplicate samples and assessed using the checks outlined within the LNM Project-Data Management and QA/QC SOP to further ensure proper field precision. See section B4 and Table B4-1, or the LNM Project-Data Management and QA/QC SOP for more information on this process and quantified acceptance criteria. Any samples that fall outside of the acceptable precision range for a specific parameter will be flagged and the appropriate qualifier code, as listed in the LNM Project-Data Management and QA/QC SOP, will be added to the AWQMS database.

CBL will follow quality control processes (e.g., laboratory duplicates) as required for the individual laboratory analyses by their quality system. Refer to CBL's Quality Assurance/Quality Control Webpage and Laboratory Methods Webpage for specific discussions on performance measurements. The specific methods utilized for each parameter are listed in Section B2 - Methods for Environmental Information Acquisition, Table B2-1. See also section B4, QC Statistics, for more information on quality control methods and applicable formulas (ex; relative percent difference (RPD)).

The precision for in-situ measurements is also captured through the equipment sondes' manufacturer accuracy and measurement ranges. These ranges are reported in Section B2 - Methods for Environmental Information Acquisition, Table B2-2. Equipment will be maintained and calibrated regularly following the Water Quality Equipment Maintenance and Calibration SOP.

Accuracy (Bias)

Accuracy (Bias) is a measure of the overall agreement of a measurement to a known value. This project meets data accuracy goals by calibrating, standardizing, and verifying equipment following the frequency and specification criteria outlined in section B4.2. Accuracy in the field will be assured through the consistent execution of the approved proper sampling techniques. Field collection staff will follow the Collection and Handling of Water Samples SOP for the collection of in-situ field parameters and water samples collected for further laboratory analysis. Additionally, equipment sondes will be maintained and calibrated regularly following the Water Quality Equipment Maintenance and Calibration SOP. Manufacturer accuracy ranges for in-situ equipment are provided in Section B2 - Methods for Environmental Information Acquisition, Table B2-2. Any calibration samples that fall outside of the acceptable range for a specific equipment will be flagged and an appropriate qualifier code will be added to AWQMS for those data.

For laboratory assessments of the water quality samples, checks on accuracy will be calculated and reported by CBL. Refer to CBL's Quality Assurance/Quality Control Webpage[17] and Laboratory Methods Webpage[18] for specific discussions on these performance measurements. For additional information on the specific analytical methods and procedures utilized for each parameter, the

[17] https://www.umces.edu/quality-assurancequality-control
[18] https://www.umces.edu/nasl/methods

methods for each parameter are listed in Section B2 - Methods for Environmental Information Acquisition, Table B2-1 and SOP documentation is maintained on the CBL website (https://www.umces.edu/nasl/methods). Any calibration samples that fall outside of the acceptable range for a specific equipment will be flagged and an appropriate qualifier code will be added to AWQMS for those data.

Representativeness

Representativeness is defined as the measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Sample design and procedures identified in the QAPP were chosen to optimize the potential for obtaining samples that reflect the true state of the environment, within practical limits. This project achieves the representativeness goal through its Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies SOP that includes detailed procedures designed by experienced field scientists to select sample locations that will adequately characterize the actual conditions of the impoundment. Field Staff also complete thorough reconnaissance of the site, including in-person site visits prior to station selection and, as applicable, interviews with available impoundment managers to ensure that stations are representative of each individual impoundment.

Sample collections will be made under all weather conditions, if necessary (i.e., rain, snow) and follow a consistent schedule. Additionally, to ensure collected samples are representative of the sample waters, sample containers, as described in the Collection and Handling of Water Samples SOP, will be sterilized and pre-labeled prior to field collection. Sample containers and any associated collection equipment will be rinsed three times with site water prior to collecting the samples, unless noted otherwise in field collection protocols.

Comparability

Comparability is a qualitative measure that describes how data collected throughout the system can be compared to other data collected within the system. The dataset should have enough equivalence, comparability, or similarity to other data to make a meaningful analysis. This project achieves comparability through utilizing a set of standardized sample collection and handling techniques (See collection and handling of water samples SOPs), analytical methods (see CBL Laboratory SOPs and analytical methods), and reporting techniques. To minimize differences, the same laboratory (CBL) will be used for each survey. The laboratory methods used for each analysis will be recorded to allow for comparison between samples; the project intends to use the same laboratory methods for each parameter for the duration of the project. See Table B2-1 for the analytical methods to be used for each parameter.

The standardization of the lake nutrient study project, guided by this QAPP also ensures the comparability of datasets collected at different lakes under this project to water quality standards. Additionally, temporal variables will be controlled as sample collections will be made primarily in the mornings, between the timeframe of 9AM - 12 PM. Whether collection occurs during standard time

or daylight savings time will be noted on sample collection events. Any deviations in sampling times or modified methods will be noted with the datasets and considered during data analysis.

Additional checks for data comparability are included within theLNM Project-Data Management and QA/QC SOP; for example, the data will be checked to ensure data are in correct units and comparable methods, e.g., nutrients as nitrate or total nitrogen, dissolved vs. total. Following the QA/QC procedures outlined within the LNM Project-Data Management and QA/QC SOP and within the Lakes QAPP will ensure the data is of documented quality.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system, expressed as a percentage of the number of valid measurements that should have been collected (i.e., measurements that were planned to be collected). At this time, no sampling locations have been deemed more critical to the overall project goal than any other. The completeness goal is 90% for each analytical parameter and field measurement type (see section B4, QC Statistics, for the formula) in this project. If the completeness goal is not met, the Project Manager and QAM will decide next steps, and sampling or analysis will be conducted again if necessary and possible.

In support of completeness goals, all sample containers will be filled properly and collected appropriately as described in The Collection and Handling of Water Samples SOP. Samples will also be checked for completeness by assuring they are preserved appropriately and met holding times and are labeled properly as specified in section B2.

Due to a variety of situations, all samples scheduled to be collected might not be (e.g., a storm may prohibit sampling, etc.) or the data from the samples cannot be used (e.g., sample bottles were broken in transit, sample holding times were grossly exceeded, etc.). Any notes will be made if a sample cannot be taken due to weather or other unforeseen circumstances. Data collection efforts and subsequent records of data entry into AWQMS, for both field collection and laboratory analysis data, will be tracked by a centrally accessible spreadsheet (GoogleDrive) and maintained by the Project Manager and Field Data Manager. The spreadsheet will maintain records of field visits, data entry tasks, checks for proper database uploads, as well as other qualifying information on the data collection (i.e., notes on equipment calibration checks, relevant field notes, etc.) Although this is tracked, the actual number of samples collected and achievement of the completeness goal for each lake is not known until after the sampling is completed and calculated as part of the data review.

Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. The term "detection limit" is closely related to sensitivity and is often used synonymously. This project meets sensitivity goals by ensuring method detection limits/reporting limits are sufficient to capture the environmental conditions and regulatory requirements for this project, see Table B2-1 for the method detection limits for each assessed parameter. The Lab Data Manager will provide a qualifier code for any data

under the applicable detection limit; additional review checks are also completed by the QAM and Project Manager to ensure that the value reported is above the method detection limit or an appropriate qualifier code is added.

The in-situ field equipment used in the project also meets the required limits for the project's environmental conditions and regulatory requirements, the range and accuracy of the equipment sondes are reported inTable B2-2.

A7. Distribution List

The QAPP and all attachments (including SOPs, figures, references, and any subsequent revisions) shall be distributed to the following individuals and organizations as listed in Table A7-1.

A complete copy of the original version, all revisions of the QAPP and all SOPs and other attachments will be maintained in digital PDF format within the Maryland Department of the Environment by the Project Manager and made available to approval authorities upon request. Details on the retention of records and document revision are in section A-12. The project roles listed in Table A7-1 are detailed in Section A8.

Table A7-1 QAPP Distribution List and Project Roles

Name	Project Role	Organizational Affiliation	Email
Matthew Stover	Senior Manager	MDE, Water & Science, WPRPP	matthew.stover@maryland.gov
Delegated Approving Official	Delegated Approving Official	US EPA Region 3 Applied Science and Quality Assurance Branch	
Samantha Stanchak	Designated Project Manager	US EPA Region 3	stanchak.samantha@epa.gov
Melinda Cutler	Project/Operations Manager	MDE, Water & Science, WPRPP	melinda.cutler@maryland.gov
Jeff White	Acting WPRPP Program Manager	MDE, Water & Science, WPRPP	jeff.white@maryland.gov
Bel Martinez da Matta	Quality Assurance Manager (QAM)	MDE, Water & Science, WPRPP	bel.martinezdamatta@maryland.gov
Allison O'Hanlon	Senior Field Manager	MDE, Water & Science, FSP	allison.ohanlon@maryland.gov
Shawn Lowman	Field Data Manager	MDE, Water & Science, FSP	shawn.lowman@maryland.gov
Jerry Frank	Laboratory Data Manager	UMCES CBL	frank@umces.edu
Becky Monahan	Principal Data User	MDE, Water & Science, WPRPP	becky.monahan@maryland.gov

Name	Project Role	Organizational Affiliation	Email
Guido Yactayo	Principal Data User	MDE, Water & Science, WPRPP	guido.yactayo@maryland.gov

A8. Project Organization

Each staff member is individually and ultimately responsible for understanding and adhering to the quality and operation procedures they perform, and for the quality of the data they collect or produce. The specific responsibilities of personnel involved in project implementation are enumerated below.

EPA Region 3 Delegated Approving Official (DAO):

- This role has the EPA approval authority for the QAPP.
- The role will be knowledgeable of EPA requirements for QAPPs and other equivalent QA documents, follow the quality document review process outlined in the US EPA Region 3 Quality Management Plan (QMP), and acquire DAO certification as outlined in the QMP.
- The role may not approve QA documents they authored or prepared, or for projects/programs they manage.

Senior Manager:

- This person will provide overall direction for and leadership oversight of the project.
- The Senior Manager will meet with project members as needed over planning and QA topics.
- The senior manager will review and internally approve the QAPP and any other relevant documentation.
- Additionally, this role will oversee resource allocation for the project.

Project Operations Manager:

- The person responsible for the overall project. The Project Operations Manager ("Project Manager") will coordinate the tasks and goals of the QAPP with the Field and Laboratory Data Managers, and data users, ensuring all protocols and this QAPP are followed during sampling and other operations.
- The Project Manager will review impoundments selected, station maps, field data QA/QC correspondence, and quarterly data validation results. If issues are found, they will recommend corrective actions and ensure these actions are completed.
- The Project Manager will facilitate effective communication and execution of planning, budget, monitoring, and QA/QC tasks overall.
- In coordination with the Quality Assurance Manager, the Project Manager will maintain and review this QAPP on a yearly basis.
- The role will maintain the QAPP and associated records according to MDE's retention policies (see A-12) and distribute the final QAPP and any subsequent revisions to individuals identified in Table A7-1.

Project Quality Assurance Manager (QAM):

- The person chiefly responsible for overseeing the QA/QC of the project.
- The QAM will run the QA/QC data verification reports and will present results to the Project Manager and other relevant project roles.
- Throughout data collection, the QAM will review field staff data quality assessment and quality issues. If QA/QC issues are identified, the QAM will coordinate with the Project Manager to suggest corrective actions and ensure adequate corrective action is taken.
- If needed, the QAM will discuss quality-related issues with their organization's senior manager, even if outside of their direct supervisory chain.
- The QAM will assist the Project Manager in maintaining, reviewing, and assessing this QAPP for effectiveness.
- The QAM will review the QAPP annually and submit it to EPA if there are material changes made. After the annual review, the updated QAPP will be sent to staff on the distribution list of the QAPP.

Field Data Manager:

- The person responsible for organizing field data collection.
- The Field Data Manager will review and provide feedback on the impoundments selected for sampling and map monitoring stations at each lake.
- This role will document and communicate field collection QA/QC issues, on topics such as calibration, hold times, performance reviews, with the QAM through a monitoring tracking spreadsheet and, when needed, through meetings and email correspondences.
- This role will ensure all project personnel are properly trained and/or have the skills to fulfill assigned project tasks.
- They will assist with acquiring collection permits or other permissions as applicable, and ensure all equipment and supplies are sufficient.
- This person will coordinate with the Project Manager as needed to review and update the QAPP.
- A senior FSP staff member will serve this role.

Field Staff:

- Field Staff are responsible for reading and being very familiar with this QAPP and the related standard operating procedure(s) (SOPs) or methods for any operation they perform.
- These persons will ensure they are properly trained and/or have the skills to fulfill assigned tasks.
- This role will identify and report to either the Field Data Manager or the Project Manager of any emerging/unanticipated problems, data anomalies, or other project/data issues.
- This role will annotate the related SOPs for any activity they perform if necessary and permanent changes arise or will coordinate with the Field Data Manager to develop new SOPs if a gap exists.
- This role will assist with recording, entering to AWQMs, verifying, and validating data as outlined in this QAPP.
    - Note, a field staff member separate from the one who first entered field data will check the uploaded data for accuracy and consistency in the AWQMS database.

- This role will maintain data and retain field project records in conjunction with the Project Manager and in accordance with MDE's Records Retention policy.
- FSP field staff as assigned will serve this role.

Laboratory Data Manager:

- This role will be responsible for the laboratory sample analysis and submission of the laboratory data to MDE in MDE's outlined format.
- The Laboratory Data Manager will correspond with the Project Operations Manager, QAM, and Field Data Manager on QA/QC issues and operational processes.
- The Chesapeake Biological Laboratory at University of Maryland Center for Environmental Science will serve as a contractor support for the laboratory analysis of collected samples. Jerry Frank from CBL will serve as the Laboratory Data Manager.

Principal Data Users (IR and TMDL Staff):

- IR and TMDL staff will be the principal data users of the impoundment monitoring efforts; as such, staff will communicate early in the project with Senior or Project management about any specific needs and objectives.
- This role will assist the QAM and Project Manager where needed and be responsible for coordinating with the Project Manager and Field Data Manager in the selection of impoundments to sample.
- IR and TMDL Staff will be responsible for reading reports or other documentation to understand any quality concerns, e.g, any limitations to data use, flags on lab data, etc., before using information/data.
- WPRPP staff as assigned will serve this role.

A9. Project Quality Assurance Manager Independence

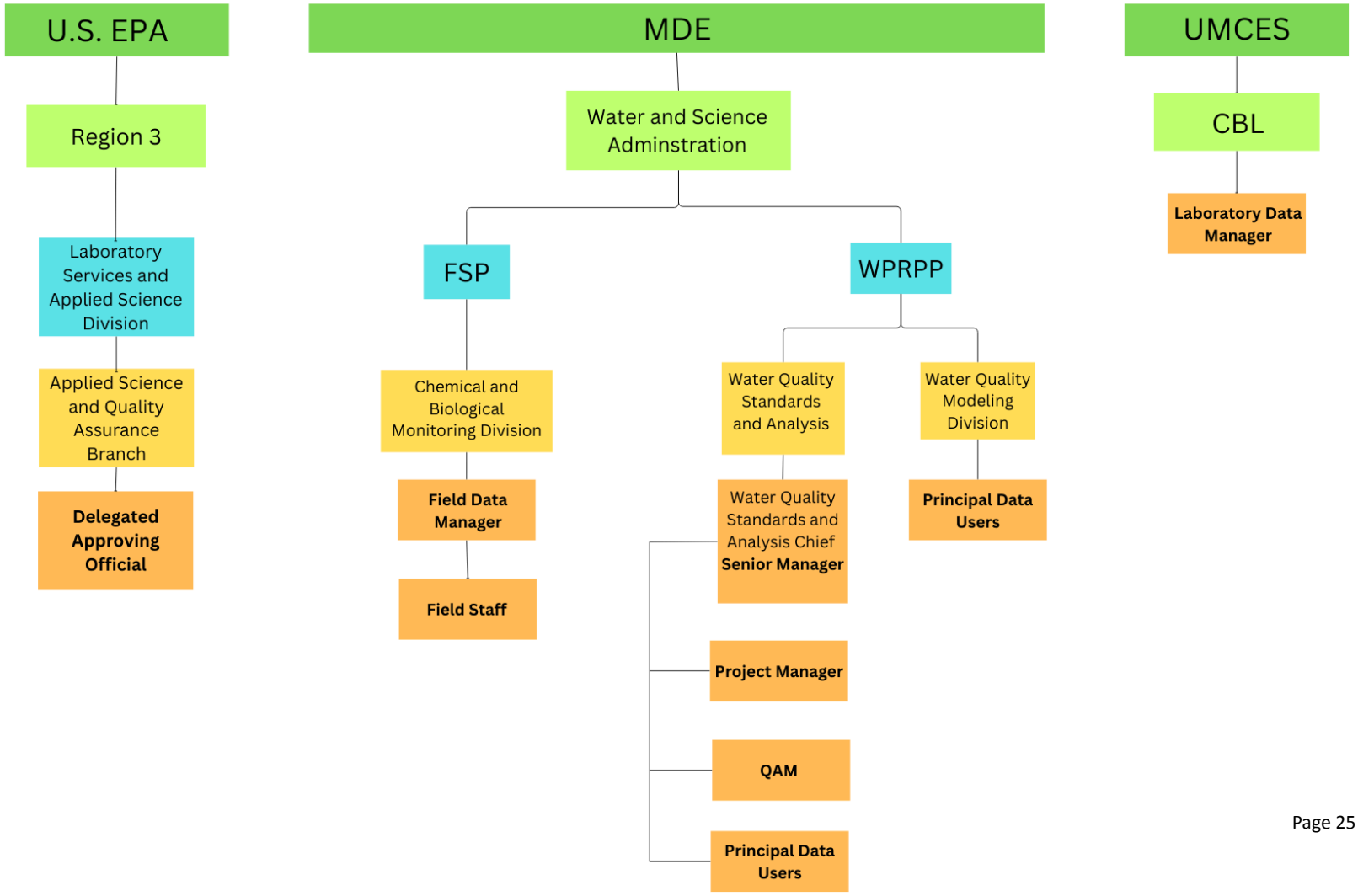
The QAM for the work described in this QAPP is not involved in the collection or laboratory analysis of the data for submission. They are contacted for assistance by the Project Manager or Technical Staff and are responsible for providing feedback on the Quality Assurance objectives and needs of EPA and MDE. They provide assistance with the management of the final data product and maintaining internal copies of the QAPP. The QAM does not otherwise use or engage with the data product in any way that would present a conflict with the project.

The Project Manager or designee will not have authority to sign QAPPs for the QAM or designee, nor will the QAM or designee have authority to sign QAPPs for the Project Manager or designee.

A10. Project Organization Chart and Communications Project Organization Chart

Figure A10-1 Project Organization Chart

This organization chart outlines all organizations responsible and involved in the project. Modifications to this chart will be completed as necessary on annual review of the Lakes QAPP. Lines of authority are provided in the organizational chart and project roles are bolded in black.



Communication

Project communication is detailed in Table A10-1. MDE project personnel will have access to the project's shared Google Drive folder. As soon as they are aware and within one business day, all project personnel will raise discrepancies, QAPP non-conformances, and process improvements to the Project Manager. After consulting with the QAM and Senior Manager if needed, the Project Manager gives final approval on any changes, notifies the affected members of the project team, and saves relevant documentation in the project folder. As needed, the Project Manager will elevate discrepancies and QAPP non-conformances to the appropriate EPA contacts.

The Field Data Manager will coordinate field surveys, including securing permissions and/or collection permits for sample locations. Landowners will be contacted by phone, then mail, if necessary, to seek approval to access their property. Please see the Sampling Station Selection and Naming SOP for more information on sample locations and the LNM Project-Data Management and QA/QC SOP for more details regarding communication pathways related to data communication.

Table A10-1 Communication Pathways

Communication Driver	Responsible Entity	Procedure (timing, pathway, etc.)
Manage field project phase	Project Manager and Field Data Manager	The Project Manager and Field Data Manager will inform the scientists about all field activities and any other pertinent project information.
Report field activities to Project Manager	Field Data Manager	Progress in field data collection will be recorded via the centrally shared Google Drive spreadsheet. The spreadsheet will be continuously updated as collection activities occur.
Report laboratory activities to Project Manager	Laboratory Data Manager	All materials and information about the project will be forwarded to the Project Manager. At a minimum, regular updates will be given once a quarter.
Reporting Lab Data Quality Issues	Laboratory Data Manager	The lab will communicate any issues in the quarterly data report and / or through the inclusion of applicable qualifier codes for the datasets.

Communication Driver	Responsible Entity	Procedure (timing, pathway, etc.)
Issues encountered in field data collection	Field Staff	Scientists will communicate any issues or deviations from the QAPP to the Field Data Manager within one business day of that activity. The Field Data Manager will report issues as needed to the Project Manager.
Corrective actions for field activities and data analysis	Project Manager and QAM	The Project Manager, in coordination with the QAM, will determine the need for corrective action for field and analytical issues and communicate those to affected staff as soon as possible.
Issues encountered in data collection or analyses.	Project Manager and EPA Region 3 Contacts	As needed, the Project Manager will elevate discrepancies and QAPP non-conformances to the appropriate EPA contacts.

A11. Personnel Training/Certification

The Field Data Manager will oversee and ensure proper training of field staff involved in sampling. All employees conducting field sampling have reviewed the SOPs for YSI DS Pro and In-Situ Aqua Troll 600 sondes and undergone training by the Field Data Manager or other qualified senior field staff in the general operation and calibration of the sondes as well as other field instruments, including a standard thermometer, OTT MF Pro Flow Meter, and filter kits. Field staff responsible for water quality sonde maintenance & calibration procedures will familiarize themselves with all manufacturers protocols for all equipment used including manuals, training videos, and tutorials. During an employee's first months of collection, the Field Data Manager or appointed senior field staff will supervise employee techniques to ensure that the employee possesses necessary skills to perform the sampling tasks. All field personnel will follow the procedures outlined in the SOPs.

If new equipment or sampling techniques are introduced for the project, appointed senior field staff with experience in the new equipment will provide demonstration and training for other respective field staff. If no senior field staff have experience with the new equipment, training may be received from the manufacturer. Training will be overseen by the Field Data Manager to ensure all relevant staff are properly trained in the new equipment / sampling techniques. Any unknown procedures will be reviewed in the office and/or field prior to sampling.

Internal individual performance audits will be conducted periodically by qualified senior staff. Technical on-site evaluations of field sample collection and processing techniques, and proper equipment use will be made. Retraining of staff will be conducted, if necessary.

A12. Documents and Records

Project-Specific Documents and Records

Project records will be managed in accordance with the current MDE policies, as described in the Documents and Records section of MDE's QMP (MDE, 2020). The Project Manager will be responsible for saving electronic files on the shared drive to ensure they are automatically backed up. Hard copy records will be filed in the field office location. Documents and records will include, but are not limited to:

- *Field Data Sheets.* These sheets will be used on-site to record field measurements and environmental conditions at the sampling locations. The original sheets will be maintained and archived by the Field Data Manager at the FSP office. Field sheets will also be scanned and saved as electronic PDFs within the project's shared GoogleDrive.

- *Laboratory Transfer Sheets.* Laboratory Transfer Sheets for nutrient and chlorophyll-a analyses will be prepared by the Field Data Manager prior to the surveys and sent with the samples to the laboratory and returned with the final laboratory results. Original copies will be maintained and archived by the Field Data Manager at the FSP office. Laboratory transfer sheets will also be scanned and saved as electronic PDFs within the project's shared Google Drive.

- Field Equipment Maintenance / Calibration Records. Field equipment will be calibrated according to the Water Quality Equipment Maintenance and Calibration SOP. Equipment will be maintained following manufacturer guidelines. Calibration and maintenance records generated by these processes will be reviewed and maintained by the Field Data Manager at the FSP office. Any issues with calibration or equipment failure will be noted in the shared data tracking sheet and communicated with the QAM and Project Manager as needed. The proper data qualifier codes will be assigned to data in the AWQMS database as needed by the Project Manager.

- *Standard Operating Procedures.* SOPs for fieldwork procedures will be maintained with the project QAPP files on MDE's internal network servers and within a cloud storage folder (i.e. Google Drive). The persons conducting fieldwork for this project will periodically review these SOPs.

- *Data Tracking Sheet.* A centrally accessible data tracking sheet will be maintained on Google Drive for all project members. The data tracking sheet will record the receival and entry of field and laboratory data into AWQMS and ensure accurate and complete data entry . Field related quality assurance comments on the data will also be noted within this tracking sheet. These notes will be periodically reviewed by the QAM and Project Manager and may result in the assignment of additional qualifier codes to finalized data within AWQMS.

- *Laboratory Data Sheets.* The Chesapeake Biological Laboratory (CBL) at the University of Maryland Center for Environmental Science (UMCES) will conduct the project's nutrient analyses and chlorophyll-a (CHLA) analyses. CBL sends final laboratory results via a shared Google Drive folder, accessible to all project team members. These data sheets will be reviewed for quality assurance and quality control by the QAM and Project Manager following the LNM Project-Data Management and QA/QC SOP.

- *Final Data Results.* Field and laboratory data will be entered into MDE's database, Ambient Water Quality Management System (AWQMS). Data entry will be tracked using the Data Tracking Sheet. The QAM and Project Manager will review the final data results at least quarterly to ensure the completeness and accuracy of the dataset, following the procedures outlined in the LNM Project-Data Management and QA/QC SOP. At the end of the project, finalized data results will be uploaded from AWQMS into the Water Quality Portal (WQX) by the Project Manager with support from the QAM.

- *Landowner permission documentation.* The Field Data Manager is responsible for securing landowner permissions, as needed, for sampling activities. Documentation for landowner permissions will be saved to MDE's internal network location and within a cloud storage folder via Google Drive.

- *QA/QC assessment results, corrective actions, and quality issues.* Any relevant reports, notes, or emails following data QA/QC activities, corrective actions, deviations from QAPP methods, etc. will be saved to MDE's internal network location and within a cloud storage folder via Google Drive. For ease of reference, notes will be stored under a folder labeled for the year of the data collection activity.

- *Data analyses and reports.* Any data analyses and reports created for this project will be saved to MDE's internal network location.

- *Receipts for purchasing equipment and supplies.* The Field Data Manager and delegated field staff are responsible for purchasing equipment and supplies. Purchase receipts will be saved according to MDE's Documents and Records policies (MDE, 2020).

- *Photos*. Any photo documentation for the project will be saved to MDE's internal network location and within a cloud storage folder via Google Drive. JPG file names will contain the lake name, station, and date the photo was taken.

- *Project QAPP.* The QAPP document, including any amendments or revisions, and all related materials (SOPs, attachments and referenced files) will be maintained in two locations on an MDE internal server: one in an internal MDE network location and another in a cloud storage folder via Google Drive where the QAM maintains all QAPP documentation. Additionally, print copies of the QAPP and its attachments are kept at the Project Manager and QAM's discretion at MDE's Baltimore Office.

QAPP Preparation and Distribution

This QAPP conforms to the format described in the U.S. Environmental Protection Agency publication Quality Assurance Project Plan Standard [Directive No: CIO 2105-S-02.0] (U.S. EPA, 2023). The QAPP shall always govern the operation of the project and must be accessible during operations. Each responsible party listed in Table A7-1 shall adhere to the procedural requirements of the QAPP and ensure that subordinate personnel do likewise.

This QAPP shall be reviewed at least annually to ensure that the project will achieve all intended purposes. In addition, it is expected that ongoing and perhaps unexpected changes may need to be made to the project. Project Managers, QA Staff and other applicable personnel in Table A7-1 shall participate in the review of the QAPP. The Project Manager shall authorize all changes or deviations in the operation of the project. The review and any revisions will be documented. If significant changes need to be made, the QAPP will be sent to the DAO again for approval. Examples of significant revisions include changes in:

1) the scope of the project resulting in new or revised objectives
2) implementation such as how information will be collected, produced, evaluated, or used
3) the design, construction, operation, or application of environmental technology
4) the statement of work or workplan for extramural agreements
5) expiration of the QAPP
6) the organization's mission or structure, such as in the delegation status of QAPPs
7) performance criteria as to how results will be assessed for acceptance.

The Project Manager will document the effective date of all changes made in the QAPP and distribute revised versions to all individuals listed in Table A7-1.

Field Documentation

To thoroughly document field activities, dedicated bound logbooks (or electronic equivalents), checklists, forms, electronic devices and/or other field documentation methods must be used for field data collection including, but not limited to, sampling, measurements, and observations. For field operations, all document control and records management requirements identified in the QMP, The Collection and Handling of Water Samples SOP, and the Lake Nutrient Data Management and QA/QC SOP must be followed.

Storage

While the project is underway, project information will be stored in a central filing cabinet at MDE headquarters or the Field Office, and on MDE's internal computer network, according to the standard retention time policies as outlined in the Quality Management Plan for MDE (MDE, 2020). Upon completion of the project, paper records (paper field sheets, station lists, field pack information, etc.) and any electronic media (e.g., CDs, flashdrives) will be retained in perpetuity at the MDE Field Office. Electronic records will be stored in perpetuity on MDE's main computer network and cloud-based storage (I.e. Google Drive) .

B Implementing Environmental Operations

This section details how the study design has been developed for the IR and TMDL programs to ensure that the data quality objectives are met. It discusses the preparation necessary prior to conducting fieldwork, the procedures and methods to be followed during and after field sampling, and the maintenance of the equipment used to ensure reliable measurements. A comprehensive monitoring plan that includes the selection of sampling locations, analytical parameters, and quality control samples, as well as the development of survey documentation should be operational prior to commencing fieldwork.

B1. Identification of Project Environmental Information Operations

To provide high quality data for IR assessment and TMDL development, this project includes extensive field, laboratory, and data verification SOPs that provide a standardized and stringent collection process. These SOPs ensure that data collected is accurate, representative, comparable, and complete. See the SOPs for the Lake Nutrient Monitoring project. The SOPs will also be placed in the project files and made available for routine referencing when needed.

Lakes are selected for sampling based on criteria in the Lake Prioritization List and will be monitored for 2 summers and 1 winter. Water quality sampling will be conducted twice a month from April to October and once a month from November to March. Sampling frequency is increased during April to October to capture variable hydrodynamic and meteorological conditions during the warmer season months. This schedule is subject to change due to inclement weather or other competing Program objectives.

Stations are selected for each lake following the Sampling Station Selection and Namin in Free Flowing and Free Flowing Impoundment Waterbodies. To appropriately characterize the water quality and conditions of an entire impoundment, sampling stations will be located both within the impoundment and on any designated input or output tributaries. Therefore, some of the field sampling parameters and protocols vary between land collection (inputs/outputs) and boat collection (in lake). For example, secchi depth information is taken only at boat collection stations and flow is taken only on land stations. Please see the Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies SOP and the Collection and Handling of Water Samples SOP for comprehensive details on field data collection protocols. Table B1-1 shows the sampling components for this project.

Table B1-1 Sampling Components

Component/Matrix	Parameter(s)	# of Samples or Measurements	Frequency	Equipment
Surface Water Grab Samples	Nitrogen, Phosphorous, Chlorophyll a, and phaeophytin	1 sample	At each station in each lake 2X a month April-October 1X a month November-March	Bottleware, coolers, ice or ice packs
In situ Water Quality	Temperature, pH, Dissolved Oxygen, Salinity, Turbidity, Specific Conductance	1 measurement per parameter. These parameters are also used for depth profiles. 1 set of depth profile readings taken every 1-3 meters. Bottom readings will be taken at 1.0 meter above the bottom and the top readings at approximately 0.5 meters from the top.	At each station 2X a month April-October 1X a month November-March	YSI DS Pro & In-situ Aqua Troll 600, water quality sondes.
In situ Water Quality	Air Temperature - Celsius	1 measurement per lake	At each lake 2X a month April-October and 1X a month November-March	Standard Thermometer
Flow	Flow - cubic feet per second	1 set of flow reading for land stations only	At each station 2X a month April-October 1X a month November-March	OTT MF Pro Flow Meter
Water Light Penetration	Light Penetration Water Depth	1 secchi measurement for boat or in-lake stations only	At each station 2X a month April-October 1X a month November-March	Secchi Disk [The same individual will read the secchi disc to reduce error.]
Depth	Max Depth - meters	-1 set of depth readings for in-lake stations -Depth readings to interpret flow velocity at land stations	At each station 2X a month April-October 1X a month November-March	In-lake station - YSI DS Pro & In-situ Aqua Troll 600,

Component/Matrix	Parameter(s)	# of Samples or Measurements	Frequency	Equipment
				water quality sondes. Land station- Measuring stick or OTT MF Pro Flow Meter
Geospatial	outfall locations, shoreline types, and the surrounding land use	NA	Once before start of field activities	GIS layers
Geospatial	Distance from shore	20	Once at start of project's field activities	Rangefinder and/or GIS

B2. Methods for Environmental Information Acquisition

The project will follow the SOPs outlined below for the acquisition of environmental information. More information is included in MDE's SOPs. The Project Manager will oversee the maintenance of all SOPs associated with the project QAPP. The Project Manager will work in conjunction with the Field Data Manager, QAM, and Laboratory Data Manager in order to ensure up-to-date and accurate project policies and procedures are documented in the SOPs.

Field Data Collection

Once the lakes have been selected, water quality stations for each lake survey will be determined following the Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies SOP. Samples will be collected twice a month from April until October, and once a month from November through March for each station. This schedule is subject to change due to inclement weather conditions, equipment malfunctions, and competing Program objectives. For in-lake samples, surface samples will be collected at all stations. A limited number of bottom samples will be selected for stations based on depth and channel dynamics. Typically, a bottom sample will be collected at stations deeper than 5 meters in areas prone to stratification or anoxia. For land stations, or inputs/outputs of the lakes, flow measurements will also be collected in addition to the other surface samples.

As a quality control check, one duplicate sample will be collected for each lake at each sampling event, which averages to be about 10% of samples. The selection of a duplicate site in each lake is at the discretion of the field staff. However, once selected, the duplicate sample will come from the same station at each sampling event.

Field data will be collected following the standardized operating procedures listed below.

- Sampling Station Selection and Naming in Free Flowing and Free Flowing Impoundment Waterbodies SOP
- Water Quality Equipment Maintenance and Calibration SOP

In-situ measurements of pH, temperature, dissolved oxygen, conductivity and salinity will be made using a YSI Pro DS or In-Situ Aqua Troll 600. At the stations collected from boats, the meter will be zeroed for depth and a vertical profile of pH, temperature, dissolved oxygen, conductivity and salinity will be measured throughout the water column at a maximum of 3 meter intervals. The bottom readings will be taken at 1.0 meter above the bottom and the top readings at approximately 0.5 meters below the surface.

At the stations collected from land, water samples will be collected directly in sample bottles in stainless steel buckets and one set of in-situ water quality measurements will be taken. In-situ water quality measurements will be taken using a multiprobe water quality sonde. Upon completion of the surveys, the multiprobe sonde will be thoroughly rinsed with de-ionized water. Secchi readings will be taken at impoundments stations when feasible. All measurements will be recorded on the field survey sheets, in addition to any comments about conditions that could influence the equipment performance or explain unusual data.

The sondes are multi-probe instruments with accuracy and measurement ranges reported by the manufacturer as follows:

Table B2-1 In-situ Field Parameters for YSI Pro DS[19] or In-Situ Aqua Troll 600[20]

Matrix	Parameter	Accuracy	Measurement Range	EPA Method Code
Water	pH	± 0.2 unit	0-14 units	Std. Methods 4500-H+, EPA 150.2
Water	Dissolved oxygen	±0.1 mg/L from 0 to 8 mg/L ±0.2 mg/L from 8 to 20 mg/L ±10% of reading from 20 to 50 mg/L	0 to 50 mg/L	EPA-approved In-Situ Methods (under the Alternate Test Procedure process): 1002-8-2009, 1003-8-2009, 1004-8-2009
Water	Temperature	± 0.2C	-5 to 50° C (23 to 122° F)	EPA 170.1
Water	specific conductance	±0.5% of reading plus 1 µS/cm	0 to 200,000 µS/cm	Std. Methods 2510, EPA 120.1

[19]https://www.ysi.com/File%20Library/Documents/Brochures%20and%20Catalogs/YSI-ProDSS-Catalog.pdf
[20] https://in-situ.com/pub/media/support/documents/aquatroll-500-600-700-800-spec-sheet-ltr-en.pdf

Matrix	Parameter	Accuracy	Measurement Range	EPA Method Code
		from 0 to 100,000 µS/cm; ±1.0% of reading from 100,000 to 200,000 µS/cm		
Water	Salinity	±1.0% of reading or ±0.1 ppt, whichever is greater	0-70 ppt	
Water	Turbidity	0 to 999 (0.3 or ±2% of reading, whichever is greater) 1000 to 4000 (±5% of reading)	0-4000 NTU	ISO 7027

All in-situ parameters will be measured at each station, as described in the Collection and Handling of Water Samples SOP. Water clarity will be measured in impoundments when possible using the techniques described in the Standard Operating Procedures. Air temperature will be measured at each station with a standard thermometer and recorded in Celsius. Flow will be measured at all “land” stations (Input/outputs) with a OTT MF Pro Flow Meter and follow the procedures outlined in the Collection and Handling of Water Samples SOP.

Laboratory Data Collection

Laboratory analyses for each parameter will follow SOPs outlined on the CBL website (CBL, 2023) for each respective analytical method, see Table B2-2 Water Quality Parameters Analyzed for the Lake Monitoring Program for more information.

Data packages from the CBL will be submitted to a centrally accessible Google Drive for all project members. Data will be uploaded by CBL at least quarterly and reviewed by the Project Manager and QAM for quality assurance and quality control purposes, following the LNM Project-Data Management and QA/QC SOP.

Table B2-2 Water Quality Parameters Analyzed for the Lake Monitoring Program

Parameters analyzed by the Chesapeake Biological Laboratory (CBL) at the University of Maryland Center for Environmental Science (UMCES)				
PARAMETER	**ABBR**	**DETECTION LIMIT**	**METHOD/REFERENCE**	**MAXIMUM HOLDING TIME**
Nitrate- + Nitrite-N	NO3 + NO2	0.0057 mg N/L (detection limit for ASTM method), 0.0009 mg N/L (detection limit for EPA method).	EPA Method 353.2, Rev. 2.0 (1993) & ASTM D-7781-14	28 days at 4°C (Freezing is used as the preservation technique)
Phosphate	PO_4	0.0034 mg P/L	EPA Method 365.1, Rev. 2.0 (1993)	28 days at 4°C (Freezing is used as the preservation technique)
Ammonium-N	NH4	0.009 mg N/L	SM4500-NH3, G-2011	28 days at 4°C (Freezing is used as the preservation technique)
Total Nitrogen	TN	0.05 mg N/L	EPA Method 353.2, w/alkaline persulfate digestion	28 days at -20°C
Total Phosphorus	TP	0.0015 mg P/L	EPA Method 365.1, w/alkaline persulfate digestion	28 days at -20°C
Phaeophytin (Spectrophotometer)	CHL-PHAEO	0.74 µg/L	EPA 446.0, SM 10200H.2b	28 days at -20°C
Chlorophyll-a (Spectrophotometer)	CHLA	0.62 µg/L	EPA 446.0, SM 10200H.2b	28 days at -20°C
* Information taken from CBL, 2024				

The nitrate, phosphate, and ammonium parameter samples will be collected in the field as whole-water samples using the procedures described in the Collection and Handling of Water Samples SOP and processed and analyzed by UMCES CBL. The dissolved parameters TN, TP, and CHLA pads will be processed in the field or at the laboratory using the filtering techniques described in the Collection and Handling of Water Samples SOP and forwarded to the appropriate laboratory for analysis.

All samples collected will be preserved on ice to 4º C until transferred to the Annapolis Field Office where they will be stored in a freezer until transferred to the laboratories for analysis within the holding time specified in the Table B2-2 above.

B3. Integrity of Environmental Information

Information/Data/Sample Handling

Unbound checklists and forms must remain in control of the field office lead, transferred to the Project Manager, and kept in the project file upon return from the field. Hard copy records will be kept in the field office and scanned to be saved electronically in the project folder. See section A12. Documents and Records for additional information on field documentation handling.

Information/Data/Sample Handling

The field sheets and laboratory transfer forms generated are shown in Figures B.1 – B.4 and described below.

- **Field survey sheets.** One sheet will be generated for each station location. This sheet will be pre-printed with the survey name, station identification number, sample type (duplicate, surface, bottom, boat, instream) and notations of activities to be performed on-site (i.e., flow measurements, chlorophyll-a collections). See Figure B.1.
- **Station location sheets**. One sheet will be generated for each individual survey to be conducted. This sheet will contain the station identification number, detailed written description of the station location, latitude and longitude and the type of sample to be collected.
- **Station location maps**. One map will be created for each survey. The map will be a detailed road map or NOAA navigational chart with the station location and identification clearly marked.
- **UMCES laboratory transfer sheets.** One sheet will be generated for each survey. This sheet will be pre-printed with the survey name and date, station identification numbers, sample type and sample depth. See Figure B.2.

Following the completion of items 1 through 4, a “field pack” will be compiled for each survey. It will consist of the field survey sheets, station location sheet and station location map. The laboratory transfer sheets will be completed immediately following surveys.

Figure B3-1 Field Sheet

						AWQMS:		QA/QC:	
Date:	Field Scientist(s):				Equip # ID:				
Station ID	VIF0000	VIF0001							
Bottle #	LAR-1	LAR-2 S							
Start Time 24hr									
End Time 24hr									
Sample/Reading Depth	0.1	0.5	1						
BR/IS									
Air Temp oC									
Weather Yesterday									
Weather Today									
Cloud Cover %									
Wind Direction									
Wind Velocity Min. knots									
Wind Velocity Max. knots									
Secchi Depth m									
Wave Height m									
Total Depth m									
Water Temp oC									
pH									
D.O. mg/l									
Specific Conductivity uS/cm									
Salinity ppt									
Turbidity NTU									
Discharge CFS									
Chlorophyll Filter Vol. m									
Comments: LAR-2 DUP	DUP Vol.								

When Total Depth >5M, collect Bottom sample = "LAR -2 B"

Write "LAR-2 B" in appropriate Column

Readings/Sample **1 M** off bottom

Weather Codes:		**Wave Height: m**	
0 = Cloudless	5 = Drizzle/Light Rain	Flat Calm - 0.03m	Slight Ripple - 0.09m
1 = Cloudy/Partly Cloudy	6 = Rain	Ripple 1ft - 0.2m	1-2ft = 0.4m
2 = Overcast	7 = Snow, Sleet, or Hail	2-4ft = 1.00m	4-6ft = 1.5m
3 = Drifting Snow/Dust/Sandstorm	8 = Rain Showers	6-8ft = 2.10m	8-13ft = 3.00m
4 = Fog	9 = Thunderstorms, Squalls		
Wind Velocity: Knots			
0-1, 1-3, 4-6, 7-10, 11-16, 17-21, 22-27			

Figure B3-2 UMCES Laboratory Transfer Sheet

MDE
LNM PROJECT 2024-2025
UMCES VOLUME SHEET
Eastern Shore Lakes

Date:_____ Scientist signoff:_____

Station Code	Sample #	Layer Code	Depth (m)	Time (MLTY)	Salinity	CHL-A Filtered Volume (ml)
GIV0012	ES-1	S	0.0			
ADK0019	ES-2	S	0.0			
TUI0006	ES-3	S	0.0			
SAA0005	ES-4	S	0.0			
CMP0016	ES-5	S	0.0			
LML0021	ES-6	S	0.0			
PAD0008	ES-7	S	0.0			
LML0000	ES-8	S	0.0			

A monthly calendar schedule will be developed for lake sampling fieldwork, as well as spreadsheets that will track sampling dates. On a monthly basis, these documents will be updated to reflect changes in scheduling and sample collections.

Details on how the samples and associated laboratory transfer sheets will be handled at the FSP are described in the SOP for Sample Collection and Handling of Samples at the FSP.

Laboratory Certification/Accreditation

All laboratory water samples will be analyzed by the Chesapeake Biological Laboratory (CBL) with the University of Maryland Center for Environmental Science (UMCES). The laboratory is nationally accredited with a National Environmental Laboratory Certification (NELAC) from the State of New York DOH, and Florida State DOH. Retention of these credentials requires bi-annual on-site audits, annual internal audits, and successful semiannual completion of proficiency test (PT) samples. Other credentials include the New York Dept. of Health Environmental Laboratory Approval Program (ELAP) PT Program (bi-annual) and ERA Proficiency Testing and Certified Reference Material Program. Analytical services provided by the CBL are documented on their Nutrient Analytical Services Webpage. Each method will be followed when submitting samples, which will help ensure field and laboratory aspects of the sampling are linked to produce reliable data of known quality.

B4. Quality Control

This section describes the activities used to assess the effectiveness of this QAPP and its associated Quality Control and Quality Assurance Programs, and ensure that it is properly implemented. This will largely be accomplished by internal and external audits that evaluate field, laboratory and data management activities; equipment; contract labs; and individual performance. In addition, the response actions and measures to be taken as a result of these audits or other unanticipated problems are discussed.

QC Activities

To provide high quality lakes data that meets the environmental information objectives described in section A.6, the following QA QC protocols are performed. Additional information is included in the LNM Project-Data Management and QA/QC SOP. Data transference is routinely checked and validated by field staff while in the field. Field datasheets are reviewed on site by the senior field staff member before departure to ensure no missing and/or questionable data. Data entered into AWQMS will be routinely checked against the original data sheets with 100% verification. To ensure a thorough review, a separate field staff member than the staff member that originally input the field data sheets will check the AWQMS data entry. Errors caught during cross-checking will be flagged and corrected, to the extent possible, in consultation with field staff that participated in the data collection.

FSP field staff will maintain a tracking spreadsheet containing detailed notes on environmental operation which contains information on calibration results, sampling complications if they occur, and any other information relevant to the project. If issues occur during sampling, field staff and the Field Data Manager will additionally coordinate with the Project Manager and QAM and determine the most appropriate corrective action.

For laboratory assessments of the water quality samples, checks on precision and accuracy will be calculated and reported by the laboratory performing the sample analyses – Chesapeake Biological Laboratory (CBL). To ensure precise, accurate, and comparable analyses, the laboratory uses lab duplicates for 10% of samples, lab spikes for 10% of samples, analysis deviation from standard curves, method detection limits, blind audits, and split samples. Corrective actions depend on the specific precision or accuracy violation but may involve rerunning a given analysis or giving a given sample a qualifier code. For specific information on laboratory QA practices, see the CBL's Quality

Assurance/Quality Control Webpage[21] or analytical method specific QA/QC practices, see CBL's Laboratory Methods Webpage[22] and visit the corresponding link for the given analytical method. Please see each SOP for the method specific QAQC procedures, as well as calibration acceptance and continued verification. Laboratory quality data will be reviewed as part of the data package, considered in data analysis, and reported in the final report as appropriate.

Other specific QC activities are described in Table B4-1. For more details, please see the LNM Project-Data Management and QA/QC SOP.

Table B4-1 QC Activities

QC Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Individual(s)	Communication Route
Field Data					
Field duplicates	One station per lake per sampling event (~8%-20% of field samples)	RPD<=20% (or 30% for TP) for concentrations > 5 x MDL	Qualify associated field data and coordinate with field and lab to decrease error.	Field Staff collect the duplicates QAM checks RPD	The duplicate, checks of RPD, and any qualifiers are listed in the communication tracking sheet.
Sonde Calibration	Pre and post calibration is performed once a week to document any drift.	Accuracy is within 10% of the standard calibration number	Equipment calibration and maintenance logs will be checked to ensure that no problems exist with equipment that may affect field observations reported on the field sheets. If calibration results highlight errors, the specific parameters are removed from the field sheets and sensors will be repaired or replaced before using the sonde again.	Field Staff	Recorded in the field sheet comments and the communication tracking sheet.
Field Sheet review	Every field collection survey	Reviewed for completeness and accuracy.	Any parameters that appear unusual or out of range will be investigated.	Field Staff	Recorded in the field sheet comments and the

[21] https://www.umces.edu/quality-assurancequality-control
[22] https://www.umces.edu/nasl/methods

QC Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Individual(s)	Communication Route
					communication tracking sheet.
Flow measurements	All “land” (input/output) stations	Reviewed for accuracy and anomalies	If necessary, flow values will be re-calculated. Any suspect numbers will be verified or omitted, and corrections made, if necessary.	Field Staff	Recorded on field sheets and related project tracking sheets.
Field Data Entry	Quarterly	100% accuracy for field data entry into AWQMS database	Any inaccuracies are corrected in AWQMS.	Field Staff	Recorded in the field sheet comments and the communication tracking sheet.
Hold Times	Quarterly	Sample date - lab analysis date is to be less than 28 (or 30 for chl-a and phaeophytin)	Add proper qualifier code to associated field data and coordinate with field and lab to decrease future error.	Project Manager; QAM	Recorded in the lab data sheet, assessed in data verification step, and issues noted in the communication tracking sheet.
Lab Data- note that checks differ slightly for chlorophyll-a and phaeophytin. Please see CBL SOPs for more information.					
Correlation Coefficient	1 per batch if acceptable.	≥ 0.995	If <0.995, evaluate data points of the calibration curve. If any data point is outside established limits, reject as outlier.	Lab Data Manager	Qualifier code added to data on lab data sheet
Quality Control Sample (QCS)/ Certified Reference Material (CRM)	Beginning of run and every 20 samples.	± 10%	If QCS value is outside ± 10% of the target value reject the run, correct the problem and rerun samples	Lab Data Manager	Qualifier code added to data on lab data sheet

QC Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Individual(s)	Communication Route
Initial Calibration Verification (ICV)	Beginning of run following standard curve.	± 10%	Recalibrate if outside acceptance limits.	Lab Data Manager	Qualifier code added to data on lab data sheet
Continuing Calibration Verification (CCV)	After every 10 samples.	± 10%	If outside 10%, correct the problem. Rerun all samples following the last in-control CCV.	Lab Data Manager	Qualifier code added to data on lab data sheet
Method Blank/Laboratory Reagent Blank (LRB)	Following the ICV and after every 10 samples prior to the CCV.	≤ Method Quantitation Limit	If the LRB exceeds the quantitation limit, results are suspect. Rerun the LRB. If the concentration still exceeds the quantitation limit, reject or qualify the data, or raise the quantitation limit.	Lab Data Manager	Qualifier code added to data on lab data sheet.
Laboratory Fortified Sample Matrix Spike	After every 10 samples.	± 10%	If the recovery of any analyte falls outside the designated acceptance limits and the QCS is in control, the recovery problem is judged matrix induced. Repeat the LFM and if the sample results are again outside the acceptable recovery range, the sample should be reported with a “matrix induced bias” qualifier.	Lab Data Manager	Qualifier code added to data on lab data sheet.
Laboratory Duplicate	After every 20 samples.	±10%	If the RPD fails to meet the acceptance limits, the samples should be reanalyzed. If the RPD again fails to meet the acceptance limits, the sample must be reported with a qualifier identifying the sample analysis result as not having acceptable RPD for duplicate analysis.	Lab Data Manager	Qualifier code added to data on lab data sheet.

*Note that the table above does not include representativeness or completeness checks, for instance data entry checks. Please see section A.6 and B.4 for more information on these data quality indicators.

QC Statistics

Following the DQIs outlined in Section A6, the following QC statistics will be calculated. For more information on when and how these statistics are calculated, see the Lake Nutrient Monitoring (LNM) Project-Data Management and QA/QC. If issues are highlighted as part of the QC assessment, the QAM and Project Manager will contact the Lab Data Manager to investigate and correct the issue or otherwise use a qualifier code for the data for informational purposes.

Table B4-2 QC Statistics

Calculation	Formula	Abbreviations
Duplicate Precision	RPD = $\frac{(D_L-D_S)}{(D_L+D_S)/2}$ x 100	RPD = relative percent difference between duplicate determinations D_L and D_S = results for the duplicate values with D_L = larger of two observed values D_S = smaller of two observed values
Completeness	%C = $\frac{V}{}$ x 100 V >= N	%C=percent completeness V =number of measurements judged valid N=target number of measurements necessary to achieve a specific statistical level of confidence in decision making
Method Detection Limit and Result Comparison	MDL> RV	MDL= Method Detection Limit RV= Result Value
Total and constituent comparison for nitrogen and phosphorous	NH3+NO2+NO3=<TN and PO4=<TP	NH3= Ammonia Value NO2= Nitrite Value NO3=Nitrate Value TN=Total Nitrogen PO4=Phosphate Value TP= Total Phosphorus

B5. Instrument/Equipment Calibration, Testing, Inspection, and Maintenance

The Field Data Manager is responsible for ensuring instruments and equipment used for taking and handling field samples are to be inspected, maintained, and cleaned according to manufacturer's recommendations. Extra batteries, chargers, and other critical spare parts will be packed for field activities. The manufacturer's guidelines, an inventory of spare parts, and the maintenance log are located in the FSP laboratory area. CBL will maintain their laboratory equipment according to their SOPs for a given analytical method found on the CBL Laboratory Methods Webpage

The water quality sondes will be pre-calibrated on the Friday prior to the sampling work for pH, conductivity, turbidity, and dissolved oxygen, no more than 72 hours prior to field use. In addition, the meters will be post-calibrated following use in the field, no more than 48 hours after use, to document any drift from expected values that may have occurred during its use. Any deviations noted will be reported to the QA/QC section that makes any necessary corrections to the field data. All pre-and post calibrations will be conducted as recommended by the manufacturer.

Weekly inspections and preventative maintenance are conducted on-site at the FSP office by trained field staff. These procedures will follow the manufacturer's guidelines, as well as the in-house Water Quality Equipment Maintenance and Calibration SOP. The weekly maintenance activities performed are listed in the following table:

Table B5-2 Weekly Water Quality Sonde Maintenance Schedule

D.O. probe	Clean sensor
pH probe	Replace porous junction Replace electrolyte Clean glass in-situ pH reference electrode Replace pH standard
Conductivity probe	Clean sensor Examine and clean cell block
Turbidity probe	Clean sensor Examine and clean cell block
General	Clean wiring/gold pins

After sampling, equipment will be cleaned of aquatic plants, animals, and debris before leaving the site. On return to the office, all equipment will again be rinsed and cleaned with a 10% bleach solution (1 part bleach per 9 parts water) for a minimum exposure time of 10 minutes then rinsed off and then dried.

B6. Inspection/Acceptance of Supplies and Services

The Field Data Manager will conduct regular inspection of all equipment to ensure proper functioning. All sample bottles will be inspected by the Field Data Manager or designee to ensure they are free of any contaminants. The Field Data Manager will use a checklist to ensure all items are available during sampling. Additionally, CBL and the Lab Data Manager are responsible for properly maintaining their facilities and all equipment used in the laboratory analyses described in this project. Laboratory supplies and acceptance standards are described in CBL's SOPs for a given analytical method.

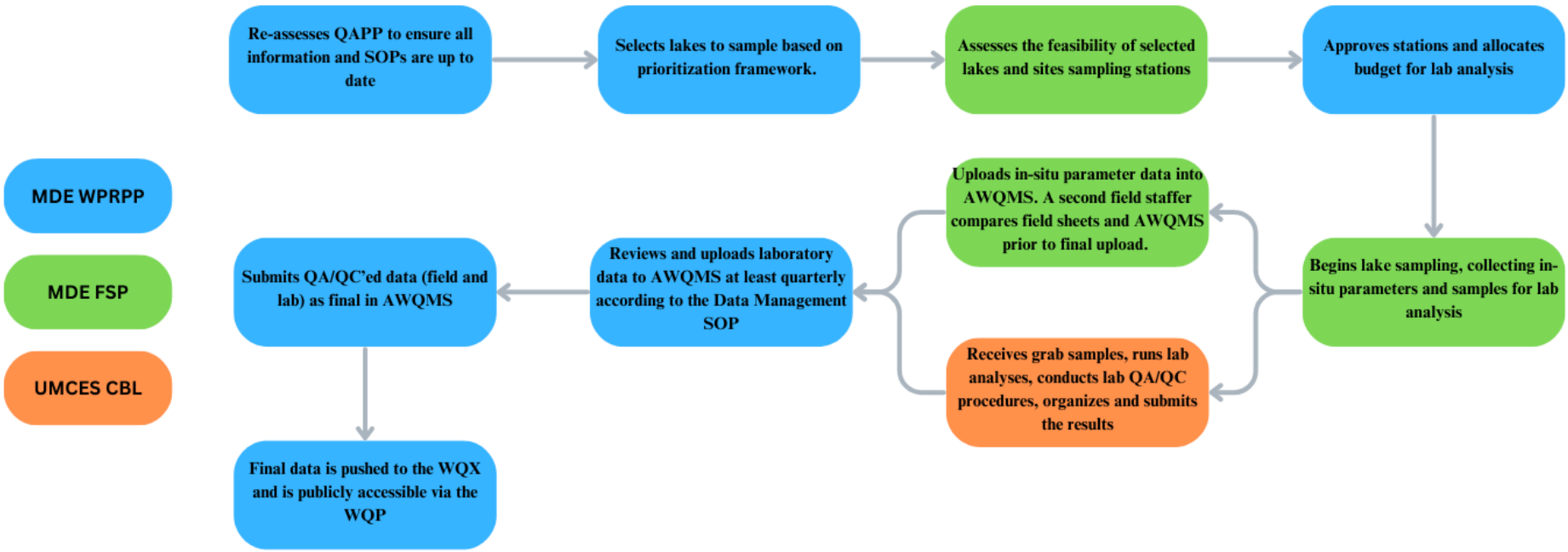
New and used sondes will be tested to meet calibration standards described in section B5. Containers will be inspected for breakage and proper sealing of caps. Filtering equipment is examined prior to field use for leaks, cracks, etc. Equipment such as thermometers and hoses will be checked routinely to ensure proper operating conditions and cleanliness. Sondes, thermometers, flow meters, safety equipment, containers, coolers, filtering kits, and other relevant sampling equipment will all be acquired by MDE from reputable suppliers. Damaged equipment will be returned or replaced.

Laboratory services received for this project will also be reviewed upon receipt. The QAM or IR and TMDL staff from WPRPP will review the received lab data for completeness and accuracy as described in section B4 and the LNM Project-Data Management and QA/QC SOP .

B7. Environmental Information Management

The environmental information process for this project is summarized in the following diagram:

Figure B7-1 Environmental Information Process Diagram



Field data sheets are checked for accuracy prior to leaving the field site. Data is then checked again upon return to the field office and data is entered into the AWQMS database by FSP staff. Hard copies of the original data sheets are kept on file in the Field Office. Scanned PDFs of the original field data sheets and laboratory transfer sheets are scanned and added to the shared Google Drive. Data generated by the laboratory is sent via a shared Google Drive to the Project Manager. The Project Manager enters the laboratory data into AWQMS.

AWQMS is used to record and organize all data. Once all data is entered, the Program Manager, with assistance from IR Staff, TMDL Staff, or the QAM as needed, inspects the data for accuracy and corrects any errors, cross checking with calibration and QC logs to confirm successful sampling and data management.

MDE incorporates checks at multiple points throughout this process to minimize loss of information during data entry by having separate reviews of lab and field data.

- Reviewers will compare field sheets to AWQMS entries and CBL's lab excel data to AWQMS entries respectively.
- All data entry and error correction activities are recorded in a set of documents prior to and immediately after any data management activity.
- Queries have been set up within Microsoft Access to facilitate the analysis of data without risking any alteration to the master dataset. Both completeness and accuracy will be checked in this process.
- The spreadsheet tracking sheet will serve as a place to document sample specific notes and issues that inform project management.
- Notes specific to samples and data use will be reflected in the AWQMS notes column field as well.

C Assessment, Response Actions, and Oversight

This section describes the activities used to assess the effectiveness of this QAPP and its associated QA/QC Program, and ensure that it is properly implemented. This will largely be accomplished by internal and external audits that evaluate field, laboratory and data management activities; equipment; contract labs; and individual performance. In addition, the response actions and measures to be taken as a result of these audits or other unanticipated problems are discussed.

C1. Assessments and Response Actions

During the project, the Project Manager and QAM will assess the project's activities to ensure that the QAPP is being implemented as planned. The purpose is to help to ensure that everything is on track and serves to minimize learning about critical deviations toward the end of the project when it may be too late to remedy the situation.

The Field Data Manager will conduct a general review prior to each major primary data collection step and take corrective action (if any is necessary). As part of the review, the Field Data Manager will ensure equipment is ready to go and all calibrations are checked; all sampling methods and equipment will be reviewed by staff prior to initiating sampling. The Project Manager will meet regularly with project implementation staff and the Field Data Manager to identify emerging/unanticipated problems and be responsible for stop work orders, corrective actions, and follow-up.

At least once annually, the QAM will assess the sample collection methodologies, field measurement procedures, and record keeping to ensure activities are being conducted as planned (and as documented in this QAPP). Any deviations that are noted will be corrected immediately to ensure all subsequent samples and field measurements collected are valid. If the deviations are associated with technical changes and/or improvements made to the procedures, the QAM will verify that the changes have been documented by the Project Manager and addressed in an amendment to this QAPP.

Audits of the QA procedures and QC activities

Internal individual performance audits will be conducted periodically by qualified senior field staff and reported to the Field Data Manager. Technical on-site evaluations of field sample collection and processing techniques, and proper equipment use will be made. Retraining of staff will be conducted, if necessary. Any issues relevant to data quality will be reported to the Project Manager and data will be assigned an appropriate qualifier code by the Field Data Manager, see the Lake Nutrient Monitoring (LNM) Project-Data Management and QA/QC for a list of qualifier codes.

Data management activities will be evaluated monthly by the Field Data Manager. Monthly schedules will be updated to reflect scheduling changes due to inclement weather or other factors to capture the status of data completeness for the project. All field sheets, flow measurements, and laboratory results are periodically reviewed by the Project Manager and QAM to determine if the data meets the quality standards set forth in this QAPP. In the event that discrepancies or unusual conditions are noted, the lab or field scientists will be contacted, as necessary.

Laboratory analysis activities will be evaluated by the Laboratory Data Manager following the policies and procedures of the CBL. The Laboratory Data Manager will assign any data qualifier codes to laboratory data prior to submission to MDE, see theLNM Project-Data Management and QA/QC SOP for qualifier codes. The QAM will also review laboratory data following the LNM Project-Data Management and QA/QC SOP.

An internal technical systems audit will be conducted annually by the QAM after all surveys have been completed and all laboratory results have been received. The QAM will follow protocols outlined in the LNM Project-Data Management and QA/QC SOP. The Project Manager may assist the QAM as needed with the audit process. Field sheets, laboratory results, equipment logs, and tracking sheets will be examined for completeness and discrepancies. Any anomalies will be addressed and corrected, if necessary. In addition, the adequacy of equipment, supplies, laboratory analytical procedures, data collection and reporting procedures, and sample collection and processing procedures will be reviewed and assessed as needed by the Project Manager. Any recommendations or changes will be reflected in future versions of this QAPP document. A description of quality control checks and acceptable corrective actions are provided in Table B4-1: QC Activities.

External audits, if found necessary, will be conducted by qualified individuals from the Environmental Protection Agency or other federal agency.

The Project Manager holds primary responsibility for ensuring that the problems identified through the audits are responded to and corrected in a timely fashion. The Project Manager will coordinate and maintain communication with the QAM and Data Managers.

If any problems are identified from the audits discussed above, various measures will be taken. In the event of equipment failure, laboratory logs will be reviewed and calibration/maintenance techniques will be reassessed and improved, as necessary. If problems are found with sampling team error, team members will be retrained, as necessary. If failure is not due to equipment methods or sampling error, specifications may be revised for the next sampling season. In all cases, the appropriate qualifier codes will be assigned to the data as needed. For a list of qualifier codes applicable to the project, The LNM Project-Data Management and QA/QC SOP.

C2. Oversight and Reports to Management

There are various reports that will be made available to management to address the status of the project. A centrally accessible (Google Drive) data tracking sheet will be maintained and available for reference for all project team members. The data tracking sheet will reflect the current status of field and laboratory data collection / analysis and entry into the AWQMS. An example of the data tracking sheet can be found in The LNM Project-Data Management and QA/QC.

The Laboratory Data Manager will send laboratory data at least quarterly, to the MDE team via Google Drive submissions. Laboratory data will be reviewed by the QAM, with assistance as needed by the Project Manager, following the quality checks and data verification procedures outlined in the Data Verification SOP. Through these data review efforts, a quarterly report will be generated to highlight any data quality issues. Data qualifier codes will be assigned and/or corrective actions will

be taken as needed following the data review, see Table B4-1 for a list of quality control checks with planned corrective actions.

The Field Data Manager and Laboratory Data Manager (Data Managers) also have oversight authority for their respective field and laboratory data collection teams. Upon identification of any data issues, the Data Managers will assign the appropriate qualifier code to the data, see The LNM Project-Data Management and QA/QC SOP for applicable qualifier codes for the project.

If data issues affect large portions of the dataset, or other data quality issues arise under the discretion of the Data Managers, the Data Managers will prepare and send a report detailing the data quality issue. This report will be sent to the Project Manager and QAM through email communications and entail:

- A description of the issue
- What data the quality issue affects
- Planned recourse or management actions that the Data Managers will undertake to remediate the issue for future data collection / analysis

Documentation for assessment activities, corrective actions, etc. will be kept in the shared Google Drive project folder. Two kinds of reports will be prepared: progress reports, and final reports. Progress reports will note the status of project activities, identify any QA problems encountered, and explain how they were handled. The final report will analyze and interpret data, present observations, draw conclusions, identify data gaps, and describe any limitations in the way the results should be interpreted. Reports that will be produced are outlined in Table C2-1.

Table C2-1 Reports

Type	Frequency	Timeframe	Transmission Route	Preparer(s)	Recipient(s)
Readiness Review Memo	Periodic	Before each major data collection step	Email	Project Manager	Field Data Manager, Field Staff, Data Users, QAM
Quarterly Progress Reports	Every 4 months	4 months after start date and ongoing	Email	Project Manager	All Project Personnel
Final Report	Once	At conclusion of project	PDF sent through email	Project Manager	Distribution List as seen in Table A7-1

D Environmental Information Review and Useability Determination

D1. Environmental Information Review

During information/data review, verification, and validation, staff will be guided by the data quality criteria listed in A6 as well as any additional criteria discussed in B2-B7. All onsite analytical data will be reviewed against QAPP requirements. The Project Manager, scientists, and relevant staff will:

1) Ensure that all sampling and analytical methods or SOPs were followed.

2) Establish that all method required QC samples were run and met required limits.

3) Establish that all QAPP required QC samples were run and met required limits.

The Project Manager and QAM will review each laboratory data package's narrative report and summary tables to see whether the laboratory "flagged" any sample results based on poor or questionable data quality or exceedances of the laboratory's QC criteria.

Through the data verification step, as described in the LNM Project-Data Management and QA/QC SOP, the QAM will check for data anomalies including but not limited to:

- Missing data,
- Data that fall outside the range of the expected or plausible based on industry averages,
- non-standard environmental aspects/indicators,
- incorrect/non-standard units,
- incorrect reporting years,
- incorrect normalizing factors or bases of normalization,
- incorrect calculations, conversions, etc.).

When possible, checking for data anomalies will be automated as part of the electronic data entry process into AWQMS or other automation softwares (i.e. RStudio and Microsoft Access), refer to the LNM Project-Data Management and QA/QC SOP for more information. Data anomalies will be flagged and corrected, to the extent possible, in consultation with field data collection staff and the Project Manager. When data used for analysis are incomplete, the potential impact of their incompleteness on the analysis will be described in relevant reports.

If at any point during review, the Project Manager identifies a problem (e.g., the use of substandard data when higher-quality data are available, a faulty algorithm, a mismatch between a data set and the question it is meant to answer), the Project Manager, field staff and any relevant staff will discuss corrective action. If necessary, the Project Manager will issue a stop-work order until a solution is agreed upon. The Project Manager will implement corrective action. If the solution involves changes in project design, the Project Manager will amend the QAPP as necessary, pass it through quality review if necessary, and then re-distribute it to the Distribution List.

Field Sampling and Measurement Data

Any information collected during sample collection and field measurements is considered field data. Once the field staff return to the office following a sampling event, they are responsible for conducting a technical review of the field data to ensure that all information is complete and any deviations from the planned methodologies are documented. (Note: This function is typically performed by a third party not directly involved in the activities. However, due to the small size of the staff, the field staff may self-evaluate their activities.) For the purpose of this project, the review will be documented using the monitoring tracking spreadsheet to ensure that data meet the data quality indicators and practices described in section A.6.

Laboratory Data

For the data generated by the off-site laboratory (The Chesapeake Biological Laboratory), the laboratory is responsible for its own internal data review and verification prior to submitting the associated lab results package to the Project Manager. The details of the review (including checking calculations, reviewing for transcription errors, ensuring the data package is complete, etc.) are discussed in the laboratory's QA /QC Webpage[23].

D2. Useability Determination

The purpose of the Lake Nutrient Monitoring sampling project is to assess impoundment water quality data against state regulatory standards for use in the Integrated Report and for TMDL development for impaired impoundments. This process allows Maryland to identify waters with impaired conditions and establish a plan to improve these waters. These operations fulfill sections 303(d), 305(b), and 314 requirements of the Clean Water Act.

Data must fulfill the requirements of this QA Project Plan to be useful for the overall project and support decision making under the Watershed Protection, Restoration, and Planning Program. To ensure data usability (after all the data have been assembled, reviewed, verified, and validated) a final usability determination should be made prior to summarizing the information in the Quarterly and Annual Reports. Once the field data and laboratory data are received through AWQMS, the QAM is responsible for further review and validation of the whole data package. For the purpose of this project, final data review and validation will be conducted using the accuracy and usability assessment steps provided below in conjunction with the QC criteria and activities (i.e., frequency, acceptance limits, and corrective actions) defined in section B.4- Quality Control. Once all the data from the field and laboratory have been reviewed, the Project Manager and QAM will make an overall assessment concerning the final usability of the data (and any limitations on its use) in meeting the project's needs.

Some steps of this assessment will include, but not necessarily be limited to:

1) Discussions with Field Staff, IR and TMDL staff, or other scientists.
2) Review of deviations from the QAPP or associated SOPs to determine whether these deviations may have impacted data quality (and determining whether any impacts are widespread or single

[23] https://www.umces.edu/quality-assurancequality-control

incidents, related to a few random samples or a batch of samples, and/or affecting a single or multiple analyses).

3) Evaluation of the field and laboratory results and QC information such as ensuring data are reported in compliance with the project action limits and quantitation limits, the sample preparation/analytical procedures were performed as written, the sample container, preservation, and holding times met the requirements listed in Table B2-2 Water Quality Parameters Analyzed for the Lake Monitoring program, and; the integrity of the sample (ensuring proper chain of custody and correct sample storage temperatures) is documented from sample collection through shipment and ultimate analysis, and the data packages.
4) Review of any other external information which might influence the results, such as off-site activities in the vicinity, meteorological conditions (such as storm events preceding sampling), etc.
5) Evaluation of whether the completeness goals defined have been met.
6) Examination of any assumptions made when the study was planned, if those assumptions were met, and, if not, how the project's conclusions are affected.
7) This review will include evaluation of the field and laboratory duplicate results, field and laboratory blank data, matrix spike recovery data, and laboratory control sample data pertinent to each analysis.

The final project report will contain an evaluation of the certainty of project results prepared by the Project Manager. For each conclusion reached by the project (i.e., each determination that an anticipated outcome has or has not been achieved, and the basis for each decision made or recommended by project authorities), this evaluation will describe, in narrative form: the quality of data and the methodologies used to inform the conclusion, the subsequent confidence in the conclusion, and the validity of generalizing results beyond the project.

References

See Table A4-1 for SOPs.

CBL (Chesapeake Biological Laboratory). 2023. University of Maryland Center for Environmental Science, May 2023. Nutrient Analytical Services Laboratory, Standard Operating Procedures, https://www.umces.edu/nasl/methods, Solomons, Maryland.

In-Situ, Inc. August 2024. AquaTROLL Multiparameter Sondes Specification Sheet. https://in-situ.com/pub/media/support/documents/aquatroll-500-600-700-800-spec-sheet-ltr-en.pdf

MDE (Maryland Department of the Environment). 2020. Maryland Department of the Environment Quality Management Plan, https://mde.maryland.gov/Documents/MDE%20QMP%20Mgmt%20Plan%20Signed.pdf

U.S. EPA (Environmental Protection Agency) (a), August 2023. Quality Assurance Project Plan Standard [IT/IM Directive]. Directive No: CIO 2105-S-02.1, Office of Mission Support, Washington, DC. https://www.epa.gov/system/files/documents/2024-04/quality_assurance_project_plan_standard.pdf

U.S. EPA (b) Region 3. 2020. Quality Management Plan. U.S. Environmental Protection Agency Region 3: Philadelphia, PA. R3QMP001-20200601. https://www.epa.gov/quality/epa-region-3-quality-management-plans.

Xylem Environmental Solutions. 2023. YSI ProDSS Multiparameter Water Quality Field Instrument. https://www.ysi.com/File%20Library/Documents/Brochures%20and%20Catalogs/YSI-ProDSS-Catalog.pdf

Attachment K

EPA Region 3 Quality Assurance Project Plan (QAPP) Template

Region 3 Quality Assurance Project Plan (QAPP) Template

Template Instructions

This template is intended to aid in the writing of QAPPs in accordance with the EPA QAPP Standard (effective July 18, 2023). The Standard should still be reviewed since every project is different. The level of detail of a QAPP should be based on a graded approach. Using this template does not guarantee first round approval but helps streamline the process for author and quality reviewer.

On the title page and throughout the rest of the document, change "Project" to "Program" if the QA document is a Quality Assurance Program Plan (QAPrP) instead of a QAPP. Change the logo on the title page as required.

TEXT

Text included in the template is intended to be edited and customized for quality assurance project plans for EPA and non-EPA organizations. The text has been written to indicate what changes or additions need to be made. EPA-specific requirements and requirements only for non-EPA organizations are denoted by foot notes.

EXAMPLES OF LOGO, TABLES, FIGURES, & ATTACHMENTS

Are provided as examples and should be modified/deleted as necessary.

TABLES & FIGURES

Tables and Figures are numbered by section and sequence order to facilitate their addition or deletion, i.e., *Table/Figure Section#–Sequence* in that section e.g., Table A2-1, A2-2, A2-3, B3-1.

DEFINITIONS

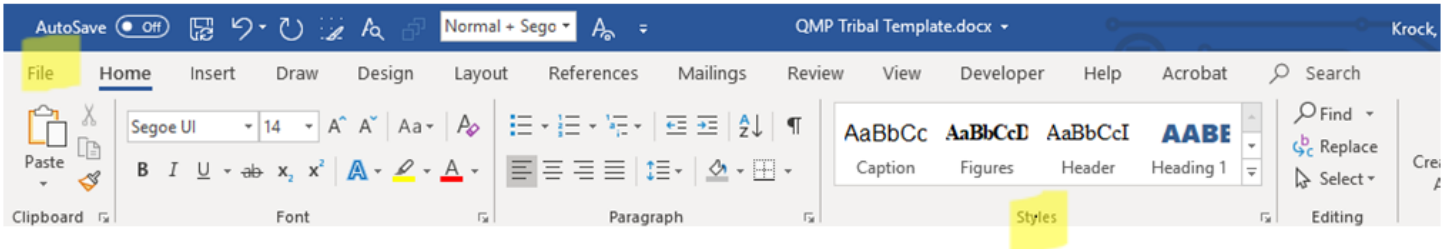
Are defined in Comments.

DELETE

Delete instructional text, comments, etc. before finalizing QAPP.

STYLES

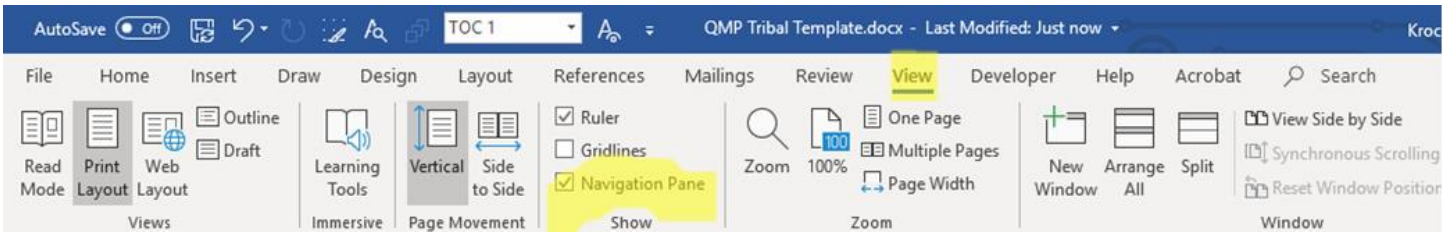
Are used for titles of sections, tables, and figures which allows for the Table of Contents to be automatically updated. Follow the table below to ensure each section level has the correct style.



Style	Example Section Level
Heading 2	A, B, C, D
Heading 3	A1, A2, A4… and Attachment Titles
Heading 4	Sub Section, e.g., Background, Other QA Documents
Caption	# and Title of Tables
Caption	# and Title of Figures
(Calibri Font)	Main body

NAVIGATION

Turn on the Navigation Pane to easily move through this document. View check box for ***Navigation Pane***



A Program Management and Information/Data Quality Objectives

A1. Title Page

U.S. Environmental Protection Agency, Region 3
Division:
Branch:

Quality Assurance Project Plan
Title

Effective Date: **Month ##, 202#**

Effective Date	Month ##, 202#
Period of Applicability	Month ##, 202#- Month ##, 202#
Revision/version control information	

A2. Approval Page

Concurrence

Project/Operations Manager

Name: Organization:	Signature: Date:

Author (if different than Project Manager)

Name: Organization:	Signature: Date:

Senior Manager

Name: Organization:	Signature: 01Date:

Project Quality Assurance Manager

Name: Organization:	Signature: Date:

EPA Designated Project Manager[1]

Name: Organization:	Signature: Date:

Approval

EPA Region 3 Delegated Approving Official[2]

Name: Organization:	Signature: Date:

.

[1] Only needed for entities external to EPA. May include, but not limited to Project Officer (PO), Contracting Officer Representative (COR) Program Specialist Site Assessment Managers (SAM), Remedial Project Managers (RPM) On-Scene Coordinators (OSC).

[2] Note: This approval action represents EPA's determination that the document(s) under review comply with applicable requirements of the EPA Region 3 Quality Management Plan and other applicable requirements in EPA quality regulations and policies. This approval action does not represent EPA's verification of the accuracy or completeness of document(s) under review, and is not intended to constitute EPA direction of work by contractors, grantees or subgrantees, or other non-EPA parties.

A3. Table of Contents, Document Format, and Document Control

Document Format

This Quality Assurance Project Plan (QAPP) was developed in accordance with the U.S. EPA Quality Assurance Project Plan Standard. The order of the elements in this QAPP follows the Standard, as seen in the Table of Contents. The QAPP is also in accordance with the U.S. EPA Region 3 Quality Management Plan, DCN R3QMP001-20200601.

Document Control

This table shows changes to this controlled document over time.

Add rows as you have different versions. DCN###.0 is the original and will have no changes. If there is new version you would add a row and input DCN###.1 and then what modifications were done, e.g., Added X, Changed Y, Removed Z.

Table 1 QAPP Versions

DCN Version	Changes	Effective Date
Region 3 Quality Assurance Project Plan (QAPP) Template	N/A- Original Document	08/18/2023

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A4. Project Purpose, Problem Definition, and Background

Purpose and Problem Definition

- Describe the purpose of the project's environmental information operations (e.g., source of project request, monitoring, use of existing data)[3]
- Define the problem(s) to be addressed and question(s) to be answered.
- Identify the environmental decision(s) that need to be made.
- Discuss how the results of the environmental information operations link to possible actions.

Background

- Describe or cite background information from a historic, scientific, or regulatory perspective, e.g., applicable regulatory programs and standards.

Other QA Documents[4][5]

- List any other QA documents that are related, i.e., QAPP for other portion of work by EPA Office of Research & Development (ORD), state, other agency, etc.
- Include Standard Operating Procedures (SOPs) if relevant.

[3] Environmental Information includes data and information that describe environmental processes or conditions. Examples include, but are not limited to:

- direct measurements of environmental parameters or processes.
- analytical testing results of environmental conditions (e.g., geophysical or hydrological conditions).
- information on physical parameters or processes collected using environmental technologies.
- calculations or analyses of environmental information.
- information provided by models
- information compiled or obtained from databases, software applications, decision support tools, websites, existing literature, and other sources.
- development of environmental software, tools, models, methods, applications
- design, construction, and operation or application of environmental technology.
- Non-EPA Organizations: Include organization's Quality Management Plan (QMP) and other relevant documents.
- EPA-specific: Leave in below table: R3 QMP and for field work, R3 Field SOPs.

- Other quality assurance documents that may be related to this project are listed in Table A4-1.The table is an example and not a complete list. Remove or add relevant documents as necessary.

Table A4-1 . Other QA Planning Documents that have Relevant Requirements

Document Title	Directive #, DCN, or Revision	Effective Date	Pertinence to this QAPP
SOP			SOP to be followed during sampling
ORD QAPP			QAPP for second phase of work
U.S. EPA Quality Assurance Project Plan Standard		July 18, 2023	QAPP developed in accordance with
U.S. EPA Records Management Policy	CIO 2155.5	June 9, 2020	Records managed in accordance with
U.S. EPA Region 3 Quality Management Plan	R3QMP001-20200601	June 1, 2020	QAPP developed in accordance with
U.S. EPA Region 3 Standard Operating Procedure: Personnel and Training	R3FAP001-02072017	February 7, 2017	Field SOP to be followed
U.S. EPA Region 3 Standard Operating Procedure: Document Control	R3FAP002-02072017	February 7, 2017	Field SOP to be followed.
U.S. EPA Region 3 Standard Operating Procedure: Records Management	R3FAP003-02072017	February 7, 2017	Field SOP to be followed.

Document Title	Directive #, DCN, or Revision	Effective Date	Pertinence to this QAPP
U.S. EPA Region 3 Standard Operating Procedure: Sampling and Environmental Data Management	R3FAP004-02072017	February 7, 2017	Field SOP to be followed.
U.S. EPA Region 3 Standard Operating Procedure: Field Documentation	R3FAP005-02072017	February 7, 2017	Field SOP to be followed.
U.S. EPA Region 3 Standard Operating Procedure: Field Equipment	R3FAP006-02072017	February 7, 2017	Field SOP to be followed.
Sample Submission Procedures for the U.S. EPA Region 3. U.S. Environmental Protection Agency, Region 3, Laboratory Services and Applied Science, Laboratory Services Branch: Fort Meade, MD.	Revision 15	August 22, 2019	Lab SOP to be followed.
U.S. EPA Region 3 Laboratory, Ft. Meade, Maryland Analytical Request Form Instructions (ARF 2.1)	Version: 04/01/2021	April 1, 2021	Lab SOP to be followed.

A5. Project Task Description

- Include
  - all project tasks/ work to be performed.
  - schedule for accomplishing the tasks.
  - products to be produced.
- If relevant, identify any known time constraints (e.g., project completion deadlines, unchangeable deadlines for particular phases, seasonality issues that influence when you want to collect data).

Table A5-1. Task Schedule and Products

Task	Schedule	Product
Planning	Month Day, 2024 – Month Day, 2024	QAPP
Testing equipment, preparing supplies and safety plan		Readiness Review, Field Work Control Plan
Field Sampling of X		Data
Processing of Samples		Data
Reviewing & Compiling existing data		Data
Analyzing of Laboratory Samples		Data
Running Data Analysis		Data
Drafting Report		Draft report with review comments
Finalizing Report		Final Report
Completing all documentation and records activities		Final Project Record Package

A6. Information/Data Quality Objectives and Performance/Acceptance Criteria

This element describes quality specifications at two levels:

1) at the level of the decision or study question (Quality Objectives)
2) at the level of the information/data used to support the decision or study question (Performance/Acceptance Criteria).

Data Quality Objectives

Describe the project's information/data quality objectives [how "good" the data (data quality) need to be to support the scientific conclusions and/or decisions for your project], e.g., determine the level of sensitivity you must achieve to assess whether samples meet regulatory criteria or the project's action limits.

Identify how the data will be used to support the project's objectives.

- What *TYPE* of data are needed?
- *WHO* will use the data?
- *WHAT* will the data be used for? For example, data collected will be used to:
  - compare with
    - previous sampling or analytical efforts
    - a regulatory standard
    - historical studies
  - create a geospatial map and database or decision tool from existing data
  - develop a model that performs accurately and precisely to satisfy regulatory or scientific objectives.
    - accurately characterize an environment, e.g., waterbody, soil, local air quality, biological assemblage, contaminated site, etc.
    - ascertain if there is a threat to public health or the environment.
    - locate and identify potential sources of contamination to formulate remediation, treatment, or disposal options., or verify attainment of clean-up goals.
  - HOW MUCH data are needed?

The data areas are *TYPE* X, Y, and Z. *WHO* will use the data to *WHAT*. *HOW MUCH DATA* are needed. Organization recognizes the importance of ensuring that data are of sufficient quality to meet the needs of the project. Organization is committed to collecting primary data and obtaining existing data of the highest quality possible within the constraints of project resources. All data used for analysis will be reviewed first using the quality procedures outlined in this QAPP. The involved Laboratories will follow their internal quality procedures and perform all necessary quality assurance as required for each parameter's method. QAQC data will be reviewed and reported in the final report and will be considered in data analysis as appropriate.

Performance and Acceptance Criteria

Provide performance[6] and acceptance[7] criteria to achieve those quality objectives.

Performance Criteria

The performance criteria that the data will need to achieve to minimize the possibility of either making erroneous conclusions or failing to keep uncertainty in estimates to within acceptable levels based on the quality objectives include:

Field and lab quality requirements- as discussed throughout this QAPP
Detection limits- Table X: Parameters and Methods shows that the detection limits meet or are below the applicable regulatory limits for this project (Table X: Regulatory Limit).
Data Quality Indicators, as outlined below.

Acceptance Criteria

Existing data to be collected for this project, their intended uses, and their limitations/acceptance criteria are described in Table A6-1. When appropriate, data will be uploaded or manually entered into the project database using the same quality protocols described for primary data.

Table A6-1. Existing Data

Existing Data Type	Source	Intended Use	Limitations/ Acceptance Criteria
Hydrological data	USGS Website- Water Data for the Nation https://waterdata.usgs.gov/nwi	To provide hydrological data for a site if needed	USGS's website notes on the stream gage's page when data are provisional and subject to revision until they have been thoroughly reviewed and received final approval. USGS's website also may indicate data quality for periods of time or certain parameters in the site's "Remarks". Data users should note in metadata upon data submission if the data is marked as provisional or has other QA notes on the USGS website. Additional follow-up to the

[6] Performance criteria address the adequacy of information that is to be collected for the project. These criteria often apply to new information collected for a specific use.

[7] Acceptance criteria address the adequacy of existing information proposed for inclusion in the project. These criteria often apply to information drawn from existing sources.

Existing Data Type	Source	Intended Use	Limitations/ Acceptance Criteria
			website should occur to determine if there are any status changes to the data.

Data Quality Indicators

Data quality indicators (DQIs) are important in determining total measurement and sampling uncertainty, and thus assist in determining if performance (and acceptance) criteria were met for quality objectives. The DQIs are precision, accuracy, representativeness, comparability, completeness, and sensitivity.

For ALL data areas/parameters: Address the 6 data quality indicators (DQIs)- Precision, Accuracy/Bias, Representativeness, Comparability, Completeness, and Sensitivity.

Precision[8]

- Field and Lab duplicates (e.g., 1 duplicate/20 samples or duplicates of 10% samples (and at least one per sampling event))

The site will be sampled in duplicate during the project for water chemistry, biological sampling and continuous sensors (where possible) at a rate of 1 duplicate/20 samples (and at least one per sampling event). The precision for equipment is listed as resolution in Table A6-2. The Laboratory will follow quality control processes (e.g., duplicates) as required for the individual analyses by their quality system. See section B4, QC Statistics, for the formula of relative percent difference (RPD).

Accuracy (Bias)[9]

- Field blank (1 blank/matrix/day or 1 blank/20 samples/matrix, whichever is more frequent)
- Rinsate/Equipment Blank (1 blank/matrix/day or 1 blank/20 samples/matrix, whichever is more frequent) if relevant.
- Accuracy of any data collection equipment, e.g., temperature sensors will have a minimum accuracy of ±0.5°C

[8] Precision is the measure of agreement among repeated measurements of the same property under identical or substantially similar conditions.

[9] Accuracy (Bias) is a measure of the overall agreement of a measurement to a known value.

- Percent recovery is an assessment of the accuracy of laboratory analytical methods (see section B4, QC Statistics).

Field blanks will be collected for water quality samples at a rate of 1 blank/matrix/day or 1 blank/20 samples/matrix, whichever is more frequent. These blanks will contain pure water and the appropriate preservatives (e.g., nitric acid, sulfuric acid, or none). The Laboratory will follow quality control processes (e.g., spikes, blanks) as required for the individual analyses by their quality system. The Laboratory will calculate percent recovery as an assessment of the accuracy of laboratory analytical methods (see section B4, QC Statistics).

Representativeness[10]

- sample design and collection represent site conditions, e.g., sample location, container rinsing/sterility.
- ensuring that a temperature blank sample is in each cooler of samples that has a temperature requirement associated with its preservation (see Table B2-1)

Sample design and procedures identified in the QAPP were chosen to optimize the potential for obtaining samples that reflect the true state of the environment, within practical limits. Deployed equipment will be placed using best professional judgment to ensure the recorded data will represent site conditions at the desired depths and location. The water quality and biological samples will be taken at the prescribed locations in the protocol to ensure they represent the site. The general water quality containers and sampling apparatus will be rinsed 3 times with site water prior to collecting the samples unless noted otherwise in the protocol.

Comparability

Ensure data are in correct units and comparable methods, e.g., nutrients as nitrate or total nitrogen, dissolved vs. total.

Discuss any variables that may affect variability, e.g., timeframe, season, weather, different equipment, etc.

All data from historical studies, recorded from the field meter, and received from the laboratory will be checked to ensure they are in common units. A record of the laboratory methods used will be kept for each parameter to ensure comparability across space and time. All biological samples will be collected and processed using the prescribed protocols. Any deviations will be noted and considered during data analysis.

[10] Representativeness is defined as the measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Completeness[11]

How much data is required to meet Quality Objectives, e.g., what % of data do you need to have to evaluate results for your purpose?

Optionally may include samples will be checked for completeness by assuring they are preserved appropriately and met holding times (can reference laboratory parameters table in latter section), labeled properly, and shipment coolers include Temperature Blanks (1/cooler).

At this time, no sampling locations have been deemed more critical to the overall project goal than any other. All samples will be properly labeled with the parameter, station, time, sampler, type (e.g., grab sample), and any preservative used. All sample containers will be filled fully and preserved appropriately according to the methods. All water quality samples will be preserved and/or chilled/frozen according to their method. Temperature blanks will be shipped in each cooler of samples that has a temperature requirement associated with its preservation so they can be tested upon laboratory receipt to ensure the temperature is =/<6º C. Samples will be shipped in sufficient time for the laboratory to process them before the holding times expire. Any notes will be made if a sample cannot be taken due to weather or other unforeseen circumstances.

Due to a variety of situations, all samples scheduled to be collected might not be (e.g., a storm may prohibit sampling, etc.) or the data from the samples cannot be used (e.g., sample bottles were broken in transit, sample holding times were grossly exceeded, etc.). The completeness goal is 90% for each analytical parameter and field measurement type (see section B4, QC Statistics, for the formula). If the completeness goal is not met, the Project Manager and QAM will decide next steps, and sampling or analysis will be conducted again if necessary and possible.

Sensitivity[12]

- Ensure the method detection limits/reporting limits are sufficient for Quality Objectives (e.g., detection limits are lower than the regulatory standards being looked at for the project)
  - Lab samples- can reference parameters table that has detection limits in latter section.
  - Equipment- may include resolution (e.g., 1 µS/cm) and range (e.g., 0 to 10,000 µS/cm).

[11]Completeness is a measure of the amount of valid data obtained from a measurement system, expressed as a percentage of the number of valid measurements that should have been collected (i.e., measurements that were planned to be collected).

[12] Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. The term "detection limit" is closely related to sensitivity and is often used synonymously.

The standard R3 LSASD Laboratory's method detection limits/reporting limits are sufficient for this project as found in their *Sample Submission Procedures for the Laboratory and Technical Services Branch (LTSB) Laboratory Section*, Revision 16; June 8, 2022.

The equipment used also meets the required limits for the project's environmental conditions and regulatory requirements as seen in Table A6-2.

Optional

This table is an example. Modify contents as relevant.

Table A6-2. Equipment Specifications

Equipment	Conductivity Range	Conductivity Accuracy	Conductivity Resolution	Temperature Range	Temperature Accuracy	Temperature Resolution
Equipment X	0-100,000 µS/cm	±0.5% of reading + 1 µS/cm	1 µS/cm	-5°C to 60°C	0.1°C	0.1°C
Equipment Y						

A7. Distribution List

Include all individuals and their organization affiliation who shall receive copies of the approved QAPP and any subsequent revisions.

- Project / Operations Manager
- Quality Assurance Manager
- Other personnel involved in environmental information and quality operations for the project, as well as contractors, subcontractors and grantees in key operations and quality roles, if applicable.

The following individuals in Table A7-1 will receive a copy of this QAPP and any subsequent revisions. A complete copy of the original version and all revisions of the QAPP shall be maintained in the organization's files by the Project Manager and made available to approval authorities upon request. The project roles listed in Table A7-1 are detailed in Section A8.

Table A7-1. QAPP Distribution List and Project Roles

Name	Project Role	Organizational Affiliation
	Senior Manager	
	Delegated Approving Official	
	Project/Operations Manager	
	Scientist	
	Scientist	
	Quality Assurance Manager (QAM)	
	Contractor	
	Contractor	
	Laboratory Sample Coordinator	
	Principal Data User	

A8. Project Organization

For every role listed in Table A7-1, describe responsibilities. Roles that must be included are:

- The approval authority for the QAPP=EPA Region 3 Delegated Approving Official (DAO)
- Senior manager having authority for the organization/group conducting the environmental information operations.
- Project Manager
- Project QAM
  - Individual responsible for maintaining the QAPP, which may be a role listed under QAM or Project Manager instead.
- Operations and quality staff conducting or supporting project operations (e.g., field scientists, laboratory sample coordinator)
- All contractors, subcontractors, or sub-grantees supporting project operations.

- Internal or external principal environmental information or data users

Each staff member is individually and ultimately responsible for understanding and adhering to the quality and operation procedures they perform, and for the quality of the data they collect or produce. The responsibilities of personnel involved in project implementation are enumerated below.

The Senior Manager, who has leadership authority for the project, will be responsible for the following activities:

- Oversee resource allocation.
- Review and internally approve the QAPP and any other relevant documentation (e.g., health and safety plan)

The Delegated Approving Official (DAO) has the responsibility to:

  - Be knowledgeable of EPA requirements for QAPPs and other equivalent QA documents.
  - Follow the quality document review process outlined in the US EPA Region 3 Quality Management Plan (QMP)Acquire DAO certification as outlined in the QMP.
  - Not approve QA documents they authored or prepared, or for projects/programs they manage.

The Project Manager(s) will:

- Conduct outreach with potential participants, data users, and stakeholders.
- Ensure all project personnel are properly trained and/or have the skills to fulfill assigned project tasks.
- Submit Analytical Request Form (ARF) to Laboratory Sample Coordinator.
- Conduct a readiness review prior to any data collection step, including completing any relevant health and safety plans and acquiring collection permits or other permissions as applicable, and ensuring all equipment and supplies are sufficient.
- Oversee participation, data collection, and data analysis tasks, ensuring all protocols and this QAPP are followed during sampling and other operations.
- Authorize all changes or deviations in the operation of the project, including management and implementation of any corrective actions.
- Issue reports as applicable, including preparing a summary of any data quality issues.
- Retain project records according to applicable Agency policy.
- Review and approve QAPP and any other relevant documentation.
- Distribute final QAPP and any subsequent revisions.
- Maintain and amend this QAPP as necessary and notify QAM.

The Scientists will be responsible for:

- Reading and being very familiar with this QAPP and the related standard operating procedure(s) (SOPs) or methods for any operation they perform.
- Ensuring they are properly trained and/or have the skills to fulfill assigned task.
- Identifying and reporting to the Project Manager any emerging/unanticipated problems, data anomalies, or other project/data issues.
- Annotating the related SOPs for any activity they perform if necessary and permanent changes arise or authoring new SOPs if a gap exists.
- Recording, entering, verifying, and validating data as outlined in this QAPP.
- Maintaining data and retaining project records in conjunction with the project manager and in accordance with applicable Agency policy.

The Quality Assurance Manager (QAM) will be responsible for the following activities:

- Reviewing QAPP
- Assessing effectiveness of the QAPP.
- Discussing any corrective actions or other quality issues with Project Manager and any relevant staff as applicable.
- As necessary, discussing quality-related issues with their organization's senior manager, even if outside of their direct supervisory chain.

The Principal Data User will need to:

- Communicate early in the project with Senior or Project management about any specific needs and objectives.
- Read reports or other documentation to understand any quality concerns, e.g, any limitations to data use, flags on lab data, etc., before using information/data.

A9. Project Quality Assurance Manager Independence[13]

Describe how the Project QAM's independence is ensured. The Project QAM is not required to be independent of senior management who are nominally, but not functionally, involved in operations.

The Project QAM shall be independent of environmental information operations. This independence will be ensured by the QAM not participating in any environmental information collection activities outside of their role of quality oversight, e.g., the QAM will not collect data but can conduct assessments in the field. The Project QAM is not required to be independent of senior management who are nominally, but not functionally, involved in operations. The Project Manager

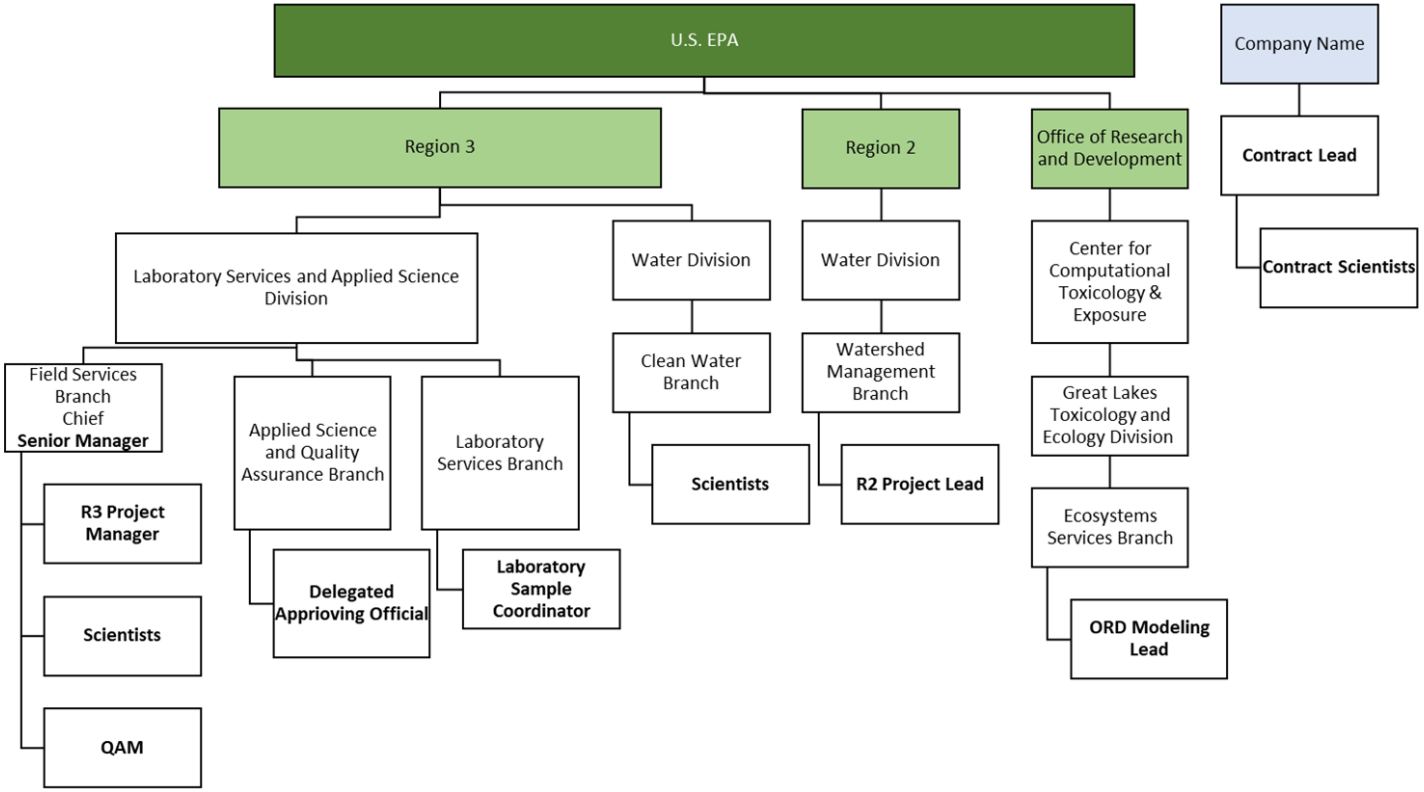
[13] Non-EPA Organizations: The two functions, QA and operations, must remain independent; however, in small organizations outside of EPA and EPA contractors (e.g., small tribal departments), these two functions may be combined with approval from the EPA R3 QAM.

or designee will not have authority to sign QAPPs for the QAM or designee, nor will the QAM or designee have authority to sign QAPPs for the Project Manager or designee.

A10. Project Organization Chart and Communications Project Organization Chart

Show all organizations responsible and involved in the project. Modify chart as necessary. Lines of authority are shown in the organization chart. Lines of authority are shown in the organizational chart. Project roles are bolded black.

Figure A10-1. Project Organization Chart



Communication[14]

To ensure that users of the QAPP understand the processes and responsibilities when communication is necessary:

- Discuss lines of communication and timing.
- Can do optional table also. Example below.
- Describe or cite the standard procedures for communications to include elevating discrepancies and QAPP non-conformances; process improvements; and seeking concurrence and approvals between project personnel, and/or between contractors.

Project communication is detailed in Table A10-1. Region 2 will communicate with the contractor, but the Region3 Project Manager will communicate with all other leads and personnel involved in operations. EPA project personnel will have access to the project's Microsoft Teams site. As soon as they are aware and within one business day, all project personnel will raise discrepancies, QAPP non-conformances, and process improvements to the Project Manager. After consulting with the QAM and Senior Manager if needed, the Project Manager gives final approval on any changes, notifies the affected members of the project team, and saves relevant documentation in the project folder.

Table A10-1. Communication Pathways

Communication Driver	Responsible Entity	Procedure (timing, pathway, etc.)
Manage field project phase	R3 Project Manager	The R3 Project Manager will inform the scientists about all field activities and any other pertinent project information.
Manage modeling project phase	ORD Project Lead	The ORD Project Manager will inform the modeling scientists about all modeling activities and any other pertinent project information.
Report contractor activities to EPA Project Manager	Contractor's Lead	All materials and information about the project will be forwarded to the EPA Project Manager. At a minimum, regular updates will be given once a month.
Reporting Lab Data Quality Issues	Lab Point of Contact	The lab will communicate any issues in the data report.

[14]Non-EPA Organizations: Shall also describe communication procedures to EPA to include elevating discrepancies and QAPP non-conformances.

Communication Driver	Responsible Entity	Procedure (timing, pathway, etc.)
Issues encountered in field or with data analysis	Scientists	Scientists will communicate any issues or deviations from the QAPP to the Project Manager within one business day of that activity.
Corrective actions for field`1 activities and data analysis	R3 Project Manager and QAM	The R3 Project Manager, in coordination with the QAM, will determine the need for corrective action for field and analytical issues and communicate those to affected staff as soon as possible.

The Region 3 Project Manager will be the communications champion for any communications outside of the project team. Landowners will be contacted by phone, then mail, if necessary, to seek approval to access their property. A one-pager on the project will be developed for landowners or public that approach field personnel wanting more information. It may contain:

1) Who to contact for more information?
2) Why is EPA doing this project?
3) What is the goal of the project?
4) How does this project help EPA meet its mission to protect public health and the environment?
5) Who will be involved and/or impacted by the research (Federal Agencies, Community Groups, Local Government) and how will this research inform their decision making?
6) If applicable, what is a specific key messages for targeted group(s)?

A collector's permit will be obtained from Agency, which also is considered notification to the State/entity of sampling in that area.

If public health issues/impacts are anticipated or detected for this project, answers to the following questions optionally may be included in this section to help all personnel understand the process if asked:

- What are the potential issues/impacts?
- What entities will be notified (public, federal, state, tribal, etc.)?
- Who will be responsible for notifying and coordinating with the entities?
- Who specifically will be notified in the entity?

A11. Personnel Training/Certification[15]

- Identify the individual responsible for ensuring personnel conducting operations are qualified, trained, and experienced.
- List any specialized training or certifications needed by personnel to successfully participate in the operations. Training may include on-the-job training as well as training on internal procedures.
  - how the training will be provided
  - how the necessary skills will be assured.
- procedure and responsible individual to document training records and skill evaluation
- Do not state a specific persons' educational background (e.g., Jane Doe has a PhD); detail what training and/or experience is needed for the person in that project role to perform the task(s) properly, e.g., .certification for Annual EPA Method 9 (Smoke School), biological taxonomic identification, etc.

The Project Manager is responsible for ensuring that all scientists involved with data generation have the necessary training to successfully complete their tasks and functions. The Project Manager will document attendance at any training sessions. An experience sampler, as determined by X, will be present during all sampling. All project members must be familiar with the protocols. Any unknown procedures will be reviewed in the office and/or field prior to sampling.

Optional:

Can include a table with the specific trainings.

Table A11-1. Trainings

Project Function	Training Title / Description	Delivery Method	Training Date or Frequency	Trainer	Trainees

[15] • EPA-specific: For field activities, reference all Personnel and Training requirements identified in the current version of the EPA Quality Assurance Field Activities Procedure (QAFAP). Example language: For the field activities, all Personnel and Training requirements identified in the current version of the EPA Quality Assurance Field Activities Procedure (QAFAP) will be followed. This information is also in the most current version of EPA Region 3's Standard Operating Procedure (SOP) Personnel and Training [2017, DCN # R3FAP001-02072017].

A12. Documents and Records[16]

- Itemize the information and records that will be part of the project.
- Describe or reference the management of the documents and records, including the QAPP [Note: Management of project information/data is covered in B7 Environmental Information Management.]
- Include or reference all applicable requirements for the final disposition of records and documents, including location and length of retention period.

Project-Specific Documents and Records

Project records will be managed in accordance with the current EPA policies. The Project Manager will be responsible for saving electronic files on the shared drive to ensure they are automatically backed up. Hard copy records will be filed in location and scanned to be saved electronically in the project folder. Documents and records will include, but not limited to:

Modify as needed.

1) QAPP (including amendments and revisions) and documentation of any deviations from QAPP.
2) Training records
3) Sampling permit
4) Landowner permission documentation
5) Field forms
6) Photos
7) Final sample results
8) Data analyses
9) Assessment results, corrective action(s), and any quality issues
10) Reports
11) Receipts for purchasing supplies/equipment.
12) Equipment calibration and maintenance logs
13) Biological taxonomic identification sheets

QAPP Preparation and Distribution

This QAPP conforms to the format described in the U.S. Environmental Protection Agency publication Quality Assurance Project Plan Standard [Directive No: CIO 2105-S-02.0]. The QAPP shall always govern the operation of the project and must be accessible during operations.

[16] EPA-specific: For field activities, include or reference all Document Control and Records Management requirements identified in the current version of the EPA QAFAP.

Each responsible party listed in Table A7-1 shall adhere to the procedural requirements of the QAPP and ensure that subordinate personnel do likewise.

This QAPP shall be reviewed at least annually to ensure that the project will achieve all intended purposes. In addition, it is expected that ongoing and perhaps unexpected changes may need to be made to the project. Project Managers, QA Staff and other applicable personnel in Table A7-1 shall participate in the review of the QAPP. The Project Manager(s) shall authorize all changes or deviations in the operation of the project. The review and any revisions will be documented. If significant changes need to be made, the QAPP will be sent to the DAO again for approval. Examples of significant revisions include changes in:

1) the scope of the project resulting in new or revised objectives
2) implementation such as how information will be collected, produced, evaluated, or used
3) the design, construction, operation, or application of environmental technology
4) the statement of work or workplan for extramural agreements
5) expiration of the QAPP
6) the organization's mission or structure, such as in the delegation status of QAPPs
7) performance criteria as to how results will be assessed for acceptance.

The Project Manager will document the effective date of all changes made in the QAPP and distribute revised versions to all individuals listed in Table A7-1.

Field Documentation

To thoroughly document field activities, dedicated bound logbooks (or electronic equivalents), checklists, forms, electronic devices and/or other field documentation methods must be used for field data collection including, but not limited to, sampling, measurements, and observations.

This section below is EPA-specific but external entities can also choose to follow or may be instructed to follow by the respective EPA program.

For field operations, all document control and records management requirements identified in the current version of the EPA QAFAP will be followed. This information is also in the most current versions of EPA Region 3's Standard Operating Procedures (SOPs*) Document Control* [2017, DCN # R3FAP002-02072017], *Records Management* [2017, DCN # R3FAP003-02072017], and *Field Documentation* [2017, DCN # R3FAP005-02072017].

The following requirements are included in these SOPs and apply to all field documentation:

1) For project-generated documentation (e.g., QAPP, field forms), the project 's unique identifier (number(s) and/or name) and sequential page numbers, incorporating both the current page number and the total number of pages (e.g., "page x of y"), must be on each page.
2) Field documentation shall include:
   a) Name and location of project
   b) Team members present.

c) Dates and time of field work
d) Measurement/sampling identification and collection method.
e) Calibration information if applicable.
f) Maps/sketches if relevant
g) Conditions that may adversely impact the quality of measurements/samples, if applicable (for example, rain, wind, smoke, dust, extreme temperatures, etc.)

3) Unless prohibited by environmental conditions, pens with permanent ink must be used to record all data. When environmental conditions or preservatives such as ethanol do not make it feasible to use permanent ink, entries should be made using a non-smear pencil. Pencil entries should be made permanent as soon as possible after the original entry, e.g., through photocopying, imaging, or equivalent means, and shall be added to the project file.
4) Data or other information that has been entered incorrectly must be corrected by drawing a single line through the incorrect entry and initialing and dating the correction. Under no circumstances should the incorrect material be erased, made illegible, or obscured so that it cannot be read.

Storage

While the project is underway, project information will be stored in a central filing cabinet at organization location, and on the organization's secure computer network, according to the organization's data management plan/standard policy. Upon completion of the project, paper records and electronic media (e.g., CDs) will be retained for x years at organization location. Electronic records will be stored for x years on the organization's main computer network and at a secure off-site location. Details of the records schedule, as outlined in EPA Records policy, is shown in Table A12-1.

Table A12-1. Records Schedule and Disposition

Modify table as necessary.

Record Type and Closure	Schedule	Items	Disposal
Project Records Close when activity, project, or topic is complete	1035 Title: Environmental Programs and Projects	**Item a -Historically significant,** e.g., assess ongoing threats to human health and the environment, document significant actions, contribute new and advanced technologies/methodologies that have continuing value beyond EPA's use. **Item b- Ongoing Operational Value**	**Item a:** Permanent, Transfer to the National Archives 15 years after file closure. **Item b**- Destroy 20 years after file closure.

Record Type and Closure	Schedule	Items	Disposal
		not required for the history of project but have operational value throughout the life of the project, e.g., scientific research project files, methodology, QAPPs, raw data, laboratory notebooks, correspondence, data collection media, interim and final reports, quality assurance assessments. **Item c- Routine**, e.g., SOPs, sampling and analytical data files **Item d- Short-term** not considered essential for ongoing management of the project, e.g., drafts of interim progress reports; equipment notebooks or logs for calibration, maintenance, and inspection	**Item c-** Destroy 10 years after file closure. **Item d**- Destroy 5 years after file closure.
Enforcement Support Close when activity, project, or <u>case</u> is complete.	1044 Title: Compliance and Enforcement	**Item a**- Historically significant, e.g., Environmental Impact Statements, Development and enforcement of standards by states **Item b**- Long-term **Item c**- routine, e.g., credentials, action files **Item d-** short term, e.g., field notebooks	**Item a**- Permanent, Transfer to the National Archives 15 years after file closure. **Item b**- Destroy 20 years after file closure. **Item c**- Destroy 10 years after file closure. **Item d**- Destroy 5 years after file closure.

Record Type and Closure	Schedule	Items	Disposal
Equipment/ Supplies Purchases (Close after completion or when no longer needed); OR Contracts (Close when activity or contract completed/ terminated)	1004 Title: Acquisitions and contracts	Item b- Routine acquisitions and contracts, e.g., contract management, acquisition of goods or services, receipts Item d- Purchase card logs and supporting documentation	Item b- Destroy 6 years after file closure. Item d- *Destroy 3 years after file closure.*

B Implementing Environmental Operations

In the Group B Section, if the Standard Operating Procedures (SOPs) and/or referenced materials are well documented and readily available to all key personnel, citations may be adequate; however, because weblinks may change over time, one current, controlled version of the referenced documents (such as pdf) should be placed in the project file and made available for routine referencing when needed.

B1.Identification of Project Environmental Information Operations[17]

Describe what operations will be conducted for the project (NOT 'How'- that is described in section B2).

- how they will satisfy the project purpose, and the quality objectives already outlined
- Sample locations
  - optional map
  - optional table of site/sample IDs with lat/longs
  - if sample locations are not known in advance, discuss how the sites will be chosen in the field.
- frequency of sampling at each location
- matrices to be sampled.
- environmental parameters of interest in each matrix
- any design assumptions or what to do if sampling becomes inaccessible (e.g., no sampling for x number of days after storm event, defined as "X" inches of rain after "Y" number of dry days)
- any phases, seasonality, etc.

Optional Table

Table B1-1. Sampling Components

Component/Matrix	Parameter(s)	# of Samples or Measurements	Frequency	Equipment
Sediment Characterization	Grain Size, Density, and TOC	100	At each site every month	Ponar Sampler

[17] EPA-specific: Field operations will be conducted in accordance with U.S. EPA Region 3 Standard Operating Procedures: Sampling and Environmental Data Management, DCN R3FAP004-02072017 and if applicable, Field Inspections and Investigations, DCN R3FAP007-02072017.

Component/Matrix	Parameter(s)	# of Samples or Measurements	Frequency	Equipment
Surface Water Grab Samples	Nitrogen, Phosphorous, and Chlorophyll a	100	At each site every month	Bottleware
In situ Water Quality	Temperature, pH, Dissolved Oxygen, Conductivity, Total Suspended Solids	30 measurements per parameter	At each site every month	YSI Meter
Water Light Penetration	Light Penetration Water Depth	30	At each site every month	Secchi Disk [The same individual will read the secchi disc to reduce error.]
Water Depth	Bathymetry	10	Once at start of project's field activities	Echosounder and GIS
Water Depth	Bathymetry	30	Once at start of project's field activities	Vexilar portable depth finder
Water Depth	Bathymetry	30	Once at start of project's field activities	Boat depth finder
Geospatial	outfall locations, shoreline types, and the surrounding land use	NA	Once before start of field activities	GIS layers

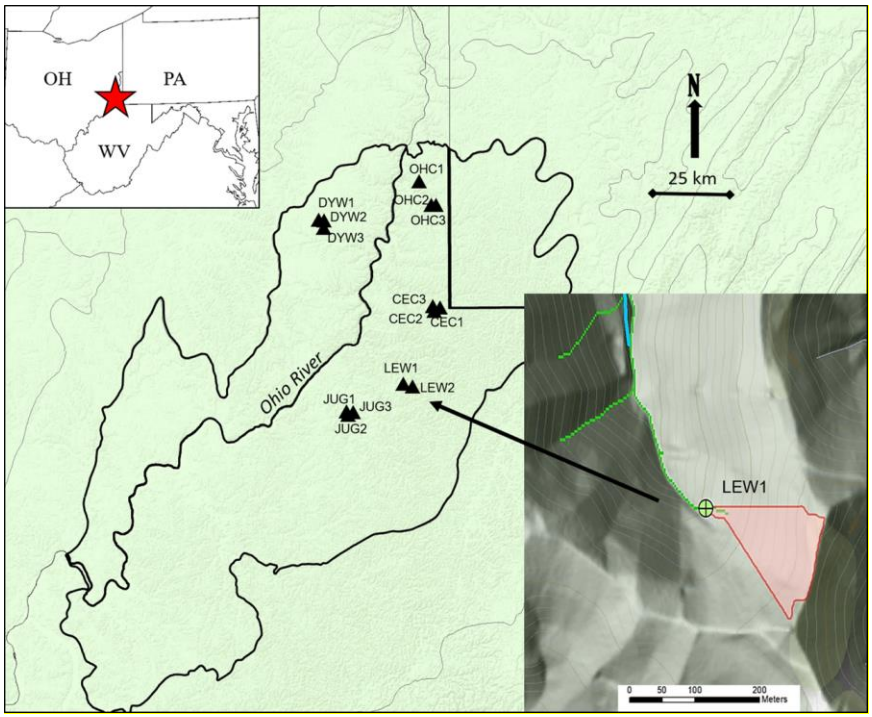
Component/Matrix	Parameter(s)	# of Samples or Measurements	Frequency	Equipment
Geospatial	Distance from shore	20	Once at start of project's field activities	Rangefinder and/or GIS

Table B1-2. Site Information 1

Site ID	Site Name, Description	Site Type	Latitude	Longitude

Map of site locations with one site enlarged to show example of stream drainage area in red.

Figure B1-1. Map of Sites



B2.Methods for Environmental Information Acquisition

Explain how primary data will be collected, processed, and analyzed by identifying data collection procedures and methods for EACH operation/matrix/parameter including as applicable, but not limited to

- Field Activities Environmental Measurements, derived from tools, instruments, observational results, investigations, and sample collection. Describe sampling methods as applicable, including:
  - Specific procedures
  - Sequencing of samples
  - Sample containers, volumes, preservation and holding times (see Table B2-1))
  - How samples are to be homogenized, composited, split, or filtered
  - Equipment and support facilities needed and preparation steps
  - Decontamination and disposal of waste by-products
- Laboratory Analyses, (see Table B2-1)
  - Analytical methods by number/identifier, version/revision date and regulatory citation (if applicable)
    - Laboratory data package turnaround time needed, if important to schedule.
  - For non-standard method applications, appropriate method performance study information is needed. If previous performance studies are not available, they shall be developed during the project and included as part of the project results.
  - Existing Information

- Collection process for Existing Information as seen in Table A6-1.
  - If the information is to be combined with new environmental information, describe the criteria to ensure compatibility.
- Environmental Technology[18]
  - Identify whether the technology is primarily for pollution prevention, contamination containment, storage, or remediation.
  - Describe the physical parameters or processes collected using environmental technologies as well as the specific systems, devices, and their components applicable to both hardware and methods or techniques that measure and/or remove pollutants or contaminants and/or prevent them from entering the environment.

Reference SOPs as applicable with hyperlink or put in attachments. SOPs shall be available to personnel conducting the environmental information operations. Include:

- version/revision date of the SOP
- any modifications from the standard SOPs
- the specific option or equipment being used if the SOP has multiple selections.

[18] Environmental Technology includes systems, devices and their components applicable to both hardware and methods or techniques that measure and/or remove pollutants or contaminants and/or prevent them from entering the environment. Examples include but are not limited to:

• Pollution prevention: measurement, monitoring, reduction, control, and/or treatment processes, such as wet scrubbers (air), granulated activated carbon unit (water), filtration (air, water).

• Contamination: containment to prevent further movement of the contaminants, such as capping, and solidification or vitrification, and biological treatment.

• Storage containers, methods, or facilities, such as drums, tanks, and ponds or lagoons.

• Remediation processes and their components, and/or technologies, such as soil washing (soil), pump and treatment, soil vapor extraction (soil), land farming and other bioremediation processes

Table B2-1. Water Quality Parameters[19]

Parameter	Quantitation Limit	Method	Holding Time	Min. Volume	Container Type[20]	Preservative[21]
Boron	50 µg/L	200.7 Metals; ICP-AES	6 months	200 mL	Plastic	pH <2 HNO_3
Calcium	500 µg/L	200.7 Metals; ICP-AES	6 months	200 mL	Plastic	pH <2 HNO_3
Iron	100 µg/L	200.7 Metals; ICP-AES	6 months	200 mL	Plastic	pH <2 HNO_3
Potassium	2000 µg/L	200.7 Metals; ICP-AES	6 months	200 mL	Plastic	pH <2 HNO_3
Magnesium	500 µg/L	200.7 Metals; ICP-AES	6 months	200 mL	Plastic	pH <2 HNO_3
Sodium	1000 µg/L	200.7 Metals; ICP-AES	6 months	200 mL	Plastic	pH <2 HNO_3
Manganese	2 µg/L	200.8 Metals; ICP-MS	6 months	200 mL	Glass or plastic	pH 2 HNO_3
Copper	30 µg/L	200.8 Metals; ICP-MS	6 months	200 mL	Glass or plastic	pH 2 HNO_3
Aluminum	1 µg/L	200.8 Metals; ICP-MS	6 months	200 mL	Glass or plastic	pH 2 HNO_3
Lead	1 µg/L	200.8 Metals; ICP-MS	6 months	200 mL	Glass or plastic	pH 2 HNO_3

[19] Containers needed per each sampling site (or for duplicate or blank):

- 1 500 mL plastic container – metals (both AES and MS) (pH<2 HNO3)
- 1 500 mL plastic container – anions (28 days) (cool, ≤ 6º C)
- 1 250- or 500-mL plastic container – anions (48 hrs.)- NO2, NO3, OP (cool, ≤ 6º C)
- 1 250- or 500-mL plastic container – anions (filtered)- soluble OP (filtered after collection & placed in another dry container, cool, ≤ 6º C)
- 1 L plastic container- TP, TN, NH3-N (pH<2 H2SO4, cool, ≤ 6º C)

[20] Plastic is Polyethylene)

[21] Do not allow to be frozen.

Parameter	Quantitation Limit	Method	Holding Time	Min. Volume	Container Type[20]	Preservative[21]
Zinc	2 µg/L	200.8 Metals; ICP-MS	6 months	200 mL	Glass or plastic	pH 2 HNO_3
Sulfate	0.25 mg/L	300.0 Anions by Ion Chromatography (IC)	28 Days	400 L	Glass or Plastic	Cool <6°C
Chloride	0.5 mg/L	300.0 Anions by Ion Chromatography (IC)	28 Days	400 L	Glass or Plastic	Cool <6°C
Fluoride	0.1 mg/L	300.0 Anions by Ion Chromatography (IC)	28 Days	400 L	Glass or Plastic	Cool <6°C
Bromide	0.5 mg/L	300.0 Anions by Ion Chromatography (IC)	28 Days	400 L	Glass or Plastic	Cool <6°C
Nitrite-N (NO_2)	0.05 mg/L	300.0 Anions by IC	48 hours	200 mL	Glass or Plastic	Cool <6°C
Nitrate-N (NO_3)	0.15 mg/L	300.0 Anions by IC	48 hours	200 mL	Glass or Plastic	Cool <6°C
Orthophosphate (OP)	0.25 mg/L	300.0 Anions by IC	48 hours	200 mL	Glass or Plastic	Cool <6°C
Soluble Orthophosphate	0.25 mg/L	300.0 - Anions by IC; Filtered in field with 0.45 µm filter	48 hours	200mL	Glass or Plastic	Cool <6°C
Total Nitrogen (TN) - digested	1 mg/L	353.2	28 Days	500 mL	Glass or Plastic	pH<6 H_2SO_4, Cool <6°C
Total Phosphorous (TP)	0.05 mg/L	365.4	28 Days	200 mL	Glass or Plastic	pH<2 H_2SO_4, Cool <6°C
Ammonia-Nitrogen (NH_3-N)	0.01 mg/L	SM 4500-NH_3 BH	28 Days	200mL	Glass or Plastic	pH<2 H_2SO_4, Cool <6°C

B3.Integrity of Environmental Information

Describe or cite procedures and requirements to ensure the integrity of the operations, such as sample handling and custody, to include but not limited to:

- field documentation
- packaging
- transport and/or shipment from the site
- storage at the laboratory
- sample labels example
- Chain of Custody (COC) forms example
- shipping protocols
- if laboratory involvement:
  - identify each laboratory to be used as well as the laboratory's current accreditation and/or certification for the applicable analytes and matrices.

Information/Data/Sample Handling

Unbound checklists and forms must remain in control of the operations lead, transferred to the Project Manager, and kept in the project file upon return from the field. Hard copy records will be scanned to be saved electronically in the project folder. See section *A12. Documents and Records* for additional information on field documentation handling.

Original digital images will not be modified. A photo log will be kept of all digital images with:

1) Description of what is in the image, including orientation, if appropriate.
2) Date and time taken.
3) Name of the photographer.

For sample tags, as shown in Attachment 2, the following information must be included using permanent non-erasable ink:

1) Project number
2) Unique identification or station number
3) Identification of sampler
4) Date and time of sample collection
5) Sample designation as grab or composite
6) Sample designation as preserved or unpreserved and identification of the preservative
7) The parameter to be analyzed.

The Chain of Custody (COC) documentation, as shown in Attachment 3, must include:

1) Site name that is recorded on the Laboratory Analytical Request Form (Project Name)
2) Analytical Request number (Project Number)
3) Sampler's name/signature
4) Sample ID (Station Number)

5) Date and Time of collection (recorded in 24-hour clock time)
6) Type of sample (grab or composite)
7) Sample description (Station Location)
8) Accurate number of containers
9) Parameters requested.
10) Preservation of sample
11) Sample tag/label numbers
12) Sample remarks (i.e., filtered for dissolved components, or if it is a field duplicate)
13) Date, Time and Signatures for sample receipt and transfer

Sample Transportation

Samples will be shipped via UPS overnight to the U.S. EPA Region 3 Laboratory in Fort Meade, MD following Sample Submission Procedures for the Laboratory and Technical Services Branch (LTSB) Laboratory Section, (most current version).

The steps to ship samples are to:

1) Select a sturdy cooler in good condition.
2) Complete the Chain of Custody, 1 per cooler. Retain a copy.
3) Complete a Hazard and Risk Exposure Data Sheet (Attachment 4) and attach to the OUTSIDE of each shipping container so that it is available for review by the laboratory before opening any coolers.
4) Line the cooler with a large heavy-duty plastic bag and put some ice in the bottom.
5) Place another large heavy-duty plastic bag in the cooler and place samples in there, ensuring samples are properly and securely placed.
    a) Be sure the lids on all bottles are tight (will not leak).
    b) Put electrical tape around lids if applicable.
    c) Ensure samples in the cooler are listed on the corresponding COC.
    d) Check each sample tag/label is secured to each container since they might loosen and fall off if the containers get cold or wet.
    e) Wrap any glass containers in bubble wrap and pack to minimize breakage.
6) Add a temperature blank (sample or small bottle with water) in each cooler. Ensure it is marked as temperature blank.
7) Seal the sample bag (compressing any air out) with a zip tie.
8) Add more ice on top of samples and then seal ice bag with a zip tie, ensuring melted ice water will not leak out.
    a) The loaded cooler must not be heavier than 50 pounds to allow for safe handling. Separate samples into multiple coolers if needed to keep the weight under 50 pounds.
    b) Ensure that the ice is fresh before shipment and use adequate amounts of ice to ensure samples will remain cold for up to 36 hours.
9) Place the COC Record and a return cooler label into a sealed plastic Ziploc bag and tape the bag to the inner side of the cooler lid.

10) Close the cooler and affix a signed custody seal to the lid.
11) Complete/print a priority overnight shipping label with all required info.
    a) Retain a copy of the tracking number.
12) Place the shipping label on top of the cooler and securely tape, with packing tape, the top of the cooler shut, ensuring tape goes over the custody seal and the shipping label to prevent it from falling off.
13) Ensure the package is shipped before the overnight deadline.
14) Notify the LTSB Sample Scheduling Coordinator as soon as possible when (1) samples have been shipped, (2) a scheduled shipment has been changed/canceled, or (3) there are changes in the number or types of samples.

Laboratory Certification/Accreditation

All laboratory water samples will be analyzed by the EPA Region 3 Laboratory at the Environmental Science Center, Fort Meade, MD (Region 3, Laboratory Services and Applied Science Division, Laboratory & Technical Services Branch). The EPA Region 3 Laboratory Sample Submission Process will be followed when submitting samples, which will help ensure field and laboratory aspects of the sampling are linked to produce reliable data of known quality. Analytical services provided by the R3 Lab are documented in their Laboratory Quality Manual. This manual describes the Laboratory's quality procedures, which are ISO 17025 accredited by A2LA accreditation body. The Laboratory also holds Drinking Water certification from the EPA Office of Water (Cincinnati) in inorganics, organics, and microbiology.

B4.Quality Control

Describe

- Quality Control (QC) activities needed for each operation to meet quality objectives and performance/acceptance criteria. Can be done in optional Table, see Table B4-1.
  - frequency of each QC activity
  - actions to be taken when problems occur.
  - responsible individual(s) for corrective actions and how this should be documented (e.g., lost samples, broken equipment, inaccessible sampling locations, etc.)
- Procedures to be used to calculate applicable statistics (e.g., precision and bias).
- For field and lab, possibly also the use of blanks, duplicates, matrix spikes, laboratory control samples, and surrogates.
- For existing data, possibly also the use of systematic review, independent secondary review of studies in the open literature, and QC of constructed databases or spreadsheets.
- For using models or modeling, possibly also model calibration, and model validation (sensitivity analyses).

QC Activities

Field datasheets are reviewed on site before departure to ensure no missing and/or questionable data. The Field Activities Review Checklist, Attachment 5, will be used by the Project Manager or QAM to ensure field data were collected appropriately and completely. Data transference is routinely checked and validated by scientists. Data entered into the computer will be routinely checked against the original data sheets with 100% verification. Errors caught during cross-checking will be flagged and corrected, to the extent possible, in consultation with data collection scientists. Data analysis will be checked to ensure it was conducted correctly. Other specific QC activities are described in Table B4-1.

The involved Laboratories will follow their internal quality procedures, e.g., duplicates, spikes, blanks, and perform all necessary quality assurance as required for each parameter's method. Laboratory quality data will be reviewed (see Attachment 6 for checklist) as part of the data package, considered in data analysis, and reported in the final report as appropriate.

Optional

Table B4-1. QC Activities

Operation	QC Activity	Frequency	Actions to Be Taken if Problems	Responsible Individual(s)	Communication Route

QC Statistics

Following the DQIs outlined in Section A6, the following QC statistics will be calculated.

Table B4-2. QC Statistics

Calculation	Formula	Abbreviations
Duplicate Precision	RPD = $\frac{(D_L-D_S)}{(D_L+D_S)/2} \times 100$	RPD = relative percent difference between duplicate determinations D_L and D_S = results for the duplicate values with D_L = larger of two observed values D_S = smaller of two observed values

Calculation	Formula	Abbreviations
Completeness	%C = V x 100 N	%C=percent completeness V =number of measurements judged valid N=target number of measurements necessary to achieve a specific statistical level of confidence in decision making
Laboratory Control Samples (accuracy)	% R = M x 100 T	%R=percent recovery M=measured concentration T=true spiked concentration
Laboratory Matrix Spike (accuracy)	% R = (S-U) x 100 T	%R=percent recovery S=measured concentration of spiked sample U=measured concentration of unspiked sample T=true spiked concentration

B5.Instrument/Equipment Calibration, Testing, Inspection, and Maintenance[22]

Detail

- Ensure that the instruments/equipment are available and in working order when needed.
- Ensure that calibration will be conducted, documented, and be traceable to the instrument.
- Availability of critical spare parts

Except for the laboratory, the project manager is responsible for ensuring instruments and equipment used for taking and handling samples are to be inspected, maintained, and cleaned according to manufacturer's recommendations. Extra batteries, chargers, and other critical spare parts will be packed for field activities. The laboratory will maintain their equipment according to their SOPs.

[22]EPA-specific: Equipment will be managed as outlined in the most current version of EPA Region 3's SOP Field Equipment [2017, DCN # R3FAP006-02072017]

Calibration of the field meter will be done the same week it will be used in the field and before the sampling occurs using appropriate standards. The dissolved oxygen probe will be calibrated on the day it is used and at the site to properly represent conditions due to changes in barometric pressure. Calibration standards will be traced using the manufacturer, the lot number, and the expiration date in the field logbook for the meter and the chemical inventory and management notebook. Continuous sensors will be compared to calibrated equipment if they can't be discreetly calibrated.

After sampling, equipment will be cleaned of aquatic plants, animals, and mud before leaving the site. On return to the office, all equipment will be rinsed and dried for 5 days before use again. If there is a need for a shorter turnaround, the equipment will be cleaned with a 10% bleach solution (1 part bleach per 9 parts water) for a minimum exposure time of 10 minutes and then dried for 48 hours.

Optional

Table B5-1. Equipment Maintenance and Calibration

Parameter, Instrument	Maintenance Schedule & Activity	Calibration Schedule & Activity	Calibration Criteria	Corrective Action	Person(s) Responsible
Temperature Sensor. Brand Multimeter, ID#0000	As needed and according to manufacturer's manual	Annual check of endpoints of desired temperature range (0° to 40°C) against a NIST thermometer.	±0.5°C of true value at both endpoints	Remove from use if doesn't pass criteria.	Project Manager or Designee
pH Sensor. Brand Multimeter, ID#0000	As needed and according to manufacturer's manual	Initial: two-point calibration bracketing expected field sample range (using 7.0 and either 4.0 or 10.0 pH buffer, depending on field conditions). Post-sampling each day: one-point check with 7.0 pH buffer	Initial: two-point calibration done electronically; one-point check (using 7.0 pH buffer) ± 0.1 pH units of true value. Post: ±0.5 pH units of true value of 7.0 pH buffer.	Recalibrate. Qualify Data	Project Manager or Designee

B6.Inspection/Acceptance of Supplies and Services

Describe

- how supplies and services[23] are inspected and accepted
- the individual(s) responsible for inspection and acceptance

Attachment 1 is an example of a Field Equipment and Supplies checklist that could be used.

All sample bottles will be inspected by the Project Manager or designee to ensure they are free of any contaminants. The Project Manager will use a checklist (see attachment 1) to ensure all items are available during sampling.

Contractor services will be reviewed as outlined in the Statement of Work for Contract #00000.

B7.Environmental Information Management

Detail

- Data management scheme, from generation (e.g., how will data be recorded in field), processing, compilation, and then final storage.
- How data will be analyzed (e.g., statistical methods, comparison to existing data)
- Mechanism for detecting and correcting errors and for preventing loss of information during data entry and reporting.
- Individuals responsible for elements of the data management scheme
- Any required computer hardware/software and any requirements for configuration
- Include examples of any checklists and forms.

Upon return to the office, the datasheets are scanned and submitted to the Project Manager by the scientists weekly and inspected. Hard copies of the original data sheets are kept on file in the Project Manager's office. Data generated by the Laboratory is sent via email to the Project Manager. As needed, the Project Manager will provide the field and/or laboratory data to the scientists for digital data entry.

Microsoft Access is used to record and organize all data. Once all data are entered, the Program Manager inspects the data for accuracy and corrects any errors, cross checking with calibration and QC logs to confirm successful sampling and data management.

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[23] Supplies may include but are not limited to spare parts for instruments/equipment, standard materials and solutions, sample bottles, calibration gases, reagents, hoses, deionized water, potable water, and electronic data storage media.

Services provided by vendors to include, but not limited to contractors, sub-contractors, and sub-grantees may include document development, performing environmental information operations.

All data entry and error correction activities are recorded in a set of documents prior to and immediately after any data management activity. Queries have been set up within Access to facilitate the analysis of data without risking any alteration to the master dataset. These queries will be used to compare the current data to historical existing data from the sites.

C Assessment, Response Actions, and Oversight

C1. Assessments and Response Actions

- Discuss how you plan to ensure that the project will be conducted as described in the QAPP.
- Describe the assessment activities (can reference section B4, Table B4-1):[24]
  - timeframe/frequency
  - person responsible
  - type, may include but not limited to:
    - audits, performance evaluations, management reviews, peer reviews, inspections, surveillances, readiness reviews (including competency assessment, pre-award assessment of proposal, or technical assessment), peer consultations, product reviews (e.g., data inspection, software testing, pre-dissemination reviews, or review of contractor deliverables).
- Identify who will be responsible for stop work orders, corrective actions, and follow up.
- Address how assessment findings, non-conformances, and corrective actions will be documented and communicated and by whom.

During the project, the Project Manager and QAM will assess the project's activities to ensure that the QAPP is being implemented as planned. The purpose is to help to ensure that everything is on track and serves to minimize learning about critical deviations toward the end of the project when it may be too late to remedy the situation.

The Project Manager will conduct a Readiness Review prior to each major primary data collection step and take corrective action (if any is necessary). Collection of primary data will not begin until the Project Manager certifies readiness. The Project Manager will meet regularly with project implementation staff to identify emerging/unanticipated problems and be responsible for stop work orders, corrective actions, and follow-up.

At least once annually, the QAM will assess the sample collection methodologies, field measurement procedures, and record keeping to ensure activities are being conducted as planned (and as documented in this QAPP). Any deviations that are noted will be corrected immediately to ensure all subsequent samples and field measurements collected are valid. If the deviations are associated with technical changes and/or improvements made to the procedures, the QAM will verify that the changes have been documented by the Project Manager and addressed in an amendment to this QAPP.

Optional

[24] Assessment is the evaluation process used to measure the performance or effectiveness of a system and its elements. Assessments may also be used as an investigative tool where problems may be suspected.

Table C1-1. Assessments

Type	Frequency	Project Phase(s)	Person(s) Responsible	Assessed Staff

C2. Oversight and Reports to Management[25]

- Describe the oversight activities that ensure that mechanisms are in place to capture the project status and any QA issues that arise.
- Identify reports (e.g., readiness review email memos, progress reports, final report, sampling permit report to state agency).

Documentation for assessment activities, corrective actions, etc. will be kept in the electronic project folder. Two kinds of reports will be prepared: progress reports, and final report. Progress reports will note the status of project activities, identify any QA problems encountered, and explain how they were handled. The final report will analyze and interpret data, present observations, draw conclusions, identify data gaps, and describe any limitations in the way the results should be interpreted. Reports that will be produced are outlined in Table C2-1.

Optional

Table C2-1. Reports

Type	Frequency	Timeframe	Transmission Route	Preparer(s)	Recipient(s)
Readiness Review Memo	Periodic	Before each major data collection step	Email	Project Manager	Scientists, QAM
Quarterly Progress Reports	Every 4 months	4 months after start date and ongoing	Email	Project Manager	All Project Personnel

[25] Non-EPA Organizations: Distribution shall include the Project Operations Manager, the Project QAM of the organization conducting the work, and the EPA organization sponsoring the work.

Type	Frequency	Timeframe	Transmission Route	Preparer(s)	Recipient(s)
Final Report	Once	At conclusion of project	PDF sent through email	Project Manager	Distribution List as seen in Table A7-1

D Environmental Information Review and Useability Determination

D1. Environmental Information Review

Describe

- information/data verification[26] and validation[27] activities to ensure that data meet requirements specified in this QAPP and relevant SOPs.
- any data quality assessment[28] activities. See Attachments 5 &6. Some other possible questions when reviewing data:
  - Were the DQIs met?
  - Is the quality of the data consistent across data?
  - Does the data meet the data quality objectives?
  - Integrity…is data compromised via corruption/falsification?
  - Were methods followed?
- responsible person and documentation of these activities.

During information/data review, verification, and validation, staff will be guided by the data quality criteria listed in A6 as well as any additional criteria discussed in B3-B7. All onsite analytical data will be reviewed against QAPP requirements. The Project Manager, scientists, and relevant staff will:

1) Ensure that all sampling and analytical methods or SOPs were followed.
2) Establish that all method required QC samples were run and met required limits.
3) Establish that all QAPP required QC samples were run and met required limits.

The Project Manager and QAM will review each laboratory data package's narrative report and summary tables to see whether the laboratory "flagged" any sample results based on poor or questionable data quality or exceedances of the laboratory's QC criteria.

Trained project staff will check for data anomalies (e.g., missing data, data that fall outside the range of the expected or plausible based on industry averages, non-standard environmental aspects/indicators, incorrect/non-standard units, incorrect reporting years, incorrect normalizing factors or bases of normalization, incorrect calculations, conversions, etc.). When possible, checking for data anomalies will be automated as part of the electronic data entry process. Data anomalies will be flagged and corrected, to the extent possible, in consultation with data collection

[26]Data Verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements.

[27] Data Quality Assessment is the scientific and statistical evaluation of data to determine if the data obtained from environmental information operations are of the right type, quality, and quantity to support their intended use.

staff and project manager(s). When data used for analysis are incomplete, the potential impact of their incompleteness on the analysis will be described in relevant reports.

If at any point during review, the Project Manager identifies a problem (e.g., the use of substandard data when higher-quality data are available, a faulty algorithm, a mismatch between a data set and the question it is meant to answer), the Project Manager, scientists and any relevant staff will discuss corrective action. If necessary, the Project Manager will issue a stop-work order until a solution is agreed upon. The Project Manager will implement corrective action. If the solution involves changes in project design, the Project Manager will amend the QAPP as necessary, pass it through quality review if necessary, and then re-distribute it to the Distribution List.

D2. Useability Determination

Describe or reference the process that will be used to determine whether the environmental information is useable, including:

- documentation
- individual(s) responsible
- communication of determination

Once all the data from the field and laboratory have been reviewed, the Project Manager and QAM will make an overall assessment concerning the final usability of the data (and any limitations on its use) in meeting the project's needs. Some steps of this assessment will include, but not necessarily be limited to:

1) Discussions with Scientists.
2) Review of deviations from the QAPP or associated SOPs to determine whether these deviations may have impacted data quality (and determining whether any impacts are widespread or single incidents, related to a few random samples or a batch of samples, and/or affecting a single or multiple analyses).
3) Evaluation of the field and laboratory results and QC information.
4) Review of any other external information which might influence the results, such as off-site activities in the vicinity, meteorological conditions (such as storm events proceeding sampling), etc.
5) Evaluation of whether the completeness goals defined have been met.
6) Examination of any assumptions made when the study was planned, if those assumptions were met, and, if not, how the project's conclusions are affected.

The final project report will contain an evaluation of the certainty of project results prepared by the Project Manager. For each conclusion reached by the project (i.e., each determination that an anticipated outcome has or has not been achieved, and the basis for each decision made or recommended by project authorities), this evaluation will describe, in narrative form: the quality of data and the methodologies used to inform the conclusion, the subsequent confidence in the conclusion, and the validity of generalizing results beyond the project.

References

See Table A4-1.

Attachments are Examples only and can be deleted/modified.

Attachment 1: Field Equipment and Supplies Checklist

Overall

- ☐ Waterproofed sheets
- ☐ Field clipboards
- ☐ Pencils, Ballpoint pens, & Permanent Markers
- ☐ GPS with extra batteries
- ☐ Digital camera with extra battery
- ☐ iPad
- ☐ Scientific Collecting Permit
- ☐ Site ID list
- ☐ QAPP
- ☐ Safety Plan
- ☐ Maps
- ☐ Flagging
- ☐ Compass
- ☐ Landowners contact info.

Habitat Assessment

- ☐ Thalweg poles
- ☐ Clinometer
- ☐ Densiometer
- ☐ Rangefinder
- ☐ Measuring tapes
- ☐ Gravelometers
- ☐ Collapsible shovel
- ☐ Collapsible rake

Macroinvertebrate Sampling

- ☐ D-frame net
- ☐ Sieve bucker
- ☐ Regular bucker
- ☐ Sampling bottles with caps
- ☐ Ethanol
- ☐ Forceps
- ☐ Labels
- ☐ Pencil and Permanent Marker

In Situ Water Chemistry

- ☐ Field Meter, & charger, manual, backup
- ☐ Calibration standards, waste container, and notebook

Grab Water Chemistry

- ☐ Wet ice
- ☐ Dry ice
- ☐ 50 1L bottles
- ☐ 25 500mL Bottles
- ☐ 3 Amber 2L bottles
- ☐ Blank DI water
- ☐ Nitrile gloves
- ☐ Nitric acid
- ☐ Sulfuric acid
- ☐ Safety glasses
- ☐ Acid waste container(s)
- ☐ Fine permanent marker
- ☐ Sample Labels
- ☐ Tape strips
- ☐ Filtering Supplies
    1. Capsule filters
    2. 45 µm filters
    3. Filter pump and backup
    4. Apparatus and stoppers
    5. Filter cup
    6. Tubing
    7. 12 Clean forceps
    8. Distilled water squirt bottle and refill water
    9. Graduated cylinder

Shipping

- ☐ Wet Ice
- ☐ Dry Ice
- ☐ Dry Ice shipping box & hazard label
- ☐ 2 large bags per cooler (outer for wet ice and inner for samples)
- ☐ Zip ties
- ☐ UPS Shipping bills and clear sleeves
- ☐ COC sheets and Ziploc bags
- ☐ Ballpoint pen
- ☐ ESC Environmental hazard sheet and clear sleeves
- ☐ Custody seal for coolers
- ☐ Packaging tape
- ☐ Scissors

Attachment 2: Sample Tags

Printable label format

Project Code: **# or Name**
Station No.: **SITEID**
Location or Site Name:_____
Designate: ☒ Grab-500mL Sampler:_____
Analyses: Preservative:
☒**ANIONS** ☒None (wet ice only)

Date (YYYY/MM/DD):_____Time: _____

Project Code: **# or Name**
Station No.: **SITEID**
Location or Site Name:_____
Designate: ☒ Grab-1L Sampler:_____
Analyses: Preservative:
☒**ALKALINITY** ☒None (wet ice only)

Date (YYYY/MM/DD):_____Time:_____

Project Code: **# or Name**
Station No.: **SITEID**
Location or Site Name:_____
Designate: ☒ Grab Sampler: _____
Analyses: Preservative:
☒ **CHLOROPHYLL A** ☒Frozen on Dry Ice
☒ Filtered, volume: mL

Date (YYYY/MM/DD):_____Time: _____

Project Code: **# or Name**
Station No.: **SITEID**
Location or Site Name:_____
Designate: ☒ Grab 1L Sampler: _____
Analyses: Preservative:
☒**TKN, NH_4, TPO** ☒**H_2SO_4**

Date (YYYY/MM/DD):_____Time:_____

Project Code: **# or Name**
Station No.: **SITEID**
Location or Site Name:_____
Designate: ☒ Grab-1L Sampler:_____
Analyses: Preservative:
☒**METALS, HARDNESS** ☒ HNO_3

Date (YYYY/MM/DD):_____Time:_____

Project Code: **# or Name**
Station No.: **SITEID**
Location or Site Name:_____
Designate: ☒ Grab-500mL Sampler:_____
Analyses: Preservative:
☒**TOC/DOC** ☒H_2SO_4

Date (YYYY/MM/DD):_____Time: _____

Project Code: **# or Name**
Station No.: **SITEID**
Location or Site Name:_____
Designate: ☒ Grab-1L Sampler:_____
Analyses: Preservative:
☒**TSS 1 of 2** ☒None (wet ice only)

Date (YYYY/MM/DD): _____Time: _____

Project Code: **# or Name**
Station No.: **SITEID**
Location or Site Name:_____
Designate: ☒ Grab-1L Sampler:_____
Analyses: Preservative:
☒**TSS 2 of 2** ☒None (wet ice only)

Date (YYYY/MM/DD):_____Time:_____

Attachment 3: Hazard and Risk Exposure Data Sheet

To be attached to outside of sample coolers being transported to Region 3's Laboratory in Ft. Meade, MD

Hazard and Risk Exposure Data Sheet

Region 3, Laboratory and Technical Services Branch
Ft Meade, Maryland
HAZARD AND RISK-EXPOSURE DATA SHEET
LEVELS OF PERSONAL PROTECTION DURING SAMPLING

BACKGROUND

Under the authority Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) of 1980, Section 311 of the Clean Water Act, and Subtitle I of the Resource Conservation and Recovery Act (RCRA), EPA has been delegated the responsibility to undertake response actions with respect to the release or potential release of oil, petroleum, or hazardous substances that pose a substantial threat to human health or welfare, or the environment.

GENERAL

This form is to be used when collecting Environmental Samples (i.e. streams, farm ponds, wells, soils etc.) and for Hazardous Sample (i.e. drums, storage tanks, lagoons, leachates, hazardous waste sites). This information is intended for use as a guide for the safe handling of these laboratory samples in accordance with EPA and OSHA regulations. The sample classification(s) and levels of personal protection used by the sampler in all situations will enable the analyst to be better aware of potential exposure to substances in air, splashes of liquids, or other direct contact with material due to work being done.

DEGREE OF PROTECTION

____ Level A: Highest level of respiratory, skin, and eye protection needed. Fully encapsulated suit, respirator self-contained (Tank type).

____ Level B: Highest level of respiratory protection but lesser level of skin protection needed. Chemical suit, respirator self-contained (Tank type).

____ Level C: Lesser level of respiratory protection than Level B. Skin protection criteria are similar to Level B. Chemical suit, canister respirator/cartridge

____ Level D: Work uniform without any respirator or skin hazards. Lab coat, gloves etc.

CLASSIFIED FIELD SAMPLES

Environmental Hazardous Comb. (Env. & Haz.) Radioactive

Site Name:_____Sampling Date: _____

Station No._____

Field pH:_____
(Must be taken prior to submission of aqueous samples)

Sampler:_____Work Phone Number:_____

Personal observations at time of sampling (surroundings):
Sample collection observations (physical sample, odors etc.):

Attachment 4: Field Activities Review Checklist

Reviewer's Name (print): _____Reviewer's Project Role:_____

Reviewer's Signature: _____Date of Review: ___/____/_____

Mark each action "Yes," "No," or "NA" (not applicable), and comment as appropriate.

Review Answer	Review Action	Comment(s)
	All required field information was recorded, and in ink (if pencil, scanned as soon as returned to the office).	
	Field measurement data were recorded in the appropriate logbooks(s) or forms.	
	Deviations from SOPs, along with any pertinent verbal approval authorizations and dates, were documented.	
	Samples that may be affected by deviations from SOPs were flagged appropriately.	
	Field measurement calibration standards were not expired and were in the correct concentrations.	
	Field calibrations were performed, and results were within manufacturer-specified limits for all parameters.	
	Field measurement QC samples were within the QAPP-specified limits for all parameters.	
	Samples were collected at the correct sites.	
	The correct number of samples for each type of analysis and the correct volume was collected.	
	Certified clean sample containers, appropriate for the intended analysis, were used.	
	Requested/required field quality control (QC) samples (blanks and duplicates) were collected, and at the correct frequency.	

Review Answer	Review Action	Comment(s)
	Samples were preserved with the correct chemicals, if required.	
	Samples were stored and/or shipped at the proper temperature.	
	Chain-of-custody documents were completed properly.	
	Custody seals were applied and intact when relinquishing custody of the samples.	
	Sample holding times were not exceeded during field operations.	

Attachment 5: Laboratory Data Package Review Checklist

Reviewer's Name (print):_____Reviewer's Project Role:_____

Reviewer's Signature:_____Date of Review:____/____/_____

Mark each action "Yes," "No," or "NA" (not applicable), and comment as appropriate.

Review Answer	Review Action	Comment(s)
	Final data package includes chain-of-custody forms.	
	Chain-of-custody forms were properly completed and signed by everyone involved in transporting the samples.	
	Laboratory records indicate sample custody seals were intact upon receipt.	
	Samples arrived at the laboratory at the proper temperature.	
	All requested analyses were performed and were documented in the analytical report.	
	Analyses were performed according to the methods specified in the approved QAPP.	
	Holding times for extraction and analysis were not exceeded.	
	Method detection and/or quantitation limits were included in the report, and reported results were within these limits.	
	A narrative summarizing the analyses and describing any analysis problems was included in the final report.	
	Data qualifiers and flags were explained in the report.	

Review Answer	Review Action	Comment(s)
	Method (laboratory) blank results were included for all analyses, at the appropriate frequency, and showed no laboratory contamination.	
	Matrix spike data were included for all pertinent analyses, and results were within QAPP, or laboratory defined criteria.	
	Laboratory Control Sample data were included for all analyses, and results were within QAPP, or laboratory defined criteria.	
	Laboratory Duplicate data were included for all analyses, and results were within QAPP, or laboratory defined criteria.	
	Field blanks do not contain analytes of interest or interfering compounds and included for all pertinent analyses.	
	Field Duplicates are within QAPP-defined criteria and included for all analyses.	

Attachment L

MDE-provided MS Excel data template

L Att 2025 MDE Provided MS Excel Data Template

Translation of Columns

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Please visit the EPA.gov page below for a complete list of https://www.epa.gov/waterdata/storage-and-retrieval-and-water-quality-exchange-domain-services-and-downloads#:~:text=GetDom	Monitoring Location ID	Monitoring Location Name	Monitoring Location State	Monitoring Location Latitude	Monitoring Location Longitude	Monitoring Location Type	Activity Type	Activity Start Date	Activity Start Time	Relative Depth	Depth/Height	Depth/Height Unit	Activity Media	Activity Comment	Result Status	CAS #	Characteristic Name	Method Speciation	Sample Fraction	Result Value Type
	Station ID	Station name	Pennsylvania or Maryland	Latitude	Longitude	Reservoir	Sample-Routine = Lab data	mm-dd-yyyy	hh:mm AM/PM	Surface	Actual depth	m	Water or left blank		Final	#	Ammonium	as N	Dissolved	Actual
							Field Msr/Obs			Bottom						#	Chlorophyll a		Non-Filterable	Actual
							Quality Control										Cloud cover			Estimated
																	Depth of			Actual
																	Depth, Secchi			Actual
																	Dissolved			Actual
																	Nitrate +	as N	Dissolved	Actual
																#	Orthophospha	as P	Dissolved	Actual
																	pH			Actual
																	Phaeophytin -		Non-Filterable	Actual
																	Salinity			Actual
																	Specific			Actual
																	Temperature,			Actual
																	Temperature,			Actual
																	Total Nitrogen,	as N	Total	Actual
																	Total	as P	Total	Actual
																	Turbidity			Actual
																	Wave height			Estimated
																	Weather condition			Actual
																	Wind			Actual
																	Wind velocity			Estimated
																	If different characteristic			

V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
Result Value	Result Unit	Result Qualifier 1	Result Qualifier 2	Result Qualifier 3	Result Qualifier 4	Result Qualifier 5	Result Qualifier 6	Detection Limit Type1	Detection Limit Value1	Detection Limit Unit1	Result Comment	Analytical Method ID	Analytical Method Context	Analytical Method Name	Laboratory Name
	mg/L	Reference EPA List linked in A2	Reference EPA List linked in A2	Reference EPA List linked in A2	Reference EPA List linked in A2	Reference EPA List linked in A2	Reference EPA List linked in A2	Method Detection Level		Same as the Result Unit		Reference EPA List linked in A2	Reference EPA List linked in A2	Reference EPA List linked in A2	
	ug/L														
	%														
	m														
	m														
	mg/L														
	mg/L														
	mg/L														
	None														
	ug/L														
	ppt														
	uS/cm														
	deg C														
	deg C														
	mg/L														
	mg/L														
	NTU														
	m														
	None														
	Deg														
	knots														

Example Results

**These results are an example from one of MDE's lakes.

Monitoring Location I	Monitoring Location	Monitoring Location	Monitoring Location	Monitoring Location	Monitoring Location	Activity Typ	Activity Start Date	Activity Start Time	Relative Depth	Depth/Heig	Depth/Height Unit	Activity Media	Activity Commen	Result Stat	CAS #	Characteristic Name	Method Speciatio	Sample Fraction	Result Value Type
VIF0001	Lake Artemesia	Maryland	38.983967	-76.920603	Reservoir	Quality Control Sample-Field Replicate	04-17-2024	9:52:00 AM	Surface	0.5	m	Water		Final	14798-03-9	Ammonium	as N	Dissolved	Actual
VIF0001	Lake Artemesia	Maryland	38.983967	-76.920603	Reservoir	Sample-Routine	04-17-2024	9:52:00 AM	Surface	0.5	m	Water		Final	14798-03-9	Ammonium	as N	Dissolved	Actual
VIF0002	Lake Artemesia	Maryland	38.985204	-76.923118	Reservoir	Sample-Routine	04-17-2024	10:05:00 AM	Surface	0.5	m	Water		Final	14798-03-9	Ammonium	as N	Dissolved	Actual
VIG0001	Lake Artemesia	Maryland	38.985696	-76.920654	Reservoir	Sample-Routine	04-17-2024	9:43:00 AM	Surface	0.5	m	Water		Final	14798-03-9	Ammonium	as N	Dissolved	Actual
VIG0003	Lake Artemesia	Maryland	38.987732	-76.921835	Reservoir	Sample-Routine	04-17-2024	9:35:00 AM	Surface	0.5	m	Water		Final	14798-03-9	Ammonium	as N	Dissolved	Actual
VIG0004	Lake Artemesia	Maryland	38.989892	-76.92245	Reservoir	Sample-Routine	04-17-2024	9:23:00 AM	Surface	0.5	m	Water		Final	14798-03-9	Ammonium	as N	Dissolved	Actual
						Quality													

Result Valu	Result Uni	Result Qualifier	Result Qualifier	Result Qualifier	Result Qualifier	Result Qualifier	Result Qualifier	Detection Limit Type	Detection Limit Value	Detection Limit Unit	Result Commen	Analytical Method ID	Analytical Method	Analytical Method	Laboratory Name
0.008	mg/L	DL						Method Detection Level	0.009	mg/L		4500-NH3(G)	APHA	4500 NH3 G ~ Ammonia in Water Using Automated Phenate Method,	UMCES Chesapeake Biological Laboratory
0.011	mg/L							Method Detection Level	0.009	mg/L		4500-NH3(G)	APHA	4500 NH3 G ~ Ammonia in Water Using Automated Phenate Method,	UMCES Chesapeake Biological Laboratory
0.011	mg/L							Method Detection Level	0.009	mg/L		4500-NH3(G)	APHA	4500 NH3 G ~ Ammonia in Water Using Automated Phenate Method,	UMCES Chesapeake Biological Laboratory
0.014	mg/L							Method Detection Level	0.009	mg/L		4500-NH3(G)	APHA	4500 NH3 G ~ Ammonia in Water Using Automated Phenate Method,	UMCES Chesapeake Biological Laboratory
0.012	mg/L							Method Detection Level	0.009	mg/L		4500-NH3(G)	APHA	4500 NH3 G ~ Ammonia in Water Using Automated Phenate Method,	UMCES Chesapeake Biological Laboratory
0.012	mg/L							Method Detection Level	0.009	mg/L		4500-NH3(G)	APHA	4500 NH3 G ~ Ammonia in Water Using Automated Phenate Method,	UMCES Chesapeake Biological Laboratory

Final Template

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
Monitoring Location ID	Monitoring Location Name	Monitoring Location State	Monitoring Location Latitude	Monitoring Location Longitude	Monitoring Location Type	Activity Type	Activity Start Date	Activity Start Time	Relative Depth	Depth/Height	Depth/Height Unit	Activity Media	Activity Comment	Result Status	CAS #	Characteristic Name	Method Speciation	Sample Fraction

T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
Result Value Type	Result Value	Result Unit	Result Qualifier 1	Result Qualifier 2	Result Qualifier 3	Result Qualifier 4	Result Qualifier 5	Result Qualifier 6	Detection Limit Type 1	Detection Limit Value 1	Detection Limit Unit 1	Result Comment	Analytical Method ID	Analytical Method Context	Analytical Method Name	Laboratory Name

Attachment M

Conowingo Hydroelectric Project
(FERC Project No. 405)

Debris Management Plan, Revision
("Debris Management Plan")

CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NUMBER 405

DEBRIS MANAGEMENT PROGRAM

Prepared for:

Exelon.

Prepared by:

GOMEZ AND SULLIVAN ENGINEERS

September 2021
(Revision 1, October 2021)

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1 INTRODUCTION

Exelon Generation Company, LLC (Exelon) operates the Conowingo Hydroelectric Project (Project), located on the Susquehanna River in Maryland. The Project is operated under a Federal Energy Regulatory Commission (FERC or the Commission) license (Project No. 405) issued March 19, 2021. The Project Boundary encompasses approximately 9,923 acres, including Conowingo Pond, the dam, the powerhouse, the tailrace, and the Project's 15 recreation sites.

License Article 427, entitled *Debris Management Program*, requires Exelon to develop a debris management program within six months of license issuance. The provisions in the program specified in Article 427 include the following:

a) *A description of the program, including: debris management goals, a description of debris management methods, timeframes for when debris will be collected and the frequency of skimmer and clamming operations, specific size criteria for target floating debris, a description of best management practices for the storage of the debris materials at Hopkins Cove and other licensee- owned lands within the project boundary, procedures for removal of stored debris, and procedures for tracking debris storage and removal.*

b) *A provision for a public hotline for boaters to link directly to the licensee to report areas of hazardous floating debris.*

c) *A provision to employ clamming, one or more skimmer barges, or any other equally or more effective measure to remove as much floating and water surface trash and debris that accumulates in the reservoir behind the Conowingo Dam as is reasonably practicable, but in any event no fewer than 50 loads nor more than 450 loads of trash and debris per year, where a "load" consists of the maximum volume of trash and debris that can be safely transported in a standard 20-yard dumpster. The licensee must monitor and record the duration of the clamming/trash and debris removal events (number of hours), and the amount of debris and trash removed and subsequently disposed of during each clamming/trash and debris removal event (in cubic yards) and submit the data to the Maryland Department of the Environment (MDE) each year by November 30.*

d) *A provision requiring the licensee to respond, in a timely fashion, to any complaint from a marina operator, or public boat ramp "monitor," such as the Maryland Department of Natural Resources, relating to accumulated trash and debris at project facilities interfering with recreational uses in Conowingo Pond, by removing, to the extent reasonably practicable and safe, any accumulated trash and debris that is interfering with recreational uses during the recreational season between Memorial Day and Labor Day and properly disposing of removed materials. The licensee must maintain, for review by MDE and Commission staff, records of complaints filed (name, date, time, location, nature of the trash and/or debris issue and amount) and corrective actions taken (date, time, description of action, and amount of trash and/or debris removed).*

e) *A provision to sponsor at least two annual community-based cleanups of Conowingo Pond, tributaries upstream of the Conowingo Project that feed Conowingo Pond, and the Susquehanna River and tributaries downstream of the project. Licensee must*

advertise each event, provide all needed supplies, and be responsible for the disposal of collected materials.

f) A provision specifying that, after any storm event which results in trash and debris blocking water supply intakes in the Susquehanna River downstream of the Conowingo Dam, the licensee must ensure that the trash and debris blocking water supply intakes and recreation facilities within the project boundary is removed as soon as it is safe to enter the water.

g) A provision for an annual report to be filed with the Commission by April 1 throughout the license term, summarizing the previous year's debris removal efforts, hotline action items, and outcomes.

1.1 Project Description

The Project has 11 generating units with a hydraulic capacity of 86,000 cfs and nameplate capacity of 570.15 megawatts. The Conowingo Pond has a surface area of 8,868 acres and approximately 43 miles of shoreline excluding islands in the reservoir.

The Project has a drainage area of approximately 27,100 square miles. Woodlands account for 62 percent of the total land cover of the basin, agricultural land makes up 24 percent, and urban developed land comprises nine percent (SRBC 2021). Debris is primarily natural consisting of large woody debris, brush and shrubs, leaves, grass clippings and dead animals that fall into the river and/or tributaries. However, during high flow events as much as fifteen (15) percent of debris mass in the Susquehanna River Basin is artificial (man-made debris) such as tires, trash, plastic and glass bottles, propane tanks, oil tanks, docks, barrels, drums, floats, boats, pickup truck liners, sandboxes, and tarps (URS 2012).[1]

During the winter and spring months, trash and debris accumulate behind the Conowingo Dam due to high river flows caused by heavy rain and melting snow within the Susquehanna River basin. The hydraulic capacity of the turbines in the Conowingo powerhouse is approximately 86,000 cubic feet per second (cfs). When river flows exceed this amount, crest gates are opened to pass the additional flow of the river. Conowingo does not intentionally divert debris through the dam. When the river flow exceeds 86,000 cfs, crest gates must be opened to allow the extra river flow to pass down river. During high river flow periods, debris will flow uncontrolled through the crest gates and continue downstream. Debris management operations are not conducted during high river flow periods due to safety concerns.

[1] The final study plan determination required Exelon to conduct a Debris Management Study. The study was completed in August 2012 and summarized the type and quantity of debris at Conowingo, debris transport, and current debris management efforts at Conowingo and other hydroelectric facilities upstream of Conowingo. This study is provided in Appendix A of this Program.

2 DEBRIS MANAGEMENT

The purpose of this Debris Management Program (Program) is to outline how Exelon intends to reduce the accumulation of natural and man-made debris floating on the surface of the reservoir behind Conowingo Dam and sites within the Project Boundary over the term of the license for the Project. Figure 2-1 provides the location of the Project Boundary, hydropower, and Project recreation facilities where debris is managed. The Shoreline Management Plan required by License Article 428 includes provisions and Best Management Practices Exelon employs for preventing artificial (human-made) and natural debris from recreation sites and other lands within the Project Boundary from entering the reservoir.

2.1 Debris Management at the Conowingo Dam

Much of the floating debris that reaches the dam is prevented from reaching the trash rack of the intake works by a 40-foot-deep skimmer wall. However, some debris can become waterlogged and can sink below that wall to enter the intakes. Debris that is smaller than the spacing of the trash rack bars is passed through the turbines and discharged downstream. Larger size debris can sink or could become jammed in the trash rack (potentially causing impacts to turbine operations). Exelon employs clamming with the three existing gantry cranes with grapple attachments to remove submerged debris from the intakes and floating debris that accumulates at the face of the dam. The gantry cranes are rated for 90 tons, but access to submerged and floating debris is limited by accessibility of the cranes to reach into the water. Large trees and woody debris removed from the pond may be placed on the deck to be cut into smaller pieces to fit into the dumpster. Trash is sorted and placed in separate dumpsters (such as plastics, metals, and tires).

Consistent with the License, no fewer than 50 loads nor more than 450 loads of trash and debris will be collected per year, where a "load" consists of the maximum volume of trash and debris that can be safely transported in a standard 20 cubic yard dumpster. Exelon will monitor and record the duration of the clamming/trash and debris removal events (number of hours), and the amount of debris and trash removed and subsequently disposed of during each trash and debris removal event (number of loads).

Trash and debris will be transported to, and stored temporarily at, Hopkins Cove prior to final disposal and/or recycling.

2.1.1 Timeframe and Frequency of Debris Removal

Clamming operations are performed throughout the year. Clamming operations increase after high flow events or when submerged or floating debris at the powerhouse intakes need to be removed; however, removal of debris that accumulates in front the units will be conducted when reasonably practicable throughout the year. Debris management activities will not take place during high river flows due to safety concerns.

2.1.2 Hurricane and Tropical Storm Procedures

Hurricanes, tropical storms and tropical depressions impacting the Susquehanna River Basin can have special challenges for the operation of Conowingo Dam. These challenges include the safe passage of flows well in excess of plant capacity through the use of spillway gates, as well as managing debris from sources upstream of Conowingo Pond. However, regular clamming events during the year will be maintained in accordance with Article 427 paragraph c below.

> *(c) "A provision to employ clamming, one or more skimmer barges, or any other equally or more effective measure to remove as much floating and water surface trash and debris that accumulates in the reservoir behind the Conowingo Dam as is reasonably*

practicable, but in any event no fewer than 50 loads nor more than 450 loads of trash and debris per year, where a "load" consists of the maximum volume of trash and debris that can be safely transported in a standard 20-yard dumpster. The licensee must monitor and record the duration of the clamming/trash and debris removal events (number of hours), and the amount of debris and trash removed and subsequently disposed of during each clamming/trash and debris removal event (in cubic yards) and submit the data to the Maryland Department of the Environment (MDE) each year by November 30."

As part of its debris-removal commitment in paragraph (c) of Article 427, Exelon will undertake the following procedures during the Atlantic Hurricane Season of June 1 – November 30:

1. Between June 1 and November 30, upon identification by the National Hurricane Center (NHC) in its five-day forecast that a hurricane, tropical storm, or tropical depression is forecasted to track over the Susquehanna Basin (Forecasted SB Major Storm Event), Exelon's in-house meteorologist will assess the risk of a major flow event on the Susquehanna River at Conowingo. As soon as practicable but in no event later than 24 hours after the NHC forecasts a Forecasted SB Major Storm Event, Exelon's meteorologist will apprise Conowingo Station of the risk of the storm causing a major flow event on the Susquehanna River. This risk assessment will be updated daily until the storm passes. Exelon will communicate the risk assessment and updates to MDE as soon as possible but in no event later than 24 hours after Exelon's meteorologist completes the risk assessment and/or updates. Conowingo Station will keep records of storm notices and updates received.

2. If the initial risk assessment or subsequent update indicates that the probability of a major-flow event is moderate to high:

    a. Exelon will as soon as possible but in no case later than 12 hours after the risk assessment is communicated to Conowingo Station and MDE, evaluate the debris field in front of Conowingo Dam with regard to both the amount of debris and the likelihood that such debris would move downstream with spillway operations. Exelon will email the evaluation to MDE as soon as possible but in no event later than 24 hours after the evaluation of the amount of debris and likelihood of downstream movement. Conowingo Station will keep records of such assessments, including photographs.

    b. As part of its storm readiness procedure, Exelon will take reasonably practicable actions, limited to clamming operations, to remove debris; provided that pre-storm river flows and/or wind conditions are such that debris removal can be conducted safely.

3. In no event will debris removal operations or the associated placement of equipment for such removal interfere with dam and powerhouse operations, including storm preparation, needed to safely pass the flow event. In the event that Exelon determines to not remove debris due to interference with powerhouse operations, including storm preparation or safety, Exelon will communicate this to MDE via email with an explanation of the basis for Exelon's conclusion that removal of debris will interfere with powerhouse operations, including storm preparation or safety.

2.2 Debris Management – Recreation Sites

Debris at Project recreation sites will be removed to the extent reasonably practicable and safe during the recreation season (Memorial Day to Labor Day) and will be properly disposed of at appropriate sites as described in the following sections and consistent with the Recreation Plan and Shoreline Management Plan (handling of woody debris).[2] Exelon will maintain, for review by MDE and Commission staff, records of complaints filed (name, date, time, location, nature of the trash and/or debris issue and amount) and corrective actions taken (date, time, description of action, and amount of trash and/or debris removed).

Exelon will evaluate the debris complaint and determine the appropriate method and site for safe debris removal. In some cases, if the debris cannot be safely removed no further action may be taken until safety concerns have been resolved. Exelon may use watercraft or skimmer boats to collect debris from the pond. Debris accumulated along the shoreline may be removed via land access, if possible (i.e., from coves or marinas) to do so safely. Debris collected will be disposed of properly or taken to Hopkins Cove for temporary staging. Debris collection sites are shown in Figure 2-1 (Fisherman's Park and Shures Landing are the only debris collection sites downstream of the Conowingo Dam).

2.2.1 Timeframe and Frequency of Removal

Exelon will conduct monthly inspections at the Category 1 formal recreation sites/debris management sites shown on Figure 2-1. All formal recreation sites have trash cans and/or dumpsters for public use. Exelon will continue to monitor and empty these trash receptacles on a regular basis to maintain good housekeeping practices.

If debris and trash notifications or complaints are received between Memorial Day and Labor Day, Exelon will conduct as-needed maintenance to remove the accumulations as soon as river flow and weather conditions are conducive to working safely. It is anticipated that Marina or public boat ramp "monitors," such as the Maryland Department of Natural Resources or the Pennsylvania Fish and Boat Commission, will also track trash and debris concerns within the project boundary and their input will support the tracking effort. In addition, Exelon will monitor trash and debris accumulations throughout the Conowingo Pond following any storm event and remove trash and debris in accordance with license requirements as soon as conditions are safe.

2.3 Debris Management - Community Clean-up Efforts

Exelon will continue to sponsor at least two (2) community-based cleanups of Conowingo Pond, tributaries upstream of the Conowingo Project that feed Conowingo Pond, and the Susquehanna River each year. Exelon will advertise each event, provide all needed supplies, and be responsible for the disposal of collected materials.

Trash and debris collected will be disposed of properly.

2.4 Best Management Practices for Debris Storage

Debris may be stored at Hopkins Cove, which is located about 0.6 miles upstream of the Conowingo Dam, and will be separated and sorted as organic, tires, plastic, trash, and metal. Artificial debris will be collected in dumpsters (each with 20 cubic yard capacity) and disposed of directly through a licensed vendor.

[2] In accordance with the Shoreline Management Plan (Article 428) woody debris shall be left in place unless the debris is determined, on a case-by-case basis, to be a navigational or safety hazard.

Although it is not anticipated, if any potentially hazardous material is recovered and identified during debris removal activities it will be disposed of in accordance with appropriate safety provisions and regulations.

2.5 Procedures for Removal of Temporarily Stored Debris

Artificial debris will be removed and recycled or disposed of at a landfill once the dumpsters at Hopkins Cove and recreation sites approach their storage capacity. Collected woody debris will be mulched as needed and reused locally. Metals are recycled and plastics and tires are disposed of properly.

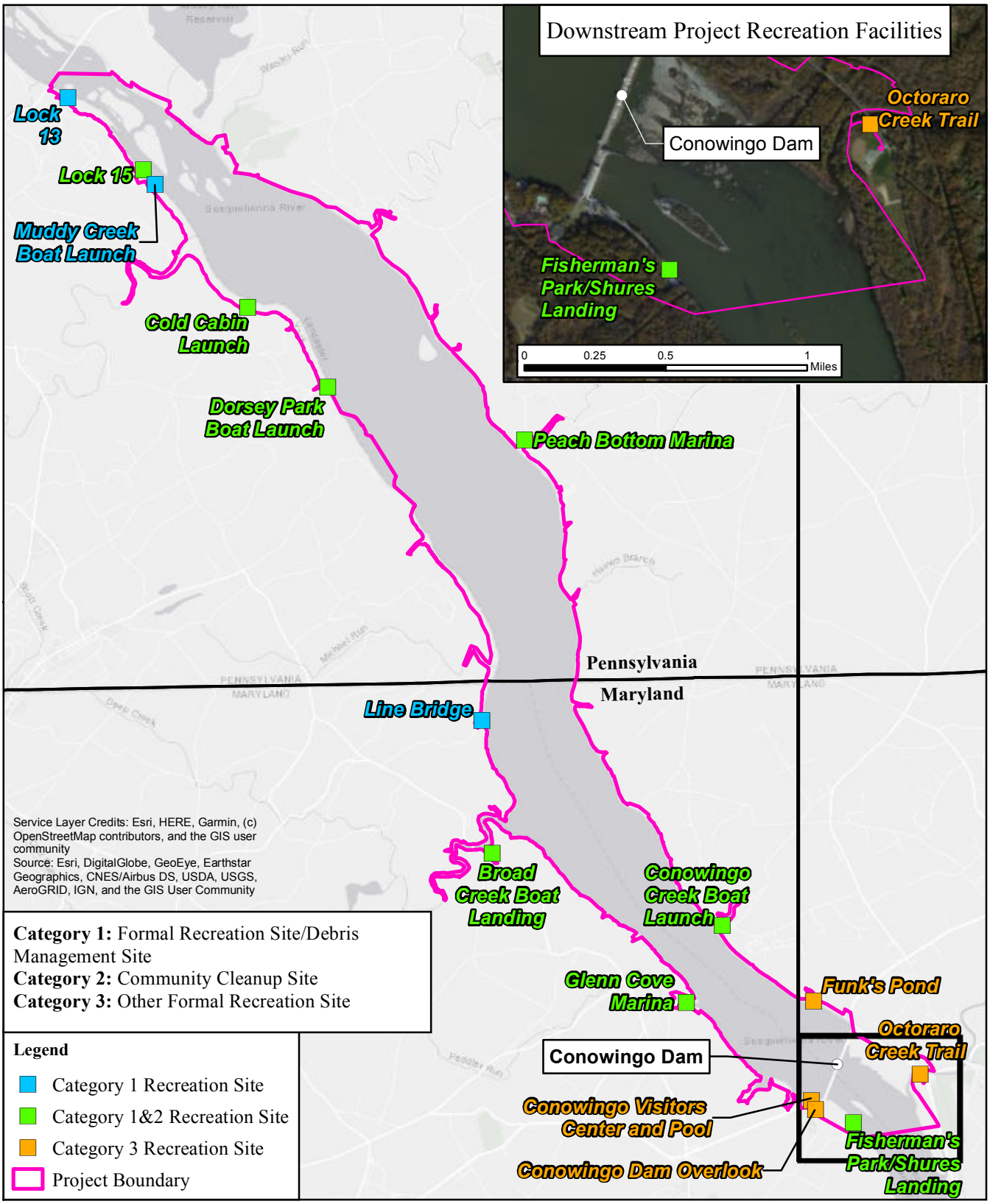
2.6 Hotline

The public will be able to call the Conowingo Visitor Center (410 – 457- 2427) to report areas of hazardous floating debris to Exelon. This number is posted on Exelon's webpage and will be posted at kiosks located at the recreation sites. In addition, the Glen Cove and Peach Bottom Marina operators will also direct the public to contact the Conowingo Visitor Center with any debris concerns and/or complaints.

Exelon will respond, in a timely fashion, to any complaints by marina operators, or public "monitor", such as the Maryland Department of Natural Resources or the Pennsylvania Fish and Boat Commission, related to accumulated trash and debris interfering with recreational uses during the recreational season between Memorial Day and Labor Day.

Exelon will maintain, for review by MDE and Commission staff, complaint records including the following:

- Complaint
    - Name
    - Date and time
    - Location of debris/trash
    - Nature of trash and/or debris issue and amount
- Corrective actions taken
    - Date and time
    - Description of action
    - Amount of debris/trash removed



EXELON GENERATION COMPANY, LLC

CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

N

0 0.75 1.5 3 Miles

Figure 2-1:
Project Recreation Facilities Location Map

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Path: X:\GISMaps\project_maps\debris_management_plan\figure_2-1_debris_management_locations.mxd

3 IMPLEMENTATION SCHEDULE

Exelon will continue to routinely remove debris and trash from the reservoir, the Conowingo Dam and recreation sites within the Project Boundary (provided it is safe to do so) in accordance with License requirements based on the following inspections/requests: Exelon's monthly inspections, on an as needed basis due to "monitor" requests or complaints, and following storm events. In order for the public to provide debris concerns, Exelon will post the Conowingo Visitor Center phone number at Recreation Site kiosks, Exelon's website, and on social media. Cleanup days are generally scheduled during the spring and fall. Details about the cleanup days will be posted on recreation site kiosks, Exelon's website, and on social media.

4 REGULATIONS AND RULES

In addition to the procedures outlined in this program, and the other plans required by the License issued on March 19, 2021, debris management and waste disposal at the Project will be governed by the following regulations and rules[3]:

- Federal
    - Solid/Hazardous Waste - Code of Federal Regulations (CFR) Title 40 – Parts 239-299)
- Maryland
    - Solid Waste - County Comprehensive Solid Waste Management Plans as defined by Code of Maryland Regulations (COMAR) 26.03.03
        - Harford County Plan– 2015-2024[4]
        - Cecil County Plan – 2016-2025[5]
    - Hazardous Waste – COMAR 26.13
- Pennsylvania
    - Solid Waste – Act 97
    - Hazardous Waste – Pa. Code Title 25, Chapters 260 - 270

[3] Exelon will monitor for future updates or revisions to debris management and disposal rules and regulations and comply as appropriate.
[4] 2015-2024 Harford County Solid Waste Management Plan (Harford County 2015).
[5] 2016-2025 Cecil County Solid Waste Management Plan (Cecil County 2015).

5 REPORTING

5.1 MDE Annual Report

Exelon will submit a summary of debris and trash removal events at the Conowingo Dam described under Section 2.1 to MDE annually by November 30 throughout the license term and will cover the preceding twelve calendar month period. The first report will cover the period from November 1, 2020, to October 31, 2021. Annual reports will include the duration of the clamming/trash and debris removal events (number of hours), and the amount of debris and trash removed and subsequently disposed of during each trash and debris removal event (in number of loads or dumpsters).

5.2 Federal Energy Regulatory Commission Annual Report

Throughout the License term, an annual report summarizing debris removal efforts will be filed with the Commission by April 1 each year for the preceding year. The first report will be filed April 1, 2022 and will cover the period of January 1 through December 31, 2021. The report will contain the following:

- Summary of debris and trash removal events including the duration of the clamming/trash and debris removal events, and amount of debris and trash removed and subsequently disposed of (in cubic yards).
- Summary of community cleanup efforts.
- Summary of Hotline Action Items.
- Details of any plans that require Commission approval including costs and implementation schedule.
- Proposed modifications to the Program.
- Consultation documentation.

6 MODIFICATIONS TO PROGRAM

Any modification to this Program will be filed by Exelon and will require the approval of the Commission. Approval from the Commission will not be requested until after consultation with the appropriate Federal and State agencies, non-governmental organizations, and local governments including but not limited to the following: Maryland Department of the Environment, Maryland Department of Natural Resources, Pennsylvania Fish and Boat Commission, the Pennsylvania Department of Environmental Protection, Harford and Cecil Counties in Maryland, and York and Lancaster Counties in Pennsylvania. Those consultations will be documented as part of any filing by Exelon to the Commission.

7 REFERENCES

Cecil County DPW. 2015. 2016 - 2025 Cecil County Solid Waste Management Plan. Accessed from: https://www.ccgov.org/home/showdocument?id=19965

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APPENDIX A. CONOWINGO DEBRIS MANAGEMENT STUDY – REVISED STUDY PLAN 3.14

FINAL STUDY REPORT
DEBRIS MANAGEMENT STUDY
RSP 3.14

CONOWINGO HYDROELECTRIC PROJECT

FERC PROJECT NUMBER 405

Prepared for:

Exelon.

Prepared by:

URS Corporation

Gomez and Sullivan Engineers, P.C.

August 2012

EXECUTIVE SUMMARY

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt Conowingo Hydroelectric Project (Project). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014. FERC issued the final study plan determination for the Conowingo Project on February 4, 2010, approving the revised study plan with certain modifications.

The final study plan determination required Exelon to conduct a Debris Management Study, which is the subject of this report. The purposes of this study are to: 1) analyze hydrologic conditions that initiate debris management actions; 2) review current debris management practices to ensure that they are consistent with best management practices; and 3) if not consistent with best management practices, assess need for additional practices to reduce impacts to Pond and downstream users.

An initial study report (ISR) was filed on February 22, 2011, containing Exelon's 2010 study findings. An initial study report meeting was held on March 9, 10 and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May 27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) was filed on January 23, 2012 addressing comments from stakeholders received at the March ISR meeting, those comments addressed by Exelon in the May 27, 2011 responses to ISR comments, as well as editorial and minor text changes. This final study report is being filed with the Final License Application for the Project.

At present, Exelon employs clamming (with three gantry cranes with grapple attachments) to remove submerged debris from the intakes as well as floating surficial debris in front of the dam. Debris management activities do not take place during high river flows due to safety concerns.

Debris trapped at Conowingo Dam does not always originate from the entire upstream Susquehanna River watershed of 27,100 square miles, due to the hydraulic capacities of the two upstream projects, Safe Harbor (110,000 cfs) and Holtwood (31,500 cfs). Debris trapped by the Conowingo Dam (hydraulic capacity of 86,000 cfs) at river flows below the Holtwood hydraulic capacity of 31,500 cfs likely originates almost entirely from the contributing watershed of 314 square miles between Holtwood and

Conowingo Dams. For flows between 31,500 cfs and 86,000 cfs, debris from the contributing drainage area of 1,010 square miles, between Safe Harbor and Conowingo Dams, would likely be captured at Conowingo Dam. At flows above 86,000 cfs, debris passes Conowingo Dam through the spill gates. Only at flows above the Safe Harbor hydraulic capacity of 110,000 cfs, would debris from the upper Susquehanna River would be mobilized into the system. Thus, the quantity of debris reaching the dam and available for removal can be very limited.

All debris removed is taken to Hopkins Cove where it is separated and sorted as organic, tires, plastic, trash, and metal. Organic debris (natural) is recycled and ground up into mulch. Artificial debris is sent to a disposal/recycling facility or landfill.

Exelon sponsors community-based clean-ups of Conowingo Pond and its tributaries upstream of the dam, and the Susquehanna River and tributaries downstream of the dam (Exelon Cleanup Day; Conowingo Creek cleanup; Lower Susquehanna Heritage Greenway River Sweep).

Debris management practices at the York Haven, Safe Harbor, and Holtwood Projects are similar to those employed at the Conowingo Project. These efforts focus on clearing trash racks that protect the intakes and generating units, and clearing the forebay to maintain unrestricted flow to turbine units.

Current debris management practices of the Conowingo Project are consistent with Best Management Practices and there is no need to institute additional practices.

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LIST OF ABBREVIATIONS

Exelon – Exelon Generation Company, LLC

FERC – Federal Energy Regulatory Commission

ILP – Integrated Licensing Process

ISR- Initial Study Report

MW - Megawatt

NOI – Notice of Intent

PAD – Pre-Application Document

Project - Conowingo Hydroelectric Project

PSP – Proposed Study Plan

RSP – Revised Study Plan

SRBC – Susquehanna River Basin Commission

USGS – United States Geological Survey

USR- Updated Study Report

1.0 INTRODUCTION

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt (MW) Conowingo Hydroelectric Project (Project). Exelon is applying for license renewal using the FERC's Integrated Licensing Process (ILP). The current license for the Conowingo Project was issued on August 14, 1980 and expires on September 1, 2014.

Exelon filed its Pre-Application Document (PAD) and Notice of Intent (NOI) with FERC on March 12, 2009. On June 11 and 12, 2009, a site visit and two scoping meetings were held at the Project for resource agencies and interested members of the public. Following these meetings, formal study requests were filed with FERC by several resource agencies. Many of these study requests were included in Exelon's Proposed Study Plan (PSP), which was filed on August 24, 2009. On September 22 and 23, 2009, Exelon held a meeting with resource agencies and interested members of the public to discuss the PSP.

Formal comments on the PSP were filed with FERC on November 22, 2009 by Commission staff and several resource agencies. Exelon filed a Revised Study Plan (RSP) for the Project on December 22, 2009. FERC issued the final study plan determination for the Project on February 4, 2010, approving the RSP with certain modifications.

The final study plan determination required Exelon to conduct a Debris Management Study, which is the subject of this report. The objectives of this study are to:

1. Analyze hydrologic conditions that initiate debris management actions;

2. Review current debris management practices to ensure that they are consistent with best management practices (BMPs); and

3. If not consistent with best management practices, assess need for additional practices to reduce impacts to Pond and downstream users.

An initial study report (ISR) was filed on February 22, 2011, containing Exelon's 2010 study findings. An initial study report meeting was held on March 9, 10 and 11, 2011 with resource agencies and interested members of the public. Formal comments on the ISR including requested study plan modifications were filed with FERC on April 27, 2011 by Commission Staff, several resource agencies and interested members of the public. Exelon filed responses to the ISR comments with FERC on May

27, 2011. On June 24, 2011, FERC issued a study plan modification determination order. The order specified what, if any, modifications to the ISRs should be made. For this study, FERC's June 24, 2011 order required no modifications to the original study plan. An updated study report (USR) was filed on January 23, 2012 addressing comments from stakeholders received at the March ISR meeting, those comments addressed by Exelon in the May 27, 2011 responses to ISR comments, as well as editorial and minor text changes. This final study report is being filed with the Final License Application for the Project.

2.0 BACKGROUND

The Susquehanna River Basin has a drainage area of 27,510 square miles with over 40,000 miles of streams in New York, Pennsylvania, and Maryland (SRBC 2004). Of this total drainage, nearly 27,100 square miles are located above the Conowingo Dam. Woodlands account for 70 percent of the total land cover of the basin, agricultural land makes up 22 percent, and urban developed land comprises seven percent (SRBC 2006).

Conowingo Dam is located at river mile (RM 10) of the Susquehanna River main stem. Three additional hydroelectric facilities are located upstream of Conowingo Dam - Holtwood Dam (RM 24), Safe Harbor Dam (RM 34) and York Haven Dam (RM 56). Some of the natural and human-generated debris moving through the Susquehanna River watershed gets trapped behind the hydroelectric facilities on the main stem in the lower Susquehanna River. Most debris is transported during high flow events, particularly during March and April.

Article 41 of the current FERC license for the Conowingo Project required the licensee, in consultation with the United States Army Corps of Engineers and Susquehanna River Basin Commission (SRBC), and in cooperation with the other three lower Susquehanna River hydro facilities, to conduct a study to determine the magnitude of river-borne debris and its management, the results of which would be filed with FERC within two years. This study[1] (cited in Brethauer 1985) was jointly prepared by the licensees of the four lower Susquehanna River hydro facilities and filed with FERC in August 1982. It reported an average of 75,000 cubic yards of debris is passed over or through each dam annually with the quantity of debris being nearly proportional to river flow.[2] This study also determined that 75 percent of the total estimated volume of material was discharged during high flow events (January through May) and concluded that debris management should be implemented as a basin-wide program.[3] Additionally, the report recommended that the most effective method to reduce debris affecting the lower Susquehanna River basin and Chesapeake Bay is at its source.[4]

[1] River-Bourne Debris Study Report (Susquehanna River Debris Electric Utilities Report (Safe Harbor Water Power Corporation, FERC Project No. 1025. FERC License Mandate Article #40. August 5, 1982.

[2] The value of 75,000 cubic yards as the average annual quantity of debris passing over or through each dam is cited by reference and the manner by which this number was calculated is not provided in the referenced source document. While it represents a quantity of debris reaching and passing the dams, it does not reflect the amount of debris being trapped by the dams.

[3] Letter (March 25, 1999) from PP&L, Inc. to FERC re Response to February 26, 1999 Request for Information from J. Mark Robinson on Management of River-Borne Debris

[4] Letter (March 24, 1999) from Susquehanna Power to FERC re Debris Management Plan

A 1989 cooperative agreement by the operators of the hydroelectric facilities, SRBC, and regulatory agencies led to routine debris removal actions during normal to low flows. However, during high flows debris may pass through dam gates, overtop spillways, and continue downstream. Local groups participate in annual clean-ups to remove debris in the watershed. In June 1999, at the Conowingo Project station, SRBC, Maryland State Department of the Environment, and FERC convened a public meeting to address management of floating debris in the Susquehanna River basin. It was noted that the Susquehanna River Basin is one of the most flood-prone basins in the country and that debris flow is flood-related and interstate in nature.

3.0 METHODS

The tasks outlined below identify the methods used to achieve the study objectives.

3.1 Review Existing Information

Existing data for this study was obtained from the following sources:

1. Current debris management practices implemented at the four hydroelectric facilities of the lower Susquehanna River were identified. To supplement information on Exelon's practices at Conowingo Dam, operators at each of the three hydroelectric facilities dams upstream of Conowingo Dam were contacted (letter dated August 5, 2010 – Appendix A) for information related to debris management practices they employ. Responses were received by November 16, 2010 (Appendix B).

2. Lower Susquehanna River watershed data relevant to debris management were researched. These included information pertaining to land cover, debris sources, and non-facility watershed clean-up efforts.

3. Hydrologic data from the USGS gage No. 01576000 (Susquehanna River at Marietta, PA) and USGS gage No. 01578310 (Susquehanna River at Conowingo, MD) provided information on the frequency and timing of high flow events.

3.2 Debris Management Assessment

Current facility debris management practices and watershed clean-up programs were evaluated to categorize volumes and types of debris. Photographs illustrate commonly observed debris conditions found in Conowingo Pond. Historic data were reviewed to identify trends in the type and quantity of debris, and relations, if any, with management techniques or river flow.

To identify any relation between hydrologic conditions and debris management activities at Conowingo Dam, hydrologic data of the Susquehanna River were compared with quantities of debris removal. This was accomplished by plotting quantities of debris collected at Conowingo Dam versus average monthly flows of the river measured at USGS gage No. 01576000 (Susquehanna River at Marietta, PA).

3.3 Identify and Evaluate Potential Improvements

The results of Task 1 and Task 2 were assessed to identify the need for improvements to the current management program at Conowingo Dam or watershed clean-up efforts within Conowingo Pond and its tributaries. Debris collection and removal management practices implemented at other similar facilities are provided.

4.0 RESULTS AND DISCUSSION

Debris is a term used to collectively refer to the remains of something broken down or destroyed. In Conowingo Pond, debris is found in a variety of forms, locations, and quantities. These are described below.

4.1 Debris Type and Occurrence

Debris can be natural or artificial (human-derived). In the Susquehanna River Basin, the vast majority of debris is natural in origin (SRBC 1999).

4.1.1 Natural Debris

Natural debris primarily consists of streamside vegetation that falls directly into a water body or onto is its banks or floodplain. Floods or mass wasting on slopes may carry this material into the stream. Examples of natural debris include tree trunks and branches; brush and shrubs; leaves, grass clippings and dead animals. In Conowingo Pond natural debris is typically found as large woody debris accumulations (debris rafts or slugs) along the river shoreline or behind the dam; isolated logs within the river or stranded on exposed substrates during lower flows; and accumulations of woody debris behind and within tributary culverts. Figures 4.1.1-1 through 4.1.1-8 illustrate typical occurrences of natural debris in Conowingo Pond

Natural debris is organic and therefore biodegradable. However, some items such as large tree limbs or entire trees often take a long time to degrade and, as floating but partially submerged, are potential hazards to recreational boaters. Older trees that become waterlogged will be submerged below the water surface and minimally visible.

Natural debris also provides aquatic and semi-aquatic organisms with diverse habitat. Large secure debris provides good functional habitat while also protecting the shoreline from erosion. Secure debris can also trap sediment providing additional substrate for emergent wetlands. Figures 4.1.1-9 through 4.1.1-12 illustrate avian use of natural debris in the pond.

4.1.2 Artificial Debris

Artificial debris, derived from human activities, compiles about 15 percent of the debris masses formed during high flows in the Susquehanna River basin (SRBC 1999). Examples of this type of debris include tires, metal and plastic 55-gallon drums, bottles and containers, shoreline structures, boats, lumber, appliances, furniture, garbage, etc. These items potentially may contain hazardous materials that can harm the aquatic community and recreational users of the river.

In Conowingo Pond, artificial debris is found mixed in amongst the natural debris slugs or as part of degraded shoreline structures. Figures 4.1.1-2, 4.1.1-6, 4.1.1-8, and 4.1.2-1 through 4.1.2-3 illustrate typical occurrences of artificial debris in the pond. Artificial debris has little habitat value and is visually unpleasant. It also can be harmful to fish and wildlife if eaten.

4.2 Debris Quantity

Conowingo Dam receives variable volumes of debris on an annual basis. Debris collected here has included wood sticks and logs, leaves, floating grass, tires, trash, plastic and glass bottles, propane tanks, oil tanks, docks, barrels, drums, floats, boats, pickup truck bed liners, sandboxes, and tarps. Most is trapped between the trash racks and head works. Some of the debris is more than 75 feet below the water level.

Table 4.2-1 provides quantities of debris collected and removed from the dam 1989 through 1998. Table 4.2-2 reports the amount of debris removed by either skimming (using boat skimmer) or clamming (clam shell in front of trash racks) from 2004 through September 2011. Between 1992 and 2008, Conowingo Dam utilized a self-propelled skimmer barge to capture floating debris. The skimmer barge was retired in 2008. In early 2011 Exelon added another crane with boom and grapple for removing debris. Thus, Exelon currently employs clamming by gantry cranes (three) with grapple attachments.

4.3 Debris Sources and Transport

As noted earlier, the largest quantities of debris are delivered to the lower Susquehanna River during high flow events from forested areas. Precipitation, storm runoff, and elevated stream flows dislodge upland, stream bank, and in-stream debris. Wind throw, decaying trees, and leaf drop from riparian areas adjacent to streams contribute to debris accumulation. High storm winds may also blow tarps, empty drums, and bed liners into the river. During low flows, debris may become stranded at higher elevations and pile up as flood flows recede or pool levels are lowered. In the fall, senescent aquatic vegetation can become dislodged and create a short-term in-stream source.

Stranded debris accumulates within tributary culverts or piles at the upstream side at wing walls in Conowingo Pond (Figures 4.1.1-5 through 4.1.1-8). Debris also impedes normal tributary inflow to Conowingo Pond by being deposited within the tributaries themselves (Figures 4.3-2 and 4.3-3). Not all debris that enters Conowingo Pond is transported to the dam; debris may be stranded on shallows as water elevations recede; or become waterlogged and lodged in place within bottom sediment, if large enough, or become too heavy to be carried all the way downstream to the dam before impinging the shoreline. This material may not be carried to the dam until the next large flow event.

To evaluate if a relationship between high river flow and quantity of debris could be discerned, annual debris collection quantities at Conowingo Dam were plotted against average monthly flows measured at the Marietta gage[5]. Figure 4.3-1 displays the lack of an obvious trend from the limited data available. A data gap between 1998 and 2006 exists for quantity of debris collected. Available debris removal data are recorded as annual totals and therefore cannot be correlated with monthly river flow. However, it is still possible that a large-scale megascopic relation between annual removal quantities and river flow would be evident in the data, if present. A review of the data finds this is not the case due to the combination of the following circumstances summarized in Table 4.3-1. Safe Harbor, Holtwood, and Conowingo each have different hydraulic capacities. Thus, at different river flows, the factors determining the quantity of debris trapped at Conowingo Dam are: 1) river flow in relation to the project hydraulic capacity of each facility and 2) contributing drainage area.

York Haven is a run-of-river facility; debris reaching the dam from the upstream watershed passes over the facility or is sluiced downstream (see Section 4.4.2.1). Safe Harbor is a peaking facility with a maximum turbine hydraulic capacity of 110,000 cfs.[6] Debris passes Safe Harbor when flows exceed its hydraulic capacity. Thus, until a river flow of 110,000 cfs is exceeded, the debris passing York Haven is trapped at Safe Harbor.

Holtwood is also a peaking facility with an approximate hydraulic capacity of 31,500 cfs (PPL Holtwood 2007). Thus, for debris originating from the watershed upstream of Holtwood Dam to reach Conowingo Dam, river flows must exceed 31,500 cfs. As indicated in Table 4.3-1, until Safe Harbor's hydraulic capacity of 110,000 cfs is exceeded, the material trapped at Holtwood is from the watershed of its reservoir, Lake Aldred.

The Conowingo Dam utilizes limited active storage in combination with the operation of the Muddy Run Pumped Storage Project to meet peak electrical demand. The maximum hydraulic capacity of the Conowingo powerhouse is 86,000 cfs (Exelon 2009). When this flow is exceeded water and debris are carried through dam gates, over the dam spillway and downstream. When river flows are below 31,500 cfs, the debris reaching and trapped at Conowingo comes from the Conowingo Pond watershed. When river flow exceeds the Holtwood hydraulic capacity (31,500 cfs), yet remains below Conowingo's hydraulic capacity (86,000 cfs), debris from both the Lake Aldred and Conowingo Pond watersheds will be trapped at Conowingo. This same material will pass Conowingo only when 86,000 cfs is exceeded.

[5] http://nwis.waterdata.usgs.gov/nwis
[6] Safe Harbor Water Power Corporation website. http://www.shwpc.com/facts_figures.html.

Debris from the entire lower Susquehanna River watershed does not reach Conowingo until it can pass Safe Harbor, at flows over 110,000 cfs. At 110,000 cfs Conowingo Project will have at least two crest gates open; most debris passes through both the Safe Harbor and Conowingo crest gates. Debris is never intentionally diverted over the spillway at Conowingo but passes only when flows exceed the Project hydraulic capacity and crest gates are opened.

The quantity of debris reaching Conowingo Dam is a combined function of the varied hydraulic capacities of upstream facilities and changing contributing watershed areas. It is therefore not surprising there is no obvious relationship between river flow and quantity of debris removal at Conowingo Dam. Additionally, the trapping of debris at the mouths of tributaries to Conowingo Pond reduces the quantity of material actually reaching Conowingo Dam from the pond watershed. This further skews the already non-direct relationship between river flow and debris removal at Conowingo Dam**.** And, debris remaining within Conowingo Pond between large flow events by stranding or lodging are related to storm flows that preceded the one that carried it to the dam.

Ultimately, when compared to the quantity of debris generated in the entire lower Susquehanna River watershed, relatively little debris reaches Conowingo Dam due to the trapping of debris at Safe Harbor and tributary mouths. The daily mean discharges measured at Conowingo were reviewed (January 1, 1968 through December 31, 2010). On average, Project capacity was exceeded 35 days per year during this period. In 2004 stream flows exceeded Project capacity a total of 77 days. When debris is trapped at Conowingo during the remainder of the year, the contributing watershed is either 314 square miles or 1,010 square miles, in contrast to the 27,100 square miles of total drainage upstream of Conowingo Dam (Table 4.3-1). This limits the quantity of debris available for removal at Conowingo which is reflected in the actual debris removal quantities provided in Tables 4.2-2 and 4.4.2.2-1 from Conowingo and Safe Harbor, respectively, for the same time period. Much less is removed at Conowingo because much less reaches Conowingo.

4.4 Debris Management Efforts

4.4.1 Conowingo Pond and Below the Dam

Exelon estimates approximately 75 percent of the debris removed at Conowingo Dam is natural and the remaining 25 percent is artificial. At present, Exelon employs clamming (with three gantry cranes with grapple attachments) to remove submerged debris from the area upstream of the powerhouse intakes as well as floating surficial debris in front of the powerhouse intakes (Figure 4.4.1-1). Debris management activities do not take place during high river flows due to safety concerns.

Exelon does not remove debris before it reaches the upriver side of the dam. Exelon does, however, sponsor community-based clean-ups in the pond and downstream of the dam.

- The first annual Exelon Cleanup Day on June 11, 2011 collected nine 30-cubic yard dumpsters of debris and five drums of chemicals from Hopkins Cove, Glen Cove, Broad Creek boat launch, Line Bridge Road launch, and Dorsey Park. Trash, tires, sunken boats, lawn furniture, and bottles were hauled off-site by a commercial waste disposal company.

- An April 2011 clean-up of the Conowingo Creek launch collected one 30-cubic yard dumpster of debris hauled off-site by a commercial waste disposal company.

- The Lower Susquehanna Heritage Greenway River Sweep on April 23, 2011, an annual event co-sponsored by Exelon, removed 24-tons of debris (tires, propane tanks, glass, toys, and textiles)[7] downstream of the dam at Port Deposit, Havre de Grace, and Exelon's Octoraro Creek Trail.

4.4.2 Upstream Hydroelectric Facilities

The following information was provided to Exelon by York Haven Power Corporation (YHPC), Safe Harbor Water Power Corporation (SHWPC), and PPL Holtwood LLC (Appendix B).

4.4.2.1 York Haven Dam

The York Haven facility has a limited ability to collect and remove debris. The project's hydraulic capacity is 16,000 cfs. When the flow is exceeded most of the debris is spilled over the project's two dams. This condition occurs more than 60 percent of the time.

Debris management at York Haven focuses on clearing the trash racks that protect the intakes and generating units, and clearing the forebay to maintain unrestricted flow to the units. Rack cleaning is performed by a trash rake which guides debris to a sluice gate which is opened to return trash rack and forebay debris to the river. An effort is made to remove artificial debris in the forebay prior to opening the sluice. Chainsaws attached to long, stout poles are used to cut up logs.

In addition, York Haven routinely collects and disposes of debris at recreation areas and uses boats and divers to collect trash. It is estimated that approximately 25 cubic yards of debris per year is removed in this manner

[7] Theresa G. Wiseman (Lower Susquehanna Heritage Greenway). Rain-Soaked River Sweep. *Enviro News: A newsletter for environmental programs in Harford County*. Fall 2011. p.3

4.4.2.2 Safe Harbor Dam

Debris is removed at Safe Harbor Dam with a clam shell at the skimmer wall and unit intakes, and a trash rake on intake screens. The types of debris removed at Safe Harbor include natural tree wood, tree foliage, grasses, trash (e.g., bottles appliances, LP gas tanks, tires and rims, plastic 55-gallon drums) and dead animals (e.g., deer, pigs, fish, turtles, birds, cattle). Natural debris is ground and used for fuel at a co-generation trash burning plant and material that is already decayed is used for compost. Artificial material is disposed at an off-site landfill. The quantity of debris collected 2005 through 2010 is shown in Table 4.4.2.2-1.

4.4.2.3 Holtwood Dam

A trash rake suspended from an overhead bridge crane is used to remove debris on unit intake screens. Wood and plastics are segregated and disposed of as wood only or plastics mixed with incidental station maintenance waste to the Lancaster County solid waste Management Authority. Holtwood estimates that 110 to 150 tons of wood debris is removed annually. Quantification of the amount of artificial debris removed is precluded because of the mixing with facility debris. Debris removal at the existing skimmer wall is hindered by accessibility. A new skimmer wall upstream of the station is being installed as part of the Holtwood Project expansion. This is will improve access to the river and debris removal.

4.4.3 Debris Management at Other Recent FERC Relicensing Projects

When available, debris management practices for FERC projects are readily accessible and represent current practices. Therefore, Exelon also reviewed debris management practices reported at projects that recently underwent FERC relicensing. To be relevant to the Conowingo Project, projects in the mid-Atlantic region of the country were examined (Claytor Lake Hydroelectric Project and Smith Mountain Hydroelectric Project, both in Virginia).

A Debris Management Study was prepared in support of Appalachian Power Company's Claytor Lake Hydroelectric Project near Blacksburg, Virginia (Kleinschmidt 2008b). At Claytor Lake, a 4,400 acre impoundment, debris removal is accomplished solely through a non-profit organization to which the facility donates equipment. These efforts are done on the impoundment prior to reaching facility intakes.

The Smith Mountain Hydroelectric Project, also in Virginia, impounds an area of 20,600 acres with a drainage area of approximately 1,029 square miles (Kleinschmidt 2008a). Debris removal within the impoundment is achieved with a mechanical skimmer boat. The lake area is so large and dendritic much of the debris never reaches the intakes for removal. Debris is generally removed within coves of the lake

where it collects rather than at the project intakes. During large debris flows a contractor provides additional removal capabilities.

In a survey of facility operators and debris management plans filed with FERC (described in a FERC filing related to the Smith Mountain Project proceeding) it is reported that hydroelectric facilities, in general, manage debris once it reaches forebays or intakes. Debris typically accumulates at overflow dams until high waters pass it downstream. Material will be physically removed by trash rakes or other equipment if it cannot be passed and may be hauled to a disposal facility. At reservoirs, facilities generally support volunteer clean-up efforts.

5.0 CONCLUSIONS

This study fulfills the three study objectives defined in Section 1.0.

1. Debris management activities to remove debris trapped behind Conowingo Dam take place under safe low flow conditions. The varying hydraulic capacities of upstream facilities, and varying contributing watershed areas to Conowingo Dam under different river flow conditions, combine to influence the amount of debris that reaches Conowingo Dam such that there is no direct relationship between river flow and the quantity of debris removed.

   At river flows under 31,500 cfs (hydraulic capacity of Holtwood) the debris trapped by Conowingo Dam originates from the tributaries of Conowingo Pond while Holtwood traps upstream debris. Additionally, much of the tributary debris is trapped at stream mouths and does not reach Conowingo.

   At flows greater than 31,500 cfs and less than 86,000 cfs (hydraulic capacity of Conowingo) the debris reaching and being trapped at Conowingo includes material that passes Holtwood as well as Conowingo Pond tributary debris. Since debris will not pass Safe Harbor until flows of 110,000 cfs are exceeded, the material passing Holtwood under these conditions is from tributaries to Lake Aldred. Once river flow exceeds 86,000 cfs, debris is no longer trapped at Conowingo but passes through the dam.

2. The review of the debris management practices of the three upstream facilities and other recent FERC relicensing projects indicates that the practices implemented at Conowingo Dam are similar to, and consistent with, the typical best management practices of other hydroelectric facilities.

3. Conowingo Dam practices are consistent with other facilities. Therefore, there is no need to institute additional practices..

TABLE 4.2-1: QUANTITY OF DEBRIS COLLECTED AT CONOWINGO DAM (1989 - 1998)

Year	Volume Removed (cy)
1989	4,350
1990	4,160
1991	2,960
1992	2,880
1993	3,000
1994	3,600
1995	0
1996	1,634
1997	60
1998	900

TABLE 4.2-2: DEBRIS REMOVAL ACTIVITIES AT CONOWINGO DAM (2004 - 2010)

Year	Clamming		Skimming	
	Days Active	Dumpster Loads[1]	Days Active	Skimmer Loads[1]
2004	40	-	69	-
2005	75	-	3	-
2006	27	53 (636 cy)	17	46
2007	45	71 (852 cy)	3	15
2008	26	46 (552 cy)	5	8
2009	43	88 (1,056 cy)	*	*
2010	19	102 (2,040 cy)[2]	*	*
2011[3]	19	77 (1,540 cy)[2]	*	*

[1] Each dumpster load is approximately 30 cy and each skimmer load is approximately 12 cy

[2] Each dumpster load is approximately 20 cy

[3] Through September 15, 2011

* Skimmer was retired in 2008.

TABLE 4.3-1: IMPACTS OF UPSTREAM HYDRO FACILITIES ON DEBRIS REACHING CONOWINGO DAM AT VARYING RIVER FLOWS.

River Flow (cfs) *	York Haven (YH)		Safe Harbor (SH)		Holtwood (H)		Conowingo (C)	
	Debris	Source	Debris	Source	Debris	Source	Debris	Source
<31,500	passes	watershed upstream of YH (25,022 sq. miles)	trapped	watershed upstream of SH (26,090 sq. miles)	trapped	Lake Aldred watershed (696 sq. miles)	trapped	Conowingo Pond watershed (314 sq. miles)
>31,500 - 86,000	passes	watershed upstream of YH (25,022 sq. miles)	trapped	watershed upstream of SH (26,090 sq. miles)	passes	Lake Aldred watershed (696 sq. miles)	trapped	Lake Aldred & Conowingo Pond watershed (1010 sq. miles)
> 86,000 - 110,000	passes	watershed upstream of YH (25,022 sq. miles)	trapped	watershed upstream of SH (26,090 sq. miles)	passes	Lake Aldred watershed (696 sq. miles)	passes	Lake Aldred & Conowingo Pond watershed (1010 sq. miles)
> 110,000	passes	watershed upstream of YH (25,022 sq. miles)	passes	watershed upstream of SH (26,090 sq. miles)	passes	watershed upstream of H (26,786 sq. miles)	passes	watershed upstream of C (27,100 sq. miles)

* Hydraulic Capacities

31,500 cfs (H)

86,000 cfs (C)

110,000 cfs (SH)

TABLE 4.4.2.2-1: VOLUME OF DEBRIS COLLECTED AT SAFE HARBOR DAM (2005-2010).

Year	Clamming (cu yds)
2005	690
2006	4,545
2007	2,505
2008	4,545
2009	11,865
2010*	5,610

*** Data through July 2010**
Source: Safe Harbor Water Power Company

FIGURE 4.1.1-1: NATURAL DEBRIS ALONG THE EASTERN SHORELINE OF CONOWINGO POND (AUGUST 2010)

FIGURE 4.1.1-2: ACCUMULATION OF DEBRIS AT THE CONOWINGO DAM INTAKE STRUCTURE

FIGURE 4.1.1-3: LARGE LOG STRANDED ATOP BEDROCK ISLAND IN HOLTWOOD GORGE (OCTOBER 2006)

FIGURE 4.1.1-4: NATURAL DEBRIS STRANDED AT MT. JOHNSON ISLAND DURING LOW POOL LEVEL (JULY 2007)

FIGURE 4.1.1-5: DEBRIS COLLECTING AT A RAILROAD CULVERT OUTLET (JUNE 2008)

FIGURE 4.1.1-6: DEBRIS BUILD-UP IN SMALL CULVERT (SOFT BALL IN FOREGROUND) (JUNE 2008)

FIGURE 4.1.1-7: DEBRIS BUILD-UP AT TRIBUTARY CULVERT (SEPTEMBER 2007)

FIGURE 4.1.1-8: CLOSE-UP OF THE TRASH DEBRIS TRAPPED AT CULVERT (JULY 2008)

FIGURE 4.1.1-9: GREAT BLUE HERON USING DEBRIS TO REST AND FORAGE (JULY 2007)

FIGURE 4.1.1-10: CLOSE-UP OF GREAT BLUE HERON RESTING ON NATURAL DEBRIS (JULY 2007)

FIGURE 4.1.1-11: SMALL TERN RESTING ON FLOATING DEBRIS (SEPTEMBER 2007)

FIGURE 4.1.1-12: GREAT BLUE HERON CAPTURES SMALL FISH FROM SHORELINE DEBRIS (MAY 2007)

FIGURE 4.1.2-13: NATURAL AND ARTIFICIAL DEBRIS ON POINT BAR ACROSS FROM PEACH BOTTOM MARINA IN PETERS CREEK (MAY 2007)

FIGURE 4.1.2-2: ABANDONED DOCK NEAR MOUTH OF MUDDY CREEK (JULY 2008)

FIGURE 4.1.2-3: COLLAPSING CINDER BLOCK BULKHEAD (MAY 2008)

FIGURE 4.3-1: AVERAGE MONTHLY FLOW VS. ANNUAL QUANTITY OF DEBRIS COLLECTED (1989 THROUGH 2009)

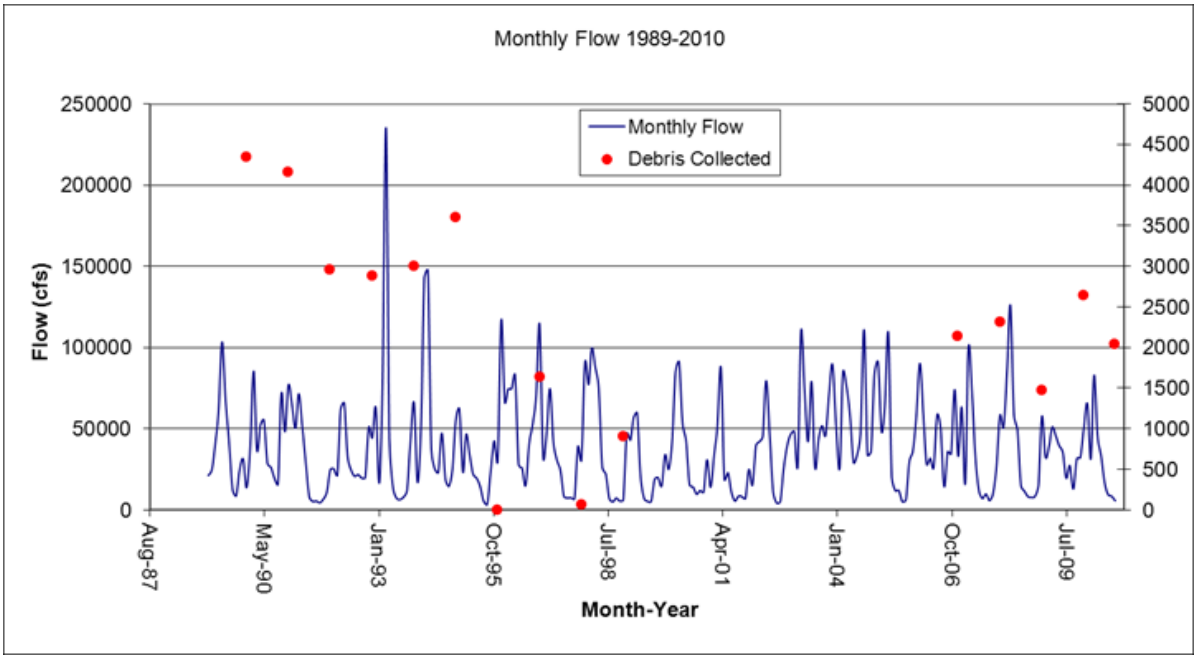

FIGURE 4.3-2: DEBRIS WITHIN TRIBUTARY. RAILROAD CULVERT IN BACKGROUND (SEPT 2007)

FIGURE 4.3-3: DEBRIS WITHIN TRIBUTARY. RAILROAD CULVERT IN BACKGROUND (SEPT 2007)

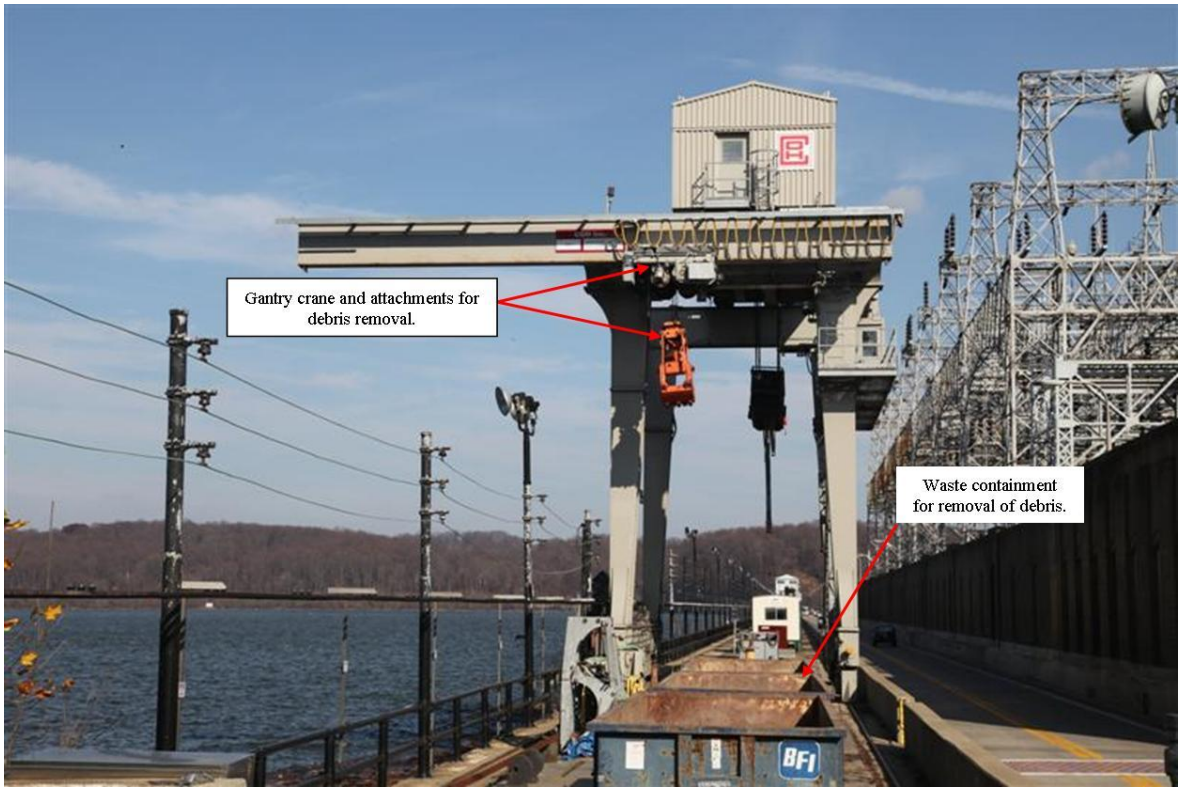

FIGURE 4.4.1-1: DEBRIS REMOVAL EQUIPMENT USED AT CONOWINGO DAM

6.0 REFERENCES

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APPENDIX A-UPSTREAM DAM OWNER CONTACT LETTERS

Exelon Power
300 Exelon Way
Kennett Square, PA 19348
Telephone 610.765.5826
Fax 610.765.5980
www.exeloncorp.com

Via Electronic Mail

Mr. Doug Weaver
York Haven Power Company, LLC
1 Hydro Park Drive and Locust Street
York Haven, PA 17370

RE: Request for Information on Debris Management Practices

Dear Doug,

We are requesting operational information in regards to debris management at your facility. As part of Exelon's ongoing FERC relicensing effort it was requested to identify the debris management practices of hydroelectric facilities upstream of Conowingo Dam and assess the impact on debris accumulation in the Conowingo Pond. This information will ultimately be used in the Debris Study Report submitted to FERC as an Initial Study Report.

Please provide the following information as it pertains to your facility;

- Methods of debris removal
- Types of debris removed (wood, plastic, metal, etc)
- Source of debris disposal
- Quantity of material removed annually (past 5+ years)

Any additional information in regards to debris management at your facility would be welcomed.

If possible, your response to this matter by August 27, 2010 would be greatly appreciated. If you have any questions please feel free to contact Dr. Marjorie L. Zeff, 215-367-2549, marjorie_zeff@urscorp.com.

Respectfully submitted,

Colleen E. Hicks
Manager Regulatory and Licensing, Hydro
Exelon Power

Exelon Power
300 Exelon Way
Kennett Square, PA 19348
Telephone 610.765.5826
Fax 610.765.5980
www.exeloncorp.com

Via Electronic Mail

Mr. Juan Kimble, P.E.
President and Chief Executive Officer
Safe Harbor Water Power Corporation
1 Powerhouse Road
Conestoga, PA 17516

RE: Request for Information on Debris Management Practices

Dear Juan,

We are requesting operational information in regards to debris management at your facility. As part of Exelon's ongoing FERC relicensing effort it was requested to identify the debris management practices of hydroelectric facilities upstream of Conowingo Dam and assess the impact on debris accumulation in the Conowingo Pond. This information will ultimately be used in the Debris Study Report submitted to FERC as an Initial Study Report.

Please provide the following information as it pertains to your facility;

- Methods of debris removal
- Types of debris removed (wood, plastic, metal, etc)
- Source of debris disposal
- Quantity of material removed annually (past 5+ years)

Any additional information in regards to debris management at your facility would be welcomed.

If possible, your response to this matter by August 27, 2010 would be greatly appreciated. If you have any questions please feel free to contact Dr. Marjorie L. Zeff, 215-367-2549, marjorie_zeff@urscorp.com.

Respectfully submitted,

Colleen E. Hicks
Manager Regulatory and Licensing, Hydro
Exelon Power

Exelon Power
300 Exelon Way
Kennett Square, PA 19348
Telephone 610.765.5826
Fax 610.765.5980
www.exeloncorp.com

Via Electronic Mail

Mr. Christian N. Porse
Site Supervisor
PPL Holtwood LLC
482 Old Holtwood Road
Holtwood, PA 17532

RE: Request for Information on Debris Management Practices

Dear Chris,

We are requesting operational information in regards to debris management at your facility. As part of Exelon's ongoing FERC relicensing effort it was requested to identify the debris management practices of hydroelectric facilities upstream of Conowingo Dam and assess the impact on debris accumulation in the Conowingo Pond. This information will ultimately be used in the Debris Study Report submitted to FERC as an Initial Study Report.

Please provide the following information as it pertains to your facility;

- Methods of debris removal
- Types of debris removed (wood, plastic, metal, etc)
- Source of debris disposal
- Quantity of material removed annually (past 5+ years)

Any additional information in regards to debris management at your facility would be welcomed.

If possible, your response to this matter by August 27, 2010 would be greatly appreciated. If you have any questions please feel free to contact Dr. Marjorie L. Zeff, 215-367-2549, marjorie_zeff@urscorp.com.

Respectfully,

Colleen E. Hicks
Manager Regulatory and Licensing, Hydro
Exelon Power

APPENDIX B-UPSTREAM DAM OWNER RESPONSE LETTERS

YHPC, LLC.
Water Power for the Future
http//www.yorkhavenpower.com

York Haven Hydro Station
Hydro Park Drive & Locust Street
PO Box 67
York Haven, PA 17370

717-266-6454
717-266-9472 (fax)

October 9, 2010

Colleen E. Hicks
Manager, Regulatory and Licensing, Hydro
Exelon Power
300 Exelon Way
Kennett Square, PA 19348

Re: Request for Information on Debris Management Practices

Dear Ms. Hicks:

This letter responds to your letter transmitted via e-mail on August 5, 2010, requesting information concerning the debris management practices at the York Haven Project.

The York Haven Project has only limited capacity to intercept and remove debris emanating from the upstream drainage area. As you are aware, the York Haven Project is the most upstream of the four hydroelectric projects on the lower Susquehanna River, and receives water from a drainage basin of 24,973 square miles above the project (representing nearly 40,000 linear miles of streams. The Project has a 20-unit facility with 7 vertical turbine generators and 13 horizontal units, having a combined installed capacity of 19.650 kW.

Compared to other hydro facilities on the Susquehanna mainstem, the configuration of the York Haven project is unusual. The headrace is formed by a 3,000 foot stone masonry wall that extends north from the powerhouse to the main dam. The powerhouse sits within the river, aligned parallel to natural river flow. The concrete-covered, rock-filled dam extends from the end of the headrace's masonry wall in the western portion of the River for approximately 5,000 feet in a northeast direction to Three Mile Island, with a maximum height of 17 feet and an average height of 10 feet; and a gravity overflow dam, known as the East Channel Dam, extends approximately 950 feet from the east shore of Three Mile Island to the east bank of the River.

The Susquehanna River Basin Commission has estimated that approximately 90 percent of river debris is transported during high flow, as it is during these times that the shorelines of the mainstem and tributaries are scoured. When river flow exceeds the York Haven project's hydraulic capacity of 16,000 cfs, which is approximately 63 percent of the time, water is spilled over the Project's two dams, and most of the river-borne debris is carried naturally downstream.

Only a small portion of the river-borne debris enters the York Haven Project's headrace annually. In 1985, the Project's operators estimated that roughly 5,000 cubic yards, or 1,300 tons of debris, enters the headrace on an annual basis. The preponderance of this material (over 90 percent) is leaves, grass, twigs and shorter food material. Man-made material accounts for an estimated 5 percent of the total, and includes tires, plastics, bottles, cans, parts of structures (such as piers, wharves and bulkheads) and an occasional appliance or steel drum. The remaining material involves larger trees and an occasional land animal carcass.

The existing debris management at the York Haven Project is focused on keeping the trash racks that protect the generating units in good working order, and clearing the forebay to provide unrestricted flow to the units so as to minimize head losses and maintain engineering integrity. The intake structure is constructed on the upstream face of the powerhouse and is approximately 25 feet tall. The intake structure is protected by a trashrack that slopes at approximately 30 degrees from vertical. The rack cleaning is performed by a trash rake, where raking teeth are moved up and down the trash rack. Because the original powerhouse design called for manual raking, the platform above the intake structure is very narrow.

Debris on the trashrack is guided down the face of the sluice by the trash rake. Once the rake is near the sluice gate, the sluice gate is opened and debris from the trash rakes and in the forebay is returned to the river. The project makes reasonable efforts to remove man-made trash from the forebay prior to opening the sluice, although in high flow conditions not all of such debris is safely accessible.

Debris management at the York Haven Project continues to be a labor-intensive activity, including efforts by operators using chainsaws attached to long, stout poles to cut up logs. York Haven routinely collects and disposes of debris at recreational use areas, and uses boats and divers to collect trash upstream of the channel. Although we do not have specific records of the amount of debris removed from the river, we would estimate it to be in the range of up to 25 cubic yards per year.

The limitations confronted by the York Haven Project in terms of debris management and removal capability have been discussed in some detail with the Pennsylvania Department of Environmental Protection ("PaDEP"). These discussions led to the conclusion that, given the hydraulic and engineering limits confronted at this site, York Haven is implementing the maximum practicable program.

Should you have any questions regarding the above response, please contact me at your convenience.

Sincerely,

D E Weaver /s

Douglas E Weaver

Douglas Weaver
Project Manager

Enclosures

Safe Harbor Water Power Corporation

1 POWERHOUSE ROAD, CONESTOGA, PA 17516-9651 ■ Telephone 717-872-0225 ■ Fax 717-872-0223

JUAN A. KIMBLE
PRESIDENT AND & CEO

Email
jkimble@shwpc.com
http://www.shwpc.com

REGULATORY,
ENVIRONMENTAL & SAFETY

AUG 17 2010

August 11, 2010

Ms. Colleen E. Hicks
Manager Regulatory and Licensing, Hydro
Exelon Power
300 Exelon Way
Kennett Square, PA 19348

Request for Information on Debris Management Practices

Dear Ms. Hicks:

Please find the following response to your request for our debris operational information:

- Methods of debris removal: Clam shelling at our skimmer wall and unit intakes and trash rake operation on unit intake screens.

- Types of debris removed: Natural tree wood, tree foliage and grasses; manmade trash (i.e. bottles, appliances, LP gas tanks, tires & rims, plastic 55 gal. drums, etc.) and dead animals (deer, pigs, fish, turtles, birds, cattle, etc.)

- Source of debris disposal: Natural tree wood, tree foliage and grasses are reduced in size by an industrial grinding machine by an outside contractor with most of the decayed material removed. The ground natural materials are used for fuel at a co-generation trash burning plant. The wood grinding contractor uses the decayed natural material along with other soil to create top soil.
  All manmade materials removed from the natural materials including the tires and rims are disposed of at a landfill.

- Quantities of materials removed annually estimated in cubic yards:

2005:	690
2006:	4,545
2007:	2,505
2008:	4,545
2009:	11,865
Year to date July 2010:	5,610

The above information is the current process at Safe Harbor. I hope this data is helpful for your study.

Sincerely,

Juan A. Kimble

Copy: Guy W. Hager
John H. Kaufman, Jr.
Ted C. Rineer

PPL Holtwood, LLC
482 Old Holtwood Road
Holtwood, PA 17532-9720
Tel. 717.284.6200 Fax 717.284.6234
ncporse@pplweb.com

November 8, 2010

REGULATORY, ENVIRONMENTAL & SAFETY
NOV 16 2010

Ms. Colleen E. Hicks
Manager Regulatory and Licensing, Hydro
Exelon Power
300 Exelon Way
Kennett Square, PA 19348

Re: Request for Information on Debris Management Practices

Dear Colleen,

As requested I am providing information on the debris handling and disposal practices at the PPL Holtwood Hydroelectric Station.

- Methods of debris removal

  Debris is removed from the hydroelectric unit intake trash screens by raking the screens. A trash rake suspended from an overhead bridge crane is utilized. Debris removal at the skimmer wall is hampered by accessibility and overflow conditions on the dam.

- Types of debris removed (wood, plastic, metal, etc.)

  All manner of wood and plastic materials are collected and disposed. Materials are segregated and disposed either as wood only or plastics that are mixed with plant incidental maintenance waste.

- Source of debris disposal

  All materials are handled by Lancaster County Solid Waste Management Authority.

- Quantity of material removed annually

  Wood debris removed annually averages 100 to 150 tons. Other man-made debris cannot be quantified due to mixing with plant incidental maintenance waste.

As you are aware, the expansion project is currently in process at Holtwood. Included in the work scope is a new skimmer wall upstream of the plant that will provide improved equipment access to the river area. As identified in the agreement between Exelon Power and PPL Holtwood LLC, future efforts at debris removal at Holtwood will be undertaken as a result of the improved access.

I trust this provides the information needed. If you have further questions, please contact me.

Sincerely,

N. Christian Porse
Site Supervisor
PPL Holtwood LLC

cc: M. Bennett PPL
P. Hackenbrack PPL

Attachment N

Conowingo Hydroelectric Project
(FERC Project No. 405)

Sediment Management Plan

CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NUMBER 405

SEDIMENT MANAGEMENT PLAN

Prepared for:

Exelon.

Prepared by:

GOMEZ AND SULLIVAN ENGINEERS

August 2012
(Revised September 2021)

EXECUTIVE SUMMARY

To address sediment accumulation within the Project boundary, the Conowingo Hydroelectric Project (FERC Conowingo Project No. 405 or Project) draft Sediment Management Plan (2012 Plan) was developed in 2012 at the Federal Energy Regulatory Commission's (FERC or the Commission) request[1]. Historically, sediment accumulation has occurred at three of the Project recreation sites: Broad Creek, Conowingo Creek, and Peach Bottom Marina. High-sediment watershed loadings due to agricultural land use contribute heavily to sedimentation at the three recreation sites. Sediment accumulation at recreation facilities limits boat launch egress and ingress. Figure 1-1 shows the location of these sites relative to Conowingo Dam.

On March 19, 2021, FERC issued a new license for the Conowingo Project. In License Article 420 of the new license, FERC requires that Exelon Generation Company, LLC (Exelon) file a revised Sediment Management Plan (Plan) with the following revisions:

> a) 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 sediment has been accumulating, in order to improve and maintain recreational boating access. The provision should address how the dredged material will be disposed.
>
> b) A provision that beginning in 2022, the licensee must conduct a bathymetric survey of Conowingo Pond at 5-year intervals to monitor sediment transport and depositional patterns within the pond. The licensee must file the results of each bathymetric survey with the Commission by March 31 of the following year. The results of each bathymetric survey must include an analysis of any change in sediment deposition or scour in the pond from the previous survey(s), including the 2011 survey, so that any changes in sediment depositional or scour patterns in the pond over time since the 2011 survey can be monitored.
>
> c) Measures (e.g., metrics for magnitude or frequency of sediment loading following high flows and storm events) that would trigger action to maintain boating access between the 5-year monitoring intervals.

The Sediment Management Plan is also cross referenced in the Recreation Plan, which has been submitted for FERC approval.

As a result, Exelon has updated the 2012 Plan to incorporate the requirements of License Article 420 as well as to include information on the 2019 and 2020 Peach Bottom Marina Dredging project and findings of additional investigations and data collected since the draft version of the Plan was filed in 2012.

Monitoring

The revised Sediment Management Plan outlines specific monitoring measures that will be implemented to identify sediment transport and depositional patterns at the Project, and impaired boating use at recreation facilities. Bathymetric surveys of Conowingo Pond, including the boating recreation facilities, will be performed at five-year intervals. The results of each bathymetric survey will include an analysis of any change in sediment deposition or scour in Conowingo Pond from the previous survey(s) so that any changes

[1] In its Year Two Determination on Requests for Modifications to the Project Study Plan on May 21, 2012, the FERC required Exelon, to develop a Sediment Management Plan for inclusion in its Final License Application. On August 31, 2012 Exelon filed a draft of the Plan with FERC which was included as Appendix C in the FLA.

in sediment depositional or scour patterns in the Pond can be monitored. Exelon will monitor water depth at the three recreational boating facilities with bathymetric monitoring every five years and biannual water depth monitoring at the three recreation boating facilities.

A bathymetric survey of Conowingo Pond and the three recreation sites was most recently performed in August 2020 to prepare dredging feasibility assessments for these sites.

In addition, Exelon proposes to conduct post-construction bathymetric surveys at the recreation facilities after each dredging event for up to three years following construction upon approval from FERC. Post-construction monitoring surveys will be conducted twice a year, once between May 1st and Memorial Day (after spring runoff and before the recreational boating season) and between Labor Day and October 1st. These post-construction surveys will be used to determine sedimentation rates at the recreation sites and assess dredging benchmarks and frequency. Exelon will conduct post-construction bathymetric surveys in 2022 and 2023 at Peters Creek[2]. Given the land use similarities within the watersheds, observations from the post-construction bathymetric surveys at Peters Creek will be used to inform approaches to future dredging activities at Conowingo Creek.

Benchmarks and Evaluation of Actions

Per Article 406, the licensee must operate the Project with a normal range of operation for Conowingo Pond between elevations 101.2 NGVD29 and 110.2 NGVD29, with a minimum elevation of 107.2 feet NGVD 29 on weekends between Memorial Day and Labor Day, to meet recreational needs. Based on the monitoring described above, when water depth or bathymetric data indicate that navigation channel bed elevations exceed elevation 103.2 NGVD[3] at the recreation boating sites, Exelon will evaluate what actions to implement to alleviate impaired boating use at the recreational facilities. Potential actions include dredging of the problem areas as well as alternative recreation use at the sites, which may require less dredging or no dredging. In its evaluation, Exelon will consider several factors, including but not limited to recreation usage of the site and associated draft needs, dredging alternatives (e.g., maintenance dredging), estimated cost versus benefit, sediment disposal and beneficial/innovative reuse options, and environmental factors such as the presence of protected species and habitat (e.g., northern map turtle[4]).

Based on the benchmark of channel elevations exceeding elevation 103.2 ft NGVD, a bathymetric survey conducted in August 2020 indicates action needs to be taken at Broad Creek. The channel bed elevations generally varied from 104-105 NGVD at Broad Creek. Approximately 3,100 CY needs to be excavated from Broad Creek to maintain adequate draft in the channel for boating. Exelon proposes to dredge Broad Creek by 2027 pending receipt of all necessary local, state, and federal approvals. The overall implementation schedule for sediment management activities is provided in Table E-1.

[2] Exelon conducted post-construction bathymetric surveys at Peters Creek in March 2020 and August 2020.

[3] State Organization for Boating Access (SOBA) recommends the water at the toe of launching ramps and boat channels be a minimum of three feet deep for motorized boating (SOBA 2006). Conowingo Pond is maintained at elevation 107.2 feet NGVD during the recreation season (Memorial Day through Labor Day). Therefore, when the elevations within the channels at Peters Creek, Broad Creek, or Conowingo Creek exceed 104.2 feet, motorized boating could be impaired at the recreation pond level. Therefore, when channel elevations are at elevation 103.2 NGVD or above based on monitoring, Exelon will consider actions to alleviate potential impaired boating use, including dredging of the problem areas as well as alternative recreation use at the sites which may require less dredging or no dredging.

[4] Following approval of the Conowingo Hydroelectric Project Northern Map Turtle Protection Plan, Exelon will conduct ten years of northern map turtle population monitoring as stipulated in Article 424 of the new FERC license.

The bathymetric survey conducted in August 2020 indicates action may also be required at Conowingo Creek to restore adequate water depth for motorized boating. However, due to ongoing concerns with sedimentation influx of the recently dredged Peach Bottom Marina (in 2019/2020), Exelon is proposing to delay starting the Conowingo Creek restoration design and permitting process until post-construction bathymetric information can be obtained at Peach Bottom Marina. A report of findings and dredging recommendations or alternatives will be completed by August 31, 2024.

The implementation schedule shown in Table E-1 takes into account the various phases of a dredging project from pre-design data collection to site restoration/closeout. Additional site-specific data that could be needed includes additional sediment testing, dredging feasibility analyses, investigation of sediment disposal and beneficial/innovative options, additional data on sensitive resources such as northern map turtles and consultation with resource agencies on mitigative measures, recreation usage data, and post-construction monitoring at Peach Bottom Marina. Exelon will initiate consultation with the USACE, PADEP, and MDE with regards to maintenance dredging at the three recent sites based on the post construction bathymetric mapping and begin development of permit applications.

Table E-1 Implementation Schedule

Task	Begin	End	Frequency
Bathymetric Surveys of Conowingo Pond & Recreation Sites	2022	2070	Every 5 years
Bathymetric Survey Report[5]	2023	2071	Every 5 years
Water Depth Monitoring	2022	2070	May and Sept. every year
Peach Bottom Marina			
Initial Peach Bottom Marina Dredging	2015	2020	
Subsequent Peach Bottom Marina Dredging[6]	TBD	TBD	
Broad Creek			
Initial Broad Creek Dredging	2022	2027	
BC - Pre-Design Data Collection	2022	2022	
BC - Design	2022	2023	
BC – Permitting	2024	2026	
BC – Construction	2026	2027	
BC – Site Restoration/Permit Closeout	2027	2027	

[5] Report to be filed every five years by March 31 of the year following five-year bathymetric surveys.

[6] Exelon's determination of dredging frequency at this site will be based on post-construction bathymetric monitoring, a site-specific recreation use assessment at Peach Bottom Marina, and receipt of map turtle survey and other Rare, Threatened, Endangered species data. Exelon is initiating preparation and submittal of maintenance dredging permits and consultations for Peach Bottom Marina based upon the recent dredging of the marina.

Task	Begin	End	Frequency
Subsequent Broad Creek Dredging[7]	TBD	TBD	
Conowingo Creek			
Initial Conowingo Creek Dredging[8]	2024	2029	
CC – Pre-Design Data Collection	2024	2024	
CC - Design	2024	2025	
CC – Permitting	2026	2028	
CC – Construction	2028	2029	
CC – Site Restoration/Permit Closeout	2029	2029	
Subsequent Conowingo Creek Dredging[9]	TBD	TBD	
Post Construction Bathymetric Surveys			
Peach Bottom Marina[10]	2022	2023	May and Sept. for 2 years following construction
Broad Creek	2028	2030	May and Sept. for 3 years following construction
Conowingo Creek	2030	2032	May and Sept. for 3 years following construction

2019/2020 Peach Bottom Marina Dredging Project

Between August 2019 and June 2020, Exelon dredged approximately 9,500 cubic yards (CY) of sediment from Peters Creek at Peach Bottom Marina to restore boating access at the site. The dredging area included dredging on the Susquehanna River side of the Norfolk Southern Railroad train trestle to provide access from the marina to the Susquehanna River.[11] Construction involved both conventional hydraulic and mechanical dredging because of varying sediment grain sizes and difficult maneuverability near the boat launch caused by the narrow channel and water levels. In order to create a dewatering area, the steep marina parking lot was temporarily demolished and regraded. The temporary grading of the marina parking lot required the excavation and temporary relocation of approximately 12,000 cubic yards of earth. After dewatering was complete, the parking lot was regraded and repaved. The sediment was transported from

[7] Exelon's determination of dredging frequency at this site will be based on post-construction bathymetric monitoring, a site-specific recreation use assessment at Broad Creek, and receipt of map turtle survey and other Rare, Threatened, Endangered species data.

[8] Given the impact on dredging design, Exelon will start the dredging design process at Conowingo Creek after the post-construction bathymetric monitoring at Peach Bottom Marina.

[9] Exelon's determination of dredging frequency at this site will be based on post-construction bathymetric monitoring, a site-specific recreation use assessment at Conowingo Creek, and receipt of map turtle survey and other Rare, Threatened, Endangered species data.

[10] Post construction surveys at Peach Bottom Marina were conducted in March and August 2020.

[11] Dredging equipment had to be mobilized twice with cranes to dredge on both sides of the trestle.

the dewatering site to land that Exelon owned in Fulton Township, Pennsylvania. The overall cost of the project was approximately $5.5 M (~$579/CY). The time for design, permitting, procurement of a contractor, and construction was five years and included time of year restrictions for in-water work due to the Chesapeake Logperch and working outside of the recreation season (after Labor Day).

Sediment Loadings

A comparison of the post-construction survey of the Peach Bottom Marina dredging area performed in March 2020 with the August 2020 bathymetric survey indicates that the channel has filled in between 1-2 feet in certain locations within the dredged channel since the March 2020 post-construction survey. Most of the channel appears to be navigable.

The aggradation of the channel in a short duration is evidence of high watershed sediment loading in Peters Creek, which is primarily caused by agricultural land use (86% of the sediment loading is from cropland). Modification of land use practices is outside of Exelon's control and the corresponding sediment loading to Peach Bottom Marina will likely continue to be high in the future. The annual sediment loading for Conowingo Creek, whose land use is also characterized by a high percentage of agricultural land, is 2.5 times that of Peters Creek. The annual sediment loading for Broad Creek is 32% more than Peters Creek, but the watershed is four times larger. Based on estimated annual sediment loadings, frequent aggradation at the recreational boating sites is expected over the life of the license.

Sediment Sampling

Exelon has collected several sediment samples at each of the three recreation boating sites since the draft Plan was filed in 2012. Sediment samples at Broad Creek, Conowingo Creek, and Peters Creek were obtained in 2012. The grain-size at Broad Creek varied between 74% fines (silts/clays) in 2012 to approximately 41% fines in 2020, while the samples revealed the sediment composition at Conowingo Creek remained consistent at approximately 72% fines. The grain size at Peters Creek varied between 60% and 58% fines for the 2012 and 2015 data sets, respectively.

Analytical test results were compared to current clean fill management policies in Maryland and Pennsylvania as shown in Tables E-2 and E-3. The results indicate that dredged spoil disposal options may potentially be limited by analytical test results, which exceed Maryland and Pennsylvania state thresholds for exceedances of arsenic (MD/PA), thallium (MD), nickel (MD), and ammonia (PA) concentrations[12].

Table E-2: 2020 Sediment Sampling – Maryland Analyte Exceedances

		Analyte		
Screening Criteria		**Arsenic (mg/kg)**	**Thallium (mg/kg)**	**Nickel (mg/kg)**
EPA Screening Level I (Residential)[13]		0.68	0.078	82
EPA Screening Level II (Non-residential)[11]		3.0	1.2	1100
Sample Location	**Sample ID**			
Conowingo Creek	CC - 1	7.1	0.15	130
	CC - 2	7.1	0.12	100

[12] Analytical sampling results from 2015 for sediment at Peters Creek prior to dredging exceeded the Pennsylvania state threshold for cobalt.

[13] Screening levels in this Table are based on a Hazard Quotient of 0.1.

		Analyte		
Broad Creek	BC - 1	4.3	0.12	56
	BC -2	16	0.15	370

The EPA regional screening levels vary based on what is referred to as the hazard quotient (HQ), the ratio of exposure concentration to a reference concentration where there are observable health effects. The regional screening levels (RSLs) vary between either using an HQ of 0.1 or 1.0. For the purposes of the table above, an HQ of 0.1 was selected for the initial screening based on recommendations in the Maryland Innovative Reuse and Beneficial Use of Dredged Material Guidance Document (MDE 2019). Use of a HQ of 0.1 results in a lower screening value by a factor of 10 then a HQ of 1.0. For sediment samples with one or only a few analytes that exceed these conservative screening levels, the regulating agency for sediment disposal/reuse (MDE) may adjust the HQ screening levels to 1.0. This would increase the residential arsenic screening level to 6.8, thallium screening level to 0.78, and nickel screening level to 820. In this case CC-1, CC-2, and BC-2 would only exceed residential use screening levels for arsenic and none of the samples would exceed residential use screening levels for thallium or nickel.

Exelon will consult with MDE about whether background levels of arsenic, thallium, and nickel are similar to those from Conowingo Creek and Broad Creek and whether their disposal or re-use would be restricted to non-residential/industrial uses.

In addition, Exelon will explore the possibility of disposing sediment from Conowingo Creek and Broad Creek on its Fulton Hill property in Pennsylvania. Based on the analytical tests, one of the Conowingo Creek samples exceeded the clean fill standard for ammonia and one of the Broad Creek samples exceeded the clean fill standard for arsenic. Therefore, sediment from Conowingo Creek and Broad Creek could not be disposed of at the Fulton Hill site without further discussion with PADEP about whether it was possible if testing of background levels indicated similar levels of ammonia and arsenic.

Table E-3. 2020 Sediment Sampling – Pennsylvania Analyte Exceedances

		Analyte	
Screening Criteria		Ammonia (mg/kg)	Arsenic (mg/kg)
Clean Fill Limit		360	12
Sample Location	**Sample ID**		
Conowingo Creek	CC - 1	460.0	7.1
	CC - 2	130.0	7.1
Broad Creek	BC - 1	89.0	4.3
	BC -2	100.0	16.0

Dredging Technology Review

Since the August 2012 draft Sediment Management Plan was filed, Exelon has conducted literature reviews of conventional and innovative dredging technologies and reviewed their applicability to sediment management at the Conowingo recreation sites. Conventional hydraulic dredging, which was performed at Peach Bottom Marina, appears to be the most complicated and requires the most space for staging and dewatering of sediment and is not conducive to sites with a lot of debris or coarse gravel/sediment (upstream of Peach Bottom Marina boat launch). Utilizing conventional hydraulic dredging is likely the least suitable sediment removal method for these sites given the limited open/flat space adjacent to the coves.

The mechanical dredging approach used to dredge upstream of the boat launch at Peach Bottom Marina was less complicated than the initial hydraulic dredging approach. Mechanical dredges are capable of

removing coarse sediment and debris. There are more pieces of equipment in the water compared to hydraulic dredging and there is more material handling required, but the upland footprint of the work area required for dredging is minimal and there is much less water management involved. The mechanical dredging approach used at Peters Creek could likely be replicated at the Broad Creek and Conowingo Creek sites. However, similar to conventional hydraulic dredges, any conventional mechanical dredges at Peters Creek or Conowingo Creek in the future would potentially need to be mobilized twice, with cranes, if sediment removal was required on both sides of the Norfolk Southern Railroad train trestle at each cove.

Steep upland slopes, the presence of railroad trestles at two sites, and limited space for dewatering increase the difficulty of using traditional dredging and dewatering methods. These constraints also increase the level of effort needed for site analysis, design and permitting. In addition, the effects on the environment can be high due to the need for upland tree clearing and earthwork regrading (e.g., for leveling a dewatering pad). Collectively these impacts increase cost and prolong project schedule. As such, Exelon's strategies will incorporate alternative dredging technologies and innovative beneficial reuse of the dredged sediment as a means of reducing schedule duration, cost, environmental, and recreational impacts associated with the dredging projects. To this end, Exelon investigated innovative dredging technologies, such as the Dino6 dredge by Geoform International Inc. and Sand Wand and Sediment Collector technologies by Streamside Systems, Inc. Based on the size of the equipment and potential dewatering systems required, a Dino6 dredge may be a potential sediment removal method to consider for annual or maintenance dredging at the recreation sites. Exelon will continue to explore alternative dredging and material handling technologies as the engineering design and environmental permit requirements are prepared for each site.

Dredged Material Disposal Alternatives

Several end uses for dredged material were evaluated since the draft Plan was filed in August 2012, including landfill disposal, beneficial or innovative reuse, and disposal on Exelon property (i.e., at Fulton Hill where the Peach Bottom Marina dredged material was placed). Landfill disposal is expensive because of transport costs and tipping fees. A preliminary investigation of beneficial reuse included using excavated dredge material for wetland enhancement, shoreline stabilization or habitat improvement projects was conducted, and additional work will occur as part of the design and permitting work to determine if a suitable location is present in the Conowingo Project. Offsite and on-site innovative reuses were evaluated and some may have potential, such as sieving the material into different gradation sizes for Conowingo Project reuse. Coarse dredged material greater than ½" could potentially be used for aggregate in construction, such as road repair or other minor projects surrounding Conowingo Pond at the Project. The August 2020 analytical testing results indicate the fine dredged material could potentially be reused on-site at the Conowingo Project but it would require further consultation with MDE.

Off-site innovative uses include but are not limited to manufacturing structural fill, traffic barriers, bricks, permeable pavers, or soil for growing sod. Beneficial reuse alternatives will be explored more fully as the engineering design and environmental permit requirements are prepared for each site.

Environmental Considerations

An important consideration in the determination of whether dredging is suitable for the recreation boat sites is potential impacts to sensitive environmental resources, such as special status species and their habitats. Depending on the particular impact involved, such as northern map turtle in Broad Creek and Conowingo Creek, Project impacts may be mitigated by decreasing or avoiding dredging or by considering a change to the recreation opportunities at the site (e.g., changing use from motorized boating to canoes and kayaks) to

reduce impacts. Consultations with resource agencies such as MDNR and Towson University will occur as part of design and permitting of the dredging projects.

Another way to mitigate potential impacts to protected plant and animal species is to avoid specific activities during certain times of the year. However, following time-of-year restrictions for dredging activities for all of the potential identified sensitive species may preclude dredging at any time of the year. Therefore, alternative mitigation measures will need to be developed in coordination with the resource agencies in order to allow dredging. Of particular note are northern map turtle basking areas at Broad Creek and Conowingo Creek. The northern map turtle is listed as threatened in Maryland and a species of conservation concern in Pennsylvania. Any changes to the type of recreational boating or amenity at these sites in the future will be coordinated with the Recreation Plan under Article 426. Public outreach and consultation with Resource Agencies will occur with any changes submitted to FERC for approval.

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LIST OF ABBREVIATIONS

BMP	best management practice
BUILD	Beneficial Use: Identifying Locations for Dredge
CDF	confined disposal facility
Conowingo Project	Conowingo Hydroelectric Project
CY	cubic yards
DMMP	dredged material management program
EPA	Environmental Protection Agency
Exelon	Exelon Generation Company, LLC
FERC or the Commission	Federal Energy Regulatory Commission
FLA	Final License Application
GIS	geographic information system
GPM	gallons per minute
HQ	hazard quotient
kW	kilowatt
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MDOT MPA	Maryland Department of Transportation Maryland Port Authority
MDS	Mobile Dewatering System
mg/kg	milligram per kilogram
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWI	National Wetlands Inventory
PADEP	Pennsylvania Department of Environmental Protection
PCBs	polychlorinated biphenyls
PFBC	Pennsylvania Fish and Boat Commission
Plan or SMP	Sediment Management Plan
ROE	right of entry
RSLs	regional screening levels
RUSLE	Revised Universal Soil Loss Equation
SOBA	State Organization for Boating Access
TCLP-RCRA	Toxicity Characteristic Leaching Procedure – Resource Recovery and Conservation Act
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

1 INTRODUCTION

Exelon Generation Company, LLC (Exelon) operates the Conowingo Hydroelectric Conowingo Project (Project), located on the Susquehanna River in Maryland. The Project is operated under a Federal Energy Regulatory Commission License (Project No. 405), with the most recent license issued March 19, 2021. The Project boundary encompasses approximately 9,923 acres, including Conowingo Pond (Pond), the dam, the powerhouse, the tailrace, and the project's 15 recreation sites.

Historically, sediment accumulation has occurred at three of the Project recreation boating sites: Broad Creek, Conowingo Creek, and Peach Bottom Marina. Shallow water depths due to sediment accumulation limit boat launch egress and ingress. Figure 1-1 shows the location of the recreation boating sites relative to Conowingo Dam. Exelon is required to operate and maintain Project recreation facilities according to the revised Recreation Management Plan as specified in Article 426 of the new license.

In 2012, Exelon filed a draft Sediment Management Plan (2012 Plan) with the Conowingo Final License Application (FLA). The 2012 Plan was developed to determine methods for identifying and addressing sediment accumulation issues at the Conowingo Dam powerhouse intake structure in addition to the three Project recreation facilities listed above. Components of the 2012 Plan included an inspection program to monitor sediment accumulation at the powerhouse intakes and evidence of abrasion for the turbines; bathymetric surveys of Conowingo Pond every five years; site-specific dredging evaluations at the recreation facilities, and the development of benchmarks for action. Sediment management at the Conowingo powerhouse intakes described in the 2012 Plan is considered maintenance so the associated monitoring, inspection, and any remedial actions are incorporated in the Conowingo FERC Operation and Maintenance Program.

In the FERC License dated March 19, 2021, Article 420, entitled *Sediment Management Plan,* requires Exelon to update the 2012 Plan filed with the 2012 FLA within six months of license issuance. The revisions to the 2012 Plan specified in Article 420 include the following:

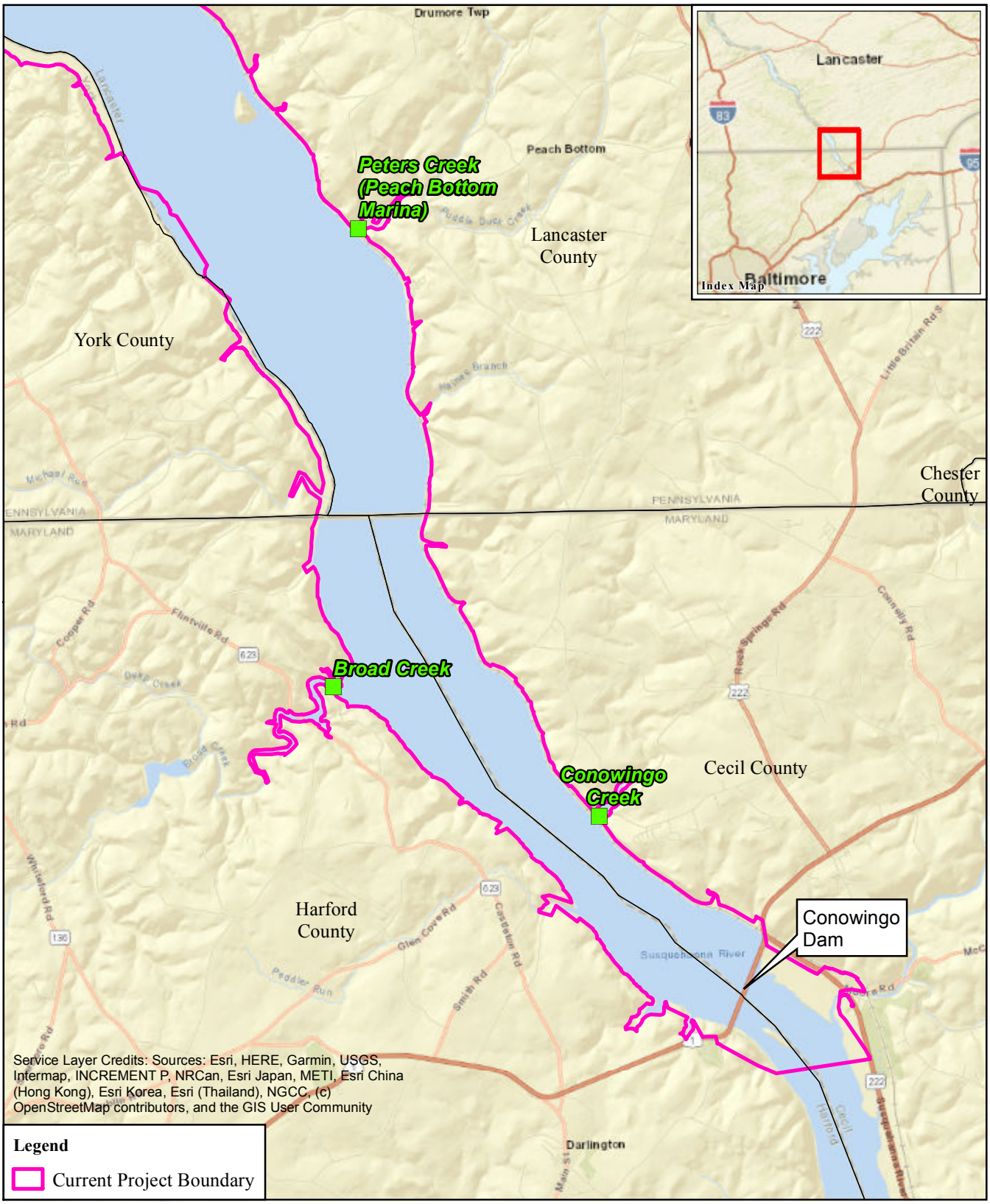
a) *A provision to conduct dredging with the frequency and depth needed to maintain the navigation channel at the Conowingo Creek, Peters Creek (Peach Bottom Marina), and Broad Creek boat ramps, where sediment has been accumulating, in order to improve and maintain recreational boating access. The provision should address how the dredged material will be disposed.*

b) *A provision that beginning in 2022, the licensee must conduct a bathymetric survey of Conowingo Pond at 5-year intervals to monitor sediment transport and depositional patterns within the pond. The licensee must file the results of each bathymetric survey with the Commission by March 31 of the following year. The results of each bathymetric survey must include an analysis of any change in sediment deposition or scour in the pond from the previous survey(s), including the 2011 survey, so that any changes in sediment depositional or scour patterns in the pond over time since the 2011 survey can be monitored.*

c) *Measures (e.g., metrics for magnitude or frequency of sediment loading following high flows and storm events) that would trigger action to maintain boating access between the 5-year monitoring intervals.*

The Sediment Management Plan (Plan) is also cross-referenced in the Recreation Management Plan.

The purpose of the Sediment Management Plan is to outline how Exelon intends to manage sedimentation at Exelon's boat launch facilities at Broad Creek, Conowingo Creek, and Peters Creek (i.e., Peach Bottom Marina).



EXELON GENERATION COMPANY, LLC

CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

N

0 0.5 1 2
Miles

Figure 1-1:
Location Map

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2 DREDGING CONSIDERATIONS

While developing the revised Plan, Exelon collected additional bathymetric and sediment data; calculated sediment loadings; and investigated sediment dredging methods and sediment disposal options, sensitive species and habitat considerations, and permitting requirements. Summaries of these efforts are summarized below.

2.1 Bathymetry

Conowingo Pond Bathymetric Data Collection

Bathymetric surveys of Conowingo Pond were conducted during the years 2011[14], 2013[15], 2014[16], 2015[17], 2016[18] and 2020. Occasionally, the lower portions of some tributaries and coves were entered, but the data collected in those locations was minimal given the large extent of the Conowingo Pond surveys. Figure 2.1-1 shows a map of the riverbed elevation within Conowingo Pond based on the 2020 survey.

Peters Creek Construction Surveys (August 2019 – March 2020)

In the fall of 2019 prior to dredging Peach Bottom Marina, a pre-construction bathymetric survey was conducted to check the predicted dredging volume. The survey/dredging area covered the Peters Creek channel starting approximately 300 ft upstream of the marina boat ramp and extended approximately 700 ft into the Susquehanna River beyond the train trestle. A post-construction survey of the dredging area was performed in March 2020.

August 2020 Survey

A bathymetric survey was conducted for Conowingo Pond, Broad Creek, Conowingo Creek, and Peters Creek (Peach Bottom Marina) during the week of August 10, 2020. Bathymetric data was collected using an Acoustic Doppler Current Profiler linked to a Real-Time Kinematic Global Positioning System unit. Figure 2.1-1 through Figure 2.1-4 show the results of the August 2020 bathymetric survey. Figure 2.1-2 shows bathymetric mapping for Broad Creek at two different scales- zoomed in at 1"=100' for details of observation and sediment sampling locations and zoomed out at 1"=250' to see the entire areal extent of bathymetric mapping.

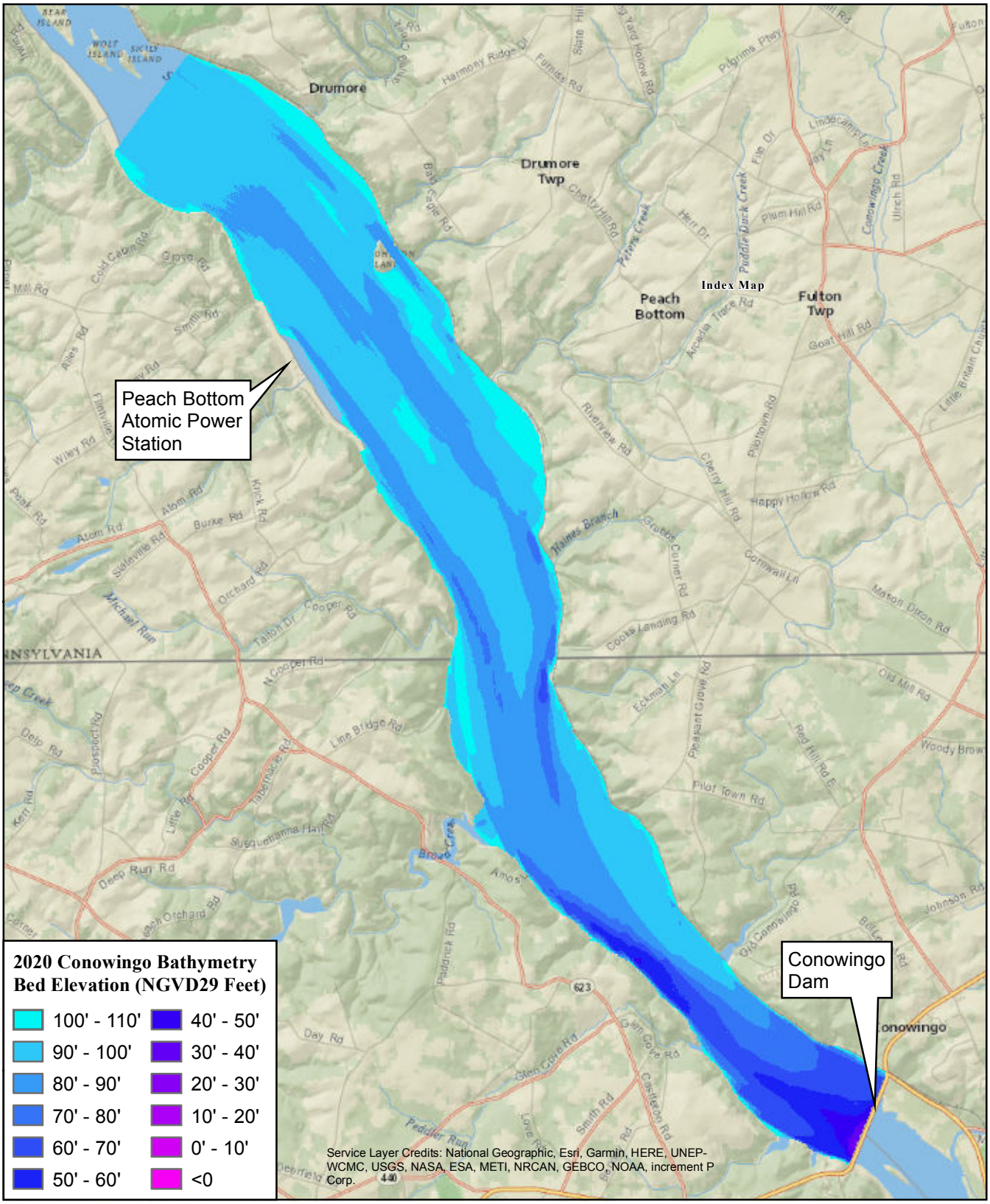
[14] Gomez and Sullivan Engineers, P.C. 2012. Conowingo Pond Bathymetry Survey Analysis. Internal memo prepared for Exelon Generation Company, LLC. Henniker, NH: Author.

[15] Gomez and Sullivan Engineers, D.P.C. 2014. Conowingo Pond 2013 Bathymetry Survey Analysis. Internal memo prepared for Exelon Generation Company, LLC. Henniker, NH: Author.

[16] Gomez and Sullivan Engineers, D.P.C. 2015. Conowingo Pond 2014 Bathymetry Survey Analysis. Internal memo prepared for Exelon Generation Company, LLC. Henniker, NH: Author.

[17] Gomez and Sullivan Engineers, D.P.C. 2017. Lower Susquehanna River Integrated Sediment and Nutrient Monitoring Program, Lower Susquehanna River Reservoir System Bathymetric Data Collection, Internal Final Report prepared for Exelon Generation Company, LLC. Henniker, NH: Author.

[18] Lower Susquehanna River Integrated Sediment and Nutrient Monitoring Program, Lower Susquehanna River Reservoir System Bathymetric Data Collection, Internal Final Report prepared for Exelon Generation Company, LLC. Henniker, NH: Author.



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N

0 0.5 1 2 Miles

Figure 2.1-1:
2020 Conowingo Pond Bed Elevation

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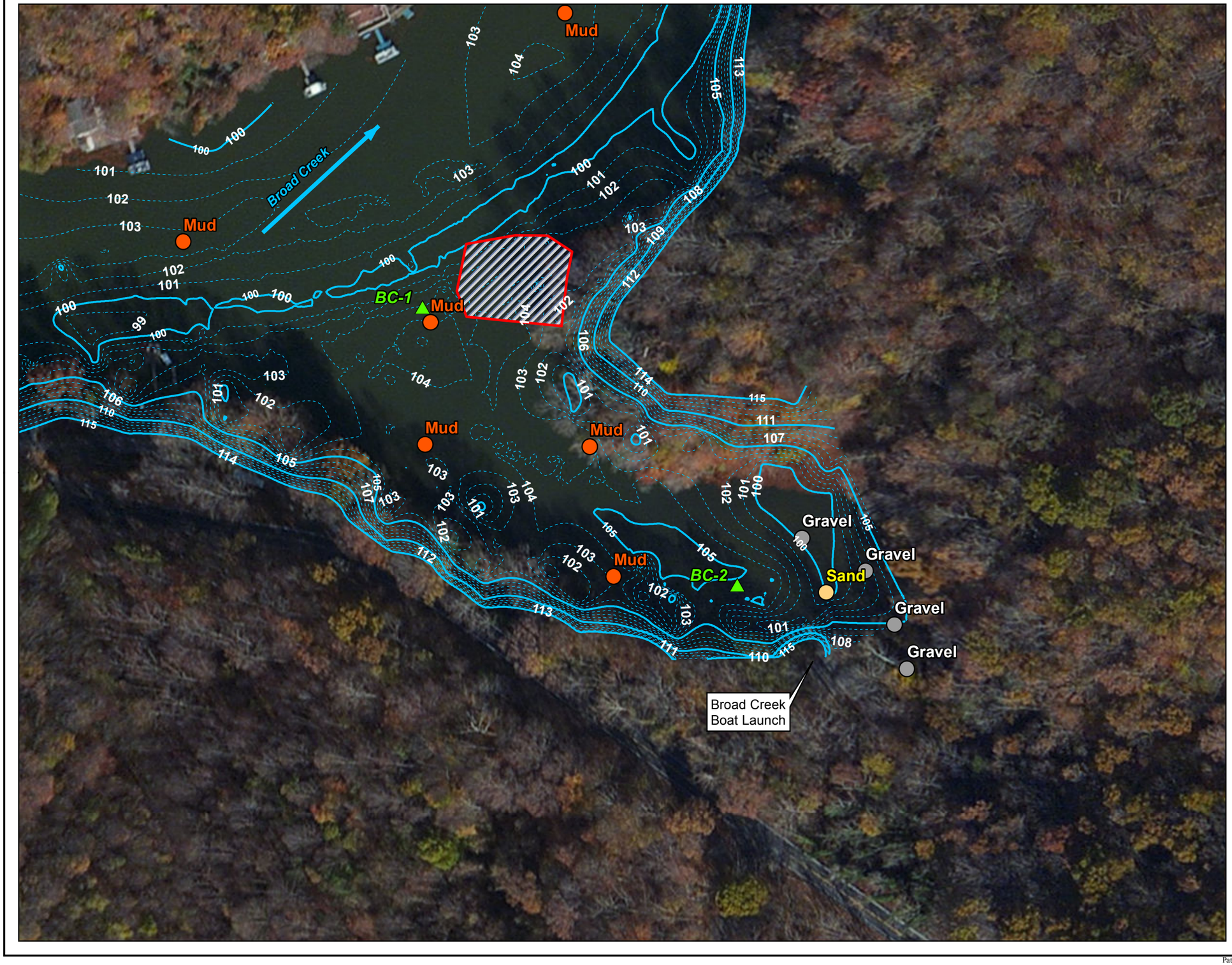

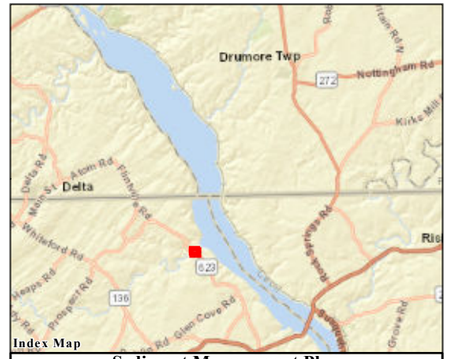

Sediment Management Plan

Figure 2.1-2:
2020 Broad Creek
Bathymetric and Sediment Survey
1 of 2

Legend

- Sampling Location
- 1 Foot Contour
- Major Contour (5 ft)
- Gravel Bar

Substrate

- Gravel
- Mud
- Sand

N

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)
Conversion: NAVD88 + 0.85 feet = NGVD29

Horizontal Datum: North American Datum of 1983 (NAD 83)
State Plane Maryland FIPS 1900 Feet Projection

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1 inch = 100 feet

0 50 100 200 Feet

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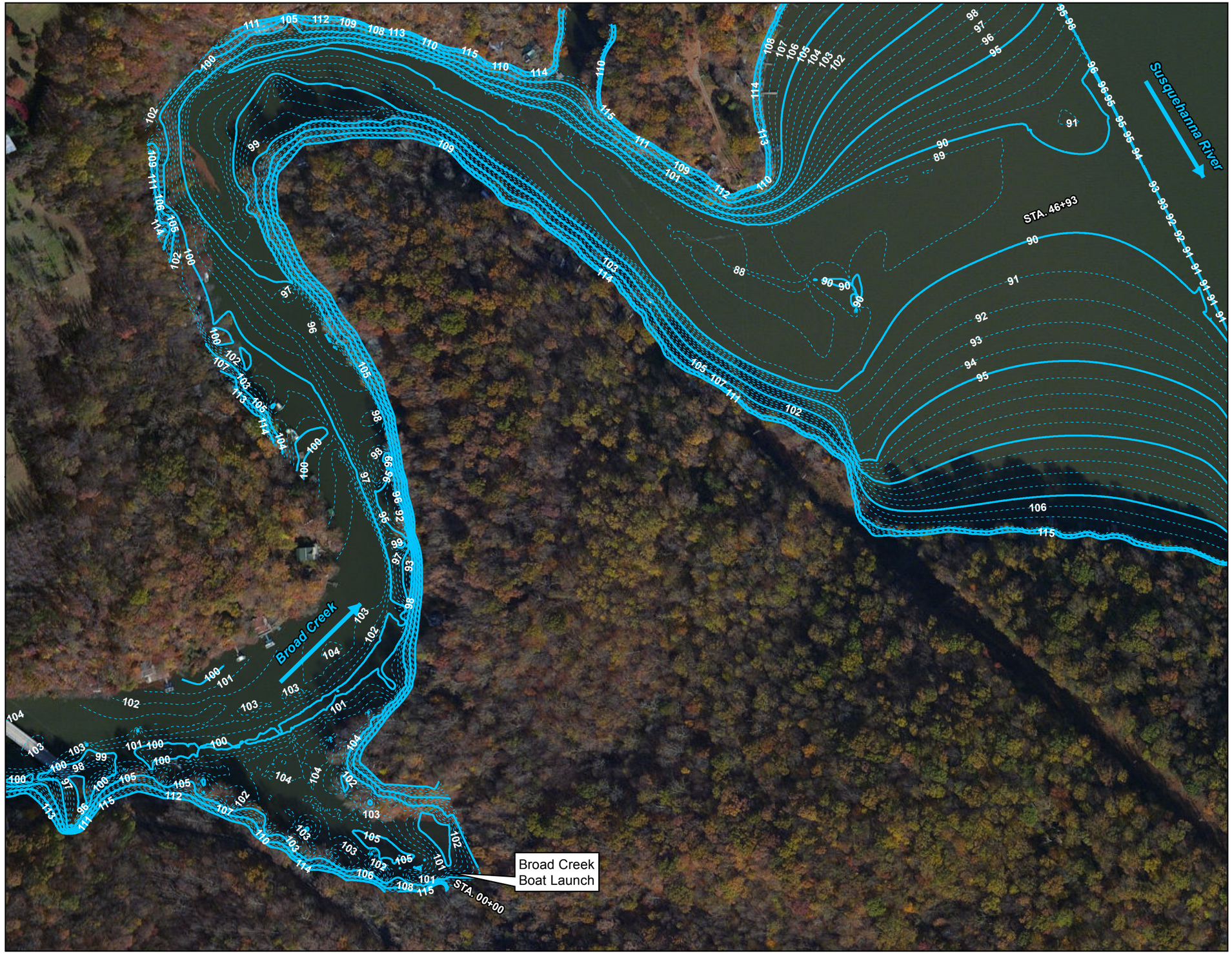

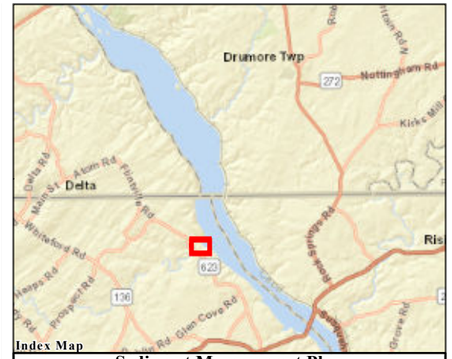

Sediment Management Plan

Figure 2.1-2:
2020 Broad Creek
Bathymetric Survey
2 of 2

Legend

- Major Contour (5 ft)
- 1 Foot Contour

N

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)
Conversion: NAVD88 + 0.85 feet = NGVD29

Horizontal Datum: North American Datum of 1983 (NAD 83)
State Plane Maryland FIPS 1900 Feet Projection

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
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1 inch = 250 feet

0 125 250 500 Feet

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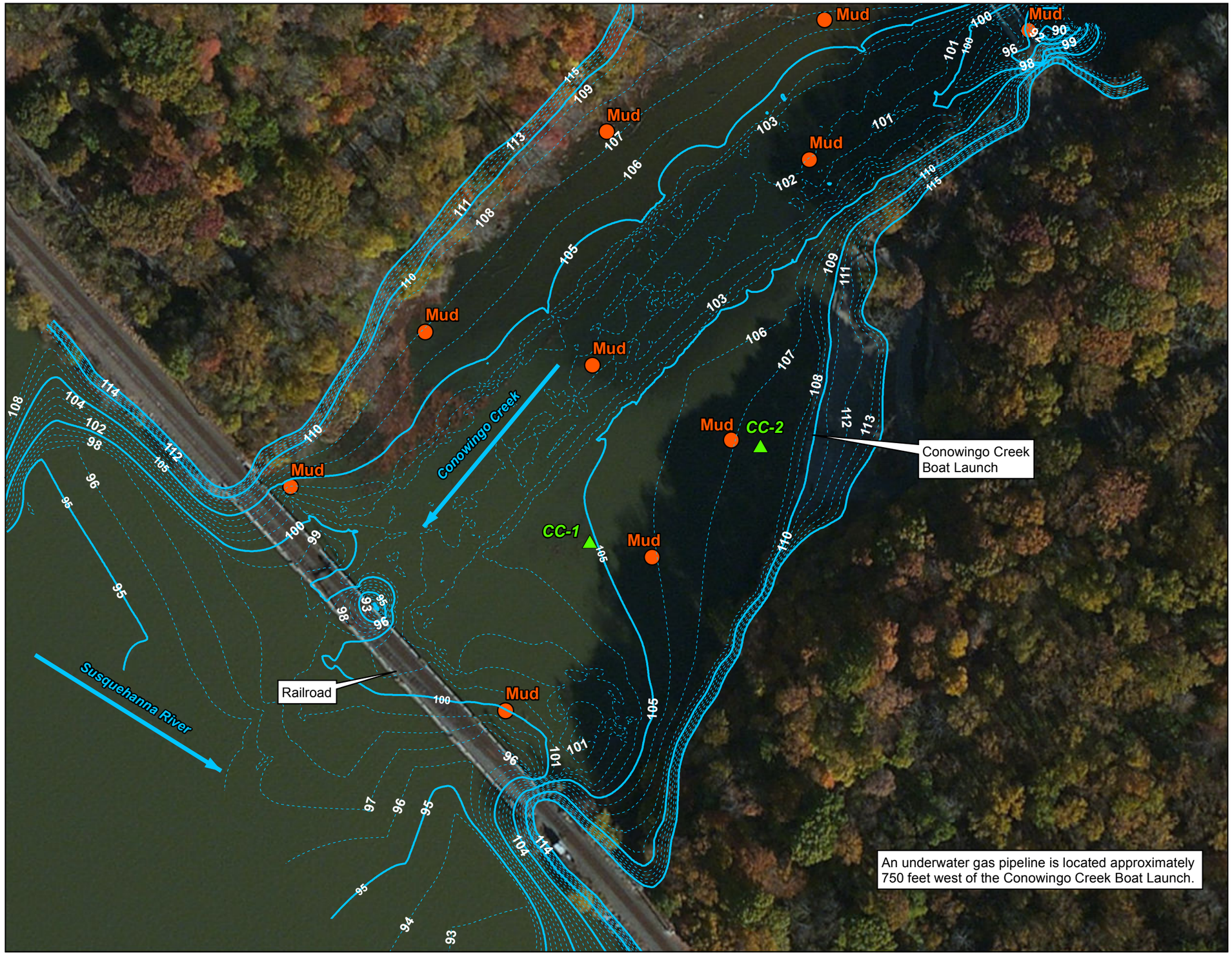

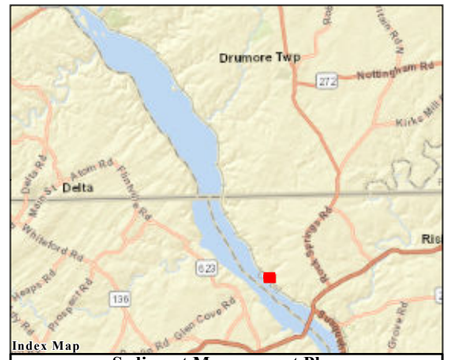

Sediment Management Plan

Figure 2.1-3:
2020 Conowingo Creek
Bathymetric and Sediment Survey

Legend

- Sampling Locations
- Major Contour (5 ft)
- 1 Foot Contour

Substrate

- Gravel
- Mud
- Sand

N

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)
Conversion: NAVD88 + 0.85 feet = NGVD29

Horizontal Datum: North American Datum of 1983 (NAD 83)
State Plane Maryland FIPS 1900 Feet Projection

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1 inch = 100 feet

0 50 100 200 Feet

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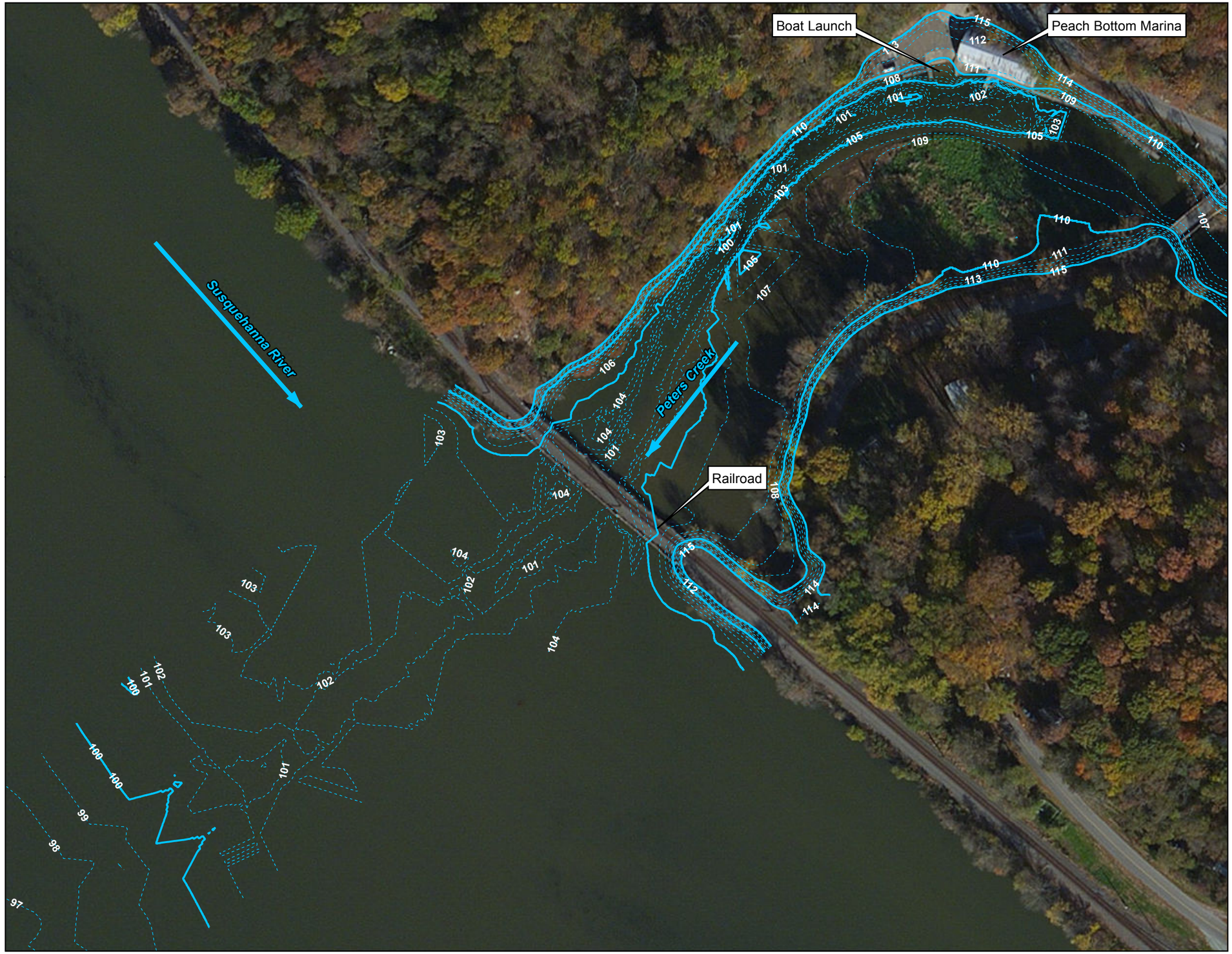

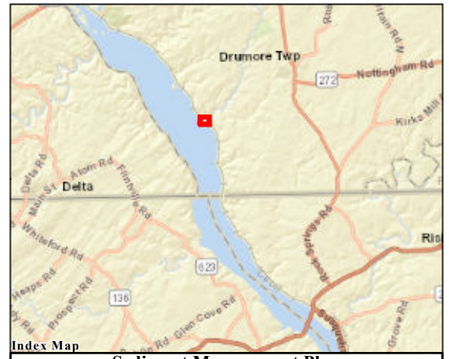

Sediment Management Plan

Figure 2.1-4:
2020 Peters Creek
Bathymetric and Sediment Survey

Legend

Major Contour (5 ft)

1 Foot Contour

N

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)
Conversion: NAVD88 + 0.85 feet = NGVD29

Horizontal Datum: North American Datum of 1983 (NAD 83)
State Plane Pennsylvania South FIPS 1900 Feet Projection

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1 inch = 125 feet

0 62.5 125 250 Feet

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2.2 Sediment Sampling

Various sediment sampling efforts have been performed within Broad Creek, Conowingo Creek and Peters Creek since the draft Sediment Management Plan was submitted with the FLA in 2012. The sediment sampling efforts summarized below indicate that dredged spoil disposal options may potentially be limited by analytical test results which exceed Pennsylvania and Maryland state thresholds for exceedances of cobalt (PA), arsenic (MD and PA), thallium (MD), nickel (MD), and ammonia (PA) concentrations.

S.T. Hudson Engineers, Inc. 2013 Sediment Sampling Report

In December 2012, S.T. Hudson Engineers collected six core samples within Conowingo Creek, Peters Creek, and Broad Creek. Sediment sample analysis included particle size distribution (grain-size), and analytical testing for the following: semi-volatile organics, metals, polychlorinated biphenyls (PCBs), pesticides, dioxins, gross Alpha and Beta, Radium 226-228 Gamma Spec, and full toxicity characteristic leaching procedure – Resource Recovery and Conservation Act (TCLP-RCRA) testing. Broad Creek and Conowingo Creek are in Maryland, and Peters Creek is in Pennsylvania.

The only analyte identified that prevented the sediment at Broad Creek, Conowingo Creek, and Peters Creek from meeting Pennsylvania Department of Environmental Protection (PADEP) and Maryland Department of the Environment (MDE) clean fill criteria was elevated concentrations of cobalt. Cobalt concentrations at these three sites ranged from 17.1 – 30 mg/kg. The PADEP Clean Fill Policy (Document No. 258-2182-773) dated August 7, 2010, listed the residential limit for cobalt as 8.1 mg/kg and the non-residential limit for cobalt in Clean Fill as 22 mg/kg. On January 16, 2021, PADEP replaced the 2010 Clean Fill Policy with an updated version (Document No. 258-2182-773). In accordance with the 2021 policy, Table 4 from Appendix A of 25 Pa. Code, Chapter 250, indicates the clean fill concentration limit for cobalt was increased to 59 mg/kg (PADEP 2021). Therefore, cobalt levels demonstrated from the 2012 samples no longer exceed Pennsylvania clean fill limits.

In Maryland, the determination for clean fill is based upon United States Environmental Protection Agency (EPA) standards. Based on the May 2021 EPA standards, the cobalt levels at Broad Creek and Conowingo Creek exceed the standard for Category I/Resident Soils (2.3 mg/kg) and fall under the Category II/Industrial Soils standard (35 mg/kg)[19]. Category II soils may be used at all non-residential and non-recreational sites without restriction (MDE 2017)[20].

Grain-size analyses revealed the sediment was primarily brown-clayey silt at Broad Creek, consisting of 74% fines (passing #200 sieve), 25% sand, and 1% gravel. Sediment at Conowingo Creek was classified as brown silt with 72% fines, 26% sand, and 2% gravel. Sediment at Peters Creek was classified as brown silt and clay with an average of 60% fines, 30% sand, and 10% gravel.

Peach Bottom Marina Dredging Sediment Sampling (2015)

In 2015, sediment samples were collected for every 1,000 CY of sediment to be dredged during the Peach Bottom Marina dredging project. For every 1,000 CY of sediment within the proposed dredge area, four sediment cores were taken. A volatile organics analysis "grab sample" was collected from one of the cores

[19] The EPA regional screening levels vary based on what is referred to as the hazard quotient (HQ), the ratio of exposure concentration to a reference concentration where there are observable health effects. The RSLs vary between either using an HQ of 0.1 or 1.0. For the purposes of this evaluation an HQ of 0.1 was selected for the initial screening based on recommendations in the 2019 innovative reuse and beneficial use guidance from MDE.

[20] Additional guidance on the reuse of various dredged materials/soils can be found here: https://mde.state.md.us/programs/Marylander/Documents/Dredging/Facts_about_Fill-Ver_1320on021617.pdf

and the remaining sediment (from all four cores) was combined into a single "composite sample" for semi-volatile, herbicide, pesticide, PCB and metals analysis. Results were compared to chemical thresholds provided in the PADEP Clean Fill Policy, which revealed that cobalt was the only analyte that exceeded the residential limit (8.1 mg/kg). Cobalt levels from the sediment sampling were determined to be between 16.2 and 26.3 mg/kg. A subsequent background analysis of cobalt in the drainage basin upstream of Peters Creek and in upland soils in December 2016 determined that the cobalt levels were consistent with area background levels and PADEP allowed unrestricted placement of the dredge spoils at the designated dredge spoil disposal area. Geotechnical tests including grain size analyses were also performed in 2015.

The grain size analyses indicated that the sediment in Peters Creek was classified as primarily brown silt and brown silty sand with some gravel. The sediment had an average of 58% fines, 31% sand, and 11% gravel.

Broad Creek and Conowingo Creek Sediment Sampling (2020)

In September 2020, a total of four sediment samples from Broad Creek (BC-1 and BC-2) and Conowingo Creek (CC-1 and CC-2) were collected (two for each site) for grain size analysis and analytical testing.[21] The sediment sampling locations are shown on Figure 2.1-2 and Figure 2.1-3. Analytical testing methods were selected based on the Maryland Innovative Reuse and Beneficial Use of Dredged Material Guidance Document (MDE 2019) and guidance from the laboratory. The chemical groups evaluated included metals, volatile organic compounds, semi-volatile organic compounds, PCBs, dioxins and furans, herbicides, pesticides, and nutrients. The State of Maryland utilizes EPA regional screening levels (RSLs) as described in the 2019 Reuse and Beneficial Use of Dredged Material Guidance Document published by MDE. The sampling results indicated that the samples exceeded EPA category I standard for residential use for thallium (0.078 mg/kg) and nickel (82 mg/kg) and the EPA Category II standard for non-residential restricted use soil and fill for Arsenic (3 mg/kg). Thallium levels varied between 0.12 and 0.15 mg/kg, nickel levels varied between 100 and 370 mg/kg and arsenic levels varied between 4.3 and 16 mg/kg. A comparison of the 2020 sediment samples to Maryland state standards is provided in Table 2.2-1.

Table 2.2-1: 2020 Sediment Sampling – Maryland Analyte Exceedances

		Analyte		
Screening Criteria		**Arsenic (mg/kg)**	**Thallium (mg/kg)**	**Nickel (mg/kg)**
EPA Screening Level I (Residential)[22]		0.68	0.078	82
EPA Screening Level II (Non-residential)[21]		3.0	1.2	1100
Sample Location	**Sample ID**			
Conowingo Creek	CC - 1	7.1	0.15	130
	CC - 2	7.1	0.12	100
Broad Creek	BC - 1	4.3	0.12	56
	BC -2	16	0.15	370

The EPA regional screening levels vary based on what is referred to as the hazard quotient (HQ), the ratio of exposure concentration to a reference concentration where there are observable health effects. The RSLs vary between either using an HQ of 0.1 or 1.0. For the purposes of the table above, an HQ of 0.1 was

[21] Additional sampling will be conducted as part of the design and permitting of Broad Creek and Conowingo Creek and options for sediment disposal will be re-evaluated.
[22] Screening levels in this Table are based on a Hazard Quotient of 0.1.

selected for the initial screening based on recommendations from the Innovative Reuse and Beneficial Use of Dredged Material Guidance Document (MDE, 2019). Use of a HQ of 0.1 results in a lower screening value by a factor of 10 then a HQ of 1.0. For sediment samples with one or only a few analytes that exceed the more conservative screening levels based on a HQ of 0.1, the regulating agency for sediment disposal/reuse (MDE) may adjust the HQ screening levels to 1.0. This would increase the residential arsenic screening level to 6.8, thallium screening level to 0.78, and nickel screening level to 820. In this case, CC-1, CC-2, and BC-2 would only exceed residential use screening levels for arsenic and none of the samples would exceed residential use screening levels for thallium or nickel.

Exelon will consult with MDE about whether background levels of arsenic, thallium, and nickel are similar to those from Conowingo Creek and Broad Creek and whether their disposal or re-use would be restricted to non-residential/industrial uses.

In addition, Exelon will explore the possibility of disposing sediment from Conowingo Creek and Broad Creek on its Fulton Hill property in Pennsylvania. Based on the analytical tests, one of the Conowingo Creek samples exceeded the clean fill standard for ammonia and one of the Broad Creek samples exceeded the clean fill standard for arsenic as shown in Table 2.2-2.Therefore, sediment from Conowingo Creek and Broad Creek could not be disposed of at the Fulton Hill site without further testing of background levels of ammonia and arsenic and consultation with PADEP.

Table 2.2-2. 2020 Sediment Sampling – Pennsylvania Analyte Exceedances

		Analyte	
Screening Criteria		Ammonia (mg/kg)	Arsenic (mg/kg)
Clean Fill Limit		360	12
Sample Location	**Sample ID**		
Conowingo Creek	CC - 1	460.0	7.1
	CC - 2	130.0	7.1
Broad Creek	BC - 1	89.0	4.3
	BC -2	100.0	16.0

Grain size analyses indicated the sediment at Broad Creek consisted of 41% fines, 48% sand, and 11% gravel on average while sediment at Conowingo Creek consisted of 72% fines, 27% sand, and 1% gravel.

2.3 Sediment Loading

The annual sediment loading rate can be used as a planning tool to estimate the volume of sediment that settles at a site on an annual basis, which can inform how often potential dredging may need to occur and to inform potential sediment management decisions. Annual sediment loading rates were estimated at Broad Creek, Conowingo Creek, and Peters Creek using a variety of methods as described below.

2.3.1 Modeling

Annual sediment loading rates for Broad Creek, Conowingo Creek, and Peters Creek (Peach Bottom Marina) were estimated using the Model My Watershed program, provided by the Stroud Water Research Center, in order to quantify the amount of sedimentation at these sites. Model My Watershed is a geographic information system (GIS) based watershed modeling tool that uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to model sediment and nutrient transport within a watershed. The model simulates runoff and sediment and nutrient loadings for source areas within a watershed using the SCS Curve Number approach and the Revised Universal Soil Loss Equation (RUSLE) equation. RUSLE was developed by the United States Department of Agriculture for

agricultural and forested watersheds to predict long term average soil losses due to overland flow. Land use within the watersheds at the three sites is predominantly cultivated crops, deciduous forest, and pasture/hay so use of the RUSLE equation to estimate annual sediment loading is appropriate for these watersheds.

The modeling approach assumed that the source of sediment at these coves is primarily from the tributary watershed versus the mainstem Susquehanna River. This assumption is consistent with observations from the Lower Susquehanna River Integrated Sediment and Nutrient Monitoring Program[23] and coarser sediment observed in Peters Creek versus the Susquehanna River during the dredging of Peters Creek in 2019 and 2020.

The predicted sediment loadings from the Model My Watershed computer program were compared with data collected in the field for a larger Conowingo Pond tributary, Muddy Creek. Muddy Creek has a drainage area of 138 mi^2 in comparison to the drainage areas for the watersheds of the recreation sites which range in size from 10 mi^2 for Peters Creek to 40 mi^2 for Broad Creek.

USGS obtained suspended sediment samples at Station 01577500 Muddy Creek at Castle Fin, PA from 2012 to 2019. Samples were obtained roughly two to three times per month during this period. The Model My Watershed program discussed above was used to model sediment loading rates in Muddy Creek. The results from this model were compared to the field measured data obtained from the USGS. Table 2.3.1-1 shows the results of the Model My Watershed program are the same order of magnitude as the observed data from Muddy Creek.

Table 2.3.1-1: Sediment Loading Muddy Creek Observations vs Modeling Results

Modeling Program	Sediment Load Results (kg/year)	% Difference
USGS Gage Muddy Creek	44,587,370	
Model My Watershed	36,909,350	-17%

Results of the modeling analysis for Broad Creek, Conowingo Creek, and Peters Creek as well as watershed characteristics such as size and slope are included in Table 2.3.1-2. Results indicate that sediment loadings for existing conditions at the three sites are high and are influenced highly by land use. This is especially true for Conowingo Creek and Peters Creek which are heavily used for agricultural purposes. Converting annual loadings from kilograms to cubic yards required estimating the sediment density based on the specific gravity and percent solids measured for each sediment sample and assuming that the sediment is fully saturated.

[23] Gomez and Sullivan Engineers, D.P.C. 2017. Lower Susquehanna River Integrated Sediment and Nutrient Monitoring Program, Lower Susquehanna River Reservoir System Bathymetric Data Collection, Internal Final Report prepared for Exelon Generation Company, LLC. Henniker, NH: Author.

Table 2.3.1-2: Sediment Loading Modeling Results

Site	Drainage Area (mi^2)	Mean Basin Slope (%)	Sediment Loading Rate (kg/yr)	Loading Rate Per Square Mile ($kg/mi^2/yr$)	Percent Sediment Load from Croplands	Saturated Density (per cubic foot)	Volume of Sediment Deposited (CY/yr)[24]
Broad Creek	40	8.9	5,060,501	126,513	55%	138.0	2,993
Conowingo Creek	39	5.6	9,515,014	243,975	72%	138.8	5,596
Peters Creek	10	8.8	2,897,656	278,621	86%	157.9	2,253

As stated earlier, modeling of annual sediment loadings can be used as a planning tool to inform decisions, but it has limitations on exact quantitative predictions of sediment loadings for the three sites. First, modeling predicts average annual sediment loadings which may vary drastically from year-to-year sediment loadings. For instance, an unusually large rainfall event one year may generate a sediment load equivalent to the average annual loadings of many years. Second, models are based on data that can change over time. For example, the primary driver of watershed sediment loadings is land use practices which can change over time. It is expected that Best Management Practices (BMPs) required by watershed implementation plans to reduce sediment and nutrient loadings to the Chesapeake Bay[25] will also reduce soil losses for the watersheds that drain to the three recreation sites. Also, modeling at the recreation sites assumes that the source of sediment is limited to the tributary watershed and that there is no mixing with sediment carried by the Susquehanna River. In actuality, sediment transport at the three sites may be more complicated because the Susquehanna River backwaters into the coves at the three recreation sites. Lastly, the computations of sediment deposited each year are based on the average saturated sediment density values, which were calculated based on a small amount of data. The sediment density was based on just two samples at each creek which may or may not be representative of conditions throughout the navigable area in each creek.

To inform its decisions, Exelon will continue to monitor sediment model enhancements and updates as well as progress to reduce upland sediment loads with the implementation of BMPs.

[24] Values of sediment deposited at the three sites assume that all sediment delivered by the stream settles at the three sites. These values also assume that all of the sediment load at these sites comes from the respective watersheds, and not the Susquehanna River.

[25] On December 29, 2010, EPA established the Chesapeake Bay Total Maximum Daily Load (TMDL), a historic and comprehensive "pollution diet" for nitrogen, phosphorus, and sediment. In order to achieve reductions in nutrient and sediment loadings to the Bay, watershed implementation plans have been developed by the six states and District of Columbia that are part of the Chesapeake Bay watershed.

2.3.2 Peters Creek (Peach Bottom Marina) Sedimentation Rate

Approximately 9,500 CY of sediment was dredged from Peach Bottom Marina between 2019 and 2020. Bathymetric data of Peach Bottom Marina were collected prior to dredging in August 2019, after dredging had been completed in March 2020, and five months later in August 2020. The data from each of these bathymetric surveys were plotted at various locations in the creek to show the increase in deposited sediment that had occurred in the nine months after dredging of the marina was completed. The data were also used to estimate the approximate volume of accumulated sediment in the marina over the nine-month period. The cross-sectional area of sediment accumulation at each transect was calculated and the distance between each transect was used with the average end area method to estimate the volume of sediment that was deposited. The cross-sections showing the results of the pre-construction, post-construction, and the most recent survey (August 2020 – 5 months after dredging completion) are provided in Appendix A.

Most cross-sections show that the dredged volume has filled in by more than two feet in places within a nine-month period, with some cross-sections being about half full. The volume of deposited sediment since the dredging project was completed was estimated to be approximately 3,300 CY in nine months, which is equivalent to a sediment loading of approximately 4,358 CY/year. This is approximately two times higher than the volumetric accumulation calculated based on the Model My Watershed results (2,253 CY/year). It should be noted that the modeling results are based on 30 years of modeled data, while the bathymetry results are only from one year of data so the field conditions may not be comparable to the average annual sediment loading conditions.

2.3.3 Peters Creek TMDL Analysis (PADEP)

The Model My Watershed results were compared to the sediment loading rates for Peters Creek that were modeled by PADEP for the September 2020 Peters Creek Watershed TMDL (PADEP, 2020). PADEP also used Model My Watershed to establish existing loading conditions for Peters Creek. The PADEP TMDL report states that under existing conditions, the sediment loading rate for Peters Creek would be equivalent to approximately 1,264 CY/year[26]. This is approximately 78% lower than Exelon's Model My Watershed results and approximately 244% lower than the sedimentation rate determined from the results of the bathymetric analysis. The large discrepancy in Exelon's modeling results and PADEP's modeling results is most likely due to differing drainage area sizes used in each respective model. The drainage area used in the PADEP study (5.3 mi^2) appeared to exclude Puddle Duck Creek and other tributary drainage areas between the Peach Bottom Marina boat launch and the confluence of Peters Creek and Puddle Duck Creek in contrast to a drainage area size of 10 mi^2 used for this plan. Even so, the PADEP sediment loading rate for Peters Creek indicates that the Creek on average would need to be dredged every 7.5 years to maintain sufficient draft for boating if a similar channel was dredged as compared to the 2019 and 2020 project. However, this dredging project was very invasive and resulted in significant disruption to the existing parking lot and restoration. Exelon is reviewing conventional and innovative dredging and materials handling methods in order to limit the footprint of disturbance for future dredging activities. In the meantime, additional bathymetry is being proposed to review post construction channel depth in 2022 and 2023.

[26] Based on a saturated sediment density of 157.9 pounds per cubic foot for sediment in Peters Creek. The sediment density was calculated using sampling data collected in 2020.

2.4 Peters Creek (Peach Bottom Marina) Dredging

In August 2015, Exelon began the design and permitting process with the goal of dredging Peters Creek at Peach Bottom Marina to restore recreational boating access. In June 2017, state permits were obtained for the dredging project. Exelon began the procurement process in the first quarter of 2018, but the Peach Bottom Marina Dredging project start date was delayed due to the lack of responses on the bid process and the cost. In the first quarter of 2019, Exelon worked with permitting agencies to improve the design and issue amended permits in an effort to procure additional bids. By August 2019, a contractor was selected and construction began in August 2019 and finished in June 2020. Exelon dredged approximately 9,500 CY of sediment from the channel. The dredging area included dredging on the Susquehanna River side of the Norfolk Southern Railroad train trestle to restore boating access between the marina and the Susquehanna River, as well as within Peters Creek. Sediment downstream of the marina boat launch was removed using an 8-inch hydraulic dredge in 2019, while the more granular sediment and gravel upstream of the boat launch was removed with a mechanical dredge in 2020.

During the hydraulic dredging, a complicated dewatering system including booster pumps, pipes, de-sanding equipment and geotubes was staged temporarily at the parking lot across from the marina as shown in the pictures in Appendix B. The parking lot was demolished, and significant earthwork was required to accommodate the dewatering system for the hydraulic dredging. The parking lot area was ultimately restored to its original condition after all of the sediment had been relocated to a pasture owned by Exelon approximately one mile north of the marina along Slate Hill Road (Fulton Hill). Sediment removed through mechanical means was also transported to Fulton Hill. The stockpiled sediment at Fulton Hill was ultimately spread across the property and graded into the pasture.

By June 2020, the marina parking lot was regraded and restored. The temporary grading of the marina parking lot required the excavation and temporary relocation of approximately 12,000 cubic yards of earth in addition to the transportation of 9,500 CY of dredged sediment to the pasture disposal site. The overall cost of the project was approximately $5.5M (~$579/CY).

2.5 Dredging Technology Review

Since the 2012 draft Sediment Management Plan was filed, Exelon has reviewed alternative equipment and methods for dredging and managing sediment at the Project's boating recreation sites. The benefits and disadvantages for various methods are summarized based on a literature review and experience from past construction projects, including but not limited to the Peach Bottom Marina dredging project in 2019 and 2020.

2.5.1 Conventional Technology – Hydraulic Dredges

2.5.1.1 General Description

Hydraulic dredging was used to remove sediment downstream of the boat ramp at Peach Bottom Marina between October and December 2019. Many hydraulic dredges similar to the one at Peach Bottom shown in Appendix B, have cutterhead attachments, which cut channel-bed sediment and pump it through the intake pipe along with water forming a dredge slurry. The typical range for cutterhead sizes is 6 to 12-inches in diameter; the dredge at Peach Bottom had an 8-in cutterhead attachment.

As the cutterhead is moved along the channel bed, it takes in sediment and water in a slurry form. The intake pipe can be moved mechanically or by hand along the bottom of the channel depending on the contractor's equipment. These types of dredges are usually limited to dredging fines, some sands and small

gravel. For large volumes of coarse gravel or in areas where debris can collect, hydraulic dredging is not recommended.

Many hydraulic cutterhead dredges can only dredge a narrow swath in front of them. Any time a cutterhead dredge has to cut outside that limited space in front of it, the dredge needs to be re-positioned; therefore, in coves with irregular or non-linear boundaries (i.e., around docks or bulkheads), such as those at the Project recreation boating sites, it can be an inefficient means of dredging. Conventional hydraulic dredges also typically require at least 3-4 feet of draft to rotate due to the depth of the dredge pontoons. It is difficult to maintain enough draft in the coves when Conowingo Pond is at a lower pond elevation. The hydraulic dredge used at Peach Bottom Marina was approximately 43-ft long and had an operating width of 18.5-ft. Cranes were required to mobilize the dredge.

The intake pipe from the dredge conveys the slurry to shore and eventually to a Confined Disposal Facility (CDF), mechanical de-sanding equipment, belt filter presses, and/or geotubes for dewatering. Additional booster pumps along the pipeline may be required to prevent dredged material from getting stuck in the dredge line depending on the location of the dewatering site.

2.5.1.2 Dewatering

In many cases, 80% of the volume pumped through a hydraulic dredge intake (dredge) pipe is water and 20% is sediment. Dewatering methods for hydraulic dredging can vary and involve a wide variety of equipment and products. One alternative is the dredge line can discharge to a temporary (or permanent) CDF basin. CDF basins are either upland or in-water cells where dredge slurry is pumped. The dredged sediment is allowed to settle over time in the ponds before the supernatant is decanted/pumped out of the basin and returned to the original water body. To aid in enhancing the settling process, polymers can be injected into the pipelines or at the basins to help coagulate the fine dredged material.

Polymers may also be used in conjunction with geotubes to dewater finer material. Geotubes are large geotextile bags made with a fine mesh. The mesh is sized to retain fines and let water pass through it. However, there is a variety of substrate sizes at each of the Conowingo Pond coves not just fine material. Additional screening equipment in the dewatering system can be used in series with geotubes to remove larger aggregate that dewaters quickly from taking up space in the geotubes as was done for the recent dredging at Peach Bottom Marina.

Construction of dewatering facilities can require large areas of earth disturbance for the CDF and geotube laydown areas as well as the water collection.

Hydraulic dredging projects can also be prone to delays due to pumping difficulties and if a component anywhere along the dredge or supernatant return line breaks down, dredging production likely has to stop. For the Peach Bottom Marina dredging project, typical issues or delays during the hydraulic dredging, included debris/tires getting stuck on the dredge cutterhead, the booster pump going offline, replacing screens or parts on the de-sanding equipment, fixing the generator powering the polymer injector/de-sanding equipment, or fixing the supernatant collection and discharge system. Similar problems should be anticipated at the other Conowingo recreation boating sites.

2.5.1.3 Application to Conowingo Sediment Management

Peach Bottom Marina and the other two recreation boating sites are similar in that the coves are surrounded by steep topography and there is limited area readily available adjacent to the sites for contractor equipment staging and sediment dewatering. While the marina parking lot was temporarily used for dewatering at

Peters Creek, it was expensive to remove the existing pavement, perform enough grading to fit geotubes at the site, build a water collection system, and restore the site. In addition, neither Broad Creek, nor Conowingo Creek have substantial parking lots or similar areas to use on a temporary basis. At both of these sites, there are public roads nearby which limit the size of potential staging/laydown areas for construction.

2.5.2 Conventional Technology – Mechanical Dredges

2.5.2.1 General Description

Mechanical dredging requires mounting an excavator or excavator cab on a barge to excavate sediment from the channel bed and load it onto a barge or scow. The barges/scows transport the material to shore where it is offloaded with an excavator into a truck or directly into a dewatering area prior to offsite disposal/reuse.

Mechanical dredges are generally more maneuverable in small spaces and better adapted to water bodies with shallow and fluctuating water levels such as the three recreation boating sites.

Mechanical dredging requires more material handling during dredging operations, but the overall process is simplified compared to hydraulic dredging due to the lower volume of water being managed during construction.

2.5.2.2 Dewatering

During mechanical dredging operations, approximate ratios of 80% sediment to 20% water can be expected, which is the reverse of the ratio expected from hydraulic dredging. As a result, mechanical dredging requires less equipment and materials and consequentially less space for dewatering than hydraulic dredging.

Mechanically dredged sediment stockpiled at a temporary or permanent location can be either actively or passively dewatered. It may be possible to passively dewater sediment on a barge. For dredged material with a significant volume of fines, the contractor may need to mix in a dewatering additive such as lime kiln dust or an approved equal into the stockpile to dewater the material efficiently. If the material is primarily a mixture of sand and gravel, the material will likely dry out quickly without an additive.

Mechanical dredging typically involves fewer delays during construction than hydraulic dredging due to its more simplified approach. There were no delays or shutdowns during mechanical dredging portion of the Peach Bottom Marina dredging project.

2.5.2.3 Application to Conowingo Sediment Management

Mechanical dredging at Peach Bottom Marina was more efficient than hydraulic dredging. The equipment did require a crane to mobilize, and assembly of the dredge was required. In the future, if mechanical dredging is required on both sides of the Norfolk Southern Railroad trestles at Peach Bottom Marina and Conowingo Creek, the equipment would likely need to be mobilized twice as conventional mechanical dredges wouldn't be able to pass under the existing train trestles.

Mechanical dredges would be able to remove larger gravels as well as debris, if needed. However, mechanical dredging would be a concern for environmental reasons. Generally, mechanical dredging causes more turbidity than hydraulic dredging and staff at MDE have indicated that impacts from hydraulic dredging are considered temporary while those from mechanical dredging are considered permanent.

For an initial dredging of Broad Creek and Conowingo Creek, it is expected that mechanical dredging would be more efficient and cost-effective than conventional hydraulic dredging given the limited area

adjacent to the creeks for staging/dewatering and the additional capability to remove woody debris, if any is present.

2.5.3 Innovative Technology

Due to the small footprint of the recreation sites, it is anticipated that substantial grading and the removal of a number of trees may be required to apply conventional dredging, dewatering, and materials handling methods making dredging the recreation sites costly and time consuming due to the long periods required for design, permitting, and construction. Therefore, in addition to conventional dredging technologies, Exelon will continue to explore innovative dredging and material handling technologies as the engineering design and environmental permit requirements are evaluated for each site. Based on preliminary research, the Dino6 Dredge by Geoform International, Inc., and Sand Wand/Sediment Collectors by Streamside Systems, Inc. are examples of an innovative technology under consideration and is discussed below.

2.5.3.1 Innovative Technology - Dino6 Dredge by Geoform International, Inc.

The Dino6 is a small 21.5-ft long, 6.5-ft wide hydraulic dredge on pontoons, which can be mobilized with a pickup truck and launched similar to a motorboat (see Appendix B). The horizontal steel bar cutterhead, controlled with a hoist is lowered to the channel bed where it agitates the sediment, which is then sucked into a 6-in pipe with a submersible pump at a rate of up to 1,500 gallons per minute (GPM). The dredge can typically pump the dredged slurry to within 400 ft of the dredge, beyond that a booster pump may be required to transport the slurry to the dewatering area (Geoform International, Inc. 2020).

Various dewatering technologies are compatible with the Dino6 dredge based on correspondence with contractors, including metal roll-off containers with Mobile Dewatering System (MDS) geotubes from Tencate Geosynthetics (Tencate). The MDS units are made of geotextile fabric which trap fines but allow water to pass through them but each unit is only approximately 22-ft long with a storage capacity of approximately 25 CY each so they can fit inside a metal roll-off box. Because of the limited storage capacity in each bag, it is recommended by the manufacturer that several MDS units be set up at once. Once an MDS unit has been filled with sediment, the roll-off box with the MDS unit inside can be picked up with a truck and transported to a different location. The MDS unit with sediment inside can be dumped out of the roll-off box to complete the dewatering process while the roll-off container is transported back to the dredging site and a new MDS unit is installed inside it and dredging can continue.

Alternatively, Dino6 dredges have also been used in series with mechanical dewatering systems available through manufacturers/contractors such as Tri-Flo International, Inc. (Tri-Flo). Tri-Flo has a trailer with dewatering equipment including screens and hydrocyclones, which have been used at projects with Dino6 dredges in the past. The 8-ft wide x 30-ft long trailer is typically mobilized with a tractor trailer truck and requires a 100 – 200-kilowatt (kW) generator to operate. The hydraulic line from the dredge is connected directly to the trailer, where it is fed through a series of hydrocyclones which are used to sort and dewater the slurry. The sediment dewatered by the trailer is typically dry enough to pass paint filter drying tests without modification and is ready for transportation to its final destination. Prior to returning the water from the slurry to the water source, it is recommended that a clarifier(s) is installed in series with the trailer to capture any remaining fines which may remain.

Dino6 - Application to Conowingo Sediment Management

Based on the mobility and size of the Dino6 dredge, it may be worth considering for annual maintenance dredging of Broad Creek, Conowingo Creek, and Peters Creek. If a mechanical dewatering alternative would not be compatible due to the size of the equipment and space required, roll-off MDS units described

above may be a suitable alternative if the determined end-use for the removed sediment is disposal at an upland location. Once filled, the MDS units could be staged at an off-site location, such as Exelon's debris management site at Hopkins Cove or a site similar to Fulton Hill that Exelon owns.

2.5.3.2 Sand Wand / Sediment Collector by Streamside Systems, Inc.

Streamside Systems, Inc. (Streamside) offers innovative sediment removal solutions including their Sand Wand and Sediment Collector technologies. The Sand Wand is a manually operated device, which uses a water jet and suction to remove sediment from a stream bed. Once the sediment is removed it is discharged to a sediment basin/trap, geotextile filter bag or tank for offsite removal. This technology appears to be most suited for specific areas where selective removal of sediment is desired.

By contrast, Streamside also offers bedload sediment collectors, which are metal devices that stretch across stream channels which intercept and collect coarse-grained sediment as it passes over the device, while fine sediment is not collected and remains in suspension, migrating downstream. Similar to the Sand Wand, the sediment collected by the bedload sediment collectors is pumped to a sediment basin/trap, tank, or other dewatering device prior to offsite disposal. Exelon conducted a pilot in 2019 just upstream of the Peach Bottom Marina using a small sediment collector. A decision was made not to move forward with this technology at this location due to the sediment handling and truck traffic in the area utilized primarily for Exelon ground leases (cottage leases).

2.6 Dredged Material Disposal Alternatives

FERC License Article 420 states that the revised Plan should have a provision on how dredged material will be disposed. Several end uses for dredged material were evaluated since the draft Plan was filed in August 2012, including landfill disposal, beneficial or innovative reuse, and disposal at Fulton Hill where the Peach Bottom Marina dredged material was placed or other Exelon property. Options for sediment disposal particularly reuse are continually evolving and will continue to change over the life of the license. Because of this dynamic and the suitability of alternatives is site-specific, Exelon will determine the best sediment disposal alternative for each recreation boating site if it is dredged.

The benefits and disadvantages for different sediment disposal alternatives are summarized below.

2.6.1 Landfill Disposal

Modern Landfill in York, PA, and the Republic Materials Landfill in Conestoga, PA are approximately 40 miles from Peach Bottom Marina and even further from the two recreation boating sites in Maryland. The only landfill in Harford County, where Broad Creek is located, is the Harford County Waste Disposal Center, which only accepts residential waste. In Cecil County where Conowingo Creek is located, the primary solid waste disposal facility is the Central Landfill Facility just outside North East, MD, approximately 21 miles from Conowingo Creek and 27 miles from Broad Creek.

Normally the dredged material would be accepted as daily cover material at approximately $34/ton. A sales representative from Modern Landfill suggested that the cost of disposal would be at least $42/ton for clean regular landfill material. The Cecil County Department of Public Works Fee schedule suggests that the cost for contaminated soil disposal is $237/ton. These costs are just the tipping fees and do not include the transportation cost to the landfills, which could be substantial based on their distance from the recreation sites.

2.6.2 Beneficial and Innovative Reuse

Exelon has conducted a desktop review of alternative disposal options for dredged material based on the Innovative Reuse and Beneficial Use of Dredged Material Guidance Document published in 2019 by MDE and from previous dredging projects.

2.6.2.1 Beneficial Reuse

Beneficial reuse of dredged material, as defined by the 2019 guidance from MDE, includes the restoration of underwater grasses, restoration of islands, stabilization of eroding shorelines, the creation or restoration of wetlands, and the creation, restoration, or enhancement of fish or shellfish habitats.

As a part of their maintenance dredging program for the Port of Baltimore, Chesapeake Bay, and Delaware Canal, the Maryland Department of Transportation Maryland Port Authority (MDOT MPA) manages several dredged material management program (DMMP) sites. There are several active placement sites, which beneficially reuse dredged material for wetland or lost island restoration projects (MDOT MPA 2020). The two closest sites to the Conowingo Project are Pearce Creek and Masonville, which are both approximately 50 miles from Conowingo Dam. Currently, MDOT MPA sites are only accepting material from what are considered maintenance dredging projects. Additional discussions between MDOT MPA and Exelon would be required to confirm whether the cove dredging around Conowingo Pond could be considered "maintenance" (MDOT MPA 2019).

Additionally, the 2019 guidance from MDE recommends that if sediment is used for beach nourishment or marsh creation, it should not exceed 10% silts and clays. If the dredged material exceeds this threshold, the perimeter of the beach or marsh should be protected with breakwaters or similar structures to limit migration of the sediment (MDE 2019). Based on the current grain size analyses, sediment at each potential dredging site exceeds 40% fines and would require a breakwater or stabilized/hardened shoreline for any new beach nourishment or marsh creation project to prevent it from migrating. At this time, no potential marsh restoration projects have been identified within the Project Boundary.

To identify other beneficial reuse opportunities for dredged material, the State of Maryland along with other agencies developed the Beneficial Use: Identifying Locations for Dredging (BUILD) program described below.

BUILD Program

In October 2019, the Maryland Department of Natural Resources (MDNR), National Oceanographic and Atmospheric Administration (NOAA), and Chesapeake & Coastal Service developed the online BUILD tool. The purpose of the tool is to help with aligning potential dredging projects with potential restoration or other wetland/waterway projects which could use dredged material.

The online GIS mapping tool includes several data layers which include spatial, timeline/temporal, and qualitative (sediment characteristic) data. The data layers include but are not limited to:

- Upcoming dredging projects
- Dredging project buffers
- Potential restoration buffers
- Lost islands

- Dredged material placement sites
- Previous dredging projects
- MDE Wetlands/Waterways permits issued related to dredging/restoration projects.

The manual suggests that, to make beneficial reuse financially feasible, the distance between dredging and restoration projects should be less than four miles (Specht 2019). At this time, no potential restoration or reuse locations shown in the BUILD tool are within four miles of any of the recreation sites.

2.6.2.2 Innovative Reuse

Innovative reuse of dredged material includes the recycling of dredged material for the manufacturing of commercial, agricultural, industrial, or other products. Typical innovative uses include but are not limited to daily cover at landfills, fill materials for brownfield site reclamation, roadway sub-base/bed material, parking lot foundations, or embankments. Bench scale chemical and physical testing is required after the material is dredged to determine the engineering properties of the soil and whether an amendment is required.

2.6.2.3 On-site Innovative Reuse

One alternative for the innovative reuse of dredged material would be for Exelon to rent or purchase a portable aggregate/topsoil screener. Dried dredged material is dumped on top of the screen with a bobcat or excavator and the screen vibrates using a small diesel engine. The vibrating screen offers a wide variety of grid sizes which could be used to develop different gradations and the equipment can be relocated to another site with a pickup truck.

The vibration of the screens separates the gravel and coarse sand from fine material. Dredged material greater than ½" could potentially be used for aggregate in construction projects, such as road repair or other minor projects surrounding Conowingo Pond. Based on grain size analysis completed to date, such a device would be most effective at sorting out and obtaining gravel/stone for reuse from Broad Creek. This could substantially decrease the overall cost of dredging. The aggregate would likely need to be washed prior to use at another site. The August 2020 analytical testing results indicate the fine dredged material could potentially be reused on-site at the Conowingo Project, but it would require further consultation with MDE. In addition, Exelon will continue to look for other opportunities to reuse dredged sediment in wetland creation/restoration, shoreline stabilization, or habitat improvement projects.

2.6.2.4 Offsite Innovative Reuse

When soil additives are added to dredged material, it is referred to as "processed" dredged material. Typical additives include lime or fly ash, which can aid in dewatering the material and modify/stabilize dredged material. One company that accepts "processed" dredged material for recycling is CleanEarth. The company has a receiving facility in Hagerstown, MD (approximately 120 miles from Conowingo Dam). The company produces stabilized materials for pavement subbase or structural fill for construction from non-hazardous dredged material.

Additionally, in January 2021, Governor Larry Hogan and the Maryland Board of Public Works approved contracts to study other innovative uses for sediment dredged from Baltimore Harbor (AJOT 2021). The innovative reuses included:

- Structural fill and concrete applications (Harford Industrial Minerals Inc. of Joppa, MD)

- General use/production of retainer walls and low-compression strength blocks (Susquehanna Concrete Products of Magnolia, MD)
- Traffic barriers/shoreline protection structures (Northgate Environmental Management Inc. of Frederick, MD)
- Re-engineered soil for growing sod (FasTrak Express, Inc. of Rising Sun)
- Manufacturing ceramic brick and permeable pavers (Belden-Eco Products LLC).

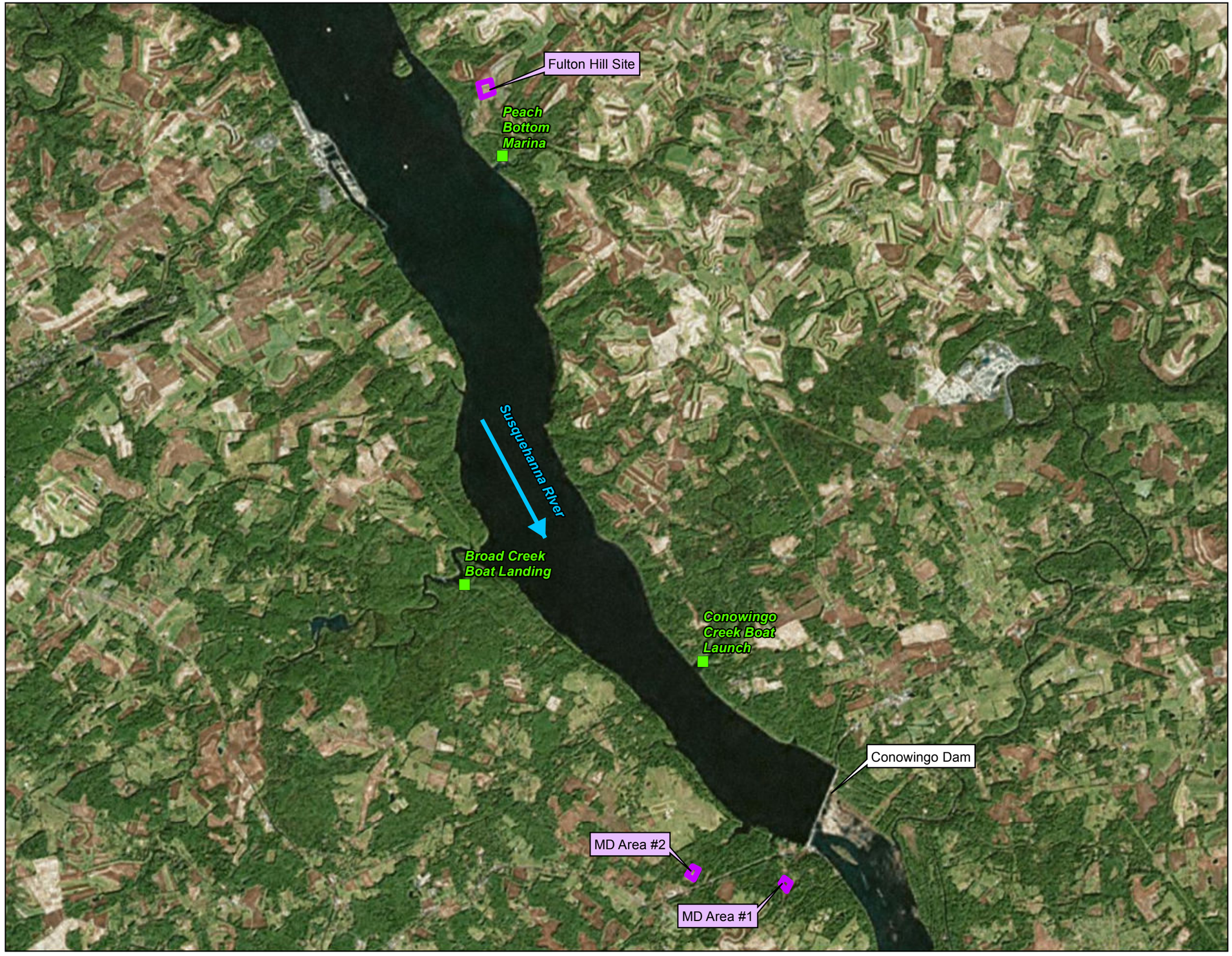
2.6.2.5 Fulton Hill or Other Exelon Property owned property

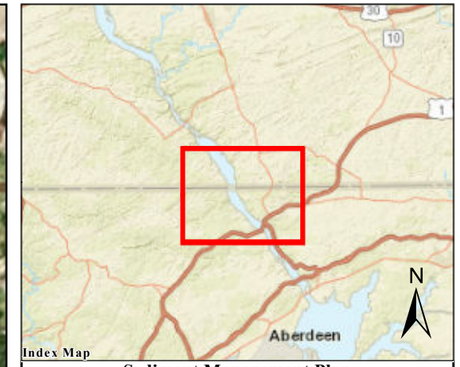
A third innovative reuse disposal alternative for consideration is spreading the material across the Fulton Hill site shown on Figures 2.6.2.5-1 and Figure 2.6.2.5-2 where sediment from the Peach Bottom Marina dredging project was spread. The site is leased by Exelon to a local farmer. Since two of the recreation sites are in Maryland, the soil samples would need to meet Maryland and Pennsylvania standards for material handling and disposal for this alternative to work. As mentioned in Section 2.2, the 2020 samples taken at Broad Creek and Conowingo Creek exceeded Pennsylvania clean fill concentration limit standards for ammonia and arsenic respectively. To determine the potential for placing the dredged material from Broad Creek and Conowingo at Fulton Hill, Exelon will need to consult with PADEP to see if the Fulton Hill site could be considered for disposal if background sediment sampling from the Fulton Hill site indicated similar "background" concentrations for ammonia and arsenic.[27]

While there would be no tipping fee to pay a landfill for disposal at the Fulton Hill site, there would be construction costs for the installation/maintenance of erosion controls, grading/spreading the material across the site, and re-seeding/restoring the site. The dredged material would be spread in an approximately 4-6" layer across the area used during the Peach Bottom dredging. Topsoil may also need to be imported to continue farming, depending on the fertility of imported dredged material and existing soil at Fulton Hill.

Two additional potential locations for stockpiling/spreading the dredged/sorted material in Maryland on Exelon owned property were identified using land ownership maps and aerial imagery and are shown on Figures 2.6.2.5-1 and Figure 2.6.2.5-3. One location is approximately half a mile south from the Conowingo Visitor Center along Shuresville Rd and the other is located on the north side of Route 1, approximately 1 mile from the Conowingo Visitor Center. These two locations are approximately five and six acres in area, respectively, and approximately seven miles from Broad Creek and five miles from Conowingo Creek.

[27] Sediment sampling was conducted in December 2016 for the recent Peach Bottom Marina dredging project to determine background concentrations of cobalt within the Peters Creek watershed.





Sediment Management Plan

Figure 2.6.2.5-1:
Potential Stockpiling Locations

Legend

- Marina Location
- Potential Stockpiling Site

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)Horizontal Datum: North American Datum of 1983 (NAD 83)State Plane Maryland FIPS 1900 Feet Projection

N

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
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CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

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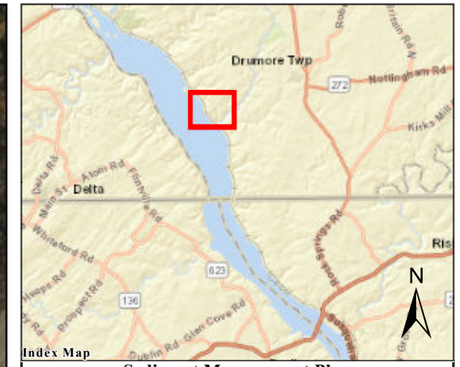

Sediment Management Plan

Figure 2.6.2.5-2:
Fulton Hill – Peach Bottom Marina Disposal Location

Legend

- Marina Location
- Potential Stockpiling Site

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)Horizontal Datum: North American Datum of 1983 (NAD 83)State Plane Maryland FIPS 1900 Feet Projection

N

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

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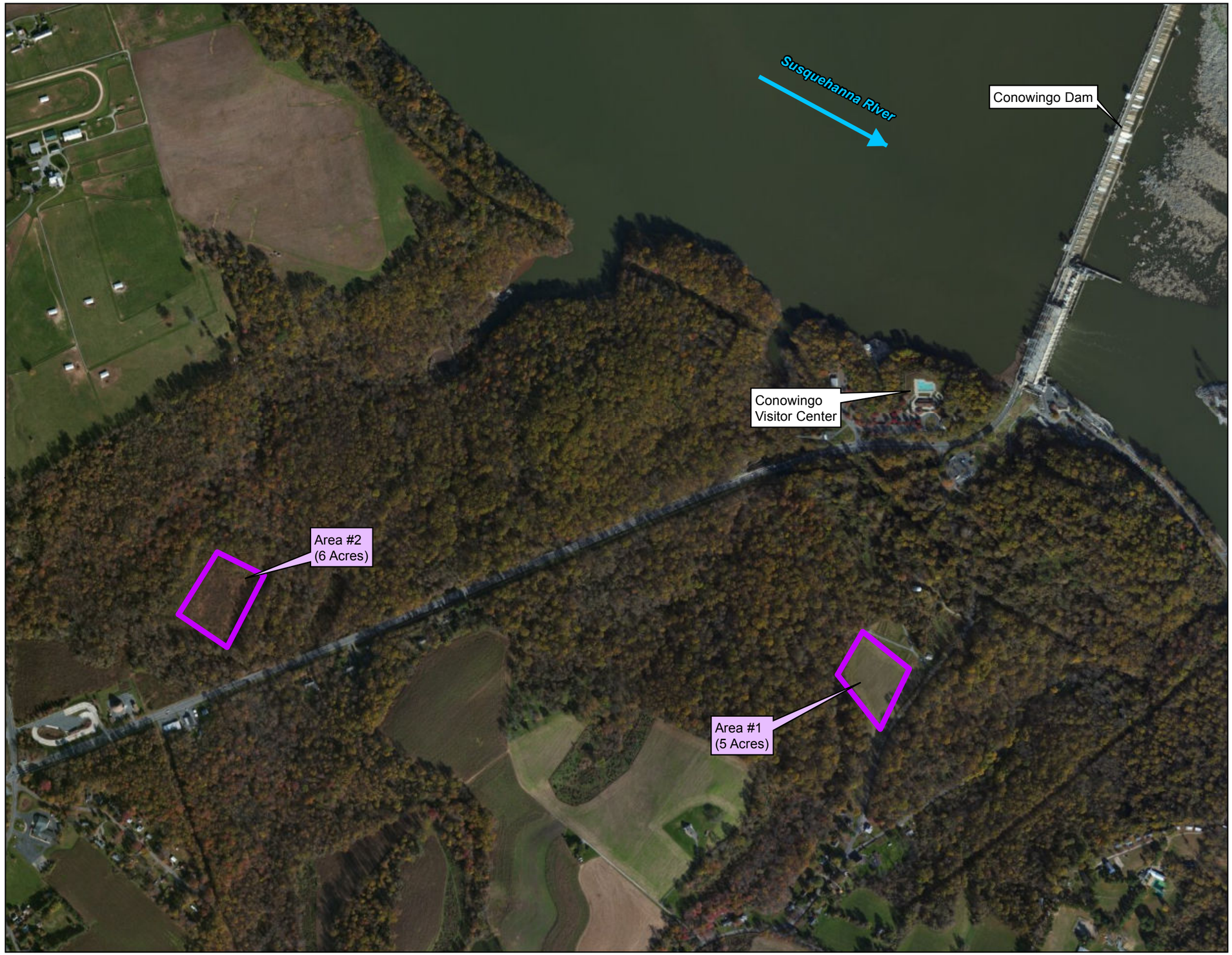

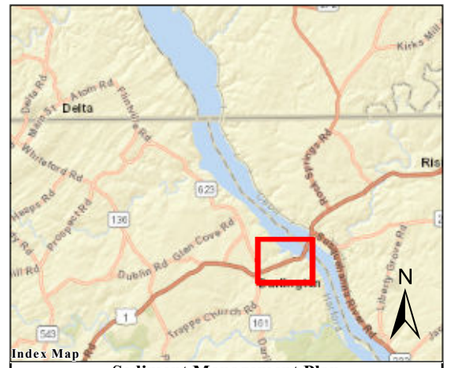

Sediment Management Plan

Figure 2.6.2.5-3:
Potential Stockpiling/Disposal Locations
Exelon Owned Property - Maryland

Legend

Potential Stockpiling Site

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)Horizontal Datum: North American Datum of 1983 (NAD 83)State Plane Maryland FIPS 1900 Feet Projection

N

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

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2.7 Environmental Considerations and Permitting

Dredging at the three boating sites has the potential to impact sensitive resources, including protected species and lands. An important consideration in the determination of whether dredging is suitable for the recreation boating sites is potential impacts to sensitive environmental resources, such as special status species and their habitats. Depending on the particular impact involved, such as northern map turtle in Conowingo Creek, project impacts may be mitigated by decreasing or avoiding dredging or by considering a change to the recreation opportunities at the site (e.g., changing use from motorized boating to canoes and kayaks). Other environmental factors that will be considered in the evaluation of potential sediment management actions include beneficial reuse, such as using the excavated dredge material for wetland enhancement, shoreline stabilization or habitat improvement projects.

If dredging is the selected action for a boating site, permitting will be required so Section 2.7.3 is provided to outline the potential required permits and regulatory approvals that may be required at the federal, state, and local level. In addition, any future dredging activities will comply with the Conowingo Shoreline Management Plan (Article 428) to protect water quality.

2.7.1 Sensitive Environmental Resources

The following discusses the special status species that are most likely to be present at the recreation boating sites.

2.7.1.1 Northern Map Turtles

Of importance, is the presence of northern map turtles. The northern map turtle is listed as threatened in Maryland and a species of conservation concern in Pennsylvania. Capture, sighting, nesting, and basking data provided to Exelon by Towson University from a survey completed from April through November 2008 in the Susquehanna River within the State of Maryland show their presence at the recreation boating sites in Maryland. Since the movement of northern map turtles is not restricted by state boundaries, they could be present at Peters Creek too. As basking is essential for these turtles, consideration will be given to minimizing impacts to their basking habitat. Article 424 of the new FERC license requires Exelon to develop a Northern Map Turtle Protection Plan by March 2022, with a provision for population monitoring surveys, studies to determine the amount and location of needed basking habitat, as well as nest management and mitigation measures and monitoring of these measures' use and success. Implementation of the Northern Map Turtle Protection Plan will begin after FERC approval. Future dredging evaluations will consider the findings of these surveys in minimizing the impacts to these species and opportunities for enhancing their nesting and basking habitat. Consultations with resource agencies such as MDNR and Towson University will occur as part of design and permitting of the dredging projects.

2.7.1.2 Bog Turtle

Bog turtles live in herbaceous sedge meadow wetlands and need to be considered whenever potential bog turtle habitat is present. The Conowingo Creek and Peach Bottom Marina[28] are each in the vicinity of wetlands, according to the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI). The Project FERC License Article 423 requires a Bog Turtle Protection Plan to be filed with FERC by March 18, 2022. The Bog Turtle Protection Plan will include measures to protect bog turtles and their habitat throughout the Project boundary. Once finalized, all activities including dredging will need to

[28] A Phase 1 Survey was conducted prior to mechanical dredging Peters Creek on January 24, 2020. The survey determined that bog turtle habitat was not present in the project vicinity.

comply with this plan. In addition, if dredging is to occur at the recreation boating sites, it is likely that an assessment for bog turtle habitat (a Phase 1 Survey) will be required. Bog turtles are listed as a threatened species by the USFWS and the State of Maryland and considered endangered in the State of Pennsylvania.

2.7.1.3 Bald Eagle

Exelon maintains a database of Bald Eagle nests and roost locations in the vicinity of the Muddy Run Pumped Storage and Conowingo Hydroelectric Project boundaries. According to this database last updated by a 2018 survey, there are many Bald Eagle nests and roosts in the area surrounding Conowingo Reservoir, (The next survey is scheduled for 2023 and incidental nest sightings will be added to Exelon's database.) Activities at the recreation boating sites, including dredging, will need to follow Exelon's FERC-approved Bald Eagle Management Plan (License Article 421) that includes activity buffers near nests and roosts and time-of-year restrictions as well as adhering to the USFWS National Bald Eagle Management Guidelines (2007). Bald Eagles are protected under the Bald and Golden Eagle Protection Act enacted in 1940 (FWS 2018).

2.7.1.4 Indiana and Northern Long-eared Bat

Per Article 425, the following measures are required to protect Indiana and northern long-eared bat habitat and will be considered when evaluating an upland site for dewatering and/or handling of dredged materials:

> *…the licensee must avoid cutting trees equal to or greater than 3 inches in diameter at breast height on project lands from June 1 through July 31, unless a tree poses an immediate threat to human life or property. Tree removal is defined herein as cutting down, harvesting, destroying, trimming, or manipulating in any other way the trees, saplings, snags, or any other form of woody vegetation greater than 3 inches in diameter likely to be used by Indiana and northern long-eared bats.*

2.7.1.5 Chesapeake Logperch

The Chesapeake logperch is a small resident fish found only within the Susquehanna River watershed. For the Peach Bottom Marina Dredging project, the Pennsylvania Fish and Boat Commission (PFBC) requested no in-stream activity be conducted from March 15th to August 1st in order to avoid adverse impacts during the spawning season for this species. The PFBC also required that all work should be done during low-flow periods, and strict erosion and sedimentation control measures should be employed.

Since the movement of fish is not restricted by state boundaries, Chesapeake Logperch may be present in the vicinity of the Broad Creek and Conowingo Creek recreation boating sites that are in Maryland. If this species is identified during consultation with MDNR, similar time-of-year restrictions and conditions will likely be required to avoid adverse impacts during the spawning season. Chesapeake Logperch is under review as a species of concern at the Federal level and considered threatened in both Maryland and Pennsylvania.

2.7.1.6 Waterfowl Concentration and Staging Areas

Data downloaded from the Maryland GIS Data Catalog (MD iMAP, 2019) show the 458-acre Historic Waterfowl Concentration and Staging Area within the Conowingo Hydroelectric Project boundary, overlapping with the Broad Creek recreation site. Such areas are generally protected from disturbance during the winter months with a time-of-year restriction on projects of a certain scope. The new Conowingo License Article 422 includes a requirement for Exelon to prepare and enact a Waterfowl Nesting Protection Plan due to potential impacts of Project-related water level fluctuations on waterfowl nesting habitat. Any

activities that take place including at the recreation boating sites will need to align with the requirements in this plan.

2.7.1.7 Wetlands

For all of the recreation boating sites, a qualified environmental scientist will need to confirm if wetlands are present and if they will be impacted by project activities. Currently, MDNR GIS data available from the Maryland GIS Data Catalog shows that none of the Maryland project sites overlap with MDNR wetlands. NWI wetlands are present at the mouth of Conowingo Creek identified as PFO1Ah, which means that it is Palustrine, forested, broad-leaf deciduous, temporarily flooded, and impounded.

NWI data do not show a wetland at the Peach Bottom Marina; however, there is an emergent wetland in the vicinity of the marina, which Exelon delineated in 2015 and was avoided during the 2019 to 2020 dredging. The wetland is currently outside of the dredging limit but may expand with continued sediment deposition from Peters Creek. If additional dredging is considered for this site, a new wetland delineation will be required and potentially mitigation if dredging impacts the wetland.

2.7.2 Time-of-year Restrictions

Avoiding specific activities during certain times of the year can reduce potential project impacts on protected plant and animal species. Based on the current status of protected species known to be present in the area, the time-of-year restrictions for potential dredging activities are summarized in Table 2.7.2-1 below. Following these restrictions may allow Exelon to complete dredging activities without negatively impacting sensitive species; however, following all of them during dredging is impossible as they cover the complete calendar year. Alternative mitigation measures will need to be developed in coordination with the resource agencies in order to allow dredging.

Table 2.7.2-1. Dredging and Construction Time-of-year Restrictions to be Considered

Time-of-year	Restriction	Reason	Info Source	Projects
February 14-June 15	No dredging	Avoid impacting spawning anadromous and resident fish	MDNR request to MES for the Pilot Dredging Conowingo Project PFBC request to Exelon for the Peach Bottom Marina dredging project	Broad Creek Conowingo Creek Peach Bottom Marina
March 1-June 15	No dredging in areas where important finfish species have been documented to spawn	Avoid impacting spawning finfish	Federal Coastal Zone Management Act and Maryland Enforceable Coastal Policies	Broad Creek Conowingo Creek
April 1-May 31	No dredging	Avoid impacting Exelon's anadromous fish passage studies (2021)	Susquehanna River Anadromous Fish Restoration Cooperative request to MES for the Pilot Dredging Conowingo Project	Broad Creek Conowingo Creek Peach Bottom Marina
March 15-August 1	No dredging	Avoid potential impacts to protected fish species (i.e. Chesapeake logperch)	PFBC request to Exelon for the Peach Bottom Marina dredging project PFBC personal communication regarding Chesapeake logperch.	Peach Bottom Marina
April 15-October 15	No dredging within 500 yards of submerged aquatic vegetation	Avoiding damaging submerged aquatic vegetation during the growing season	Federal Coastal Zone Management Act and Maryland Enforceable Coastal Policies	Broad Creek Conowingo Creek
Late May-early September (Memorial Day-Labor Day)	Dredging should not take place during the recreation season, if possible.	Dredging may impact recreational uses.	Article 427	Broad Creek Conowingo Creek Peach Bottom Marina
June 1-July 31	No trees greater than 3 inches in diameter can be cut down.	Protect Indiana and northern long-eared bat habitat	Article 425	Broad Creek Conowingo Creek Peach Bottom Marina

Time-of-year	Restriction	Reason	Info Source	Projects
June 1-September 30	No dredging within 500 yards of shellfish areas (**mechanical and hydraulic dredging**)	Avoid damaging shellfish areas	Federal Coastal Zone Management Act and Maryland Enforceable Coastal Policies	Broad Creek Conowingo Creek
October 15-April 1	No dredging	Avoid disturbing hibernating northern map turtles	MDNR request to MES for the Pilot Dredging Conowingo Project	Broad Creek Conowingo Creek
September 1 – late fall[29]	No dredging	Avoid impacting studies of downstream passage of silver eels	Exelon coordination with USFWS for the USFWS' basin-wide study of downstream eel passage	Broad Creek Conowingo Creek Peach Bottom Marina
November 1-August 31[30]	No activities that may disturb nesting Bald Eagles within appropriate buffer zones	Avoid impacting nesting Bald Eagles	USFWS Bald Eagle Management Guidelines and Exelon Bald Eagle Management Plan	Broad Creek Conowingo Creek Peach Bottom Marina
December 16-March 14	No dredging within 500 yards of shellfish areas (**mechanical dredging**)	Avoid damaging shellfish areas	Federal Coastal Zone Management Act and Maryland Enforceable Coastal Policies	Broad Creek Conowingo Creek
Winter (specific timeline to be determined)	Unknown	Avoid impacting waterfowl	MDNR letter regarding the Pilot Dredging Conowingo Project	Broad Creek Conowingo Creek
Winter[31]	No activities that may disturb roosting Bald Eagles within appropriate buffer zones.	Avoid impacting roosting Bald Eagles	USFWS Bald Eagle Management Guidelines and Exelon Bald Eagle Management Plan	Broad Creek Conowingo Creek Peach Bottom Marina

[29] This restriction may only apply from 2021 through 2023 during years when the downstream eel passage study is taking place. The annual study end date is based on when Susquehanna River water temperatures fall below 3C, rather than a set date.

[30] This timeline is approximate. The presence or absence of birds engaged in breeding, nesting, rearing, or fledging activity at a nest will dictate if a buffer must be applied for protection.

[31] This timeline is approximate. The presence or absence of birds engaged in roosting activity at a nest will dictate if a buffer must be applied for protection.

2.7.3 Permits and Regulatory Approvals

Table 2.7.3-1 summarizes potential permits and regulatory approvals at the federal, state, and local levels that could be required for dredging at the recreation boating sites. Major permits or ones that have longer permitting process times are highlighted below. Any future dredging activities at the recreational boating sites will be coordinated with the Recreation Management Plan (Article 426) and the Shoreline Management Plan (Article 428).

2.7.3.1 U.S. Army Corps of Engineers Clean Water Act Section 404 and River and Harbors Act Section 10 Permits

The Susquehanna River is a navigable water of the United States and work in the river and its tributaries (Broad Creek, Conowingo Creek, and Peters Creek at Peach Bottom Marina) fall under the jurisdiction of the U.S. Army Corps of Engineers (USACE). Per Section 404 of the Clean Water Act, filling, grading, mechanized land clearing, ditching, other excavation activity, and piling installation in waters of the US require a Section 404 Permit from the USACE prior to the commencement of construction. Additionally, Section 10 of the Rivers and Harbors Act of 1899 requires that dredging conducted below the Ordinary High-Water elevation of navigable waters of the United States be permitted by the USACE.

The USACE can authorize dredging work a number of ways: individual permit, letter of permission, general permit, or nationwide permit. Maintenance dredging for boating sites in Maryland can be authorized by the USACE with either an individual permit, or a letter of permission[32]. To receive either of these authorizations, Exelon will need to submit a Joint Permit Application to USACE and MDE. Staff from the USACE Baltimore District have expressed willingness to authorize maintenance dredging with a letter of permission for the existing boating sites in Maryland up to a permit period of ten years.

Since dredging of Peach Bottom Marina was previously authorized for the 2019/2020 dredging project and is located in Pennsylvania where the USACE can issue permits using Nationwide Permits, the USACE could authorize maintenance dredging using a Nationwide Permit, individual permit or letter of permission. Nationwide Permit 35 (NWP 35) – Maintenance Dredging of Existing Basins seems appropriate. It covers:

> *The removal of accumulated sediment for maintenance of existing marina basins, access channels to marinas or boat slips, and boat slips to previously authorized depths or controlling depths for ingress/egress, whichever is less. All dredged material must be deposited and retained in an area that has no waters of the United States unless otherwise specifically approved by the district engineer under separate authorization. Proper sediment controls must be used for the disposal site (NWP Final Notice, 82 FR 4).*

If NWP 35 is used, authorized dredging will be limited to the dimensions of previously authorized dredging.

2.7.3.2 Maryland Permits and Regulatory Approvals

Broad Creek and Conowingo Creek are located in Maryland and will require permit and regulatory approvals from Maryland agencies and municipalities.

[32] Nationwide Permit 35 for maintenance dredging has been suspended in Maryland. The authorized activities under the Maryland State Programmatic General Permit-5 (MDSPGP-5) are not applicable to dredging projects at existing Maryland boating sites.

MDE Alteration of any Floodplain, Waterway, Tidal or Nontidal Wetland Permit

A Floodplain, Waterway, Tidal, or Nontidal Wetland permit is required in Maryland for any person who proposes to construct, reconstruct, repair, or alter a dam, reservoir, or waterway obstruction, or change in any manner the course, current, or cross section of a stream or body of water within the State.

MDE Water Appropriation or Use

This permit is required for any activity that withdraws water from the State's surface and/or underground waters, including temporary dewatering during construction (e.g., cofferdams) unless the duration of the dewatering including any intermittent periods of non-pumping is expected to last for less than thirty calendar days and the appropriation does not exceed an average of 10,000 gallons per day.

MDE NPDES Permit for Construction Activities

The National Pollutant Discharge Elimination System (NPDES) has issued a General Permit to the State of Maryland for stormwater from construction activities, which have a land disturbance of one acre or greater. Portions on dredging projects such as dewatering and staging areas, access roads, and upland sediment disposal may trigger the need for this permit.

2.7.3.3 Maryland Local Permits

Broad Creek located in Harford County will require several permits and approvals from Harford County. Likewise, Conowingo Creek located in Cecil County will require similar permits from Cecil County. These permits are triggered by ground disturbance or grading required for dewatering and staging areas, construction of access roads, sediment disposal or innovative reuse (e.g., streambank stabilization) as well as activities within the floodplain.

Erosion and Sediment Control Plan

A person may not clear or grade land without first obtaining an approved erosion and sediment control plan if the clearing or grading activities disturb more than 5,000 square feet of land area or more than 100 CY of earth.

Grading Permit

A grading permit is required prior to the start of any clearing or grading activity that may introduce sediment to any watercourse in the county or state, move more than 100 CY of earth, disturb more than 5,000 square feet of land, or create undue erosion and sediment damage to lands adjacent to the project site.

Floodplain Authorization/In-Water Conowingo Projects Permit

In Harford County, it is unlawful for any person to begin any development or construction (including filling, grading, or alteration of a watercourse) which is wholly within, partially within, or in contact with a flood hazard area until a permit is obtained from Harford County.

In Cecil County, the In-Water Projects Building Permit is required for installation of docks, piers, revetments, riprap, bulkheads or boat slips which is submitted to the Division of Permits and Inspections. Further consultation with Cecil County is required to determine the applicability of this permit for potential dredging in Conowingo Creek.

Zoning Certificate

Further consultation with both Harford and Cecil counties is required to determine the applicability of both the zoning certificate and potential building permits required for dredging and disposal/beneficial reuse. In general, building permits are only required for new construction of structures that will be occupied by a person for extended periods of time and therefore might be needed for a dredging construction project. However, a zoning certificate may be required to document any dredging activities by the Planning and Zoning departments.

Site Plan Approval

Site Plan Approval is required when applying for a zoning certificate to determine conformance with the county zoning codes and to document the location of existing and proposed improvements or uses. If it is determined that a zoning certificate is not needed for the dredging projects, submittal of a site plan approval waiver may be required. Site plans are submitted for review by the Planning and Zoning departments in Harford and Cecil County.

Stormwater Permit

For any proposed development or land disturbance exceeding 5,000 square feet of disturbance, a person shall prepare and submit a stormwater management plan. In Harford County, the stormwater management plan is submitted for review to the Department of Public Works and in Cecil County, it is submitted for review to the Division of Development Plans Review.

Forest Conservation Plan

A person who is applying for site plan approval, a grading permit, or a sediment management plan for a tract of land greater than 40,000 square feet must submit a forest conservation plan to the Planning and Zoning departments in Harford and Cecil County.

2.7.3.4 Pennsylvania Permits and Local Regulatory Approvals for Peach Bottom

The Peach Bottom Marina site is located in Lancaster County, Pennsylvania. Dredging at this site will require permit and regulatory approvals from the USACE, Pennsylvania agencies and Fulton Township. It is assumed that the same permits that were required for the 2019/2020 dredging would be required again. Table 2.7.3-1 summarizes permits and regulatory approvals that may be required.

Table 2.7.3-1 Potential Required Permits and Regulatory Approvals

Permit or Approval	Agency or Municipality	Broad Creek	Conowingo Creek	Peach Bottom Marina
Clean Water Act Section 404	USACE Baltimore District	X	X	X
River and Harbors Act Section 10	USACE Baltimore District	X	X	X
Water Withdrawal or Consumptive Use[33]	SRBC			
Alteration of Floodplain, Waterway, Tidal or Nontidal Wetland Permit	MDE	X	X	
Water Appropriation and Use	MDE	X	X	
Chapter 110 Permit for Water Withdrawal or Consumptive Use[28]	PADEP			
Chapter 105 Permit for Water Obstruction and Encroachment	PADEP			X
Chapter 102 Erosion and Sediment Control Plan	PADEP			X
Temporary Discharge Letter Approval	PADEP			X
Clean Water Act Section 401 Water Quality Certificate	MDE	X	X	
	PADEP			X
Coastal Zone Management Coastal Zone Consistency	MDE	X	X	
Endangered Species Act	USFWS Pennsylvania Field Office			X
	USFWS Chesapeake Bay Field Office	X	X	
Bald Eagle and Golden Eagle Protection Act	USFWS Pennsylvania Field Office			X
	USFWS Chesapeake Bay Field Office	X	X	
State Rare, Threatened, and Endangered Species	MDNR	X	X	
	PFBC			X

[33] While it is not anticipated that water withdrawals will be required for mechanically dredging the coves, contractor construction methods can vary.

Permit or Approval	Agency or Municipality	Broad Creek	Conowingo Creek	Peach Bottom Marina
	PGC			X
	PDCNR			X
Fisheries, DNR Lands, and Additional Natural Resources Review	MDNR	X	X	
	PDCNR			X
National Historic Preservation Act	MHT	X	X	
	PHMC			X
Permit to Install Floating Structures and Private Aids to Navigation	PFBC			X
Erosion and Sediment Control Plan County Review	Harford County Public Works	X		
	Cecil County Soil Conservation Dist.		X	
	Lancaster County Conservation Dist.			X
Grading Permit	Harford County Public Works	X		
	Cecil County Devl. Plans Review		X	
Floodplain Authorization	Harford County Planning and Zoning	X		
Building Permit – In-Water Projects (Floodplain)	Cecil County Permits and Inspections		X	
Zoning Certificate	Harford County Planning and Zoning	X		
	Cecil County Planning and Zoning		X	
	Fulton Township Zoning			X
Site Plan Approval	Harford County Planning and Zoning	X		

Permit or Approval	Agency or Municipality	Broad Creek	Conowingo Creek	Peach Bottom Marina
	Cecil County Planning and Zoning		X	
	Fulton Township Zoning			X
Stormwater Permit	Harford County Public Works	X		
	Cecil County Devl. Plans Review		X	
	Fulton Township Zoning			X
Forest Conservation Plan	Harford County Planning and Zoning	X		
	Cecil County Planning and Zoning		X	

3 MONITORING

3.1 Recreational Facilities

Sediment transport and deposition will be monitored in Conowingo Pond, at the Broad Creek, Conowingo Creek, and Peters Creek (Peach Bottom Marina) recreational facilities using bathymetric surveys and periodic water depth measurements.

3.1.1 Bathymetric Surveys

A bathymetric survey of Conowingo Pond and the three recreation sites was most recently performed in August 2020; however, Exelon proposes to conduct the 2022 bathymetric survey specified in License Article 420 in 2022 and continue the bathymetric surveys at 5-year intervals after that to monitor sediment transport and depositional patterns within the pond. The bathymetric surveys will include the Broad Creek, Conowingo Creek, and Peters Creek (Peach Bottom Marina) recreational facilities. The proposed extent of the bathymetric surveys is shown in Figure 3.1.1-1 through Figure 3.1.1-4.

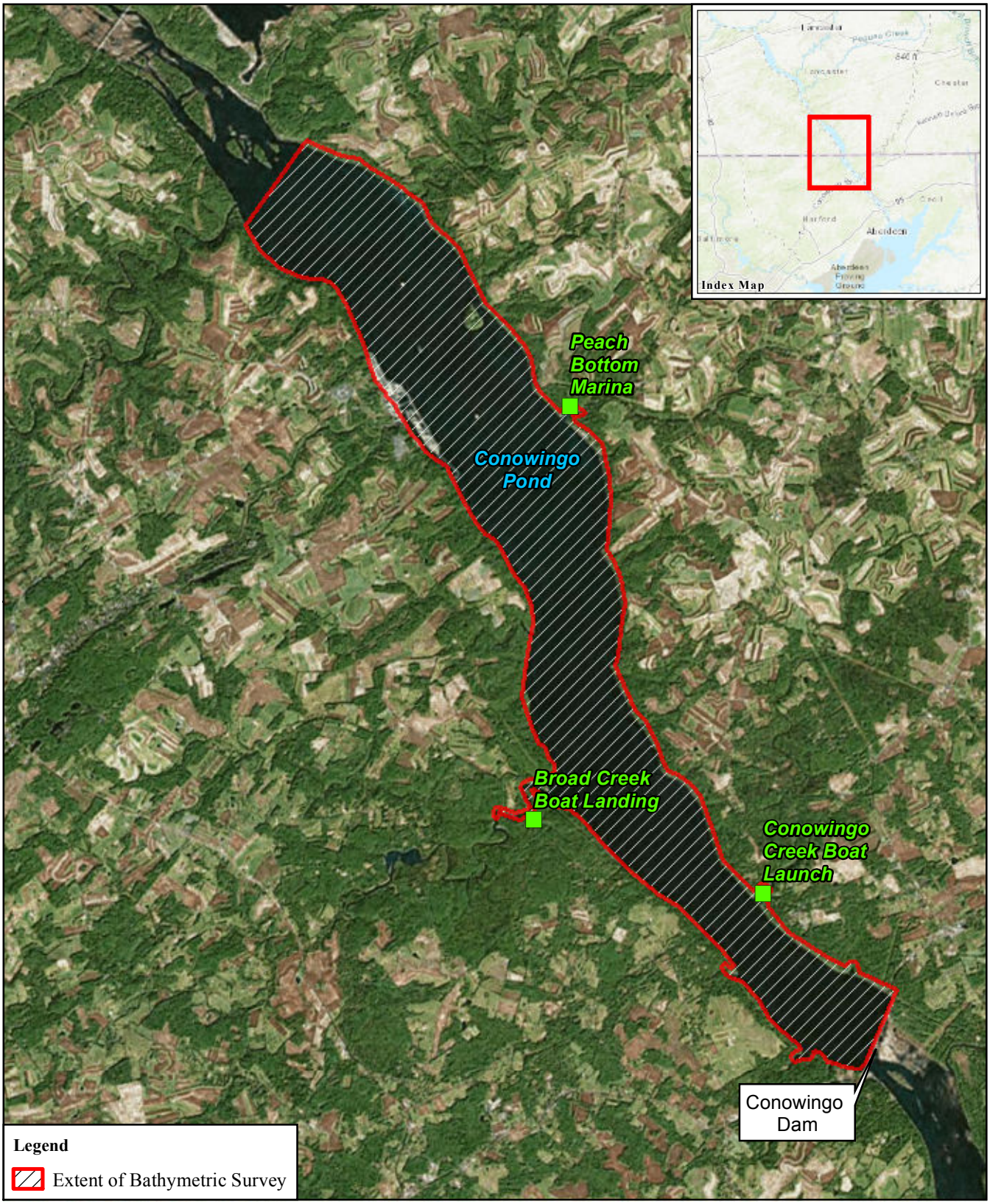
The results of each bathymetric survey will include an analysis of any change in sediment deposition or scour in Conowingo Pond from the most recent previous survey(s), so that any changes in sediment depositional or scour patterns in the Pond over time can be monitored and provided to FERC.

3.1.2 Post-Construction Bathymetric Surveys

Exelon proposes to conduct post-construction bathymetric surveys at the recreation facilities after each dredging event for up to three years following construction. Post-construction monitoring surveys will be conducted twice a year, once between May 1st and Memorial Day (after spring runoff and before the recreational boating season) and between Labor Day and October 1st. These post-construction surveys will be used to determine sedimentation rates at the recreation sites and assess dredging benchmarks and frequency.

3.1.3 Water Depth Monitoring

Water depths at the Broad Creek, Conowingo Creek, and Peters Creek (Peach Bottom Marina) recreational facilities will be monitored twice every year – between May 1st and Memorial Day (after spring runoff and before the recreational boating season) and between Labor Day and October 1st, unless there are reports of significant aggradation caused by a storm. In these cases, Exelon will determine whether additional water depth measurements are warranted and proceed accordingly. In such cases, Exelon will evaluate whether water depth measurements should be done sooner. Water depths will be measured at two critical points in each cove (Figure 3.1.1-2 through Figure 3.1.1-4), one near the boat launch and one further downstream in each creek. Monitoring points may be subject to relocation based on field observations or sedimentation patterns observed from future monitoring efforts.



EXELON GENERATION COMPANY, LLC

CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

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Miles

Figure 3.1.1-1:
Conowingo Pond
Sediment Management Plan
Extent of Bathymetric Survey

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Sediment Management Plan

Figure 3.1.1-2:
Broad Creek
Sediment Mangent Plan
Monitoring Locations

Legend

- Water Depth Monitoring Locations
- Boat Launch/Landing
- Extent of Bathymetric Survey

N

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

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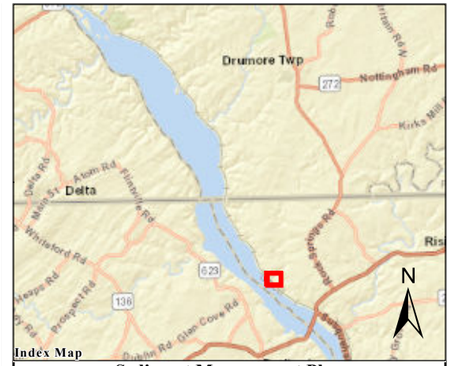

Sediment Management Plan

Figure 3.1.1-3:
Conowingo Creek
Sediment Management Plan
Monitoring Locations

Legend

- Water Depth Monitoring Locations
- Boat Launch/Landing
- Extent of Bathymetric Survey

N

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

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Sediment Management Plan

Figure 3.1.1-4:
Peters Creek (Peach Bottom Marina)
Sediment Mangement Plan
Monitoring Locations

Legend

- Water Depth Monitoring Locations
- Boat Launch/Landing
- Extent of Bathymetric Survey

N

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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

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4 IDENTIFY BENCHMARKS FOR ACTION(S)

Additional site-specific evaluations are needed before determining whether a recreation boating facility needs to be dredged. Important data to trigger these site-specific evaluations is whether the water draft depth available at each site allows for recreational boating. Exelon will monitor water depth with bathymetric monitoring every five years and biannual water depth monitoring at the three recreation boating facilities.

State Organization for Boating Access (SOBA) recommends the water at the toe of launching ramps and boat channels be a minimum of three feet deep for motorized boating (SOBA 2006). Per Article 406 of the License, Conowingo Pond is maintained at elevation 107.2 feet NGVD during the recreation season (Memorial Day through Labor Day)[34]. Therefore, when the elevations within the channels at Peters Creek, Broad Creek, or Conowingo Creek exceed 104.2 feet, motorized boating could be impaired at the recreation pond level. When channel elevations are at elevation 103.2 NGVD or above based on monitoring, Exelon will consider actions to alleviate potential impaired boating use including dredging of the problem areas as well as alternative recreation use at the sites which may require less dredging or no dredging.

SOBA also recommends channel widths to be able to "accommodate two design vessels passing safely at no-wake speed" (SOBA, 2006). The design vessels at these sites are pontoon boats with widths typically varying between approximately 8 and 12 feet. At 12 feet, two vessels passing with 10 feet between them would require a minimum channel bottom width of 34 feet. For kayaks or carry-in vessels, the channel width may be less. This criteria will be considered during Exelon's future evaluations of potential actions to alleviate impaired boating use at the sites.

[34] Per Article 406, the Licensee must operate the Project with a normal range of operation for Conowingo Pond between elevations 101.2 NGVD29 and 110.2 NGVD29, with a minimum elevation of 107.2 feet NGVD 29 on weekendsbetween Memorial Day and Labor Day, to meet recreational needs.

5 EVALUATE AND SELECT ACTION(S)

When water depth or bathymetric data indicate that elevations exceed 103.2 NGVD, Exelon will begin evaluating what actions to implement. Actions to alleviate potential impaired boating use include dredging of the problem areas as well as alternative recreation use at the sites which may require less dredging or no dredging.

To evaluate what potential action is most suitable at a site, Exelon will use site recreation use data (including surveys starting in 2030 and conducted every 10 years according to License Article 426), bathymetric and water depth monitoring data collected regularly as described in Section 4, and additional site-specific information. Additional site-specific data that could be needed are the following:

- Sediment grain size analysis and analytical testing;
- Site-specific feasibility analyses of the appropriate dredging methodology to be used, the areal extent and depth of dredging needed to support recreational boating usage, sediment disposal options, and constructability (e.g., additional constraints to be considered are railroad bridge clearances at the mouths of Peters Creek and Conowingo Creek and sediment accretion on the pond side of the Peters Creek channel). Feasibility analyses will consider lessons learned from the Peters Creek dredging activities in 2019/2020;
- Cost estimates for sediment management alternatives at each site that include construction documents, construction inspections, and continued bathymetric monitoring;
- Agency consultation with regards to impacts to sensitive resources and possible data collection related to sensitive resources;
- Disposal costs and options will be contingent on the findings of the laboratory analyses of sediment quality. Exelon will consult with the regulatory agencies, as appropriate, to determine if there are opportunities to improve habitat related to sediment removal or relocation. Exelon will work with regulatory agencies to identify appropriate disposal and beneficial/innovative reuse options that are agreeable to all parties; and
- Assessment of permitting and regulatory requirements and timeframes.

Exelon will evaluate the potential actions identified to alleviate impaired boating use at a site and determine the appropriate action considering several factors, including but not limited to recreation usage of the site and associated draft needs, dredging alternatives (e.g., maintenance dredging versus full fledge dredging project), estimated cost versus benefit, sediment disposal and beneficial/innovative reuse options, and environmental factors such as the presence of protected species and habitat (e.g., northern map turtle[35]).

Based on the benchmark of channel elevations exceeding elevation 103.2 ft NGVD, a bathymetric survey conducted in August 2020 indicates action needs to be taken at Broad Creek. The channel bed elevations generally varied from 104-105 NGVD at Broad Creek. Exelon has preliminarily identified these areas as shown in Appendix C. Approximately 3,100 CY needs to be excavated from Broad Creek to maintain adequate draft in the channel for boating. Exelon proposes to dredge these areas identified within Broad

[35] Following FERC approval of the Conowingo Hydroelectric Project Northern Map Turtle Protection Plan, Exelon will conduct ten years of northern map turtle population monitoring as stipulated in Article 424 in the new FERC license.

Creek by 2027 based on the proposed schedule in Table 5-1 below. Post-construction bathymetric monitoring at Broad Creek will be conducted for three years.

Table 5-1 Broad Creek Dredging Schedule[36]

Phase	Dates
Pre-Design Data Collection	2022-2023
Design	2022-2023
Permitting	2024-2026
Construction	2026-2027
Site Restoration/Permit Closeout	2027

Between 2019 and 2020, the main channel at Peters Creek was dredged down to elevation 101.2 NGVD. The August 2020 bathymetric survey indicates the elevation of the dredged channel downstream of the Peach Bottom Marina boat ramp has increased from 101.2 to 102.7 NGVD in some locations. The dredged channel upstream of the boat ramp in the creek appears to have increased to 103.8 NGVD in some locations. Most of channel appears to still be navigable based on the surveyed cross sections provided in Appendix A. Exelon proposes to perform post-construction bathymetric surveys at Peters Creek twice a year as described in Section 3.2 in 2022 and 2023 to evaluate sedimentation rates. In addition to the post-construction bathymetric surveys, Exelon is initiating consultation with the resource agencies about a maintenance dredging permit for Peach Bottom Marina. Table 2.7.3-1 summarizes permits and regulatory approvals that may be required.

Given the land use similarities within the watersheds, observations from the post-construction bathymetric surveys at Peters Creek will be used to inform approaches to future dredging activities at Conowingo Creek. Based on the benchmark of channel elevations exceeding elevation 103.2 ft NGVD, a bathymetric survey conducted in August 2020 indicates action needs to be taken at Conowingo Creek. The channel bed elevations generally varied from 103-104 NGVD at Conowingo Creek. Exelon has preliminarily identified these areas as shown in Appendix C. Approximately 2,600 CY needs to be excavated from Conowingo Creek to maintain adequate draft in the channel for boating.

Exelon is proposing to delay starting the Conowingo Creek restoration design and permitting process until post-construction bathymetric information can be obtained at Peach Bottom Marina. These data will inform the design. A report of findings and dredging recommendations or alternatives will be completed by August 31, 2024. Exelon proposes to dredge the areas identified within Conowingo Creek by 2029 based on the proposed schedule in Table 5-2 below. Post-construction bathymetric monitoring at Conowingo Creek will be conducted for three years.

[36] This schedule is based on the schedule for dredging Peach Bottom Marina between 2015 and 2020.

Table 5-2 Conowingo Creek Dredging Schedule[37]

Phase	Dates
Pre-Design Data Collection	2024-2025
Design	2024-2025
Permitting	2026-2028
Construction	2028-2029
Site Restoration/Permit Closeout	2029

[37] This schedule is based on the schedule for dredging Peach Bottom Marina between 2015 and 2020.

6 IMPLEMENTATION SCHEDULE

The measures proposed herein will be implemented based on the schedule in Table 6-1 below upon FERC approval of this SMP. The implementation schedule takes into account the various phases of a dredging project from pre-design data collection to site restoration/closeout. Additional site-specific data that could be needed includes additional sediment testing, dredging feasibility analyses, investigation of sediment disposal and beneficial/innovative options, additional data on sensitive resources such as map turtles and consultation with resource agencies on mitigative measures, recreation usage data, and post-construction monitoring at Peach Bottom Marina. Exelon will initiate consultation with the USACE, PADEP, and MDE with regards to maintenance dredging at the three recent sites based on the post construction bathymetric mapping and begin development of permit applications.

Table 6-1 Implementation Schedule

Task	Begin	End	Frequency
Bathymetric Surveys of Conowingo Pond & Recreation Sites	2022	2070	Every 5 years
Bathymetric Survey Report[38]	2023	2071	Every 5 years
Water Depth Monitoring	2022	2070	May and Sept. every year
Peach Bottom Marina			
Initial Peach Bottom Marina Dredging	2015	2020	
Subsequent Peach Bottom Marina Dredging[39]	TBD	TBD	
Broad Creek			
Initial Broad Creek Dredging	2022	2027	
BC - Pre-Design Data Collection	2022	2022	
BC - Design	2022	2023	
BC – Permitting	2024	2026	
BC – Construction	2026	2027	
BC – Site Restoration/Permit Closeout	2027	2027	
Subsequent Broad Creek Dredging[40]	TBD	TBD	

[38] Report to be filed every five years by March 31 of the year following five-year bathymetric surveys.

[39] Exelon's determination of dredging frequency at this site will be based on post-construction bathymetric monitoring, a site-specific recreation use assessment at Peach Bottom Marina, and receipt of map turtle survey and other Rare, Threatened, Endangered species data. Exelon is initiating preparation and submittal of maintenance dredging permits and consultations for Peach Bottom Marina based upon the recent dredging of the marina.

[40] Exelon's determination of dredging frequency at this site will be based on post-construction bathymetric monitoring, a site-specific recreation use assessment at Broad Creek, and receipt of map turtle survey and other Rare, Threatened, Endangered species data.

Task	Begin	End	Frequency
Conowingo Creek			
Initial Conowingo Creek Dredging[41]	2024	2029	
CC – Pre-Design Data Collection	2024	2024	
CC - Design	2024	2025	
CC – Permitting	2026	2028	
CC – Construction	2028	2029	
CC – Site Restoration/Permit Closeout	2029	2029	
Subsequent Conowingo Creek Dredging[42]	TBD	TBD	
Post Construction Bathymetric Surveys			
Peach Bottom Marina[43]	2022	2023	May and Sept. for 2 years following construction
Broad Creek	2028	2030	May and Sept. for 3 years following construction
Conowingo Creek	2030	2032	May and Sept. for 3 years following construction

[41] Given the impact on dredging design, Exelon will start the dredging design process at Conowingo Creek after the post-construction bathymetric monitoring at Peach Bottom Marina.

[42] Exelon's determination of dredging frequency at this site will be based on post-construction bathymetric monitoring, a site-specific recreation use assessment at Conowingo Creek, and receipt of map turtle survey and other Rare, Threatened, Endangered species data.

[43] Post construction surveys at Peach Bottom Marina were conducted in March and August 2020.

7 REPORTING

Exelon will file the results of the bathymetric survey of Conowingo Pond and the recreational facilities with FERC by March 31 of the year following the bathymetric survey. The report will include an analysis of any change in sediment deposition or scour in the pond from the previous surveys, including the most recent bathymetric survey of Conowingo Pond so that any changes in sediment depositional or scour patterns in the pond over time since the 2011 survey can be monitored. The five-year report will include the biannual water depth monitoring data described in Section 3.2.2 and a summary of any data collection, post-construction dredging bathymetric surveys, engineering and environmental analyses, permitting, procurement, or implementation of dredging activity that has occurred at these sites will also be included in the report.

8 MODIFICATIONS TO PLAN

In accordance with License Article 420, once approved, the Plan will not be amended without prior approval from FERC.

9 LITERATURE CITED

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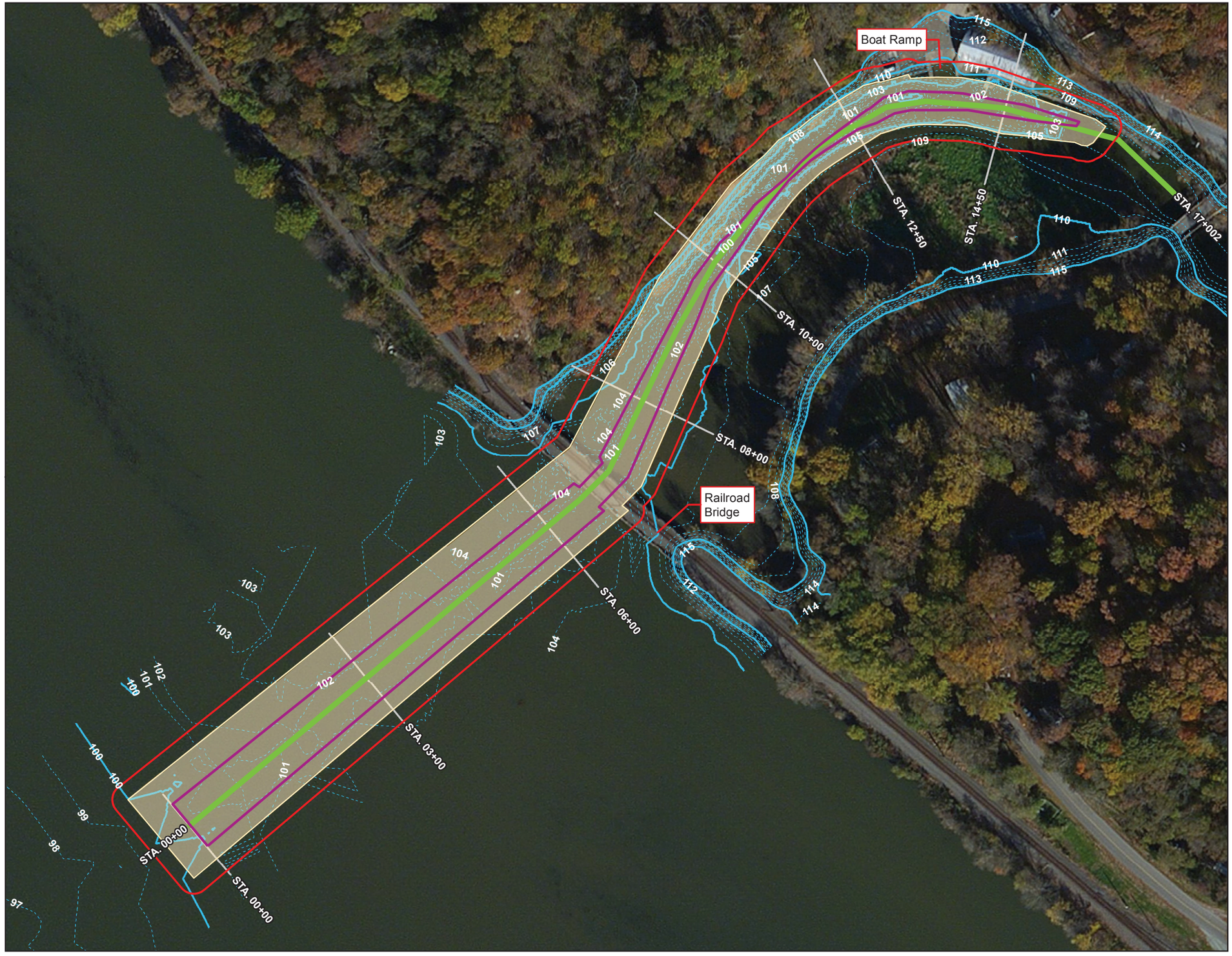
APPENDIX A. PETERS CREEK CROSS SECTIONS



Peach Bottom Marina
Dredging Area
and 2020 Bathymetric Data

Legend

- Dredging Area
- Work Area Limit
- Dredge Toe-El. 100.4
- Dredge Cross Section
- Dredge Profile
- Major Contour (5 ft)
- 1 Foot Contour

N

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)
Horizontal Datum: North American Datum of 1983 (NAD 83)
State Plane Maryland FIPS 1900 Feet Projection

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1 inch = 125 feet

0 62.5 125 250 Feet

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CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

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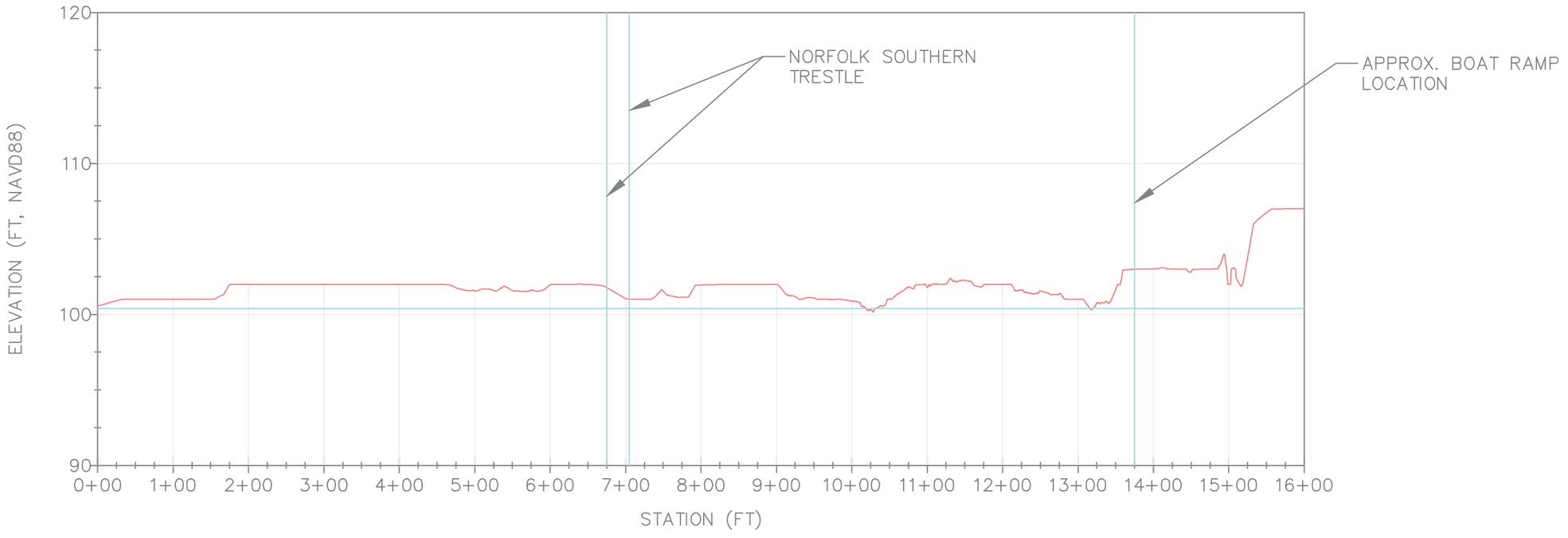
PETERS CREEK THALWEG PROFILE
(AUGUST 2020)



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2) ELEVATION DATA BASED ON A BATHYMETRIC SURVEY PERFORMED BY GOMEZ AND SULLIVAN BETWEEN AUGUST 11–14, 2020..

PRELIMINARY NOT FOR CONSTRUCTION

ISSUE	DATE	DESCRIPTION	BY	APP
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DRAWN BY:
CHECKED BY:
APPROVED BY:
PROJECT NO. 2201 DATE: 3/23/21

Exelon

GOMEZ AND SULLIVAN ENGINEERS
Williamsville, NY● Utica, NY● Albany, NY● Henniker, NH
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CONOWINGO SEDIMENT MANAGEMENT STUDY

PETERS CREEK THALWEG PROFILE

Exelon Generation Company, LLC
Conowingo Hydro Station
Muddy Run Pumped Storage Plant
4948 Conowingo Road
Darlington, MD 21034

Gomez and Sullivan Engineers, D.P.C.
41 Liberty Hill Road
PO Box 2179
Henniker, NH 03242

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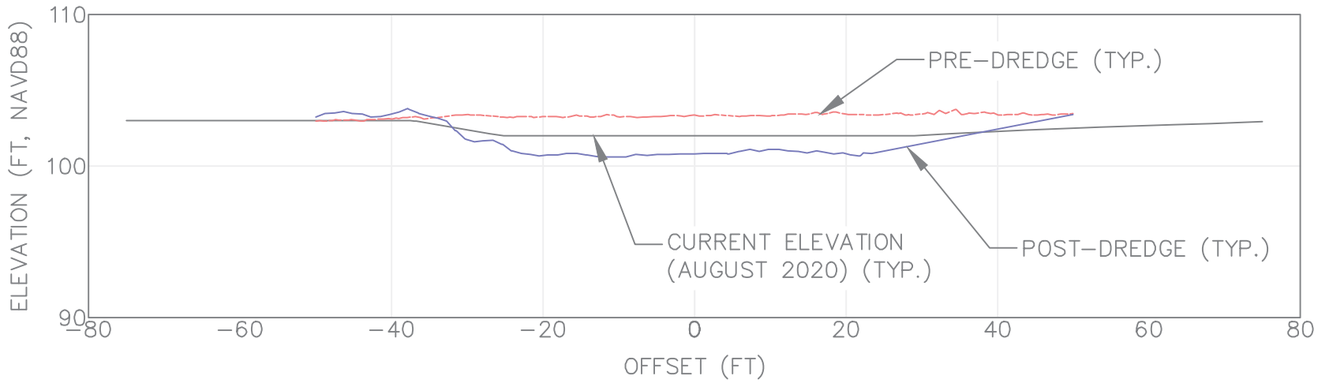

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POST−DREDGE SURVEY
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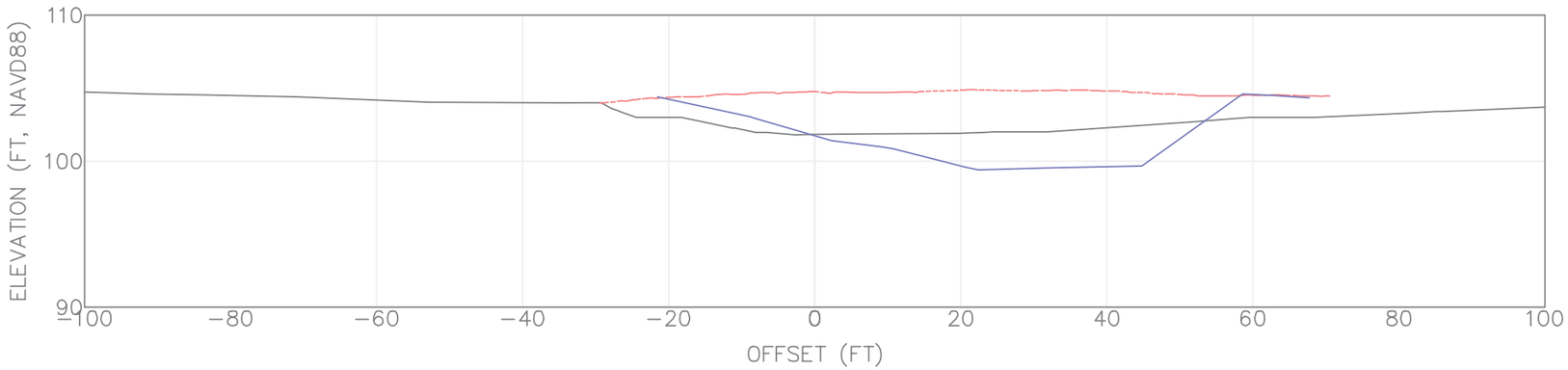
MARCH 2020 (STA. 12+00 − 15+75)

AUGUST 2020 SURVEY

STA. 6+00



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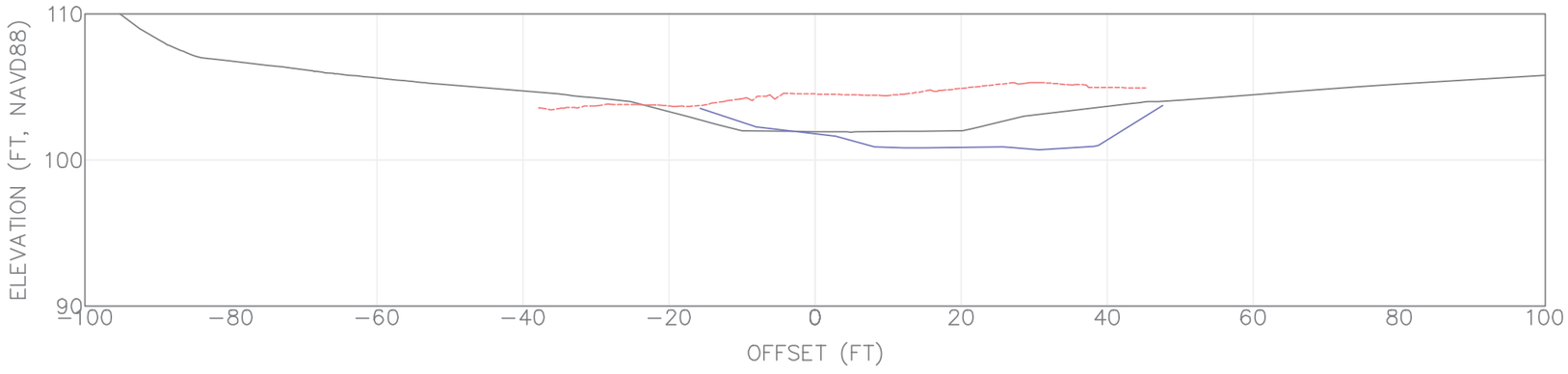

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2) VERTICAL DATUM: NAVD88

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CONSTRUCTION

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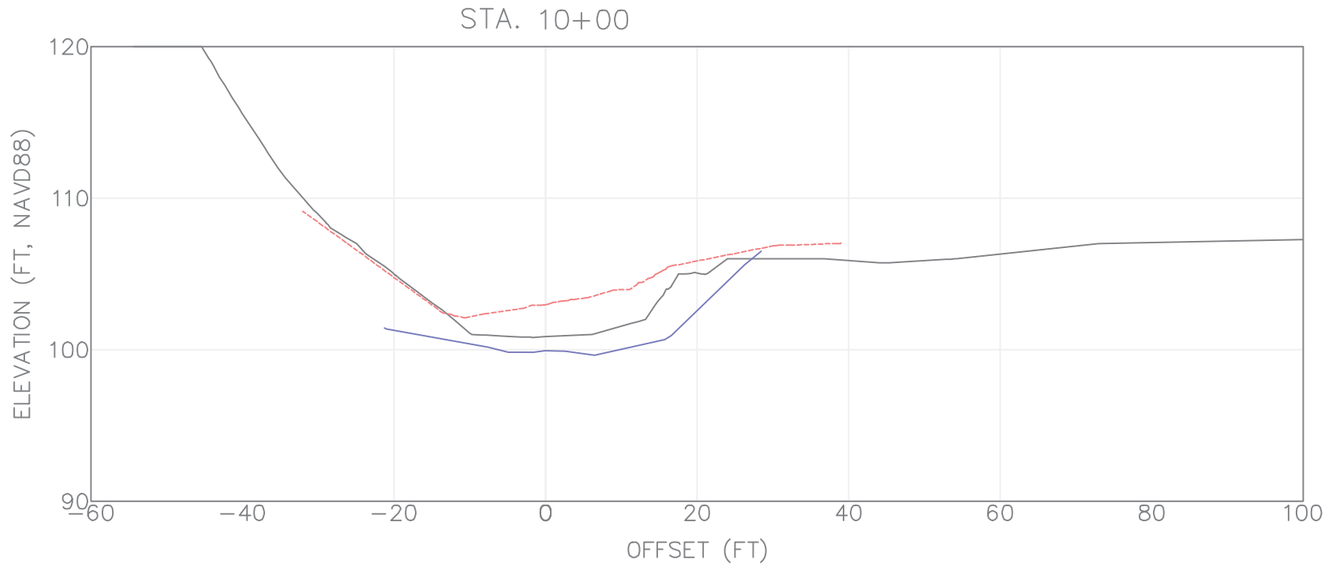

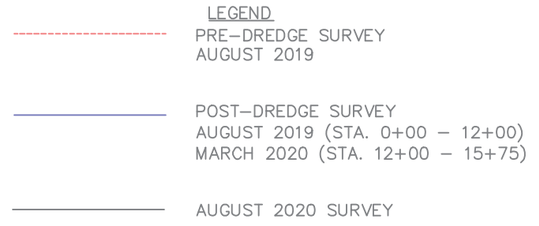

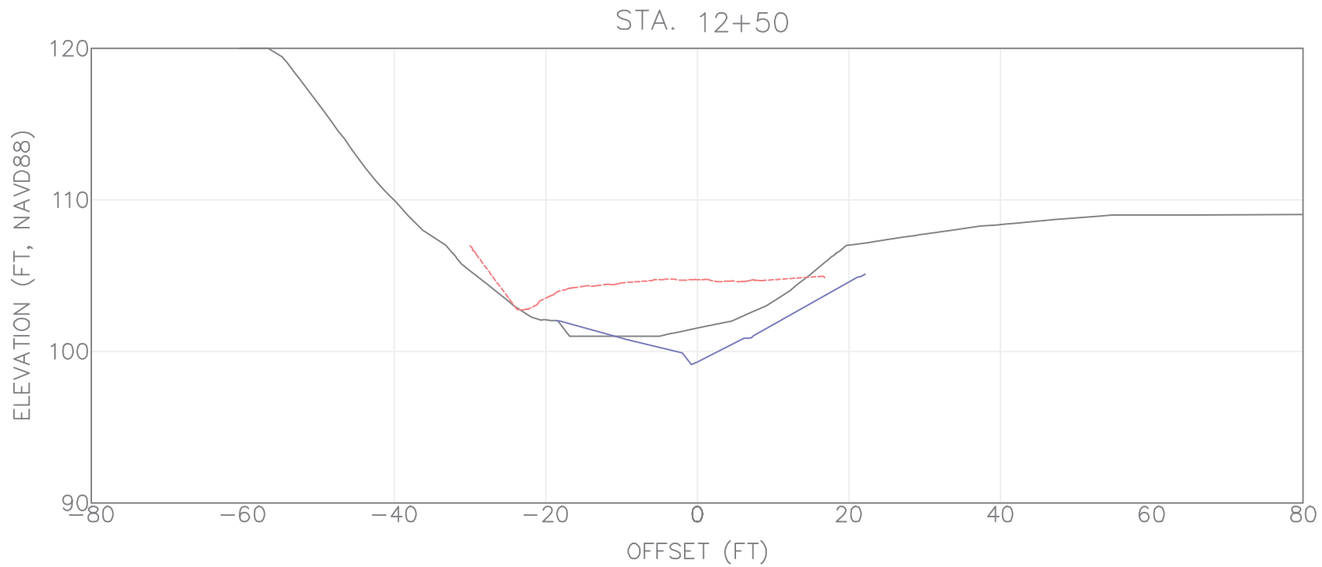

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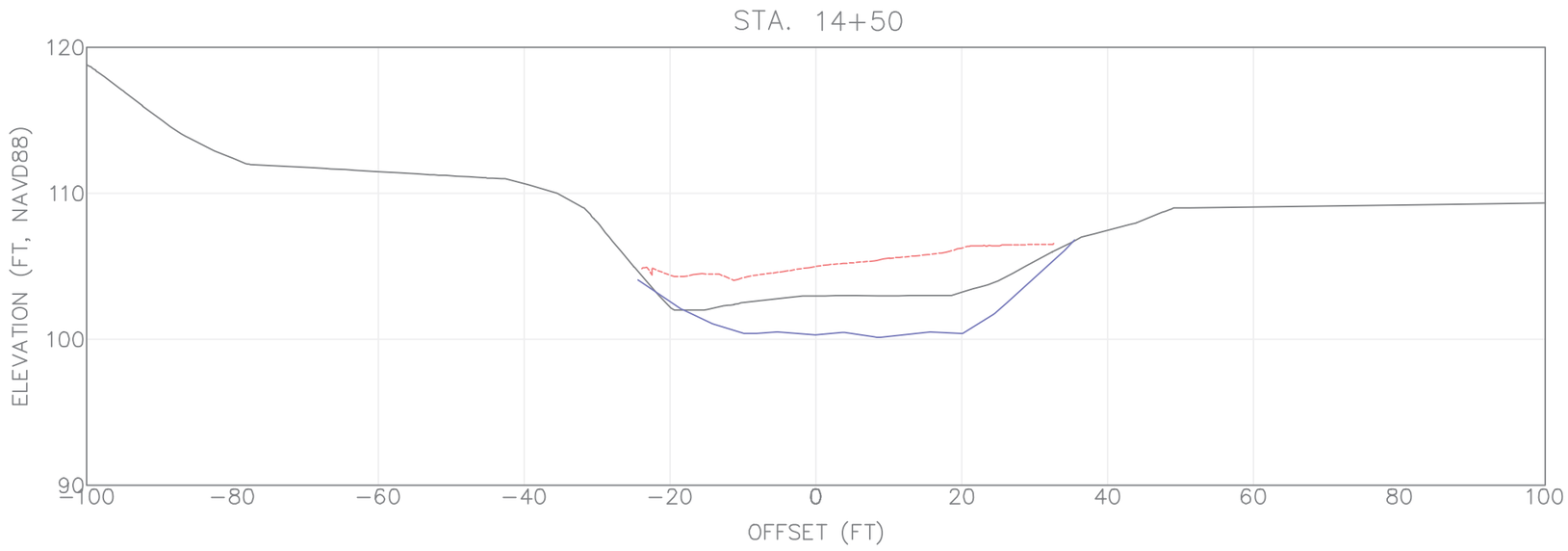

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PRE−DREDGE SURVEY
AUGUST 2019

POST−DREDGE SURVEY
AUGUST 2019 (STA. 0+00 − 12+00)
MARCH 2020 (STA. 12+00 − 15+75)

AUGUST 2020 SURVEY

NOTES:
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PETERS CREEK CROSS SECTIONS SHEET 3 OF 3

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SCALE:

DRAWING:

APPENDIX B. PICTURES OF DREDGING AND DEWATERING EQUIPMENT

Hydraulic Dredge Example

Source: GSE, November 2019 - Peach Bottom Marina, PA.

Source: GSE, November 2019 - Peach Bottom Marina, PA.

Mechanical Dredge Example

Source: GSE, March 2020 - Peach Bottom Marina, PA.

Source: GSE, March 2020 - Peach Bottom Marina, PA.

Dino6 Dredge – Geoform International, Inc.

Source: GSE, July 2021 – Geoform International, Inc.
(https://geoforminternational.com/products/dino6/)

Source: GSE, July 2021 – Geoform International, Inc.
(https://geoforminternational.com/products/dino6/)

Dewatering - Geotubes

Source: GSE, October 2020 - Peach Bottom Marina, PA.

Source: GSE, October 2020 - Peach Bottom Marina, PA.

Mechanical Dewatering – De-sander Trailer Unit

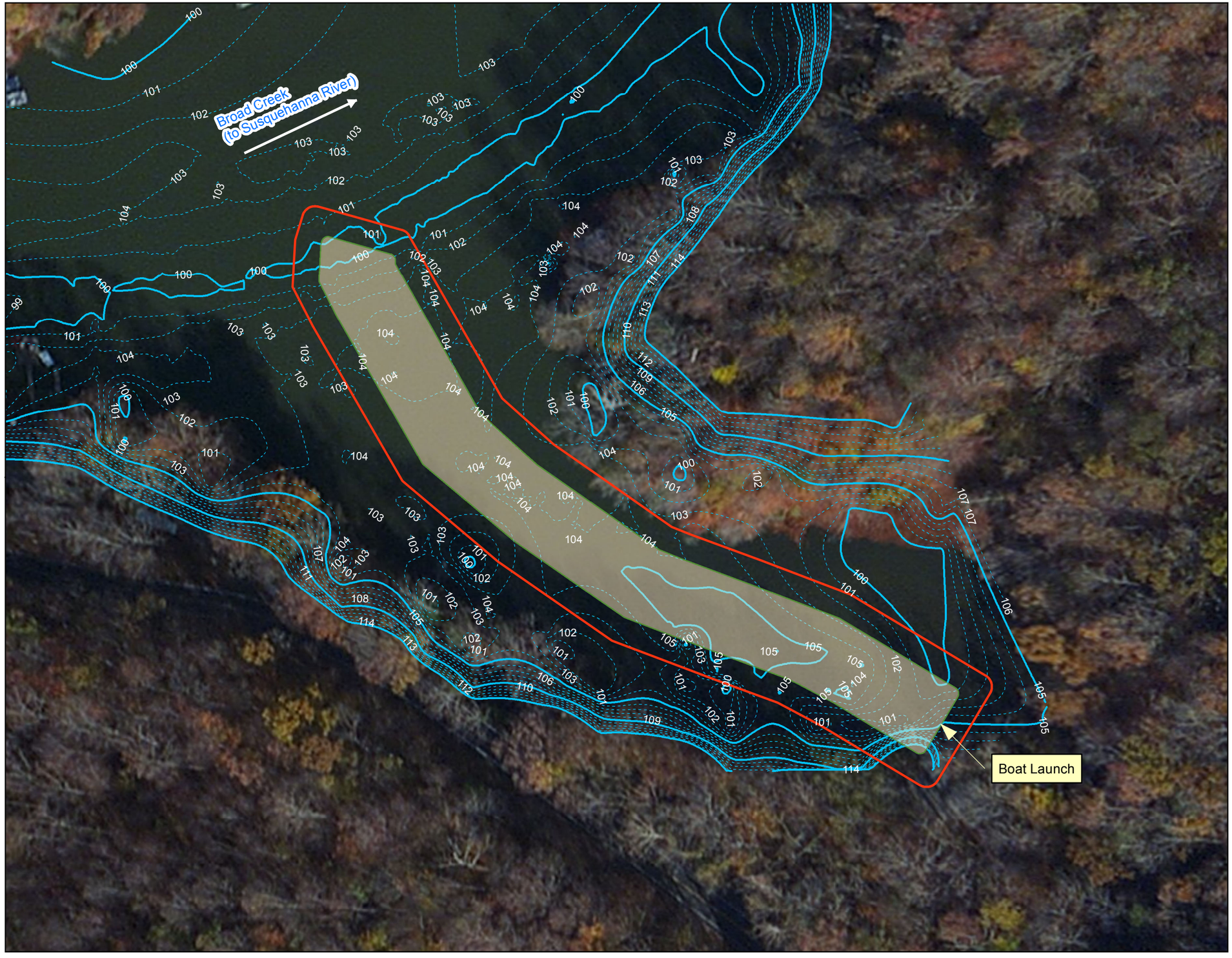
Source: GSE, October 2020 - Peach Bottom Marina, PA.

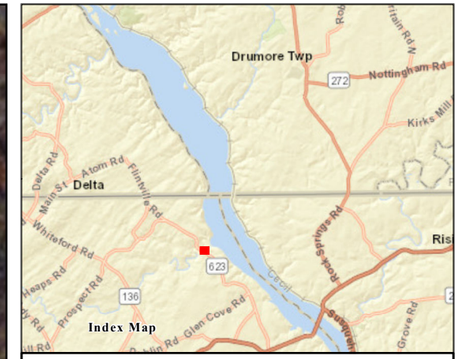
Source: GSE, October 2020 - Peach Bottom Marina, PA.

Mechanical Dewatering System (MDS) Unit in Roll-Off Container – by Tencate Inc.

Source: Tencate Inc., October 2007 - https://bishopwater.ca/wp/wp-content/uploads/2017/01/20160428122648_nb_geotube_municipal.pdf.

APPENDIX C. POTENTIAL DREDGE FOOTPRINTS AT BROAD CREEK AND CONOWINGO CREEK RECREATION SITES





Broad Creek Boat Launch
Conceptual Dredge Footprint Map

Legend

- Conceptual Dredging Footprint
- Conceptual Work Area Limit
- Major Contour (5 ft)
- 1 Foot Contour

N

Map is conceptual and not to be used for permitting or construction.

Contours were developed based on bathymetric survey data collected in August 2020.

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)
Horizontal Datum: North American Datum of 1983 (NAD 83)
State Plane Maryland FIPS 1900 Feet Projection

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1 inch = 75 feet

0 37.5 75 150 Feet

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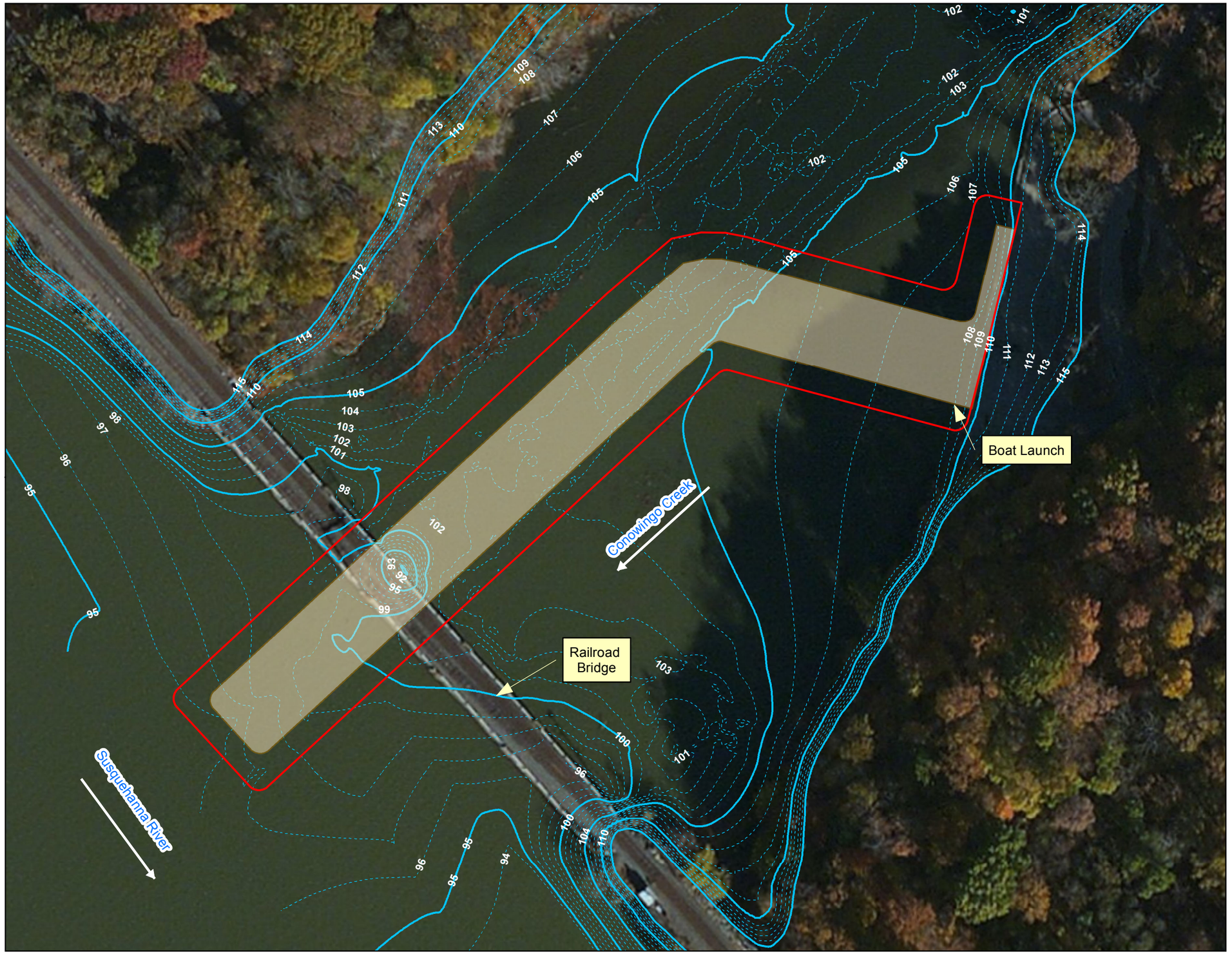

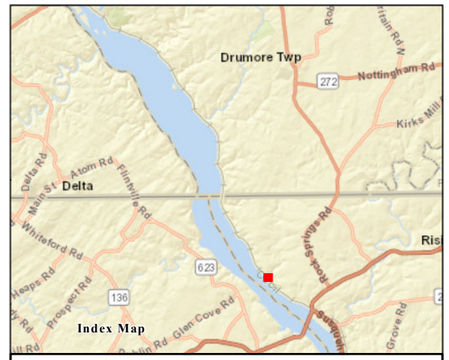

Conowingo Creek Boat Launch Conceptual Dredge Footprint Map

Legend

- Conceptual Dredging Footprint
- Conceptual Work Area Limit
- Major Contour (5 ft)
- 1 Foot Contour

N

Map is conceptual and not to be used for permitting or construction.

Contours were developed based on bathymetric survey data collected in August 2020.

Vertical Datum: North American Vertical Datum of 1988 (NAVD 88)
Horizontal Datum: North American Datum of 1983 (NAD 83)
State Plane Maryland FIPS 1900 Feet Projection

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1 inch = 75 feet

0 37.5 75 150 Feet

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Attachment O

Conowingo Hydroelectric Project
(FERC Project No. 405)

Shoreline Management Plan
("SMP")

CONOWINGO HYDROELECTRIC PROJECT
FERC PROJECT NUMBER 405

SHORELINE MANAGEMENT PLAN

Prepared for:

Exelon.

Prepared by:
TRC Companies, Inc.

GOMEZ AND SULLIVAN ENGINEERS

August 31, 2012
Revised September 2021

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2.3 Hydroelectric Facilities 2-2
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LIST OF ABBREVIATIONS

ADA	Americans with Disabilities Act
APE	Area of Potential Effect
BEMP	Bald Eagle Management Plan
CLI	Conservation Landscape Initiative
Conowingo Project	Conowingo Hydroelectric Project (FERC Project No. 405)
FERC	Federal Energy Regulatory Commission
FWS	U. S. Fish and Wildlife Service
HPMP	Historic Properties Management Plan
IBA	Important Bird Area
LWCF	Land and Water Conservation Fund
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MHT	Maryland Historical Trust
NPS	National Park Service
PADCNR	Pennsylvania Department of Conservation and Natural Resources
PADEP	Pennsylvania Department of Environmental Protection
PBAPS	Peach Bottom Atomic Power Station
PFBC	Pennsylvania Fish and Boat Commission
PGC	Pennsylvania Game Commission
PHMC	Pennsylvania Historical and Museum Commission
RMP	Recreation Management Plan
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SMP	Shoreline Management Plan

EXECUTIVE SUMMARY

The Conowingo Hydroelectric Project (Federal Energy Regulatory Commission (FERC) Project No. 405) (Conowingo Project) Shoreline Management Plan (SMP) was developed beginning in 2009 and filed with FERC August 30, 2012 after considerable consultation with the public, local townships, county officials, and Resource Agencies including but not limited to the United States Fish and Wildlife Service (FWS), Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Department of Conservation and Natural Resources (PADCNR), Maryland Department of Natural Resources (MDNR), Maryland Department of the Environment (MDE), Susquehanna River Boating Commission (SRBC), and the National Park Service (NPS). FERC issued the Conowingo Hydroelectric Project License on March 19, 2021. The FERC License includes Article 428, which reads as follows:

> *Article 428.* Shoreline Management Plan*. Within six months of license issuance, the licensee must file with the Commission for approval, a revision to the Shoreline Management Plan filed on August 31, 2012. The revised plan must include the following modifications:*
>
> *a) A provision for reviewing and updating the plan every 10 years, with the first update to be filed with the Commission in 2030.*
>
> *b) A requirement that, prior to submitting a proposed update to the Shoreline Management Plan to the Commission, the licensee must submit to the Maryland Department of the Environment (MDE) for review and comment all proposed modifications, including an assessment of the impacts of deleted, revised, or new measures on water quality.*
>
> *c) A requirement that, prior to submitting an application to FERC for a non-project use of project land, the licensee must, in addition to complying with the requirements of Article 430: (i) prepare, or require the third-party requesting the non-project use of project land to prepare, a written assessment of the impacts on water quality of the proposed use; (ii) provide this assessment to MDE for review to determine whether the proposed use is consistent with Maryland water quality standards, including designated and achieved uses; and (iii) consult with MDE regarding the proposed use.*
>
> *d) With the exception of any activities required pursuant to the license, prior to making any modifications to shoreline vegetation for viewshed maintenance and development and recreation access within the project boundary, a requirement that the licensee must: (i) prepare a written assessment of the impacts on water quality of the proposed modifications; (ii) provide this assessment to MDE for a determination regarding whether the proposed modifications are consistent with Maryland water quality standards, including designated and achieved uses; and (iii) not undertake any such modifications until MDE notifies the licensee in writing that it has no objections to the proposed modifications.*
>
> *e) A requirement that the licensee must consult with MDE regarding any proposed modification of an existing use of project lands in cases where such use may affect any sensitive aquatic resource identified by licensee in the "sensitive resources overlays" included in licensee's Shoreline Management Plan.*

> *Each proposed update to the plan must be developed after consultation with the U.S. Fish and Wildlife Service, the National Park Service, the Pennsylvania Department of Conservation and Natural Resources, the Maryland Department of Natural Resources, and MDE. The licensee must 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 must 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 must include the licensee's reasons, based on project-specific information.*
>
> *The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.*

As a result, Exelon has updated the SMP to incorporate the requirements in Article 428. In addition, Exelon has made minor updates to several outdated references.

The Conowingo Project SMP is a framework for the management of Project lands and river shoreline areas consistent with broader local, regional, state, and federal regulations, initiatives, and planning guidelines. The SMP enables Exelon to fulfill its license responsibilities and obligations for the Project, including the protection and enhancement of the Project's environmental and recreational values. More specifically, the SMP will:

- Protect environmental attributes such as wetlands, habitat, and spawning areas.
- Preserve the scenic quality of the Project lands for boaters and shoreline recreationists.
- Maintain existing water quality.
- Protect historic and cultural resources.
- Ensure cooperation with federal, state, and local government agencies to coordinate adjacent land uses and proposed infrastructure with shoreline uses.
- Ensure coordination with separate regulatory authority permitting review and approval efforts.
- Minimize conflicts among differing uses.

In accordance with Article 428 (a), the SMP will be reviewed and updated every 10 years, with the first update to be filed with FERC in 2030. Prior to submitting a proposed update of the SMP to FERC, in accordance with Article 428 (b), Exelon will submit a draft proposed update to the FWS, NPS, PADCNR, MDNR, and MDE for review and comment of all proposed modifications, including an assessment of the impacts of deleted, revised, or new measures on water quality.

The 570.15 megawatt Conowingo Project is located in a rural setting on the Susquehanna River in Pennsylvania (Lancaster and York Counties) and Maryland (Cecil and Harford Counties). Conowingo Dam and the lowermost six miles of the Project reservoir, Conowingo Pond, are located in Maryland and the upper eight miles of the reservoir are located in Pennsylvania. The FERC Project boundary extends

approximately 2.5 miles downstream of the dam along the east bank of the river and approximately one-half mile downstream along the west bank of the river. Lands within the FERC Project boundary comprise approximately 9,923 acres, including 8,868 acres of open water and 1,055 acres above the normal high water elevation in Lancaster and York Counties in Pennsylvania and Harford and Cecil Counties in Maryland.

The Conowingo Project provides access to many recreational and natural resources within the lower Susquehanna River Corridor. Access to additional resources are provided by other FERC-regulated hydroelectric projects and through county, state, and federal preservation initiatives and recreational facilities. At the Conowingo Project, Exelon provides various public recreational facilities. Over 736 acres of the 1,055 acres of Project lands are used for this purpose. These recreation facilities include trails, day use and interpretive sites, boat launch facilities, a swimming pool, shoreline fishing access, and public access lands.

Exelon has programs and policies that guide and support the recreational use and management of the Project lands. These programs and policies are consistent with FERC regulations requiring licensees to provide public access and recreational opportunities on Project lands which meet area recreational needs. The Project's public recreation facilities are managed under a Recreation Management Plan (RMP), which is specified in Article 426 of the license issued on March 19, 2021 and is incorporated by reference into this SMP.

Exelon has developed a six-category land use classification system for Project lands based on aerial photography interpretation, ground truthing, and corporate operating procedures and policies. These land classifications are defined as follows:

- Class 1: Project Operations: Lands used for power generation and electric transmission/distribution infrastructure and purposes.

- Class 2: Developed Recreation: Lands managed for developed public recreational facilities and activities. This includes commercial recreation facilities.

- Class 3: Natural/Undeveloped: Lands that are primarily undeveloped and generally available for public access and use.

- Class 4: Industrial and Other Non-Project Lands: Lands managed for industrial/commercial uses and other non-Project uses including shoreline stabilization projects.

- Class 5: Public Access Lands: Public access lands are Project lands managed by federal, state, county agencies or conservation organizations under agreement with Exelon. Public access and use of the lands is generally allowed, though it may be governed by the managing entity according to the type or level of activity or by season. These are typically unimproved lands, though parking areas, trails and other infrastructure may be provided.

- Class 6: Cottage Lands: Lands leased to individuals for seasonal use.

Consistent with these land use classifications, the SMP outlines specific shoreline management measures that have been developed to minimize or eliminate negative effects to shoreline resources. Exelon's focus on erosion control as a measure to improve overall water quality in the Susquehanna River watershed is reflected in both the shoreline management measures of the Plan and the best management practices (BMPs) included in Appendix A of the Plan. The measures included in this SMP are described below.

Shoreline Erosion Control. Modifications are allowed to shoreline vegetation in order 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. If the buffer function is impaired, a planting plan, using native species included in the native plant guide for this SMP, will be devised and implemented to mitigate for the reduced function.

General Maintenance. Modifications are allowed to shoreline vegetation to maintain the health of the shoreline vegetation, provided the modifications do not impair the overall function of the vegetated buffer. If the buffer function is impaired by vegetation removal, a planting plan, using only native species included in the native plant guide for this SMP, will be devised and implemented to mitigate for the reduced function.

Erosion and Remediation Policy. Exelon has identified and characterized incidences of erosion in the Conowingo Project boundary. Erosion areas that affect Project shoreline resources will be addressed through a remediation and monitoring program.

Woody Debris Management. Woody debris is defined as trees and woody material that extend from the shoreline into the impoundment. This material can provide important habitat for fish and wildlife and shall be left in place unless the debris is a navigational or safety hazard. If the woody debris must be removed, it shall be managed and disposed of in accordance with the policies outlined in the Debris Management Plan required by Article 427.

Approval of Non-Project Use of Project Lands. Any use of lands and waters or construction within the Conowingo Project boundary by a non-licensee must be permitted by all applicable local, county, state, or federal agencies. Exelon must also approve the activity before work can begin. In accordance with Article 430 Use and Occupancy, parties requesting non-Project use of Project lands will provide details to Exelon regarding the location and desired development or use, and Exelon will address Article 428, paragraph (c) requirements to comply with the requirements of Article 430 and, "(i) prepare, or require the third-party requesting the non-project use of project land to prepare, a written assessment of the impacts on water quality of the proposed use; (ii) provide this assessment to MDE for review to determine whether the proposed use is consistent with Maryland water quality standards, including designated and achieved uses; and (iii) consult with MDE regarding the proposed use" prior to submitting an application to FERC for a non-project use of project land. If it is determined that an activity will be allowed and has received all necessary permits and approvals, including FERC and/or MDE approval when required, Exelon will issue written permission to the party for its development and/or use of Project lands.

Shoreline Vegetation Management. Shoreline vegetation provides many benefits to the Conowingo Project including wildlife habitat, aesthetic value, and maintaining water quality by providing a filter strip to control run-off. Existing shoreline vegetation will be preserved in accordance with license requirements and Maryland water quality standards. It currently varies in extent depending on the location of the Conowingo Project boundary relative to the impoundment shoreline and current land use. Existing improved and developed areas with limited shoreline vegetative cover such as the cottage clusters, the Peach Bottom Atomic Power Station (PBAPS), recreation sites and facilities, and the dam and associated generating facilities, can be maintained as they currently exist. Modifications to the shoreline vegetation in other areas will be considered for viewshed maintenance and development, recreation access, shoreline erosion control, and general Project related maintenance of the vegetated shoreline. With the exception of any activities required pursuant to the license, prior to making any modifications to shoreline vegetation for viewshed maintenance and development and recreation access within the project boundary, Exelon will address Article 428, paragraph (d) requirements and "(i) prepare a written assessment of the impacts on water quality of the proposed modifications; (ii) provide this assessment to MDE for a determination regarding whether the proposed modifications are consistent with Maryland water quality standards,

including designated and achieved uses; and (iii) not undertake any such modifications until MDE notifies the licensee in writing that it has no objections to the proposed modifications."

Viewsheds. Modifications and maintenance of vegetation is allowed to provide a reasonable view of the water, provided the modifications do not impair the overall function of the vegetated buffer. If the buffer function is impaired, a planting plan, using the native species plant list included in this SMP, will be devised and implemented to mitigate for the reduced function from vegetation removal. Modifications to shoreline vegetation related to viewsheds are subject to the requirements of Article 428 and require the written assessment and consultation with MDE as described above.

Access Trails. Modification of the existing vegetation is allowed to provide access trails to the water, provided the modifications do not impair the overall function of the vegetated buffer. If the buffer function is impaired, a planting plan, using the native species plant list included in this SMP, will be devised and implemented to mitigate for the reduced function from vegetation removal. Modifications to shoreline vegetation related to viewsheds are subject to the requirements of Article 428 and require the written assessment and consultation with MDE as described above.

Sensitive Natural Resource Protection Overlays and Policies. Research and numerous studies were conducted to assess and determine the potential effects of project operations on various resources. Exelon has compiled existing and new data on these resources to develop a "sensitive resources" overlay to apply to the six land use classifications described above. This overlay is defined as areas within the Conowingo Project boundary that contain (or may contain) resources protected by state or federal law or executive order, and other natural features important to the area or natural environment. In accordance with Article 428, Exelon must consult with MDE regarding any proposed modification of an existing use of project lands in cases where such use may affect any sensitive aquatic resource identified by Exelon.

Bald Eagle Management Plan. Exelon developed a Bald Eagle Management Plan (BEMP) in consultation with the FWS and the Pennsylvania Game Commission (PGC) to address the use of Exelon-owned lands by Bald Eagles for nesting, roosting, foraging, and in accordance with the Muddy Run Pumped Storage Project FERC License. This plan will be updated in accordance with Article 421. The BEMP provides for the management of Bald Eagle on Exelon lands by implementing the FWS' National Bald Eagle Management Guidelines (2007) and state agency guidance. The range of protective measures include, but are not limited to, seasonal restrictions, distance buffers, and landscape buffers.

Osprey Management Policy. In consultation with state and federal agencies, Exelon will implement measures on Exelon lands to protect Osprey from potential disturbances or other impacts. Protective measures will include, but are not limited to, seasonal restrictions, distance buffers, and appropriate permitting prior to any necessary nest management.

Historic Properties Management Plan. Exelon has developed, in consultation with Pennsylvania Historical and Museum Commission (PHMC) and the Maryland Historic Trust (MHT), an Historic Properties Management Plan (HPMP) to address historic and cultural resources in accordance with Article 429.

Conowingo Islands Public Use Policy. Exelon's Conowingo Islands Public Use policy establishes guidelines for the use of the islands located in the upper reach of Conowingo Pond from the Pennsylvania Route 372 bridge approximately 1.3 miles downstream, as well as Mt. Johnson Island, which is located five miles downstream of the Route 372 bridge. The policy restricts and regulates island use in order to protect the islands' rare species, cultural resources, and unique geologic and physical features. The Policy is included in Appendix B and will be updated as needed.

Cottage Rules and Regulations. Exelon has developed rules and regulations regarding the use of Project lands for seasonal cottages. Lessees are required to comply with all applicable local, state, and federal laws

for the development and use of the land, as well as Exelon's land use rules. Exelon's rules and regulations for cottages address such issues as erosion control, vegetation removal, wastewater disposal, shoreline development, and cultural resource protection. It is Exelon's policy not to create any new cottage lease lots within the Conowingo Project boundary. In addition, 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 and the land will be restored to a natural condition. No future cottage leases will be issued at the site. The rules and regulations are included in Appendix C and are currently being modified to include the provisions of the license. Exelon reserves the right to amend the policy from time to time as circumstances may require, subject to FERC approval, as necessary.

Public Recreation and Access Facilities. Subject to Exelon's ability to comply with applicable license conditions, Exelon leases numerous parcels of land to local, county, and state agencies and to commercial vendors for development and operation of public recreation and access facilities, within and around the Conowingo Project. The agreements specify that the respective lessees will use the properties for park and public recreation, including providing river access and facilities such as boat launches while complying with all applicable local, state, and federal regulations. All of these sites and facilities, within the Conowingo Project boundary, are Project recreation facilities regulated under Exelon's FERC license. Exelon will continue to partner with the agencies and vendors for the operation of these facilities and their use by the public. With the exception of any activities required pursuant to the license, prior to making any modifications to shoreline vegetation for viewshed maintenance and development and recreation access within the project boundary, Exelon will address Article 428, paragraph (d) requirements and "(i) prepare a written assessment of the impacts on water quality of the proposed modifications; (ii) provide this assessment to MDE for a determination regarding whether the proposed modifications are consistent with Maryland water quality standards, including designated and achieved uses; and (iii) not undertake any such modifications until MDE notifies the licensee in writing that it has no objections to the proposed modifications."

In addition, Exelon has developed and implemented "Rules and Regulations Governing the Use and Occupancy of Leased Premises" for Project lands. This document has been included as part of the lease agreements for the two existing Project marina facilities, Glen Cove Marina and Peach Bottom Marina. These rules are included in Appendix D. The Rules and Regulations Governing the Use and Occupancy of Leased Premises are currently being updated and up-to-date revisions will be posted on Exelon's Conowingo, FERC License Renewals website under a Shoreline Management Plan (SMP) link.

Limitations on Public Recreational Access. Exelon provides public recreation and access to Project lands and waters pursuant to its FERC license requirements. Access and use of certain portions of Project lands will be restricted for operational, safety, and security reasons.

- Fishing in Project waters accessible to the public will be governed by applicable state regulations. Fishing will not be allowed within secure areas or areas that present public safety concerns. This includes shoreline fishing within 100 yards of the base of Conowingo Dam at Fisherman's Park (west shore) and for 4,000 feet along the east shoreline downstream of the dam. These areas are restricted for public safety reasons due to changes in water elevations and velocities from generating flows and spilling water during gate operations. In addition to safety concerns, the area along the west shore is also used as a staging and storage area related to Project operations and maintenance.

- Hunting is not allowed within the secure area of the Conowingo Project, or on other Project lands posted against hunting by Exelon. This restriction is intended to protect the public, adjacent landowners, lessees, sensitive resources, and Licensee's operating capabilities. Exelon issues

permits for offshore (water access only) stationary duck blinds and duck blind sites on Exelon land to hunters on an annual basis. The permits allow applicants (up to four individuals per permit) to have no more than two blinds or sites.

- Use of off-road vehicles on Project lands is prohibited.

- Drone use on or within the Conowingo Project boundary is prohibited unless pre-approved by Exelon. This requirement applies to small unmanned aerial systems (sUAS, UAS, or drone), that is a drone weighing less than 55lbs as defined by the Federal Aviation Administration (FAA), and applies to recreational and commercial drone users on Exelon property. Appendix E provides the full requirements of drone usage in context of the SMP.

Overall Land Use Monitoring and Enforcement. Exelon will conduct regular inspections and manage the Conowingo Project in accordance with the terms of its license and applicable FERC rules and regulations.

1 INTRODUCTION

1.1 Purpose and Scope of the Plan

The Shoreline Management Plan (SMP) for the Conowingo Hydroelectric Project (Project) provides rules and guidelines for managing multiple resources and uses of the Conowingo Project shoreline. These rules and guidelines will ensure the protection and enhancement of the Conowingo Project's recreational, environmental, historical, cultural, and scenic resources and the Conowingo Project's primary function, the generation of electricity.

The SMP enables Exelon to fulfill its license responsibilities and obligations for the Conowingo Project, including the protection and enhancement of the Conowingo Project's environmental and recreational values. More specifically, the SMP will:

- Protect environmental attributes such as wetlands, habitat, and spawning areas.
- Preserve the scenic quality of the Conowingo Project lands for boaters and shoreline recreationists.
- Maintain existing water quality.
- Protect historic and cultural resources.
- Ensure cooperation with federal, state, and local government agencies to coordinate adjacent land uses and proposed infrastructure with shoreline uses.
- Ensure coordination with separate regulatory authority permitting review and approval efforts.
- Minimize conflicts among differing uses.

The SMP applies to all Conowingo Project lands.

1.2 Background

Following the filings of proposed and revised study plans in 2009 an interim SMP was filed in February 2011. A draft SMP filed with the Federal Energy Regulatory Commission (FERC) in January 2012. The draft SMP was developed as an element of Exelon's relicensing of the Conowingo Project. Comments received from stakeholders were addressed in the version of the SMP filed with FERC on August 31, 2012[1].

On March 19, 2021 the Conowingo Project was issued a new FERC License. The FERC License requires Exelon to file for approval, a revised version of the SMP based on the requirements in FERC Article 428, which reads as follows:

> *Article 428.* Shoreline Management Plan*. Within six months of license issuance, the licensee must file with the Commission for approval, a revision to the Shoreline Management Plan filed on August 31, 2012. The revised plan must include the following modifications:*

[1] A comprehensive consultation record for the draft SMP was included in Appendix 7 of the plan filed on August 31, 2012.

a) A provision for reviewing and updating the plan every 10 years, with the first update to be filed with the Commission in 2030.

b) A requirement that, prior to submitting a proposed update to the Shoreline Management Plan to the Commission, the licensee must submit to the Maryland Department of the Environment (MDE) for review and comment all proposed modifications, including an assessment of the impacts of deleted, revised, or new measures on water quality.

c) A requirement that, prior to submitting an application to FERC for a non-project use of project land, the licensee must, in addition to complying with the requirements of Article 430: (i) prepare, or require the third-party requesting the non-project use of project land to prepare, a written assessment of the impacts on water quality of the proposed use; (ii) provide this assessment to MDE for review to determine whether the proposed use is consistent with Maryland water quality standards, including designated and achieved uses; and (iii) consult with MDE regarding the proposed use.

d) With the exception of any activities required pursuant to the license, prior to making any modifications to shoreline vegetation for viewshed maintenance and development and recreation access within the project boundary, a requirement that the licensee must: (i) prepare a written assessment of the impacts on water quality of the proposed modifications; (ii) provide this assessment to MDE for a determination regarding whether the proposed modifications are consistent with Maryland water quality standards, including designated and achieved uses; and (iii) not undertake any such modifications until MDE notifies the licensee in writing that it has no objections to the proposed modifications.

e) A requirement that the licensee must consult with MDE regarding any proposed modification of an existing use of project lands in cases where such use may affect any sensitive aquatic resource identified by licensee in the "sensitive resources overlays" included in licensee's Shoreline Management Plan.

Each proposed update to the plan must be developed after consultation with the U.S. Fish and Wildlife Service, the National Park Service, the Pennsylvania Department of Conservation and Natural Resources, the Maryland Department of Natural Resources, and MDE. The licensee must 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 must 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 must include the licensee's reasons, based on project-specific information.

The Commission reserves the right to require changes to the plan. Implementation of the plan must not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee must implement the plan, including any changes required by the Commission.

In developing this SMP, the licensee consulted with various stakeholders throughout the planning and development process. The revised SMP includes the following revisions:

- Project descriptions were updated to reflect existing conditions and the amended FERC Project Boundary approved in April 2021;
- Summaries of federal, commonwealth, and county management plans were updated as of July 2021;
- Summaries of resource management plans for the Conowingo Project (i.e. Bald Eagle and Historic Properties Management Plan) reference the articles and requirements from the FERC License issued on March 19, 2021.

2 PROJECT DESCRIPTION

2.1 Project Location and Regional Setting

The Project is located in a rural setting on the Susquehanna River in Pennsylvania (Lancaster and York Counties) and Maryland (Cecil and Harford Counties). Conowingo Dam and the lowermost six miles of the Conowingo Project reservoir, Conowingo Pond, are located in Maryland. The upper eight miles of the reservoir are located in Pennsylvania (Figure 2.1-1). The Project extends approximately 2.5 miles downstream of the dam along the east bank of the river and approximately one-half mile downstream along the west bank of the river.

Located at river mile 10, Conowingo Dam is the most downstream of the five hydroelectric projects located on the lower Susquehanna River. The upstream projects (York Haven, Safe Harbor, Holtwood, and Muddy Run) are located at river miles 56, 32, 24, and 22, respectively. Tidewater extends up the river to within approximately four miles of Conowingo Dam.

York and Lancaster Counties in Pennsylvania have 449,058 and 545,724 residents, respectively, and population densities of 481 and 550.4 people per square mile, respectively. Cecil and Harford Counties in Maryland have 102,855 and 255,441 residents, respectively, and population densities of 292 and 560 people per square mile, respectively. The nearest metropolitan area within the Susquehanna River watershed is Lancaster, Pennsylvania, approximately 32 miles to the northeast, with a population of about 59,265 people. Major metropolitan areas within 60 miles of the Conowingo Project include Baltimore, MD, Wilmington, DE, Lancaster, PA and Harrisburg, PA with populations of approximately 593,490, 70,166, 59,265 and 49,271 respectively (U.S. Census Bureau 2019).

While 79 percent of Lancaster County's population, 76 percent of York County's population (city-data.com, 2021), and 79 percent of the State of Pennsylvania's population are classified as living in urban areas (Center for Rural Pennsylvania 2019), a full 100 percent of the residents of the five Pennsylvania townships (Martic, Drumore, Fulton, Lower Chanceford, Peach Bottom) adjacent to the Conowingo Project are classified as living in rural areas. 42% percent of the population of Cecil County resides in a rural area, much lower than neighboring Harford County (82 percent) (city-data.com, 2021) and the State of Maryland as a whole (86 percent) (MDP 2010).

2.2 Project Boundary and Adjoining Land Uses

The Project has 9,923 acres of land within the Conowingo Project boundary: 8,868 acres of Project waters and 1,055 acres above the normal high-water elevation in Lancaster and York Counties in Pennsylvania and Harford and Cecil Counties in Maryland. The lands contained within the Conowingo Project boundary are those lands necessary for the operation of the Conowingo Project (See Figure 2.2-1). Project lands serve many project-related purposes, including (but not limited to) Project operations, public access, recreational use, and wildlife habitat conservation.

There are approximately 46 miles of shoreline (excluding island shoreline) within the Conowingo Project boundary: 43 miles associated with Conowingo Pond and 3 miles associated with the Susquehanna River downstream of Conowingo Dam. The Norfolk Southern rail line is largely located within the Conowingo Project boundary and abuts the entire length of the east shore of Conowingo Pond. Downstream of Conowingo Dam on the easterly side of the river, MD Route 222 is located roughly parallel to and in some areas abuts the Conowingo Project boundary.

Non-Project land adjoining the Conowingo Project boundary is primarily undeveloped forest land with scattered agricultural, residential, and industrial use. Land to the east of the rail line is mostly undeveloped forest lands with some agricultural land and residential development. Susquehannock State Park and the Ferncliff Wildflower and Wildlife Preserve, a National Natural Landmark, abut the rail line to the east. Conowingo Community Park is located adjacent to the Conowingo Project boundary near Octoraro Creek on land leased to Cecil County by Exelon. Adjoining lands along the west shore of the impoundment consist of undeveloped forest, agricultural, and residential lands. The percentage of agricultural and residential lands is higher than on the east shore.

PBAPS is located on the west shore of Conowingo Pond at river mile 18. Downstream of the Conowingo Dam, the Norfolk Southern rail line is west of MD Route 222 and is not located within the Conowingo Project boundary.

Recreation facilities in the immediate vicinity of the Conowingo Project include state and county parks, campgrounds, picnic areas, shoreline access facilities, boat launches, fishing sites, canoe portages, scenic overlooks, nature preserves, a wildflower preserve, an Environmental Center (a visitor center with interpretative displays), hiking trails, and Pennsylvania Game Lands.

2.3 Hydroelectric Facilities

The principal features of the Conowingo Project consist of the following:

- Conowingo Dam, a 4,648 foot long, 94-foot-tall structure.
- Conowingo powerhouse, integral to the dam, containing 11 generating units with a capacity of 570.15 megawatts.
- An 8,540-acre reservoir (Conowingo Pond), and approximately 1,055 acres of land within the FERC Project boundary.

Conowingo Pond also serves as the lower reservoir of the Muddy Run Pumped Storage Project (FERC Project No. 2355) and provides a source of cooling water for the PBAPS. The Muddy Run powerhouse facility is located adjacent to the northeasterly portion of the Conowingo Project impoundment (river mile 22) and PBAPS is located on the west shore of the impoundment at river mile 18. Several transmission lines associated with the three electric facilities also cross Conowingo Pond and the river.

Non-project use of Conowingo Pond is authorized for the following users in accordance with the FERC Order issued on September 2, 2015 and FERC Article 404; Peach Bottom Atomic Station, the City of Baltimore, Chester Water Authority, York Energy Center, Wildcat Point Generation Facility, and is a public water supply source for both the City of Baltimore and the Chester Water Authority, pursuant to the terms set forth in their non-project use of project lands authorizations.

The Project boundary extends approximately 2.5 miles downstream from the Conowingo Dam (east shore), and one-half mile on the west shore. Public access to some of these areas and facilities is restricted due to public safety and plant operational and security concerns.

2.4 Existing Recreation Facilities

Visitors to the Conowingo Project have the opportunity to participate in numerous recreational activities. The existing recreational facilities associated with the Conowingo Project are described below and shown

on Figure 2.4-1. The Project's public recreation facilities are managed under an RMP, which was developed in accordance with Article 426 and is incorporated by reference into this SMP.

2.4.1 Existing Facilities

Lock 13 (York County, PA.)

The Susquehanna and Tidewater Canal was a regionally important transportation canal which was in operation between 1840 and 1900. It was constructed on the west bank of the Susquehanna River and went as far north as Wrightsville, Pennsylvania (approximately 20 miles north of the Conowingo Dam), and terminated in Havre De Grace in Harford County, Maryland.

Lock 13, which consists of the unrestored remains of Lock 13 of the Susquehanna Tidewater Canal, is accessed via the Mason-Dixon Trail, located approximately 1,100 feet south of the U.S. Route 372 bridge over the Susquehanna River. The site is owned by the Licensee, although trailhead access is from the PPL Holtwood, LLC Lock 12 parking lot (Holtwood Project, FERC No. 1881).

Lock 15 (York County, PA.)

The restored Lock 15 of the Susquehanna and Tidewater Canal is accessed from Route 372 via River Road (south) and is owned and managed by the Licensee. The site includes parking for 36 vehicles, a footpath to the restored lock, interpretive displays, a picnic area, and portable restrooms.

Muddy Creek Boat Launch (York County, PA)

Muddy Creek boat launch is directly downstream of and connected to Lock 15 by a footpath. Improvements include a 20-foot-wide hard surface boat ramp, docks, parking for 44 vehicle and trailer combinations (boat trailers) and 26 cars, interpretive and informational panels, and a portable restroom. The site is owned by the Licensee and the facilities are maintained by the Pennsylvania Fish and Boat Commission (PFBC).

Cold Cabin Boat Launch (York County, PA.)

Cold Cabin boat launch is located approximately three miles downstream of U.S. Route 372 and is accessed from Route 74 by the Paper Mill Road and Cold Cabin Road. Improvements include a 12-foot-wide hard surface boat ramp, informal parking for approximately five vehicles, a picnic area, and interpretive and informational displays. The site is owned by the Licensee and the facilities are maintained by Peach Bottom Township under a lease agreement with the Licensee.

Dorsey Park (York County, PA.)

Located just upstream of the PBAPS, Dorsey Park is accessed from Flintville Road via Lay Road. The site provides two 32-foot-wide hard surface boats ramps, docks, parking for 25 boat trailers and 30 cars, a picnic area, interpretive and informational displays, and portable restrooms. The facility is owned and maintained by the Licensee.

Line Bridge (Harford County, MD.)

Line Bridge is located approximately one-half mile south of the Pennsylvania/Maryland state line and is accessed by the Line Bridge Road from Maryland State Route 623. The site provides a small, three car parking area and unimproved shoreline access for fishing and carry-in boat launching. The site is owned by the Licensee and the facilities are managed and maintained by Harford County under lease agreement with the Licensee.

Broad Creek Public Landing (Harford County, MD.)

This site is approximately two miles south of the Pennsylvania/Maryland state line and is directly off Maryland State Route 623. Facilities include a 16-foot-wide hard surface boat ramp, dock, an on-site parking area for four vehicles, and an off-site parking area for 33 boat trailers. The site is owned by the Licensee and the facilities are managed and maintained by Harford County under a lease agreement with the Licensee.

Glen Cove Marina (Harford County, MD.)

This commercial marina facility is located approximately two miles upstream of Conowingo Dam and is accessed from Maryland State Route 623 by Glen Cove Road and Berkley Road. The facility provides a hard surface boat ramp, dock, 74 boat slips, a picnic area, portable restrooms, and parking for 16 boat trailers and 20 cars. A launch fee is charged to use the ramp. Other services are provided including fuel dispensary, repair services, and slip rentals. This facility also serves as the take-out location for the Conowingo Dam canoe portage. The site and facilities are owned by the Licensee and managed and operated by a commercial contractor.

Conowingo Dam Pool and Visitors Center (Harford County, MD.)

This area is located just upstream of Conowingo Dam and is accessed directly off U.S. Route 1. The pool facility includes swimming and wading pools, a locker and changing room, a picnic area, a playground, restrooms, and a concession stand. The facility is owned by the Licensee and operated by a commercial contractor.

The Visitor Center contains informational displays and brochures focused on the region, restrooms and conference rooms, and office space for the Lower Susquehanna Heritage Greenway. The center is owned, operated and staffed by the Licensee. A small picnic area is also provided. A common parking lot providing 213[2] spaces is shared by the two facilities.

Peach Bottom Marina (Lancaster County, PA.)

This commercial marina is located approximately seven miles upstream of Conowingo Dam. Access to the facility is from Route 222 to Peach Bottom Road. The facility includes a 25-foot-wide hard surface boat ramp, dock, parking for 17 boat trailers and 33 cars, and a portable restroom. A launch fee is charged to use the ramp. Other services provided include fuel dispensary, repair services, and boat slip rentals. The site is owned by the Licensee and managed and operated by a commercial contractor.

Conowingo Creek Boat Launch (Cecil County, MD.)

The boat launch is located approximately two miles north of Conowingo Dam and is accessed from Route 222 via the Mt. Zoar Road and Conowingo Lake Road. The facility includes an 80-foot-wide hard surface boat ramp, boat tie up area, parking for nine boat trailers and ten cars, and a small picnic area. The site is owned and managed by the Licensee.

[2] Exelon completed recreation studies in 2008/2009 for the Recreation Management Plan. The results show that less than 40% of the 213 spaces are needed on an average summer weekend (approximately 80 parking spaces used). Currently Exelon uses 48 of the 213 spaces for non-recreation purposes and the remaining spaces provide sufficient recreational parking. If future demand increases, the 48 spaces can be re-appropriated for recreational use.

Funks Pond (Cecil County, MD.)

Funks Pond is located just upstream of Conowingo Dam and is accessed directly off U.S. Route 1. A non-motorized trail leads from a parking area for 24 cars off Route 1 approximately one-half mile to Funks Pond, a small (approximately two acre) inlet on the Susquehanna River. A small picnic area with two tables is located at the pond. The site is owned and managed by the Licensee.

Conowingo Dam Overlook (Harford County, MD.)

The overlook is located on the west end of Conowingo Dam off U.S. Route 1 and accessed from Shuresville Road. The site is not currently open to the public. The site provides parking and overlook of Conowingo Dam. The site is owned and managed by the Licensee. This facility is being considered as a laydown/staging area for Conowingo fish passage construction projects. The site will be reopened to the public after the fish passage construction projects are completed in accordance with the schedule specified in the recreation management plan (Article 426).

Fisherman's Park at Shures Landing (Harford County, MD.)

This site is located directly downstream of Conowingo Dam and is accessed from the Shures Landing Road. Facilities include Americans with Disabilities Act (ADA) compliant fishing platform, a picnic pavilion, picnic areas, bank fishing access, a carry-in boat launch, observation platforms, interpretive and informational displays, parking for 14 boat trailers and 104 cars, public restrooms (open during the day), and portable restrooms. The northerly trailhead for the Lower Susquehanna Heritage Greenway is located at the southerly end of the parking lot. The site is owned and managed by the Licensee. The site also serves as a canoe portage trail put-in below the dam.

Octoraro Creek Access (Cecil County, MD.)

The Octoraro Creek Access is located approximately one mile downstream of Conowingo Dam directly off Maryland Route 222. The facility includes a parking area for 12 cars, interpretive and informational display, and ADA compliant trail (approximately one-half mile in length) along Octoraro Creek to its confluence with the Susquehanna River. The site is owned and managed by the Licensee.

2.4.2 Other Recreation Sites/Facilities Using Project Lands and Waters

Mason-Dixon Trail (York County, PA. and Harford County, MD.)

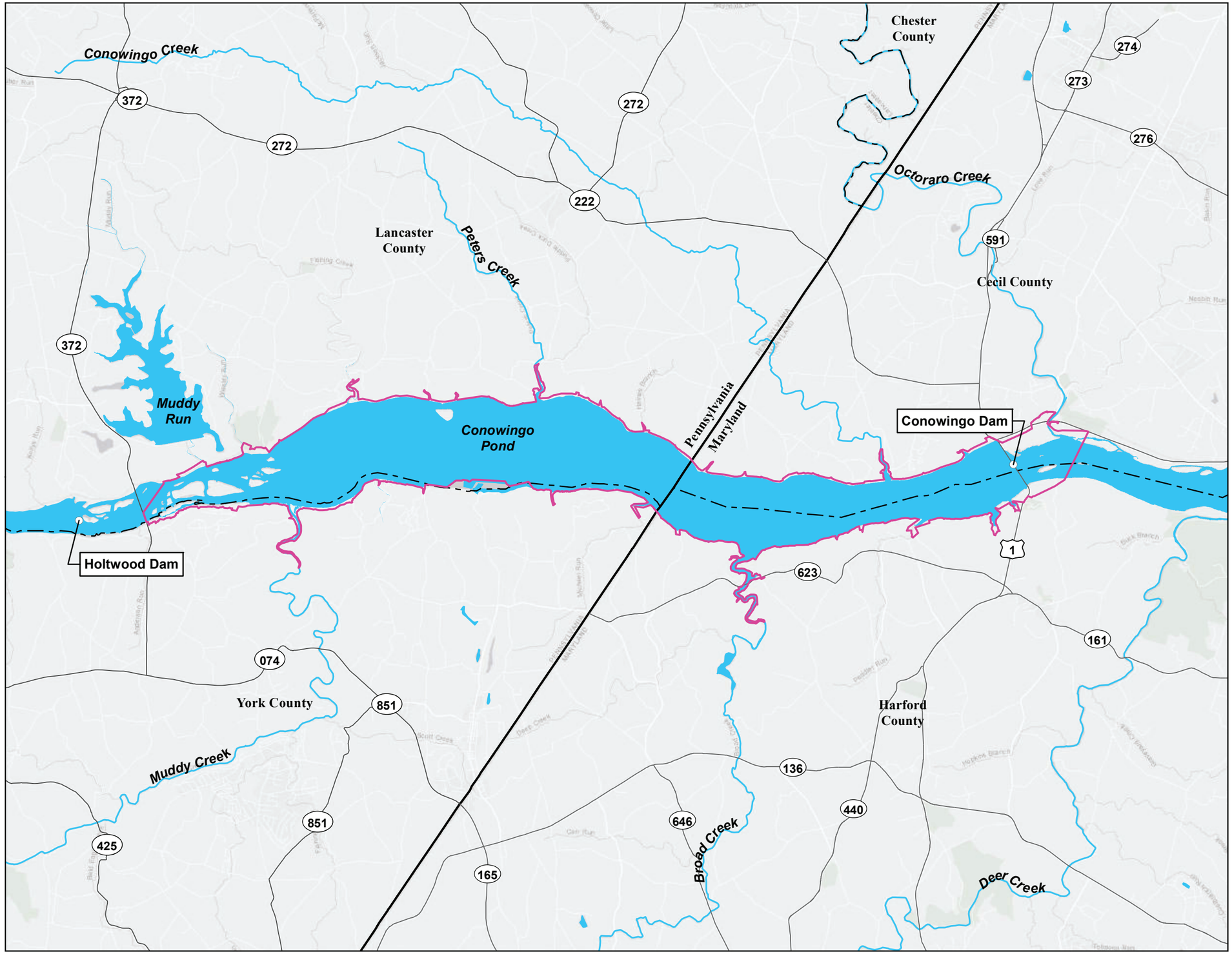
The 193-mile-long Mason-Dixon Trail connects the Appalachian Trail in Cumberland County, Pennsylvania with the Brandywine Trail in Chadds Ford, Pennsylvania. While most of the trail is well outside the Conowingo Project boundary, portions of it are located on the Licensee's Project (approximately 3.75 miles) and non-project (approximately 10.5 miles) lands. The trail passes through several of the above described recreation sites (Locks 13 and 15, Muddy Creek, Cold Cabin, Broad Creek, Glen Cove, and the Conowingo Swimming Pool/Visitor Center). The trail is both within the Conowingo Project boundary and on Exelon's non-Project lands and is maintained and managed by the volunteer Mason-Dixon Trail System, Inc. organization under a contractual agreement with the Licensee.

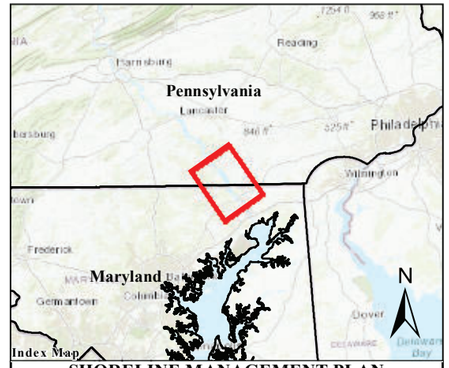
Susquehanna River Water Trail (Pennsylvania and Maryland)

The Lower Section of the Susquehanna River Water Trail, which extends approximately 53 miles from Harrisburg, Pennsylvania to the Broad Creek Boat Launch, is part of the Chesapeake Bay Gateways and Watertrails Network and is also a designated National Recreation Trail.

2.5 Enhanced Recreation Facilities

As part of the FERC license application for the Conowingo Project, Exelon is proposing Project recreation enhancements. These enhancements are included the RMP per Article 426 that addresses Exelon's management of public recreational facilities within the Conowingo Project boundary in accordance with the license. These recreation enhancement construction activities, which are pursuant to the license, will not require the written assessments described in Article 428 paragraph (d).





SHORELINE MANAGEMENT PLAN

Figure 2.1.1:
Conowingo Project Location

Legend

- Project Boundary
- State Boundary
- County Boundary

N

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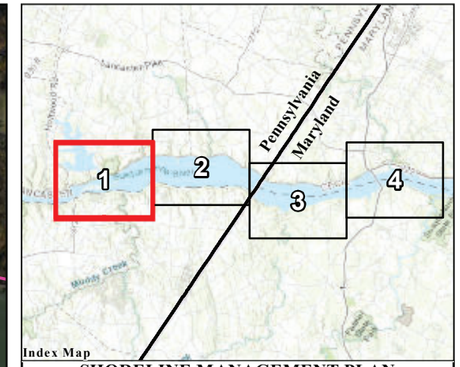

SHORELINE MANAGEMENT PLAN

Figure 2.2-1:
Conowingo Project Boundary
Map 1

Legend

- Project Boundary
- State Boundary
- County Boundary

N

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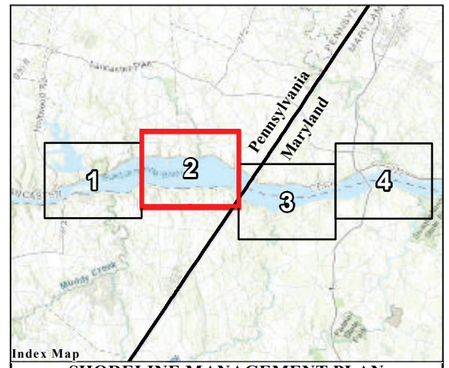

SHORELINE MANAGEMENT PLAN

Figure 2.2-1:
Conowingo Project Boundary
Map 2

Legend

- Project Boundary
- State Boundary
- County Boundary

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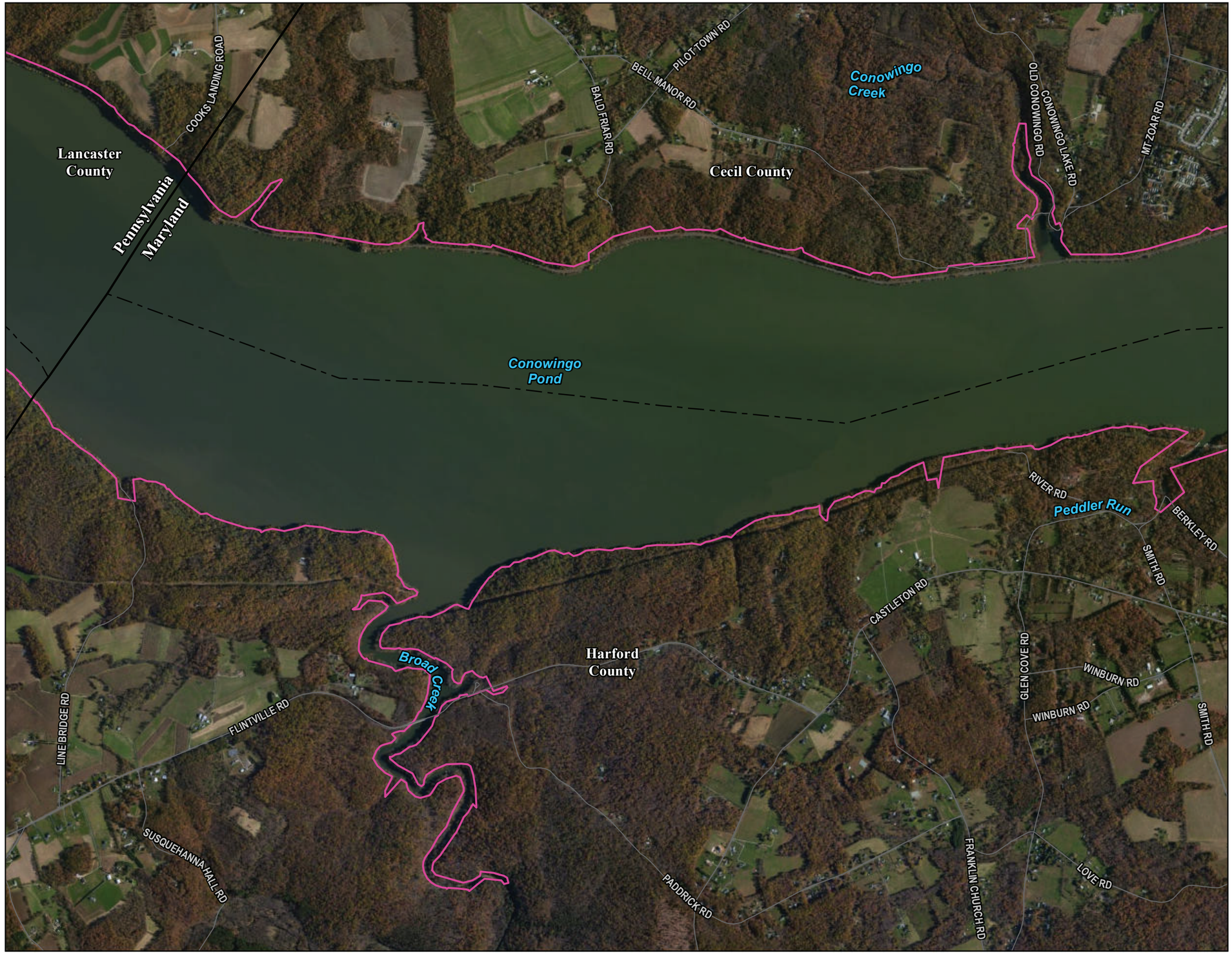

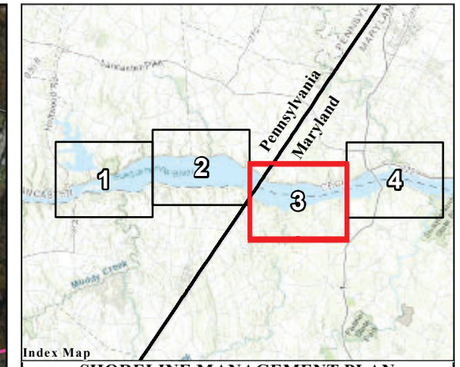

SHORELINE MANAGEMENT PLAN

Figure 2.2-1:
Conowingo Project Boundary
Map 3

Legend

- Project Boundary
- State Boundary
- County Boundary

N

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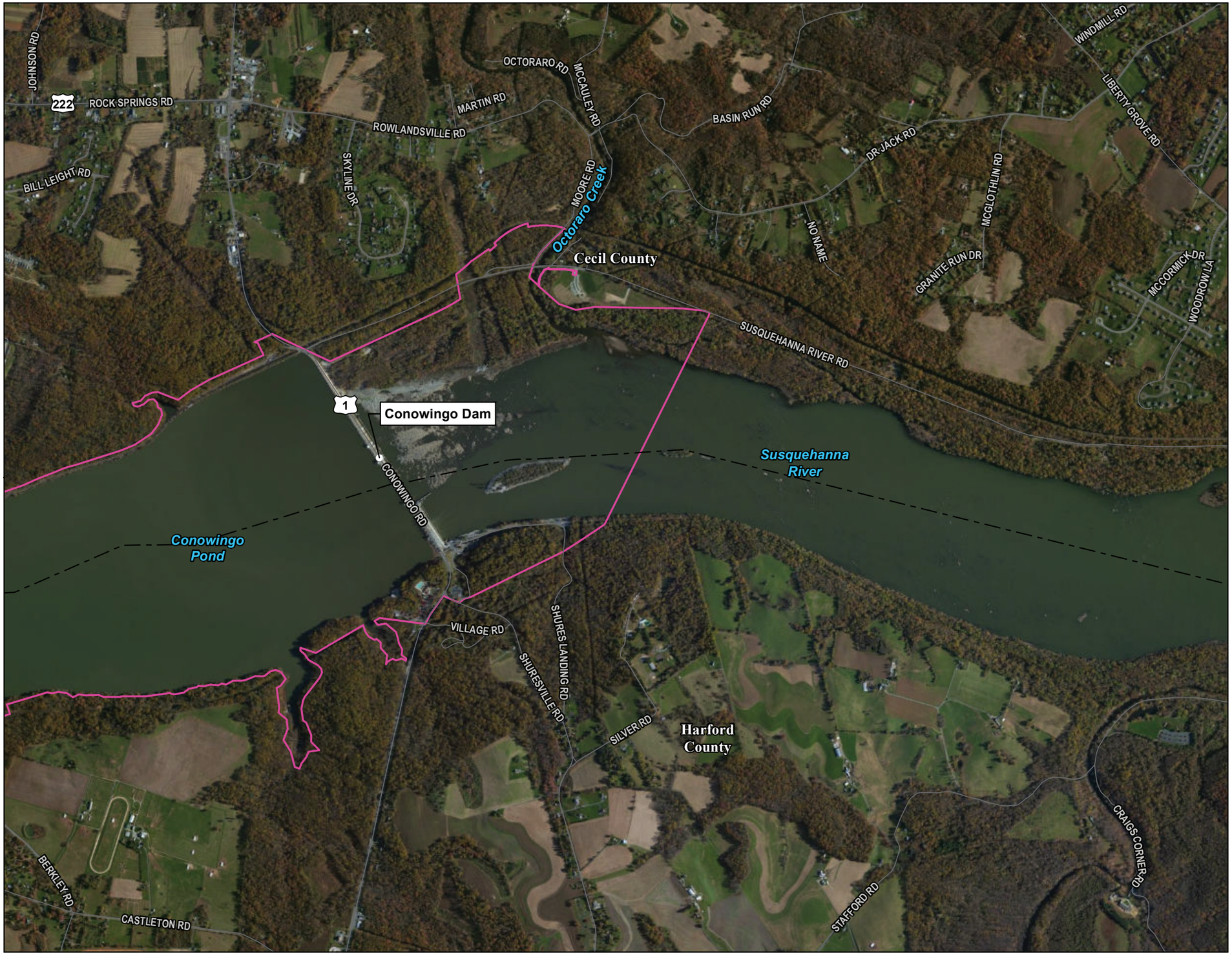

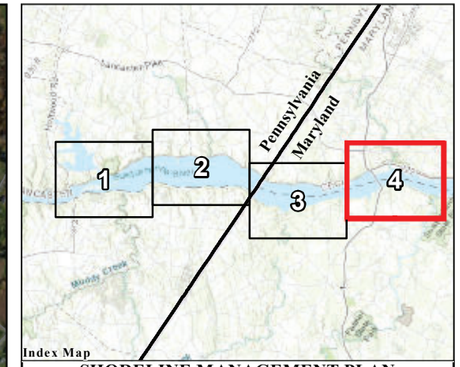

SHORELINE MANAGEMENT PLAN

Figure 2.2-1:
Conowingo Project Boundary
Map 4

Legend

- Project Boundary
- State Boundary
- County Boundary

N

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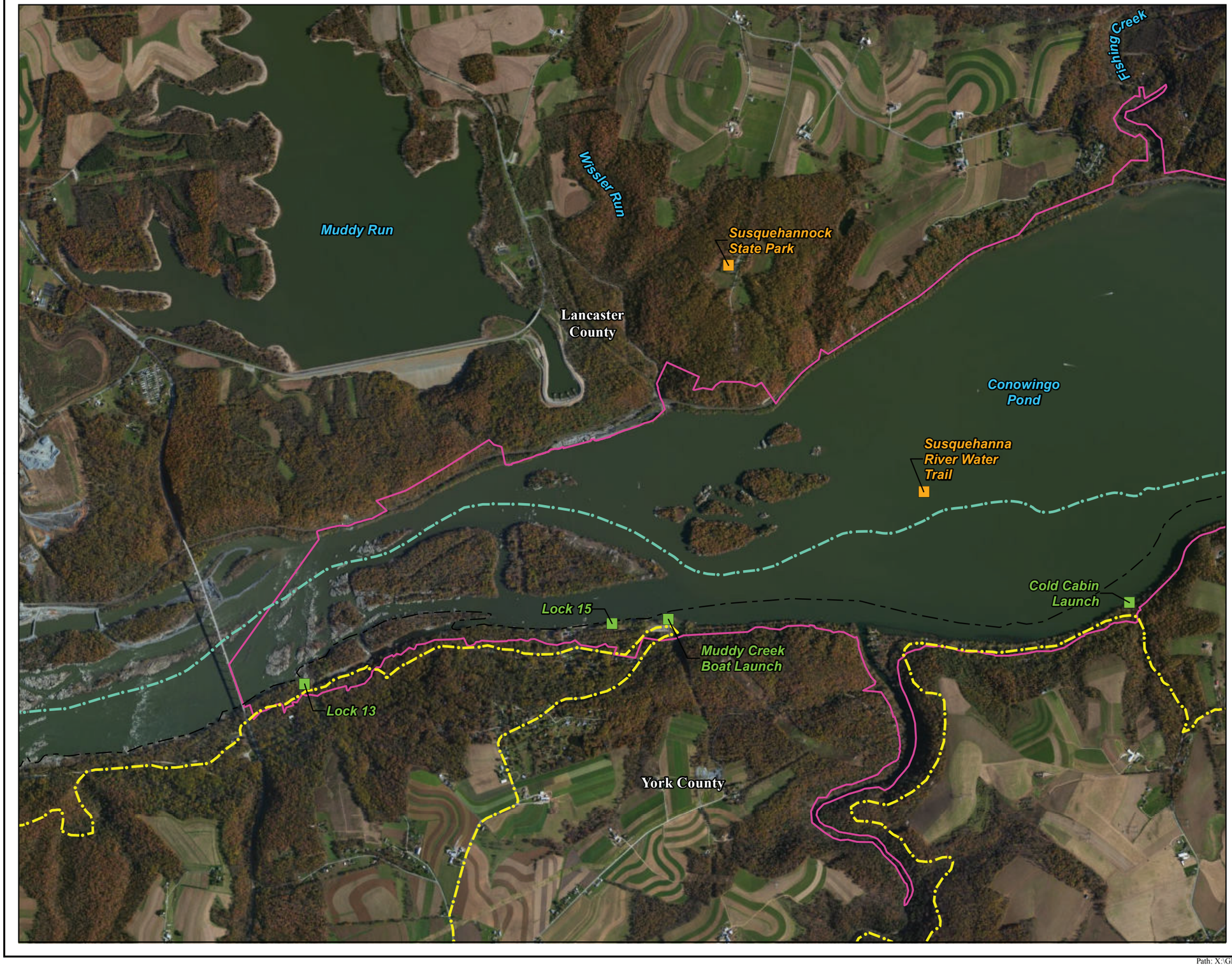

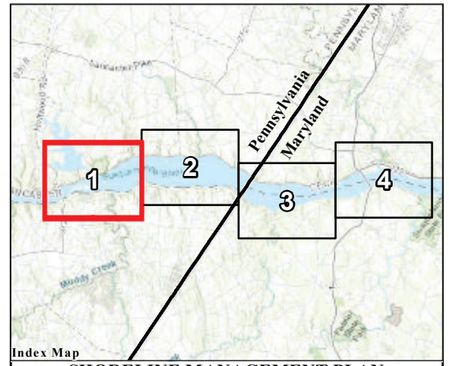

SHORELINE MANAGEMENT PLAN

Figure 2.4.1:
Conowingo Project and Non-Project Recreation Facility Map
Map 1

Legend

- Project Boundary
- Non-Project Recreation Site
- Project Recreation Site
- Mason Dixon Trail
- Susquehanna River Water Trail
- State Boundary
- County Boundary

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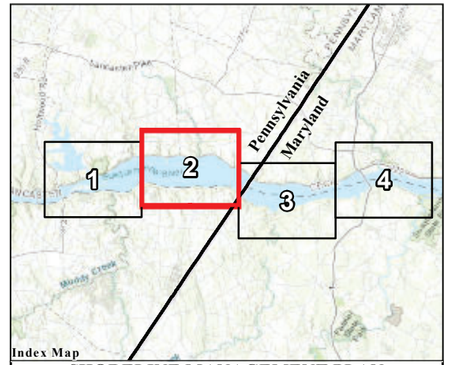

SHORELINE MANAGEMENT PLAN

Figure 2.4.1:
Conowingo Project and Non-Project Recreation Facility Map
Map 2

Legend

- Project Boundary
- Non-Project Recreation Site
- Project Recreation Site
- Mason Dixon Trail
- Susquehanna River Water Trail
- State Boundary
- County Boundary

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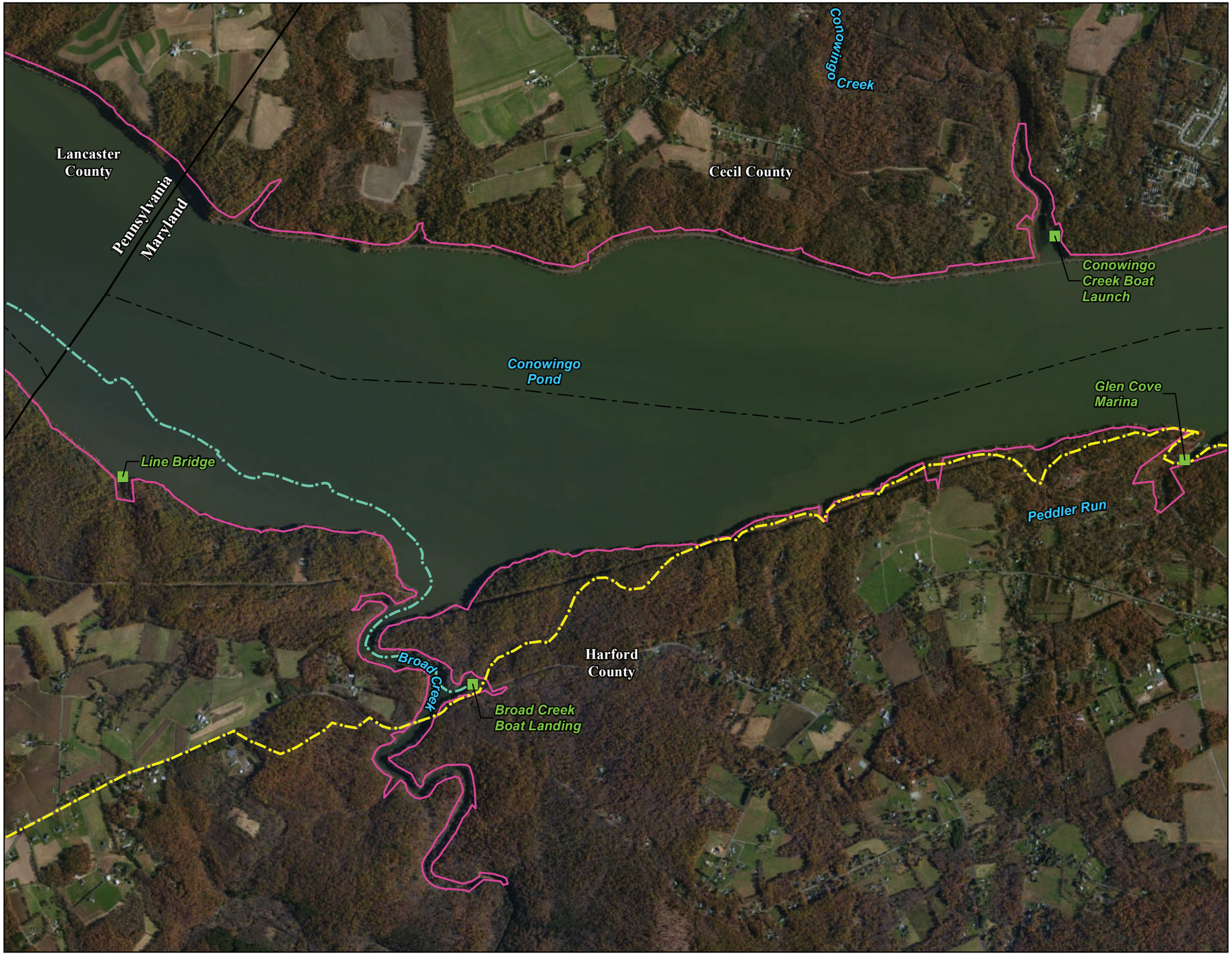

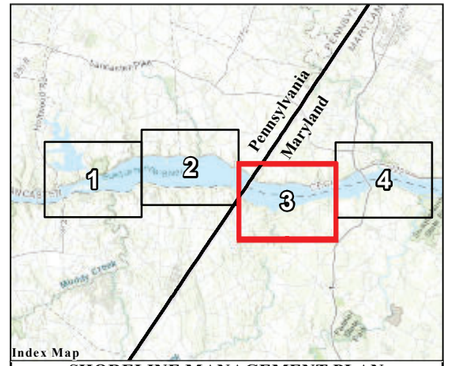

SHORELINE MANAGEMENT PLAN

Figure 2.4.1:
Conowingo Project and Non-Project Recreation Facility Map
Map 3

Legend

- Project Boundary
- Non-Project Recreation Site
- Project Recreation Site
- Mason Dixon Trail
- Susquehanna River Water Trail
- State Boundary
- County Boundary

N

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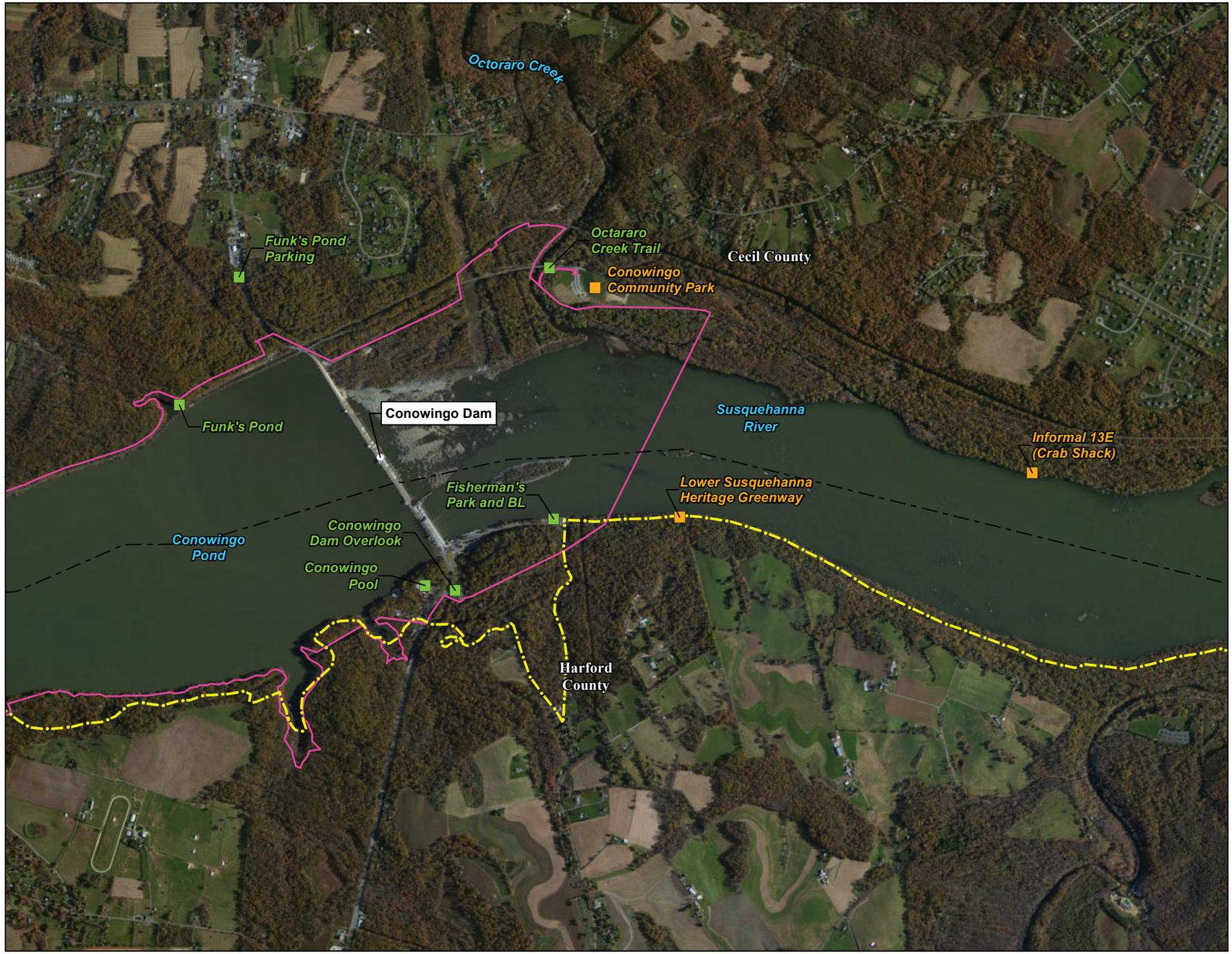

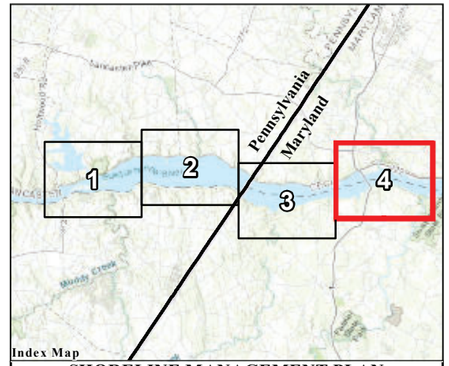

SHORELINE MANAGEMENT PLAN

Figure 2.4.1:
Conowingo Project and Non-Project Recreation Facility Map
Map 4

Legend

- Project Boundary
- Non-Project Recreation Site
- Project Recreation Site
- Mason Dixon Trail
- Susquehanna River Water Trail
- State Boundary
- County Boundary

N

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3 EXISTING ENVIRONMENTAL AND CULTURAL RESOURCES

This section discusses the resources potentially affected by activities which are managed by this SMP. Specifically, the section discusses shoreline resources that are either influenced by existing land uses or influence land use decisions. A comprehensive environmental assessment for the relicensing was provided in the Conowingo Project's Draft and Final License Applications and FERC's Final Environmental Impact Statement.

Shoreline land uses within the Conowingo Project boundary may affect existing natural resources and habitat as a result of increased surface runoff rates and nutrient loading. To address this potential impact, Exelon will incorporate BMPs to minimize or eliminate sediment and nutrient delivery to these resources as applicable, minimizing or eliminating any impacts resulting from both existing and proposed shoreline activities. In addition to BMPs such as soil erosion, sediment control, and restriction of impervious surfaces associated with new construction activities, Exelon will implement BMPs for landscaping and lawn care (pesticide and fertilizer) practices, and restrictions for vegetation removal, all of which will be beneficial to the aquatic and terrestrial resources and associated habitat of the Conowingo Project lands. A complete list of BMPs is included in Appendix A. In conjunction with the implementation of BMPs as applicable, potential effects to aquatic and terrestrial resources have been considered in the development and implementation of Project land use restrictions outlined in Section 6.0 of the SMP.

3.1 Water Resources

Conowingo Pond extends approximately 14 miles upstream from Conowingo Dam to the lower end of the Holtwood Project (FERC No. 1881) tailrace. The Conowingo Pond exhibits a surface area of 8,868 acres and contains a variety of aquatic habitats. The upper reach of the waterbody (in Pennsylvania) is characterized by potholes, deep pools and channels carved into the bedrock, with rugged island rock formations. The upper reach is relatively shallow (6.5 to 20 feet). However, a few potholes and deep pools of up to almost 100 feet deep occur along the eastern shoreline of Conowingo Pond in the vicinity of the Muddy Run powerhouse. Below the Muddy Run powerhouse to the Conowingo Dam, the Conowingo Pond broadens significantly and exhibits greater average depths (greater than 60 feet) and lower water velocities.

Downstream of the dam, bedrock formations with scattered areas of variable-sized cobble characterize the majority of the substrate in the non-tidal habitat area below the tailrace and spillway, creating a predominance of riffle and pool[3] habitat. In the summer months, there is typically little to no spill over the spillway which creates lentic (lake-like) pools among the bedrock cobble. Water will spill over the spillway when river flows exceed the capacity of the Conowingo Project (86,000 cfs). Depending on the magnitude of spill over the dam, the river becomes increasingly dominated by flowing water habitat.

All surface waters in Pennsylvania are protected for aquatic life, water supply (potable, industrial, livestock, wildlife, and irrigation), and recreation (boating, fishing, water contact sports, and aesthetics). Pennsylvania has assigned a warm water fishes aquatic life designated water use to the Pennsylvania portion of the Conowingo Pond. In addition to narrative standards that are applicable to all surface waters, specific water quality criteria for parameters such as pH, alkalinity, bacteria, color, dissolved oxygen, temperature, and certain ions, metals, and nutrients, are established for critical uses (i.e., the most sensitive designated or existing use designated for protection) in Pennsylvania.

In Maryland, all surface waters are protected to support water contact recreation, fishing, aquatic life, wildlife, and water supply (public drinking water supply, agricultural and industrial). In addition, each major stream segment within the state has been assigned to a designated use category with associated

[3] A riffle is an area of shallow swift water, while a pool is an area of deep, slow water.

minimum water quality criteria. Numeric water quality criteria for various water quality parameters (e.g., bacteria, dissolved oxygen, temperature, pH, turbidity, color, toxic substances, etc.) are specified for each designated use.

Fisheries Resources

The Conowingo Pond in both Pennsylvania and Maryland maintains a diverse warm water fishery including the anadromous American Shad (*Alosa sapidisima*). Studies completed for the relicensing in 2010 and 2011 show year to year similarities in catches amongst the various Susquehanna River sampling efforts. Thirty-four species have been documented to be present downstream of Conowingo Dam.

Gizzard Shad, Channel Catfish, Bluegill and Spotfin Shiner dominate the overall species composition. All other species formed less than 5% of the catch. Condition factor and length weight relationships of representative common fish species downstream of Conowingo Dam are comparable to those from other normal, natural populations. This is indicative of relatively favorable conditions and habitats in the lower Susquehanna (Normandeau Associates & GSE 2011).

Exelon will manage aquatic invasive species in accordance with Article 419. Exelon will consult with MDNR, MDE, PADEP, PFBC and FWS regarding invasive species management. Invasive predators including Northern Snakeheads, Blue Catfish and Flathead Catfish are known to be present in the lower Susquehanna River drainage and represent new species within area of the formal sampling program (MDNR 2021a)

3.2 Terrestrial Resources

3.2.1 Upland Habitats

The region encompassing the Conowingo Project boundary is characterized by a diversity of terrestrial botanical resources, which are influenced by soil type, hydrology, climate, and historic and current land use. The lower Susquehanna River corridor exhibits steep riverbanks, which create a rapid transition to upland habitat from the river's edge. General plant communities in the Conowingo Project area include woodlands, old fields, and cultivated fields. The primary natural plant communities include mixed mesophytic and rich hemlock-mesic hardwood forest, dry oak-mixed hardwood or red oak-mixed hardwood forest, and Virginia pine-mixed hardwood forest.

3.2.2 Wetland Resources

In addition to the open waterbodies of Conowingo Pond and the Susquehanna River below the Conowingo Dam, the Conowingo Project encompasses a variety of water-dependent habitats that can be variously defined by frequency of inundation, water depth, and geomorphic position in the landscape adjacent to an open body of water. These habitats are primarily characterized by temporarily flooded deciduous broad-leaved forested and scrub-shrub wetlands. There are few mapped wetlands on Project lands, largely due to the relatively steep sloped shoreline topography, which creates a narrow transition zone from open water to upland habitat. National Wetland Inventory mapped wetlands within the Conowingo Project boundary are depicted on Figure 3.3-1.

3.2.3 Wildlife Habitat

The forested lands within the Conowingo Project boundary provide habitat for a variety of common woodland species such as red and gray fox, raccoon, opossum, red and gray squirrel, chipmunk, turkey, and white-tailed deer. Avian wildlife species such as the Yellow-Billed Cuckoo, Black Capped Chickadee, House Wren, Song Sparrow, White-Breasted Nuthatch, Brown Creeper, and an assortment of woodpeckers have been documented along the wooded shorelines of the lower Susquehanna River. Avian species frequently interacting with the existing transmission lines where they cross Conowingo Pond include

raptors such as Bald Eagle (*Haliaeetus leucocephalus*), Osprey (*Pandion haliaetus*), Black Vulture (*Coragyps atratus*), and Turkey Vulture (*Cathartes aura*), which use towers for perching and roosting. Great Blue Herons (*Ardea herodias*) travel up and down the shorelines of the river to forage and may be traveling back and forth to a rookery downstream below Conowingo Dam. Double-crested Cormorants (*Phalacrocorax auritus*) and Herring Gulls (*Larus argentatus*) congregate in large numbers on rocky areas in the channels between Turkey Island and Lower Bear Island in the upper Conowingo Pond.

3.3 Protected Species and Habitat

3.3.1 Bald Eagle

A substantial number of Bald Eagles have established roosts within the forested shoreline of the Susquehanna River above and below the Conowingo Dam in the vicinity of the Conowingo Project. Data from studies performed by Exelon in 2018 document that Bald Eagles of all age classes utilize shoreline habitat at the Conowingo Pond and Dam area for foraging, nesting, and roosting. The shoreline forests in the Conowingo Project boundary, the Muddy Run Pumped Storage Project boundary and nearby Exelon-owned lands along Conowingo Pond and the Susquehanna River downstream of Conowingo Dam provide habitat that supported 35 nests that were identified as being either Active, Occupied, or Productive during the 2018 Bald Eagle assessment (Watts & Paxton 2019). The shoreline along the Conowingo Pond and the Susquehanna River downstream of Conowingo Dam were used with varying frequency for perching, roosting, and foraging. Eleven of the identified nests are located within the Conowingo Project boundary. Four communal roosts were found in the Conowingo Project boundary demonstrating the area's concentrated use by Bald Eagles (Watts & Paxton 2019).

As discussed in Section 6.1.11, provisions for protecting and managing Bald Eagle habitat are defined in the BEMP approved with modifications by Article 421. The BEMP addresses the use of Project lands by Bald Eagles for nesting, roosting, and foraging. The BEMP manages Bald Eagle habitat on Exelon lands by implementing the FWS' National Bald Eagle Management Guidelines (2007) and state agency guidance.

3.3.2 Osprey

Ospreys are large, fish-eating birds of prey most often seen around water. Osprey are protected by the federal Migratory Bird Treaty Act of 1918 as well as the Pennsylvania Game and Wildlife Code.

The species has historically occurred in the Conowingo Project boundary and field studies performed by Exelon in 2010 and 2011 confirm that this species was present in the Conowingo Project. In 2010, a total of 11 active Osprey nests were found in the Conowingo Project boundary and four (4) pairs of osprey successfully fledged one or more chicks. In 2010, seven of these active Osprey nests were located in the Pennsylvania portion of the Conowingo Project and three were located in the Maryland portion of the Conowingo Project Survey Area in 2010. A fourth nest located close to but not within the Conowingo Project boundary or on Project lands was also active. In 2011, these same nests were present and active with the exception of two nests in Pennsylvania. Osprey are still present within the Conowingo Project boundary in 2021.

Exelon's Osprey Management Policy is detailed in Section 6.1.12.

3.3.3 Indiana and Northern Long-eared Bat

Per Article 425, the following measures are required to protect Indiana and northern long-eared bat habitat:

> *…the licensee must avoid cutting trees equal to or greater than 3 inches in diameter at breast height on project lands from June 1 through July 31, unless a tree poses an immediate threat to human life or property. Tree removal is defined herein as cutting down, harvesting, destroying, trimming, or manipulating in any other way the trees,*

saplings, snags, or any other form of woody vegetation greater than 3 inches in diameter likely to be used by Indiana and northern long-eared bats.

3.3.4 Other Protected Species

Additional protected plant and animal species and species' habitats are present along the shoreline of the Susquehanna River and its tributaries within the Conowingo Project boundary. Exelon avoids impacting protected species through established avoidance measures and consultation with appropriate resource agencies. Consultation takes place through the USFWS' Information for Planning and Consultation online program, the Pennsylvania Natural Heritage Program's Pennsylvania Natural Diversity Inventory Environmental Review Tool, information requests to the Maryland Natural Heritage Program, and through direct contact with local, state, and federal agency staff.

Specific plans are under development for the protection of waterfowl (per Article 422), bog turtle (per Article 423), and northern map turtle (per Article 424). These plans will be filed with FERC in March 2022 following consultation with resource agencies.

3.4 Cultural Resources

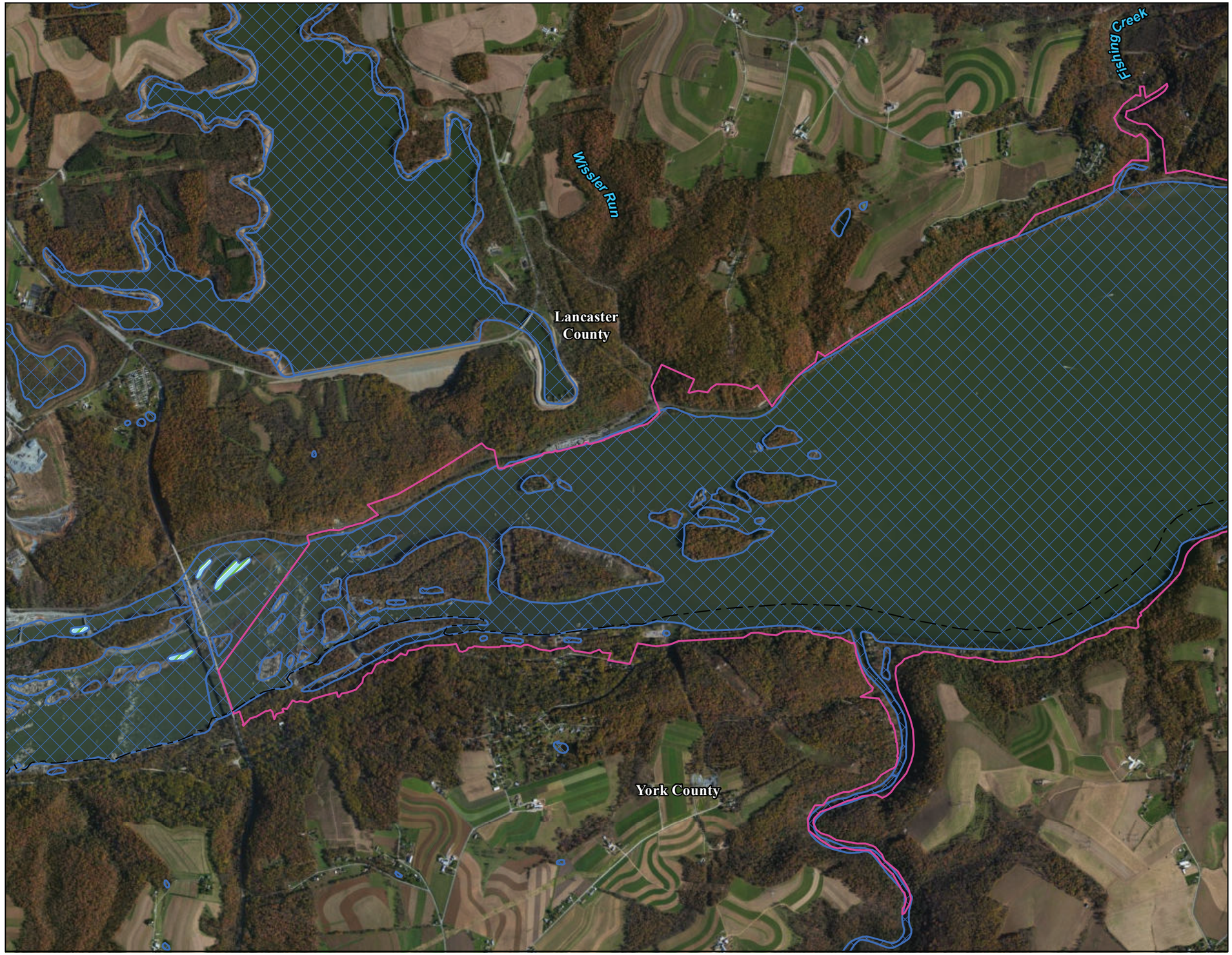
Native American archaeological sites, as well as historic architectural sites, are known to exist within the vicinity of the Conowingo Project boundary and throughout the surrounding region. The presence of archaeological sites within the Conowingo Project's Area of Potential Effect (APE)[4] and additional sites within a one-mile radius was initially documented through research at the MHT and PHMC. Historic architectural sites were documented though the completion of historical background and cartographic research at the MHT and PHMC. This research revealed that the early history of the general Project region was marked by agriculture, iron forging, quarrying, and milling, and this trend continued into the mid-nineteenth century. The development of many of the settlements and villages surrounding the Conowingo Project boundary relate directly to the proximity to the Susquehanna River and its tributaries and creeks.

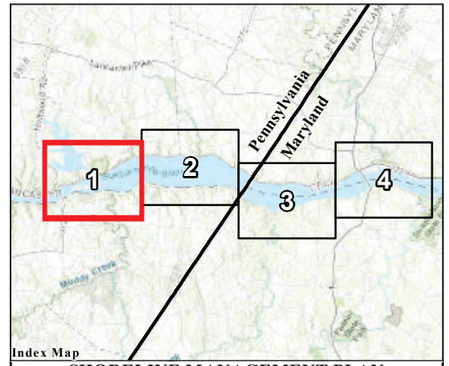
Field studies were performed by Exelon in 2010 and 2011 for historic properties including both historic architectural and archaeological resources located within the APE to determine whether any historic properties within the Conowingo Project's APE are eligible for listing on the National Register of Historic Places. These studies guided the development of a HPMP which was filed on August 31, 2012.

On May 5, 2017, a "*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) was executed.

In accordance with Article 429 Exelon will prepare and file a revised HPMP based on the HPMP filed with the Commission on August 31, 2012. The HPMP specifies how Exelon will consider and manage the historic properties within the APE throughout the term of the new License and includes the process for assessing Project-related maintenance and ground-disturbing activities to determine whether or not archaeological sites would be affected.

[4] The Project APE is defined as the lands enclosed by the Conowingo Project boundary and lands or properties outside of the Conowingo Project boundary where Conowingo Project construction and operation or Conowingo Project-related development or other enhancements may cause changes in the character or use of historic properties, if any historic properties exist.





SHORELINE MANAGEMENT PLAN

Figure 3.3-1:
National Wetland Inventory
Wetland Locations
Map 1

Legend

- Project Boundary
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Open Water
- State Boundary
- County Boundary

N

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PROJECT NO. 405

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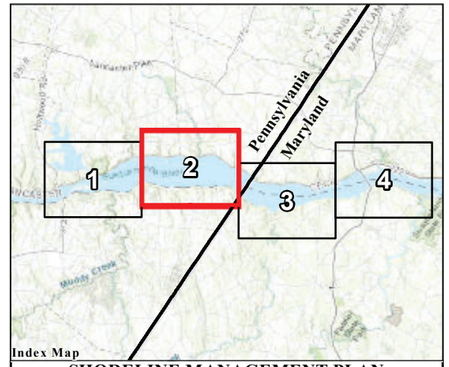

SHORELINE MANAGEMENT PLAN

Figure 3.3-1:
National Wetland Inventory
Wetland Locations
Map 2

Legend

- Project Boundary
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Open Water
- State Boundary
- County Boundary

N

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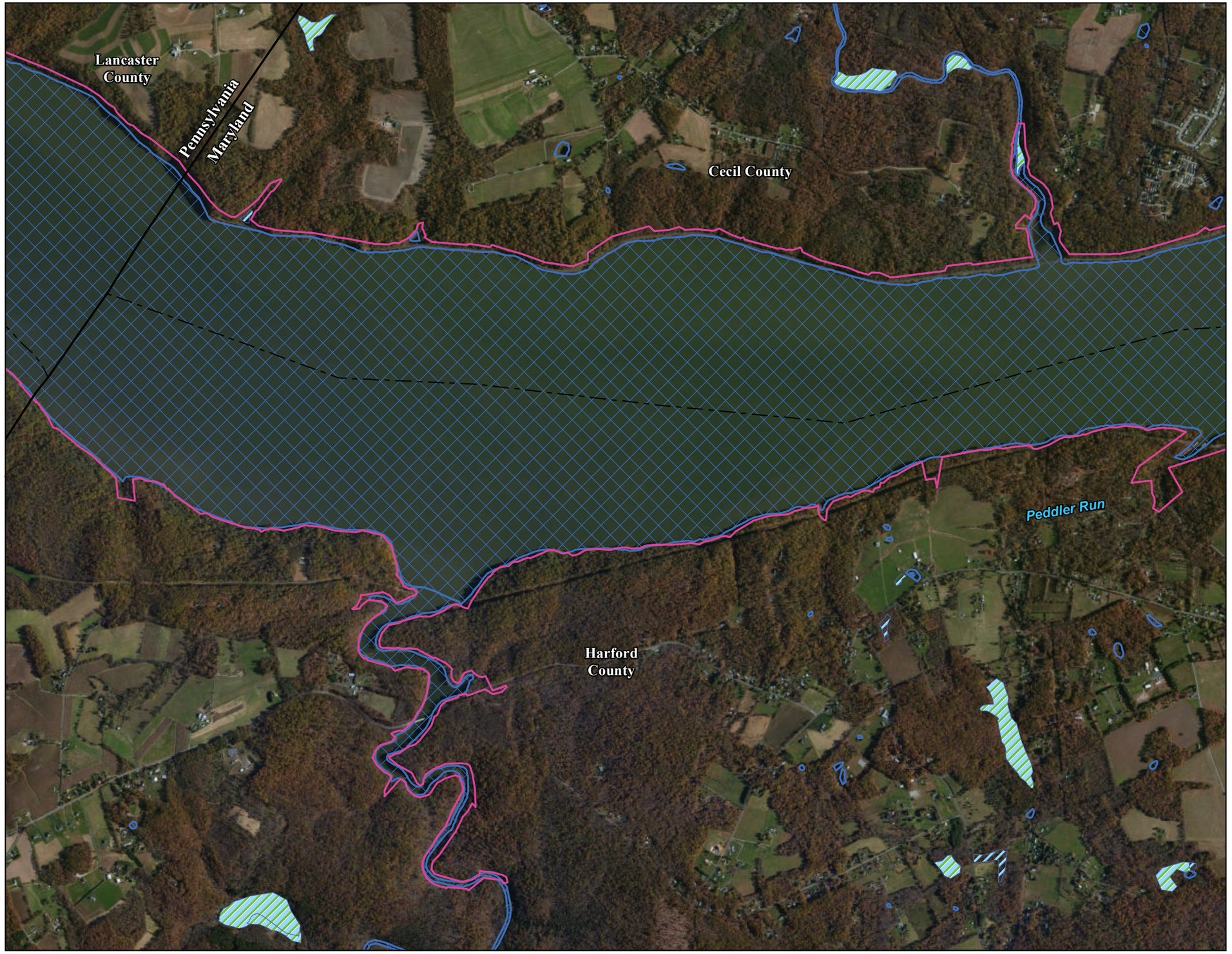

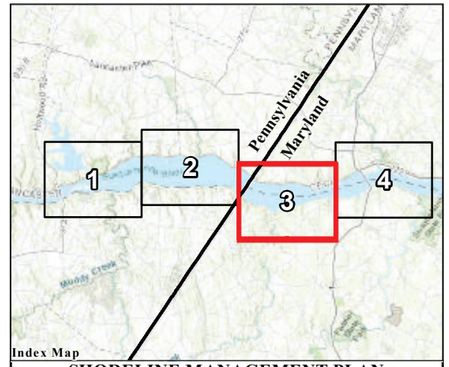

SHORELINE MANAGEMENT PLAN

Figure 3.3-1:
National Wetland Inventory
Wetland Locations
Map 3

Legend

- Project Boundary
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Open Water
- State Boundary
- County Boundary

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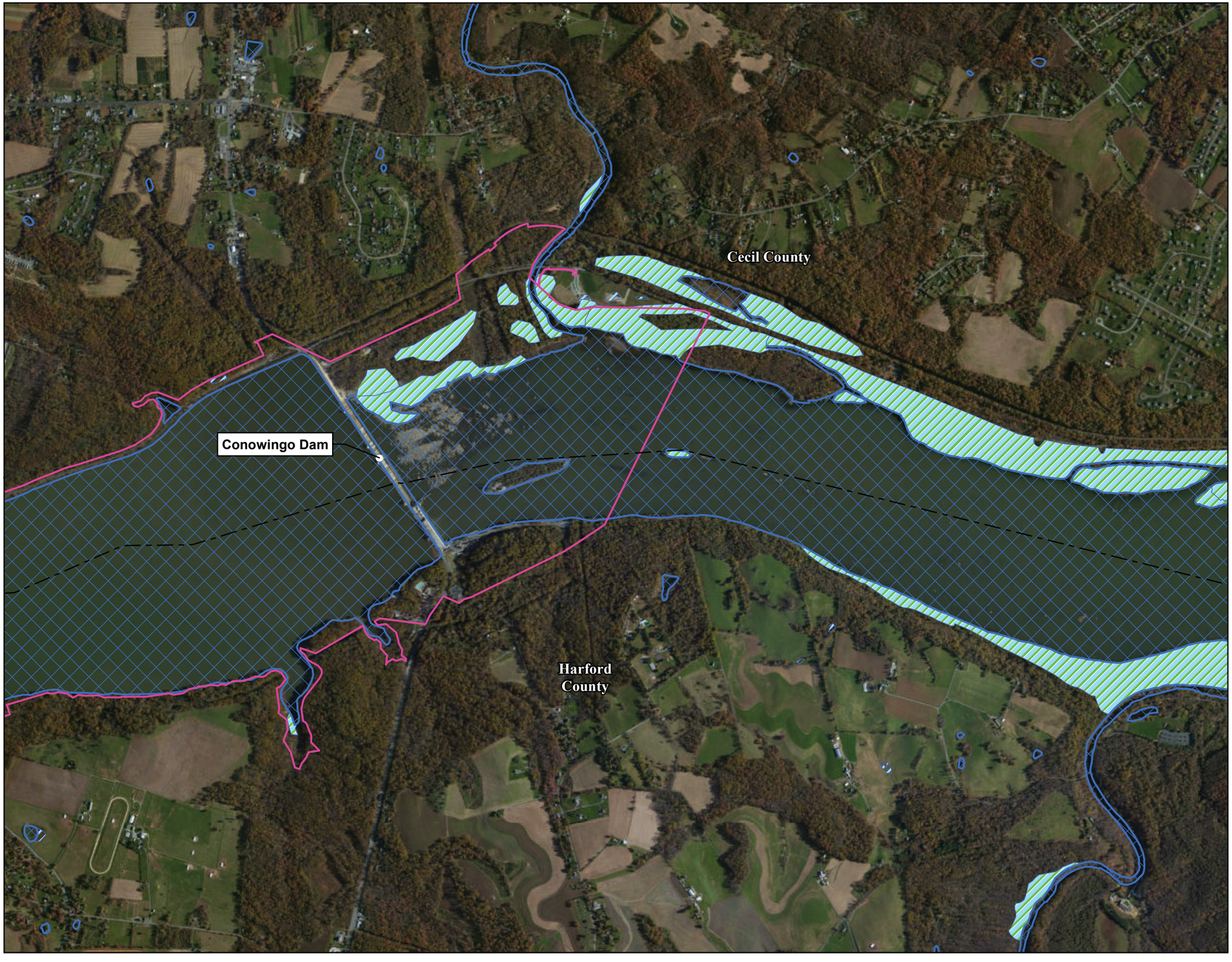

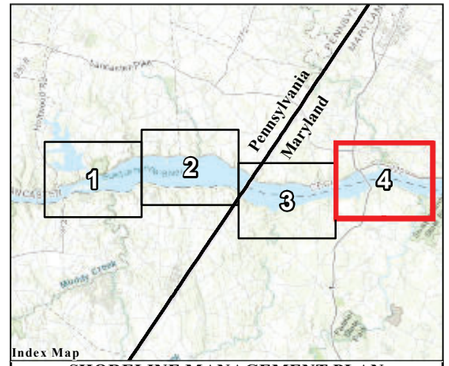

SHORELINE MANAGEMENT PLAN

Figure 3.3-1:
National Wetland Inventory
Wetland Locations
Map 4

Legend

- Project Boundary
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Open Water
- State Boundary
- County Boundary

N

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4 FEDERAL, STATE, COMMONWEALTH AND COUNTY MANAGEMENT PLANS AND PROGRAMS

Numerous federal, state and county agencies, as well as other organizations, have developed regional plans and programs to recognize, promote, protect and conserve the cultural, historic, natural, and recreational resources near the Conowingo Project. During the SMP development process, Exelon identified several plans and programs that address these resources in the lower Susquehanna River. They are summarized below. Exelon intends that the SMP, where possible, be consistent with the goals and objectives of these plans and programs.

4.1 Federal Management Plans and Programs

4.1.1 National Trail System Act of 1968

The National Trail System Act of 1968 authorized creation of a trail system comprised of National Recreation Trails, National Scenic Trails, and National Historic Trails. While National Scenic Trails and National Historic Trails may only be designated by an Act of Congress, National Recreation Trails may be designated by the Secretary of Interior or the Secretary of Agriculture to recognize exemplary trails of local and regional significance in response to an application from the trail's managing agency or organization. National Recreational Trails are administered by the NPS in partnership with American Trails, a national non-profit organization advocating for all trail interests (NPS 2018, NPS 2021b). Portions of the following designated trails are located in or adjacent to the Conowingo Project boundary:

- Captain John Smith Chesapeake National Historic Trail (parts of the trail within the Conowingo Project boundary) (LSHG 2021)
- Susquehanna River Water Trail (within the Conowingo Project boundary)
- Mason-Dixon Trail (parts of the trail are within the Project boundary) -

4.1.2 National Park Service Chesapeake Bay Gateways and Watertrails Network

The Chesapeake Bay Gateways and Watertrails Network is a growing partnership system of 170 parks, wildlife refuges, museums, historic sites, and water trails in the Chesapeake Bay watershed. Through a Memorandum of Understanding with the NPS, the partners work to provide Chesapeake experiences, interpret their Chesapeake connections, co-market the network, and promote citizen stewardship (NPS 2017). Gateway features within the Conowingo Project boundary include the Susquehanna River Water Trail (Lower Section) which traverses Conowingo Pond. The network also includes the Susquehanna State Park, located along the Susquehanna downstream of the Conowingo Project.

4.1.3 National Natural Landmark Program

Administered by the NPS, this voluntary program recognizes and encourages the conservation of sites containing outstanding biologic and geologic resources. Ferncliff Wildflower and Wildlife Preserve is a privately-owned designated National Natural Landmark in Lancaster County and is adjacent to the Conowingo Project boundary (NPS 2021)

4.1.4 Audubon Society – Important Bird Areas Program

Designated by the National Audubon Society, Important Bird Areas (IBAs) include migratory staging areas, winter roost sites, and prime breeding areas. The Project boundary overlaps with two IBAs: the 16,047-acre Lower Susquehanna River Gorge – Conowingo/Muddy Run IBA, and the 10,014-acre Susquehanna River IBA (National Audubon Society, n.d.). The Lower Susquehanna River Gorge IBA site plan lists

conservation concerns including spraying of herbicides and pesticides as well as cutting of warm season grasses before June, which disrupts ground-nesting bird species (National Audubon Society, 2013a). The Susquehanna River IBA Site Report says that the main threats to this site include over-browsing of the forest by deer, land development, invasive plant species, erosion from high levels of recreational use, and stream sedimentation (National Audubon Society, 2013b).

4.2 Maryland and Pennsylvania Management Plans and Programs

4.2.1 Statewide Comprehensive Outdoor Recreation Plans

The Land and Water Conservation Fund (LWCF) Act of 1965 requires a Statewide Comprehensive Outdoor Recreation Plan (SCORP) from each state prior to consideration by the Secretary of the Department of the Interior for financial assistance for acquisition and development projects. The LWCF Act specifically requires the states' SCORP to:

- Identify outdoor recreation issues of statewide importance based upon, but not limited to, input from the public participation program. The plan must also identify those issues the State will address through the LWCF and those issues which may be addressed by other means.
- Evaluate demand, i.e., public outdoor recreation preferences, but not necessarily through quantitative statewide surveys or analyses.
- Evaluate the supply of outdoor recreation resources and facilities but not necessarily through quantitative statewide inventories (NPS 2021a).

Pennsylvania and Maryland's current SCORPs address the period from 2020 through 2024 and 2019 through 2023 respectively. Goals of the respective plans are:

Maryland

- Identify the recreation wants and needs of citizens.
- Improve the Maryland Department of Natural Resources' (MDNR) delivery of educational services.
- Find additional mechanisms to finance day to day operations of state land units, expansion of services, capital improvements to facilitate public access, and land acquisitions.
- Continue partnering with local governments and other land conservation interests to protect and manage land and provide assistance to local governments and landowners on resource management matters.
- Research and planning.
- Land acquisition.
- Program Open Space (MDNR 2019).

Pennsylvania

- Help citizens achieve greater access and enjoyment from experiences in the commonwealth's abundance of local and state parks, state and national forests, trails, rivers, lakes, game lands, and other recreation spaces.

- Strengthen connections between outdoor recreation, healthy lifestyles, and economic benefits in communities.
- Reconnect people to the outdoors and develop a stewardship ethic through outdoor recreation opportunities and experiences.
- Develop a statewide land and water trail network to facilitate recreation, transportation, and healthy lifestyles.
- Enhance outdoor recreation through better state agency cooperation (PADCNR 2020).

4.2.2 Wild and Scenic Rivers

Each state, as well as the federal government, has a scenic and wild river program intended to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. No rivers within the Conowingo Project boundary are designated as Wild and Scenic Rivers by the federal government (DOI, n.d.), Pennsylvania, the Conowingo Project or Maryland (MDNR, n.d.).

4.2.3 Maryland State-wide Water Trails Program

Administered by MDNR, this program is responsible for promoting the protection and creation of sites that provide public access to waterways and the development of water trails and other recreational boating opportunities throughout Maryland. Currently, maps are being developed depicting the Susquehanna River based water trail between the Pennsylvania line to the Chesapeake Bay (FYC 2019).

4.2.4 Maryland Lower Susquehanna Heritage Greenway Management Plan

The Lower Susquehanna Heritage Greenway Management Plan, published in May 2000, outlines strategies for enhancing heritage resources, achieving optimum visitations, encouraging compatible economic development, establishing mechanisms to improve stewardship and insuring long-term preservation and protection of cultural, historic, scenic, and natural resources within the Heritage Area (Glen Cove to Chesapeake Bay) (Redman/Johnston Associates *et. al*, 2000). In December 2012, the Lower Susquehanna Heritage Greenway (LSHG) published a five-year plan for fiscal years 2013 to 2018 with an update to priorities and plan for future investment (LSHG 2012). The LSHG is the oversight organization for this plan.

4.2.5 Maryland Natural Heritage Program

The program seeks to sustain populations of rare plants and animals through the maintenance of healthy natural ecosystems. The ecosystems are maintained by the restoration of degraded habitats, field surveys, research into natural history requirements, and public education. The program also reviews proposed development projects for potentially harmful effects on rare species. Managed by MDNR, the program occasionally works with other agencies and private organizations to purchase properties supporting natural communities (MDNR 2021b).

4.2.6 Pennsylvania Exceptional Value Streams

Designated by PADCNR, streams with high biotic integrity and health are protected under PADEP water quality regulations under the Clean Water Act. These regulations do not permit uses along the stream that leads to any degradation of the stream quality. Fishing Creek is a designated Exceptional Value Stream (PADEP 2010).

4.2.7 Pennsylvania Lower Susquehanna Conservation Landscape Initiative

The Conservation Landscape Initiative (CLI), a PADCNR program, is a place–based strategy for natural resources stewardship and advocacy in key landscapes (PADCNR 2011b). The CLI program focuses on lands where there are strong natural assets and local readiness and support for land conservation, locally driven planning, and community economic revitalization efforts. The Lower Susquehanna CLI encompasses the Susquehanna River and riverside lands in York and Lancaster Counties.

Goals of the Lower Susquehanna CLI include:

- Improve public access to the river.
- Preserve environmentally sensitive areas.
- Preserve the forested river landscape.
- Improve water quality.
- Provide additional land and water based recreational opportunities.

4.2.8 Maryland Green Infrastructure Program

Developed by MDNR, this program is implemented as a tool to help identify and prioritize areas of greatest statewide ecological importance. It identifies large contiguous blocks of natural land interconnected by corridors to allow animal and plant propagate dispersal and migration. Individual parcels are evaluated for their relative conservation value to prioritize them for acquisition funding. Mapping of green infrastructure is available through MDNR (MDNR 2015).

4.2.9 Pennsylvania Natural Heritage Program

A partnership between The Western Pennsylvania Conservancy, PADCNR, PFBC, and PGC, in cooperation with FWS, this program gathers and provides information on the location and status of important ecological resources such as plants, vertebrates, invertebrates, natural communities, and geologic features. The program provides current, reliable, objective information to help inform environmental decisions associated with land development or land use changes (PNHP 2019).

4.3 County Management Plans and Programs

4.3.1 Lancaster County, Pennsylvania Management Plans and Programs

The Lancaster County Comprehensive Plan includes a Growth Management Element that identifies areas appropriate for urban growth and reinvestment and areas that should be maintained in agriculture, natural resource conservation, and similar uses.

In 2009, Lancaster adopted a new plan, “Greenscapes; The Green Infrastructure Element” of the Lancaster County Comprehensive Plan. This plan defines goals, objectives, and strategies to preserve, conserve, restore, and enhance natural resources through the establishment of a countywide, integrated green infrastructure system (Lancaster County 2009). Recreation goals and objectives of Greenscapes are as follows.

- Protect large open spaces for passive outdoor recreational opportunities.
- Provide a diversity of close-to-home, active recreation opportunities within Designated Growth Areas.

- Create a countywide network of open/green spaces and connections between them.
- Provide convenient, accessible opportunities for outdoor recreation and exercise.

4.3.2 York County, Pennsylvania Management Plans and Programs

The York County Comprehensive Plan is also composed of several components including an Agricultural Protection Plan, Environmental Resources Inventory, Natural Areas Inventory, and an Open Space and Greenways Plan. The Agricultural Protection Plan was established in December 2008 and analyzes designated rural areas in townships with regard to existing and proposed development, large farm parcels, soil quality, lands adjacent to preserved farms, and use of agricultural protection tools. It also provides a detailed action plan for the protection and preservation of agricultural land in township rural areas.

The Environmental Resources Inventory was last updated in February 2018 and distinguishes between areas appropriate for growth and development and areas appropriate for open space and conservation uses. The Natural Areas Inventory was last amended in October 2004 and contains information on the locations of rare, threatened, and endangered species and on the highest quality natural areas in the County.

The Open Space and Greenways Plan was adopted in December 2006 and provides a "greenprint" for developing a statewide network of greenways. The plan provides a vision for coordinated and comprehensive system of open space and greenways and supports the maintenance and enhancement of open space and greenways throughout York County. (York County 2011).

4.3.3 Cecil County, Maryland Management Plans and Programs

The Comprehensive Plan serves as the policy guide and framework for the future growth and development in Cecil County. The plan components examine land use, water resources, transportation, public facilities, economic development, housing, environmentally sensitive areas, mineral resources, and other natural resources (Cecil County 2010). Key goals and objectives of the plan include:

- Encourage the conservation of agricultural and forested lands.
- Plan and develop bicycle/pedestrian trails to create a network of trails.
- Protect recreational open space and resource lands and integrate greenways into the County's planning and development review process.
- Protect environmentally sensitive resources and natural features in all areas of the County, comprising steep slopes, streams, wetlands, floodplains, and habitat including the habitats of threatened and endangered species.

4.3.4 Harford County, Maryland Management Plans and Programs

The Harford County Master Plan and Land Use Element Plan provide direction for addressing future growth, revitalization, adequate public facilities, economic development, and preservation and protection of natural resources, agricultural lands, and historic resources. Land use policies are the core of the Master Plan.

The 2016 Harford County NEXT Master Plan uses a holistic approach to planning and focuses on six concepts; growth with a purpose, economic vitality, environmental stewardship, preserving heritage, mobility and connectivity, and promoting healthy communities -ensuring that the County is working to meet the needs of the present without compromising the ability of future generations to meet their own needs (Harford County 2016).

Additional Harford County Master Plan Elements include the following:

- Chesapeake Bay Critical Area Program – addresses land use within 1,000 feet of tidal waters and wetlands.

- Land Preservation, Parks, and Recreation Plan – addresses the County's needs for preserving open space, natural resources, and agricultural lands and providing a variety of quality recreational environments.

- The Natural Resources and Water Resources Element Plan – Includes methods for protecting environmental resources, including streams and their buffers, steep slopes, floodplains and the habitats of threatened and endangered species.

- Historic Preservation Element Plan – addresses the County's historic preservation efforts.

5 EXISTING USE OF PROJECT LANDS AND WATERS

Exelon must ensure that any shoreline development activity that occurs within the Conowingo Project boundary is consistent with Project license requirements.

There are approximately 46 miles of shoreline currently within the Conowingo Project boundary. Forty-three miles are associated with the Conowingo Pond impoundment and three miles downstream of the Conowingo Dam. The land serves many Project-related purposes, including (but not limited to) Project operations, public access, recreational use, wildlife habitat, seasonal cottages, and protection and conservation of rare, unique, and special features and biota.

Project lands along Conowingo Pond are primarily a mixture of steep wooded slopes with interspersed areas of ledge outcrops. Downstream of Conowingo Dam, Project lands consist of level wooded lands with intervals with steep slopes beyond the Conowingo Project boundary. Land use is limited is some areas due to the topography and slopes; slopes in many areas exceed 25%. The majority of Project land is undeveloped.

Exelon has programs and policies that guide and support the recreational use and management of the Conowingo Project lands (Appendices E and F). FERC regulations require licensees to provide public access and recreational opportunities on Project lands consistent with area recreational needs. In some instances, approval from FERC is required for the non-project use of Project lands. Numerous public recreation sites and facilities are located within the Conowingo Project. These range from fully built out facilities such as a public swimming pool to minimally improved boat carry-in access sites. Other portions of Project lands are managed under agreements with state, municipal, and non- governmental agencies as public recreation facilities. Two commercial marina operations are also located on Project lands.

Various utility structures, facilities and operations also occur on and adjacent to Project lands. These include electric utility generation facilities and transmission lines, municipal and utility water intakes, and an oil pipeline. The transmission lines and the pipeline which cross Project lands impact a very minimal amount of land and shoreline. Peach Bottom Atomic Power Station is located along approximately 1.5 miles of Project land along the west shore of Conowingo Pond but is not located within the Conowingo Project boundary.

Non-project use of Conowingo Pond is authorized for the following users: Peach Bottom Atomic Station, the City of Baltimore, Chester Water Authority, York Energy Center, Wildcat Point Generation Facility, and is a public water supply source for both the City of Baltimore and the Chester Water Authority, pursuant to the terms set forth in their non-project use of project lands authorizations. The various water intakes have a minimal footprint on Project lands.

There are ten clusters of seasonal cottages (totaling approximately 350) on Project lands. The majority of the cottages are located on the shorelines, but a few are also located on islands in the upper half of Conowingo Pond. Cottages are located on Big Chestnut, Little Chestnut, Hennery, and Wolf Islands, while shoreline cottages are clustered in the vicinity of Muddy Creek and Broad Creek on western side of Conowingo Pond, and Fishing Creek and Peters Creek on the eastern side.

Cottages on the Conowingo Pond islands are subject to Exelon's "Conowingo Islands Public Use Policy" (Appendix B) which regulates vegetation management and restricts any earth disturbance to minimize erosion and protect cultural resources. All cottages on Project lands are also subject to Exelon's "Cottage Rules and Regulations" (Appendix C) which includes numerous requirements focused on development standards, erosion control and natural resource protection. The Cottage Rules and Regulations are currently being updated and up-to-date revisions will be posted on Exelon's Conowingo, FERC License Renewals website under a Shoreline Management Plan (SMP) link.

Exelon has developed and maintains a number of designated recreational sites and facilities within the Conowingo Project boundary for public recreation. The Project's public recreation facilities are managed under an RMP, which is incorporated by reference into this SMP.

In addition to the RMP, Exelon has developed a land use classification system for Project lands based on aerial photography interpretation, ground truthing and corporate operating procedures and policies. Existing land uses are placed into one of the following land use classifications on the basis of the primary land use.

Class 1: Project Operations: Lands used for power generation and electric transmission/distribution infrastructure and purposes.

Class 2: Developed Recreation: Lands managed for developed public recreational facilities and activities. This includes commercial recreation facilities.

Class 3: Natural/Undeveloped: Lands that are primarily undeveloped and generally available for public access and use.

Class 4: Industrial and Other Non-Project Lands: Lands managed for industrial/commercial uses and other non-Project uses including shoreline stabilization projects.

Class 5: Public Access Lands: Public access lands are Project lands managed by federal, state, county agencies or conservation organizations under agreement with Exelon. Public access and use of the lands is generally allowed, though may be governed by the managing entity according to the type or level of activity or by season. These are typically unimproved lands, though parking areas, trails, and other infrastructure may be provided.

Class 6: Cottage Lands: Lands leased to individuals for seasonal use. These land classifications are depicted graphically on Figure 5.0-1.

Approximately 885 acres (81 percent of the terrestrial lands within the Conowingo Project boundary) of the 1,055 acres of Project lands are fully open for public use. These public use lands comprise approximately 40.5 miles of shoreline within the Conowingo Project boundary. Table 5.0-1 provides an overview of the amount of Project lands (acres) and the amount of Project shoreline (miles) for each of the six land classifications:

Table 5.0.-1: Project Acreage and Shoreline Miles by Land Use Classification

Conowingo Project	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Area (acres)	43	96	620	127	20	149
Shoreline (miles)	3	5	25	2.5	0.5	10

5.1 Project Operations (Class 1)

These lands include 43 acres and three miles of shoreline that are specifically or primarily for power generation and transmission purposes. They include generating facilities, substations/switchyards, intake and discharge areas, and transmission line facilities and corridors and, where necessary, a secure buffer area around the facilities. For security and safety purposes, access to these lands is restricted to Exelon employees and contractors.

5.2 Developed Recreational Lands (Class 2)

This classification includes 96 acres and five miles of shoreline lands that are developed and managed for public recreational opportunities and access. The lands may be managed and operated by Exelon, a commercial vendor, or a private lessee, and may have specific allowable recreational uses and operating hours.

5.3 Natural/Undeveloped Lands (Class 3)

These lands include 620 acres and 25 miles of shoreline that is mostly in a natural state without significant improvement or development and is generally available for low impact public access and use and may support improved public non-motorized trails. Natural/Undeveloped lands may be used or developed and reclassified for other purposes subject to all applicable regulations.

5.4 Industrial and Other Non-Project Lands (Class 4)

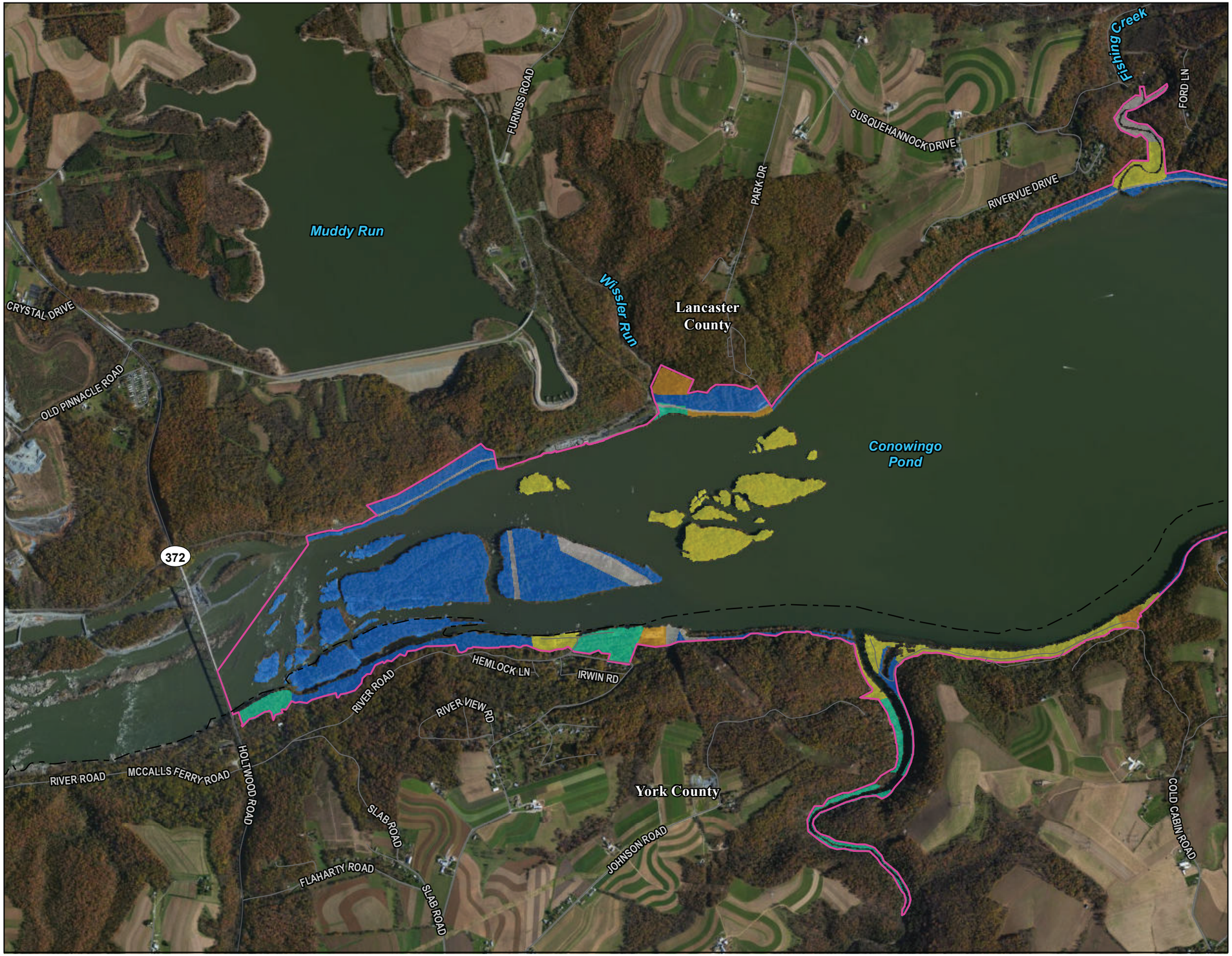
This classification includes 127 acres and 2.5 miles of shoreline lands used for industrial or commercial purposes, including non-project electric utility facilities and other non- project uses such as agriculture. These lands may be managed and operated by third parties under agreement with Exelon. Therefore, public access and other uses may be restricted. These lands may be used or developed and reclassified for other purposes subject to all applicable regulations.

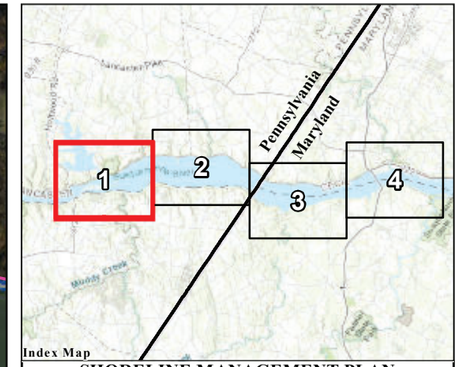
5.5 Public Access Lands (Class 5)

These lands include 20 acres and one-half mile of shoreline that are both developed recreational facilities and lands in a natural state without significant improvement or development. Public access lands are Project lands managed by federal, state, county agencies or conservation organizations under agreement with Exelon. Public access and use of the lands is generally allowed, though may be governed by the managing entity according to the type or level of activity or by season. These are typically water access recreational facilities or unimproved lands, though parking areas, trails, and other infrastructure may be provided in minimally developed areas. Other uses of these lands may be permitted by the managing entity based on the terms and conditions of the agreement with Exelon, but only if the other uses are also consistent with the requirements of the standard use and occupancy article of the FERC License.

5.6 Cottage Lands (Class 6)

Cottage lands include 149 acres and 10 miles of shoreline land that are leased to individuals for seasonal recreation. This includes the presence of seasonal structures (“cottages”) and other infrastructure for their use (access roads, utilities, docks, etc.). Use of these lands is exclusive to the lessee subject to lease terms and conditions, unless the lands are needed for Project purposes. All cottages are located on Conowingo Pond (see Figure 5.6-1).





SHORELINE MANAGEMENT PLAN

Figure 5.0-1:
Project Land Use Classification Map
Map 1

Legend

- Project Boundary
- State Boundary
- County Boundary

Land Use Classifications

- Project Operations
- Recreation
- Industrial/Other Uses
- Natural/Undeveloped Lands
- Public Access Lands
- Cottages

N

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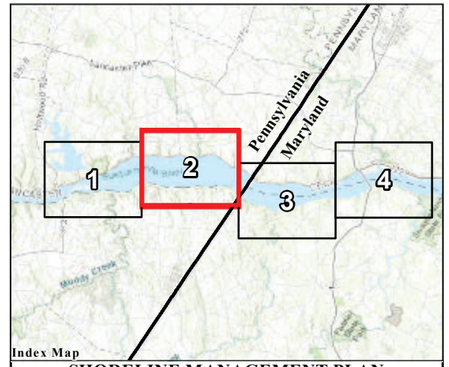

SHORELINE MANAGEMENT PLAN

Figure 5.0-1:
Project Land Use Classification Map
Map 2

Legend

- Project Boundary
- State Boundary
- County Boundary

Land Use Classifications

- Project Operations
- Recreation
- Industrial/Other Uses
- Natural/Undeveloped Lands
- Public Access Lands
- Cottages

N

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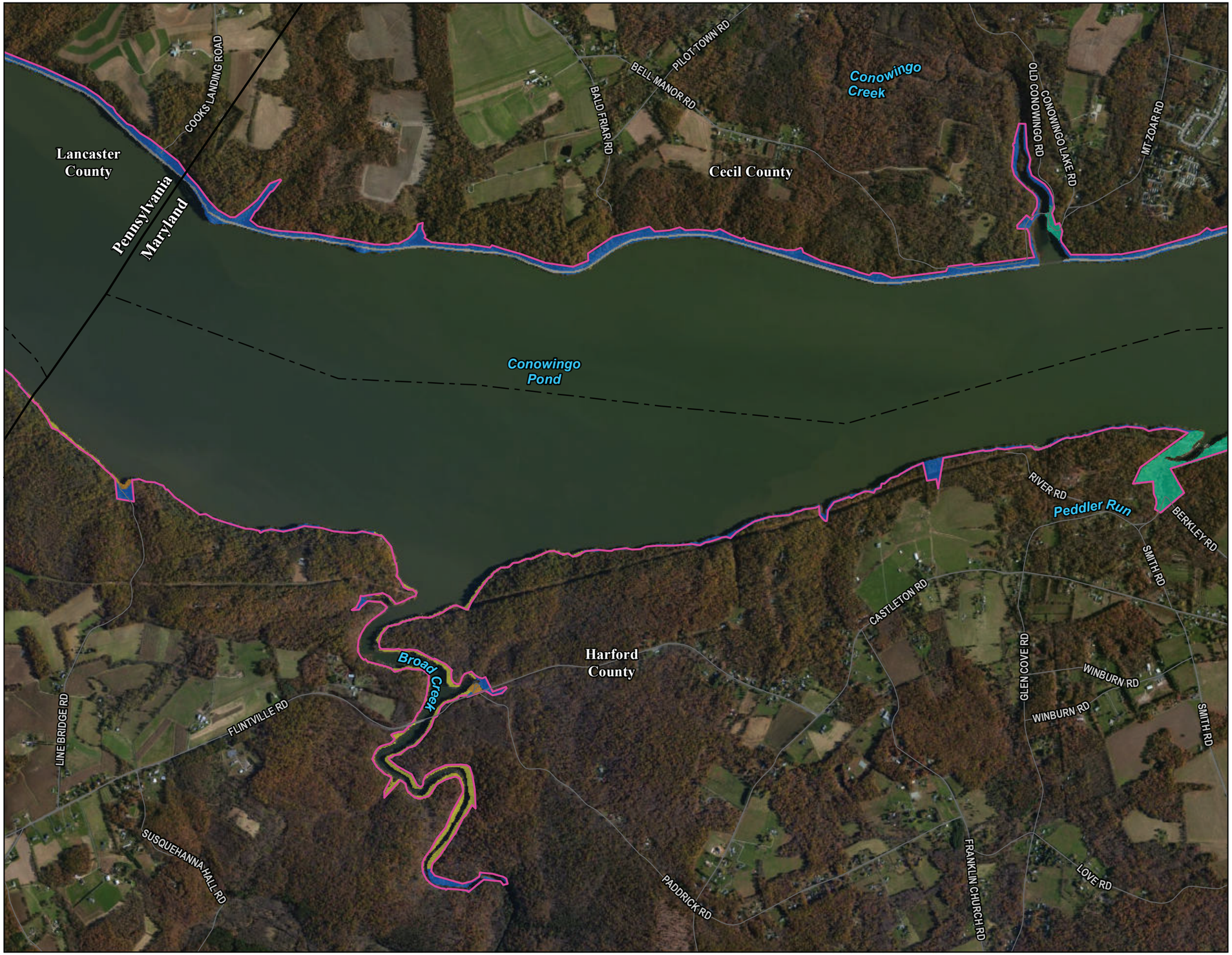

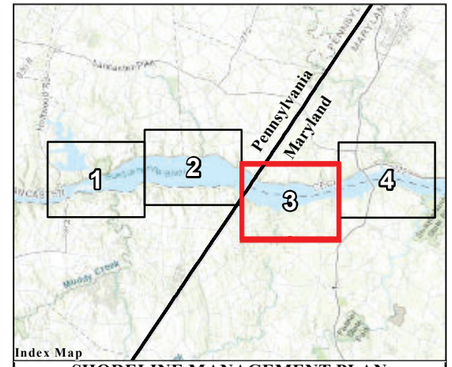

SHORELINE MANAGEMENT PLAN

Figure 5.0-1:
Project Land Use Classification Map
Map 3

Legend

- Project Boundary
- State Boundary
- County Boundary

Land Use Classifications

- Project Operations
- Recreation
- Industrial/Other Uses
- Natural/Undeveloped Lands
- Public Access Lands
- Cottages

N

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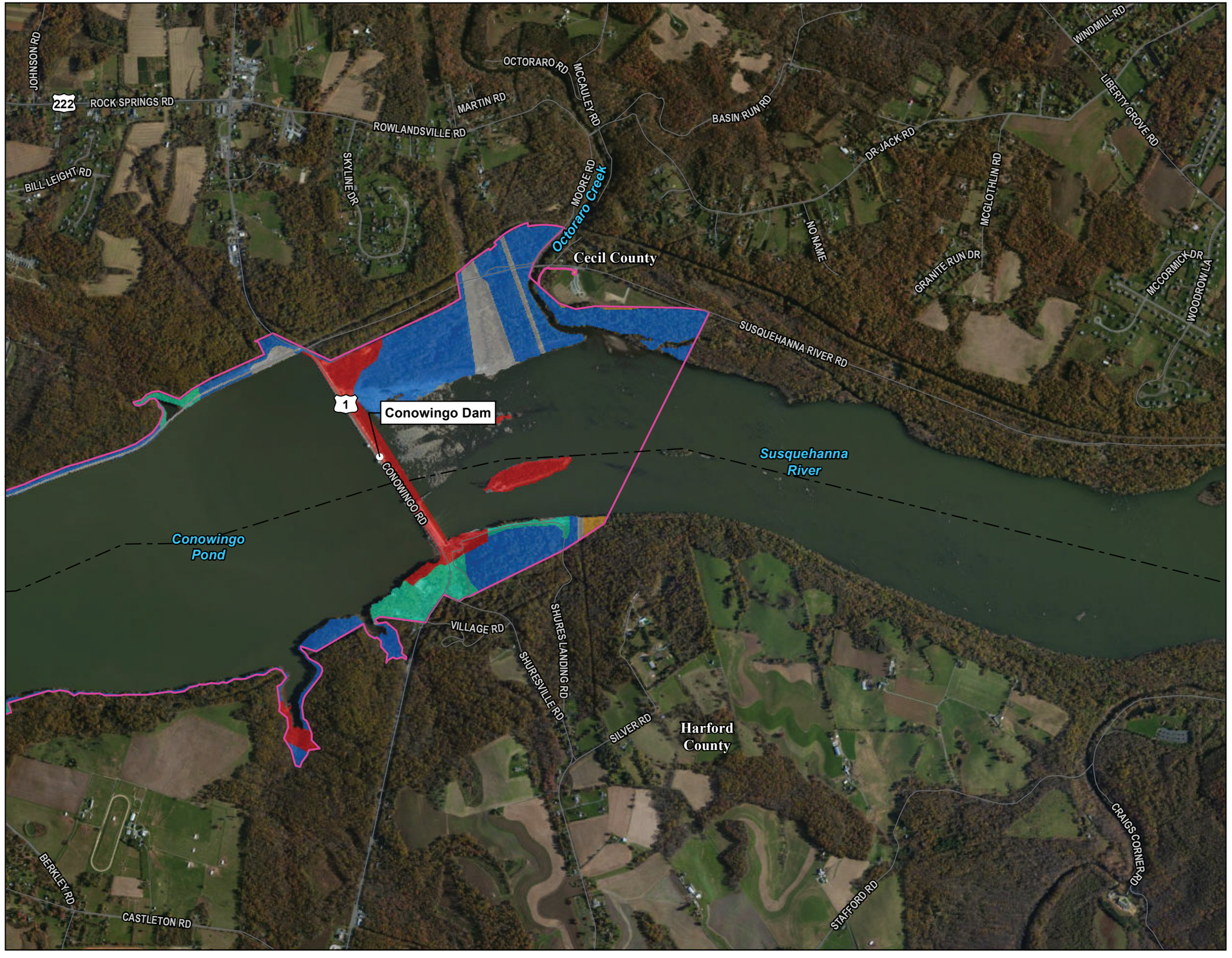

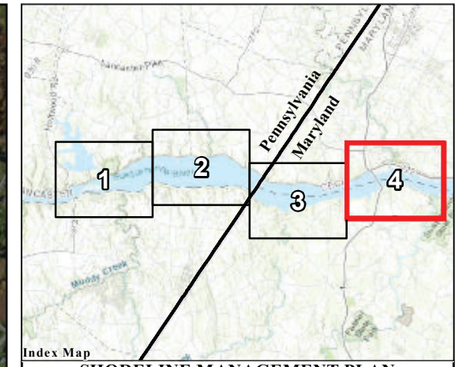

SHORELINE MANAGEMENT PLAN

Figure 5.0-1:
Project Land Use Classification Map
Map 4

Legend

- Project Boundary
- State Boundary
- County Boundary

Land Use Classifications

- Project Operations
- Recreation
- Industrial/Other Uses
- Natural/Undeveloped Lands
- Public Access Lands
- Cottages

N

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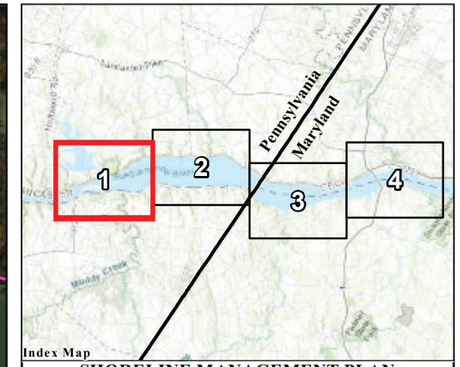

SHORELINE MANAGEMENT PLAN

Figure 5.6-1:
Cottage Clusters
Map 1

Legend

- Project Boundary
- Cottage Lot
- State Boundary
- County Boundary

N

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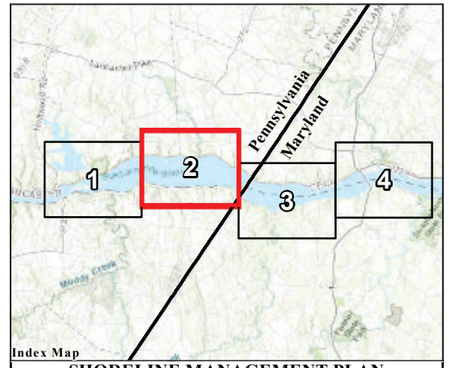

SHORELINE MANAGEMENT PLAN

Figure 5.6-1:
Cottage Clusters
Map 2

Legend

- Project Boundary
- Cottage Lot
- State Boundary
- County Boundary

N

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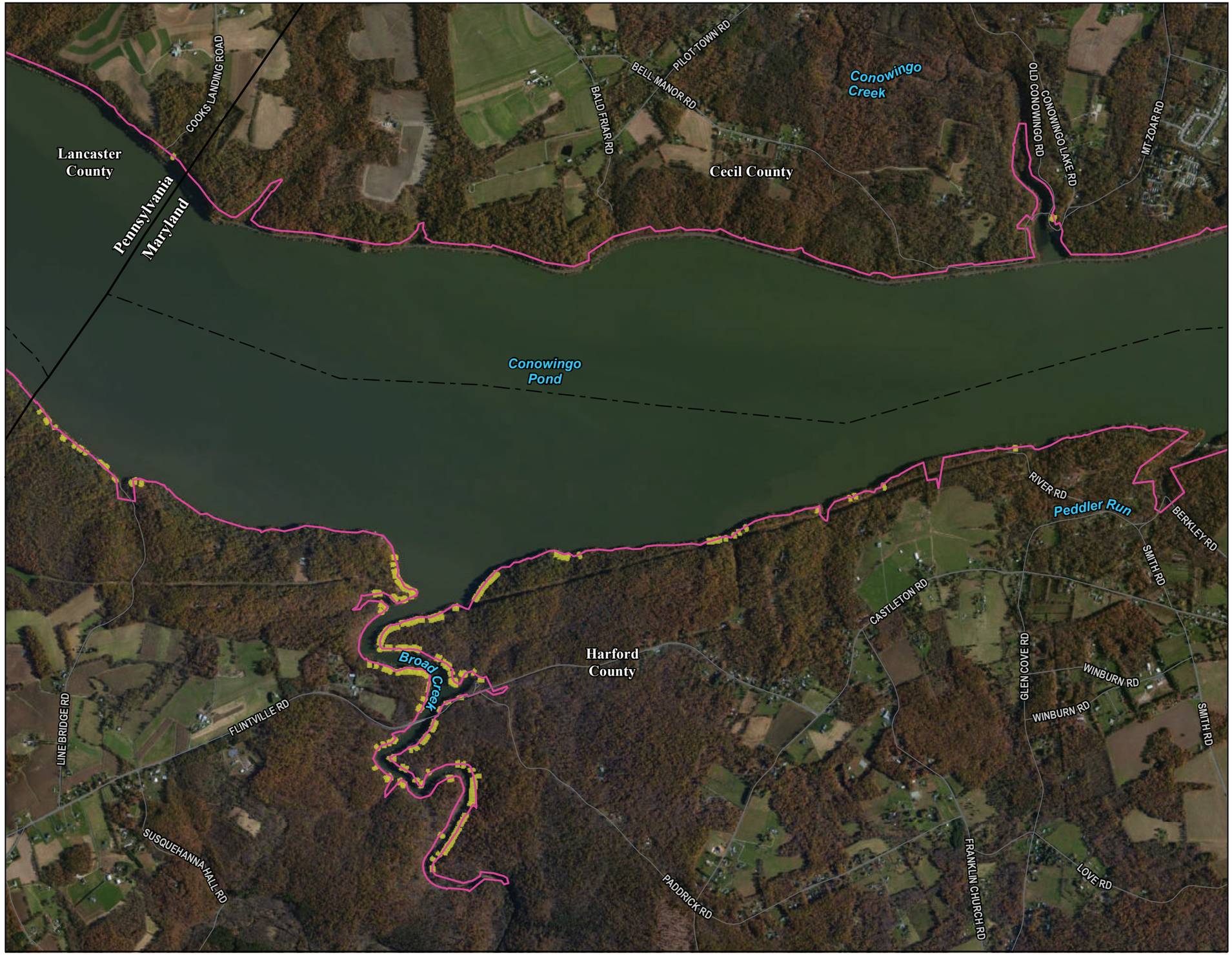

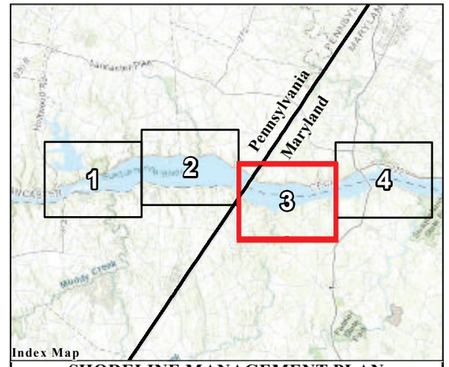

SHORELINE MANAGEMENT PLAN

Figure 5.6-1:
Cottage Clusters
Map 3

Legend

- Project Boundary
- Cottage Lot
- State Boundary
- County Boundary

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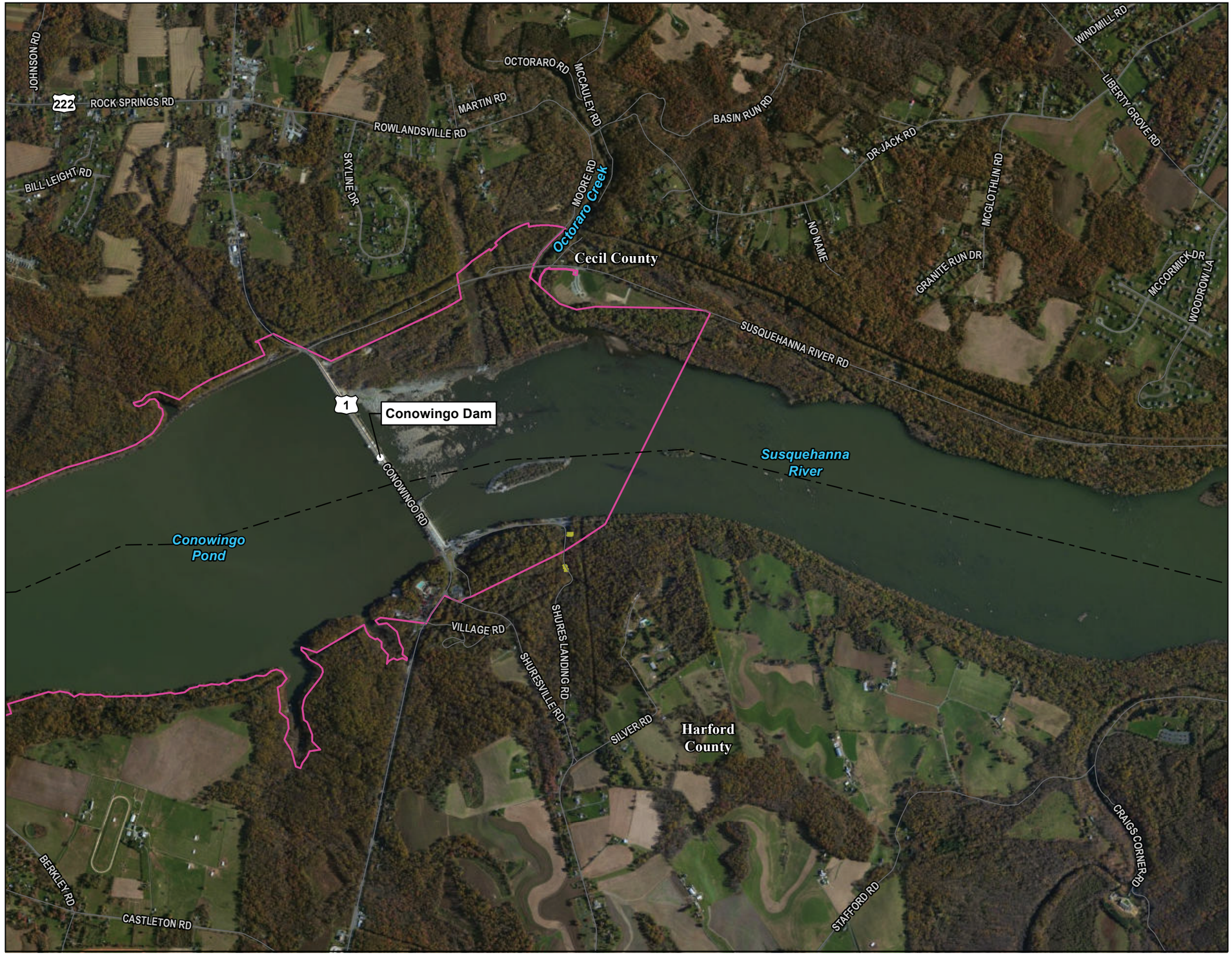

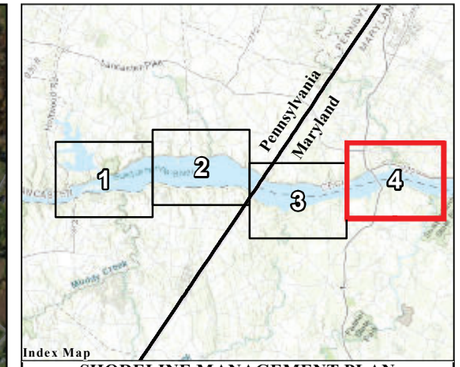

SHORELINE MANAGEMENT PLAN

Figure 5.6-1:
Cottage Clusters
Map 4

Legend

- Project Boundary
- Cottage Lot
- State Boundary
- County Boundary

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6 SHORELINE MANAGEMENT PLAN MEASURES

Multiple resources were utilized to obtain information on the Conowingo Project area in developing this SMP. Primary resources include Project relicensing studies and federal, state and regional plans pertaining to land use, development, protection and conservation, which were reviewed to determine their relationship to Project lands. Exelon's existing land use policies and programs were also reviewed, and where necessary, revised to ensure compliance with the conditions of this SMP (refer to Appendices A through G).

6.1 Shoreline Management Policies

6.1.1 General Policy

Exelon is implementing the SMP to manage multiple resources and uses of the Conowingo Project shoreline. These policies will ensure the protection and enhancement of the Conowingo Project's recreational, environmental, historical, cultural, and scenic resources, consistent with the Conowingo Project's primary function of generating electricity.

To accommodate safe uses of lands and waters within the Conowingo Project boundary by the general public, Exelon maintains designated recreational areas for public recreation including formal camping, picnicking, hiking, fishing and other day-use activities. All other Exelon owned lands, except where specifically posted, are available for informal day use activities.

In accordance with Article 428 (a), the SMP will be reviewed and updated every 10 years, with the first update to be filed with FERC in 2030. As required by Article 428 (b), prior to submitting a proposed update to the SMP to FERC, Exelon will submit to the FWS, NPS, PADCNR, MDNR, and MDE for review and comment all proposed modifications, including an assessment of the impacts of deleted, revised, or new measures on water quality. Exelon will provide a minimum of 30 days for the entities listed above to comment and make recommendations before filing updated plans with FERC. Exelon will 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. If Exelon does not adopt a recommendation, the filing must include the Exelon's reasons, based on Project-specific information.

6.1.2 Shoreline Erosion Control

Modifications are allowed to shoreline vegetation in order to construct erosion control measures, provided the modifications do not impair the overall function of the vegetated buffer and are performed consistently with applicable BMPs. Trees and shrubs on steep slopes will be maintained whenever possible. If the buffer function would be impaired, a planting plan, using the native species plant list included in Appendix F of this SMP, will be devised and implemented to mitigate for the reduced function of the disturbed shoreline.

6.1.3 General Maintenance

Modifications are allowed to shoreline vegetation to maintain the health of the shoreline vegetation, provided the modifications do not impair the overall function of the vegetated buffer. Dead, dying, diseased or hazardous trees and shrubs may be removed in accordance with Section 6.1.7 below. In addition, non-native invasive vegetation may be removed, although cut vegetation (including stems, leaves, seeds and roots) shall be containerized and properly disposed of to avoid regrowth or spreading of the invasive vegetation. If the buffer function would be impaired by vegetation removal, a planting plan will be devised and implemented to mitigate for the reduced function of the disturbed shoreline. Planting plans required by actions subject to this SMP will be prepared using the native species list included in Appendix F.

6.1.4 Erosion and Remediation Policy

Exelon has identified and characterized incidences of erosion on lands in the Conowingo Project boundary. If it is determined that any erosion areas affect Project resources, Exelon will include these areas in a remediation program, monitor the areas, and perform any required improvements in accordance with applicable BMPs.

6.1.5 Woody Debris Management

Woody debris is defined as trees and woody material that extend from the shoreline into the impoundment. This material can provide important habitat for fish and wildlife and shall be left in place unless the debris is determined, on a case-by-case basis, to be a navigational or safety hazard. If the woody debris must be removed it shall be managed and disposed of in accordance with the policies outlined in the Debris Management Plan required by Article 427.

6.1.6 Approval of Non-Project Use of Project Lands

Any use of or construction on lands within the Conowingo Project boundary by a non-licensee must be permitted by the appropriate agencies and receive Exelon approval before work can begin. Parties requesting non-Project use of Project lands will be required to provide Exelon with sufficient information for Exelon to determine if the proposed use or occupancy is consistent with the requirements of the Conowingo Project license, including this SMP, and otherwise consistent with Exelon's applicable policies. Exelon will also determine whether the proposed use or occupancy can be approved pursuant to the standard use or occupancy license article (Article 430), or whether prior approval by FERC is required. If Exelon, in its discretion, decides to support the proposed use or occupancy, it will execute the necessary conveyance of rights when it has received any necessary approval from FERC and the non-licensee has obtained all necessary permits and approvals.

In addition to complying with the requirements of Article 430, prior to submitting an application to FERC for a non-Project use of Project land, Exelon will address Article 428 paragraph (c) requirements to comply with the requirements of Article 430 and to, "(i) prepare, or require the third-party requesting the non-project use of project land to prepare, a written assessment of the impacts on water quality of the proposed use; (ii) provide this assessment to MDE for review to determine whether the proposed use is consistent with Maryland water quality standards, including designated and achieved uses; and (iii) consult with MDE regarding the proposed use" prior to submitting an application to FERC for a non-project use of project land.

Exelon has developed specifications and standards associated with the cottages to address shoreline development such as piers, docks, boat ramps, and bulkheads, as well as effects on cultural resources, and compliance with local, county, state and federal laws and regulations (see Appendix C).

6.1.7 Shoreline Vegetation Management

There are approximately 46 miles of shoreline associated with the impoundments comprising the Conowingo Project including 43 miles associated with Conowingo Pond and three miles associated with the area downstream of Conowingo Dam. Much of the shoreline is currently buffered with natural vegetation.

Shoreline vegetation provides many benefits to the Conowingo Project including wildlife habitat, maintaining water quality by providing a filter strip to control run-off, erosion, and aesthetics. Existing shoreline vegetation will be preserved where feasible. It currently varies in depth depending on the location of the Conowingo Project boundary relative to the impoundment shoreline and current land use. Existing improved and developed areas with limited shoreline vegetative cover such as the cottage clusters, the PBAPS, recreation sites and facilities, and the dam and associated generating facilities, can be maintained

as they currently exist. Modifications to the shoreline vegetation in other areas will be considered for viewshed maintenance and development, recreation access, shoreline erosion control, and general Project related maintenance of the vegetated shoreline.

With the exception of any activities required pursuant to the license, prior to making any modifications to shoreline vegetation for viewshed maintenance and development and recreation access within the Conowingo Project boundary, Exelon will address Article 428, paragraph (d) requirements and "(i) prepare a written assessment of the impacts on water quality of the proposed modifications; (ii) provide this assessment to MDE for a determination regarding whether the proposed modifications are consistent with Maryland water quality standards, including designated and achieved uses; and (iii) not undertake any such modifications until MDE notifies the licensee in writing that it has no objections to the proposed modifications."

6.1.8 Viewsheds

Modifications and maintenance of vegetation is allowed to provide a reasonable view of the water, provided the modifications do not impair the overall function of the vegetated buffer. If the buffer function would be impaired, a planting plan, using the native species plant list included in this SMP, will be devised and implemented to mitigate for the reduced function from vegetation removal.

With the exception of any activities required pursuant to the license, prior to making any modifications to shoreline vegetation for viewshed maintenance and development and recreation access within the project boundary, Exelon will address Article 428, paragraph (d) requirements and "(i) prepare a written assessment of the impacts on water quality of the proposed modifications; (ii) provide this assessment to MDE for a determination regarding whether the proposed modifications are consistent with Maryland water quality standards, including designated and achieved uses; and (iii) not undertake any such modifications until MDE notifies the licensee in writing that it has no objections to the proposed modifications."

6.1.9 Access Trails

Modifications are allowed to the vegetation to provide access trails along the shoreline and to the water, provided the modifications do not impair the overall function of the vegetated buffer. If the buffer function would be impaired, a planting plan, using the native species plant list included in this SMP, will be devised and implemented to mitigate for the reduced function from vegetation removal.

Trees and shrubs may be pruned or removed to provide or maintain an access trail. Trails will not exceed six feet and should be located so that a cleared line of sight to the water through the vegetated buffer is not created. Where possible, new trails will meander, in order to trap precipitation runoff more effectively with vegetation and natural depressions within the vegetated area.

To control trail surface erosion, areas of exposed soil will be vegetated, mulched, or surfaced with a permeable material.

With the exception of any activities required pursuant to the license, prior to making any modifications to shoreline vegetation for viewshed maintenance and development and recreation access within the project boundary, Exelon will address Article 428, paragraph (d) requirements and "(i) prepare a written assessment of the impacts on water quality of the proposed modifications; (ii) provide this assessment to MDE for a determination regarding whether the proposed modifications are consistent with Maryland water quality standards, including designated and achieved uses; and (iii) not undertake any such modifications until MDE notifies the licensee in writing that it has no objections to the proposed modifications."

6.1.10 Sensitive Natural Resource Protection Overlay and Policies

Research and numerous studies were conducted to assess and determine the existence of or potential effects (if present) of project operations on various resources, including rare, threatened and endangered species, terrestrial and aquatic habitat, historic and cultural sites and structures, wetlands, unique natural areas, and steep slopes. The presence of these resources may partially or completely limit or restrict land use and/or development, regardless of the applicable land classification described above.

Prior to the implementation of any proposed modification of an existing use or new use of Project lands by Exelon or a non-licensee, Exelon will determine if the potential use would affect any sensitive resources. Exelon will survey (or require the non-licensee proposing a non-Project use of Project lands to survey) the affected land to determine if it hosts any sensitive resources not previously identified. If any sensitive resources are identified, as provided for in Article 428 (e) Exelon will consult with MDE regarding any proposed modification of an existing use of Project lands in cases where such use may affect sensitive aquatic resources. Exelon will take appropriate protective actions developed in consultation with appropriate resource agencies prior to undertaking the proposed use, or require a non-licensee proposing to use Project lands to take the same measures as a condition of conveying the right to use or occupy project lands.

6.1.11 Bald Eagle Management Plan – Article 421

Bald Eagles use Project lands and waters for nesting, roosting, and foraging. The BEMP addresses potential impacts to Bald Eagles on Exelon lands, including the project area lands for the Conowingo Project and adjacent lands under Exelon ownership.

The BEMP provides 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. Bald eagle habitat, including nest sites, forage sites, and communal roost sites on Exelon lands will be managed through a range of measures. The range of measures will be tailored to types of activities with potential to impact eagles and will include, but not be limited to, seasonal restrictions, distance buffers, and landscape buffers.

6.1.12 Osprey Management

Exelon does not maintain a database of current Osprey nests within the Conowingo Project boundary. However, when an occupied Osprey nest is identified, Exelon will follow the PGC's Best Management Practices for Occupied Osprey Nests in Pennsylvania (Appendix G, PGC, n.d.) whenever feasible. These BMPs identify three zones, or nest buffers, around an occupied nest. When Project management needs are identified that conflict with these BMPs or may disturb nesting Osprey in any way, Exelon will consult with the FWS Chesapeake Bay Field Office, PGC, and the US Department of Agriculture Wildlife Services[5] to determine appropriate avoidance measures. PGC's published BMPs do not address problem nests located in electric transmission towers. In the event that nests located in electric transmission towers or other structures are identified as problem nests, Exelon will consult with the FWS, PGC, and the US Department of Agriculture Wildlife Services to identify the appropriate BMPs and obtain applicable permits for nest removal or relocation. A typical BMP for problem nests in towers is the installation of nest platforms on towers nearby.

[5] MDNR provided the following information for contacting the US Department of Agriculture Wildlife Service: 1-877-463-6497 (personal communication, B. Harvey, MDNR, July 2021).

6.1.13 Historic Properties Management Plan – Article 429

Exelon has developed, in consultation with PHMC and MHT, a draft HPMP to address historic and cultural resources within the Conowingo Project's APE. In accordance with Article 429 Exelon will prepare and file a revised HPMP based on the HPMP filed with the Commission on August 31, 2012. The HPMP is incorporated herein by reference.

6.1.14 Conowingo Island Public Use Policy

The policy establishes guidelines for the use of the islands located in the upper reach of Conowingo Pond from the Pennsylvania Route 372 bridge to approximately one mile downstream, as well as Mt. Johnson Island, which is located five miles downstream of the Route 372 bridge. The policy restricts and regulates island use in order to protect rare species, cultural resources, and unique geologic and physical features. The "Conowingo Islands Public Use Policy" is included as Appendix B. The Rules and Regulations Governing the Use and Occupancy of Leased Premises are currently being updated and up-to-date revisions will be posted on Exelon's Conowingo, FERC License Renewals website under a Shoreline Management Plan (SMP) link.

6.1.15 Leased Premises Policies

6.1.15.1 Cottages

Exelon has developed rules and regulations regarding the use of Project lands for seasonal cottages. 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 erosion control, vegetation removal, wastewater disposal, shoreline development, and cultural resource protection. Rules and regulations have been developed for Pennsylvania and Maryland cottages, and copies for each State are attached as Appendix C and are currently being updated to reflect the applicable provisions of the License.

It is Exelon's policy not to create any new cottage lease lots within the Conowingo Project boundary. In addition, as existing cottages are abandoned or become damaged and are not replaced due to local zoning restrictions, leases will be terminated. All structures and improvements removed from the leased lot and the property will be restored to a natural condition. No future cottage leases will be issued at the site.

6.1.15.2 Public Recreation and Access Facilities

Exelon leases numerous parcels of land to local, county and state agencies and to commercial vendors for development and operation of public recreation and access facilities within and adjacent to the Conowingo Project boundary. The agreements specify that the respective lessees will use the properties for park and public recreation access and facilities and comply with all applicable local, state and federal regulations. All of these sites and facilities within the Conowingo Project boundary are Project recreation facilities under Exelon's FERC license.

Exelon has developed "Rules and Regulations Governing the Use and Occupancy of Leased Premises" and have made this part of the lease agreements for the two existing Project marina facilities, Glen Cove Marina and Peach Bottom Marina and will be updated as needed. These rules and regulations parallel those developed for the cottages in addressing many of the same issues, and a copy is attached as Appendix D.

Exelon will continue to partner with the agencies and vendors for the operation of these facilities and their use by the public. As the Licensee, Exelon ultimately has responsibility for the operation and maintenance of the Conowingo Project facilities.

6.1.16 Policy Restricting Certain Recreational Uses

Exelon provides public recreation and access to Project lands and waters pursuant to its FERC license requirements. Access and use of certain portions of Project lands will be restricted for operational, safety and security reasons.

Fishing: Fishing in Project waters accessible to the public will be governed by applicable state regulations. Fishing will not be allowed within secure areas or areas that present public safety concerns of the Conowingo Project. This includes shoreline fishing within 100 yards of the base of Conowingo Dam at Fisherman's Park (west shore) and for 4,000 feet along the east shoreline downstream of the dam. These areas are restricted for public safety reasons due to changes in water elevations and velocities from generating flows and spilling water during gate operations. In addition to safety concerns, the area along the west shore is also used as a staging and storage area related to dam maintenance.

Boating: Boating in Project waters accessible to the public will be governed by applicable state regulations. Boating is prohibited in areas 400 yards above and 400 yards below Conowingo Dam pursuant to the Code of Maryland Annotated Regulations, Title 08.18.26.05. The boating exclusion zones are marked by buoys on Conowingo Pond and by signs downstream of the dam.

Hunting: Hunting on Project lands accessible to the public will be governed by applicable state regulations. Hunting will not be allowed on Project lands posted against hunting by Exelon, as necessary, to protect the public, adjacent landowners, lessees, employees, sensitive resources, and Licensee's operating capabilities. Hunting on Project lands accessible to the public will be governed by Exelon policies and applicable state regulations.

Exelon issues permits for offshore (water access only) stationary duck blinds and duck blind sites on Exelon land to hunters on an annual basis. The permits allow applicants (up to four individuals per permit) to have no more than two blinds or sites.

Off-Road Vehicles: Use of off-road vehicles on Project lands is prohibited. Exceptions may be made for company related purposes for employees and contractors, emergency personnel, agency personnel during their normal duties, and instances where an off-road vehicle is for ADA access for an approved activity or use.

Drones: Use of drones on Project lands is prohibited unless pre-approved by Exelon. The policy is attached as Appendix E.

7 MONITORING AND COMPLIANCE BY NON-PROJECT USERS OF PROJECT LANDS

Exelon will ensure that uses and occupancies of Project lands are consistent with the license's requirements for the protection and enhancement of environmental resources, scenic character, historic and cultural resources, the provision of public recreation, public health and safety, and the safe operation of the Conowingo Project's generating facilities.

Each conveyance of the right to use or occupy Project lands for a non-project purpose will be made subject to Exelon's obligation to comply with the Conowingo Project license. To facilitate compliance, Exelon will periodically monitor and assess affected lands and any structures thereon, as necessary. If a non-licensee fails to cure any violation of its agreement with Exelon or acts to prevent Exelon from exercising its rights with respect to monitoring and access, Exelon will revoke the conveyance and require the non-licensee to remove any improvements on Project property and restore the site to its pre-conveyance condition. In addition, each conveyance will reserve Exelon's right to take legal action as necessary to enforce the agreement or obtain remedies for breach of the agreement.

8 AMENDMENTS

In order for the SMP to remain a functional plan over the life of the FERC license, Exelon will evaluate appropriate amendments to the SMP as the facts and circumstances may warrant.

As required by Article 428 (a), the SMP will be reviewed and updated every 10 years, with the first update to be filed with FERC in 2030. Prior to submitting a proposed update of the SMP to FERC, in accordance with Article 428 (b), Exelon will submit to the FWS, NPS, PADCNR, MDNR, and MDE for review and comment of all proposed modifications, including an assessment of the impacts of deleted, revised, or new measures on water quality. Exelon will provide 30 days for the entities listed above to comment and make recommendations before filing updated plans with FERC. Exelon will 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. If Exelon does not adopt a recommendation, the filing must include the Exelon's reasons, based on Project-specific information.

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APPENDIX A. BEST MANAGEMENT PRACTICES FOR WATER QUALITY PROTECTION CONOWINGO SHORELINE MANAGEMENT PLAN

Best Management Practices

Conowingo Shoreline Management Plan

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BMP Implementation Criteria

This SMP outlines management measures which apply to all of the lands within the Conowingo Project boundary. In addition to the overall measures contained in the SMP, Exelon will incorporate, where applicable, the Best Management Practices (BMPs) included herein to the extent practicable. In addition, improvement projects which occur on Project lands that involve earth disturbance and are subject to land use permitting requirements (site plan or building permits) must also be in compliance with all applicable municipal, county, state, and federal permitting requirements associated with erosion and sedimentation measures and control.

Project Facility Landscaping and Lawn Care BMPs

Proper Storage and Handling of Chemicals

- Store chemicals in a secure facility with an impervious floor and good ventilation. The floor should have a curb, sump, or lip to contain spilled contaminants.
- Research proper construction materials and designs for storage facilities.
- Provide a secondary containment system that will hold a larger volume than the largest container/tank used.
- Store the chemicals in their original containers and organize them according to application (herbicides, pesticides, insecticides).
- Prior to use check equipment calibration and look for leaking, especially valves and overflowing tanks.
- Develop a permanent mixing/loading and washing zone on an impervious surface where washwater can be easily contained or collected. Note: Pesticide washwater should be handled separately from other washwater unless a system has been developed to handle both.
- Always follow the directions pertaining to the storage, mixing, and disposal of chemicals that are on the labels.
- All areas involved in the storage, mixing, or disposal of chemicals should be located away from surface, ground, and well-water sources.
- Maintain a current material safety data sheet for each chemical on-site. Employees should be made aware of how to safely apply chemicals.
- Have an on-site emergency plan in the event of an uncontained spill or another emergency including information on what emergency response teams to notify (LandStudies Inc. & Pennsylvania Environmental Council 17).

Selection and Application of Chemicals

Selection

- Choose chemicals with short half-lives, low toxicity, and medium sorption rates to reduce the effects of leaching and reduce runoff.
- Consider how quickly a chemical accumulates in live tissue.
- Don’t use broad-spectrum herbicides, use the most specific chemicals available.
- In general limit the use of pesticides with soils that have a persistence greater than 21 days, a soil adsorption value less than 300, and a solubility greater than 30 mg/l (per the Delaware River Basin Commission).
- Avoid using wettable powders, which are more prone to runoff.
- Vary which chemicals you use to reduce pest resistance.
- Select turf species that are resistant to pests and disease.
- Limit practices or the use of products that could possibly contribute to pollution.

Application

- Consider the weather conditions prior to application. Spray drift is affected by particle size and wind. Rain within 12 hours of application can greatly increase chemical runoff. Depending on the mode of action of the applied chemical, light irrigation or rain can increase the amount of chemical reaching the soil.
- Calibrate and check that equipment application rates are appropriate.
- Strictly follow product labels.
- Regularly look for ways to improve soil health. This will improve turf health and increase its defense against pests and disease and it will limit the amount of chemical treatment required.
- Use the life cycle of pests to determine when they are most vulnerable and time when chemicals are applied.
- Record when chemicals were applied and the effectiveness of the application for future management.
- Prior to application consider environmentally sensitive areas such as groundwater recharge areas (sinkholes, highly permeable soils, soils with low adsorptive capacity, wells), surface water bodies, and non-target areas (water bodies, natural areas and wildlife). Decide if treatment is necessary and which chemicals to use. Spot treatment or the use of covered booms may be appropriate (LandStudies Inc. & Pennsylvania Environmental Council 19).

Development of a Nutrient Management Plan

- Use quick release fertilizers primarily for turf establishment. For other areas use slow release fertilizers which release nutrients at a pace which is similar to the nutrient intake rate of the plants.
- Do not apply nutrients on frozen ground.
- Follow nutrient application recommendations from a reliable source.
- Mow, topdress, and aerate to maximize fertilizer effectiveness (LandStudies Inc. & Pennsylvania Environmental Council 21).
- Apply appropriate fertilizers and amounts based upon the plant needs for that area.
- Create non-fertilized buffers along bodies of water.
- Use slow-release fertilizers on or near steep slopes and sandy soils.
- Do not use fertilizers to deice anything.
- Stabilize disturbed soils quickly.
- Route drainage systems to low-maintenance filtering zones such as tall grass (LandStudies Inc. & Pennsylvania Environmental Council 22).

Buffer Strip Vegetation

- New vegetation should be chosen from Exelon’s native plant list included in the Shoreline Management Plan for the Project.
- Limit or eliminate fertilizer or chemical use in buffers to maximize their filtering abilities.
- Buy vegetation from local nurseries.
- Monitor and maintain health of buffers using a pest management plan.
- Install signs and fencing to protect buffers.

- Do not dispose grass clippings or pruning within buffers.
- Mow buffers once or twice a year, but make sure it is done in accordance with any applicable RTE species management plans (LandStudies Inc. & Pennsylvania Environmental Council 32).

Composted Materials Usage

- Composted material should include grass and other herbaceous clippings, green leaves, non-fat/non-animal food wastes, and small woody material. This mixture will help fight diseases your vegetation may encounter.
- Maintain the correct proportions of air, water, carbon, nitrogen and pH. Appropriate levels of each will kill undesired weed seeds.
- Consult multiple sources before beginning to compost (LandStudies Inc. & Pennsylvania Environmental Council 35).
- Use compost on clay soils to reduce surface crusting and compaction, provide nutrients, promote drainage, and improve overall soil structure.
- Use compost on sandy soils to add nutrients, increase microbial activity, and increase the capacity of the soil to hold nutrients and water.
- Use core aeration to better incorporate the compost with the soil.
- Use a 3:1 ratio, by volume, of carbon-rich material (dried leaves) to nitrogen-rich material (clippings).
- Compost material for two years to maximize the benefits for the turf.
- Test the compost for nutrients prior to application and adjust fertilization practices accordingly.
- Review and familiarize yourself with local and state regulations before beginning a compost operation (LandStudies Inc. & Pennsylvania Environmental Council 36).

Pet Waste Education/Treatment

Definition

Teaching visitors the benefits to water quality from cleaning up after their pets.

Purpose

Animal waste washed into the water supply decrease oxygen supplies, carry diseases and promote eutrophication (weed and algae growth). All of which have negatively effects on water quality.

Conditions Where Practice Applies

Public recreational locations where people own and interact with pets.

Design Criteria

Launch an education campaign describing the negative effects of leaving pet waste alone and emphasize the effects on water quality.

Install signs in public spaces asking owners to pick up after their pets.

Create stations in parks, recreational areas, or other public places with plastic bag dispensers for owners to use.

Pet waste shall be picked up and disposed of appropriately by the pet owner. Removal of pet waste from the public recreation facility shall be the responsibility of the pet owner.

Maintenance

These programs require residents and recreational users to enforce the practice amongst themselves.

Signs may need to be installed.

Generic Design Parameters

NA

Structural and Natural BMPs

Vegetated Riparian Buffers

Definition

Areas of natural vegetation maintained to protect the water quality of nearby water bodies of conveyances.

Purpose

To trap sediment, improve groundwater recharge, and slow runoff.

Conditions Where Practice Applies

For all new activities, riparian buffers may be created wherever vegetation can be supported next to bodies of water, especially on floodplains, near wetlands, on unstable slopes, or along streambanks.

Design Criteria

Make sure soil is not compacted.

Determine buffer width using slope, species of vegetation, runoff sediment characteristics, annual rainfall, pollutants and potential volumes, soils, and depth to impermeable layers.

Increase buffer width as slope increases.

Mix various types of vegetation, shrubs, grasses, and trees.

In areas where there is fast, concentrated flow incorporate other measures such as level spreaders to prevent erosion and rilling.

Maintenance

Initially buffers can require weed/pest control, fertilizing, mulching, seeding, mowing, irrigating, and pruning. Once installed check the buffer after heavy rainfall or once a year, focusing on the development of gully erosion, vegetation density, damage from foot or vehicle traffic, or damage from concentrated flows. When or if 6” of sediment has accumulated remove it.

Generic Design Parameters

Slopes should be less than 5 percent unless erosion control blankets are used (“Vegetated buffers” 2006).

Rain Garden/Bioretention Pond

Definition

Parking lot islands or small landscaped areas used to detain and treat stormwater runoff.

Purpose

To slow and treat water before it is collected in storm drain systems.

Conditions Where Practice Applies

Rain Gardens/Bioretention Ponds will be considered for all future new construction or major rectonstruction. This BMP is not applicable to existing facilities.

Raingardens may be used in locations where there are concentrations of pollutants greater than in normal stormwater only when an impermeable layer has been installed along the bottom of the filter bed.

Raingardens may be developed in highly urban areas because they can fit into parking lot islands.

Design Criteria

Bioretention areas should usually be implemented with drainage areas less than 5 acres. Designing for larger drainage areas can present clogging and conveyance issues.

The slope of the drainage area is usually around 5 percent.

The raingarden should be higher than the highest groundwater table elevation in order to prevent groundwater contamination.

The raingarden should be able to direct flow to a nearby storm drain in the event of overflow during a large storm event.

In terms of landscaping most of the plants used should be native. Plants towards the bottom of the raingarden should be able to withstand wet and dry conditions. Plants at the top of the bioretention facility should be durable and resilient, while plants of the edges should be dry.

When the soils are beneficial to infiltration process the underdrain may only be installed under some of the raingarden; otherwise, install the perforated pipe underneath the entire raingarden.

Maintenance

Standard (as needed)

- Remulch
- Treat diseased plants
- Mow grass/turf

After Project Completion

- Water plants daily for 2 weeks

Monthly

- Inspect soil and repair eroded sections
- Remove litter and debris

Twice a Year

- Remove and replace dead/diseased vegetation

Once per Year

- Add mulch
- Replace tree stakes and wires

Generic Design Parameters

Raingardens are not flood control devices.

The size of a raingarden should be 5-10 percent of the impervious area draining to it.

The soil bed should be comprised of a sand/soil mix with a layer of mulch on top of it. The raingarden should be able to hold a small 6-9" deep pond on top of these layers of soil.

Consider using pretreatment measures such as a vegetated channel to eliminate some of the sediment and pollutants from the runoff and reduce the burden put on the rain garden ("Bioretention (rain gardens)" 2006).

Rain Barrels

Definition

Large containers used to collect rooftop runoff from.

Purpose

To collect the runoff from roofs and improve overall water quality by disconnecting impervious areas.

Conditions Where Practice Applies

Structures that have roofs and receive large quantities of rainfall.

Rain barrels will be considered for all future new construction or major rectonstruction. This BMP is not applicable to existing facilities.

Design Criteria

Consider using another method unless the water being stored will be used actively by the resident/business owner in gardening, landscaping, or in some other facet.

A plan for overflow and freezing conditions should be considered.

Maintenance

Keep the hose off the ground to avoid freezing/cracking. Clean out the tank once a year. Maintain a tight seal around the barrel to prevent mosquito breeding.

Generic Design Criteria

Use a drip tape or common garden hose for watering.

Control flow through the hose using an adjustable valve.

Storm Drain Marking

Label any newly constructed storm drain that enters surface water. Complete annual survey of storm drain covers, refresh labels as necessary.

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APPENDIX B. CONOWINGO ISLANDS PUBLIC USE POLICY

CONOWINGO ISLANDS

PUBLIC USE POLICY

The "Conowingo Islands" are a group of islands located in the Susquehanna River (Conowingo Pond) extending from the Norman Wood Bridge (PA Route 372) south approximately 1.3 miles and including Mount Johnson Island located 5 miles south of PA Route 372. The islands "... constitute one of Pennsylvania's most unusual and important assemblages of rare species (Cook, 1986). The Islands also posses unique geological and other physical features (Erdmann, 1978) and important cultural resources. The Philadelphia Electric Company and its subsidiaries, The Susquehanna Power Company and Philadelphia Electric Power Company recognize the importance of these Islands and have developed this policy to maximize the protection afforded the Islands.

It is the policy of the Philadelphia Electric Company, The Susquehanna Power Company and Philadelphia Electric Power Company that use of the Islands will be restricted to:

1. Employees of Philadelphia Electric Company and Susquehanna Electric Company in performance of their official duties

2. Persons conducting bona fide scientific studies on the Islands and who have obtained prior written permission from the Real Estate Department, Philadelphia Electric Company

3. Persons participating in group tours approved in writing by the Real Estate Department, Philadelphia Electric Company

4. Tenants (and invited guests) of the Philadelphia Electric Power Company who have a current Agreement of Lease for use of (or portion of) said Islands

5. Personnel of either a law enforcement or regulatory agency, having jurisdiction over the islands, in performance of their official duties, and

6. Employees of approved contractors for the Philadelphia Electric Company, The Susquehanna Power Company or Philadelphia Electric Power Company in the performance of their official duties.

All persons not meeting one of the six critieria described above will be considered to be tresspassing and are subject to prosecution under the law.

RULES AND REGULATIONS GOVERNING THE USE AND OCCUPANCY OF LEASED PREMISES ON ISLANDS

PURPOSE

The Islands located in the Conowingo Pond contain important biological and cultural resources. The Company recognizes the importance of these valuable resources and seeks to protect them. In addition, the Conowingo Hydro-electric Project is a federally licensed project and the Company is required under its License to protect the environmental, scenic, and cultural resources found in the project. As tenants of the Philadelphia Electric Power Company you also have an obligation to help protect these important resources.

The following rules and regulations have been developed specifically for Island tenants. All conditions, procedures, and restrictions contained in the "Rules and Regulations Governing The Use and Occupancy of Leased Premises" shall apply.

GENERAL CONDITIONS

1. Tenants and their guests are responsible for helping to protect the exceptional biological, cultural, and physical features of the islands.

2. Tenants shall restrict their regular use activities on the islands to their leased premises except when required for a means of access to their leased premises.

3. Tenants are restricted to one access (or landing area) per tenant. Tenants are encouraged, when possible, to share access areas. All access areas must be properly stabilized to prevent erosion. A path from the landing area to the leased premises must be designated and properly maintained.

4. Tenants are required to report (as soon as practical) to the Real Estate Department any unauthorized use(s) of the Islands. The tenant shall supply the Department as much information about the violator(s) as possible. Pertinent information may include; boat registration numbers, hunting or fishing license numbers, physical description of persons, date, time, location, activity, etc. Violations of State laws should be reported directly to the appropriate state law enforcement Agency(Fish Commission, Game Commission, or State Police).

5. Tenants must display their cottage identification number (C.I.N.) on the stern of their boat(s) using 3 inch high letters.

6. Tenants will not be allowed to expand their existing structures or add any new structures. Exceptions may be made if the proposed structure will reduce other negative impacts to the island (ex. boardwalks).

7. Tenants are not allowed to use any rock outcrop areas (except for currently existing uses) because these areas are very fragile and ecologically important. Tenants are encouraged to phase out existing uses of these areas.

VEGETATION

1. Tenants shall not plant any type of non-native vegetation (including trees, shrubs, vines, flowers, grass, etc.) without obtaining prior written permision from the Real Estate Department. If you have any questions or doubts, contact the Department by telephone (215 841-6894) or in writing for clarification.

2. **NO** trees, shrubs, vines, flowers or vegetation of any kind may be removed from the island. No vegetation of any kind may be cut or trimmed except for the regular trimming of ornamental shrubs and mowing of lawns.

3. The Department may require the tenant to remove any non-native plants.

4. Many of the islands and adjacent shallow water areas contain plants that are listed as species of special concern by the Commonwealth of Pennsylvania.
NOTE: It is a violation of State Law to "... disturb, pick, take possess, destroy, mutilate, remove, collect, or transplant plants classified as Pennsylvania Endangered or Pennsylvania Threatened..."

5. Certain Islands or portions of Islands may be designated as ecological resource protection areas and will be off limits to all unauthorized personnel.

CULTURAL RESOURCES

1. No digging of any type is allowed on any island except as authorized in writing by the Real Estate Department under paragraphs 2 and 3 of this section.

2. A Building License Application must be submitted to the Department prior to beginning any construction activity or removal of existing structures. This provision also applies to any repair work that requires excavation or the placing of fill on the islands.

3. Tenant is required to obtain the approval of the Pennsylvania Historical and Museum Commission for any new construction or repairs that will require subsurface soil disturbance.

4. Upper and Lower Bear (Bare) Islands are on the National Register of Archeologcial Sites. The disturbance of any archeological site (whether previously known or not) is a violation of federal law.

5. Certain Islands or portions of Islands may be designated as cultural resource protection areas and will be off limits to all unauthorized personnel.

EROSION CONTROL MEASURES

1. Tenant is responsible for correcting or controlling any erosion problems resulting from their use of the leased premises, even if the problem is not on the leased premises.

2. Non-structural erosion control measures should be utilized if sufficient to correct or control the problem. These measures include using vegetation and/or rip rap.

FOR INFORMATION OR QUESTIONS, CONTACT:

Real Estate Department
Philadelphia Electric Power Company
2301 Market Street
Philadelphia, PA 19101 (215) 841-6894

Conowingo Recreation Office & Visitors Center
P. O. Box 71
Conowingo, MD 21918 (301) 457-5011

TO REPORT VIOLATIONS OF STATE LAW:

PENNSYLVANIA FISH COMMISSION:
Jim Wagner (717) 786-4662

PENNSYLVANIA GAME COMMISSION:
Southeast Division Office 1 800-228-0791

PENNSYLVANIA STATE POLICE:
Lancaster (717) 367-4141

APPENDIX C. COTTAGE RULES AND REGULATIONS (PENNSYLVANIA AND MARYLAND)

RULES AND REGULATIONS – MARYLAND

I. GENERAL CONDITIONS

A. General Information

All questions and inquiries should be directed to:

Exelon Generation Company LLC (Landlord)
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road
Darlington, MD 21034
Telephone: 610-765-5200

B. General Conduct

1. Tenant shall use the leased premises ("Premises"), which is part of Landlord's Conowingo Hydroelectric Project ("Landlord's Property") as a vacation retreat and for recreational activities only. Tenant shall not use or occupy the Premises as a domicile, primary or permanent residence. Tenant shall not permit any person or persons to use or occupy the Premises as a domicile, primary or permanent residence. "Domicile" means the place at which a person has been physically present and that the person regards as home. "Residence" means the act or fact of living in a given place for a period of time with an intent to treat it as a home. TENANT MUST EXECUTE THE CABIN AFFIDAVIT ATTACHED TO THE LEASE. Landlord has the right to verify Tenant's primary address, including but not limited to requiring Tenant to provide acceptable proof of domicile and residence.

2. The predominant use and occupation of the Premises should be by the Tenant and the Tenant's family, not by guests or other occupants of the Tenant. Guests or other occupants of the Tenant must not stay, without the Tenant present, for longer than two weeks at a time.

3. All of the conduct required of the Tenant shall be required of Tenant's guests, and Tenant shall ensure that such guests adhere strictly to the Rules and Regulations and all Laws. Tenants are responsible for the actions of their guests and occupants.

4. Tenant shall not assign or otherwise transfer or encumber the lease of the Premises ("Lease") without the prior written consent of Landlord. Tenant may only assign or otherwise transfer the Lease to an individual person (not to exceed two). Any attempted transfers to a trust, corporation, partnership, limited liability company ("LLC"), or any other legal entity shall be null and void. See Section II D below. Tenant shall make all requests for Landlord's

consent to assignment in accordance with these Rules and Regulations. Any assignment without the prior written request of Landlord shall be null and void. This includes among family members. Tenant shall not enter into any type of arrangement with anyone else regarding the use and occupancy of the Premises, including but not limited to sub leases, “caretaking” or any other arrangement that exchanges money and/or services for the use and occupancy of the Premises.

5. Tenant shall not permit any noise or other nuisances to interfere with the quiet enjoyment of other Tenants’ use of their properties or with the use and operation of Landlord’s Property as determined by Landlord in its sole discretion. Landlord shall have the right to require that Tenant immediately cease and desist any such noise or other nuisance.

   Landlord has the right to permit or prohibit or adopt reasonable restrictions with respect to Tenants displaying flags, signs, banners, images or outside displays of any nature visible to the public on the exterior of the Premises or visible from outside of the Premises. Landlord shall also have the right to require that any Tenant immediately cease and desist displaying flags, signs, banners, images or outside displays of any nature visible to the public on the exterior of the Premises or visible from outside of the Premises that are offensive, obnoxious, indecent or seriously annoying or intolerable to members of the community as reasonably determined by Exelon. Notwithstanding the foregoing, Tenants may display the American Flag, the Maryland state flag, and flags of the United States Armed Forces, POW/MIA flags, and the flag of the Maryland National Guard.

6. Tenant shall not cause or allow un-permitted or uncontrolled fires. No open fires are permitted except in properly constructed barbecue pits and any burning must comply with all federal, state and local laws, rules, regulations and ordinances (“Laws”). No open burning of leaves or other vegetation debris is permitted.

7. Tenants and their guests are not permitted to park or store vehicles, boats or boat trailers overnight on Landlord’s property outside the Premises. Tenants and their guests are permitted to park a reasonable (in the sole determination of Landlord) number of vehicles, boats and boat trailers on the Premises, during periods of occupancy, as long as they have a current valid registration which is clearly visible.

8. Tenants are not allowed to park or store any type of construction or commercial vehicle, machinery, camper, trailer or RV on any Landlord property.

9. The use of any vehicles off road (including but not limited to trucks, ATVs, UTVs, motorcycles, etc.) on any Landlord property is prohibited.

10. Hunting and the use of firearms or other weapons is prohibited on all Landlord property.

11. Tenants are not permitted to accumulate possessions on the Premises that are not properly stored, and in no event store any debris, junk, etc. All storage sheds and other storage containers must be approved in writing by the Landlord per Section II B or will otherwise be required to be removed. The number of storage units and amount of personal property kept on the Premises will be limited to a reasonable amount (in the sole determination of Landlord). This includes firewood.

12. The six (6) digit Cottage Identification Number (CIN) which has been assigned to each Cottage must be placed on the outside wall of the cottage facing the water and also one facing the primary road/driveway/path that leads to the cottage entrance from the land, and must be clearly visible. If the cottage has been assigned an EMS (emergency services) address, that address (# and street name) must also be posted with the CIN. All posted characters must be at least 4 inches in height, treated with a reflective material and in a color contrasting with the sign background.

13. The six (6) digit Cottage Identification Number (CIN) must also be marked in at least 2-inch characters on all garages, sheds, large storage containers, docks, piers, car ports and any other large stand-alone structures and improvements.

14. All dogs must be kept securely tied or on a leash at all times. The number of dogs or cats at the Premises at any one time should be kept to a reasonable number (in the sole determination of Landlord), and not create a nuisance in any way including noise, aggressive behavior and the failure to immediately clean up after them. No other types of pets or animals are allowed without prior written Landlord permission.

15. Tenants are not permitted to use the Premises as a business location for the production or sale of goods and/or services nor engage in any commercial activities, including without limitation operating or leasing campgrounds or dock facilities.

16. Immediately upon discovery, Tenant must report any potentially hazardous condition to the Landlord and, as required by law, to the appropriate state and local authority or agency.

17. Tenant shall be responsible for the correction and/or control of any erosion caused by or resulting from improvements, and/or changes made to, or on the Premises. Landlord may require Tenant to rectify any erosion problems on or affecting the Premises. Landlord has no duty to Tenant to correct any naturally occurring erosion problems.

18. Tenants are not required to carry $1M of liability insurance, whether stated in their Lease agreement or not. Tenants should consult with their insurance agent and make their own decisions regarding what types and levels of insurance coverage are advisable. Landlord does not provide insurance coverage for the Tenants' interests. Landlord has obtained additional insurance that provides coverage only for Landlord's liability with respect to the cottage properties.

19. The use of fireworks or any explosives is prohibited on all Landlord property.

20. The Rules and Regulations contained herein are not intended to substitute for or absolve Tenant of his or her legal responsibility to comply with all applicable Laws. In a situation where the Rules and Regulations contained herein are in conflict with, or are less restrictive than, the applicable federal, state, or local Law, the more restrictive statute, rule, regulation, or ordinance shall apply.

II. IMPROVEMENTS

A. Definition of Improvements and Removal of Improvements

1. In these Rules and Regulations, "improvements" shall mean and include all dwellings, fixtures, utilities, outhouses, sheds, decks, porches, patios, buildings, roads, driveways, pathways, bridges, fences and Shoreline Improvements (defined in Section VII) and any other structures or material constructed by or placed on the Premises by the Tenant or any former tenant, whether or not said improvement is affixed in any manner to the land.

2. All improvements shall remain the personal property of the Tenant at all times and shall be removed by the Tenant upon the termination of the Tenant's Lease, unless Landlord has approved the transfer to a new tenant. Tenant is responsible for any and all costs incurred by Landlord should Landlord elect to remove Tenant's improvements after the termination of Tenant's Lease.

B. Construction and Demolition

1. WITH A FEW EXCEPTIONS AS NOTED IN THESE RULES, THERE WILL BE NO CONSTRUCTION PERMITTED WHICH ENLARGES THE SIZE OF THE EXISTING IMPROVEMENTS. Landlord is not responsible for constructing, maintaining, repairing, replacing, re-constructing or demolishing Tenant's improvements.

2. Should Tenant wish to perform construction, to demolish an existing improvement, or to renovate, alter or replace an existing improvement in any manner ("construction"), a Construction Application must be submitted

to the Landlord (with all appropriate attachments) REGARDLESS OF WHETHER ANY OTHER AGENCY OR ORGANIZATION REQUIRES PERMITTING OR APPROVAL. The Construction Application must be submitted to the Landlord prior to applying for any applicable permits or beginning any construction. All expenses incurred by Tenant related to such construction or demolition, including Landlord's consent, shall be the sole responsibility and risk of Tenant. No Construction nor permit activities should begin until the Tenant receives formal written permission from the Landlord.

3. Construction Applications must contain a detailed plan and drawing including but not limited to: materials to be used, methods of construction, a site map with project location, project drawings with dimensions covering at least two sides or cross-sectional views, photos of the existing project location and a list of required permits/permissions and the agencies requiring them. Tenant is responsible for determining which Laws apply to their proposed construction or demolition activities and to contact the applicable government or agency as required by said Laws. See Attachment 1 for the Construction Application.

4. No construction shall be permitted that expands beyond the size of the existing improvements, except as permitted under Rules II 5 and 6 below, provided however, approval of construction is at the sole discretion of Landlord.

5. A new deck may be approved if all of the following conditions are met:

    a. A complete Construction Application must be submitted and approved.
    b. Any new deck plan plus any existing decks, patios, porches or the equivalent cannot exceed a total of 200 square feet.
    c. Any new deck must be constructed with pressure treated lumber or a manufactured equivalent.
    d. Deck plans must be kept basic, cannot be covered and must meet all code requirements including proper railings.All required permits must be obtained, after receiving written Landlord permission to proceed with permitting

6. A new shed may be approved if all of the following are met:

    a. A complete Construction Application must be submitted and approved
    b. Any new shed plan plus any existing sheds, outbuildings or equivalent cannot exceed a total of 150 square feet at the most, and Exelon reserves the right to limit a new shed to a smaller size.
    c. Sheds will not be permitted to have concrete foundations.
    d. All required permits must be obtained, after receiving written Landlord permission to proceed with permitting

7. If a cottage is fifty percent (50%) or more destroyed by fire, flood or other casualty, as determined by Landlord, Tenant will not be permitted to rebuild and the Lease will be terminated.

8. Tenant must be in compliance with the terms of the Lease, including but not limited to being current with any Rent or other sums due and payable, prior to submitting a Construction Application.

9. Construction Applications will be subject to written approval of Landlord. Landlord may approve or deny a Construction Application in its sole discretion. If the Construction Application is acceptable to Landlord, Landlord shall issue to Tenant a preliminary approval in writing. If the Construction Application is denied, Landlord will give Tenant written notice of such denial.

10. Within ninety (90) days after Landlord's preliminary approval of the Construction Application and prior to beginning any work, Tenant must obtain all permits and licenses required by all Laws ("applicable permits") and provide copies of all such permits and licenses to Landlord.

11. Upon receipt of the applicable permits and licenses for the work approved by Landlord, Landlord shall issue written final approval of the Construction Application to the Tenant.

12. The final approval issued by Landlord expires one (1) year from the date of issuance. If the approved construction is not completed on or before the expiration date, the Tenant must resubmit a Construction Application to the Landlord and if preliminary approval is granted, renew any expired permits.

13. Landlord's approval of the Construction Application is contingent upon Tenant's compliance with setback requirements and all other applicable Laws and regulations.

14. Within thirty (30) days of completion of the approved construction, Tenant must submit photographs of the completed work to Landlord along with copies of any inspection reports received from any agency.

15. Tenant must notify Landlord in writing at the completion of any Landlord approved and permitted demolition or removal of improvements. Within ninety (90) days after the improvement is razed or removed, the area must be restored to a condition satisfactory to Landlord, including but not limited to establishing the appropriate vegetative cover.

16. Note that these Construction requirements cover the addition of or any significant changes to all utilities and major systems including but not limited to electrical/power, water supply and plumbing, sanitary, HVAC, fireplaces and any gas/oil/fuel related items.

17. Landlord may approve or reject requests for new construction at its sole discretion, including when required to ensure structural integrity, environmental protection and safe occupation of the Premises.

C. Maintenance

1. Tenant must maintain the Premises and all improvements thereon in good repair and appearance at all times. Should Landlord determine that the Premises is not in a state of good repair and appearance, Landlord may require Tenant to perform all reasonable and necessary repairs and maintenance, including but not limited to painting and removal of any and all junk, trash, debris, or other items determined by Landlord to constitute a nuisance.

2. Prior to performing any maintenance, consult Section II B in order to determine whether the activity would actually be considered Construction and require approval.

3. Improvements shall not present a hazard to the health or safety of any Tenant or other persons or property or to the environment or be in violation of any codes, Laws or requirement of any agency.

4. Landlord may require Tenant to correct, at Tenant's sole expense, any conditions that Landlord determines to be potentially hazardous, harmful to the environment, or in violation of these Rules and Regulations.

5. All chimneys must be fireproof and constructed of tile, brick, stone, or other approved material, equipped with spark arresters, and must otherwise comply with all applicable code specifications.

6. Tenant must install and maintain in good working condition at least one smoke detector in each dwelling on the Premises. All rooms used for sleeping must also contain a smoke detector and have code appropriate windows/egress.

D. Sale of Improvements, Lease Transfer Application and Changes to Tenants on Existing Leases

1. Tenant may not transfer Tenant's interest in the Lease without the prior written approval of Landlord. Tenant and the proposed Buyer shall submit at the same time a complete Lease Transfer Application to Landlord with all required attachments. Lease Transfer Applications must include a copy of each Buyer(s)'s Driver's license, a copy of the Agreement of Sale for the improvements, payment of applicable fees, a completed Water and Sanitary sign-off form, and all final inspection reports as noted herein. Regardless of whether required by the local municipality or not, a code compliance

inspection report without exceptions (for building, sanitary or others as required) must be submitted with the application. In certain municipalities this may take the form of a use & occupancy certificate. In all cases Tenant must also arrange to have a licensed(MD) / certified(PA) inspector perform a building, electrical, water and sanitary inspection of the Premises to ensure compliance with all Laws. Tenant will be required to correct all exceptions and have the inspector issue a revised report prior to submitting the Lease Transfer Application. See Attachment 2 for the Lease Transfer Application. Contact the Cottage Program Manager for additional guidance on submitting a Lease Transfer Application as requirements change. Incomplete application packages will not be reviewed. If the transfer is approved, Landlord will require the Buyer to enter into a new Lease of the Premises substantially in the form as Attachment 3. Tenant must be in compliance with the terms of the Tenant's Lease, including but not limited to being current in the payment of Rent or other sums due and payable, prior to submitting a Lease Transfer Application. Landlord reserves the right to deny the Lease Transfer Application in its sole discretion. Landlord will commence review of the Application only when all requirements for the Application are complete and submitted and will target to complete the review within forty-five (45) days (but may take longer). Landlord's review and approval of the transfer does not provide any representation or warranty to Tenant nor Buyer regarding the condition of the improvements nor the existence of all permissions and permits that may have been required for those improvements. Landlord reserves the right to demand in the future that any improvements that were installed without Landlord permission or proper permitting be removed at any time.

2. If the Lease Transfer Application is approved, Landlord shall issue an approval letter and a new Lease Agreement, which shall be properly executed by the proposed Buyer at settlement and returned to Landlord for Landlord's execution, along with a copy of a valid Bill of Sale for the improvements. Landlord will then forward to the new Tenant a fully signed copy of the new Lease Agreement.

3. If the Lease Transfer Application is denied, Landlord will give Tenant written notice of the denial.

4. All Sales Agreements and Bills of Sale for the improvements must contain this statement: "Only the Tenant's improvements are being sold and neither land, nor water rights are included in the sale. The Landlord has no responsibility for providing, maintaining or improving access to the leased premises."

5. Installment Sales or Lease Purchase Agreements that are intended to give possession of the cottage to the Buyer while the current Tenant (seller) holds the existing Lease are not permitted.

6. Proposed transfers to remove or add a co-tenant or among family members shall be subject to Landlord's approval in accordance with all of the procedures in this Section II (D), including the Lease Transfer Application. In the event of divorce between co-tenants, Landlord will require a copy of the divorce decree documenting the disposition of cottage ownership.

7. The number of Tenant parties on a Lease will be limited to two (2) and in no case will Landlord permit a Tenant to be a trust, corporation, partnership, LLC, trust or any other legal entity.

8. The parties to the Lease must be the same as the owners of the improvements.

9. In the event of the death of a Tenant, Landlord must be provided a copy of the death certificate. If there is no surviving spouse, Landlord must also be provided a copy of the Tenant's Last Will and Testament. LEASE AGREEMENTS DO NOT AUTOMATICALLY PASS FROM THE TENANT TO THEIR HEIRS. The heirs will need to go through Landlord's lease transfer process seeking approval. When performing estate planning, families should keep in mind that only the legal owner(s) of the cottage can be a Tenant on the lease and the number of Tenants per lease is limited to two (2).

10. Tenant shall not engage in any false or misleading communications associated with the Lease and the improvements. The existence of the Lease must be clearly disclosed to any prospective buyer of the improvements.

III. ROADS, BRIDGES AND ACCESS

A. Construction or Alteration of Roads, Driveways and Bridges

1. Written permission is required from Landlord for the construction or alteration of roads, driveways, or bridges in accordance with the procedures set forth in Section II (B) above. A survey and/or drawing showing the location of the road, driveway or bridge must accompany the Construction Application submitted to Landlord.

2. In addition to obtaining written permission from the Landlord, Tenant must obtain all federal, state and local permits, where required, before constructing or altering any road, driveway or bridge.

B. Maintenance

1. Tenant must maintain roads, driveways or bridges on the Premises in good condition, and provide proper drainage in accordance with Landlord's specifications.

2. Tenant is responsible for its proportionate share of the cost of maintenance and general upkeep of non-public roads and bridges used in common with other cottage owners.

3. Tenant is prohibited from blocking or otherwise limiting access to any roads, driveways or bridges located on the Premises or any other property owned by Landlord.

4. Should Tenant fail to perform its maintenance obligations under these Rules and Regulations, Landlord, after notice to Tenant, may in its sole discretion, (i) perform such maintenance and charge Tenant for its share of the cost, or (ii) prohibit the use of the road, driveway or bridge in need of repair. Landlord shall have no obligation to repair or maintain such roads, driveways or bridges.

C. Access

1. Landlord has no responsibility for providing, maintaining or improving access to the Premises. Egress and ingress as currently practiced is not guaranteed and could be altered at any time by Landlord.

2. Landlord may grant easements (the right to use parts of the Land) over any part of the Land to others for any purpose, such as (a) roads and/or highways; (b) utility lines, either underground or overhead.

3. Tenants are prohibited from posting any signs or making any other communications regarding No Trespassing or any other restrictions to accessing and using Landlord property. Tenants are prohibited from blocking access to any Landlord property.

IV. TREES & PLANTS

1. No trees or ornamental shrubs shall be injured or damaged, by Tenants or their guests. The attaching of lights, electric lines, clotheslines, docks, or any other item to any tree or shrub, either on a temporary or permanent basis, is prohibited. Care must be taken during any construction activities to prevent injuring trees or ornamental shrubs, and if necessary, temporary protective shields shall be installed around the trees or shrubs.

2. Tenant shall not remove any tree or shrub over two (2) inches in diameter without prior written permission of Landlord. If a tenant desires to trim, cut or remove significant portions of a tree, they must first obtain written permission from Landlord. If Tenant removes any tree or shrub in violation of the Rules, Tenant shall be subject to the fees in Section VIII and lease termination. If Tenant determines that a tree is an immediate safety hazard, Tenant should vacate the Premises and address it immediately by contacting Landlord for approval to remove the tree.

3. Tenant is responsible for correcting hazardous tree conditions on or adjoining the Premises. Landlord may notify in writing the Tenant of any trees that Landlord believes should be removed. It will be the responsibility of the Tenant to have such trees removed. If such trees are not removed within the specified time period, Landlord at its option may terminate the Tenant's Lease and/or remove the tree at the Tenant's expense.

4. Tenant shall not introduce or maintain any invasive plant species or noxious weeds (including bamboo) onto the Premises, on any of Landlord's properties, or within or upon any waters of the State and is responsible for removing any such growth from the Premises.

5. Tenant shall not plant anything that will grow above 6 ft. in height without the Landlord's prior written permission. Any planting and landscaping by the Tenant shall be limited to a reasonable amount (in the sole determination of Landlord) and done strictly within the Premises.

V. WATER

1. All Premises must be served by an approved potable water source, which could include a permitted well or bottled water.

2. Tenant must obtain written permission from Landlord and all applicable permits for existing or future wells prior to use. Wells may be shared by no more than 4 cottages, with a total maximum occupancy of 24 persons. All unpermitted or prohibited wells must be abandoned in accordance with applicable Laws.

3. The use of river, creek or spring water for human consumption is prohibited and such water sources may not be attached to pressurized plumbing. Human consumption includes drinking, bathing or showering, cooking, dish washing and oral hygiene.

4. River, creek or spring water may be used for purposes other than human consumption, provided it is not attached to pressurized plumbing and that Tenant obtains all applicable permits prior to its use.

5. Tenant shall take all reasonable measures to limit the use of water. Accordingly, swimming pools, hot tubs and spas, whether above or below ground, temporary or permanent, are prohibited.

6. All use of water by Tenant, in and about the Premises, shall be at the sole risk of Tenant. Landlord has not performed any water potability tests and makes no representations with regard to the suitability of the water for domestic purposes. Tenant is responsible for performing any applicable potability testing or other water analysis and permitting. All costs incurred in

connection with such testing and permitting shall be the responsibility of the Tenant. Landlord assumes no liability for, or on account of, any water used in any manner by Tenant or Tenant's guests.

7. No exclusive rights are given or inferred as being given as to the use of any water or spring, even though a spring may be located on the Premises.

8. Construction or drilling of a new well or other water source is subject to the prior approval of Landlord in accordance with the procedures set forth in Section II (B) above, including without limitation the obligation to obtain applicable permits prior to construction.

VI. SANITARY SYSTEM REQUIREMENTS

1. All Premises must be served by an approved sanitary system, which may be a septic system, holding tank, sealed pit privy, incinerator toilet, composting toilet or chemical toilet (temporary only) ("Sanitary System"). Before beginning the construction, installation or alteration of any Sanitary System, Tenant shall comply with the procedures set forth in Section II (B) above, including the obligation to obtain written permission from Landlord and all applicable permits.

2. In the event an approved and permitted Sanitary System does not exist on the Premises, Tenant must provide the site with a Sanitary System in compliance with all applicable Laws and these Rules and Regulations. No Sanitary System shall be located closer than one hundred (100) feet of any spring, stream, or other water supply source (except as otherwise permitted by applicable Laws).

3. Subject to Landlord's prior approval, sealed pit privies, holding tanks, composting toilets, incinerator toilets and chemical toilets are permitted. Tenant must enter into a written maintenance agreement with Landlord and with the applicable agency if required and obtain all applicable permits prior to installing such systems.

4. Gray water must be collected and disposed of in an approved, permitted wastewater disposal system. Tenant must enter into a written maintenance agreement with Landlord and with the applicable agency if required and obtain all applicable permits prior to installing such systems.

5. In the event a public sanitary sewer system is installed in the area, Tenant shall be required to connect into the system, whereupon Tenant shall be responsible for all connection, maintenance, and operation fees or costs.

6. All garbage, trash or refuse must be removed from the Premises every seven (7) days. In the interim, all garbage, trash and refuse must be kept in a closed container intended for the temporary storage of garbage, trash or

refuse secure from flies, rats or other insect or animal intrusion and maintained in a good and sanitary condition in compliance with applicable Laws.

7. All Sanitary Systems and gray water systems must be maintained at all times in good working order and sanitary condition and in compliance with all applicable Laws and any applicable holding tank agreement or sealed pit privy agreement. Tenant shall be responsible for the annual winterization of all water source, sanitary, and gray water systems. TENANT MAY BE REQUIRED TO PROVIDE LANDLORD WITH A FORM OF CERTIFICATION ACCEPTABLE TO LANDLORD THAT ALL SANITARY AND GRAY WATER SYSTEMS ARE IN GOOD WORKING ORDER IN ACCORDANCE WITH APPLICABLE LAWS, AND THAT TENANT IS NOT IN DEFAULT UNDER ANY SEWAGE PUMPING AGREEMENT OR HOLDING TANK AGREEMENT. TENANT MAY ALSO BE REQUIRED TO PROVIDE LANDLORD WITH THE MOST RECENT PUMPING RECEIPT.

8. Please note that although Water and Sanitary regulations differ among the various municipalities, Exelon reserves its rights under the Lease to require Tenants to adhere to more stringent standards. In addition, Federal, State and Local regulations are subject to change at any time. Please make sure you review Sections V and VI of the Rules and are aware of the standards to which you are subject. In any circumstance, any violation of Federal, State or Local regulations or Exelon Rules that create a health or environmental issue, will be considered a default of your Lease. It is your responsibility to ensure that all Water and Sanitary systems are functioning properly, inspected and serviced regularly, and that you satisfy all State and Local reporting requirements.

VII. SHORELINE PROTECTION PROGRAM

A. Application Procedures

1. The “shoreline” is considered to be the existing shoreline at mean high water.

2. All applicable Construction rules in Section II apply to the Shoreline. Prior to the construction or repair of a pier, dock, boathouse, boat ramp, marine railway, bulkhead, retaining wall or erosion control measures or excavation in any areas that may affect the shoreline (“Shoreline Improvements”), Tenant, must submit a Construction Application to Landlord in accordance with Section II (B) of these Rules and Regulations. Landlord will make an on-site inspection of the area to determine if what the applicant has proposed should be allowed or if another type of measure may be more appropriate. Landlord may deny any Construction Application in its sole discretion. Other than routine maintenance of existing Shoreline Improvements and new erosion control measures with the prior written consent of Landlord, construction of Shoreline Improvements outside of the applicant’s Premises is not permitted.

No construction may begin until the Tenant has received Landlord's written Approval and obtained all required local, state and federal permits and authorizations, including but not limited to all permits required by the applicable state agencies (Maryland Department of the Environment – MDE or Pennsylvania Department of Environmental Protection – PaDEP), and the U.S. Army Corps of Engineers.

B. Specifications and Procedures

In addition to the applicable Laws and all requirements set forth by the applicable permitting authorities, the following specifications shall apply. Should any specification herein conflict with any applicable local, state, or federal Law or regulation, the most restrictive requirement shall apply

1. Piers or Docks

a. All new or replacement piers or docks must be a temporary, floating construction and may not exceed a total length of fifty (50) feet (or extend more than fifty (50) feet from the shoreline). If the pier is located in a cove or in a stream, the length may not exceed 25% (1/4) of the width of the cove or stream where the pier is located. Floating piers/docks must be removed from the water annually from November 15 to March 15 and securely stored above the high-water line.

b. Flotation devices for floating piers must be constructed of environmentally sound material as approved by Landlord and permitting authorities. Barrels or similar flotation devices are not permitted.

c. Piers may not interfere with navigation, present a safety hazard, or block ingress or egress to adjoining areas.

d. If an existing pier must be replaced or repaired (other than minor repairs), it must conform to current standards.

e. Piers may not be anchored or tied to trees at any time.

2. Boat Ramps and Marine Railways

a. New boat ramps and entry paths into the water will not be permitted. Repairs or reconstruction of existing ramps must be constructed of stone and/or wood. Asphalt or other petroleum-based products are prohibited.

b. Ramps may not exceed fifteen (15) feet in width and thirty (30) feet in length. The length should not exceed that necessary to be functional.

c. Marine railways may use treated wood.

d. Marine railways may not exceed fifteen (15) feet in width and should be no longer than necessary to be functional. Landlord may, however, restrict the length because of site conditions.

3. Erosion Control Measures (Bulkheads, Retaining Walls, Sea Walls, Rip Rap, etc.)

a. No erosion control measure shall significantly alter the existing shoreline.

b. The planting of native species vegetative cover and/or rip-rapping shall be used if adequate to control the problem.

c. Erosion control measures, including bulkheads, retaining walls and rip rap, may not be installed or replaced without the prior written approval of Landlord.

d. The structure shall not significantly detract from the scenic value of the area. Landlord will typically prefer plans consisting of wood and/or stone but not the use of concrete.

C. Landlord assumes no liability for injury or damage in the construction, use or removal of any Shoreline Improvement made by the current or any former Tenant.

VIII. COMPLIANCE; AMENDMENTS

In the event of Tenant's failure to comply with these Rules and Regulations and Laws, Landlord may impose a fee on Tenant of up to $250 per day until such failure is cured and/or terminate Tenant's Lease in accordance with its terms. Landlord may also impose fixed fees of up to $2,500 for non-compliance issues and/or terminate Tenant's Lease in accordance with its terms. Landlord shall have the right to amend these Rules and Regulations at any time as Landlord deems necessary.

IX. CULTURAL RESOURCE PROTECTION GUIDELINES

Landlord has developed, in cooperation with the Pennsylvania Bureau of Historic Preservation and the Maryland Geological Survey, Division of Archeology, the following rules and regulations. The specific intent of these guidelines is to provide for the protection of cultural resources, and to avoid any disturbance of historic and prehistoric

sites except when justified for scientific purposes and/or when performed in accordance with such State and Federal regulations and guidelines as may apply.

A. No one shall mar, deface, remove, destroy or in any other way damage, any standing structure, ruins, foundation or other man-made feature of a potentially historic nature on lands of Landlord, without first having obtained the written permission of Landlord.

B. No one shall perform any sub-surface archaeological investigations, or in any way disturb the soil for the purpose of searching for and/or obtaining historic or prehistoric artifacts on land of Landlord without having first obtained the written permission of Landlord, nor shall same be performed without the prior knowledge and written sanction of the following:

In Maryland: The State Historic Preservation Officer and/or the Geological Survey, Division of Archeology

C. Full and complete reports must be prepared. Said reports shall incorporate maps, site profiles, descriptions and photographs of artifacts and features, soil descriptions, topography, excavation procedures, directions and distance to the nearest water and all such other related details as may be required.

D. Landlord shall be supplied with a copy of each report so generated. The appropriate State agency shall be supplied with two copies of same, one of which shall contain original photographs.

E. All artifacts and related material recovered in sub-surface investigations shall become the property of Landlord and shall be turned over to the respective State agency. Same shall remain available to Landlord and other responsible public and private organizations and agencies for the purpose of study and/or public display.

F. All artifacts must be properly labeled with site number and lot and must be readily identifiable by pit and level. Site numbers must conform to the trinomial numbering system adopted by both Pennsylvania and Maryland.

G. All burials encountered during the course of such archeological investigations shall be treated with the highest respect and shall be handled on a case by case basis under the strict control of the State agency having jurisdiction. It is the policy of said agencies and of Landlord, to discourage the removal or disturbance of human remains, unless there is a significant scientific purpose to be served by same, and unless provisions are made, in consultation with, and with the approval of living descendants of the interred, for the timely study and the ultimate reburial of the remains.

H. While the collection of artifacts from the surface is widespread, and though not strictly prohibited under these regulations, it does have a significantly negative

effect on archeological sites. The distribution of surface artifacts is the only information available for many sites. Those finding artifacts are therefore encouraged to report finds to Landlord so that same might be photographed and recorded.

I. Tenant is required to consult with the appropriate State Preservation Office prior to any construction work that may affect surface or sub-surface archaeological sites, and prior to new additions to existing structures or the construction of new structures.

J. On property which is within the boundaries of Federally-regulated projects such as the Conowingo Hydro-Electric Project (F.E.R.C. No. 405), Tenants' properties require additional precautions regarding cultural resources under the provisions of the National Historic Preservation Act of 1978 (section 106), Executive Order 11593, and the regulations of the Advisory Council on Historic Preservation (36 CFR 800).

X. CONTACT INFORMATION

1. Tenant Contact Information – for all changes to Tenant contact information including primary mailing address, phone numbers and email addresses, Tenant must complete Tenant Information form (see Attachment 4) and return to Landlord at the time of the change. Tenant Information form must be signed by all Tenants who had signed the Lease agreement. Failure to update Landlord as to changes in contact information that result in Landlord's inability to contact Tenant will prompt Landlord to terminate the Lease upon the next annual expiration date.

DISCLAIMER: The following list is intended as a reference to the Tenant for contacting the municipalities or agencies that may require permits or approvals for specified construction activities. The list is not intended to be an exclusive list and Landlord makes no guarantees or warranties as to the accuracy of the information contained herein below. Tenant is responsible for determining which federal, state, and/or local Laws apply to their proposed use, occupancy and construction activities and to contact the applicable government or agency as required by said Laws.

Maryland

River Basin Permit Section
Baltimore District
U.S. Army Corps of Engineers
P.O. Box 1715
Baltimore, MD 21203

Water Resources Administration
Maryland Department of Natural Resources
Tawes State Office Building
Annapolis, MD 21401

State Administrator of Archeology
Maryland Historical Trust
Shaw House
21 State Circle
Annapolis, MD 21401

Department of Planning and Zoning
Harford County, Maryland
220 S. Main Street
Bel Air, MD 21014

Office of Planning and Economic Development
Cecil County, Maryland
Room 300, Court House
Elkton, MD 21921

Department of Inspections, Licenses and Permits
Harford County, Maryland
220 S. Main Street
Bel Air, MD 21014
410.638.3344
http://www.harfordcountymd.gov/dilp/

Cecil County Dept of Permits & Inspections
200 Chesapeake Blvd., Suite 2200
Elkton, MD. 21921
Office: 410.996.5235
http://www.ccgov.org/dept_permits/

Port Deposit
64 South Main Street
Port Deposit, MD 21904
Administration: 410-378-2121

ATTACHMENT 1 – page 1 of 2

CONSTRUCTION APPLICATION

Tenant Information **Application Date:** _____

Name:_____ Cottage ID Number (C.I.N.) _____
Address:_____
City:_____ State:_____ Zip:_____
Home Phone:_____ Cell/Other Phone(s):_____
Email(s): _____

Authorization Requested For (check appropriate items)

Addition to Cottage _____ Deck/Patio _____ Boat Ramp _____
Shed/Outbuilding _____ Well _____ Sidewalk/Pathway _____
Fence _____ Sanitary _____ Landscaping/Plantings _____
Parking Area _____ Pier/Dock _____ Utilities/Major Systems _____
Bulkhead/Walls _____ Road/Bridge _____
New Construction (specify) _____
Removal or demolition of _____
Other (specify) _____

Procedure (see section II B of the current Rules & Regulations for additional guidelines & requirements)

1) Tenant must adhere to all requirements as contained in the Lease and the current Cottage Rules and Regulations document and obtain written preliminary approval from Exelon prior to applying for local, state or federal building permits.
2) This application must include with it a sufficient plan and drawing including but not limited to: materials to be used, methods of construction, a site map with project location, project drawings with dimensions (if applicable), photos of the existing project location and a list of all required permits/permissions and the agencies requiring them.
3) Exelon shall give Tenant written notice of preliminary approval or denial within 45 days of the receipt of all necessary and complete application documents. Incomplete packages will not be reviewed.
4) Within 90 days after receipt of the preliminary approval, Tenant must submit to Exelon copies of all permits issued by the appropriate local, state or federal authorities. Exelon will provide a final written approval or denial within 15 days of receiving all necessary permits.
5) **No work can be started until all necessary permits have been received AND Exelon issues its final written approval of this application.**
6) Failure to comply with this procedure may result in fees and/or termination of the Tenant's Lease in accordance with the Rules and Regulations. Exelon reserves the right to deny this application in Exelon's sole discretion.

Preparation Fee: Please submit a check in the amount of $50.00 with this application made payable to: Exelon Generation Company, LLC.

NOTE: COLLECTION/CASHING OF FEE/CHECK DOES NOT CONSTITUTE PROJECT APPROVAL

Please submit this application to:

Exelon Generation
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road
Darlington, MD 21034

PLEASE DIRECT QUESTIONS TO (610) 765-5200 (Cottage Program Manager)

ATTACHMENT 1 – page 2 of 2

CONSTRUCTION APPLICATION

Failure to comply with this procedure may result in denial of the application and/or termination of the Tenant's Lease in accordance with the Rules and Regulations.

PLEASE DIRECT ALL QUESTIONS TO (610) 765-5200 (Cottage Program Manager).

Note that all Tenants listed on the existing Lease, must sign below

CURRENT TENANT(S):

_____
Signature

_____
Print Name

_____
Signature

_____
Print Name

EXELON USE ONLY

Reviewed (I) _____ APPROVED _____ _____
(F) _____ DATE
Fee Rec'd (C) _____

ATTACHMENT 2 – page 1 of 3

LEASE TRANSFER / CHANGE APPLICATION

This application must be submitted to Exelon Generation Company, LLC with all required and complete documentation. Contact the Exelon Cottage Program Manager for additional lease transfer guidelines as requirements change. Incomplete application packages will not be reviewed..

CURRENT TENANT(S) INFORMATION **APPLICATION DATE:** _____

Name: _____ Cottage ID Number (CIN): _____

Name: _____ Cottage Address: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone(s): _____ Email(s):_____

NEW TENANT(S) INFORMATION – all fields required
Name(s) (as should appear on Lease): Tenant 1: _____

Tenant 2: _____

How is Tenant 2 related to Tenant 1(Spouse/Parent/Child/Sibling/Other):_____

Address: _____

City: _____ State: _____ Zip: _____

Home Phone: _____ Cell Phone(s): _____

Email Address(es): _____

EST. SETTLEMENT DATE: _____ **PURCHASE PRICE:** _____

Please submit this Request to: **Exelon Generation**
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road
Darlington, MD 21034

Procedure (see section II D of the current Rules and Regulations for additional guidelines and requirements)

NOTE: COLLECTION/CASHING OF FEE/CHECK DOES NOT CONSTITUTE LEASE TRANSFER APPROVAL

TO BE SUBMITTED WITH THIS APPLICATION:

1. The Lease Transfer Requirements Checklist (see page 3 of 3 for additional requirements)
2. An application fee in the amount of $250 by check made payable to Exelon Generation Company, LLC.
3. A clean inspection report from a licensed(MD) or certified(PA) inspector. Inspection should cover building, electrical, water and sanitary of the Premises to ensure compliance with local, state and federal codes/laws.
4. Copy of the Agreement of Sale for the Tenant improvements ("Improvements"). Agreement of Sale must include: "Only the Tenant's improvements are being sold and neither land, nor water rights are included in the sale. The Landlord has no responsibility for providing, maintaining or improving access to the leased premises."
5. Copy the Buyer(s)'s driver's license.
6. The completed Water and Sanitary Sign Off form.
7. Contact the Exelon Cottage Program Manager for additional application requirements as they do change.
8. **NO SALE should be finalized until you have Exelon's final written approval to proceed with closing.**

ATTACHMENT 2 – page 2 of 3

LEASE TRANSFER / CHANGE APPLICATION

TO BE SUBMITTED AFTER EXELON PRELIMINARY WRITTEN APPROVAL AND SETTLEMENT:

Within ten (10) days after settlement, the following must be submitted:

1. A "Bill of Sale" for the improvements signed by both parties. **NOTE: The New Tenant(s) on the Lease must be the same as the Buyers who have signed the Bill of Sale.** Bill of Sale must include the following: “Only the Tenant’s improvements are being sold and neither land, nor water rights are included in the sale. The Landlord has no responsibility for providing, maintaining or improving access to the leased premises.”
2. A new Lease Agreement (provided by Exelon at time of preliminary approval) signed by the new tenant(s).
3. All other documents that may be required as a result of Exelon’s preliminary approval.

Exelon reserves the right to deny this application if the Lease is in default or in Exelon’s sole discretion.

Failure to comply with this procedure may result in denial of the application and/or termination of the Tenant’s Lease in accordance with the Rules and Regulations.

PLEASE DIRECT ALL QUESTIONS TO (610) 765-5200 (Cottage Program Manager).

Note that all Tenants listed on the existing and future Leases, must sign below

CURRENT TENANT(S):	**NEW TENANT(S):**
_____	_____
Signature	**Signature**
_____	_____
Print Name	**Print Name**
_____	_____
Signature	**Signature**
_____	_____
Print Name	**Print Name**

EXELON USE ONLY

Fee received: _____ Date: _____
Approved: _____ Date: _____
File No.: _____

ATTACHMENT 2 – page 3 of 3

Lease Transfer Requirements Checklist Cottage Identification #:_____

This Form MUST be submitted as the cover page to your Lease Transfer Application package

All documents, in the required condition and with no errors or discrepancies, must be submitted at the same time with this checklist. Exelon will not accept documents if they are submitted at different times. This will delay the lease transfer review significantly.

Your lease transfer application package must include:

1) This **Lease Transfer Requirements Checklist** [ ]
2) The **Lease Transfer Application** including signature page [ ]
3) Copy of Drivers Licenses for all Buyers [ ]
4) Signed **Water and Sanitary Compliance Sign Off** form [ ]
5) **Agreement of Sale** with all of the following: [ ]
    a. Sales price
    b. Exelon six-digit Cottage Identification Number (CIN)
    c. EMS address of cottage (incl. Municipality/County/State)
    d. All Buyer and Seller Names and Signatures
    e. This exact wording: "Only the Tenant's improvements are being sold and neither land, nor water rights are included in the sale. The Landlord has no responsibility for providing, maintaining or improving access to the leased premises."
6) A **Well License** between Exelon and the current Tenant [ ] or N/A
    a. If there is a well on site and a license hasn't already been completed
7) The last **Septic Pumping Receipt** [ ] or N/A
    a. If not applicable, explain: _____
8) A third-party **Inspection Report** with no exceptions, within last 12 months [ ]
    a. Exceptions must be cleared and all photos and references regarding exceptions removed from the report to avoid confusion. NOTE that any work to clear exceptions that is considered Construction under the Exelon Rules and Regulations must be approved by Exelon in writing prior to starting.
    b. Report must clearly document the current condition and systems regarding the water source and sanitary/septic disposal and state that they "are in good working order and in compliance with applicable laws".
9) **Municipal Inspection Reports** with no exceptions, for PA cottages [ ] or Md
    a. Township will issue either:
        i. Separate Building/Zoning and Sewage reports
        ii. Or a passing building/zoning and sanitary inspections will be evidenced by a Certificate of Use and Occupancy (ie Drumore)

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ATTACHMENT 3 – Example Form of the Current Lease

THIS LEASE IS NOT TRANSFERABLE WITHOUT THE PRIOR WRITTEN APPROVAL OF LANDLORD

LEASE - Md

THIS LEASE AGREEMENT (this "Lease") is made this XXXXX day of XXXXXXXXXXXXXXXXXX, 20XXXXX (the "Effective Date"), by and between Exelon Generation Company, LLC ("Landlord") and XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX ("Tenant"). Tenant's liability shall be joint and several if Tenant is more than one party.

BACKGROUND

A. Landlord, as successor by merger to PECO Energy Power Company, is the owner of a parcel of land located in XXXXXXXXXXXX County, Maryland, identified as Lot No. XXXXXXXX, as outlined in red on the plan attached to this Lease as **Exhibit A** (the "Land").

B. Landlord and Tenant, intending to be legally bound hereby, intend to enter into a lease of the Land on the following terms and conditions.

1. Term. Unless sooner terminated in accordance with the terms of this Lease, Landlord agrees to lease the Land to Tenant for a term beginning on the Effective Date and ending on September 30th of the calendar year following the Effective Date (the "Term"). Thereafter, this Lease shall continue upon the same terms and conditions, subject to the adjustment of Rent in accordance with Paragraph 2 hereof, from year to year until terminated by either party by written notice at least thirty (30) days prior to the expiration of the then current term.

2. Payment of Rent. Tenant agrees to pay to Landlord annual rent in the amount of $XXXXXXXXXX ("Rent") on the first day of September. Tenant will send or deliver the Rent to Exelon Generation Company, LLC, 1310 Point Street, 18th Floor, Baltimore, MD, 21231, Attn: Real Estate & Facilities, unless Landlord notifies Tenant in writing that the Rent should be sent or delivered to another address. Except as otherwise provided herein, Landlord is not required to send Tenant a bill for the Rent, and the lack of a bill does not mean that Tenant is not required to pay Rent on or before the date set forth above. The Rent shall increase annually by the amount of three percent (3%), including the Rent which will be due on the September 1st following the Effective Date. Tenant shall pay to Landlord the adjusted Rent within five (5) days after receipt of a bill from Landlord for the adjusted Rent amount. Landlord reserves the right to charge Tenant as additional rent Landlord's costs arising out of this Lease, including without limitation the cost of enforcing the provisions of this Lease.

3. Late Charge. Tenant must pay the Rent by the first day of each September. If the Rent is not received by Landlord within ten (10) days after the Rent is due, Tenant must pay an additional charge equal to five percent (5%) of the overdue Rent.

4. Condition of Land. Tenant has inspected the Land before signing this Lease. Tenant accepts the Land "AS IS" on the day Tenant signs this Lease. Landlord has made no promises or representations to Tenant concerning the condition of the Land.

5. Maintenance and Repair; Ownership of Tenant's Improvements. Tenant owns and is solely responsible for all improvements on the Land. Tenant agrees to maintain in good condition all improvements on the Land, including without limitation all dwellings, fixtures, sheds, outhouses, decks, fences, driveways, bridges, Shoreline Improvements (as defined in the Rules and Regulations) and all other structures or materials placed on the Land by Tenant or any former tenant, whether or not said improvement is affixed to the Land ("Tenant's Improvements"). At the expiration or earlier termination of this Lease, Tenant will leave the Land in at least as good condition as when this Lease began, except for normal wear and tear.

6. Non-Interference. Landlord may use the Land to operate Landlord's facilities, including without limitation Conowingo Hydro-Electric Station, Muddy Run Pumped Storage Facility and Peach Bottom Generating Station (the "Project"). Tenant understands that efficient and economical operation of the Project is the main purpose of Landlord's use of its property including the Land. Tenant understands that the Landlord's operation of the Project may limit Tenant's use of the Land from time to time. Regardless of what else this Lease says, Tenant will not interfere with Landlord's use of the Land or the use of the Land by Landlord or its affiliates for the Project. Tenant waives or gives up any rights to file a lawsuit against Landlord or its affiliates for anything relating to the maintenance, operation or new construction of the Project or the use of the Land for Landlord's corporate purposes.

7. Landlord Reservations. Landlord may grant easements (the right to use parts of the Land) over any part of the Land to others for any purpose, such as (a) roads and/or highways; (b) utility lines, either underground or overhead. All standing timber on the Land shall remain the property of Landlord. Tenant may not cut, remove or destroy any timber nor remove any rock, stone, gravel, soil or other material from the Land.

8. Rules and Regulations. Tenant's use of the Land is subject to all Laws and Landlord's rules and regulations, a copy of which is attached hereto as **Exhibit B** as they may be amended from time to time (the "Rules and Regulations"). Landlord shall provide Tenant with copies of all changes in the Rules and Regulations as they occur. FAILURE TO COMPLY WITH ANY OF THE LAWS AND THE RULES AND REGULATIONS WILL BE CONSIDERED A VIOLATION OF THE TERMS AND CONDITIONS OF THIS LEASE AGREEMENT AND MAY RESULT IN A FEE OF UP TO $250.00 PER DAY IMPOSED AGAINST TENANT BY LANDLORD AND/OR TERMINATION OF THE LEASE. In addition to Landlord's right and option to assess fees against Tenant and to terminate the Lease, Landlord has the right but not the duty to enter the Land and cure any violation of the Rules and Regulations or other terms and conditions of this Lease, and to assess all costs incurred by Landlord as a result of curing any such violation(s) against Tenant. ATTACHED HERETO AS **EXHIBIT C** IS THE CABIN AFFIDAVIT EXECUTED BY TENANT.

9. Use of Land. Tenant shall use the Land only for a vacation retreat and recreational activities. Tenant shall **NOT:**

(a) **USE OR OCCUPY THE LAND AS A PRIMARY PERMANENT RESIDENCE OR DOMICILE.** "Domicile" means the place at which a person has been physically present and that the person regards as home. "Residence" means the act or fact of living in a given place for a period of time with an intent to treat it as a home.

(b) Construct or install any new buildings, structures or other improvements on the Land or enlarge any buildings, structures or Tenant Improvements, without the prior written consent of Landlord in accordance with the procedures set forth in the Rules and Regulations and all Laws.

(c) Dispose of or store any toxic or hazardous substances, including but not limited to hazardous waste, on the Land.

(d) Disturb other tenants of Landlord.

(e) Interfere with the Landlord's use of the properties surrounding the Land.

(f) Dispose or store any flammable, explosive or hazardous materials on the Land.

(g) Engage in any commercial activities, including without limitation operating or leasing campgrounds or dock facilities.

10. No Representations. Tenant agrees that:

(a) Landlord makes no promises about the condition of the Land.

(b) Landlord is not required to make any repairs or alterations to the Land either now or in the future.

(c) Landlord is not required to maintain the Land, the surrounding property, or the Tenant Improvements, building or structures on the Land.

(d) Landlord is not required to provide any utility service to the Land, such as telephone, electricity, heat, water, gas, sewer or trash removal, regardless of whether such services exist at the time the Tenant signs this Lease.

11. Access. Tenant is responsible for acquiring and maintaining access to the Land. Landlord has no responsibility for providing, maintaining or improving access.

12. Inspection of Premises. Landlord, its employees and representatives may inspect the Land at any time without providing Tenant with notice.

13. Taxes. Landlord will pay real estate taxes on the Land, including Tenant's Improvements, unless real estate taxes on Tenant's Improvements are separately assessed and billed directly to Tenant. Landlord will send Tenant a bill for the real estate taxes and Tenant will reimburse Landlord for the real estate taxes as additional rent within thirty (30) days after the date of the bill.

14. No Waiver. Landlord is not required to enforce this Lease. If Landlord does not enforce a part of this Lease, this does not mean Landlord cannot enforce the same part, or a different part, later. The payment of Rent by Tenant after Tenant violates this Lease does not mean that the violation of this Lease is forgiven.

15. Compliance with Laws. Tenant agrees to comply at its expense with all Federal, state and local laws that apply to Tenant's Improvements or Tenant's use of the Land ("Laws"). It is Tenant's responsibility to be aware of all Laws that apply to the Land.

16. Indemnification. Tenant assumes responsibility for any action by Tenant, Tenant's contractors, representatives or guests on or near the Land. If a claim is made against Landlord because of something that Tenant, its contractors, representatives or guests do on the Land, Tenant shall pay all of Landlord's costs and expenses which occur because of the claim (including Landlord's attorney's fees). If Landlord pays any money in order to settle or defend the claim, Tenant shall pay Landlord the amount that Landlord paid.

17. Insurance. Tenant will be solely responsible for purchasing insurance to cover damage or theft of the Tenant's Improvements and personal property located on the Land as well as for liability and any other risks. Landlord does not provide any insurance coverage for the Tenant's interests. Tenant assumes responsibility for any action by Tenant, Tenant's contractors, representatives or guests which violates the Tenant's insurance policy.

18. Waiver of All Claims. Tenant understands and recognizes that, by signing this Lease, Tenant waives any and all claims against Landlord relating to the Land, Tenant's Improvements or personal property thereon or any previous leases of the Land. This includes, but is not limited to, claims for lost value of Tenant's property; lost use of the Land; or, loss, removal or destruction of Tenant's Improvements or personal property. Tenant further waives any claims for damages grounded upon an expectation of future gain, restitution or unjust enrichment.

19. Default. Tenant shall be in default under this Lease, if any of the following occur (each an "Event of Default"):

(a) Tenant does not pay the Rent, additional rent or other amounts Tenant is required to pay under this Lease when it is due and fails to make payment to Landlord of the overdue Rent within five (5) days written notice from Landlord;

(b) Tenant violates any part of this Lease or the Rules and Regulations or misrepresents any facts as to occupancy and fails to cure such violation within thirty (30) days after receipt of notice from Landlord to cure such violation;

(c) Tenant has not used or occupied the Land for more than twelve (12) consecutive months;

(d) Tenant occupies the Cottage as a domicile, primary or permanent residence;

(e) Tenant permits anyone else to occupy the Cottage as a domicile, primary or permanent residence;

(f) Tenant becomes insolvent or files for bankruptcy; or

(g) Tenant's rights to the Land are sold under execution or other legal process.

After the expiration of applicable cure periods, Landlord shall have all rights and remedies allowed by law and equity, including, without limitation, the right to terminate this Lease by sending written notice to Tenant. If Landlord does not immediately terminate the Lease after Tenant violates this Lease, Landlord can terminate the Lease at a later date.

20. Removal of the Tenant's Property. Prior to the expiration of this Lease or within ninety (90) days after the earlier termination of this Lease due to an Event of Default or otherwise, Tenant shall remove all of Tenant's Improvements and personal property, including trailers, mobile homes and personal belongings, owned by Tenant and restore the Land to a condition satisfactory to Landlord, unless Landlord has previously approved the sale of the Tenant's Improvements in accordance with the Rules and Regulations and has issued a new lease to the purchaser of the Tenant's Improvements. In the event Tenant fails to remove the Tenant's Improvements and personal property prior to the expiration of this Lease or within ninety (90) days after the earlier termination of this Lease, then the Tenant's Improvements and personal shall become the property of Landlord without any further act or notice by Landlord to Tenant. Landlord may thereafter occupy, sell, lease, repair or remove Tenant's Improvements and personal property. However, in the event Landlord elects to remove Tenant's Improvements and personal property, Tenant agrees to pay Landlord the cost incurred by Landlord for such removal within thirty (30) days of receipt of a bill from Landlord.

21. Notices. All notices under this Lease, shall be deemed to have been properly given only when written notice has been served by (i) personal delivery, (ii) by certified mail, return receipt requested, or (iii) by recognized overnight carrier, to the other party at its address as follows:

If to Landlord:

Exelon Generation
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road
Darlington, MD 21034

If to Tenant:
XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX

If a notice sent to Tenant by certified mail is not accepted by Tenant, Landlord may post the notice at the Land.

22. Brokerage Commissions. There are no commissions or fees to be paid to any real estate broker or salesperson for this Lease. If Tenant has agreed to pay any commission or fee to a real estate broker, Tenant will pay that commission or fee. If Landlord has agreed to pay any commission or fee to a real estate broker, the Landlord will pay that commission or fee.

23. Federal Energy Regulatory Commission ("FERC"). The Land is part of a project licensed by the Federal Energy Regulatory Commission (FERC). Because of the FERC License the following requirements apply:

(a) Tenant's use of the Land will not endanger health, create a nuisance or otherwise be incompatible with the recreational use on any part of Landlord's land. Tenant will take all reasonable precautions to ensure that the use and maintenance of the Land will protect the scenic, cultural, recreational and environmental value of the Land.

(b) Landlord may terminate this Lease if Landlord's License from FERC is terminated. If Landlord terminates the Lease for this reason, Landlord will give Tenant thirty (30) days notice before the termination date.

24. Floods. Tenant waives or gives up any claims against Landlord for flooding by water or the presence or flow of ice on the Susquehanna River or any of its tributaries.

25. Severability. If any part of this Lease is not legal for any reason, the rest of this Lease shall continue to be valid and enforceable.

26. Governing Law. This Lease is made in the Laws of the State of Maryland.

27. Legal Action. A lawsuit regarding this Lease may only be filed in the county where the Land is located, or in the United State District Court in the state in which the Land is located and in the division closest in proximity to the Land. BOTH PARTIES ALSO WAIVE THEIR RIGHT TO A TRIAL BY JURY IF A LAWSUIT IS FILED REGARDING THIS LEASE AGREEMENT. Tenant shall pay Landlord all of its costs and expenses, including without limitation attorneys' fees, incurred by Landlord in enforcing Tenant's obligations under this Lease whether or not Landlord files a lawsuit against Tenant.

28. No Assignment. Tenant shall not assign, sublease or otherwise transfer or encumber this Lease without the prior written consent of Landlord. Tenant shall make all requests for Landlord's consent to assignment in accordance with the Rules and Regulations. Any assignment without the prior written request of Landlord shall be null and void.

29. Entire Agreement. This Lease replaces and cancels all other leases between Landlord and Tenant for the Land. Tenant understands the promises in this Lease shall be binding upon Tenant. This Lease contains the full and complete agreement between Tenant and Landlord. Any change, modification or waiver of the promises in this Lease may only be made by a written agreement signed by Landlord and Tenant. No promises were made by Landlord to Tenant other than those promises contained in this Lease.

EXECUTED BY THE PARTIES ON THE NEXT PAGE

Landlord and Tenant, intending to be legally bound, agree to the terms of this Lease effective as of the Effective Date.

TENANT(S):

XXXXXXXXXXXXXXXXXXXXXXXXXX
Signature

XXXXXXXXXXXXXXXXXXXXXXXXXX
Print Name

XXXXXXXXXXXXXXXXXXXXXXXXXX
Signature

XXXXXXXXXXXXXXXXXXXXXXXXXX
Print Name

LANDLORD:

EXELON GENERATION COMPANY, LLC

BY:_____

File No. _____
Initials _____

CABIN AFFIDAVIT (Lease Exhibit C) **Type** or **print legibly**

Cabin Identification & Location:

Exelon Cottage Identification Number (CIN) _____ See Attachment A for Map

Street Number & Name (EMS) _____

Township, Borough or City Name _____

County and State _____

Cabin Owner/Tenant Name(s): – Must List all Cabin Owners/Tenants

Owner/Tenant 1 _____ Owner/Tenant 2 _____

List Any Other Owners/Tenants _____

Cabin Owner/Tenant Primary Addresses – Must Be Physical Address and Not PO Box:

Owner/Tenant 1:
Street Number & Name _____

City, State & Zip Code _____

Owner/Tenant 2:
Street Number & Name _____

City, State & Zip Code _____

Owner/Tenant Other:
Street Number & Name _____

City, State & Zip Code _____

Owner/Tenant Attestation:

I attest to the fact that the cabin identified above:

1. Will be utilized for recreational activities only.
2. Will not be utilized as a domicile ("domicile" means the place at which a person has been physically present and that the person regards as home), permanent or primary residence ("residence" means the act or fact of living in a given place for a period of time with an intent to treat it as a home) by myself or any other person for any period of time.
3. Will not be used for any commercial purposes or as a place of employment.
4. Will not exceed two stories in height (excluding the basement, if any).
6. Will not be a mailing address for bills or correspondence.
7. Will not be listed as any individual's place of residence on a tax return, driver's license, vehicle registration or voter registration.

For each Owner/Tenant provide two of the following showing name and primary address:☐ tax return,

☐ driver's license, ☐ vehicle registration, ☐ voter registration, ☐ passport, ☐ recent pay stub, ☐ recent utility bill.

I solemnly affirm under the penalties of perjury and upon personal knowledge that the contents of this document are true and correct.

_____
Owner/Tenant 1 Signature / Date

_____
Owner/Tenant 2 Signature / Date

_____
Owner/Tenant Other Signature / Date

Page left intentionally blank

ATTACHMENT 4

Exelon Cottage Program - Tenant Information Collection/Change Form

Cottage Identification # (CIN): _____

Today's Date: _____

Cottage Address: _____

Tenant Contact Information (all fields required)

Primary Residence (not a PO Box):

Address:_____ City/State/Zip:_____

Home Phone:_____ Cell Phone(s): _____

Other/Work/Cell Phone(s) if you wish to list: _____

Email address(s): _____

If mail needs to be sent to a PO Box:

Address:_____ City/State/Zip:_____

If the above includes changes from prior contact information please list the old address, phone # and/or email that is being replaced:

_____

_____

All Tenants listed on the Lease must sign below verifying the above information:

CURRENT TENANT(S):

_____
Signature

_____
Print Name

CURRENT TENANT(S):

_____
Signature

_____
Print Name

Return completed form to:
Exelon Generation
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road; Darlington, MD 21034
Questions: 1-610-765-5200

RULES AND REGULATIONS – PENNSYLVANIA

I. GENERAL CONDITIONS

A. General Information

All questions and inquiries should be directed to:

Exelon Generation Company LLC (Landlord)
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road
Darlington, MD 21034
Telephone: 610-765-5200

B. General Conduct

1. Tenant shall use the leased premises ("Premises"), which is part of Landlord's Conowingo Hydroelectric Project ("Landlord's Property") as a vacation retreat and for recreational activities only. Tenant shall not use or occupy the Premises as a domicile, primary or permanent residence. Tenant shall not permit any person or persons to use or occupy the Premises as a domicile, primary or permanent residence. "Domicile" means the place at which a person has been physically present and that the person regards as home. "Residence" means the act or fact of living in a given place for a period of time with an intent to treat it as a home. TENANT MUST EXECUTE THE CABIN AFFIDAVIT ATTACHED TO THE LEASE. Landlord has the right to verify Tenant's primary address, including but not limited to requiring Tenant to provide acceptable proof of domicile and residence.

2. The predominant use and occupation of the Premises should be by the Tenant and the Tenant's family, not by guests or other occupants of the Tenant. Guests or other occupants of the Tenant must not stay, without the Tenant present, for longer than two weeks at a time.

3. All of the conduct required of the Tenant shall be required of Tenant's guests, and Tenant shall ensure that such guests adhere strictly to the Rules and Regulations and all Laws. Tenants are responsible for the actions of their guests and occupants.

4. Tenant shall not assign or otherwise transfer or encumber the lease of the Premises ("Lease") without the prior written consent of Landlord. Tenant may only assign or otherwise transfer the Lease to an individual person (not to exceed two). Any attempted transfers to a trust, corporation, partnership, limited liability company ("LLC"), or any other legal entity shall be null and void. See Section II D below. Tenant shall make all requests for Landlord's

consent to assignment in accordance with these Rules and Regulations. Any assignment without the prior written request of Landlord shall be null and void. This includes among family members. Tenant shall not enter into any type of arrangement with anyone else regarding the use and occupancy of the Premises, including but not limited to sub leases, “caretaking” or any other arrangement that exchanges money and/or services for the use and occupancy of the Premises.

5. Tenant shall not permit any noise or other nuisances to interfere with the quiet enjoyment of other Tenants’ use of their properties or with the use and operation of Landlord’s Property as determined by Landlord in its sole discretion. Landlord shall have the right to require that Tenant immediately cease and desist any such noise or other nuisance.

   Landlord has the right to permit or prohibit or adopt reasonable restrictions with respect to Tenants displaying flags, signs, banners, images or outside displays of any nature visible to the public on the exterior of the Premises or visible from outside of the Premises. Landlord shall also have the right to require that any Tenant immediately cease and desist displaying flags, signs, banners, images or outside displays of any nature visible to the public on the exterior of the Premises or visible from outside of the Premises that are offensive, obnoxious, indecent or seriously annoying or intolerable to members of the community as reasonably determined by Exelon. Notwithstanding the foregoing, Tenants may display the American Flag or flags permitted in accordance with the Pennsylvania American, Commonwealth and Military Flag Act.

6. Tenant shall not cause or allow un-permitted or uncontrolled fires. No open fires are permitted except in properly constructed barbecue pits and any burning must comply with all federal, state and local laws, rules, regulations and ordinances (“Laws”). No open burning of leaves or other vegetation debris is permitted.

7. Tenants and their guests are not permitted to park or store vehicles, boats or boat trailers overnight on Landlord’s property outside the Premises. Tenants and their guests are permitted to park a reasonable (in the sole determination of Landlord) number of vehicles, boats and boat trailers on the Premises, during periods of occupancy, as long as they have a current valid registration which is clearly visible.

8. Tenants are not allowed to park or store any type of construction or commercial vehicle, machinery, camper, trailer or RV on any Landlord property.

9. The use of any vehicles off road (including but not limited to trucks, ATVs, UTVs, motorcycles, etc.) on any Landlord property is prohibited.

10. Hunting and the use of firearms or other weapons is prohibited on all Landlord property.

11. Tenants are not permitted to accumulate possessions on the Premises that are not properly stored, and in no event store any debris, junk, etc. All storage sheds and other storage containers must be approved in writing by the Landlord per Section II B or will otherwise be required to be removed. The number of storage units and amount of personal property kept on the Premises will be limited to a reasonable amount (in the sole determination of Landlord). This includes firewood.

12. The six (6) digit Cottage Identification Number (CIN) which has been assigned to each Cottage must be placed on the outside wall of the cottage facing the water and also one facing the primary road/driveway/path that leads to the cottage entrance from the land, and must be clearly visible. If the cottage has been assigned an EMS (emergency services) address, that address (# and street name) must also be posted with the CIN. All posted characters must be at least 4 inches in height, treated with a reflective material and in a color contrasting with the sign background.

13. The six (6) digit Cottage Identification Number (CIN) must also be marked in at least 2-inch characters on all garages, sheds, large storage containers, docks, piers, car ports and any other large stand-alone structures and improvements.

14. All dogs must be kept securely tied or on a leash at all times. The number of dogs or cats at the Premises at any one time should be kept to a reasonable number (in the sole determination of Landlord), and not create a nuisance in any way including noise, aggressive behavior and the failure to immediately clean up after them. No other types of pets or animals are allowed without prior written Landlord permission.

15. Tenants are not permitted to use the Premises as a business location for the production or sale of goods and/or services nor engage in any commercial activities, including without limitation operating or leasing campgrounds or dock facilities.

16. Immediately upon discovery, Tenant must report any potentially hazardous condition to the Landlord and, as required by law, to the appropriate state and local authority or agency.

17. Tenant shall be responsible for the correction and/or control of any erosion caused by or resulting from improvements, and/or changes made to, or on the Premises. Landlord may require Tenant to rectify any erosion problems on or affecting the Premises. Landlord has no duty to Tenant to correct any naturally occurring erosion problems.

18. Tenants are not required to carry $1M of liability insurance, whether stated in their Lease agreement or not. Tenants should consult with their insurance agent and make their own decisions regarding what types and levels of insurance coverage are advisable. Landlord does not provide insurance coverage for the Tenants' interests. Landlord has obtained additional insurance that provides coverage only for Landlord's liability with respect to the cottage properties.

19. The use of fireworks or any explosives is prohibited on all Landlord property.

20. The Rules and Regulations contained herein are not intended to substitute for or absolve Tenant of his or her legal responsibility to comply with all applicable Laws. In a situation where the Rules and Regulations contained herein are in conflict with, or are less restrictive than, the applicable federal, state, or local Law, the more restrictive statute, rule, regulation, or ordinance shall apply.

II. IMPROVEMENTS

A. Definition of Improvements and Removal of Improvements

1. In these Rules and Regulations, "improvements" shall mean and include all dwellings, fixtures, utilities, outhouses, sheds, decks, porches, patios, buildings, roads, driveways, pathways, bridges, fences and Shoreline Improvements (defined in Section VII) and any other structures or material constructed by or placed on the Premises by the Tenant or any former tenant, whether or not said improvement is affixed in any manner to the land.

2. All improvements shall remain the personal property of the Tenant at all times and shall be removed by the Tenant upon the termination of the Tenant's Lease, unless Landlord has approved the transfer to a new tenant. Tenant is responsible for any and all costs incurred by Landlord should Landlord elect to remove Tenant's improvements after the termination of Tenant's Lease.

B. Construction and Demolition

1. WITH A FEW EXCEPTIONS AS NOTED IN THESE RULES, THERE WILL BE NO CONSTRUCTION PERMITTED WHICH ENLARGES THE SIZE OF THE EXISTING IMPROVEMENTS. Landlord is not responsible for constructing, maintaining, repairing, replacing, re-constructing or demolishing Tenant's improvements.

2. Should Tenant wish to perform construction, to demolish an existing improvement, or to renovate, alter or replace an existing improvement in any manner ("construction"), a Construction Application must be submitted

to the Landlord (with all appropriate attachments) REGARDLESS OF WHETHER ANY OTHER AGENCY OR ORGANIZATION REQUIRES PERMITTING OR APPROVAL. The Construction Application must be submitted to the Landlord prior to applying for any applicable permits or beginning any construction. All expenses incurred by Tenant related to such construction or demolition, including Landlord's consent, shall be the sole responsibility and risk of Tenant. No Construction nor permit activities should begin until the Tenant receives formal written permission from the Landlord.

3. Construction Applications must contain a detailed plan and drawing including but not limited to: materials to be used, methods of construction, a site map with project location, project drawings with dimensions covering at least two sides or cross-sectional views, photos of the existing project location and a list of required permits/permissions and the agencies requiring them. Tenant is responsible for determining which Laws apply to their proposed construction or demolition activities and to contact the applicable government or agency as required by said Laws. See Attachment 1 for the Construction Application.

4. No construction shall be permitted that expands beyond the size of the existing improvements, except as permitted under Rules II 5 and 6 below, provided however, approval of construction is at the sole discretion of Landlord.

5. A new deck may be approved if all of the following conditions are met:

    a. A complete Construction Application must be submitted and approved.
    b. Any new deck plan plus any existing decks, patios, porches or the equivalent cannot exceed a total of 200 square feet.
    c. Any new deck must be constructed with pressure treated lumber or a manufactured equivalent.
    d. Deck plans must be kept basic, cannot be covered and must meet all code requirements including proper railings.All required permits must be obtained, after receiving written Landlord permission to proceed with permitting

6. A new shed may be approved if all of the following are met:

    a. A complete Construction Application must be submitted and approved
    b. Any new shed plan plus any existing sheds, outbuildings or equivalent cannot exceed a total of 150 square feet at the most, and Exelon reserves the right to limit a new shed to a smaller size.
    c. Sheds will not be permitted to have concrete foundations.
    d. All required permits must be obtained, after receiving written Landlord permission to proceed with permitting

7. If a cottage is fifty percent (50%) or more destroyed by fire, flood or other casualty, as determined by Landlord, Tenant will not be permitted to rebuild and the Lease will be terminated.

8. Tenant must be in compliance with the terms of the Lease, including but not limited to being current with any Rent or other sums due and payable, prior to submitting a Construction Application.

9. Construction Applications will be subject to written approval of Landlord. Landlord may approve or deny a Construction Application in its sole discretion. If the Construction Application is acceptable to Landlord, Landlord shall issue to Tenant a preliminary approval in writing. If the Construction Application is denied, Landlord will give Tenant written notice of such denial.

10. Within ninety (90) days after Landlord's preliminary approval of the Construction Application and prior to beginning any work, Tenant must obtain all permits and licenses required by all Laws ("applicable permits") and provide copies of all such permits and licenses to Landlord.

11. Upon receipt of the applicable permits and licenses for the work approved by Landlord, Landlord shall issue written final approval of the Construction Application to the Tenant.

12. The final approval issued by Landlord expires one (1) year from the date of issuance. If the approved construction is not completed on or before the expiration date, the Tenant must resubmit a Construction Application to the Landlord and if preliminary approval is granted, renew any expired permits.

13. Landlord's approval of the Construction Application is contingent upon Tenant's compliance with setback requirements and all other applicable Laws and regulations.

14. Within thirty (30) days of completion of the approved construction, Tenant must submit photographs of the completed work to Landlord along with copies of any inspection reports received from any agency.

15. Tenant must notify Landlord in writing at the completion of any Landlord approved and permitted demolition or removal of improvements. Within ninety (90) days after the improvement is razed or removed, the area must be restored to a condition satisfactory to Landlord, including but not limited to establishing the appropriate vegetative cover.

16. Note that these Construction requirements cover the addition of or any significant changes to all utilities and major systems including but not limited to electrical/power, water supply and plumbing, sanitary, HVAC, fireplaces and any gas/oil/fuel related items.

17. Landlord may approve or reject requests for new construction at its sole discretion, including when required to ensure structural integrity, environmental protection and safe occupation of the Premises.

C. Maintenance

1. Tenant must maintain the Premises and all improvements thereon in good repair and appearance at all times. Should Landlord determine that the Premises is not in a state of good repair and appearance, Landlord may require Tenant to perform all reasonable and necessary repairs and maintenance, including but not limited to painting and removal of any and all junk, trash, debris, or other items determined by Landlord to constitute a nuisance.

2. Prior to performing any maintenance, consult Section II B in order to determine whether the activity would actually be considered Construction and require approval.

3. Improvements shall not present a hazard to the health or safety of any Tenant or other persons or property or to the environment or be in violation of any codes, Laws or requirement of any agency.

4. Landlord may require Tenant to correct, at Tenant's sole expense, any conditions that Landlord determines to be potentially hazardous, harmful to the environment, or in violation of these Rules and Regulations.

5. All chimneys must be fireproof and constructed of tile, brick, stone, or other approved material, equipped with spark arresters, and must otherwise comply with all applicable code specifications.

6. Tenant must install and maintain in good working condition at least one smoke detector in each dwelling on the Premises. All rooms used for sleeping must also contain a smoke detector and have code appropriate windows/egress.

D. Sale of Improvements, Lease Transfer Application and Changes to Tenants on Existing Leases

1. Tenant may not transfer Tenant's interest in the Lease without the prior written approval of Landlord. Tenant and the proposed Buyer shall submit at the same time a complete Lease Transfer Application to Landlord with all required attachments. Lease Transfer Applications must include a copy of each Buyer(s)'s Driver's license, a copy of the Agreement of Sale for the improvements, payment of applicable fees, a completed Water and Sanitary sign-off form, and all final inspection reports as noted herein. Regardless of whether required by the local municipality or not, a code compliance

inspection report without exceptions (for building, sanitary or others as required) must be submitted with the application. In certain municipalities this may take the form of a use & occupancy certificate. In all cases Tenant must also arrange to have a licensed(MD) / certified(PA) inspector perform a building, electrical, water and sanitary inspection of the Premises to ensure compliance with all Laws. Tenant will be required to correct all exceptions and have the inspector issue a revised report prior to submitting the Lease Transfer Application. See Attachment 2 for the Lease Transfer Application. Contact the Cottage Program Manager for additional guidance on submitting a Lease Transfer Application as requirements change. Incomplete application packages will not be reviewed. If the transfer is approved, Landlord will require the Buyer to enter into a new Lease of the Premises substantially in the form as Attachment 3. Tenant must be in compliance with the terms of the Tenant's Lease, including but not limited to being current in the payment of Rent or other sums due and payable, prior to submitting a Lease Transfer Application. Landlord reserves the right to deny the Lease Transfer Application in its sole discretion. Landlord will commence review of the Application only when all requirements for the Application are complete and submitted and will target to complete the review within forty-five (45) days (but may take longer). Landlord's review and approval of the transfer does not provide any representation or warranty to Tenant nor Buyer regarding the condition of the improvements nor the existence of all permissions and permits that may have been required for those improvements. Landlord reserves the right to demand in the future that any improvements that were installed without Landlord permission or proper permitting be removed at any time.

2. If the Lease Transfer Application is approved, Landlord shall issue an approval letter and a new Lease Agreement, which shall be properly executed by the proposed Buyer at settlement and returned to Landlord for Landlord's execution, along with a copy of a valid Bill of Sale for the improvements. Landlord will then forward to the new Tenant a fully signed copy of the new Lease Agreement.

3. If the Lease Transfer Application is denied, Landlord will give Tenant written notice of the denial.

4. All Sales Agreements and Bills of Sale for the improvements must contain this statement: "Only the Tenant's improvements are being sold and neither land, nor water rights are included in the sale. The Landlord has no responsibility for providing, maintaining or improving access to the leased premises."

5. Installment Sales or Lease Purchase Agreements that are intended to give possession of the cottage to the Buyer while the current Tenant (seller) holds the existing Lease are not permitted.

6. Proposed transfers to remove or add a co-tenant or among family members shall be subject to Landlord's approval in accordance with all of the procedures in this Section II (D), including the Lease Transfer Application. In the event of divorce between co-tenants, Landlord will require a copy of the divorce decree documenting the disposition of cottage ownership.

7. The number of Tenant parties on a Lease will be limited to two (2) and in no case will Landlord permit a Tenant to be a trust, corporation, partnership, LLC, trust or any other legal entity.

8. The parties to the Lease must be the same as the owners of the improvements.

9. In the event of the death of a Tenant, Landlord must be provided a copy of the death certificate. If there is no surviving spouse, Landlord must also be provided a copy of the Tenant's Last Will and Testament. LEASE AGREEMENTS DO NOT AUTOMATICALLY PASS FROM THE TENANT TO THEIR HEIRS. The heirs will need to go through Landlord's lease transfer process seeking approval. When performing estate planning, families should keep in mind that only the legal owner(s) of the cottage can be a Tenant on the lease and the number of Tenants per lease is limited to two (2).

10. Tenant shall not engage in any false or misleading communications associated with the Lease and the improvements. The existence of the Lease must be clearly disclosed to any prospective buyer of the improvements.

III. ROADS, BRIDGES AND ACCESS

A. Construction or Alteration of Roads, Driveways and Bridges

1. Written permission is required from Landlord for the construction or alteration of roads, driveways, or bridges in accordance with the procedures set forth in Section II (B) above. A survey and/or drawing showing the location of the road, driveway or bridge must accompany the Construction Application submitted to Landlord.

2. In addition to obtaining written permission from the Landlord, Tenant must obtain all federal, state and local permits, where required, before constructing or altering any road, driveway or bridge.

B. Maintenance

1. Tenant must maintain roads, driveways or bridges on the Premises in good condition, and provide proper drainage in accordance with Landlord's specifications.

2. Tenant is responsible for its proportionate share of the cost of maintenance and general upkeep of non-public roads and bridges used in common with other cottage owners.

3. Tenant is prohibited from blocking or otherwise limiting access to any roads, driveways or bridges located on the Premises or any other property owned by Landlord.

4. Should Tenant fail to perform its maintenance obligations under these Rules and Regulations, Landlord, after notice to Tenant, may in its sole discretion, (i) perform such maintenance and charge Tenant for its share of the cost, or (ii) prohibit the use of the road, driveway or bridge in need of repair. Landlord shall have no obligation to repair or maintain such roads, driveways or bridges.

C. Access

1. Landlord has no responsibility for providing, maintaining or improving access to the Premises. Egress and ingress as currently practiced is not guaranteed and could be altered at any time by Landlord.

2. Landlord may grant easements (the right to use parts of the Land) over any part of the Land to others for any purpose, such as (a) roads and/or highways; (b) utility lines, either underground or overhead.

3. Tenants are prohibited from posting any signs or making any other communications regarding No Trespassing or any other restrictions to accessing and using Landlord property. Tenants are prohibited from blocking access to any Landlord property.

IV. TREES & PLANTS

1. No trees or ornamental shrubs shall be injured or damaged, by Tenants or their guests. The attaching of lights, electric lines, clotheslines, docks, or any other item to any tree or shrub, either on a temporary or permanent basis, is prohibited. Care must be taken during any construction activities to prevent injuring trees or ornamental shrubs, and if necessary, temporary protective shields shall be installed around the trees or shrubs.

2. Tenant shall not remove any tree or shrub over two (2) inches in diameter without prior written permission of Landlord. If a tenant desires to trim, cut or remove significant portions of a tree, they must first obtain written permission from Landlord. If Tenant removes any tree or shrub in violation of the Rules, Tenant shall be subject to the fees in Section VIII and lease termination. If Tenant determines that a tree is an immediate safety hazard, Tenant should vacate the Premises and address it immediately by contacting Landlord for approval to remove the tree.

3. Tenant is responsible for correcting hazardous tree conditions on or adjoining the Premises. Landlord may notify in writing the Tenant of any trees that Landlord believes should be removed. It will be the responsibility of the Tenant to have such trees removed. If such trees are not removed within the specified time period, Landlord at its option may terminate the Tenant's Lease and/or remove the tree at the Tenant's expense.

4. Tenant shall not introduce or maintain any invasive plant species or noxious weeds (including bamboo) onto the Premises, on any of Landlord's properties, or within or upon any waters of the State and is responsible for removing any such growth from the Premises.

5. Tenant shall not plant anything that will grow above 6 ft. in height without the Landlord's prior written permission. Any planting and landscaping by the Tenant shall be limited to a reasonable amount (in the sole determination of Landlord) and done strictly within the Premises.

V. WATER

1. All Premises must be served by an approved potable water source, which could include a permitted well or bottled water.

2. Tenant must obtain written permission from Landlord and all applicable permits for existing or future wells prior to use. Wells may be shared by no more than 4 cottages, with a total maximum occupancy of 24 persons. All unpermitted or prohibited wells must be abandoned in accordance with applicable Laws.

3. The use of river, creek or spring water for human consumption is prohibited and such water sources may not be attached to pressurized plumbing. Human consumption includes drinking, bathing or showering, cooking, dish washing and oral hygiene.

4. River, creek or spring water may be used for purposes other than human consumption, provided it is not attached to pressurized plumbing and that Tenant obtains all applicable permits prior to its use.

5. Tenant shall take all reasonable measures to limit the use of water. Accordingly, swimming pools, hot tubs and spas, whether above or below ground, temporary or permanent, are prohibited.

6. All use of water by Tenant, in and about the Premises, shall be at the sole risk of Tenant. Landlord has not performed any water potability tests and makes no representations with regard to the suitability of the water for domestic purposes. Tenant is responsible for performing any applicable potability testing or other water analysis and permitting. All costs incurred in

connection with such testing and permitting shall be the responsibility of the Tenant. Landlord assumes no liability for, or on account of, any water used in any manner by Tenant or Tenant's guests.

7. No exclusive rights are given or inferred as being given as to the use of any water or spring, even though a spring may be located on the Premises.

8. Construction or drilling of a new well or other water source is subject to the prior approval of Landlord in accordance with the procedures set forth in Section II (B) above, including without limitation the obligation to obtain applicable permits prior to construction.

VI. SANITARY SYSTEM REQUIREMENTS

1. All Premises must be served by an approved sanitary system, which may be a septic system, holding tank, sealed pit privy, incinerator toilet, composting toilet or chemical toilet (temporary only) ("Sanitary System"). Before beginning the construction, installation or alteration of any Sanitary System, Tenant shall comply with the procedures set forth in Section II (B) above, including the obligation to obtain written permission from Landlord and all applicable permits.

2. In the event an approved and permitted Sanitary System does not exist on the Premises, Tenant must provide the site with a Sanitary System in compliance with all applicable Laws and these Rules and Regulations. No Sanitary System shall be located closer than one hundred (100) feet of any spring, stream, or other water supply source (except as otherwise permitted by applicable Laws).

3. Subject to Landlord's prior approval, sealed pit privies, holding tanks, composting toilets, incinerator toilets and chemical toilets are permitted. Tenant must enter into a written maintenance agreement with Landlord and with the applicable agency if required and obtain all applicable permits prior to installing such systems.

4. Gray water must be collected and disposed of in an approved, permitted wastewater disposal system. Tenant must enter into a written maintenance agreement with Landlord and with the applicable agency if required and obtain all applicable permits prior to installing such systems.

5. In the event a public sanitary sewer system is installed in the area, Tenant shall be required to connect into the system, whereupon Tenant shall be responsible for all connection, maintenance, and operation fees or costs.

6. All garbage, trash or refuse must be removed from the Premises every seven (7) days. In the interim, all garbage, trash and refuse must be kept in a closed container intended for the temporary storage of garbage, trash or

refuse secure from flies, rats or other insect or animal intrusion and maintained in a good and sanitary condition in compliance with applicable Laws.

7. All Sanitary Systems and gray water systems must be maintained at all times in good working order and sanitary condition and in compliance with all applicable Laws and any applicable holding tank agreement or sealed pit privy agreement. Tenant shall be responsible for the annual winterization of all water source, sanitary, and gray water systems. TENANT MAY BE REQUIRED TO PROVIDE LANDLORD WITH A FORM OF CERTIFICATION ACCEPTABLE TO LANDLORD THAT ALL SANITARY AND GRAY WATER SYSTEMS ARE IN GOOD WORKING ORDER IN ACCORDANCE WITH APPLICABLE LAWS, AND THAT TENANT IS NOT IN DEFAULT UNDER ANY SEWAGE PUMPING AGREEMENT OR HOLDING TANK AGREEMENT. TENANT MAY ALSO BE REQUIRED TO PROVIDE LANDLORD WITH THE MOST RECENT PUMPING RECEIPT.

8. Please note that although Water and Sanitary regulations differ among the various municipalities, Exelon reserves its rights under the Lease to require Tenants to adhere to more stringent standards. In addition, Federal, State and Local regulations are subject to change at any time. Please make sure you review Sections V and VI of the Rules and are aware of the standards to which you are subject. In any circumstance, any violation of Federal, State or Local regulations or Exelon Rules that create a health or environmental issue, will be considered a default of your Lease. It is your responsibility to ensure that all Water and Sanitary systems are functioning properly, inspected and serviced regularly, and that you satisfy all State and Local reporting requirements.

VII. SHORELINE PROTECTION PROGRAM

A. Application Procedures

1. The “shoreline” is considered to be the existing shoreline at mean high water.

2. All applicable Construction rules in Section II apply to the Shoreline. Prior to the construction or repair of a pier, dock, boathouse, boat ramp, marine railway, bulkhead, retaining wall or erosion control measures or excavation in any areas that may affect the shoreline (“Shoreline Improvements”), Tenant, must submit a Construction Application to Landlord in accordance with Section II (B) of these Rules and Regulations. Landlord will make an on-site inspection of the area to determine if what the applicant has proposed should be allowed or if another type of measure may be more appropriate. Landlord may deny any Construction Application in its sole discretion. Other than routine maintenance of existing Shoreline Improvements and new erosion control measures with the prior written consent of Landlord, construction of Shoreline Improvements outside of the applicant’s Premises is not permitted.

No construction may begin until the Tenant has received Landlord's written Approval and obtained all required local, state and federal permits and authorizations, including but not limited to all permits required by the applicable state agencies (Maryland Department of the Environment – MDE or Pennsylvania Department of Environmental Protection – PaDEP), and the U.S. Army Corps of Engineers.

B. Specifications and Procedures

In addition to the applicable Laws and all requirements set forth by the applicable permitting authorities, the following specifications shall apply. Should any specification herein conflict with any applicable local, state, or federal Law or regulation, the most restrictive requirement shall apply

1. Piers or Docks

a. All new or replacement piers or docks must be a temporary, floating construction and may not exceed a total length of fifty (50) feet (or extend more than fifty (50) feet from the shoreline). If the pier is located in a cove or in a stream, the length may not exceed 25% (1/4) of the width of the cove or stream where the pier is located. Floating piers/docks must be removed from the water annually from November 15 to March 15 and securely stored above the high-water line.

b. Flotation devices for floating piers must be constructed of environmentally sound material as approved by Landlord and permitting authorities. Barrels or similar flotation devices are not permitted.

c. Piers may not interfere with navigation, present a safety hazard, or block ingress or egress to adjoining areas.

d. If an existing pier must be replaced or repaired (other than minor repairs), it must conform to current standards.

e. Piers may not be anchored or tied to trees at any time.

2. Boat Ramps and Marine Railways

a. New boat ramps and entry paths into the water will not be permitted. Repairs or reconstruction of existing ramps must be constructed of stone and/or wood. Asphalt or other petroleum-based products are prohibited.

b. Ramps may not exceed fifteen (15) feet in width and thirty (30) feet in length. The length should not exceed that necessary to be functional.

c. Marine railways may use treated wood.

d. Marine railways may not exceed fifteen (15) feet in width and should be no longer than necessary to be functional. Landlord may, however, restrict the length because of site conditions.

3. Erosion Control Measures (Bulkheads, Retaining Walls, Sea Walls, Rip Rap, etc.)

a. No erosion control measure shall significantly alter the existing shoreline.

b. The planting of native species vegetative cover and/or rip-rapping shall be used if adequate to control the problem.

c. Erosion control measures, including bulkheads, retaining walls and rip rap, may not be installed or replaced without the prior written approval of Landlord.

d. The structure shall not significantly detract from the scenic value of the area. Landlord will typically prefer plans consisting of wood and/or stone but not the use of concrete.

C. Landlord assumes no liability for injury or damage in the construction, use or removal of any Shoreline Improvement made by the current or any former Tenant.

VIII. COMPLIANCE; AMENDMENTS

In the event of Tenant's failure to comply with these Rules and Regulations and Laws, Landlord may impose a fee on Tenant of up to $250 per day until such failure is cured and/or terminate Tenant's Lease in accordance with its terms. Landlord may also impose fixed fees of up to $2,500 for non-compliance issues and/or terminate Tenant's Lease in accordance with its terms. Landlord shall have the right to amend these Rules and Regulations at any time as Landlord deems necessary.

IX. CULTURAL RESOURCE PROTECTION GUIDELINES

Landlord has developed, in cooperation with the Pennsylvania Bureau of Historic Preservation and the Maryland Geological Survey, Division of Archeology, the following rules and regulations. The specific intent of these guidelines is to provide for the protection of cultural resources, and to avoid any disturbance of historic and prehistoric

sites except when justified for scientific purposes and/or when performed in accordance with such State and Federal regulations and guidelines as may apply.

A. No one shall mar, deface, remove, destroy or in any other way damage, any standing structure, ruins, foundation or other man-made feature of a potentially historic nature on lands of Landlord, without first having obtained the written permission of Landlord.

B. No one shall perform any sub-surface archaeological investigations, or in any way disturb the soil for the purpose of searching for and/or obtaining historic or prehistoric artifacts on land of Landlord without having first obtained the written permission of Landlord, nor shall same be performed without the prior knowledge and written sanction of the following:

In Maryland: The State Historic Preservation Officer and/or the Geological Survey, Division of Archeology

C. Full and complete reports must be prepared. Said reports shall incorporate maps, site profiles, descriptions and photographs of artifacts and features, soil descriptions, topography, excavation procedures, directions and distance to the nearest water and all such other related details as may be required.

D. Landlord shall be supplied with a copy of each report so generated. The appropriate State agency shall be supplied with two copies of same, one of which shall contain original photographs.

E. All artifacts and related material recovered in sub-surface investigations shall become the property of Landlord and shall be turned over to the respective State agency. Same shall remain available to Landlord and other responsible public and private organizations and agencies for the purpose of study and/or public display.

F. All artifacts must be properly labeled with site number and lot and must be readily identifiable by pit and level. Site numbers must conform to the trinomial numbering system adopted by both Pennsylvania and Maryland.

G. All burials encountered during the course of such archeological investigations shall be treated with the highest respect and shall be handled on a case by case basis under the strict control of the State agency having jurisdiction. It is the policy of said agencies and of Landlord, to discourage the removal or disturbance of human remains, unless there is a significant scientific purpose to be served by same, and unless provisions are made, in consultation with, and with the approval of living descendants of the interred, for the timely study and the ultimate reburial of the remains.

H. While the collection of artifacts from the surface is widespread, and though not strictly prohibited under these regulations, it does have a significantly negative

effect on archeological sites. The distribution of surface artifacts is the only information available for many sites. Those finding artifacts are therefore encouraged to report finds to Landlord so that same might be photographed and recorded.

I. Tenant is required to consult with the appropriate State Preservation Office prior to any construction work that may affect surface or sub-surface archaeological sites, and prior to new additions to existing structures or the construction of new structures.

J. On property which is within the boundaries of Federally-regulated projects such as the Conowingo Hydro-Electric Project (F.E.R.C. No. 405), Tenants' properties require additional precautions regarding cultural resources under the provisions of the National Historic Preservation Act of 1978 (section 106), Executive Order 11593, and the regulations of the Advisory Council on Historic Preservation (36 CFR 800).

X. CONTACT INFORMATION

1. Tenant Contact Information – for all changes to Tenant contact information including primary mailing address, phone numbers and email addresses, Tenant must complete Tenant Information form (see Attachment 4) and return to Landlord at the time of the change. Tenant Information form must be signed by all Tenants who had signed the Lease agreement. Failure to update Landlord as to changes in contact information that result in Landlord’s inability to contact Tenant will prompt Landlord to terminate the Lease upon the next annual expiration date.

DISCLAIMER: The following list is intended as a reference to the Tenant for contacting the municipalities or agencies that may require permits or approvals for specified construction activities. The list is not intended to be an exclusive list and Landlord makes no guarantees or warranties as to the accuracy of the information contained herein below. Tenant is responsible for determining which federal, state, and/or local Laws apply to their proposed use, occupancy and construction activities and to contact the applicable government or agency as required by said Laws.

Pennsylvania

Pennsylvania Fish and Boat Commission
Executive Director
P.O. Box 67000
1601 Elmerton Avenue
Harrisburg, PA 17106-7000
717.705.7800

Fulton Township Supervisors
777 Nottingham Road
Peach Bottom, PA 17563
717.548.3514

Martic Township Supervisors
370 Steinman Farm Road
Pequea, Pa. 17565
717.284-2167

Drumore Township Supervisors
1675 Furniss Road
Drumore, PA 17518-0038
717.548.2660

Lancaster County Conservation District
1383 Arcadia Road, Room 200
Lancaster, PA 17601
717.200.5361 ext 5

Pennsylvania Department of
Environmental Protection (PADEP)
Department of Environmental Protection Headquarters
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17101
717.783.2300

Peach Bottom Township Supervisors
6880 Delta Road, Suite 3
Delta, PA 17314
717.456.5083

Lower Chanceford Township Supervisors
4120 Delta Road
Airville, PA 17302
717.862.3589

York County Conservation District
118 Pleasant Acres Road
York, PA 17402
717.840.7430

U.S. Army Corps of Engineers
Philadelphia District
The Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107
215.656.6728

ATTACHMENT 1 – page 1 of 2

CONSTRUCTION APPLICATION

Tenant Information **Application Date:** _____

Name:_____ Cottage ID Number (C.I.N.) _____
Address:_____
City:_____ State:_____ Zip:_____
Home Phone:_____ Cell/Other Phone(s):_____
Email(s): _____

Authorization Requested For (check appropriate items)

Addition to Cottage _____ Deck/Patio _____ Boat Ramp _____
Shed/Outbuilding _____ Well _____ Sidewalk/Pathway _____
Fence _____ Sanitary _____ Landscaping/Plantings _____
Parking Area _____ Pier/Dock _____ Utilities/Major Systems _____
Bulkhead/Walls _____ Road/Bridge _____
New Construction (specify) _____
Removal or demolition of _____
Other (specify) _____

Procedure (see section II B of the current Rules & Regulations for additional guidelines & requirements)

1) Tenant must adhere to all requirements as contained in the Lease and the current Cottage Rules and Regulations document and obtain written preliminary approval from Exelon prior to applying for local, state or federal building permits.
2) This application must include with it a sufficient plan and drawing including but not limited to: materials to be used, methods of construction, a site map with project location, project drawings with dimensions (if applicable), photos of the existing project location and a list of all required permits/permissions and the agencies requiring them.
3) Exelon shall give Tenant written notice of preliminary approval or denial within 45 days of the receipt of all necessary and complete application documents. Incomplete packages will not be reviewed.
4) Within 90 days after receipt of the preliminary approval, Tenant must submit to Exelon copies of all permits issued by the appropriate local, state or federal authorities. Exelon will provide a final written approval or denial within 15 days of receiving all necessary permits.
5) **No work can be started until all necessary permits have been received AND Exelon issues its final written approval of this application.**
6) Failure to comply with this procedure may result in fees and/or termination of the Tenant's Lease in accordance with the Rules and Regulations. Exelon reserves the right to deny this application in Exelon's sole discretion.

Preparation Fee: Please submit a check in the amount of $50.00 with this application made payable to: Exelon Generation Company, LLC.

NOTE: COLLECTION/CASHING OF FEE/CHECK DOES NOT CONSTITUTE PROJECT APPROVAL

Please submit this application to:

Exelon Generation
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road
Darlington, MD 21034

PLEASE DIRECT QUESTIONS TO (610) 765-5200 (Cottage Program Manager)

ATTACHMENT 1 – page 2 of 2

CONSTRUCTION APPLICATION

Failure to comply with this procedure may result in denial of the application and/or termination of the Tenant's Lease in accordance with the Rules and Regulations.

PLEASE DIRECT ALL QUESTIONS TO (610) 765-5200 (Cottage Program Manager).

Note that all Tenants listed on the existing Lease, must sign below

CURRENT TENANT(S):

_____
Signature

_____
Print Name

_____
Signature

_____
Print Name

EXELON USE ONLY

Reviewed (I) _____ APPROVED _____ _____
(F) _____ DATE
Fee Rec'd (C) _____

ATTACHMENT 2 – page 1 of 3

LEASE TRANSFER / CHANGE APPLICATION

This application must be submitted to Exelon Generation Company, LLC with all required and complete documentation. Contact the Exelon Cottage Program Manager for additional lease transfer guidelines as requirements change. Incomplete application packages will not be reviewed..

CURRENT TENANT(S) INFORMATION **APPLICATION DATE:** _____

Name: _____ Cottage ID Number (CIN): _____

Name: _____ Cottage Address: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone(s): _____ Email(s):_____

NEW TENANT(S) INFORMATION – all fields required
Name(s) (as should appear on Lease): Tenant 1: _____

Tenant 2: _____

How is Tenant 2 related to Tenant 1(Spouse/Parent/Child/Sibling/Other):_____

Address: _____

City: _____ State: _____ Zip: _____

Home Phone: _____ Cell Phone(s): _____

Email Address(es): _____

EST. SETTLEMENT DATE: _____ **PURCHASE PRICE:** _____

Please submit this Request to:
Exelon Generation
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road
Darlington, MD 21034

Procedure (see section II D of the current Rules and Regulations for additional guidelines and requirements)

NOTE: COLLECTION/CASHING OF FEE/CHECK DOES NOT CONSTITUTE LEASE TRANSFER APPROVAL

TO BE SUBMITTED WITH THIS APPLICATION:

1. The Lease Transfer Requirements Checklist (see page 3 of 3 for additional requirements)
2. An application fee in the amount of $250 by check made payable to Exelon Generation Company, LLC.
3. A clean inspection report from a licensed(MD) or certified(PA) inspector. Inspection should cover building, electrical, water and sanitary of the Premises to ensure compliance with local, state and federal codes/laws.
4. Copy of the Agreement of Sale for the Tenant improvements ("Improvements"). Agreement of Sale must include: "Only the Tenant's improvements are being sold and neither land, nor water rights are included in the sale. The Landlord has no responsibility for providing, maintaining or improving access to the leased premises."
5. Copy the Buyer(s)'s driver's license.
6. The completed Water and Sanitary Sign Off form.
7. Contact the Exelon Cottage Program Manager for additional application requirements as they do change.
8. **NO SALE should be finalized until you have Exelon's final written approval to proceed with closing.**

ATTACHMENT 2 – page 2 of 3

LEASE TRANSFER / CHANGE APPLICATION

TO BE SUBMITTED AFTER EXELON PRELIMINARY WRITTEN APPROVAL AND SETTLEMENT:

Within ten (10) days after settlement, the following must be submitted:

1. A "Bill of Sale" for the improvements signed by both parties. **NOTE: The New Tenant(s) on the Lease must be the same as the Buyers who have signed the Bill of Sale.** Bill of Sale must include the following: “Only the Tenant’s improvements are being sold and neither land, nor water rights are included in the sale. The Landlord has no responsibility for providing, maintaining or improving access to the leased premises.”
2. A new Lease Agreement (provided by Exelon at time of preliminary approval) signed by the new tenant(s).
3. All other documents that may be required as a result of Exelon’s preliminary approval.

Exelon reserves the right to deny this application if the Lease is in default or in Exelon’s sole discretion.

Failure to comply with this procedure may result in denial of the application and/or termination of the Tenant’s Lease in accordance with the Rules and Regulations.

PLEASE DIRECT ALL QUESTIONS TO (610) 765-5200 (Cottage Program Manager).

Note that all Tenants listed on the existing and future Leases, must sign below

CURRENT TENANT(S):	**NEW TENANT(S):**
_____	_____
Signature	**Signature**
_____	_____
Print Name	**Print Name**
_____	_____
Signature	**Signature**
_____	_____
Print Name	**Print Name**

EXELON USE ONLY

Fee received: _____ Date: _____
Approved: _____ Date: _____
File No.: _____

ATTACHMENT 2 – page 3 of 3

Lease Transfer Requirements Checklist Cottage Identification #:_____

This Form MUST be submitted as the cover page to your Lease Transfer Application package

All documents, in the required condition and with no errors or discrepancies, must be submitted at the same time with this checklist. Exelon will not accept documents if they are submitted at different times. This will delay the lease transfer review significantly.

Your lease transfer application package must include:

1) This **Lease Transfer Requirements Checklist** [ ]
2) The **Lease Transfer Application** including signature page [ ]
3) Copy of Drivers Licenses for all Buyers [ ]
4) Signed **Water and Sanitary Compliance Sign Off** form [ ]
5) **Agreement of Sale** with all of the following: [ ]
    a. Sales price
    b. Exelon six-digit Cottage Identification Number (CIN)
    c. EMS address of cottage (incl. Municipality/County/State)
    d. All Buyer and Seller Names and Signatures
    e. This exact wording: "Only the Tenant's improvements are being sold and neither land, nor water rights are included in the sale. The Landlord has no responsibility for providing, maintaining or improving access to the leased premises."
6) A **Well License** between Exelon and the current Tenant [ ] or N/A
    a. If there is a well on site and a license hasn't already been completed
7) The last **Septic Pumping Receipt** [ ] or N/A
    a. If not applicable, explain: _____
8) A third-party **Inspection Report** with no exceptions, within last 12 months [ ]
    a. Exceptions must be cleared and all photos and references regarding exceptions removed from the report to avoid confusion. NOTE that any work to clear exceptions that is considered Construction under the Exelon Rules and Regulations must be approved by Exelon in writing prior to starting.
    b. Report must clearly document the current condition and systems regarding the water source and sanitary/septic disposal and state that they "are in good working order and in compliance with applicable laws".
9) **Municipal Inspection Reports** with no exceptions, for PA cottages [ ] or Md
    a. Township will issue either:
        i. Separate Building/Zoning and Sewage reports
        ii. Or a passing building/zoning and sanitary inspections will be evidenced by a Certificate of Use and Occupancy (ie Drumore)

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ATTACHMENT 3 – Example Form of the Current Lease

THIS LEASE IS NOT TRANSFERABLE WITHOUT THE PRIOR WRITTEN APPROVAL OF LANDLORD

LEASE - Pa

THIS LEASE AGREEMENT (this "Lease") is made this XXXXX day of XXXXXXXXXXXXXXXXXX, 20XXXXX (the "Effective Date"), by and between Exelon Generation Company, LLC ("Landlord") and XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX ("Tenant"). Tenant's liability shall be joint and several if Tenant is more than one party.

BACKGROUND

A. Landlord, as successor by merger to PECO Energy Power Company, is the owner of a parcel of land located in XXXXXXXXXXXXXXX Township, XXXXXXXXXXXX County, Pennsylvania, identified as Lot No. XXXXXXXX, as outlined in red on the plan attached to this Lease as **Exhibit A** (the "Land").

B. Landlord and Tenant, intending to be legally bound hereby, intend to enter into a lease of the Land on the following terms and conditions.

1. Term. Unless sooner terminated in accordance with the terms of this Lease, Landlord agrees to lease the Land to Tenant for a term beginning on the Effective Date and ending on September 30th of the calendar year following the Effective Date (the "Term"). Thereafter, this Lease shall continue upon the same terms and conditions, subject to the adjustment of Rent in accordance with Paragraph 2 hereof, from year to year until terminated by either party by written notice at least thirty (30) days prior to the expiration of the then current term.

2. Payment of Rent. Tenant agrees to pay to Landlord annual rent in the amount of $XXXXXXXXXX ("Rent") on the first day of September. Tenant will send or deliver the Rent to Exelon Generation Company, LLC, 1310 Point Street, 18th Floor, Baltimore, MD, 21231, Attn: Real Estate & Facilities, unless Landlord notifies Tenant in writing that the Rent should be sent or delivered to another address. Except as otherwise provided herein, Landlord is not required to send Tenant a bill for the Rent, and the lack of a bill does not mean that Tenant is not required to pay Rent on or before the date set forth above. The Rent shall increase annually by the amount of three percent (3%), including the Rent which will be due on the September 1st following the Effective Date. Tenant shall pay to Landlord the adjusted Rent within five (5) days after receipt of a bill from Landlord for the adjusted Rent amount. Landlord reserves the right to charge Tenant as additional rent Landlord's costs arising out of this Lease, including without limitation the cost of enforcing the provisions of this Lease.

3. Late Charge. Tenant must pay the Rent by the first day of each September. If the Rent is not received by Landlord within ten (10) days after the Rent is due, Tenant must pay an additional charge equal to five percent (5%) of the overdue Rent.

4. Condition of Land. Tenant has inspected the Land before signing this Lease. Tenant accepts the Land "AS IS" on the day Tenant signs this Lease. Landlord has made no promises or representations to Tenant concerning the condition of the Land.

5. Maintenance and Repair; Ownership of Tenant's Improvements. Tenant owns and is solely responsible for all improvements on the Land. Tenant agrees to maintain in good condition all improvements on the Land, including without limitation all dwellings, fixtures, sheds, outhouses, decks, fences, driveways, bridges, Shoreline Improvements (as defined in the Rules and Regulations) and all other structures or materials placed on the Land by Tenant or any former tenant, whether or not said improvement is affixed to the Land ("Tenant's Improvements"). At the expiration or earlier termination of this Lease, Tenant will leave the Land in at least as good condition as when this Lease began, except for normal wear and tear.

6. Non-Interference. Landlord may use the Land to operate Landlord's facilities, including without limitation Conowingo Hydro-Electric Station, Muddy Run Pumped Storage Facility and Peach Bottom Generating Station (the "Project"). Tenant understands that efficient and economical operation of the Project is the main purpose of Landlord's use of its property including the Land. Tenant understands that the Landlord's operation of the Project may limit Tenant's use of the Land from time to time. Regardless of what else this Lease says, Tenant will not interfere with Landlord's use of the Land or the use of the Land by Landlord or its affiliates for the Project. Tenant waives or gives up any rights to file a lawsuit against Landlord or its affiliates for anything relating to the maintenance, operation or new construction of the Project or the use of the Land for Landlord's corporate purposes.

7. Landlord Reservations. Landlord may grant easements (the right to use parts of the Land) over any part of the Land to others for any purpose, such as (a) roads and/or highways; (b) utility lines, either underground or overhead. All standing timber on the Land shall remain the property of Landlord. Tenant may not cut, remove or destroy any timber nor remove any rock, stone, gravel, soil or other material from the Land.

8. Rules and Regulations. Tenant's use of the Land is subject to all Laws and Landlord's rules and regulations, a copy of which is attached hereto as **Exhibit B** as they may be amended from time to time (the "Rules and Regulations"). Landlord shall provide Tenant with copies of all changes in the Rules and Regulations as they occur. FAILURE TO COMPLY WITH ANY OF THE LAWS AND THE RULES AND REGULATIONS WILL BE CONSIDERED A VIOLATION OF THE TERMS AND CONDITIONS OF THIS LEASE AGREEMENT AND MAY RESULT IN A FEE OF UP TO $250.00 PER DAY IMPOSED AGAINST TENANT BY LANDLORD AND/OR TERMINATION OF THE LEASE. In addition to Landlord's right and option to assess fees against Tenant and to terminate the Lease, Landlord has the right but not the duty to enter the Land and cure any violation of the Rules and Regulations or other terms and conditions of this Lease, and to assess all costs incurred by Landlord as a result of curing any such violation(s) against Tenant. ATTACHED HERETO AS **EXHIBIT C** IS THE CABIN AFFIDAVIT EXECUTED BY TENANT.

9. Use of Land. Tenant shall use the Land only for a vacation retreat and recreational activities. Tenant shall **NOT:**

(a) **USE OR OCCUPY THE LAND AS A PRIMARY PERMANENT RESIDENCE OR DOMICILE.** "Domicile" means the place at which a person has been physically present and that the person regards as home. "Residence" means the act or fact of living in a given place for a period of time with an intent to treat it as a home.

(b) Construct or install any new buildings, structures or other improvements on the Land or enlarge any buildings, structures or Tenant Improvements, without the prior written consent of Landlord in accordance with the procedures set forth in the Rules and Regulations and all Laws.

(c) Dispose of or store any toxic or hazardous substances, including but not limited to hazardous waste, on the Land.

(d) Disturb other tenants of Landlord.

(e) Interfere with the Landlord's use of the properties surrounding the Land.

(f) Dispose or store any flammable, explosive or hazardous materials on the Land.

(g) Engage in any commercial activities, including without limitation operating or leasing campgrounds or dock facilities.

10. No Representations. Tenant agrees that:

(a) Landlord makes no promises about the condition of the Land.

(b) Landlord is not required to make any repairs or alterations to the Land either now or in the future.

(c) Landlord is not required to maintain the Land, the surrounding property, or the Tenant Improvements, building or structures on the Land.

(d) Landlord is not required to provide any utility service to the Land, such as telephone, electricity, heat, water, gas, sewer or trash removal, regardless of whether such services exist at the time the Tenant signs this Lease.

11. Access. Tenant is responsible for acquiring and maintaining access to the Land. Landlord has no responsibility for providing, maintaining or improving access.

12. Inspection of Premises. Landlord, its employees and representatives may inspect the Land at any time without providing Tenant with notice.

13. Taxes. Landlord will pay real estate taxes on the Land, including Tenant's Improvements, unless real estate taxes on Tenant's Improvements are separately assessed and billed directly to Tenant. Landlord will send Tenant a bill for the real estate taxes and Tenant will reimburse Landlord for the real estate taxes as additional rent within thirty (30) days after the date of the bill.

14. No Waiver. Landlord is not required to enforce this Lease. If Landlord does not enforce a part of this Lease, this does not mean Landlord cannot enforce the same part, or a different part, later. The payment of Rent by Tenant after Tenant violates this Lease does not mean that the violation of this Lease is forgiven.

15. Compliance with Laws. Tenant agrees to comply at its expense with all Federal, state and local laws that apply to Tenant's Improvements or Tenant's use of the Land ("Laws"). It is Tenant's responsibility to be aware of all Laws that apply to the Land.

16. Indemnification. Tenant assumes responsibility for any action by Tenant, Tenant's contractors, representatives or guests on or near the Land. If a claim is made against Landlord because of something that Tenant, its contractors, representatives or guests do on the Land, Tenant shall pay all of Landlord's costs and expenses which occur because of the claim (including Landlord's attorney's fees). If Landlord pays any money in order to settle or defend the claim, Tenant shall pay Landlord the amount that Landlord paid.

17. Insurance. Tenant will be solely responsible for purchasing insurance to cover damage or theft of the Tenant's Improvements and personal property located on the Land as well as for liability and any other risks. Landlord does not provide any insurance coverage for the Tenant's interests. Tenant assumes responsibility for any action by Tenant, Tenant's contractors, representatives or guests which violates the Tenant's insurance policy.

18. Waiver of All Claims. Tenant understands and recognizes that, by signing this Lease, Tenant waives any and all claims against Landlord relating to the Land, Tenant's Improvements or personal property thereon or any previous leases of the Land. This includes, but is not limited to, claims for lost value of Tenant's property; lost use of the Land; or, loss, removal or destruction of Tenant's Improvements or personal property. Tenant further waives any claims for damages grounded upon an expectation of future gain, restitution or unjust enrichment.

19. Default. Tenant shall be in default under this Lease, if any of the following occur (each an "Event of Default"):

(a) Tenant does not pay the Rent, additional rent or other amounts Tenant is required to pay under this Lease when it is due and fails to make payment to Landlord of the overdue Rent within five (5) days written notice from Landlord;

(b) Tenant violates any part of this Lease or the Rules and Regulations or misrepresents any facts as to occupancy and fails to cure such violation within thirty (30) days after receipt of notice from Landlord to cure such violation;

(c) Tenant has not used or occupied the Land for more than twelve (12) consecutive months;

(d) Tenant occupies the Cottage as a domicile, primary or permanent residence;

(e) Tenant permits anyone else to occupy the Cottage as a domicile, primary or permanent residence;

(f) Tenant becomes insolvent or files for bankruptcy; or

(g) Tenant's rights to the Land are sold under execution or other legal process.

After the expiration of applicable cure periods, Landlord shall have all rights and remedies allowed by law and equity, including, without limitation, the right to terminate this Lease by sending written notice to Tenant. If Landlord does not immediately terminate the Lease after Tenant violates this Lease, Landlord can terminate the Lease at a later date.

20. Removal of the Tenant's Property. Prior to the expiration of this Lease or within ninety (90) days after the earlier termination of this Lease due to an Event of Default or otherwise, Tenant shall remove all of Tenant's Improvements and personal property, including trailers, mobile homes and personal belongings, owned by Tenant and restore the Land to a condition satisfactory to Landlord, unless Landlord has previously approved the sale of the Tenant's Improvements in accordance with the Rules and Regulations and has issued a new lease to the purchaser of the Tenant's Improvements. In the event Tenant fails to remove the Tenant's Improvements and personal property prior to the expiration of this Lease or within ninety (90) days after the earlier termination of this Lease, then the Tenant's Improvements and personal shall become the property of Landlord without any further act or notice by Landlord to Tenant. Landlord may thereafter occupy, sell, lease, repair or remove Tenant's Improvements and personal property. However, in the event Landlord elects to remove Tenant's Improvements and personal property, Tenant agrees to pay Landlord the cost incurred by Landlord for such removal within thirty (30) days of receipt of a bill from Landlord.

21. Notices. All notices under this Lease, shall be deemed to have been properly given only when written notice has been served by (i) personal delivery, (ii) by certified mail, return receipt requested, or (iii) by recognized overnight carrier, to the other party at its address as follows:

If to Landlord:

Exelon Generation
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road
Darlington, MD 21034

If to Tenant:
XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX

If a notice sent to Tenant by certified mail is not accepted by Tenant, Landlord may post the notice at the Land.

22. Brokerage Commissions. There are no commissions or fees to be paid to any real estate broker or salesperson for this Lease. If Tenant has agreed to pay any commission or fee to a real estate broker, Tenant will pay that commission or fee. If Landlord has agreed to pay any commission or fee to a real estate broker, the Landlord will pay that commission or fee.

23. Federal Energy Regulatory Commission ("FERC"). The Land is part of a project licensed by the Federal Energy Regulatory Commission (FERC). Because of the FERC License the following requirements apply:

(a) Tenant's use of the Land will not endanger health, create a nuisance or otherwise be incompatible with the recreational use on any part of Landlord's land. Tenant will take all reasonable precautions to ensure that the use and maintenance of the Land will protect the scenic, cultural, recreational and environmental value of the Land.

(b) Landlord may terminate this Lease if Landlord's License from FERC is terminated. If Landlord terminates the Lease for this reason, Landlord will give Tenant thirty (30) days notice before the termination date.

24. Floods. Tenant waives or gives up any claims against Landlord for flooding by water or the presence or flow of ice on the Susquehanna River or any of its tributaries.

25. Severability. If any part of this Lease is not legal for any reason, the rest of this Lease shall continue to be valid and enforceable.

26. Governing Law. This Lease is made in the Laws of the Commonwealth of Pennsylvania.

27. Legal Action. A lawsuit regarding this Lease may only be filed in the county where the Land is located, or in the United State District Court in the state in which the Land is located and in the division closest in proximity to the Land. BOTH PARTIES ALSO WAIVE THEIR RIGHT TO A TRIAL BY JURY IF A LAWSUIT IS FILED REGARDING THIS LEASE AGREEMENT. Tenant shall pay Landlord all of its costs and expenses, including without limitation attorneys' fees, incurred by Landlord in enforcing Tenant's obligations under this Lease whether or not Landlord files a lawsuit against Tenant.

28. No Assignment. Tenant shall not assign, sublease or otherwise transfer or encumber this Lease without the prior written consent of Landlord. Tenant shall make all requests for Landlord's consent to assignment in accordance with the Rules and Regulations. Any assignment without the prior written request of Landlord shall be null and void.

29. Entire Agreement. This Lease replaces and cancels all other leases between Landlord and Tenant for the Land. Tenant understands the promises in this Lease shall be binding upon Tenant. This Lease contains the full and complete agreement between Tenant and Landlord. Any change, modification or waiver of the promises in this Lease may only be made by a written agreement signed by Landlord and Tenant. No promises were made by Landlord to Tenant other than those promises contained in this Lease.

EXECUTED BY THE PARTIES ON THE NEXT PAGE

Landlord and Tenant, intending to be legally bound, agree to the terms of this Lease effective as of the Effective Date.

TENANT(S):

XXXXXXXXXXXXXXXXXXXXXXXXXX
Signature

XXXXXXXXXXXXXXXXXXXXXXXXXX
Print Name

XXXXXXXXXXXXXXXXXXXXXXXXXX
Signature

XXXXXXXXXXXXXXXXXXXXXXXXXX
Print Name

LANDLORD:

EXELON GENERATION COMPANY, LLC

BY:_____

File No. _____
Initials _____

CABIN AFFIDAVIT (Lease Exhibit C) **Type** or **print legibly**

Cabin Identification & Location:

Exelon Cottage Identification Number (CIN) _____ See Attachment A for Map

Street Number & Name (EMS) _____

Township, Borough or City Name _____

County and State _____

Cabin Owner/Tenant Name(s): – Must List all Cabin Owners/Tenants

Owner/Tenant 1 _____ Owner/Tenant 2 _____

List Any Other Owners/Tenants _____

Cabin Owner/Tenant Primary Addresses – Must Be Physical Address and Not PO Box:

Owner/Tenant 1:
Street Number & Name _____

City, State & Zip Code _____

Owner/Tenant 2:
Street Number & Name _____

City, State & Zip Code _____

Owner/Tenant Other:
Street Number & Name _____

City, State & Zip Code _____

Owner/Tenant Attestation:

I attest to the fact that the cabin identified above:

1. Will be utilized for recreational activities only.
2. Will not be utilized as a domicile ("domicile" means the place at which a person has been physically present and that the person regards as home), permanent or primary residence ("residence" means the act or fact of living in a given place for a period of time with an intent to treat it as a home) by myself or any other person for any period of time.
3. Will not be used for any commercial purposes or as a place of employment.
4. Will not exceed two stories in height (excluding the basement, if any).
6. Will not be a mailing address for bills or correspondence.
7. Will not be listed as any individual's place of residence on a tax return, driver's license, vehicle registration or voter registration.

For each Owner/Tenant provide two of the following showing name and primary address:☐ tax return,

☐ driver's license, ☐ vehicle registration, ☐ voter registration, ☐ passport, ☐ recent pay stub, ☐ recent utility bill.

I solemnly affirm under the penalties of perjury and upon personal knowledge that the contents of this document are true and correct.

_____
Owner/Tenant 1 Signature / Date

_____
Owner/Tenant 2 Signature / Date

_____
Owner/Tenant Other Signature / Date

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ATTACHMENT 4

Exelon Cottage Program - Tenant Information Collection/Change Form

Cottage Identification # (CIN): _____

Today's Date: _____

Cottage Address: _____

Tenant Contact Information (all fields required)

Primary Residence (not a PO Box):

Address:_____ City/State/Zip:_____

Home Phone:_____ Cell Phone(s): _____

Other/Work/Cell Phone(s) if you wish to list: _____

Email address(s): _____

If mail needs to be sent to a PO Box:

Address:_____ City/State/Zip:_____

If the above includes changes from prior contact information please list the old address, phone # and/or email that is being replaced:

_____

_____

All Tenants listed on the Lease must sign below verifying the above information:

CURRENT TENANT(S):

_____
Signature

_____
Print Name

CURRENT TENANT(S):

_____
Signature

_____
Print Name

Return completed form to:
Exelon Generation
Conowingo Hydroelectric Generating Station
Attn: Cottage Program Manager
2569 Shures Landing Road; Darlington, MD 21034
Questions: 1-610-765-5200

APPENDIX D. RULES AND REGULATIONS GOVERNING USE AND OCCUPANCY OF LEASED PREMISES

RULES AND REGULATIONS
GOVERNING THE USE AND OCCUPANCY
OF LEASED PREMISES

GENERAL CONDITIONS

A. General Information

All questions, complaints, and problems should be directed to:
Real Estate & Facilities
PECO Energy Company
2301 Market Street, N3-3
Philadelphia, PA 19101.

Telephone: (215) 841-5409

B. General Conduct

1. Tenants and their guests shall not permit any noise, or other disturbance to interfere with the quiet enjoyment of others.

2. Tenants and their quests shall exercise great care to avoid the possibility of fire. No open fires are permitted except in properly constructed barbecue pits, or trash burning containers, and any burning must comply with local ordinances.

3. Tenants are responsible for the actions of their guests.

4. A six (6) digit Cottage Identification Number (C.I.N.) will be assigned to each Tenant and is to be placed on the outside wall of the cottage facing the water, and must be visible from the water. If the cottage is accessible from a road or fronts on a road, the C.I.N. must also be placed on the side of the cottage facing the road. All numbers must be at least 4 inches high.

5. All dogs must be kept securely tied or on a leash at all times.

6. Tenant must report possible hazardous conditions to the Landlord immediately upon discovery.

7. Tenant shall be responsible for the correction and/or control of any erosion caused by or resulting from improvements, and/or changes made to, or on the leased premises. Landlord may require Tenant to rectify any erosion problems on or affecting the leased premises.

However, Landlord has no duty to Tenant to correct any erosion problems.

IMPROVEMENTS

A. New Construction or Additions (Application Procedure)

1. A BUILDING LICENSE APPLICATION must be submitted (with all appropriate attachments and a check for application fee) to Landlord prior to beginning any new construction or additions, removals, or repairs which alter existing structures. (Application forms may be obtained from the Landlord in Philadelphia).

2. If the application is approved, Tenant will be notified in writing by Landlord. Tenant must then obtain a Building Permit from the local municipality. A copy of the Building Permit must be forwarded to Landlord prior to beginning any work.

3. Landlord will then issue a Building License which must be displayed in a prominent, visible location at the construction site along with the required local municipality Building Permit. If a Municipal Permit is not required, the Building License will be issued upon approval of the application by Landlord.

4. Set back regulations are variable based on site conditions, are guided by local regulations where applicable, and will be specified in the approval of the application issued by Landlord.

5. Within 30 days of completion of the approved construction, photographs of the completed construction must be submitted to Landlord.

6. Some construction projects may require permits in addition to the Municipal Building Permit. Tenants are responsible for obtaining any additional permits or approvals required by the appropriate government agencies. (The table at the end of these rules and regulations is intended as a guide to the permits or approvals required by the various agencies for specified construction activities. It is suggested that you consult with the appropriate agency prior to beginning construction.) Copies of all required permits or approvals must be submitted to Landlord before construction can begin.

7. Landlord must be notified in writing anytime a building or other improvement is to be razed or removed. The area must be

restored to a condition satisfactory to Landlord which shall include but is not limited to establishing the appropriate vegetative cover.

B. Maintenance

1. The leased premises and all improvements must be maintained in good repair and appearance. Landlord may require a Tenant to make repairs and perform necessary maintenance, including but not limited to painting, removal of junk, trash, vehicles, or other detractions from a neat and orderly appearance.

2. Improvements should not present a hazard to Tenants, or other persons or property.

3. Landlord may require conditions which it deems to be hazardous, or environmentally damaging, corrected to Landlord's specifications.

4. All chimneys must be fireproof and constructed of tile, brick, stone, or other approved material, and equipped with spark arresters.

C. Sale of Cottage (Application Procedure)

1. An "APPLICATION FOR SALE" form must be completed and submitted to Landlord at least 45 days prior to the date of settlement for the sale of the cottage. (Forms are available from Landlord or at the Recreation Office.)

2. A check for the current processing fee (as stated on the application) must accompany the completed form.

3. If the "APPLICATION FOR SALE" is approved, a new Lease Agreement will be issued prior to the settlement date, which shall be properly executed by the new owner at settlement and returned to Landlord for Landlord's execution, along with a valid Bill of Sale. A fully executed copy of the Lease Agreement will then be forwarded to the new owner.

4. All Sales Agreements must contain a statement that only the personal property of the Tenant is being sold and that no land or land rights are included in the sale. Bills of Sale must contain the same statement.

5. Installment Sales Agreements or Lease Purchase Agreements which are intended to give possession of the cottage to the buyer

while the current Tenant (seller) holds the existing Lease Agreement are not permitted.

6. Current Tenant must inform the prospective Tenant of all rules and regulations.

ROADS

A. Construction of new roads or alterations to existing roads (Application Procedure)

Written permission is required from Landlord for the construction of new roads or the alteration of existing roads. A sketch indicating the location of the road must accompany the Building License Application submitted to Landlord.

B. Maintenance of existing roads

1. Roads must be maintained in good condition, with proper drainage and meet with Landlord's specifications.

2. Landlord may require that a road be repaired to its satisfaction or the use of the road must be discontinued.

3. Tenants are responsible for maintenance and general upkeep of non-public roads in cottage areas, in common with other users.

TREES

1. No trees shall be injured or damaged, by Tenants or their guests. The attaching of lights, electric lines, clothes lines, docks, etc., either on a temporary or permanent basis is prohibited. Care must be taken during construction to prevent injuring trees, and if necessary, temporary protective shields shall be installed around the trees.

2. No trees (over 2 inches in diameter) can be cut without prior written permission of Landlord. If a tenant desires to cut down or remove significant portions of a tree, they must first obtain written permission from Landlord. Requests should be directed to the Recreation Office.

3. Requests for tree removals can only be made by the current Tenant.

4. Tenants are responsible for correcting hazardous tree conditions on or adjoining the leased premises. Landlord may notify the Tenant of any trees that Landlord believes should be removed. It will be the responsibility of the Tenant to have such trees removed. If such trees are not removed within the specified time period, Landlord at its option my terminate the Lease and/or remove the tree at the Tenant's expense.

WATER

1. All use of water by Tenant, in and about the leased premises, shall be at the sole risk of Tenant. Landlord makes no representations with regard to the water nor has it caused any of said water to be analyzed. If Tenant is using or intends to use any water for domestic purposes, it is suggested for Tenant's own protection, that before doing so and periodically thereafter, Tenant shall have said water tested by an approved lab for the purpose of determining the feasibility of safety using the water. All costs incurred in connection with such tests shall be the responsibility of the Tenant. Landlord assumes no liability for, or on account of any water used by Tenants or their guests.

2. No exclusive rights are given or inferred as being given as to the use of any water or spring, even though a spring may be located on the leased premises. Adjoining Tenants may use such water but may not unreasonably interfere with the enjoyment or use of the leased premises where the water is located.

3. All waterlines crossing roads must be buried to a depth of at least 30 inches.

SANITARY REQUIREMENTS

1. In the event a septic system does not exist on an improved site, said site must be provided with a sanitary toilet, with a vault at least four (4) feet in depth from the surface of the ground. No toilet shall be located closer than one hundred (100) feet to any spring, stream, or other water source of supply.

2. Before initiating the construction of any septic system, tenant shall consult with the appropriate county or township health department and obtain the necessary approval(s).

3. In the event a sanitary sewer system is installed in the area, Tenant shall be required to connect into the system, whereupon

tenant shall be responsible for all connection, maintenance, and operation fees or costs.

4. If garbage and/or trash is not removed from the area on a weekly (or more often) basis, each site must be provided with a garbage pit at least three (3) feet square and three (3) feet deep, and shall have a tight wooden (or other suitable material) cover. All trash and garbage must be kept in a closed container.

5. The toilet and/or garbage pit must be maintained in a good and sanitary condition.

6. In a situation where there is a difference between these regulations and the local ordinances or other regulations, the more stringent of the two shall apply.

SHORELINE PROTECTION PROGRAM

General Information (Application Procedure)

1. Anyone desiring to construct, replace, expand, or do major repairs to a pier (or dock), boathouse, boat ramp, marine railway, bulkhead, retaining wall, install any erosion control measures, or excavate in any areas that may affect the pond (or river) shoreline must submit a "BUILDING LICENSE APPLICATION" to Landlord with all appropriate attachments and/or application fees.

2. The applicant is responsible for obtaining all necessary permits (or other forms of permission) from the responsible government regulatory agencies. The table at the end of these rules and regulations is intended as a guide to the permits required by the various agencies for specified construction activities. Copies of all necessary permits or approvals must be sent to Landlord before construction can begin. Following completion of construction, photographs showing the new or modified structures must be submitted to Landlord. Landlord suggests that the Tenant consult with the appropriate agencies to determine what permits may be required before submitting the BUILDING LICENSE APPLICATION.

Specifications and Procedures

NOTE: The shoreline is considered to be the existing shoreline at mean high water.

A. Piers or Docks

1. Piers may be either permanent, floating, or a combination of both and may not exceed a total length of 50 feet (or extend more than 50 feet from the shoreline). If the pier is located in a cove or in a stream, the length may not exceed 25% (1/4) of the width of the cove or stream where the pier is located.

2. The width of the pier may not encroach across the projected lot lines or exceed 30 feet in width (whichever is less). A variance of this provision may be granted if the pier is used in common with other Tenants, permittees or licensees.

3. All permanent piers (or permanent sections of piers) must be built above the mean high water line.

4. Piers must be constructed of preservative treated lumber and pilings. Concrete, masonry, and metal construction is not permitted. Handrailings and covers on piers are permitted provided that the sides are open so as not to obscure cross vision. Covers are permitted only over the pier itself and may not extend out over the water.

5. Flotation devices for floating piers must be constructed of styrofoam billets or floats, or equivalent construction. Barrels or similar flotation devices are not permitted.

6. Piers may not interfere with navigation, present a safety hazard, or block ingress or egress to adjoining areas.

7. If an existing pier must be replaced or repaired (other than minor repairs), it must conform to current standards.

8. Piers may not be anchored or tied to trees at any time.

B. Boat Ramps and Marine Railways

1. Ramps must be constructed of poured concrete pads or precast concrete panels properly anchored and fastened together. Asphalt or other petroleum based products are prohibited.

2. Ramps may not exceed 15 feet in width and 30 feet in length. The length should not exceed that necessary to be functional.

3. Marine railways may use either treated wood or concrete ties.

4. Marine railways may not exceed 15 feet in width and should be no longer than necessary to be functional. Landlord may, however, restrict the length because of site conditions.

C. Erosion Control Measures (Bulkheads, Retaining Walls, Sea Walls, Rip Rap, etc.)

Anyone desiring to construct a bulkhead or other erosion control measure must submit a "Building License Application" to Landlord. A Division representative will make an on-site inspection of the area to determine if what the applicant has proposed should be allowed or if another type of measure may be more appropriate. If the Division approved of the proposed measure, the applicant must obtain the appropriate government agency permits or approvals before a "Building License" will be issued.

1. No erosion control measure shall significantly alter the existing shoreline.

2. The planting of vegetative cover and/or rip-rapping shall be used if adequate to control the problem.

3. Bulkheads and retaining walls must be constructed of preservative treated wood, concrete, or masonry.

4. The structure shall not significantly detract from the scenic value of the area.

CULTURAL RESOURCE PROTECTION GUIDELINES

PECO Energy Company has developed, in cooperation with the Pennsylvania Bureau of Historic Preservation and the Maryland Geological Survey, Division of Archeology, the following rules and regulations, which apply to all land owned by the Company and its subsidiaries. The specific intent of these regulations is to provide for the protection of cultural resources, and to avoid any disturbance of historic and prehistoric sites except when justified for scientific purposes and/or when performed in accordance with such State and Federal regulations and guidelines as may apply.

1. No one shall mar, deface, remove, destroy or in any other way damage, any standing structure, ruins, foundation or other man-made feature of a potentially historic nature on lands of PECO Energy Company (PECO Energy) or its subsidiaries, without first having obtained the written permission of Landlord.

2. No one shall perform any sub-surface archaeological investigations, or in any way disturb the soil for the purpose of searching for and/or obtaining historic or prehistoric artifacts on land of PECO Energy or its subsidiaries without having first obtained the written permission of Landlord, nor shall same be performed without the prior knowledge and written sanction of the following:

In Pennsylvania, The Bureau of Historic Preservation; In Maryland, The State Historic Preservation Officer and/or the Geological Survey, Division of Archeology.

a. Full and complete reports must be prepared. Said reports shall incorporate maps, site profiles, descriptions and photographs of artifacts and features, soil descriptions, topography, excavation procedures, directions and distance to the nearest water and all such other related details as may be required;

b. Landlord shall be supplied with a copy of each report so generated. The appropriate State agency shall be supplied with two copies of same, one of which shall contain original photographs;

c. All artifacts and related material recovered in sub-surface investigations shall become the property of PECO Energy, and shall be turned over to the respective State agency. Same shall remain available to PECO Energy and other responsible public and private organizations and agencies for the purpose of study and/or public display;

d. All artifacts must be properly labeled with site number and lot and must be readily identifiable by pit and level. Site numbers must conform to the trinomial numbering system adopted by both Pennsylvania and Maryland.

e. All burials encountered during the course of such archeological investigations shall be treated with the highest respect, and shall be handled on a case by case basis under the strict control of the State agency having jurisdiction. It is the policy of said agencies and of PECO Energy, to discourage the removal or disturbance of human remains, unless there is a significant scientific purpose to be served by same, and unless provisions are made, in

consultation with, and with the approval of living descendants of the interred, for the timely study and the ultimate reburial of the remains.

3. While the collection of artifacts from the surface is widespread, and though not strictly prohibited under these regulations, it does have a significantly negative effect on archeological sites. The distribution of surface artifacts is the only information available for many sites. Those finding artifacts are therefore encouraged to report finds to Real Estate & Facilities (R. T. Stark, 215-841-5193), PECO Energy Company, 2301 Market Street, Philadelphia, PA 19101, so that same might be photographed and recorded.

4. Tenant is required to consult with the appropriate State Preservation Office prior to any construction work that may affect surface or sub-surface archaeological sites, and prior to new additions to existing structures or the construction of new structures. Evidence of such consultation must be supplied to Landlord before a Building License will be issued.

Note: On property which is within the boundaries of Federally-regulated projects such as the Conowingo Hydro-Electric Project (F.E.R.C. No. 405), tenants' properties require additional precautions regarding cultural resources under the provisions of the National Historic Preservation Act of 1978 (section 106), Executive Order 11593, and the regulations of the Advisory Council on Historic Preservation (36 CFR 800).

FAILURE TO COMPLY WITH ANY OF THESE RULES AND REGULATIONS WILL BE CONSIDERED A VIOLATION OF THE TERMS AND CONDITIONS OF THE LEASE AGREEMENT AND MAY RESULT IN EITHER A $250.00 FINE LEVIED AGAINST THE TENANT OR POSSIBLE TERMINATION OF THE LEASE AGREEMENT.

River Basin Permit Section (COE)
Baltimore District
U. S. Army Corps of Engineers
P. O. Box 1715
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Water Resources Administration (WRA)
Maryland Department of Natural Resources
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State Administrator of Archeology
Maryland Historical Trust (MHT)
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21 State Circle
Annapolis, MD 21401

Executive Director
Pennsylvania Fish Commission (PFC)
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Harrisburg, PA 17120

Division of Waterways and Stormwater Management (DER)
Pennsylvania Department of Environmental Resources
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Bel Air, MD 21014

Office of Planning and Economic Development
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Drumore Township Supervisors
R. D. #1
Drumore, PA 17518

Fulton Township Supervisors
R. D. #1
Peach Bottom, PA 17563

Peach Bottom Township Supervisors
R. D. #1
Delta, PA 17314

Lower Chanceford Township Supervisors
R. D. #2
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Cecil Soil Conservation District
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Elkton, MD 21921

York County Conservation District
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York, PA 17402

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Room 6, Farm and Home Center
1383 Arcadia Road
Lancaster, PA 17601

APPENDIX E. DRONE USE REQUIREMENTS

Drone Use Requirements

1. Purpose

This document is intended to ensure proper drone use on Exelon property and compliance with all Federal, State, and Local guidelines.

These requirements apply to small unmanned aerial systems (sUAS, UAS, or drone), that is a drone weighing less than 55lbs as defined by the Federal Aviation Administration (FAA), and applies to recreational and commercial drone users on Exelon property.

These requirements are intended to supplement Federal, State, and local regulations regarding drone use. If Federal, State, Local, or Exelon guidelines change, the most current regulations must be followed when using drones on Exelon property.

2. Overview

All drone flights must be pre-approved by Exelon prior to any flights being conducted. No drone pilot may fly a drone within 1 mile of any power generation station including Conowingo Dam, Muddy Run Pump Storage facility or Peach Bottom Nuclear Power Plant. All drone pilots flying drones on Exelon property must be Part 107 certified and their certification must be current. All drone pilots must obey current FAA Tile 14 of the Code of Federal Regulations (14 CFR) Part 107 requirements. Refer to the FAA website for the most current regulations. No autonomous drone flights are permitted. All drones weighing more than 0.55lbs must have a current registration with the FAA. Drone pilots must report any incidents to Exelon that are reportable to the FAA in addition to any incidents resulting in damage to Exelon property or any person on Exelon property within 10 days of the incident. Any suspicious drone activity should be reported to local law enforcement.

1.1 General Guidelines

All drone pilots are required to follow the most current Federal, State, and local regulations including, but not limited to, the following:

- The drone may only be operated by a FAA Part 107 certified remote pilot (remote pilot in command)
- No one person may act as the remote pilot in command for more than one UAS at a time.
- The UAS must remain in the visual line-of-sight of the remote pilot in command. That is close enough to be seen without the aid of any device other than corrective lenses.
- Any drone weighing more than 0.55lbs must be registered with the FAA and a current registration must be maintained.
- The drone must only be operated during daylight hours, or during civil twilight (30 minutes before official sunrise to 30 minutes after official sunset, local time, with proper anti-collision lights.
- The drone must not exceed a ground speed of 100mph.
- The drone must not exceed a maximum altitude of 400 feet above ground level (AGL), or if higher than 400 feet AGL, the drone must remain within 400 feet of a structure.
- The drone must not carry any hazardous materials.
- The remote pilot in command must not operate a UAS if the pilot knows of any physical or mental condition that would interfere with the safe operation of the UAS.

- The remote pilot in command must inspect the drone prior to any flight activities.
- The UAS must not be operated in a reckless or careless manner.
- A visual observer, that is an additional person to aid the remote pilot in command in keeping aware of all surroundings, is encouraged but not required.

1.2 Environmental Guidelines

Once approved by Exelon, the drone operator must also follow the most current Federal, State, and local guidelines as well as minimize impact on the environment by following the environmental guidelines outlined below.

- Drone pilots should use take-off/landing pads to minimize soil or ground disturbance.
- All drone pilots shall review 1) Bald Eagle Management Plan, 2) Best Management Practices for Occupied Osprey Nests in Pennsylvania and 3) Bat Protection Measures for the Project, prior to flying drones on Exelon property. Drone flights must not interfere with Bald Eagles, Osprey, bats, or any other wildlife or habitat.
- Drone pilots should be aware of nesting & breeding seasons and do not fly close to Bald Eagle, Osprey or other nests.
- Drone pilots should fly the drone on a calm, clear day to ensure visual line of sight as well as better control over take-off and landing spots.
- Drone pilots and visual observers should stay on designated walking paths to minimize habitat disturbance.
- Drone pilots should be aware of the presence of the drone. Both the sight and sound can be disruptive to wildlife as well as other people in the vicinity.

2. References and Additional Resources

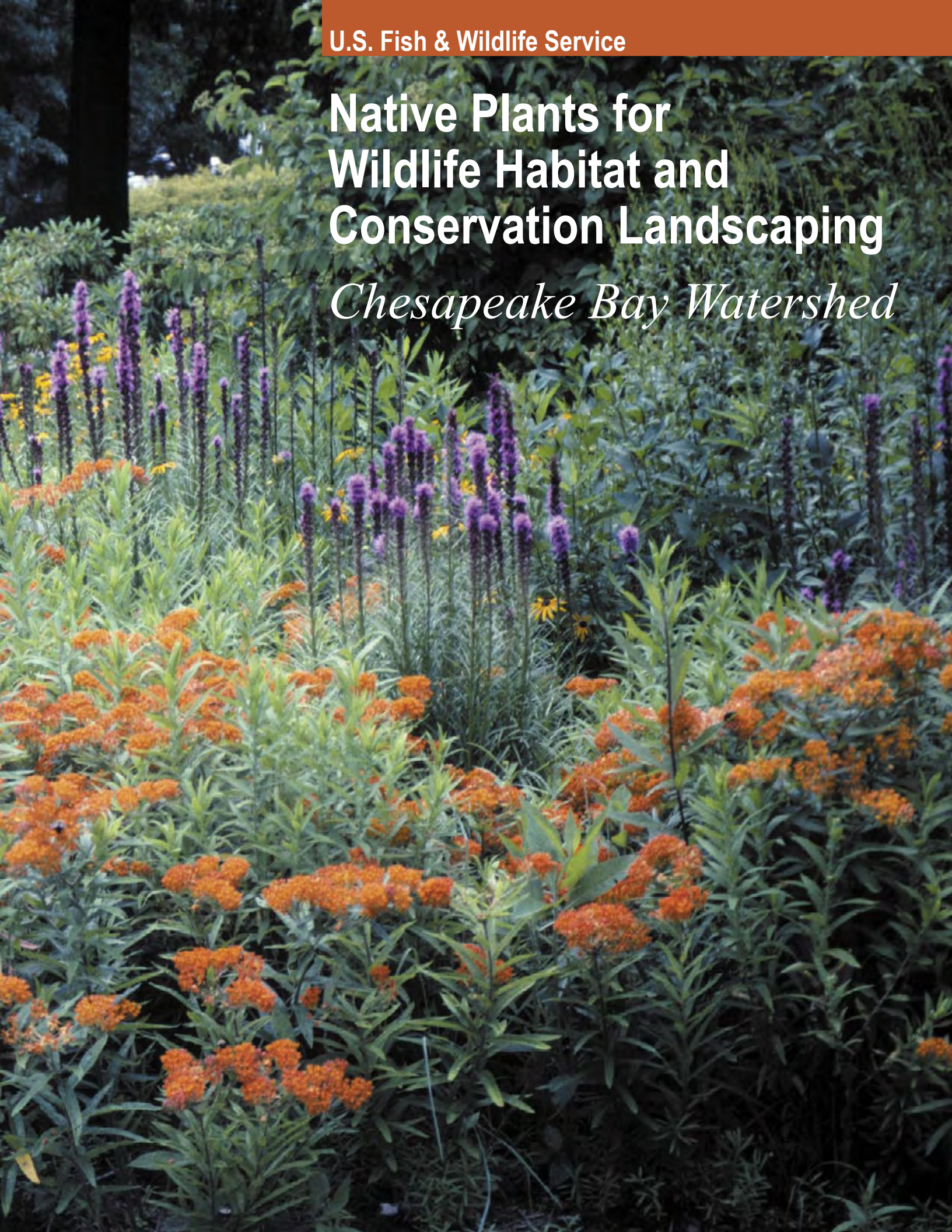
- The FAA website
  - https://www.faa.gov/uas/
- FAA Title 14 of the Code of Federal Regulations Part 107 – Small Unmanned Aircraft Systems
  - Electronic Code of Federal Regulations (eCFR)
- Final Rule on Operation of Small Unmanned Aircraft Systems Over People
  - Operations Over People General Overview (faa.gov)
- The FAA Reauthorization Act of 2018
  - FAA Reauthorization

APPENDIX F. NATIVE PLANTS FOR WILDLIFE HABITAT AND CONSERVATION LANDSCAPING

U.S. Fish & Wildlife Service

Native Plants for Wildlife Habitat and Conservation Landscaping

Chesapeake Bay Watershed



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Reviewers: species included in this guide were reviewed by the following authorities regarding native range, appropriateness for use in individual states, and availability in the nursery trade:

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2003

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To the Reader

The use of native plants in landscaping and of course habitat restoration is certainly not new. In fact, their use has grown exponentially in recent years. Natural resources professionals in turn have been flooded with requests for information on native plants to use in various types of planting projects. Communities, schools, businesses, nonprofit organizations, watershed groups, local governments, state and federal agencies and many others are enhancing and restoring habitat, solving ecological problems, reducing maintenance, or just beautifying surroundings, all using locally native plants. Natural resources professionals, in turn, have been flooded with requests for information on native plants to use in various types of planting projects. There are many excellent resources available on native plants - some more technical than others, some more comprehensive than others. The frustration voiced most frequently by users is the lack of color photographs of the plants. After all, it is the striking visual quality of these plants that is their best “selling point.”

This publication includes those pictures as well as user-friendly information on native species appropriate for planting in the Chesapeake Bay watershed and adjacent coastal regions. Although one guide cannot furnish the answers to every question, we have included as much useful information as possible in a limited space. Although the large number of species of plants included here may overwhelm some readers, this guide displays the great diversity of plants available. We hope you will bypass the over-used, non-native and sometimes invasive ornamental plants, and select the equally and often more attractive native plants. Pour through this guide the same way you look through nursery catalogs. Use it to plan and design your next planting, whether it’s a small corner of your front yard, a two-acre meadow seeding, or 100 acres of wetland restoration.

Native Plants for Wildlife Habitat and Conservation Landscaping:
Chesapeake Bay Watershed

Introduction

"Conservation landscaping" refers to landscaping with specific goals of reducing pollution and improving the local environment. In the Chesapeake Bay watershed (the land that drains to the Bay and its many tributaries), this style of landscaping is sometimes called "BayScaping," or beneficial landscaping.

Conservation landscaping provides habitat for local and migratory animals, conserves native plants and improves water quality. Landowners also benefit as this type of landscaping reduces the time and expense of mowing, watering, fertilizing and treating lawn and garden areas, and offers greater visual interest than lawn. Beneficial landscaping can also be used to address areas with problems such as erosion, poor soils, steep slopes, or poor drainage.

One of the simplest ways to begin is by replacing lawn areas with locally native trees, shrubs and perennial plants. The structure, leaves, flowers, seeds, berries and other fruits of these plants provide food and shelter for a variety of birds and other wildlife. The roots of these larger plants are also deeper than that of typical lawn grass, and so they are better at holding soil and capturing rainwater.

Benefits of conservation landscaping

Americans manage approximately more than 30 million acres of lawn. We spend $750 million per year on grass seed. In managing our yards and gardens, we tend to over-apply products, using 100 million tons of fertilizer and more than 80 million pounds of pesticides annually. The average homeowner spends 40 hours per year behind a power mower, using a quart of gas per hour. Grass clippings consume 25 to 40% of landfill space during a growing season. Per hour of operation, small gas-powered engines used for yard care emit more hydrocarbon than a typical auto (mowers 10 times as much, string trimmers 21 times, blowers 34 times). A yard with 10,000 square feet of turf requires 10,000 gallons of water per summer to stay green; 30% of water consumed on the East Coast goes to watering lawns.

The practices described in this guide reduce the amount of intervention necessary to have attractive and functional landscaping. Conventional lawn and garden care contributes to pollution of our air and water and uses up non-renewable resources such as fuel and water. Many typical landscapes receive high inputs of chemicals, fertilizers, water and time, and require a lot of energy (human as well as gas-powered) to maintain. The effects of lawn and landscaping on the environment can be reduced if properties are properly managed by using organic alternatives applied correctly, decreasing the area requiring gas-powered tools, using native species that can be sustained with little watering and care, and using a different approach to maintenance practices.

With conservation landscaping, there is often less maintenance over the long term, while still presenting a "maintained" appearance. Conservation landscapes, like any new landscape, will require some upkeep, but these alternative measures are usually less costly and less harmful to the environment. New plants need watering and monitoring during the first season until they become established. Disturbed soil is prone to invasion by weeds - requiring manual removal (pulling) instead of chemical application. Over time, desired plants spread to fill gaps and natural cycles help with pest control. Garden maintenance is reduced to only minimal seasonal cleanup and occasional weeding or plant management. The savings realized by using little or no chemicals, and less water and gas, can more than make up for initial costs of installing the landscaping. Redefining landscaping goals overall and gradually shifting to using native species provide even greater rewards in terms of environmental quality, landscape sustainability, improved aesthetics, cost savings, and bringing wildlife to the property.

Why use native plants?

Native plants naturally occur in the region in which they evolved. While non-native plants might provide some of the above benefits, native plants have many additional advantages. Because native plants are adapted to local soils and climate conditions, they generally require less watering and fertilizing than non-natives. Natives are often more resistant to insects and disease as well, and so are less likely to need pesticides. Wildlife evolved with plants; therefore, they use native plant communities for food, cover and rearing young. Using native plants helps preserve the balance and beauty of natural ecosystems.

This guide provides information about native plants that can be used for landscaping projects as well as large-scale habitat restoration. All of the plants presented are native to the designated areas, however not *all* of the native species for that area have been included. Rather, plants have been included because they have both ornamental and wildlife value, and are generally available for sale. This guide covers the entire Chesapeake Bay watershed, including south central New York; most of Pennsylvania, Maryland and Virginia; the District of Columbia; Delaware, west of Delaware Bay; and the eastern panhandle of West Virginia.

The region's wildlife, plants, habitats and network of streams and rivers leading to the Bay are tremendous resources. As the human population throughout the Chesapeake Bay watershed grows and land-use pressures intensify, it is increasingly important to protect our remaining natural areas and wildlife, and restore and create habitat. By working together, these treasures can be conserved for future generations. Individual projects are great, collective measures are even better, yet every action helps no matter what size.

Conservation landscaping elements

We can incorporate elements of natural systems into the existing areas where we live, work, learn, shop and play. Landscaping provides valuable opportunities to reduce the effects of the built environment. These areas can be both aesthetically pleasing and functional. Use of native species will make your garden or landscaping more environmentally beneficial. By combining plant selection with some of the other concepts below, you can achieve more environmental benefits.

Reduce disturbance. Carefully decide where new development will occur to avoid destruction of existing habitat as much as possible. Take advantage of the site's existing natural features.

Reduce lawn or high maintenance areas. Replace turf or ornamental plantings by adding new landscaping beds and/or enlarge existing ones with native plants.

Think big, but start small. Draw up a plan for your entire yard but choose one small area for your first effort. Trial and error with the first project will help you learn without being overwhelmed. Phase in the whole project over time.

Use native plants. Start by using natives to replace dead or dying non-native plants, or as a substitute for invasive non-natives in existing gardens or landscaping. Plan to use native plants in new landscaping projects.

Avoid invasive species. Non-native plants can be invasive. They have few or no naturally occurring measures to control them, such as insects or competitors. Invasive plants can spread rapidly and smother or out-compete native vegetation. Invasive, non-native plants are not effective in providing quality habitat. A copy of the publication "Plant Invaders of Mid Atlantic Natural Areas" can be downloaded from www.nps.gov/plants/alien/pubs/midatlantic/index.htm.

Improve water quality. Native species planted on slopes, along water bodies and along drainage ditches help prevent erosion and pollution by stabilizing the soil and slowing the flow of rainwater runoff. To collect and filter runoff, depressions can be created and planted with native plants suited to temporary wet conditions. These "rain gardens" will capture water and hold it *temporarily for a*

In certain conditions, some native plants can also become aggressive spreaders, though their spread is more limited by natural controls than non-native aggressors. Plants that seed readily (such as black-eyed Susan, *Rudbeckia* species), or that spread by lateral roots (such as mint family plants *Monarda* or *Physostegia* species) should be used sparingly or controlled in gardens. Certain native species that are difficult to control or show up uninvited should not be planted, such as cattail (*Typha* species).

day or two and remove pollutants washing off of the surrounding land.

Enhance and create wildlife habitat. An animal's *habitat* is the area where it finds food, water, shelter, and breeding or nesting space, in a particular arrangement. If we want our gardens to have the greatest ecological value for wildlife, we need to mimic natural plant groupings and incorporate features that provide as many habitat features as possible.

Plants are one of the most important features of an animal's habitat, because they often provide most, or even all of the animal's habitat needs. Animals in turn help plants to reproduce through dispersal of pollen, fruits or seeds. Consequently, plants and animals are interdependent and certain plants and animals are often found together. So, it is important that plants be selected, grouped, and planted in a way that is ecologically appropriate.

Each plant prefers or tolerates a range of soil, sunlight, moisture, temperature and other conditions, as well as a variety of other factors including disturbance by natural events, animals or human activities. Plants sharing similar requirements are likely to be found together in plant *communities* that make up different habitat types - particular groupings of plant communities commonly recognized as wetlands, meadows, forests, etc. Some plants may tolerate a wider range of conditions than others, and therefore can be found at more than one type of site, in association with a different set of plants at each. By matching plants with similar soil, sunlight, moisture and other requirements, and planting them to the existing site conditions, the planted landscapes will do a good job of approximating a natural habitat.

Instead of isolated plantings, such as a tree in the middle of lawn, group trees, shrubs and perennials to create layers of vegetation. A forest has, for example, a *canopy* layer (tallest trees), *understory* layers (various heights of trees and shrubs beneath the canopy) and a ground layer or forest floor. These layers provide the structure and variety needed for shelter, breeding or nesting space for a diversity of wildlife.

To provide food and cover for wildife year-round, include a variety of plants that produce seeds, nuts, berries or other fruits, or nectar; use evergreens as well as deciduous plants (those that lose their leaves); and allow stems and seedheads of flowers and grasses to remain standing throughout fall and winter.

All animals need water year-round to survive. Even a small dish of water, changed daily to prevent mosquito growth, will provide for some birds and butterflies. Puddles, pools or a small pond can be a home for amphibians and aquatic insects. A larger pond can provide for waterfowl, such as ducks and geese, and wading birds such as herons. Running or circulating water will attract wildlife, stay cleaner and prevent mosquitoes.

Rock walls or piles, stacked wood, or brush piles provide homes for insects, certain birds and small mammals. Fallen logs and leaf litter provide moist places for salamanders, and the many organisms that recycle such organic matter, contributing nutrients to the soil. Standing dead tree trunks benefit cavity-nesting wildlife such as woodpeckers.

Consider naturalistic planting, or habitat restoration. It may be feasible to create a more natural landscape instead of a formal one. Naturalistic landscaping uses patterns found in nature, and allows some nature-driven changes to occur. Plants multiply, and succession or gradual replacement of species may take place, with less human intervention. A property located near natural areas, such as forests, wetlands and meadows, is a good candidate for a habitat project. Expand existing forest by planting trees and shrubs along the woods line, using native species that grow in the area, and allow birds and wind to bring the understory plants over time. Wet sites, areas with clay soils, or drainage ditches can be converted to wetlands. An open piece of ground or lawn can be planted as a meadow or grassland. Schools, homes, small businesses, large corporate sites, municipalities, military installations, recreational areas and other public lands can all include habitat plantings.

How to choose plants

Finding ready information about what plants "go together" for habitat restoration, enhancement, or creation projects is difficult. Often, the professional will examine a nearby natural area and try to mimic the combination of plant species found there. That may not be possible for individuals unfamiliar with natural areas. Fortunately, by following some simple guidelines, you will have garden spaces that grow well on your site and mirror the plant communities found naturally in your area. The plant lists found at the end of this guide will also help give you a start at planting appropriate groupings.

- **Know your site and plant to the existing site conditions.** Check the sun exposure, soil moisture and soil type where you plan to plant, and choose plants that will grow and thrive in those conditions. For a few dollars your state or local cooperative extension office can analyze a small soil sample you send them (for contact information, see your government listings in the phone book). The results will include soil type (sand, clay, loam, etc.), pH and fertility status and recommendations for amending the soil to make it into "average garden soil." However, by selecting native species that thrive in the *existing* conditions, you won't need to add soil, fertilizer, lime or compost. There are a wide variety of plants that will thrive in most conditions, even the driest, poorest soil or very wet clay soil. If, however, the soil test shows extreme pH - very acidic (pH of less than 5) or very basic (pH 8 or above), your plant choices will be fairly limited. In that case, you might choose to follow the instructions for making the soil more neutral. If the soil is hard, compacted fill dirt, you might want to improve it by adding organic matter and work the ground so that it can more easily be planted. If you alter the site, then select plants suited to the new conditions.

- **Choose plants native to your region of your state.** Along with planting to the existing site conditions, use locally native plants. Use the map on page 9 to identify which **physio-geographic region** the planting site lies in. If you're close to a border dividing two regions, you may choose plants from either or both regions.

- **Choose a habitat type.** Try to create or emulate a specific habitat, like woods, wetland or meadow, and choose plants that are appropriate to both your site and the habitat. Look through this guide and mark the plants with growth requirements that match conditions at the planting site. This will help improve the success of your planting, the habitat value, and the ecological functioning of the project. This publication will eventually be made available online, in a format that can be electronically sorted by plant characteristics or growth conditions.

Where to find native plants

Most nurseries carry some native plants, and some nurseries specialize and carry a greater selection. As the demand for native plants has grown, so has the supply at nurseries. Some plants will be more readily available than others. Here, we've focused on species most appropriate for planting and available through the nursery trade. A limited number of species included here are not commonly available but are able to be nursery grown. Take this guide along with you when you visit nurseries and if you need help, ask for nursery staff familiar with native plants. If you see a plant you like, check to see if it's included in the guide for your state and physiographic region. For those species that are more difficult to find, the hope and intention is that this publication will spark a demand, and hence a greater supply. If you have a favorite plant that you can't obtain, be sure to ask your local nursery to consider adding it to their stock. A list of some of the many retail and wholesale native plant nurseries in the Chesapeake Bay region is available from the U.S. Fish and Wildlife Service, Chesapeake Bay Field Office at www.fws.gov/r5cbfo/bayscapes.htm.

For the greatest ecological value, select the "true" native species, especially if planting for wildlife benefit. There are cultivated varieties (*cultivars*) available for many native plants. These are named using the scientific name (Latin genus and species, such as *Rudbeckia fulgida*) plus the cultivar name, a third word in single quotation marks (such as *Rudbeckia fulgida* 'Goldsturm'). These varieties have been grown to provide plants with certain physical characteristics, perhaps a different flower color, different foliage or a compact shape or size. Although these are suitable for gardening use, use true species (not cultivars) if you are planning a habitat project to provide

food for wildlife. These plants are most suited to use by the native wildlife, and will increase your chances of attracting them.

Native plants should never be removed from the wild unless an area is about to be developed. Even then, it is difficult to transplant wild-collected plants and to duplicate their soil and other growth requirements in a home garden. Plants that are grown from seed or cuttings by nurseries have a much greater tolerance for garden conditions. Help to preserve natural areas by purchasing plants that have been grown, not collected.

Ask nurseries about the source of the native species sold. Did they come from seed or cuttings of plants found growing locally, or are they from another region? Ideally, the plants you use should come from stock from the same region, say, within about a 200-mile radius in the same physiographic province (coastal plain, Piedmont, or mountain). Differences exist from region to region even in the same plant species, due to differences in climactic conditions between distant locations. For example, a plant grown in Maine may flower at a different time than the same species grown in Maryland. They may have slight physical differences. These characteristics make a difference in designing gardens and they matter to wildlife seeking food sources. The more consumers ask for locally grown plants or seed, the more likely it is that nurseries will carry local stock.

Once you begin to explore and experiment with native plants, you'll soon discover that many of these plants go beyond just replacing worn out selections in your yard. Native plants will eventually reduce your labor and maintenance costs while inviting wildlife to your yard helping to create your own sense of place.

How to use this guide

Plant Names and Types

Plants are organized within each section alphabetically by scientific name. All scientific plant names used are based on names accepted by ITIS, the Integrated Taxonomic Information System. Plants are indexed at the back of the book by scientific as well as frequently used common names. Scientific names are changed periodically as new information is gathered; for those commonly recognized names that changed during development of this guide, the new names are used here, with a cross reference noted in the index. For example: *Aster divaricatus* is now *Eurybia divaricata*, so the plant is listed in the index under both *Aster* and *Eurybia*.

Plants are grouped by botanical categories: Ferns; Grasses & Grasslike Plants (includes grasses and plants with long slender leaves that may appear similar to a grass); Herbaceous Plants (includes flowers and groundcovers); Herbaceous Emergents (plants that grow in moist to wet soils, wetlands or in standing water with roots and part of their stems below water but with most of the plant above the water); Shrubs; Trees; and Vines.

A note about groundcovers: English ivy, periwinkle, creeping lily turf and Japanese pachysandra are some commonly used groundcovers, particularly for shade. However, these species are non-natives that are invasive in the landscape, so they should be *avoided*. What native alternatives can be used instead? A groundcover can be any plant that would physically cover or hide the bare ground from view. For the purposes of environmentally beneficial landscaping and habitat enhancement, any plant in the "herbaceous"category would make a good groundcover. For those gardeners and landscapers still seeking a low-growing, creeping, spreading, or clump-forming plant for a groundcover, these plants are marked with a GC symbol in the Notes column and a list is included at the end of the guide.

Characteristics

- **Height and/or Spread** The typical mature height or possible range of heights is given in feet, to the nearest half (0.5) foot. Height may vary depending on conditions (e.g., amount of moisture or sun). For trees and vines, spread is also given in feet. For trees, spread is the measurement of the crown of the plant; for vines, spread is the length a vine will grow along a surface.

- **Flowers: bloom period and flower color** The typical months in which the plant blooms are given. The exact time and duration of bloom may be shifted by days or weeks for different areas and/or depending on seasonal weather conditions and climactic trends. The basic, overall color of the flower is noted. The color of a flower's center or throat may not be included due to limited text space. For simplicity, some shades or tones of colors have been grouped, e.g. lavender, pale purple, bluish purple, even fuchsia may have been listed simply as purple; tan, brown, dark brown are all listed as brown; yellows and pinks may be similarly condensed.

- **Fruit: fruiting period, color and type** This information is provided for plants with more conspicuous fruits or visually interesting seeds. Terms used include: Achene, a dry flat seed such as in clematis; Berry, which includes small single berries such as blueberry, larger berries such as persimmon, aggregates such as blackberry and hips such as a rose hip; Capsule, including various types and sizes of dry fruits with two or more compartments containing seeds, such as iris, sweet pepperbush, hibiscus, or black-eyed Susan; Cone/cone-like such as pines, hemlock, or alder; fleshy pomes or drupes such as hawthorn, beach plum, paw paw, passion flower, or cherry; Nut/nut-like, as in acorns (oaks) or hickory; Pod, which may include pea-like legumes such as partridge pea or wild senna, *follicles* or other long pod-like *capsules* such as milkweeds, delphinium, or trumpet creeper; and Winged, such as the *samaras* of maples or elm.

- **Fall Color** The color listed indicates the fall color of the leaves, or of the stems for certain plants such as grasses. Some color shades have been grouped by the basic color, as for flower color. Evergreens, species that retain their leaves throughout the winter (in all plant categories), are designated with a ▲ symbol in the Notes column. Evergreens are popular for various landscaping uses and valuable for year-round cover for wildlife.

Growth Conditions

- **Light** The amount of sunlight a plant requires is defined as: Full Sun ☼, the site is in direct sunlight for at least six hours a day during the growing season; Partial shade ◐, the site receives approximately three to six hours of direct sunlight; and Shade ●, the site receives less than three hours of direct sunlight or filtered light.

- **Moisture** The amount of soil moisture a plant requires is defined as: Dry (D), areas where water does not remain after a rain (areas may be in full sun or in a windy location, on a steep slope, or have sandy soil); Moist (M), areas where the soil is damp, and may be occasionally saturated; and Wet (W), areas where the soil is saturated for much of the growing season, except in droughts. Many of the plants designated for wet areas tolerate specific ranges of water depths (see Flood Depth). Plants with the Dry designation can be considered drought tolerant.

- **Soil pH and Type** Many of the native plants listed will tolerate a range of soil types. Soil types are listed here as Organic (O), containing a high amount of organic material such as decayed leaves and bark; Clay or fine-textured (C) soils with a high clay content and some silt - very fine soil particles; Loamy or medium-textured (L) soils that contain a mix of mostly silt and sand but may contain some clay; and Sandy or coarse-textured (S) soils with larger particles. Soil information has necessarily been simplified for this guide, and lumped into these main categories, which will suffice for the novice. Soils in actuality are often a mixture or gradations of types, categorized by the percentages they contain of clay, silt or sand, for example clay loam (a certain mix of clay and sand); sandy clay; silt loam; or silty clay loam. For best results, select plants suited to existing site conditions rather than amending the soil. However, be aware that plant selection may be limited if your site has very sandy soil, heavy clay, compacted soil, or extreme soil pH (above 8 or below 5.5). In these cases, seek advice from a nurseryman, horticulturist, botanist, Cooperative Extension agent, or other expert.

- **Flood Depth** Some plants tolerate prolonged standing water, and occur in specific water depths or range of depths. In the Herbaceous Emergents section, the depth of water tolerated is indicated (in inches). Other types of wetland plants that can tolerate only intermittent flooding appear in other sections of the guide, and their flood tolerance

information is included in the Notes column. For more complete information on planning and planting wetlands, see the references listed at the end of this guide.

- **Salt Tolerance** Some plants that tolerate prolonged standing water can tolerate saltwater or brackish (partly salty) water. For plants in the Herbaceous Emergents section, the salinity range in which each of these plants will grow is given in parts (of salt) per thousand parts (of water) or ppt, from 0 ppt (fresh water) to the maximum salinity tolerated. For plants in other sections of the guide, the maximum salinity is given in the Notes column. Full seawater is approximately 32 ppt. If salinity is not given, then the plant grows in fresh water only or in drier conditions.

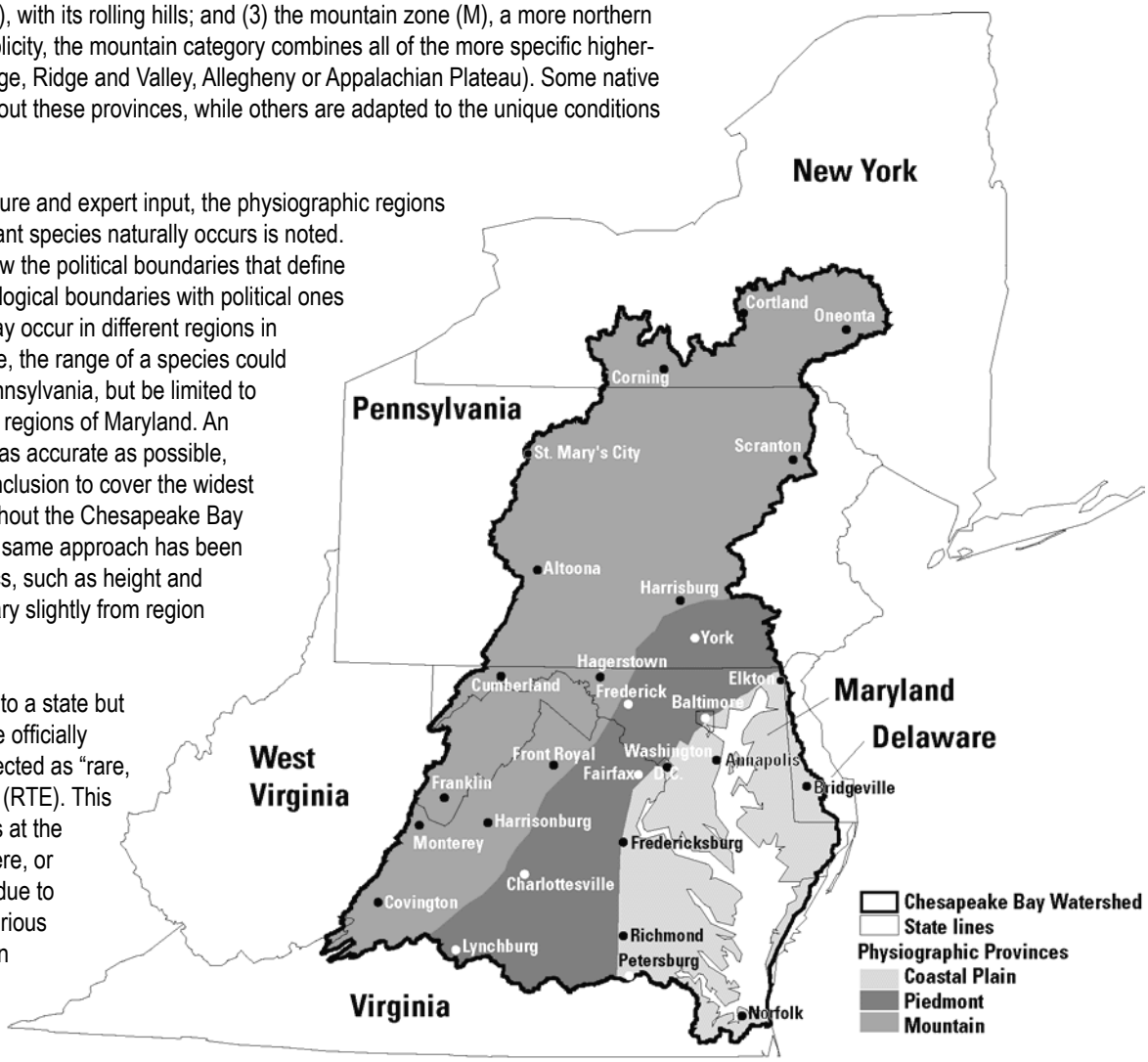
Habitat

For each plant in this guide, we include a description of habitats in which that plant may be found. Several habitat types may be mentioned as each plant is rarely found in one and only one habitat type. There are dozens of forest types, several types of wetlands including forested wetlands and even wet meadows. The habitats described include those that provide the conditions most preferred by each plant species. To help with planning projects, sample lists of plants to use in certain habitat types, or certain site conditions, are given in the back of this guide. More technically detailed information on plant communities can be found in resources listed in the references section.

Native To (Where To Use) - States and Physiographic Regions

From the sandy dunes of the coast to the rocky slopes of the mountains, the rich variety of habitats found throughout the region is strongly linked to its geology, topography and climate. For this guide, the states in the Chesapeake Bay watershed have been divided into three regions or provinces: (1) the coastal plain (C), an area with fairly flat topography and more southern climate; (2) the Piedmont plateau (P), with its rolling hills; and (3) the mountain zone (M), a more northern climate (see map). For simplicity, the mountain category combines all of the more specific higher-altitude provinces (Blue Ridge, Ridge and Valley, Allegheny or Appalachian Plateau). Some native plants are common throughout these provinces, while others are adapted to the unique conditions found only in one or two.

Based on the existing literature and expert input, the physiographic regions and states in which each plant species naturally occurs is noted. However, plants do not follow the political boundaries that define our states, so matching ecological boundaries with political ones is difficult. Certain plants may occur in different regions in different states. For example, the range of a species could extend throughout all of Pennsylvania, but be limited to the mountain and Piedmont regions of Maryland. An effort has been made to be as accurate as possible, while erring on the side of inclusion to cover the widest range of possibilities throughout the Chesapeake Bay watershed as a whole. This same approach has been used for other characteristics, such as height and bloom period, which may vary slightly from region to region.



Note: Some species native to a state but not commonly found may be officially designated and legally protected as "rare, threatened, or endangered" (RTE). This may be because the plant is at the edge of its natural range there, or its population has declined due to loss of habitat caused by various natural events and/or human activities in that region. Species that are listed in a state as RTE should

generally not be planted there, because importing species from elsewhere could potentially lead to damaging alteration of the gene pool of the remaining population. This guide lists only those states in which a plant is common and recommended for planting. As a general rule of thumb, if a plant you like is not designated in this guide for your state or your region of the state, we strongly encourage you to forego planting that and select another plant suited to your site.

Wildlife Value
The notation "high wildlife value" is based mainly on the value of the fruits, seeds and/or nectar used as food for wildlife, and the relative number of species using the plant for food. But remember that animals use leaves, twigs, roots and shoots for food or nesting material, and every plant has value as cover and/or nesting sites. In that respect, although we've marked those of higher wildlife (food) value, every plant in this guide has value to wildlife, as well as other environmental values.

The **types of wildlife** noted here are those desirable species that are likely to use the plants for food, including pollinators which are critical to plant reproduction, for gardens, natural areas and agricultural crops. The information here is fairly general. The songbird icon indicates use of a plant by small usually migratory birds, but may include upland game birds. The waterfowl icon may include shorebirds and wading birds along with ducks and geese. The hummingbird icon has been indicated separately because many people are interested specifically in attracting them. The butterfly icon may refer to the adults or to the larval stage that uses the plant as a host. The beneficial insect icon, besides butterflies, includes ladybugs, bees (essential pollinators) and other insects that serve as a pest control or other desirable role. The small mammal icon is noted for plants used by any of a variety of small animals, such as raccoons, opossums, foxes, etc., depending upon location and surrounding habitat.

Absent but not forgotten: Certain wildlife species are not represented, due in part to a lack of available information for every plant related to all types of animals. However, these are all likely to inhabit or occasionally visit a native plant garden or habitat planting, and their importance in the web of life should not be underestimated. Many insects have not been represented here, though they certainly use a wide variety of plants throughout their life cycles and are an integral part of the ecosystems we're trying to protect, conserve and enhance. Reptiles and amphibians, particularly salamanders, frogs and turtles, inhabit our yards as well as natural areas. They use plants for food and cover, and especially need water sources such as lakes, ponds, streams, puddles or even a small dish of water (aerated or changed daily to prevent mosquito breeding). Bats provide a valuable service as insect pest controllers and pollinators.

Notes
This catchall includes pertinent information that bears emphasizing or is not reflected in the other categories. It may include additional notes or clarification about the plant's characteristics, growth, and spread; tips or suggestions on cultivation; cultivars; or general use of the plant.

By providing these characteristics for each plant species we hope to provide you with a variety of choices to meet the conditions of your property as well as your personal preferences. Whether you are replacing a few individual plants, designing a new bed or planning for an entirely new look, this guide can help narrow the choices to plants most likely to thrive in your environment and create the landscape you desire.

Songbird

Waterfowl

Hummingbird

Butterfly

Beneficial insect

Small mammal

Providing the basic habitat structures described earlier and planting a diversity of plants (and therefore food sources) will bring a surprising and beneficial array of life to your property.

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Adiantum pedatum *northern maidenhair fern* UWI MC	Height: 1-2' Fruit:	Light: ◐ ● Moisture: M Soil pH: 4.5-6.5 Soil type: L S O	moist woods, rocky shaded habitats	Region: M P C States: DC MD NY PA VA WV		grows in clumps; delicate texture; herbal uses GC
Asplenium platyneuron *ebony spleenwort* RHW	Height: 0.5-1.5' Fruit:May-Sep	Light: ○ ◐ ● Moisture: M Soil pH: 4.5-7 Soil type: C L S	banks, open woods and thickets, slopes, rocky ledges, swamps	Region: M P C States: DC MD NY VA WV		easily transplanted; only moderate care needed; evergreen ▲ GC
Athyrium filix-femina *northern lady fern* UWI KJS	Height: 1-3' Fruit:	Light: ◐ Moisture: M W Soil pH: Soil type: L S	woods, banks, wooded hillsides, sandy bogs	Region: M P C States: DC DE NY WV		varieties occur throughout region; in MD, VA can also use subspecies asplenioides (southern lady fern) GC
Botrychium virginianum *rattlesnake fern* RHW	Height: 1-2' Fruit:	Light: ◐ ● Moisture: D M Soil pH: 5.6-6.9 Soil type: L O	rich, woods	Region: M P C States: DC DE MD NY VA WV		GC
Dennstaedtia punctilobula *hay-scented fern* UWI RWF	Height: 1-3' Fruit:Jul-Oct	Light: ○ ◐ Moisture: D M Soil pH: Soil type: L	open woods and fields	Region: M P C States: DC MD NY VA WV		can spread over large areas of open understory or pasture GC
Dryopteris carthusiana (D. spinulosa) *toothed or spinulose woodfern* UWI RWF	Height: 1-2.5' Fruit:Jun-Aug	Light: ◐ ● Moisture: M W Soil pH: 5-6 Soil type: L O	low woods, thickets, swamps, rich woods, rocky slopes	Region: M P States: DC DE MD NY PA VA WV		forms colonies; semi-evergreen ▲ GC
Dryopteris cristata *crested wood or shield fern, narrow swamp fern* UWI RWF	Height: 1.5-2.5' Fruit:Jun-Sep	Light: ○ ◐ ● Moisture: M W Soil pH: 3.5-6.5 Soil type: C L	shallow emergent marshes, shrub swamps, wooded swamps, open shrubby wetlands	Region: M P C States: DC DE MD NY PA VA WV		small rosette fronds ▲ GC
Dryopteris intermedia *evergreen wood-fern* UWI EJJ	Height: 2.5' Fruit:	Light: ◐ ● Moisture: D M W Soil pH: Soil type: L O	rich, moist to dry woods	Region: M P C States: DC DE NY PA VA WV		clump-former; not common on coastal plain; hybridizes with eight species ▲ GC

Ferns

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Dryopteris marginalis *marginal or evergreen shield fern, evergreen wood fern* UWI RWF	Height: 1-3' Fruit:Jun-Oct	Light: ◐ ● Moisture: D M Soil pH: Soil type: C L S	moist woods, clearings	Region:M P C States: DC DE MD NY PA VA WV		clump-former; attractive; easily transplanted ▲ GC
Onoclea sensibilis *sensitive fern* UWI KJS	Height: 1-3.5' Fruit:Jun-Oct	Light: ○ ◐ ● Moisture: M W Soil pH: Soil type: C L S	fresh tidal and nontidal marshes, meadows, swamps, woods	Region:M P C States: DC DE MD NY PA VA WV		spreads in wet areas; fertile fronds dark brown, erect GC
Osmunda cinnamomea *cinnamon fern* RHW, UWI TK	Height: 2-5' Fruit:Apr-May	Light: ○ ◐ ● Moisture: M W Soil pH: 4.5-7 Soil type: C L	woods, marshes, swamps, bogs, streamsides	Region:M P C States: DC DE MD NY PA VA WV		tolerates drought; fertile fronds reddish brown, wooly GC
Osmunda claytoniana *interrupted fern* UWI EJJ	Height: 1-4' Fruit:	Light: ◐ ● Moisture: M Soil pH: 4-6 Soil type: C L	fields, forest and swamp edges	Region:M P States: DC DE MD PA VA WV		grows in clumps GC
Osmunda regalis *royal fern* UWI EJJ	Height: 1.5-6' Fruit:Apr-Jun	Light: ○ ◐ ● Moisture: M W Soil pH: 4-6 Soil type: C L S	fresh tidal and nontidal marshes and swamps, woods, irregularly, seasonally, or permanently saturated (up to 100% of growing season)	Region:M P C States: DC DE MD NY PA VA WV		tolerates full sun if moist; tolerates drought; tolerates irregular, seasonal or permanent saturation; only tolerates flooding for a few days GC
Polystichum acrostichoides *Christmas fern* USFWS BES	Height: 0.5-2' Fruit:Jun-Oct	Light: ◐ ● Moisture: M Soil pH: 4.5-7 Soil type: L S	woods, thickets, rocky slopes	Region:M P C States: DC DE MD NY PA VA WV		grows in clumps; easily grown in rock gardens and shaded places; impartial to soil type ▲ GC
Pteridium *bracken fern* CM NRCS	Height: 1.5-6' Fruit:	Light: ○ ◐ Moisture: D M W Soil pH: Soil type: C L S	dry pine woods, swamps, marshes, fields, waste places	Region:M P C States: DC DE MD NY PA VA WV		forms large colonies; host for several ant types GC
Thelypteris noveboracensis *New York fern* USFWS BES	Height: 1-2.5' Fruit:Jun-Sep	Light: ◐ ● Moisture: M W Soil pH: 4-7 Soil type: C L S	forested wetlands, dry to damp woods, thickets	Region:M P C States: DC DE MD NY VA WV		tolerates drought; easily transplanted; forms large colonies; spreads easily GC

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Thelypteris palustris *marsh fern*	Height: 2-3' Fruit:Jun-Oct	Light: Moisture: M W Soil pH: Soil type: C L S	swamps, bogs, fields, thickets, fresh marshes, wooded streambank	Region:M P C States: DC DE MD NY VA WV		spreads GC
Woodwardia areolata *netted chain fern*	Height: 0.5-2' Fruit:Jul-Oct	Light: Moisture: M W Soil pH: Soil type:	bogs, swamps, woods	Region: P C States: DC DE MD VA		spreads by creeping rhizome GC
Woodwardia virginica *Virginia chain fern*	Height: 3-6' Fruit:Jul-Sep	Light: Moisture: M W Soil pH: Soil type:	swampy places, woods	Region: P C States: DC DE MD NY VA		spreads by creeping rhizome GC

UWI RWF

PLANTS RM91

PLANTS

RHW

Osmunda regalis

RHW

Osmunda cinnamomea

RS MNPS

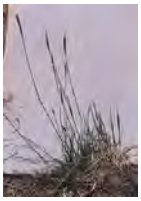
Polystichum acrostichoides

USFWS BES

New fern fiddleheads emerging.

Grasses & Grasslike Plants

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Agrostis perennans *autumn bentgrass*	 PLANTS RM95	Height: 1-3' Flowers: Jun-Oct	Light: ☼ ◐ ● Moisture: D M W Soil pH: 5.5-7.5 Soil type: C L	dry or moist thickets, open woods	Region: M P C States: DC DE PA VA WV		
Ammophila breviligulata *dunegrass, American beachgrass*	 UWI RRK	Height: 1.5-3.5' Flowers: Jul-Sep	Light: ☼ Moisture: D Soil pH: 5.8-7.8 Soil type: L S	maritime beaches, dunes, grasslands, shrublands	Region: C States: VA		prefers well-drained, sandy sites; spreads rapidly by rhizomes
Andropogon gerardii *big bluestem*	 RHW	Height: 2-6.5' Flowers: Jun-Sep	Light: ☼ ◐ Moisture: D M W Soil pH: 6-7.5 Soil type: C L S	dry or wet open woods, prairies, swales, shores; dry open areas	Region: M P States: DC DE NY PA VA WV		clump forming; attractive, with winter interest
Andropogon glomeratus (A. virginicus var. abbreviatus) *bushy bluestem*	 PLANTS	Height: 1.5-5' Flowers: Aug-Oct, reddish brown	Light: ☼ ◐ Moisture: M W Soil pH: 5-6.3 Soil type: C L S	fresh marshes, coastal areas	Region: M P C States: DC DE VA WV		tolerates drought; grows in tufts; reddish fall color
Andropogon virginicus *broomsedge*	 PLANTS JS	Height: 1-3' Flowers: Aug-Nov, reddish brown	Light: ☼ Moisture: D M W Soil pH: 4.9-7 Soil type: C L S	wet meadows, transition areas	Region: M P C States: DC DE MD NY VA WV		wildlife food and cover; tolerates drought; grows in tufts; reddish-tan fall color
Calamagrostis canadensis *bluejoint reedgrass*	 PLANTS 1995	Height: 1.5-5' Flowers: Jun-Aug	Light: ☼ ◐ Moisture: M W Soil pH: 4.5-8 Soil type: C L	meadows, bogs, thickets	Region: M States: DC DE NY VA WV		
Carex crinita var. crinita *long hair sedge*	 RHW	Height: 1-5' Flowers: Jun-Aug	Light: ☼ ◐ Moisture: M W Soil pH: 4-7.5 Soil type: C L	swales, thickets, low woods	Region: M P C States: DC DE NY VA WV		
Carex glaucodea *blue wood sedge*	 NYNHP, NYNHP	Height: 0.5-2' Flowers: May-Jul, brown to reddish	Light: ◐ ● Moisture: D M Soil pH: Soil type:	moist to dry woods and fields	Region: P C States: DC DE MD VA		clump-forming; alternative to Liriope GC

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Carex lurida *sallow sedge, lurid sedge* RHW	Height: 1-3.5' Flowers: Jun-Oct	Light: ☼ ◐ Moisture: W Soil pH: 4.9-6.8 Soil type: C L S	swales, swamps, woods	Region: M P C States: DC DE NY PA VA WV		wetland plant; interesting seeds
Carex pensylvanica *Pennsylvania sedge* CM NRCS, CM NRCS	Height: 0.5-1.5' Flowers: Apr-Jul, reddish to white	Light: ◐ ● Moisture: D M Soil pH: Soil type: S	open, dry, sandy or rocky woods, wooded slopes	Region: P C States: DC DE MD NY PA VA WV		alternative to lawn; plant densely; fine textured leaves less than 6 inches GC
Carex stricta *tussock sedge* CM NRCS	Height: 1-3.5' Flowers: May-Aug, reddish to purple brown	Light: ☼ Moisture: M W Soil pH: 3.5-7 Soil type: C L S	fresh tidal and nontidal marshes, shrub swamps, forested wetlands, swales, fields	Region: M P C States: DC DE MD NY VA WV		grows in clumps; partly persists in winter; tolerates flooding to 6 inches
Carex vulpinoidea *fox sedge* UWI RWF	Height: 0.5-3.5' Flowers: Jun-Aug	Light: ☼ ◐ Moisture: W Soil pH: 6.8-8.9 Soil type: C L	shallow emergent marshes, shrub swamps, floodplain forests, hardwood swamps	Region: M P C States: NY VA WV	 high wildlife value	grows in clumps; tolerates saturation and flooding to 6 inches
Chasmanthium latifolium *wild oats, river oats, sea oats, spanglegrass* USFWS BES, USFWS BES	Height: 2-5' Flowers: Jul-Sep, green then tan	Light: ☼ ◐ Moisture: D M Soil pH: 5-7 Soil type: C L S	streambanks, alluvial woods	Region: M P C States: DC DE MD VA WV		
Danthonia spicata *poverty oatgrass, poverty grass*  UWI RWF	Height: 0.5-2' Flowers: May-Jul	Light: ☼ ◐ ● Moisture: D M Soil pH: Soil type: S	open woods, pastures, meadows	Region: M P C States: DC DE NY PA VA WV		GC
Dichanthelium clandestinum *deer-tongue* USDA JE	Height: 2-5' Flowers: May-Oct	Light: ☼ ◐ Moisture: D M W Soil pH: 4-7.5 Soil type: C L S	moist woods, roadsides	Region: M P C States: DC DE NY PA VA WV		
Dichanthelium commutatum *variable panicgrass* PLANTS 1997	Height: 1-2.5' Flowers: May-Oct	Light: ◐ ● Moisture: D M Soil pH: 4-6.5 Soil type: L S	rocky or sandy woods	Region: M P C States: DC DE NY PA VA WV		

Grasses & Grasslike Plants

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Elymus canadensis *Canada wild rye*	Height: 2-6.5' Flowers: Jun-Oct	Light: ☼ Moisture: D M Soil pH: 5-7.9 Soil type: C L S	dry, sandy, gravely, or rocky soil	Region: M P C States: DC MD VA WV		
Elymus hystrix (Hystrix patula) *bottlebrush grass*	Height: 2-4' Flowers: Jun-Aug	Light: ☼ ◐ ● Moisture: M Soil pH: Soil type: L	alluvial woods	Region: M P C States: DC DE MD NY PA VA WV		
Elymus riparius *riverbank wild-rye*	Height: 0.5-5' Flowers: Jul-Sep	Light: ☼ ◐ Moisture: D M W Soil pH: 4.5-7.2 Soil type: C L S O	rich thickets, streamsides, alluvial flats, meadows	Region: P C States: DE PA VA WV		good for streambank conditions
Elymus virginicus *Virginia wild rye*	Height: 1-5.5' Flowers: Jun-Oct	Light: ◐ ● Moisture: D M Soil pH: 5-7 Soil type: C L S O	rich thickets, shores, meadows	Region: M P C States: DC DE MD PA VA WV		tolerates a wide range of conditions; forms clumps
Festuca rubra *red fescue*	Height: 0.5-3' Flowers: May-Jul	Light: ☼ ◐ Moisture: M W Soil pH: 5-8 Soil type: C L	dry woods, roadsides, waste areas	Region: M States: DC DE MD VA		can be used as turf grass; grows best in part shade GC
Leersia oryzoides *rice cutgrass*	Height: 5' Flowers: Jun-Oct	Light: ☼ ◐ Moisture: M W Soil pH: 5.1-8.8 Soil type: C L S	fresh tidal and nontidal marshes, meadows, ditches, muddy shores	Region: M P C States: DC DE NY PA VA WV		good for sediment stabilization, erosion control; tolerates drought; tolerates flooding to 6 inches
Panicum amarum *bitter or coastal panic grass, beachgrass*	Height: 1-3' Flowers: Aug-Oct	Light: ☼ Moisture: D M Soil pH: 5-7.5 Soil type: L S	sandy coastal shores and dunes	Region: C States: DC DE MD VA		prostrate form, produces little viable seed, use transplants; Panicum amarum var. amarulum (coastal panicgrass), taller form, can be seeded.
Panicum virgatum *switchgrass*	Height: 3-6' Flowers: Jul-Oct	Light: ☼ ◐ Moisture: D M W Soil pH: 4.5-8 Soil type: C L S	fresh and brackish tidal and nontidal marshes, wet meadows, open woods, prairies, dunes	Region: M P C States: DC DE MD NY PA VA WV		food for sparrow species; grows in clumps; controls erosion

CM NRCS

RHW

UWI EJJ

CM NRCS

RS MNPS

PLANTS 1995

CM NRCS

USFWS BES

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Saccharum giganteum (Erianthus giganteus) *giant plumegrass, sugar cane* USDA NRCS	Height: 3.5-10' Flowers: Aug-Oct	Light: ☼ ◐ Moisture: M W Soil pH: 3.5-7 Soil type: L S	swamps, low woods, swales	Region: P C States: DC DE VA		
Schizachyrium scoparium (Andropogon scoparius) *little bluestem* USFWS BES, USFWS BES	Height: 1.5-4' Flowers: Aug-Oct	Light: ☼ Moisture: D Soil pH: Soil type: L S	open woods, pinelands, clearings	Region: M P C States: DC DE MD NY PA VA WV		tolerates poor soil; clump grass; winter interest and wildlife cover; excellent forage grass
Sorghastrum nutans *Indiangrass* RHW	Height: 2.5-8' Flowers: Aug-Sep	Light: ☼ Moisture: D M Soil pH: 4.8-8 Soil type: C L S	dry slopes, prairies, borders of woods	Region: M P C States: DC DE MD NY PA VA WV		tall clump grass with beautiful seed head; nutritious for livestock
Tridens flavus *redtop, purpletop* UWI EJJ	Height: 2-6.5' Flowers: Aug-Oct	Light: ☼ ◐ Moisture: D M Soil pH: 4.5-6.5 Soil type: C L S	dry fields, roadsides, openings, forest	Region: M P C States: DC DE VA WV		
Tripsacum dactyloides *gama grass* CM NRCS	Height: 6-10' Flowers: Jun-Oct	Light: ☼ ◐ Moisture: M W Soil pH: 5.7-7.5 Soil type: C L	swales, fields, forest edges, shores	Region: M P C States: DC DE MD VA WV		excellent forage grass; often grows wild near corn fields; can hybridize with corn

See also:

In the *Herbaceous Plants* section:
Allium cernuum
Liatris pilosa v. pilosa (graminifolia), scariosa, spicata, squarrosa
Sisyrinchium angustifolium (graminoides), atlanticum

In the *Herbaceous Emergents* section:
Distichlis spicata
Dulichium arundinaceum
Iris prismatica, versicolor, virginica
Juncus canadensis, effusus
Schoenoplectus pungens v. pungens (Scirpus pungens, americanus), validus (Scirpus validus)
Scirpus atrovirens, cyperinus
Sparganium americanum
Spartina alterniflora, cynosuroides, patens, pectinata
Zizania aquatica

Andropogon virginicus provides a transition between the road and woods.

CM NRCS

Schizachyrium scoparium in a garden with **Liatris spicata** and **Asclepias tuberosa**.

USFWS BES

USFWS

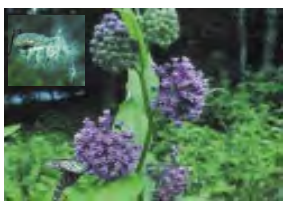
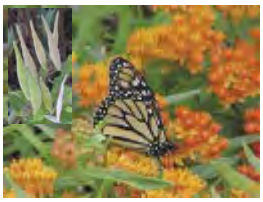
Schizachyrium scoparium in fall.

USFWS BES

Characteristic swirls of **Carex stricta**.

Herbaceous Plants

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Actaea pachypoda *doll's eyes* RHW, RHW	Height: 1-3' Flowers: Apr-Jun, whitish Fruit: Jul-Oct, white or red, berry	Light: ◐ ● Moisture: M Soil pH: Soil type: C L S	rich open woods, thickets	Region: C States: DE NY PA VA WV		interesting berries; infrequent in Piedmont and mountain regions
Agalinis purpurea *purple false foxglove* RHW	Height: 1-4' Flowers: Jul-Sep, rose-purple, white Fruit: capsule	Light: ○ Moisture: M W Soil pH: Soil type: S	moist fields, rocky shores, serpentine barrens	Region: P C States: DC DE MD NY VA WV		
Ageratina altissima var. altissima (Eupatorium rugosum) *white snakeroot* UWI KJS, USFWS BES	Height: 1-5' Flowers: Jul-Oct, white Fruit: capsule	Light: ○ ◐ ● Moisture: D M Soil pH: Soil type: C L S	rich woods, thickets, clearings, meadows	Region: M P C States: DC DE MD NY PA VA WV		tough plant; cultivars available; prefers basic soils
Allium cernuum *nodding onion* RHW	Height: 0.5-2.5' Flowers: Jun-Aug, pink, rose, white Fruit: capsule	Light: ○ ◐ Moisture: M Soil pH: Soil type: L S	ledges, gravels, rocky or wooded slopes	Region: M States: DC MD VA WV		
Anemone canadensis *round-leaved or Canadian anemone, thimbleweed* RHW	Height: 0.5-3' Flowers: May-Jul, white Fruit:	Light: ○ ◐ Moisture: M Soil pH: Soil type: C L	damp thickets, meadows, gravelly shores	Region: P States: DC NY VA		
Anemone virginiana *thimbleweed, tall anemone* RHW	Height: 1-2.5' Flowers: May-Aug, whitish Fruit:	Light: ○ ◐ Moisture: D M Soil pH: Soil type: C L S	dry rocky open woods, slopes, thickets	Region: M P States: DC DE MD NY PA VA WV		
Antennaria neglecta *field pussytoes* UWI JRS	Height: 0.5-1.5' Flowers: Apr-Jul, white Fruit:	Light: ○ ◐ Moisture: D M Soil pH: 5.5-7.5 Soil type: C L	upland meadows, pastures, open woods	Region: M P States: DC DE MD NY PA VA WV		
Aquilegia canadensis *eastern or wild columbine* RHW, USFWS BES	Height: 0.5-3' Flowers: Apr-Jul, red-yellow Fruit: capsule	Light: ○ ◐ Moisture: D M Soil pH: Soil type: L	rich rocky woods, slopes, cliffs, ledges, pastures, roadside banks	Region: M P C States: DC DE MD NY PA VA WV		commonly cultivated; spreads by seed GC

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Aralia nudicaulis *wild sarsaparilla*	RHW	Height: 0.5-1.5' Flowers: May-Jul, white or green Fruit: May-Jul, purple-black, berry	Light: ◐ ● Moisture: D M Soil pH: 5-7.2 Soil type: C L S	dry to moist woods	Region: M P C States: DC DE MD NY PA VA WV		aromatic; single-leaved; lacks an above-ground stem; not common in coastal plain
Aralia racemosa *spikenard*	RHW, RHW	Height: 1.5-6.5' Flowers: Jun-Aug, greenish-white Fruit: dark purple, berry	Light: ◐ ● Moisture: M Soil pH: Soil type: C L S	rich woods, thickets, wooded slopes and edges	Region: M P C States: DC DE MD PA VA WV		not common in coastal plain
Arisaema triphyllum *Jack-in-the-pulpit*	USFWS BES, RHW	Height: 1-3' Flowers: Mar-Jun, striped, purple or green Fruit: berry	Light: ◐ ● Moisture: M W Soil pH: 4.8-7 Soil type: L S	woods, bogs swamps	Region: M P C States: DC DE MD NY PA VA WV		red berry clusters appear late summer to fall; unusual flower; spreads rapidly from seed
Aruncus dioicus *goat's-beard*	USFWS BES	Height: 3.5-6.5' Flowers: May-Jul, white Fruit: pod	Light: ☼ ◐ Moisture: M W Soil pH: Soil type: C L S	wooded roadsides, rich woods, ravines	Region: M States: DC VA WV		
Asarum canadense *wild ginger*	USFWS BES	Height: 0.5' Flowers: Apr-May, brownish-purple Fruit: brown, capsule	Light: ◐ ● Moisture: M Soil pH: Soil type: C L S	rich woods	Region: M P C States: DC DE MD NY PA VA WV		flower inconspicuous; attractive leaves; will spread; semi-evergreen GC ▲
Asclepias incarnata *swamp milkweed*	USFWS RL	Height: 4-6' Flowers: May-Jun, pink to reddish Fruit: Aug-Nov, pod	Light: ☼ ◐ Moisture: M W Soil pH: 5-8 Soil type: C L	fresh tidal and nontidal marshes, meadows, shrub swamps, woods, shores, ditches	Region: M P C States: DC DE MD NY PA VA WV		can tolerate drought; interesting seed pod
Asclepias syriaca *common milkweed*	 RHW, RHW	Height: 3.5-6.5' Flowers: May-Aug, pale purple Fruit: Aug-Nov, pod	Light: ☼ Moisture: D Soil pH: Soil type: L S	thickets, roadsides, fields	Region: M P C States: DC DE MD NY PA VA WV		interesting seed pods; fragrant flower
Asclepias tuberosa *butterflyweed, butterfly milkweed, butterfly flower*	 USFWS RL, USFWS BES	Height: 1-3' Flowers: May-Jul, orange Fruit: Aug-Nov, pod	Light: ☼ ◐ Moisture: D M Soil pH: 4.8-6.8 Soil type: L S	dry fields, roadsides, shale barrens	Region: M P C States: DC DE MD NY PA VA WV		taproot does not transplant well but seedlings do; attractive seed pod

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	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Baptisia australis *wild blue indigo, false blue indigo* USFWS BES, USFWS BES	Height: 3-5' Flowers: May-Jun, blue, purple Fruit:	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: S	open woods, alluvial thickets, streambanks, floodplains	Region: M P States: DC MD VA WV		tolerates poor soils; flowers very showy; shrublike form
Baptisia tinctoria *yellow wild indigo* RHW	Height: 1-3' Flowers: May-Sep, yellow Fruit:	Light: ☼ ◐ Moisture: D Soil pH: 5.8-7 Soil type: L S	open woods, clearings	Region: M P C States: DC DE MD PA VA WV		tolerates poor soils
Bidens cernua *nodding beggar-ticks, nodding bur marigold* RHW	Height: 0.5-3' Flowers: Aug-Oct, yellow Fruit:	Light: ☼ ◐ Moisture: D M Soil pH: 5.1-7 Soil type: C L S	tidal marsh, sloughs, springs, pools, shore	Region: M P C States: DC DE MD NY PA VA WV		
Boltonia asteroides *star boltonia, white doll's daisy* USFWS BES	Height: 0.5-2.5' Flowers: Jul-Sep, white Fruit:	Light: ☼ ◐ Moisture: D M W Soil pH: 5.3-7 Soil type: L S	gravelly shores, sandy thickets	Region: C States: DC DE VA WV		
Caltha palustris *marsh marigold* RHW	Height: 1-2' Flowers: Apr-Jun, bright yellow Fruit:	Light: ☼ ◐ Moisture: W Soil pH: 4.9-6.8 Soil type: C L	forested wetlands, shrub swamps, streambanks, seeps, meadows	Region: M C States: DC DE MD NY VA WV		clump-forming; needs some periods of drier soil; tolerates flooding to 6 inches
Campanulastrum americanum (Campanula americana) *American or tall bellflower* RHW	Height: 1.5-6.5' Flowers: Jun-Aug, light blue Fruit: capsule	Light: ◐ ● Moisture: M Soil pH: 5.5-7.5 Soil type: C L S	rich moist woods, rocky wooded slopes, streambanks	Region: M P States: DC MD NY VA WV		
Cardamine concatenata (Dentaria laciniata) *toothwort* RHW	Height: 1-1.5' Flowers: Apr-Jun, white, purplish Fruit:	Light: ● Moisture: M Soil pH: Soil type: L S	rich woods, wooded bottoms, calcareous rocky banks	Region: M P States: DC DE MD NY VA WV		
Caulophyllum thalictroides *blue cohosh* RHW	Height: 1-2.5' Flowers: Apr-Jun, green-yellow, green-purple Fruit: dark blue, berry	Light: ☼ ◐ Moisture: M Soil pH: 4.5-7 Soil type: L	rich woods	Region: M P C States: DC DE MD NY PA VA WV		

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Chamaecrista fasciculata (Cassia fasciculata) *partridge pea, prairie senna* RHW	Height: 0.5-3' Flowers: Jul-Sep, yellow Fruit: pod	Light: Moisture: D Soil pH: Soil type: S	upland meadows, fields, streambanks	Region: M P C States: DC DE MD PA VA WV		pods coil after split open; spreads
Chamerion angustifolium spp. angustifolium (Epilobium angustifolium) *fireweed* RHW, PLANTS GAM	Height: 3-10' Flowers: Jun-Sep, magenta, pink, rarely white Fruit: capsule	Light: Moisture: D M Soil pH: Soil type: C L S	recent clearings, burned woodlands, damp ravines, open sandy areas	Region: M States: DC DE MD PA VA WV		
Chelone glabra *white turtlehead, turtlehead* RHW	Height: 1.5-6.5' Flowers: Jul-Oct, white Fruit: capsule	Light: Moisture: M W Soil pH: Soil type: C L S	woods, streambanks, swamps, thickets	Region: M P C States: DC DE MD NY PA VA WV		strong grower; herbal uses; host for Baltimore checkerspot butterfly
Chimaphila maculata *striped wintergreen, striped prince's pine* RHW	Height: 0.5' Flowers: Jun-Aug, white Fruit: capsule	Light: Moisture: D Soil pH: Soil type: C L S	acidic woods, frequently under pines	Region: M P C States: DC MD NY PA VA WV		flowers fragrant GC
Chrysogonum virginianum *green-and-gold, golden knees* USFWS BES	Height: 0.5-1' Flowers: Mar-Jun, yellow Fruit:	Light: Moisture: D M Soil pH: Soil type: L	open woods on limestone, rocky open woods	Region: M P C States: DC MD VA WV		will bloom longer if kept moist GC
Chrysopsis mariana *golden aster, Maryland golden aster* RHW	Height: 0.5-2.5' Flowers: Jul-Oct, yellow Fruit:	Light: Moisture: D Soil pH: Soil type: S	woods, openings, roadsides, serpentine barrens	Region: P C States: DC DE MD VA		GC
Cimicifuga racemosa *black snakeroot, black cohosh, fairy candles* RHW	Height: 2.5-8.5' Flowers: Jun-Sep, white Fruit: pod	Light: Moisture: M Soil pH: Soil type: C L S	rich woods, wooded slopes, ravines, thickets	Region: M P C States: DC DE MD NY PA VA WV		
Claytonia virginica *narrowleaf spring beauty, spring beauty* RHW	Height: 0.5-1' Flowers: Mar-May, white with pink Fruit: capsule	Light: Moisture: M Soil pH: Soil type: L	rich woods, thickets, clearings	Region: M P C States: DC DE MD NY PA VA WV		

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	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Clitoria mariana *Maryland butterfly pea* RHW	Height: 6' Flowers: Jun-Sep, pale blue or pinkish Fruit: pod	Light: ☼ ◐ Moisture: D Soil pH: Soil type: S	open areas	Region: M P C States: DC DE VA WV		vine-like
Conoclinium coelestinum (Eupatorium coelestinum) *mistflower, wild ageratum* RHW	Height: 1-3.5' Flowers: Jul-Oct, blue, violet or purple Fruit: capsule	Light: ◐ ● Moisture: D M W Soil pH: Soil type: C L	old fields, meadows; dry sandy woods and clearings, damp thickets, streambanks	Region: C States: DC DE VA WV		
Coreopsis tripteris *tall coreopsis, tall tickseed* RHW	Height: 3.5-10' Flowers: May-Sep, yellow Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L S	thickets, old fields, forest edges, roadsides	Region: M P C States: DC VA WV		flower has anise scent
Coreopsis verticillata *threadleaf coreopsis* USFWS BES	Height: 0.5-3.5' Flowers: Jun-Oct, yellow Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L	dry open woods, clearings, roadsides	Region: P States: DC MD VA WV		GC
Delphinium tricorne *dwarf larkspur* RHW	Height: 0.5-3' Flowers: Apr-Jun, blue, violet, white, variegated Fruit: pod	Light: ◐ ● Moisture: M Soil pH: Soil type:	rich woods, calcareous slopes, thickets, river bluffs	Region: M P States: DC VA WV		
Desmodium paniculatum *panicled or narrow-leaf tick-trefoil* RHW	Height: 1-3.5' Flowers: Jul-Sep, purplish or green Fruit: pod	Light: ☼ ◐ Moisture: D Soil pH: 6-7 Soil type: C L	clearings, edges of moist or dry woods	Region: M P C States: DC DE MD NY VA WV		not found near coast
Dicentra canadensis *squirrel corn* RHW	Height: 0.5-1' Flowers: Apr-May, greenish-white, rose tinge Fruit: capsule	Light: ◐ ● Moisture: M Soil pH: Soil type: L	rich woods	Region: M P States: DC MD NY PA VA WV		flowers hyacinth scented
Dicentra cucullaria *Dutchman's breeches* RHW	Height: 0.5-1' Flowers: Apr-Jun, white to cream Fruit: capsule	Light: ◐ ● Moisture: M Soil pH: Soil type: L S	rich woods	Region: M P States: DC DE MD NY PA VA WV		leaves basal; dormant in summer

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Dicentra eximia *wild bleeding heart* RHW	Height: 1.5-2' Flowers: Apr-Sep, pink/white Fruit: capsule	Light: ◐ ● Moisture: D M Soil pH: Soil type: L	rocky woods and cliffs, rich woods	Region: M P States: DC MD VA WV		sometimes cultivated
Dodecatheon meadia *shooting star* RHW, RHW	Height: 0.5-2' Flowers: Apr-Jun, white with yellow, lilac Fruit: capsule	Light: ☼ ◐ ● Moisture: M Soil pH: Soil type: L S	open woods, meadows, slopes, prairies	Region: M States: DC MD VA WV		
Doellingeria umbellata var. umbellata (Aster umbellatus) *flat-top white aster, parasol whitetop* RHW	Height: 1-7.5' Flowers: Aug-Oct, white Fruit:	Light: ☼ ◐ Moisture: M W Soil pH: Soil type: L S	open areas, woods	Region: M P States: DC DE MD NY PA VA WV		
Erigeron pulchellus *robin's plantain* RHW	Height: 0.5-1.5' Flowers: Apr-Sep, blue, pink, white Fruit: capsule	Light: ◐ Moisture: D M Soil pH: Soil type: L S	open woods, meadows, wooded slopes, roadsides	Region: M P C States: DC DE MD NY PA VA WV		GC
Erythronium americanum *trout lily, yellow trout lily, dogtooth violet* RHW	Height: 0.5-1' Flowers: Mar-Jun, yellow Fruit: capsule	Light: ◐ ● Moisture: M W Soil pH: Soil type: L S	woods, rich slopes, bottomlands, meadows	Region: M P States: DC DE MD NY PA VA WV		
Eupatorium dubium *Joe-Pye weed* RHW	Height: 2-5' Flowers: Jul-Oct, purple, rarely white Fruit: capsule	Light: ☼ ◐ Moisture: M W Soil pH: Soil type: S	swamps, bogs, marshes, swales	Region: M P C States: DC DE MD VA		
Eupatorium fistulosum *Joe-Pye weed, trumpet weed* RHW	Height: 1.5-10' Flowers: Jul-Oct, pink-purple Fruit: capsule	Light: ☼ ◐ Moisture: D M W Soil pH: 4.5-7 Soil type: C L	floodplains, meadows, thickets, roadsides	Region: M P C States: DC DE MD NY PA VA WV		herbal uses
Eupatorium hyssopifolium *hyssop-leaved thoroughwort, hyssop-leaved eupatorium* RHW	Height: 1-4.5' Flowers: Jul-Oct, white Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: S	dry fields, roadsides, railroad right of ways, woods, fields, salt meadows	Region: C States: DC DE MD VA		

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	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Eupatorium maculatum *spotted Joe-Pye weed* CAB	Height: 2-6.5' Flowers: Jul-Sep, purple to pale lavender Fruit: capsule	Light: ☼ ◐ Moisture: M Soil pH: 5.5-7 Soil type: C L	floodplains, swamps, alluvial thickets, grasslands	Region: M P States: DC NY WV		
Eupatorium perfoliatum *common boneset* RHW	Height: 1-5' Flowers: Jul-Oct, white Fruit: capsule	Light: ☼ ◐ ● Moisture: M W Soil pH: Soil type: C L S	floodplains, swamps, bogs, streambanks, meadows	Region: M P C States: DC DE MD NY PA VA WV		
Eupatorium purpureum *green-stemmed Joe-Pye weed* RHW	Height: 2-6.5' Flowers: Jul-Oct, pink, purple, cream Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: C L S	open woods, fields, floodplains	Region: M P C States: DC DE MD NY PA VA WV		occurs in drier, shadier habitats than other joe-pye-weeds; injured or dried plant has vanilla scent
Eurybia divaricata (Aster divaricatus) *white wood aster* RHW, USFWS BES	Height: 0.5-3' Flowers: Jul-Oct, white Fruit:	Light: ◐ ● Moisture: D M Soil pH: Soil type:	dry woods, clearings	Region: M P States: DC DE MD NY PA VA WV		GC
Gentiana clausa *closed gentian, bottle gentian* USFWS BES	Height: 1-3.5' Flowers: Aug-Oct, blue Fruit: capsule	Light: ◐ Moisture: M W Soil pH: 5.8-7.2 Soil type: L	moist open woods, streambanks, meadows	Region: M P C States: DC MD PA VA WV		
Geranium maculatum *wild geranium, wood geranium* RHW	Height: 1-2' Flowers: Apr-Jul, lavender or pink Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L	woods, roadsides, fields	Region: M P C States: DC DE MD NY PA VA WV		adaptable plant; long bloom time; spreader; herbal uses; explosive seed capsule GC
Goodyera pubescens *downy rattlesnake plantain* USFWS BES	Height: 0.5-1.5' Flowers: Jun-Aug, whitish Fruit:	Light: ◐ Moisture: D M Soil pH: Soil type: C L S	dry to moist woods	Region: M P C States: DC DE MD NY VA WV		very handsome throughout winter ▲
Helenium autumnale *yellow or common sneezeweed* USFWS BES	Height: 1.5-6' Flowers: Jul-Nov, yellow Fruit: capsule	Light: ☼ ◐ ● Moisture: M Soil pH: 4-7.5 Soil type: C L S	woods, swamps, riverbanks, alluvial thickets, meadows, marshes, ditches	Region: M P C States: DC DE MD NY PA VA WV		tolerates wet areas; showy flowers; herbal uses

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Helianthus angustifolius *swamp sunflower* RHW	Height: 1.5-5.5' Flowers: Aug-Oct, yellow Fruit: capsule	Light: Moisture: M W Soil pH: 4-7 Soil type: L S	swamps, moist, sandy areas	Region: C States: DC DE MD VA		
Helianthus decapetalus *ten-petaled or thin-leaved sunflower* BZ	Height: 1.5-5' Flowers: Jul-Oct, yellow Fruit: capsule	Light: Moisture: M Soil pH: Soil type: S	fields, bottomlands, stream banks, roadsides	Region: M P C States: DC DE NY PA VA WV		
Helianthus divaricatus *woodland sunflower, rough sunflower* RHW	Height: 1.5-6.5' Flowers: Jul-Sep, yellow Fruit: capsule	Light: Moisture: D M Soil pH: Soil type: S	dry open woods, wooded slopes, shale barrens, roadsides	Region: M P C States: DC DE MD NY PA VA WV		
Heliopsis helianthoides *oxeye sunflower, oxeye* RHW	Height: 1-5' Flowers: Jun-Sep, pale yellow Fruit: capsule	Light: Moisture: D M Soil pH: 5.6-6.8 Soil type: L S	fields, open woods, floodplains, thickets, streambanks	Region: P C States: DC DE MD PA VA WV		long bloom time
Hepatica nobilis var. acuta (H. acutiloba) *sharp-lobed hepatica* UWI KJS, UWI KJS, UWI JRS	Height: 0.5-2' Flowers: Mar-Jun, bluish, white, pink Fruit: capsule	Light: Moisture: D M Soil pH: Soil type: L S	rich upland woods, rocky slopes	Region: M States: NY PA VA		may bloom throughout year (rarely) GC
Hepatica nobilis var. obtusa (H. americana) *round-lobed hepatica, liverleaf* RHW	Height: 0.5-2' Flowers: Mar-Jun, white to lavender Fruit: capsule	Light: Moisture: D M Soil pH: Soil type: L S	dry or rocky woods, dry upland slopes	Region: M P C States: DC DE MD NY PA VA WV		GC
Heracleum maximum (H. lanatum) *cow parsnip* RHW	Height: 3.5-10' Flowers: May-Aug, white to pink Fruit:	Light: Moisture: M W Soil pH: 5.4-7.3 Soil type: C L S	rich woods, wooded roadside banks, marshy flats, streambanks, ditches	Region: M P C States: DC DE MD NY PA VA WV		can cause a dermatitis (skin) reaction
Heuchera americana *alumroot* MOBOT	Height: 1-3.5' Flowers: Apr-Jun, green, white, pink, purple Fruit: capsule	Light: Moisture: D M Soil pH: Soil type: L S	rich woods, rocky slopes, shale cliffs	Region: M P States: DC DE MD NY PA VA WV		long bloom time; many cultivars and hybrids; semi-evergreen GC

Herbaceous Plants

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Heuchera villosa *hairy heuchera, hairy alumroot* PLANTS JSP	Height: 1-2.5' Flowers: Jun-Oct, white to greenish to pinkish Fruit: capsule	Light: ◐ ● Moisture: D M Soil pH: Soil type:	damp rocks, rich wooded slopes	Region: M States: DC MD VA		GC
Houstonia caerulea *bluet, innocence, Quaker-ladies* RHW	Height: 0.5-1' Flowers: Apr-Jun, blue, lilac, white Fruit: capsule	Light: ○ ◐ Moisture: M Soil pH: Soil type:	meadows, fields, and thickets, open woods, forest edges	Region: M P C States: DC DE MD VA WV		
Hydrophyllum virginianum *Virginia waterleaf* RHW	Height: 1-2.5' Flowers: May-Aug, lavender, white Fruit: capsule	Light: ◐ ● Moisture: M Soil pH: Soil type: C L S	woods, thickets, streambanks	Region: M P C States: DC DE MD NY PA VA WV		
Hylotelephium telephioides (Sedum telephioides) *Allegheny stonecrop* RHW	Height: 0.5-1.5' Flowers: Aug-Sep, pale pink Fruit: pod	Light: ○ ◐ ● Moisture: Soil pH: Soil type:	dry rocky places	Region: M States: DC MD NY VA WV		naturally occurs in bare rock outcrops, but does well in garden; rare in PA, threatened in NY GC
Impatiens capensis (I. biflora) *jewelweed, touch-me-not* USFWS BES	Height: 1.5-5' Flowers: May-Oct, orange, yellow, white Fruit: capsule	Light: ◐ ● Moisture: M W Soil pH: 5.4-7.4 Soil type: C L S	moist meadows, swamps, streambanks, open woods	Region: M P C States: DC DE MD NY PA VA WV		ripe seed pod explodes with contact; remedy for poison ivy itching
Ionactis linariifolius (Aster linariifolius) *stiff-leaf aster, flaxleaf whitetop aster* RHW	Height: 0.5-2' Flowers: Aug-Oct, blue, yellow eye Fruit:	Light: ○ Moisture: D M Soil pH: Soil type: S	grasslands, successional shrublands, oak-hickory forest, dry rocky woods and edges	Region: M P C States: DC DE MD NY VA WV		
Jeffersonia diphylla *twinleaf* RHW	Height: 0.5-1' Flowers: Apr-May, white Fruit: capsule	Light: ◐ ● Moisture: M Soil pH: Soil type: L	rich woods	Region: M P States: DC MD VA WV		
Lespedeza capitata *round-head bush clover* UWI KJS	Height: 2-6' Flowers: Jul-Sep, yellowish white Fruit:	Light: ○ Moisture: D Soil pH: Soil type: L S	fields, thin woods	Region: M P C States: DC DE NY PA VA WV		

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Liatris pilosa var. pilosa (L. graminifolia) *grass-leaf blazingstar* RHW	Height: 1-3.5' Flowers: Aug-Oct, purple Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: C L S	open woods, forest edge, salt marsh edges, dune hollows	Region: P C States: DC DE MD VA		
Liatris scariosa *eastern or northern blazing star, tall gayfeather* RHW	Height: 1-3.5' Flowers: Aug-Sep, lavender to rose-purple Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L S	dry upland woods	Region: M P C States: DC DE MD VA WV		
Liatris spicata *gayfeather, blazingstar, spiked blazing star* USFWS RL	Height: 1-6.5' Flowers: Jul-Aug, rose-purple or white Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: 5.6-7.5 Soil type: C L S	moist meadows, open areas	Region: P C States: DC DE VA WV		
Liatris squarrosa *plains blazing star* RHW	Height: 0.5-2.5' Flowers: Jul-Sep, rose Fruit: capsule	Light: ☼ ◐ Moisture: M Soil pH: Soil type: L S	dry open fields and banks	Region: P C States: DC DE VA		
Lilium canadense *Canada lily* RHW	Height: 1.5-6.5' Flowers: Jun-Aug, yellow, orange, red Fruit: capsule	Light: ☼ ◐ Moisture: M W Soil pH: Soil type: L	fields, thickets, woods	Region: M P States: DC DE MD NY PA VA WV		
Lilium philadelphicum *wood lily* RHW	Height: 1-3.5' Flowers: Jun-Aug, yellow, red-orange Fruit: capsule	Light: ☼ ◐ Moisture: D Soil pH: Soil type: L S	open woods, forest edges, thickets	Region: M P C States: DC DE NY PA VA WV		
Lilium superbum *Turk's cap lily* RS MNPS	Height: 4-8' Flowers: Jul-Aug, yellow-orange, orange-red Fruit: capsule	Light: ☼ ◐ Moisture: M W Soil pH: Soil type: L S	meadows, streamsides	Region: M P C States: DC DE MD NY PA VA WV		leaves in whorl around stem; takes several years to bloom
Limonium carolinianum *sea lavender* PLANTS LA	Height: 0.5-2' Flowers: Jul-Oct, lavender Fruit:	Light: ☼ Moisture: M W Soil pH: 6-8.5 Soil type: C L S	irregularly flooded high salt marshes	Region: C States: DE MD NY VA		tolerates salinity to 30 ppt

Herbaceous Plants

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Lobelia cardinalis *cardinal flower* RHW	Height: 2-4' Flowers: Jul-Oct, red Fruit:	Light: ☼ ◐ Moisture: M W Soil pH: 5.8-7.8 Soil type: C L	fresh tidal and nontidal marshes, wooded swamps, seeps, banks of ponds, rivers, streams	Region: M P C States: DC DE MD NY PA VA WV		long bloom time; biennial, must reseed
Lobelia siphilitica *great blue lobelia* RHW, USFWS BES	Height: 1-5' Flowers: Aug-Oct, blue, violet Fruit: capsule	Light: ☼ ◐ ● Moisture: M W Soil pH: Soil type: C L S	woodlands, meadows, swamps	Region: M P States: DC DE MD NY PA VA WV		long bloom time; white cultivars available
Lupinus perennis *lupine, sundial lupine* RHW	Height: 1-2' Flowers: Apr-Jul, blue, rarely pink or white Fruit: pod	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: S	open woods, fields, roadsides, streambanks	Region: M P C States: DC DE NY VA WV		prefers acidic soil
Maianthemum canadense *Canada mayflower* RHW	Height: 0.5' Flowers: May-Jul, white Fruit: pale red speckled, berry	Light: ◐ ● Moisture: M Soil pH: Soil type: C L S	woods	Region: M P C States: DC DE MD NY PA VA WV		fragrant flowers GC
Maianthemum racemosum ssp. racemosum (Smilacina racemosa) *false Solomon's seal* PLANTS JA, PLANTS WSJ	Height: 1-3.5' Flowers: May-Jul, white Fruit: red, berry	Light: ◐ ● Moisture: M Soil pH: Soil type: C L S	dry to moist woods, clearings, bluffs	Region: M P C States: DC DE MD NY PA VA WV		flowers in plume-like clumps at tip of stem; herbal uses
Medeola virginiana *Indian cucumber* RHW, RHW	Height: 1-3.5' Flowers: May-Jun, yellowish Fruit: dark purple or black, berry	Light: ☼ ◐ Moisture: M Soil pH: Soil type: L S	woods	Region: M P C States: DC DE MD NY PA VA WV		rhizome is edible
Melanthium virginicum *Virginia bunchflower* RHW	Height: 2.5-6.5' Flowers: Jun-Aug, greenish Fruit: capsule	Light: ☼ ◐ Moisture: M Soil pH: Soil type: C L S	woods, seepages, clearings	Region: P C States: DC DE MD VA WV		
Mertensia virginica *Virginia bluebells* RHW	Height: 1-2.5' Flowers: Mar-Jun, pink turning blue Fruit: Mar-May, nut/nut-like	Light: ◐ ● Moisture: M W Soil pH: 4.5-8 Soil type: C L	rich wooded slopes, floodplains	Region: M P C States: DC DE MD NY PA VA WV		dormant in summer; flower color blue, pink, or white according to soil acidity

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Mimulus ringens *monkeyflower, Allegheny monkeyflower* RHW	Height: 1-3' Flowers: Jun-Oct, blue Fruit: capsule	Light: Moisture: W Soil pH: Soil type: L	open swamps, meadows, shores	Region: M P C States: DC DE NY PA VA WV		interesting flowers
Mitchella repens *partridgeberry* USFWS, RHW	Height: 0.5' Flowers: May-Jul, white Fruit: July-Dec, scarlet, berry	Light: Moisture: D M Soil pH: Soil type: L S	dry acidic woods	Region: M P C States: DC DE MD NY PA VA WV		two flowers form one fruit; berry edible; slow creeper, forms mats under trees
Mitella diphylla *twoleaf miterwort, bishop's cap* RHW, RHW	Height: 0.5-1.5' Flowers: Apr-Jun, white Fruit: capsule	Light: Moisture: M Soil pH: Soil type: C L S	rich, woods	Region: M P C States: DC DE MD NY PA VA WV		
Monarda bradburiana (M. fistulosa) *wild bergamot, horsemint* RS MNPS	Height: 1.5-5' Flowers: Jun-Sep, pink to purple Fruit: nut/nut-like	Light: Moisture: D M Soil pH: 6-8 Soil type: C L	fields, thickets, roadsides, forest edges	Region: M P C States: DC DE MD NY PA VA WV		confused with bee-balm (M. didyma); aromatic; herbal uses
Monarda didyma *beebalm, Oswego tea* USFWS BES	Height: 2-5' Flowers: Jul-Sep, red Fruit: nut/nut-like	Light: Moisture: M W Soil pH: Soil type: L	creek banks, floodplains, woods	Region: M States: DC MD NY PA VA WV		showy flowers; aromatic; herbal uses
Monarda punctata *horsemint, spotted bee-balm* RHW	Height: 0.5-3.5' Flowers: Jun-Oct, yellow and purple Fruit: nut/nut-like	Light: Moisture: D Soil pH: Soil type: L S	open sandy fields	Region: M P C States: DC DE MD NY VA		
Nuttallanthus canadensis (Linaria canadensis) *blue, old-field, or Canada toadflax* PLANTS WSJ	Height: 0.5-2.5' Flowers: Apr-Sep, light blue Fruit: capsule	Light: Moisture: D M Soil pH: Soil type: L S	maritime grasslands and shrublands, successional shrubland, woods, fields	Region: M P C States: MD NY VA WV		delicate flowers; prefers well-drained soil
Oenothera biennis *common evening primrose* RHW	Height: 1.5-6.5' Flowers: Jun-Oct, yellow Fruit: capsule	Light: Moisture: D Soil pH: 5-7 Soil type: C L S	cultivated fields, waste ground, roadsides	Region: M P C States: DC DE MD NY PA VA WV		flowers open in evening; biennial

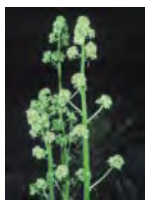
Herbaceous Plants

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Oenothera fruticosa *narrow-leaved sundrops*	 RHW	Height: 1-3' Flowers: May-Sep, yellow Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: 4.5-7 Soil type: C L S	fields, meadows, roadsides	Region: M P C States: DC DE MD NY PA VA WV		
Oenothera perennis *sundrops*	 UWI RWF	Height: 0.5-3' Flowers: May-Aug, yellow Fruit: capsule	Light: ☼ Moisture: D M Soil pH: Soil type: L S	fields, pastures, roadsides, shaly slopes	Region: M P States: DC DE MD NY PA VA WV		similar to evening primrose (O. biennis); long bloom time; spreader
Opuntia humifusa (O. compressa) *eastern prickly-pear cactus*	 RHW	Height: 0.5-1' Flowers: Jun-Jul, yellow Fruit: purplish to deep red, fleshy	Light: ☼ Moisture: D Soil pH: Soil type: L S	sandy coastal dunes, shaly soils	Region: M C States: DC DE MD VA WV		fruit edible, used for jelly GC
Osmorhiza longistylis *sweet cicely, anise root*	 RHW	Height: 1.5-4' Flowers: May-Jun, white to green Fruit:	Light: ◐ ● Moisture: M Soil pH: Soil type: C L S	rich woods, wooded slopes, thickets	Region: M P C States: DC DE MD NY VA WV		all plant parts have anise scent
Oxalis violacea *violet wood sorrel*	 RHW	Height: 0.5' Flowers: Apr-Jul, violet Fruit: capsule	Light: ◐ ● Moisture: D M Soil pH: Soil type: L	woods	Region: M P States: DC DE MD PA WV		GC
Packera aurea (Senecio aureus) *golden ragwort, golden groundsel*	 RHW	Height: 0.5-2.5' Flowers: Apr-Aug, yellow Fruit: capsule	Light: ☼ ◐ ● Moisture: M W Soil pH: Soil type: L	moist fields, woods, floodplains, roadsides	Region: M P C States: DC DE MD NY PA VA WV		wetland plant; long bloom time; aggressive spreader
Penstemon digitalis *beardtongue, tall white or foxglove beardtongue*	 USFWS BES, RHW	Height: 2-5' Flowers: Jun-Aug, white or faintly purple Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: 5.5-7 Soil type: C L S	open woods, meadows	Region: M P C States: DC DE MD NY PA VA WV		tolerates poor drainage; variety of cultivars
Penstemon laevigatus *smooth or eastern beardtongue*	 UWI MRB	Height: 1-3.5' Flowers: May-Jul, purplish Fruit: capsule	Light: ☼ ◐ ● Moisture: M Soil pH: Soil type:	rich woods, fields	Region: M States: DC MD VA WV		

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Phlox carolina *thick-leaved phlox* PLANTS WSJ	Height: 1-2.5' Flowers: May-Jun, pink to purple, rarely white Fruit: capsule	Light: Moisture: D M W Soil pH: Soil type: L S	open woods	Region: M States: DC VA		GC
Phlox divaricata *woodland or wild blue phlox, wild sweet William* RHW	Height: 1.5' Flowers: Apr-Jun, blue, lavender, white Fruit: capsule	Light: Moisture: M Soil pH: 5.5-7.2 Soil type: C L S	rich woods	Region: M P States: DC MD NY PA VA WV		aromatic; showy flower; dormant in summer (leaves disappear); frequently cultivated; evergreen
Phlox maculata *phlox, meadow phlox, wild sweet William* PLANTS WSJ	Height: 1-3' Flowers: May-Sep, rose, pink, purple, rarely white Fruit: capsule	Light: Moisture: M W Soil pH: 5.9-6.8 Soil type: C L	meadows, streambanks, thickets	Region: M P C States: DE PA VA WV		aromatic; showy flowers; a frequent escapee from cultivation
Phlox paniculata *summer phlox, garden phlox* RHW, USFWS BES	Height: 1.5-6.5' Flowers: Jul-Oct, pink, red-purple, white Fruit: capsule	Light: Moisture: M Soil pH: Soil type: L	rich, open woods, roadsides, streambanks, thickets	Region: M P C States: DC PA VA WV		aromatic; showy flowers frequently escapes from cultivation
Phlox stolonifera *creeping phlox* RHW, USFWS BES	Height: 0.5-1.5' Flowers: Apr-Jun, blue, red-purple, violet Fruit: capsule	Light: Moisture: D M Soil pH: Soil type: L S	rich woods	Region: M States: DC MD VA WV		GC
Phlox subulata *moss phlox, moss-pink* USFWS BES, USFWS BES, RHW	Height: 0.5' Flowers: Apr-Jun, rose, pink, white Fruit: capsule	Light: Moisture: D Soil pH: 5.7-7.5 Soil type: C L S	rock crevices, ledges	Region: M P States: DC MD NY VA WV		nice rock garden plant
Physostegia virginiana *obedient plant, false dragonhead* USFWS BES, USFWS BES	Height: 1.5-5' Flowers: Jun-Sep, pink to purple Fruit: nut/nut-like	Light: Moisture: D M Soil pH: Soil type: C L S	moist open areas, streambanks, shorelines	Region: M P States: DC MD PA VA WV		flowers showy; spreads rapidly by underground stems; best in full sun; can escape cultivation
Podophyllum peltatum *Mayapple* RHW	Height: 1-2' Flowers: Apr-May, white Fruit: yellow, berry	Light: Moisture: M Soil pH: Soil type: L	rich woods, open fields	Region: M P C States: DC DE MD NY PA VA WV		ripe fruit edible; woodland groundcover; mottled foliage GC

Herbaceous Plants

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Polemonium reptans *Jacob's ladder, Greek valerian*	 RHW	Height: 0.5-1.5' Flowers: Apr-Aug, blue Fruit: capsule	Light: ◐ ● Moisture: M Soil pH: Soil type: L S	rich or rocky woods, wooded floodplains	Region: M P States: DC DE MD PA VA WV		attractive flowers; slow spreader; herbal uses GC
Polygonatum biflorum *Solomon's seal, dwarf Solomon's seal*	 RHW	Height: 0.5-6.5' Flowers: Apr-Jun, white or green Fruit: blue to black, berry	Light: ◐ ● Moisture: D M Soil pH: Soil type: L	woods	Region: M P C States: DC DE MD NY PA VA WV		flowers dangle along stalk
Polygonatum pubescens *Solomon's seal, downy Solomon's seal*	 UWI KJS	Height: 1-3.5' Flowers: Apr-Jun, yellowish-green Fruit: blue to black, berry	Light: ☼ ◐ ● Moisture: D M Soil pH: Soil type: C L S	dry to moist woods	Region: M P C States: DE NY PA VA WV		herbal uses; edible
Porteranthus trifoliatus (Gillenia trifoliata) *Bowman's root*	 RHW	Height: 1.5-4' Flowers: May-Jul, white Fruit: pod	Light: ☼ ◐ Moisture: M Soil pH: Soil type: C L S	open upland woods, clearings, rocky slopes, roadsides	Region: M P States: DC DE MD PA VA WV		established plants drought tolerant; spreads to form tight clumps; seldom needs dividing; yellow fall color
Pycnanthemum incanum *hoary mountain mint*	 RHW	Height: 3' Flowers: Jul-Sep, white to lavender, purple spots Fruit: nut/nut-like	Light: ● Moisture: D Soil pH: Soil type: C L S	upland woods, fields, thickets, barrens	Region: M P C States: DC DE MD NY PA VA WV		
Pycnanthemum tenuifolium *narrow-leaved mountain mint*	 PLANTS RM89	Height: 1.5-2.5' Flowers: Jul-Sep, purple to white Fruit: nut/nut-like	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: S	streambanks, floodplains, moist fields	Region: M P C States: DC DE NY PA VA WV		
Rhexia virginica *Virginia meadow-beauty*	 RHW	Height: 1-3.5' Flowers: Jun-Sep, dark pink Fruit: capsule	Light: ☼ Moisture: W Soil pH: Soil type: L	open areas	Region: M P C States: DC DE VA WV		also R. mariana for MD
Rudbeckia fulgida *early, eastern, or orange coneflower*	 USFWS RL	Height: 1.5-3.5' Flowers: Jul-Oct, yellow-orange, black eye Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L	moist fields, meadows	Region: P States: DC DE MD VA		cultivars have nice foliage

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Rudbeckia hirta *black-eyed Susan* USDA MG	Height: 1-3.5' Flowers: Jun-Oct, yellow, black eye Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: 6-7 Soil type: C L	fields, meadows, roadsides	Region: M P C States: DC DE MD NY PA VA WV		
Rudbeckia laciniata *tall, green-headed, or cutleaf coneflower* RHW	Height: 1.5-10' Flowers: Jul-Sep, yellow Fruit: capsule	Light: ☼ ◐ Moisture: M W Soil pH: 4.5-7 Soil type: C L S	floodplains, streambanks, fields	Region: M P C States: DC DE MD NY PA VA WV		herbal uses
Rudbeckia triloba *three-lobed coneflower* PLANTS WSJ	Height: 1.5-4.5' Flowers: Jun-Oct, yellow or orange Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L S	fields, open woods, rocky slopes	Region: M P States: DC MD NY PA VA WV		
Ruellia caroliniensis *Carolina wild petunia* RHW	Height: 0.5-3' Flowers: May-Aug, lavender-blue Fruit: capsule	Light: ☼ ◐ Moisture: M Soil pH: Soil type: C L S	woods, roadsides, thickets, waste places	Region: C States: DC DE MD VA WV		actually in the nightshade family, flower fragile; a highly variable species
Sabatia angularis *rose pink, common marsh-pink* RHW	Height: 1-3' Flowers: Jul-Oct, pink or white Fruit: capsule	Light: ☼ ◐ Moisture: M Soil pH: Soil type: C L S	moist open woods, fields, marshes, meadows; uplands, shores	Region: M P C States: DC DE MD VA WV		
Salvia lyrata *lyre-leaf sage* RHW	Height: 1-2' Flowers: Apr-Jun, violet Fruit: nut/nut-like	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L S	moist pastures, upland woods, thickets, waste areas	Region: M P C States: DC DE VA WV		
Sanguinaria canadensis *bloodroot* RHW	Height: 0.5' Flowers: Mar-May, white Fruit: capsule	Light: ● Moisture: M Soil pH: Soil type: L	rich woods, open roadsides	Region: M P C States: DC DE MD NY PA VA WV		showy flowers, but blooms fleetingly; herbal uses
Saxifraga pensylvanica *eastern swamp saxifrage*  RHW	Height: 1-3' Flowers: Apr-Jun, white to green Fruit: capsule	Light: ☼ ◐ Moisture: W Soil pH: Soil type: C L S	wet woods, bogs, swamps	Region: M P C States: DC DE MD NY PA VA		

Herbaceous Plants

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Saxifraga virginiensis *early saxifrage*	Height: 0.5-1' Flowers: Mar-May, white Fruit: capsule	Light: ☼ ◐ ● Moisture: D M Soil pH: Soil type:	rock crevices, dry slopes, woods	Region: M P C States: DC DE MD NY PA VA WV		
Scutellaria integrifolia *rough or hyssop skullcap, helmet flower*	Height: 1-2.5' Flowers: May-Jul, blue, pink, white Fruit: blackish, nut/nutlike	Light: ☼ ◐ Moisture: D M W Soil pH: Soil type:	swamps, bogs, moist woods, fields	Region: M P C States: DC DE MD VA WV		
Sedum ternatum *mountain stonecrop, wild stonecrop*	Height: 0.5' Flowers: Apr-Jun, greenish-white Fruit: pod	Light: ◐ ● Moisture: M Soil pH: Soil type:	damp rocks, rocky banks, cliffs, woods	Region: M P C States: DC DE MD NY PA VA WV		creeping stems; used in rock gardens
Senna marilandica (Cassia marilandica) *Maryland or southern wild senna*	Height: 3-6.5' Flowers: Jul-Aug, yellow Fruit: pod	Light: ☼ ◐ Moisture: D M Soil pH: 4-7 Soil type: L S	dry roadsides, thickets, open woods	Region: M P C States: DC DE MD VA WV		pods important food for upland gamebirds
Silene caroliniana *wild pink*	Height: 0.5-1' Flowers: Apr-Jun, white to pink Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L	dry open woods, rocky slopes, roadside banks, shale barrens	Region: M C States: DC DE MD VA		semi-evergreen; native to limestone areas
Silene stellata *starry campion, widow's frill*	Height: 1-3.5' Flowers: Jun-Sep, white Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type:	wooded slopes, roadside banks, barrens	Region: M P C States: DC DE MD NY PA VA WV		drought-tolerant; naturalizes in woods
Silene virginica *fire pink*	Height: 1-3' Flowers: Apr-Jul, dark pink to red Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L	upland woods, wooded slopes, streambanks, clearings	Region: M P States: DC DE VA WV		
Silphium perfoliatum *cup plant*	Height: 3-8' Flowers: Jul-Oct, yellow Fruit: capsule	Light: ☼ ◐ ● Moisture: D M Soil pH: Soil type: L	floodplains, fields, moist meadows, woods	Region: M P States: DC VA WV		

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Sisyrinchium angustifolium (S. graminoides) *blue-eyed grass* CM NRCS	Height: 0.5-1.5' Flowers: Apr-Jun, blue-violet Fruit: brown, capsule	Light: ☼ ◐ Moisture: D M Soil pH: 5-7 Soil type: C L	grassy areas, damp woods	Region: M P C States: DC DE MD NY VA WV		grasslike leaves; also S. montanum in NY
Sisyrinchium atlanticum *coastal or eastern blue-eyed grass* UWI JS	Height: 0.5-2.5' Flowers: May-Jul, blue-violet Fruit: capsule	Light: ☼ Moisture: M W Soil pH: Soil type:	marshes, meadows, low woods	Region: P C States: DC DE MD VA		leaves grasslike, more slender than S. angustifolium
Solidago caesia *bluestem goldenrod, wreath goldenrod* RHW	Height: 1-3.5' Flowers: Aug-Oct, yellow Fruit: capsule	Light: ☼ ◐ ● Moisture: D M Soil pH: 5.5-7 Soil type: C L	rich deciduous woods	Region: M P C States: DC DE MD NY PA VA WV		stems bluish or purplish
Solidago canadensis var. scabra (S. altissima) *tall or late goldenrod* UWI, RRK	Height: 3.5-6.5' Flowers: Jul-Nov, yellow Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L	woods, fields, riverbanks, roadsides	Region: M P C States: DC DE MD NY PA VA WV		
Solidago canadensis *Canada goldenrod* UWI MRB	Height: 1-6.5' Flowers: Jul-Oct, yellow Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: 4.8-7.5 Soil type: C L S	fields, roadsides	Region: M P C States: DE NY VA WV		
Solidago flexicaulis *broad leaf or zig zag goldenrod* RHW	Height: 1-3.5' Flowers: Jun-Oct, yellow Fruit: capsule	Light: ◐ ● Moisture: D M Soil pH: 5.3-7 Soil type: L	moist woods, rocky wooded slopes	Region: M P States: DC DE MD NY PA VA WV		
Solidago juncea *early goldenrod* RHW	Height: 1-4' Flowers: Jun-Oct, yellow Fruit: capsule	Light: ☼ Moisture: D M Soil pH: Soil type: S	fields, meadows, rocky slopes, roadsides	Region: M P C States: DC DE MD NY PA VA WV		
Solidago nemoralis *gray, dwarf, old-field, or one-sided goldenrod* RHW	Height: 0.5-3' Flowers: Jun-Nov, yellow Fruit: capsule	Light: ☼ ◐ Moisture: D Soil pH: 6.5-7.5 Soil type: L S	fields, open woods, roadsides	Region: M P C States: DC DE MD NY PA VA WV		tolerates poor soils

Herbaceous Plants

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Solidago odora *sweet goldenrod*	RHW	Height: 1.5-5' Flowers: Jul-Oct, yellow Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: C L S	dry open woods, barrens	Region: M P C States: DC DE NY VA WV		
Solidago rugosa *wrinkle-leaf or rough-stemmed goldenrod*	RHW	Height: 1-6.5' Flowers: Aug-Nov, Fruit: capsule	Light: ☼ ◐ Moisture: M W Soil pH: 5-7.5 Soil type: L S	fields, woods, floodplains, roadsides, waste places	Region: M P C States: DC DE MD NY PA VA WV		tough plant; aggressive; strongly colonial
Solidago sempervirens *seaside goldenrod*	RHW	Height: 1-6.5' Flowers: Jul-Nov, yellow Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: 5.5-7.5 Soil type: L S	coastal areas, dunes	Region: C States: DC DE MD VA		coastal plant, may occur where road salts are used
Solidago speciosa *showy or slender goldenrod*	PLANTS TGB	Height: 2-6.5' Flowers: Jul-Oct, yellow Fruit: capsule	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L S	dry to moist open woods and fields	Region: M P States: DC MD NY VA		
Spiranthes cernua *nodding ladies' tresses*	USFWS BES	Height: 0.5-2' Flowers: Jul-Nov, white Fruit:	Light: ☼ ◐ Moisture: M W Soil pH: 4.5-6.5 Soil type: C L S	meadows, open woods, roadsides, bogs	Region: M P C States: DC DE MD NY PA VA WV		orchid flowers; herbal uses
Stachys tenuifolia (S. hispida) *hedge nettle*	RHW	Height: 1.5-3.5' Flowers: Jun-Aug, white to pink Fruit: nut/nut-like	Light: ☼ ◐ ● Moisture: M W Soil pH: 5.7-7.4 Soil type: C L S	wooded bottomlands, streambanks, meadows, fields	Region: P C States: DC DE MD VA WV		
Stellaria pubera *star chickweed, great chickweed*	RHW	Height: 0.5-1.5' Flowers: Mar-Jun, white Fruit: capsule	Light: ● Moisture: M Soil pH: Soil type:	woods, shaded rocky areas	Region: M P ? States: DC MD VA WV		
Symphyotrichum cordifolium (Aster cordifolius) *heart-leaved aster*	RHW	Height: 1-5' Flowers: Aug-Oct, blue-violet to rose Fruit:	Light: ◐ ● Moisture: D M Soil pH: Soil type: C L S	upland meadows, woods	Region: M P C States: DC NY PA VA WV		

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Symphyotrichum ericoides var. ericoides (Aster ericoides) *heath, white heath, or dense-flowered aster; frostweed* RHW	Height: 0.5-6.5' Flowers: Jul-Nov, white, rarely blue, violet, rose Fruit:	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L S	dry fields, forest edges, woods, thickets	Region: M P States: DC DE MD NY WV		forms dense mounds
Symphyotrichum laeve var. laeve (Aster laevis) *smooth blue aster* MOBOT	Height: 1-5' Flowers: Aug-Oct, pale blue, violet, white Fruit:	Light: ☼ ◐ Moisture: D Soil pH: Soil type: C L S	open areas, forest edges	Region: M P C States: DC DE MD NY PA VA WV		
Symphyotrichum novae-angliae (Aster novae-angliae) *New England aster* USFWS	Height: 1-6' Flowers: Aug-Oct, violet capsule Fruit:	Light: ☼ ◐ Moisture: M Soil pH: Soil type: L	open woods, seasonal wetlands, shores, meadows	Region: M P C States: DC DE MD NY PA VA WV		showy, frequently cultivated; tolerates drier soils and seasonal flooding GC
Symphyotrichum novi-belgii var. novi-belgii (Aster novi-belgii) *New York aster* RHW	Height: 1-4.5' Flowers: Jul-Oct, blue-violet Fruit:	Light: ☼ ◐ Moisture: M W Soil pH: Soil type: L	thickets, meadows, shores	Region: P C States: DC DE MD NY VA		
Symplocarpus foetidus *skunk cabbage* RHW, USFWS BES	Height: 1-3' Flowers: Feb-May, green to purple-brown Fruit:	Light: ◐ ● Moisture: W Soil pH: 4-7 Soil type: C L S	fresh tidal and nontidal marshes and shrub swamps, forested wetlands, seeps	Region: M P C States: DC DE MD NY VA WV		flower inconspicuous, emerges before leaves; sap has skunk-like odor
Thalictrum dioicum *early meadow rue* RHW	Height: 1-2.5' Flowers: Apr-May, green to purple Fruit: capsule	Light: ● Moisture: M Soil pH: Soil type: L	rich rocky woods, ravines, alluvial terraces	Region: M P C States: DC MD NY PA VA WV		
Thalictrum pubescens (T. polygamum) *tall meadow rue* RHW	Height: 1.5-9' Flowers: Jun-Aug, white Fruit:	Light: ☼ ◐ ● Moisture: M W Soil pH: Soil type:	rich woods, low thickets, swamps, meadows, streambanks	Region: M P C States: DC DE MD NY PA VA WV		foliage similar to columbines; clump-forming; delicate flowers; species very variable
Thalictrum thalictroides (Anemonella thalictroides) *rue anemone, windflower* RHW	Height: 0.5-1' Flowers: Apr-Jun, white Fruit:	Light: ◐ ● Moisture: D M Soil pH: Soil type: C L S	wooded banks and thickets	Region: M P C States: DC DE MD NY PA VA WV		foliage similar to columbines

Herbaceous Plants

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Tiarella cordifolia *foamflower, false miterwort* USFWS BES	Height: 0.5-1' Flowers: Apr-Jul, white Fruit: capsule	Light: ☼ ◐ ● Moisture: M Soil pH: Soil type: L	rich woods, moist rocky wooded slopes	Region: M P C States: DC MD NY PA VA WV		attractive, long-blooming; creeping, clump-forming; many cultivars GC
Tradescantia virginiana *Virginia spiderwort, widow's tears* RHW	Height: 1-3' Flowers: Apr-Jul, deep blue-purple Fruit: capsule	Light: ☼ ◐ ● Moisture: M Soil pH: 4-8 Soil type: C L	wooded slopes, shale outcrops, fields, roadsides	Region: M P C States: DC DE MD VA WV		flowers showy
Trillium erectum *purple or red trillium, wakerobin* RHW	Height: 1-1.5' Flowers: Apr-Jun, purple or greenish to white Fruit: dark red, berry	Light: ● Moisture: M Soil pH: Soil type: L	woods	Region: M P States: DC MD NY PA VA WV		flowers ill-scented
Trillium grandiflorum *white or large-flowered trillium* RHW	Height: 0.5-1.5' Flowers: Apr-Jun, white then pink Fruit: black, berry	Light: ● Moisture: M Soil pH: Soil type: L	woods	Region: M P C States: DC MD NY PA VA WV		showy flowers; common, often in large colonies
Trillium sessile *toadshade* RHW	Height: 0.5-1' Flowers: Apr-May, maroon, purple, green Fruit: berry	Light: ◐ ● Moisture: M Soil pH: Soil type: L	woods, floodplains	Region: M P States: DC MD VA WV		
Trillium undulatum *painted trillium* RHW	Height: 1-1.5' Flowers: May-Jun, white with purple Fruit: bright red, berry	Light: ☼ ◐ ● Moisture: M Soil pH: Soil type: L	woods	Region: M P States: DC MD NY PA VA WV		
Uvularia grandiflora *large-flowered bellwort* RHW	Height: 2.5' Flowers: Apr-Jun, orange-yellow Fruit: capsule	Light: ● Moisture: M Soil pH: Soil type: L	woods	Region: M States: DC NY VA WV		rhizome can be cooked and eaten; young shoots can be substituted for asparagus
Uvularia perfoliata *perfoliate bellwort, mealy bellwort* RHW	Height: 0.5-2' Flowers: Apr-Jul, yellow Fruit: capsule	Light: ☼ ◐ Moisture: M Soil pH: Soil type: L	woods	Region: M P C States: DC DE MD NY PA VA WV		rhizome can be cooked and eaten; young shoots maybe substituted for asparagus

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Uvularia sessilifolia *straw lily* RHW	Height: 0.5-1' Flowers: May-Jun, yellow Fruit: capsule	Light: ☼ ◐ ● Moisture: D M Soil pH: Soil type: L S	dry to moist woodlands	Region: M P C States: DC DE MD NY PA VA WV		rhizomes may be cooked and eaten; young shoots may be substituted for asparagus GC
Veratrum viride *green false hellebore, white hellebore* RHW	Height: 2-5' Flowers: May-Jul, yellow-green Fruit: capsule	Light: ☼ ◐ ● Moisture: M W Soil pH: Soil type: C L S	swamps, woods	Region: M P C States: DC DE MD NY PA VA WV		leaf edges will brown if soil dries and plant is in windy area; does best in cooler temps; slugs like the foliage
Verbena hastata *blue vervain, simpler's joy* RHW	Height: 1.5-5' Flowers: Jun-Oct, blue to purple Fruit: nut/nut-like	Light: ☼ ◐ Moisture: M W Soil pH: Soil type: C L S	meadows, swamps, floodplains, ditches, roadsides	Region: M P C States: DC DE MD NY PA VA WV		bright flowers; herbal uses
Verbesina alternifolia *wingstem, yellow ironweed* RHW	Height: 3.5-8' Flowers: Aug-Oct, yellow Fruit: capsule	Light: ☼ Moisture: M Soil pH: Soil type:	wooded slopes, open woodlands, riverbanks, shaded lowlands, roadsides, fields	Region: M P C States: DC DE MD NY VA WV		threatened in NY
Vernonia noveboracensis *New York ironweed* RHW	Height: 3.5-8' Flowers: Aug-Oct, purple Fruit: capsule	Light: ☼ ◐ Moisture: M W Soil pH: Soil type: L	streambanks, fields, freshwater marshes	Region: M P C States: DC DE MD NY PA VA WV		brilliant flowers; tall upright form adds structure to garden; spreads
Veronicastrum virginicum (Veronica virginica) *Culver's root* RHW	Height: 3-6.5' Flowers: Jun-Sep, white, pink Fruit: capsule	Light: ☼ ◐ Moisture: M W Soil pH: Soil type: C L S	rich woods, meadows, thickets, swamps	Region: M P States: DC DE MD NY VA WV		
Viola conspersa *American dog violet* UWI RWF	Height: 0.5-1' Flowers: Apr-Jul, pale blue, violet Fruit: green, capsule	Light: ☼ ◐ ● Moisture: M W Soil pH: Soil type:	woods, fields, swamps	Region: M P C States: NY PA VA WV		delicate plant and flower; edible GC
Viola cucullata *marsh blue violet, blue marsh violet* RHW	Height: 0-0.5' Flowers: Apr-Jul, pale purple Fruit: green, capsule	Light: ◐ ● Moisture: M W Soil pH: Soil type: C L S	bogs, meadows, swamps	Region: M P C States: DC DE PA VA WV		stemless; self-sows; can become a nuisance GC

Herbaceous Plants

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Viola hastata *halberdleaf yellow violet*	RHW	Height: 0.5-1' Flowers: Apr-May, yellow w/ violet Fruit: green, capsule	Light: Moisture: D Soil pH: Soil type:	rich deciduous woods	Region: M States: DC MD VA WV		GC
Viola pedata *bird's foot violet*	RHW	Height: 0-0.5' Flowers: Mar-Jun, pale blue or w/ purple-black tips Fruit: green, capsule	Light: Moisture: D M Soil pH: Soil type: L S	sandy or rocky barrens, dry forested slopes	Region: M P C States: DC DE MD VA WV		stemless GC
Viola pubescens var. pubescens (V. pennsylvanica) *yellow violet, downy violet*	RHW	Height: 0.5-1.5' Flowers: May-Jun, yellow, purple veins Fruit: green, capsule	Light: Moisture: M Soil pH: 6-7 Soil type: L	moist or dry woods, swamps	Region: M P States: DC DE NY PA VA WV		
Viola sororia (V. papilionacea) *common blue violet*	RHW	Height: 0.5' Flowers: Mar-Jun, dark blue, violet Fruit: green with purple, capsule	Light: Moisture: M Soil pH: 6-7.8 Soil type: C L	dry to moist woods, swamps, thickets	Region: M P C States: DC DE MD NY PA VA WV		delicate plant and flower; edible; spreader; stemless
Viola striata *striped cream violet, striped violet*	MP	Height: 0.5-1' Flowers: Apr-Jun, ivory w/ purple Fruit: green, capsule	Light: Moisture: M W Soil pH: Soil type: L	alluvial woods, swamps, fields	Region: M P C States: DC DE MD NY PA VA WV		
Yucca filamentosa (Y. flaccida) *Adam's needle*	RHW	Height: 2-2.5' Flowers: Jun-Sep, white Fruit:	Light: Moisture: D Soil pH: 5.5-7.5 Soil type: L S	coastal sand dunes, outcroppings on thin rocky soils	Region: C States: DC DE MD VA		flower stalk can rise 5-15 feet above foliage
Zizia aurea *golden-alexanders*	RHW	Height: 1-2.5' Flowers: Apr-Jun, yellow Fruit:	Light: Moisture: D M Soil pH: Soil type: C L S	wooded bottomlands, streambanks, moist meadows, floodplains	Region: M P C States: DC DE NY PA VA WV		

See also:

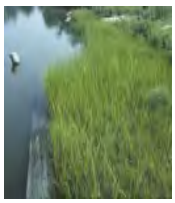
In the *Vines* section:
Smilax herbacea

In the *Herbaceous Emergents* section:
Iris prismatica, versicolor, virginica

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Distichlis spicata *saltgrass* UWI EJJ	Height: 0.5-1.5' Flowers: Aug-Oct Fruit: pod	Light: Moisture: M W Soil pH: 6.4-10.5 Soil type: C L Flood Depth: Salinity: 0-50 ppt	tidal salt marshes, from Mean High tide above to spring tide level; high salinity; wet depressions	Region: C States: DC DE MD VA		often intermixed with Spartina patens, forms dense mats
Dulichium arundinaceum *three-sided sedge* UWI AH	Height: 1-3.5' Flowers: Jul-Oct Fruit: brown, nut/nut-like	Light: Moisture: W Soil pH: 4.7-7.5 Soil type: C L S Flood Depth: 0-12"	fresh tidal and nontidal marshes, bogs, swamps, pond edges	Region: M P C States: DC DE NY PA VA WV		grows best where water rarely draws down
Hibiscus moscheutos (H. palustris) *rose mallow, eastern rosemallow* CM NRCS	Height: 3-6' Flowers: Jul-Sep, cream, pink Fruit: Sep-Mar, brown, capsule	Light: Moisture: M W Soil pH: 4-7.5 Soil type: C L Flood Depth: 0-6" Salinity: 0-15 ppt	fresh to brackish tidal marshes, occasionally nontidal marshes	Region: C States: DC DE MD VA WV		common along coast; persists in winter; split seed capsules; use H. laevis in Piedmont
Iris prismatica *slender blueflag* RHW	Height: 1-3' Flowers: May-Jun, blue Fruit: green to brown, capsule	Light: Moisture: M W Soil pH: Soil type: Flood Depth: 0-6" Salinity: 0-0.5 ppt	fresh to moderately brackish tidal marshes, meadows, shores, swamps, forested wetlands	Region: C States: DC DE VA		leaves 1/4-inch wide, narrower than Iris versicolor
Iris versicolor *blue flag* RHW	Height: 3' Flowers: May-Jun, blue Fruit: green to brown, capsule	Light: Moisture: M W Soil pH: Soil type: L S Flood Depth: 0-6" Salinity 0-0.5 ppt	fresh to moderately brackish tidal marshes, meadows, shores, swamps, forested wetlands	Region: M P C States: DC DE MD NY PA VA		
Iris virginica *Virginia blue flag* RHW	Height: 1-2' Flowers: May-Jul, blue Fruit: green to brown, capsule	Light: Moisture: W Soil pH: 4.8-7.3 Soil type: C L Flood Depth: 0-6" Salinity: 0-0.5 ppt	fresh to moderately brackish tidal marshes, meadows, shores, swamps, forested wetlands	Region: P C States: DC VA WV		
Juncus canadensis *Canada rush* UWI AH	Height: 1-4' Flowers: Jul-Oct, greenish brown Fruit: brown, capsule	Light: Moisture: M W Soil pH: 4.5-5.9 Soil type: C L S Flood Depth: Salinity: 0-0.5 ppt	fresh to slightly brackish tidal and nontidal marshes, swamps, ponds and pond borders, shores, wet meadows, shallow water	Region: P C States: DC DE MD NY PA WV		
Juncus effusus *soft rush* CM NRCS, USFWS BES	Height: 1-4' Flowers: Jun-Sep, greenish brown Fruit: brown, capsule	Light: Moisture: M W Soil pH: 5.5-7 Soil type: C L S Flood Depth: 0-12"	fresh tidal and nontidal marshes, shrub swamps, meadows, ditches	Region: M P C States: DC DE MD NY PA VA WV		often grows in clumps

Herbaceous Emergents

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Juncus roemerianus *black needlerush, needlegrass rush, needlegrass rush*	 PLANTS LA	Height: 1-4' Flowers: May-Oct, yellow-green Fruit: July-Nov, brown, capsule	Light: Moisture: M W Soil pH: 3.5-7 Soil type: C L Flood Depth: Salinity: 0-25 ppt	brackish and salt marshes, above Mean High tide to spring tide level	Region: C States: DE MD VA		some nitrogen fixing value
Justicia americana *American water-willow*	 RHW	Height: 1-3' Flowers: Jun-Oct, white with purple Fruit: achene (dry, flat seed)	Light: Moisture: W Soil pH: 5.4-7.6 Soil type: C L S Flood Depth:	muddy edges of shallow freshwater streams, lakes, ponds; shores	Region: M P States: DC MD PA VA WV		has underground stems and forms colonies
Kosteletzkya virginica *seashore mallow*	 RHW	Height: 1.5-4.5' Flowers: Jul-Sep, pink Fruit: brown, capsule	Light: Moisture: W Soil pH: Soil type: Flood Depth: Salinity: 0-10 ppt	irregularly flooded salt and brackish marshes, above Mean High tide to spring tide level	Region: C States: DC DE MD VA		common near the coast; looks similar to Hibiscus
Nuphar lutea (N. advena) *spatterdock, yellow water lily, cow-lily, American lotus*	 RHW	Height: 1-1.5' Flowers: May-Oct, yellow Fruit: green, berry	Light: Moisture: W Soil pH: Soil type: C L S Flood Depth: 12-36"	fresh tidal and nontidal marshes, swamps, ponds	Region: M P C States: DC DE MD NY VA WV		large leaves floating but rooted; fruit berry-like, many seeded, somewhat flattened, leathery
Nymphaea odorata *fragrant water lily, American water lily, white water lily*	 RHW	Height: 1-4' Flowers: Jun-Sep, white Fruit: green, berry	Light: Moisture: W Soil pH: Soil type: C L S Flood Depth: 12-48"	tidal and nontidal fresh waters, shallow lakes, ponds	Region: P C States: DC DE MD NY VA		large leaves floating but rooted; fruit berry-like, many seeded, somewhat flattened, leathery
Orontium aquaticum *golden club*	 RHW	Height: 1.5-2' Flowers: Apr-Jun, yellow Fruit: green, berry	Light: Moisture: W Soil pH: Soil type: C L S Flood Depth:	edges of regularly flooded tidal fresh marshes, inland shores, pond borders, on mud or in shallow water	Region: C States: DC DE MD VA WV		fruit is a thick fleshy spike covered with small dark green berry-like structures
Peltandra virginica *arrow arum*	 RHW, RHW	Height: 2' Flowers: Apr-Jul, green to white Fruit: green or black	Light: Moisture: W Soil pH: 5.2-9.5 Soil type: C L S Flood Depth: 0-12" Salinity: 0-2 ppt	fresh to moderately brackish tidal and nontidal marshes, swamps, shallow waters of lakes and ponds	Region: C States: DC DE MD NY VA WV		globular head of berries enclosed in green leathery case, curved downward
Pontederia cordata *pickerelweed*	 UWI MC	Height: 3.5' Flowers: Jun-Nov, purple Fruit:	Light: Moisture: W Soil pH: 6-8 Soil type: C L S Flood Depth: 0-18" Salinity: 0-3 ppt	fresh to moderately brackish, tidal and nontidal marshes, shallow water of ponds or lakes	Region: P C States: DC DE MD NY VA		spreads vigorously; a small bladder-like structure crested with toothed ridges holds one seed

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Sagittaria latifolia *duck potato, arrowhead, broadleaf arrowhead* RHW	Height: 0.5-4' Flowers: Jul-Sep, white Fruit: green, achene (dry, flat seed)	Light: Moisture: W Soil pH: 4.7-8.6 Soil type: C L Flood Depth: 0-24" Salinity:	fresh tidal and nontidal marshes, swamps; borders of lakes, streams and ponds	Region: P C States: DC DE MD NY PA VA WV		
Saururus cernuus *lizard's tail* RHW	Height: 1.5-4.5' Flowers: Jun-Sep, greenish white Fruit: capsule	Light: Moisture: W Soil pH: Soil type: C L S Flood Depth: 0-12"	fresh tidal and nontidal marshes, swamps, shallow water	Region: C States: DC DE MD VA WV		fragrant flower; often forms extensive colonies
Schoenoplectus pungens var. pungens (Scirpus pungens, Scirpus americanus) *common three-square* CM NRCS	Height: 4' Flowers: Jun-Sep, brown Fruit: Jun-Sep, brown, achene (dry, flat seed)	Light: Moisture: W Soil pH: Soil type: C L S Flood Depth: 0-6" Salinity: 0-15 ppt	fresh and brackish tidal and nontidal marshes, shores, shallow water	Region: M P C States: DC DE MD VA	high wildlife value	spike above flower is up to 5 inches tall
Schoenoplectus validus (Scirpus validus) *great bulrush, soft stem bulrush* PLANTS 1995	Height: 6-10' Flowers: Jun-Sep, brown Fruit: Jun-Sep, brown, achene (dry, flat seed)	Light: Moisture: W Soil pH: Soil type: C L S Flood Depth: 0-12" Salinity: 0-5 ppt	fresh to brackish tidal and nontidal marshes, pond edges, quiet waters, emergent marshes	Region: M P C States: MD NY PA VA	high wildlife value	spreads rapidly
Scirpus atrovirens *black or green bulrush, dark green bulrush* PLANTS JA	Height: 3-6' Flowers: Jun-Aug, brown Fruit: Jun-Aug, brown, achene (dry, flat seed)	Light: Moisture: W Soil pH: 4-8 Soil type: C L Flood Depth: Salinity:	shallow emergent marshes, shrub swamps, floodplain forests, wooded swamp, bogs, wet meadows, swales, ditches	Region: M P C States: MD NY PA VA WV	high wildlife value	grows in clumps or sod-forming
Scirpus cyperinus *woolgrass, woolgrass bulrush* USDA JK	Height: 4-5' Flowers: Aug-Sep, brown Fruit: Aug-Sep, brown, achene (dry, flat seed)	Light: Moisture: M W Soil pH: 4.8-7.2 Soil type: C L S Flood Depth: Salinity:	fresh tidal and nontidal marshes, swamps, forested wetlands, meadows, ditches, ponds, bogs	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	grows in large clumps, often extensive colonies
Sparganium americanum *American bur-reed* RHW	Height: 5' Flowers: May-Aug, greenish Fruit: green to brown, achene (dry, flat seed)	Light: Moisture: W Soil pH: 4.9-7.3 Soil type: C L S Flood Depth: 0-6"	fresh nontidal marshes, shallow waters, muddy shores	Region: M P C States: DC DE NY PA VA WV		good for sediment stabilization
Spartina alterniflora *salt marsh or smooth cordgrass*  USFWS	Height: 2-7' Flowers: Jul-Sep Fruit:	Light: Moisture: M W Soil pH: 5.4-7 Soil type: C L S Flood Depth: Salinity: 0-35 ppt	salt and brackish tidal marshes (mid-tide up to Mean High tide level)	Region: C States: DC DE MD VA		good for shore stabilization; important in seaside habitats; short form (<1.5 ft) found in irregularly flooded high marsh, tall form in regularly flooded low marsh

Herbaceous Emergents

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Spartina cynosuroides *big cordgrass* PLANTS LA	Height: 3.5-10' Flowers: Aug-Oct Fruit:	Light: Moisture: M W Soil pH: 5.8-7.5 Soil type: C L S Flood Depth: Salinity: 0-10 ppt	fresh and brackish tidal marshes, near Mean High tide and above to spring tide level	Region: C States: DC DE MD NY PA VA		soil stabilizer; not drought tolerant
Spartina patens *salt meadow hay* CM NRCS	Height: 1-3' Flowers: Jul-Sep Fruit: achene (dry, flat seed)	Light: Moisture: M W Soil pH: 5.3-7.5 Soil type: C L S Flood Depth: Salinity: 0-35 ppt	coastal salt and brackish tidal marshes; irregularly flooded high marsh at or above Mean High tide line	Region: C States: DC DE MD VA		forms large mats; good for shore erosion control
Spartina pectinata *freshwater cordgrass, prairie cordgrass* CM NRCS	Height: 4' Flowers: Jul-Sep Fruit: achene (dry, flat seed)	Light: Moisture: M W Soil pH: 6-8.5 Soil type: L Flood Depth: 0-6" Salinity: 0-3 ppt	brackish and fresh tidal and nontidal marshes, shores, wet meadows; upper half of intertidal zone and above to spring tide level	Region: M P C States: DC DE MD NY PA VA WV		shore stabilizer; low drought tolerance
Zizania aquatica *wild rice* RHW	Height: 6-10' Flowers: Jun-Sep Fruit: achene (dry, flat seed)	Light: Moisture: M W Soil pH: 6.4-7.4 Soil type: C L S Flood Depth: 0-36" Salinity:	fresh tidal and nontidal marshes, streamsides, shallow waters	Region: C States: DC DE MD NY VA		annual; edible

See also:

In the *Ferns* section:
- **Dryopteris cristata**
- **Onoclea sensibilis**
- **Osmunda cinnamomea, regalis**
- **Thelypteris palustris**
- **Woodwardia areolata, virginica**

In the *Grasses & Grasslike Plants* section:
- **Andropogon glomeratus (virginicus var abbreviatus), virginicus**
- **Calamagrostis canadensis**
- **Carex crinita var. crinita, lurida, stricta, vulpinoidea**
- **Elymus virginicus**
- **Leersia oryzoides**
- **Panicum amarum, virgatum**

In the *Herbaceous Plants* section:
- **Asclepias incarnata**
- **Bidens cernua**
- **Caltha palustris**
- **Doellingeria umbellata var. umbellata (Aster umbellatus)**
- **Lobelia cardinalis**
- **Sabatia angularis**
- **Symphyotrichum novae-angliae (Aster novae-angliae)**
- **Symplocarpus foetidus**
- **Verbena hastata**
- **Vernonia noveboracensis**

Wetland plants (**Spartina alterniflora**, here) stabilize the shoreline without obstructing the homeowner's view.

USFWS

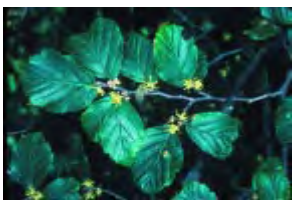
Wetlands of any size provide valuable habitat for wildlife.

USFWS BES

USFWS RM

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Alnus serrulata *smooth alder, hazel alder* USFWS BES, PLANTS WSJ	Height: 12-20' Flowers: Mar-Apr, purple Fruit: Aug-Feb, brown, cone/cone-like Fall color: yellow, red	Light: Moisture: M W Soil pH: 5.5-7.5 Soil type: C L	fresh tidal and nontidal marshes, shrub swamps, forested wetlands	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	forms thickets along watercourses; nitrogen fixing; tolerates flooding to 3 inches
Aralia spinosa *Devil's walking stick* RHW	Height: 20-30' Flowers: Jul-Aug, white Fruit: Aug-Sep, black, berry Fall color: yellow	Light: Moisture: D M Soil pH: 5.5-7.1 Soil type: C L S	moist woods, stream banks, roadsides	Region: M P C States: DC DE MD VA WV	high wildlife value	seeds are poisonous if chewed; low maintenance; spreads from new shoots; thorny, clublike stem
Baccharis halimifolia *high-tide bush, groundsel tree, sea myrtle* USFWS BES	Height: 6-12' Flowers: Aug-Sep, white Fruit: Oct-Nov, silvery white, achene Fall color: purple	Light: Moisture: D M W Soil pH: 7-8.5 Soil type: C L S O	fresh to salt marshes, ditches, shores, dunes	Region: C States: DE MD VA		volunteers in disturbed places; shallow, lateral roots; tolerates flooding to 6 inches; tolerates salinity to 15 ppt
Callicarpa americana *American beautyberry, French mulberry* USFWS BES	Height: 6' Flowers: Jun-Aug, lavender-pink Fruit: Sep-Mar, lavender, berry Fall color:	Light: Moisture: D M Soil pH: 4.8-7 Soil type: C L S		Region: C States: DC VA		flowers from new growth; if overgrown prune to 6-18 inches tall; will regain height in one season
Ceanothus americanus *New Jersey tea* RHW	Height: 3' Flowers: May-Sep, white Fruit: Sep-Oct, black Fall color: yellow to tan	Light: Moisture: D Soil pH: 4.3-6.5 Soil type: C L S	meadows, fields, glades, open woods, borders, rocky areas, openings	Region: M P C States: DC DE MD NY PA VA WV		tough; tolerates moist soil if well drained; fixes nitrogen; tolerates dryness
Cephalanthus occidentalis *buttonbush* RHW	Height: 6-12' Flowers: Jul-Aug, creamy white Fruit: Sep-Jan, green to brown Fall color: yellow-green	Light: Moisture: M W Soil pH: 6.1-8.5 Soil type: C L S O	fresh tidal and nontidal marshes, shrub swamps, forested wetlands; stream, lake and pond edges	Region: M P C States: DC DE MD NY PA VA WV		needs sun to flower; flowers fragrant; interesting fruit; tolerates drought; leaves may persist into winter; tolerates flooding to 36 inches
Clethra alnifolia *sweet pepperbush, summersweet* USFWS	Height: 6-12' Flowers: Jul-Aug, white/pink Fruit: Sep-Feb, brown, capsule Fall color: yellow	Light: Moisture: M W Soil pH: 4.5-6.5 Soil type: C L S	tidal and nontidal forested wetlands, shrub swamps, bogs, woods, coastal river floodplains, lakeshores	Region: C States: DC DE MD NY VA		very fragrant; tolerates some flooding by partly salty water
Comptonia peregrina *sweetfern* USFWS BES	Height: 3' Flowers: Apr-May, yellow-green Fruit: Aug-Oct, green to brown, cone/cone-like Fall color: brown	Light: Moisture: D Soil pH: 4-7 Soil type: L S O	hillsides, cliffs, woods openings, sand flats and barrens, fields, dunes	Region: M P C States: DC DE MD NY PA VA WV		fragrant; fixes nitrogen, leaves may persist into winter

Shrubs

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Cornus amomum *silky dogwood, red willow, silky cornel* RHW	Height: 6-12' Flowers: May-Jun, white Fruit: Aug, blue, berry Fall color: orange, red or purple	Light: ☼ ◐ Moisture: M W Soil pH: 6.1-7.5 Soil type: C L S	forested wetlands, floodplains, shrub wetlands, stream and pond banks, clearings	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	
Cornus racemosa *red-panicled or gray dogwood* UWI KJS, UWI KJS	Height: 6-12' Flowers: May-Jun, white Fruit: Aug-Sep, white, red stems, berry Fall color: purple	Light: ☼ ◐ ● Moisture: D M Soil pH: 6.1-8.5 Soil type: C L	open wooded floodplains, forested wetlands, shrub swamps, rocky woods or ledges, fencerows	Region: M P States: NY VA WV	high wildlife value	tolerates a variety of conditions; berries are food for many songbirds and small mammals
Corylus americana *American hazelnut or filbert* UCONN, UCONN, UCONN	Height: 10-15' Flowers: Mar-Apr, brown or red Fruit: Aug-Sep, light brown, nut/nut-like Fall color: yellow orange	Light: ◐ Moisture: D M Soil pH: 6.1-7.5 Soil type: C L	dry woodlands, forest edges, hillsides, fence rows, ravines, floodplain woods, brushy pastures	Region: M P States: DC DE MD NY PA VA WV		forms large thickets; edible nut; male catkins brown, female red
Gaultheria procumbens *wintergreen, checkerberry* RHW, RHW	Height: 0.5' Flowers: May-Aug, white to pink Fruit: Jul-Apr, red, berry Fall color: evergreen	Light: ◐ ● Moisture: D M Soil pH: 4-6.5 Soil type: L S O	clearings, steep rocky open slopes, sandy oak woods, hummocks in bogs	Region: M P C States: DC DE MD NY PA VA WV		dense, mat-like form; forms colonies; edible fruits, leaves; wintergreen taste and scent GC ▲
Gaylussacia baccata *black huckleberry* RHW	Height: 1.5-3' Flowers: May-Jun, white to pink Fruit: Jul-Sep, black, berry Fall color: reddish-purple	Light: ◐ ● Moisture: D M W Soil pH: 4.5-6.5 Soil type: C L S	woods, thickets	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	very common; fruits edible but many-seeded
Gaylussacia frondosa *dangleberry* CM NRCS	Height: 2-4' Flowers: Apr-Jun, greenish to purple Fruit: Jul-Oct, blue, berry Fall color: reddish-purple	Light: ☼ ◐ ● Moisture: D M W Soil pH: 4.5-6.5 Soil type: S	woods and thickets	Region: M C States: DC DE MD NY VA	high wildlife value	berries borne on long, drooping stems
Hamamelis virginiana *witch hazel*  RHW	Height: 15-30' Flowers: Sep-Dec, yellow Fruit: Oct-Nov, tan brown, capsule Fall color: yellow	Light: ◐ ● Moisture: D M Soil pH: 5.5-6.5 Soil type: C L S	woods or brushy fields, moist or dry	Region: M P C States: DC DE MD NY PA VA WV		noted for fall/winter bloom; medicinal uses, leaves may persist into winter
Hydrangea arborescens *wild or smooth hydrangea* RHW	Height: 3-6' Flowers: Jun-Aug, white Fruit: Oct-Jan, brown, capsule Fall color: yellow	Light: ◐ ● Moisture: M Soil pH: 6.1-8.5 Soil type: L S	rich upland or floodplain woods, streambanks	Region: M P States: DC MD PA VA WV		eaves poisonous to humans; does best on loamy soils

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Hypericum densiflorum *dense St. John's wort* RHW	Height: 1.5-6' Flowers: Jul-Sep, yellow Fruit: Oct-Apr, brown, capsule Fall color: yellow green	Light: Moisture: D M W Soil pH: 5.5-7 Soil type: C L S O	low boggy places, seepage slopes, pond and lake edges, wet meadows, streambanks, ditches, moist pinelands	Region: M P C States: DC DE MD VA		blooms small but form dense flat-topped clusters; can spread aggressively
Ilex glabra *inkberry* USFWS BES, USFWS BES	Height: 6-10' Flowers: May-Jun, greenish white Fruit: Sep-Mar, black, berry Fall color: evergreen	Light: Moisture: D M Soil pH: 4.5-6 Soil type: C L S O	forested wetlands, shrub swamps, sandy woods	Region: C States: DE NY VA	high wildlife value	berries persist through winter; male and female flowers on separate plants; tolerates some salt flooding; short cultivars (4-5') available
Ilex laevigata *smooth winterberry* RHW, RHW	Height: 10-12' Flowers: May-Jul, white to cream Fruit: Sep-Feb, red, scarlet, berry Fall color: yellow	Light: Moisture: M Soil pH: 4.5-6.5 Soil type: C L S O	wooded swamps	Region: C States: DC DE MD VA	high wildlife value	berries provide winter bird food; prefers soil with a calcareous layer
Ilex verticillata *winterberry, winterberry holly, black alder* USFWS BES	Height: 6-12' Flowers: Jun-Jul, greenish white Fruit: Aug-Feb, red, Fall color:yellow to brown	Light: Moisture: M W Soil pH: 4.5-6.5 Soil type: C L S O	fresh tidal swamps, shrub swamps, forested wetlands	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	berries provide winter bird food, poisonous to humans; berries on female plants, need male plant to pollinate
Itea virginica *tassel-white, Virginia sweetspire* USFWS BES	Height: 6-10' Flowers: Jun-Jul, white Fruit: Aug-Mar, brown, capsule Fall color: red to purple	Light: Moisture: M W Soil pH: 5.1-7.5 Soil type: C L S	forested wetlands, shrub swamps, streambanks, shallow water	Region: C States: DC DE MD VA		fruit capsules on stalk; plant will sucker, form thickets; tolerates flooding to 6 inches
Iva frutescens *marsh elder, high tide bush* PLANTS LA, RHW	Height: 2-10' Flowers: Aug-Oct, greenish white Fruit: not conspicuous, capsule Fall color:	Light: Moisture: D M Soil pH: 5-5.7 Soil type: C L S	tidal brackish and salt marshes	Region: C States: DE MD VA		similar to Baccharis halimifolia but with opposite leaves; tolerates salinity to 15 ppt
Kalmia angustifolia *sheep laurel, lambkill* CM NRCS	Height: 2-3' Flowers: May-Jul, white, pink, purple, red Fruit: Sep-Mar, brown, capsule Fall color: evergreen	Light: Moisture: M W Soil pH: 4.5-6 Soil type: C L S O	pastures, barrens, slow wooded streams, swamp borders, bogs, thickets	Region: C States: DC DE MD NY PA VA		foliage poisonous to hoofed browsers (not eaten by deer)
Kalmia latifolia *mountain laurel* USFWS BES	Height: 12-20' Flowers: May-Jul, white to pink/purple Fruit: May-Jun, brown, capsule Fall color: evergreen	Light: Moisture: D M W Soil pH: 4.5-6 Soil type: C L S O	woods, ridge tops, fields, swamps, mountain meadows and slopes	Region: M P C States: DC DE MD NY PA VA WV		foliage poisonous to hoofed browsers; PA state flower

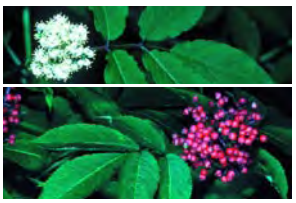
Shrubs

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Leucothoe racemosa *fetterbush, sweetbells* RHW, PLANTS WSJ	Height: 13' Flowers: May-Jun, white, pinkish Fruit: brown, capsule Fall color:	Light: ◐ ● Moisture: M W Soil pH: 4.5-6 Soil type: C L	swamps, woods, thickets	Region: M P C States: DC DE MD NY PA VA		zig-zag twigs, reddish or greenish; tends to sucker, forming thickets
Lindera benzoin *spicebush* CM NRCS, RHW, CM NRCS	Height: 6.5-16' Flowers: Mar-May, yellow Fruit: Sep-Oct, scarlet, berry Fall color: yellow	Light: ◐ ● Moisture: M W Soil pH: 4.5-6.5 Soil type: L S	woods, wooded slopes, dunes, floodplain forests	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	all parts edible and aromatic; herbal uses
Lyonia ligustrina *male-berry* RHW	Height: 6-12' Flowers: May-Jul, white Fruit: Sep-Mar, brown, capsule Fall color: orange to red	Light: ◐ ● Moisture: M Soil pH: 4-6 Soil type: C L S O	open areas, swamps, woods	Region: M P C States: DC DE MD NY PA VA WV		berry-like capsules persist through winter
Lyonia mariana *stagger-bush* RHW, CM NRCS	Height: 0.5-6.5' Flowers: May-Jun, white, pale pink Fruit: Sep-Feb, brown, capsule Fall color: red	Light: ◐ ● Moisture: D M Soil pH: 4-6 Soil type: S	swamps, moist or dry woods	Region: C States: DC DE MD VA		interesting woody capsules persist through winter
Morella caroliniensis (Myrica heterophylla) *southern or swamp bayberry* PLANTS	Height: 8-12' Flowers: Apr-Jun, yellowish-green Fruit: Sep-Apr, bluish white, berry Fall color: evergreen	Light: ○ ◐ ● Moisture: D M W Soil pH: 4.5-7 Soil type: C L S	dry or moist thickets, woods, bogs	Region: C States: DE VA		glossy dark green leaves, leaves larger than M. cerifera, plants fuller
Morella cerifera (Myrica cerifera) *wax myrtle, southern bayberry* USFWS BES, PLANTS	Height: 6-15' Flowers: Mar-Jun, yellowish-green Fruit: Sep-Apr, bluish white, berry Fall color: evergreen in southern areas	Light: ○ ◐ Moisture: D M W Soil pH: 5.5-7 Soil type: C L S	tidal and nontidal fresh and brackish marshes, swamps, sandy dune swales, upland woods	Region: C States: DE MD VA		fragrant; loses leaves north and west of Ches. Bay, MD north; may reach 30 feet; can be pruned as hedge; nitrogen fixer; tolerates salinity to 10 ppt
Morella pensylvanica (Myrica pensylvanica) *northern bayberry, candleberry* CM NRCS	Height: 5-10' Flowers: Mar-Apr, yellowish-green Fruit: Sep-Apr, bluish white, berry Fall color:	Light: ○ ◐ Moisture: D M W Soil pH: 5.1-6.5 Soil type: C L S	tidal and nontidal fresh and brackish marshes, swamps, sand flats, dunes	Region: C States: DC DE MD NY VA	high wildlife value	fragrant leaves; tends to sucker and form large colonies; waxy berries persist through winter; tolerates salinity to 20 ppt
Photinia melanocarpa (Aronia melanocarpa) *black chokeberry* USFWS BES	Height: 3-6' Flowers: Apr-May, white or pink-tinged Fruit: Sep-Nov, black, berry Fall color: crimson red	Light: ○ ◐ Moisture: D M W Soil pH: 5.1-6.5 Soil type: C L S O	bogs, swamps, springs, dunes, cliffs, fields, clearings, wet or dry thickets, creek banks, balds, rock outcroppings	Region: M P C States: DE MD NY PA VA WV		can be pruned as hedge

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Photinia pyrifolia (Aronia arbutifolia) *red chokeberry* USFWS BES, VT	Height: 1.5-13' Flowers: Mar-May, white, purple-tinged Fruit: Sep-Dec, red, berry Fall color: orange to red	Light: ◐ ◑ Moisture: D M W Soil pH: 5.1-6.5 Soil type: C L S	forested wetlands, shrub bogs, upland forests, fields, dunes	Region: M P C States: DC DE MD NY PA VA WV		tolerates infrequent flooding by water with some salt; can be pruned as hedge
Physocarpus opulifolius *ninebark* USFWS BES	Height: 5-12' Flowers: May-Jul, white, pink Fruit: Jul-Mar, orange to red, capsule Fall color:yellow to purple	Light: ◐ ◑ Moisture: M W Soil pH: 6.1-8.5 Soil type: C L	thickets, along streams in sand or gravel bars, rocky slopes	Region: M P States: DC NY PA VA WV		papery bark continually molts in thin strips; very drought tolerant; adaptable
Prunus maritima *beach plum* CM NRCS	Height: 1-8' Flowers: Apr-May, white Fruit: Aug, blue-purple, fleshy Fall color:	Light: ◐ ◑ Moisture: D M Soil pH: 5.8-7.7 Soil type: L S	ocean dunes, roadsides, hedgerows	Region: C States: DE MD	high wildlife value	edible fruit, prized for jams and jellies; salt tolerant
Rhododendron atlanticum *dwarf or coast azalea* GM ARS, USFWS BES	Height: 1-2.5' Flowers: Apr-May, white, purple-tinged Fruit: brown, capsule Fall color:	Light: ◑ ● Moisture: M Soil pH: 4.2-5.7 Soil type: S	coastal, sandy soils	Region: C States: DE MD VA		flowers very fragrant; colonial, arising from spreading underground stems;
Rhododendron calendulaceum *flame azalea* RHW	Height: 5-9' Flowers: May-Jun, yellow, orange, red Fruit: Aug-Feb, brown, capsule Fall color: yellow green	Light: ◑ Moisture: D M Soil pH: 5.1-6 Soil type: C L	open oak woods, dry rocky woodlands, damp slopes, mountain streambanks, heath balds	Region: M States: VA WV		
Rhododendron canescens *sweet azalea* PLANTS, PLANTS	Height: 3-10' Flowers: Apr-May, white or pink Fruit: brown, capsule Fall color:	Light: ◑ Moisture: M Soil pH: 4.2-5.7 Soil type: S	woods	Region: C States: DC DE MD		
Rhododendron maximum *great laurel, rosebay rhododendron* RHW, USFWS BES	Height: 15-20' Flowers: May-Aug, white, pink Fruit: Sep-Nov, tan to red, capsule Fall color: evergreen	Light: ◑ ● Moisture: M W Soil pH: 4.5-6 Soil type: L	mountain slopes, woods, sheltered coves, ravines, streamsides	Region: M P States: DC MD NY PA VA WV		needs space; may form dense thicket
Rhododendron periclymenoides *pinxterbloom, pink azalea, pinxter flower* RHW	Height: 3-10' Flowers: Apr-May, pink, purple, white Fruit: Aug-Mar, brown, capsule Fall color: dull yellow	Light: ◐ ◑ ● Moisture: D M W Soil pH: 4.5-5.5 Soil type: L	woods, low swampy areas, limestone cliffs	Region: M P C States: DC DE MD NY PA VA WV		will tolerate thin soils over bedrock; open, airy quality; susceptible to disease and insects

Shrubs

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Rhododendron prinophyllum *rose, roseshell, mountain or early azalea*	 PLANTS	Height: 2-8' Flowers: May-Jun, pink Fruit: May-Sep Fall color:	Light: ☼ ◐ ● Moisture: D M Soil pH: Soil type: O	rocky or rich woods	Region: M States: PA VA WV		may reach 15 feet tall, but rarely; flowers have clove-like scent
Rhododendron viscosum *swamp azalea*	 RHW	Height: 6.5-10' Flowers: May-Aug, white, pink Fruit: Aug-Mar, brown, capsule Fall color: yellow, orange, to purple	Light: ☼ ◐ Moisture: M W Soil pH: 4-6 Soil type: C L S O	wet floodplain woods, streambanks, swamp edges, hillside bogs, ditch banks, clearings	Region: M P C States: DC DE MD NY VA		attractive spreading, loose-branched habit; demands acid soil; susceptible to disease and insects
Rhus aromatica *fragrant sumac*	 RHW, RHW	Height: 6' Flowers: Mar-May, greenish yellow Fruit: Jul-Mar, dark wine red, berry Fall color: red	Light: ☼ ◐ Moisture: D Soil pH: 6.1-8.5 Soil type: L S	limestone cliffs, open upland woods, rocky bluffs, oak barrens, forednes, barren rock	Region: M P States: DC MD NY VA WV	high wildlife value	fuzzy edible berry clusters; aromatic leaves; shorter cultivars available; male and female separate plants
Rhus copallina *shining, winged, flameleaf, or dwarf sumac*	 RHW, CM NRCS	Height: 20-35' Flowers: Jul-Sep, greenish yellow Fruit: Oct-Nov, red, berry Fall color: rich red	Light: ☼ ◐ Moisture: D Soil pH: 5.3-7.5 Soil type: C L S	thickets, fields, open woods, roadsides, fencerows	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	forms large colonies; winter food for wildlife
Rhus glabra *sweet or smooth sumac*	 CM NRCS	Height: 2-20' Flowers: Jun-Jul, greenish Fruit: Aug-Oct, red, berry Fall color: red	Light: ☼ Moisture: D M Soil pH: 5.3-7.5 Soil type: L S	dry or moist open areas, shale barrens, fields, dry open slopes, roadsides, fencerows	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	fuzzy berry clusters; male and female may be on separate plants; extremely drought resistant
Rhus hirta (R. typhina) *staghorn sumac*	 RHW	Height: 35-50' Flowers: Jun-Jul, yellow-green Fruit: Jul-Feb, red, berry Fall color: orange-red	Light: ☼ Moisture: D M Soil pH: 4.5-7.2 Soil type: C L S	fields, roadsides, forest edges	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	spreads by lateral roots to form colonies; female plants produce seed; winter food for wildlife
Ribes rotundifolium *Appalachian or eastern gooseberry*	 USFWS BES	Height: 3-6' Flowers: May-Jul, greenish purple Fruit: Jul-Aug, purple or greenish, berry Fall color: red	Light: ◐ Moisture: D Soil pH: 6.1-8.5 Soil type: C L S	rocky upland woods	Region: M P States: DC MD NY VA WV		do not use near apple orchards; may spread cedar apple rust
Rosa carolina *pasture rose*	 RHW, RS MNPS	Height: 0.5-3' Flowers: May-Jun, pale pink Fruit: Aug-Mar, red, berry Fall color: yellowish to orange	Light: ☼ ◐ Moisture: D M Soil pH: 6.1-8.5 Soil type: C L S	dry fields, open woods; rocky banks, shale barrens	Region: M P C States: DC DE MD NY VA WV	high wildlife value	edible fruit is a berry-like hip; thorns

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Rosa palustris *swamp rose* PLANTS WSJ	Height: 8' Flowers: Jun-Aug, pink Fruit: Jul-Mar, red, berry Fall color:	Light: ☼ ◐ ● Moisture: M W Soil pH: 4-7 Soil type: C L	fresh tidal and nontidal marshes, forested wetlands, shrub swamps, streambanks	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	edible fruit is a berry-like hip; thorns; tolerates flooding to 3 inches
Rubus allegheniensis *Allegheny blackberry* USFWS BES, RHW	Height: 3-9' Flowers: May-Jun, white Fruit: Jul-Sep, black, berry Fall color: orange, red, to purple	Light: ☼ ◐ Moisture: D M Soil pH: 4.5-7.5 Soil type: C L	roadsides, fence rows, fields, thickets, open woods, clearings	Region: M P States: DC DE MD NY PA VA WV	high wildlife value	prickly; juicy edible fruit used by people and wildlife
Rubus odoratus *purple flowering raspberry, fragrant thimbleberry* PLANTS WSJ	Height: 3-6' Flowers: Jun-Sep, rose purple Fruit: Jul-Sep, dull red, berry Fall color: pale yellow	Light: ◐ ● Moisture: M Soil pH: 5.1-6 Soil type: C L S	forest edges, rocky ledges, rocky wooded slopes	Region: M P States: DC DE MD NY PA VA WV	high wildlife value	feels sticky; fruit edible; spreads by suckers
Salix humilis *prairie willow* PLANTS 1997	Height: 6-12' Flowers: Apr-May, greenish yellow Fruit: May-Jun, brown, capsule Fall color: dull yellow	Light: ☼ Moisture: D M W Soil pH: 6.1-7.5 Soil type: C L S O	dry thickets, openings, boggy swales; mountain ridges, barrens, meadows, roadsides	Region: M P C States: DC DE PA VA WV	high wildlife value	typically spreads up to twice it's height; flowers are catkins
Sambucus nigra ssp. canadensis (S. canadensis) *common elderberry, American elder* RS MNPS, USFWS	Height: 6-12' Flowers: Jun-Jul, white Fruit: Aug-Sep, purple to black, berry Fall color: yellow green	Light: ☼ ◐ ● Moisture: D M W Soil pH: 6.1-7.5 Soil type: C L S O	fresh tidal and nontidal marshes, swamps, wet meadows, moist woods, fields	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	berries eaten by 48 species of birds
Sambucus racemosa var. racemosa (S. pubens) *red elderberry, scarlet elder*  RHW, RHW	Height: 6-12' Flowers: May, white Fruit: Jun-Jul, red, berry Fall color: yellow green	Light: ● Moisture: D M Soil pH: 6.1-8.5 Soil type: L	rich woods, dry rocky woods, along creeks, rock crevices, sheltered coves, ravines	Region: M States: PA VA WV	high wildlife value	important summer wildlife food; one of earliest blooming shrubs; fragrant
Spiraea alba var. latifolia (Spiraea latifolia) *broad-leaved meadow-sweet* RHW	Height: 3-6' Flowers: Jun-Sep, white or pinkish Fruit: Sep-Mar, brown, capsule Fall color: yellow	Light: ☼ Moisture: M Soil pH: Soil type: L S	bogs, woods, barrens, swamps	Region: M States: DC DE MD NY VA WV		similar to S. alba but twigs more purplish or red
Spiraea alba *narrow-leaved meadow-sweet* RHW	Height: 3-6' Flowers: Jun-Sep, white Fruit: Sep-Mar, brown to red brown, capsule Fall color: yellow	Light: ☼ Moisture: M Soil pH: 6.6-7.5 Soil type: C L S O	bogs, swamps, meadows	Region: M States: DC DE MD NY VA WV		bark may be shaggy, orange-brown

Shrubs

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Spiraea tomentosa *steeplebush, hardback spirea*	 RHW	Height: 3-6' Flowers: Jul-Sep, pink to purple Fruit: Sep-Mar, brown, capsule Fall color: yellow green	Light: ☼ Moisture: M W Soil pH: 5.1-6 Soil type: C L S O	meadows, fields, bogs, swamps, lake edges, marshes, dunes, swales	Region: M P C States: DC DE MD NY VA WV		cultivars available with white or red flowers
Staphylea trifolia *American bladdernut*	 RHW	Height: 3-15' Flowers: May, greenish white Fruit: Aug-Dec, red-brown, capsule Fall color: yellow	Light: ● Moisture: M Soil pH: 6.1-8 Soil type: L	rich woods, floodplain woods, ravines, shores of lakes and ponds, rocky wooded streambanks, shaded dunes	Region: M P States: DC MD PA VA WV		fruit is 3-lobed, papery, balloon-like capsule; branches green-white striped
Vaccinium angustifolium *lowbush blueberry*	 BES	Height: 1-2' Flowers: May-Jun, white or pink-tinged Fruit: Jul-Aug, blue to black, berry Fall color: red	Light: ☼ ◐ Moisture: D M Soil pH: 4-6 Soil type: C L S	dry woods, barrens, rock outcroppings	Region: M P States: DC MD NY PA VA WV	high wildlife value	edible berries often harvested, makes a nice ground layer GC
Vaccinium corymbosum *highbush blueberry*	 USFWS BES, USFWS BES	Height: 6-12' Flowers: Apr-Jun, white or pink-tinged Fruit: Jul-Aug, blue to black, berry Fall color: yellow to red	Light: ☼ ◐ ● Moisture: D M W Soil pH: 4-6.5 Soil type: L S O	forested wetlands, shrub swamps, bogs, dry to wet woods, thickets, streambanks, rock outcroppings	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	edible berries commonly cultivated
Vaccinium macrocarpon *cranberry*	 RHW	Height: 0.5-1' Flowers: Jun-Jul, white to pink Fruit: Sep-Nov, red, berry Fall color: dark green to purple to red	Light: ☼ ◐ Moisture: W Soil pH: 4-6 Soil type: L S O	sphagnum bogs, cool swampy areas	Region: M C States: DC DE MD NY PA WV		low mat form, can spread indefinitely; edible cranberries GC ▲
Vaccinium pallidum (V. vacillans) *early lowbush blueberry*	 RHW	Height: 1.5-2' Flowers: Apr-May, white, reddish Fruit: Jul-Aug, blue, berry Fall color:	Light: ☼ ◐ Moisture: D M Soil pH: Soil type: L S	dry woods and barrens	Region: M P C States: DC DE MD PA VA WV	high wildlife value	sweet berries GC
Vaccinium stamineum *deerberry*	 RHW	Height: 6-12' Flowers: Apr-Jun, white or purple Fruit: Sep-Oct, bluish black, berry Fall color: red	Light: ☼ ◐ Moisture: D M Soil pH: 4-6.5 Soil type: C L S	dry woods, openings, barrens; uplands, floodplain forests, clearings, thickets, rock outcroppings	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	berries edible but sour
Viburnum acerifolium *maple-leaved arrowwood*	 RHW, RHW	Height: 3-6' Flowers: Jun, creamy-white, pink Fruit: Aug-Dec, blue to black, berry Fall color: orange, red, purple	Light: ☼ ◐ ● Moisture: D M Soil pH: 5.1-6 Soil type: C L	floodplain forests, dry wooded slopes, woods,rocky slopes, rock outcrops, wooded ravines	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	dry, edible berries

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Viburnum dentatum (V. recognitum) *southern arrowwood* USFWS BES, RS MNPS	Height: 10-15' Flowers: May-Jun, white Fruit: Sep-Nov, blue to black, berry Fall color: reddish-purple	Light: ☼ ◐ ● Moisture: D M W Soil pH: 5.1-6.5 Soil type: L S O	swamps, wet woods, bogs, floodplain forests, streambanks, low, wet acid-sand habitats	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	stems very straight, nice structure in winter
Viburnum nudum var. cassinoides (V. cassinoides) *witherod* USFWS BES	Height: 6-12' Flowers: May-Jun, creamy white Fruit: Aug-Sep, pink to blue-black, berry Fall color: orange-red to purple	Light: ☼ ◐ Moisture: D M W Soil pH: 5.1-6.5 Soil type: L O	swamps, bogs, moist woods, barrens	Region: M P C States: MD PA		handsome stature; multiple fruit colors at once
Viburnum nudum *naked witherod, possum-haw viburnum* RHW	Height: 6.5-20' Flowers: Jun-Jul, white to cream Fruit: Sep-Oct, red to blue, then black, berry Fall color: red to purple	Light: ☼ ◐ ● Moisture: M W Soil pH: 5.1-6 Soil type: L S	wet woods, rich upland woods, swamps, margins of vernal ponds, heath bogs	Region: M P C States: DC DE MD VA	high wildlife value	edible fruit but very acidic; shallow fibrous roots, transplants well
Viburnum prunifolium *black haw* RHW	Height: 12-24' Flowers: Apr-May, white Fruit: Jul-Nov, pink to bluish-black, berry Fall color: reddish purple	Light: ☼ ◐ ● Moisture: D M W Soil pH: 4.8-7.5 Soil type: C L	woods, thickets, fields, roadsides	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	fruits edible, used for preserves

See also:

In the *Trees* section:
- **Castanea pumila**
- **Cornus alternifolia**
- **Juniperus virginiana**
- **Magnolia virginiana**
- **Malus (Pyrus) coronaria**
- **Quercus ilicifolia**
- **Salix sericea**

Rhus copallina

CM NRCS

Rosa palustris

CM NRCS

Itea virginica

USFWS BES

Vaccinium corymbosum in fall.

USFWS BES

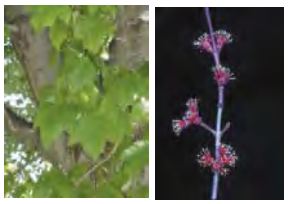
Kalmia angustifolia

RHW

Kalmia latifolia

RHW

Trees

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Acer negundo *box elder, ash leaf maple, Manitoba maple* USFWS BES, RHW	Height: 30-60' Spread: 30-60' Flowers: Apr-May, yellow-green Fruit: Jul-Sep, tan brown, winged Fall color: yellow, red	Light: ☼ ◐ Moisture: M W Soil pH: 5.2-7 Soil type: C L S	along rivers, streams, ponds, and seasonally flooded areas	Region: M P C States: DC DE MD NY PA VA WV		brittle wood; thicket-forming
Acer rubrum *red, scarlet, swamp, or soft maple*  USFWS BES, RHW	Height: 40-100' Spread: 30-75' Flowers: Mar-Apr, (inconspicuous) Fruit: Apr-Jun, red-brown or yellow, winged Fall color: red, orange, yellow	Light: ☼ ◐ Moisture: M W Soil pH: 5.4-7.1 Soil type: C L S	swamps, uplands, rocky hillsides, dunes	Region: M P C States: DC DE MD NY PA VA WV		earliest spring bloomer; adaptable
Acer saccharinum *silver, white, river, or soft maple* PLANTS DEH	Height: 50-100' Spread: 75-100' Flowers: Feb-Mar, greenish yellow Fruit: Apr-May, tan brown, winged Fall color: yellow	Light: ☼ ◐ Moisture: M W Soil pH: 5.2-7.1 Soil type: C L S	floodplains, streamsides, river bottoms, pond and lake edges	Region: M P States: DC DE MD NY PA VA WV		
Acer saccharum *sugar maple* USDA JE	Height: 60-100' Spread: 50-75' Flowers: Apr-May, yellow-green Fruit: Sep-Oct, green, tan at maturity, winged Fall color: yellow, orange, red	Light: ☼ ◐ ● Moisture: M Soil pH: 4-7.3 Soil type: L S	upland woods, mountain coves and slopes	Region: M P States: DC DE NY PA VA WV	high wildlife value	fall color; maple syrup; state tree of New York and West Virginia
Acer spicatum *mountain maple* RHW	Height: 20-35' Spread: 20-35' Flowers: May-Jun, yellow green Fruit: Jul-Sep, red or yellow, winged Fall color: orange to red	Light: ◐ ● Moisture: M Soil pH: 5.5-7 Soil type: L	cool rich woods, moist rocky slopes and flats, along small streams	Region: M States: MD NY PA VA WV	high wildlife value	short-lived, strong acid preference
Amelanchier arborea *downy serviceberry, shadbush* RHW	Height: 15-25' Spread: Flowers: Mar-May, white Fruit: red to dark purple, fleshy Fall color: yellow, red	Light: ◐ ● Moisture: D M Soil pH: 5.5-7.5 Soil type: L S	wooded river banks, swamps, rocky slopes	Region: M States: DC DE MD NY PA VA WV		used by 58 wildlife species; 35 bird species; important early summer food; berries edible to people
Amelanchier canadensis *serviceberry, shadbush, shadblow* CM NRCS	Height: 35-50' Spread: 35-50' Flowers: Apr-May, white Fruit: Jun-Jul, red to purple, fleshy Fall color: orange to red	Light: ◐ ● Moisture: M W Soil pH: 5.6-7.5 Soil type: C L S	swamps, low ground, woods, thickets	Region: M P C States: DC DE MD NY VA		
Asimina triloba *paw-paw* PLANTS JSP, USFWS BES	Height: 20-35' Spread: 20-35' Flowers: Apr-Jun, purple Fruit: Aug-Sep, yellow, berry Fall color: yellow/ copper-red	Light: ☼ Moisture: M Soil pH: 5.2-7.2 Soil type: L S	river valleys, bottomlands, understory of woods	Region: C States: DC DE MD PA VA WV		

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Betula alleghaniensis *yellow birch* PLANTS RM	Height: 60-80' Spread: 35-50' Flowers: Apr-May, yellow green Fruit: Jul-Oct, green to tan, cone/cone-like Fall color: golden yellow	Light: ◐ Moisture: M W Soil pH: 4.6-8 Soil type: L S	rich uplands, low swamps, streamsides, elevated floodplain terraces and knobs	Region: M States: MD NY PA VA WV	high wildlife value	fall color; attractive winter texture and color; prefers cool, moist conditions, common on calcareous
Betula lenta *sweet birch, black birch, cherry birch* USFWS BES, RHW	Height: 50-75' Spread: 35-50' Flowers: Apr-May, yellow green Fruit: Aug-Nov, green to tan, cone/cone-like Fall color: golden yellow	Light: ○ ◐ Moisture: D M Soil pH: 4.8-6.8 Soil type: L S	steep rocky land and lower	Region: M P States: DE MD NY PA VA WV	high wildlife value	excellent fall color; prefers moist sites, tolerates dry; colonizes open or disturbed areas
Betula nigra *river birch, red birch, black birch* USFWS BES, USFWS BES	Height: 50-75' Spread: 35-50' Flowers: Apr-May, dark brown Fruit: Jun-Aug, tan brown, cone/cone-like Fall color: yellow	Light: ○ ◐ Moisture: M W Soil pH: 4-6 Soil type: C L	along streams, rivers, ponds and swamps	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	attractive peeling bark;
Carpinus caroliniana *American hornbeam, musclewood, ironwood* USFWS BES	Height: 13-40' Spread: 35-50' Flowers: Apr-May, red or reddish-green Fruit: Jun-Oct, nut/nut-like Fall color: orange, red	Light: ◐ ● Moisture: M Soil pH: 4-7.4 Soil type: L S	river margins, bottomlands, swamps	Region: M P States: DC DE MD NY PA VA WV		slow growing and short lived
Carya alba (C. tomentosa) *mockernut hickory* USDA NRCS	Height: 60-100' Spread: 35-50' Flowers: May-Jun, light green Fruit: Sep-Oct, light reddish brown, nut/nut-like Fall color: yellow	Light: ◐ ● Moisture: D M Soil pH: 6.5-7.4 Soil type: L S	ridges, dry hills, hillsides	Region: M P C States: DC DE MD NY PA VA WV		good fall color
Carya cordiformis *bitternut or swamp hickory, pignut* PLANTS	Height: 60-100' Spread: 60-100' Flowers: Apr-May, yellow-green Fruit: Aug-Oct, yellowish green, nut/nut-like Fall color: yellow	Light: ○ Moisture: M W Soil pH: 6.5-7.4 Soil type: C L S	rich bottomlands, swamps, frequently flooded areas, dry hillsides	Region: M P C States: DC DE MD NY PA VA WV		
Carya glabra *pignut, sweet pignut, or smooth bark hickory* CM NRCS	Height: 60-100' Spread: 35-50' Flowers: Apr-May, yellow-green Fruit: Sep-Oct, dark brown, nut/nut-like Fall color: yellow	Light: ○ ◐ Moisture: D M W Soil pH: 6.5-7.4 Soil type: L	dry woods on hillsides and ridges	Region: M P C States: DC DE MD NY PA VA WV		
Carya ovata *shagbark, scalybark, or shellbark hickory* USDA NRCS	Height: 70-100' Spread: 35-50' Flowers: May-Jun, yellow-green Fruit: Sep-Oct, dark or reddish brown, nut/nut-like Fall color: brown	Light: ○ Moisture: M Soil pH: 4-6.7 Soil type: L S	dry upland slopes, lowlands, valleys	Region: M P C States: DC DE MD NY PA VA WV		attractive peeling bark

Trees

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Castanea pumila *chinquapin, eastern or Allegany chinkapin* RHW	Height: 12-20' Spread: 12-20' Flowers: Jun, pale yellow Fruit: Sep-Oct, dark brown, nut/nut-like Fall color: yellow or purple	Light: ☼ ◐ Moisture: D Soil pH: 4.5-7.5 Soil type: L S	rocky slopes, steep rocky land, rocky streambanks, sandy ridges, swamp edges, open woods	Region: M P C States: DC DE MD VA WV		sweet, edible fruit
Celtis occidentalis *common hackberry, sugarberry, nettletree* UWI KK	Height: 40-100' Spread: 40-100' Flowers: Apr-May, yellow green, brown tint Fruit: Sep-Dec, purple brown, berry Fall color: yellow	Light: ☼ ◐ ● Moisture: D M W Soil pH: 6-7.8 Soil type: C L S	drainage basins, floodplains, wooded slopes, high rocky limestone bluffs bordering streams, windbreaks	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	butterfly larval host; drought tolerant; tolerates occasional flooding; saplings can sprout in deep shade, common on limestone soils
Cercis canadensis *eastern redbud* USFWS BES, USFWS BES	Height: 20-35' Spread: 20-35' Flowers: Apr-May, pink to lavender Fruit: Jul-Dec, black, pod Fall color: golden yellow	Light: ◐ ● Moisture: D M Soil pH: 4.5-7.5 Soil type: L S	river bottoms and streambanks	Region: M P C States: DC DE MD PA VA WV		fixes nitrogen
Chamaecyparis thyoides *Atlantic white cedar* PLANTS 1997, PLANTS GFR	Height: 75' Spread: Flowers: Mar-Apr, greenish brown Fruit: bluish, cone/cone-like Fall color: evergreen	Light: ◐ ● Moisture: M W Soil pH: 4.5-5.5 Soil type: C L S	freshwater swamps, woods	Region: C States: DE MD VA		
Chionanthus virginicus *white fringetree* USFWS RS, RHW	Height: 20-35' Spread: 20-35' Flowers: May-Jun, white Fruit: Sep-Oct, bluish black, berry Fall color: yellow	Light: ☼ ◐ ● Moisture: D M Soil pH: 4.5-6.5 Soil type: L S	moist streambanks, ridges, hillsides in sandy to deep-rich soils	Region: M P C States: DC DE MD VA WV		
Cornus alternifolia *alternate-leaf or pagoda dogwood* CM NRCS	Height: 15-25' Spread: 15-35' Flowers: May-Jun, creamy white Fruit: Jul-Aug, bluish black, berry Fall color: maroon	Light: ◐ ● Moisture: M Soil pH: 5.8-7.5 Soil type: L	dry woods, forest edges, rocky slopes	Region: M States: DE MD NY PA VA WV	high wildlife value	used by 64 wildlife species; 43 bird species; keep root zone moist and acidic; tolerates full sun; young stems often purple
Cornus florida *flowering dogwood* RHW, USFWS RM	Height: 20-50' Spread: 20-50' Flowers: Apr-May, white Fruit: Sep-Dec, red to orange, berry Fall color: scarlet red	Light: ◐ Moisture: D M Soil pH: 5-7 Soil type: L	woods, woodland edges and openings, mountain slopes, coves	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	fall migrant birds eat berries; tolerates sun, best in moist, well-drained, acidic soil with organic matter, VA state tree
Crataegus crus-galli *cockspur hawthorn* USDA JE	Height: 20-35' Spread: 20-35' Flowers: May-Jun, white Fruit: Aug-Jan, dull red or green, fleshy Fall color: orange to red	Light: ☼ ◐ Moisture: D M Soil pH: 4.5-7.2 Soil type: C L S	thickets, open areas, especially in dry or rocky places, low rich slopes	Region: M P C States: DC DE MD NY PA VA WV		

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Crataegus viridis *southern thorn, green hawthorn*	 PLANTS	Height: 20-35' Spread: Flowers: Apr, white Fruit: bright red to orange, fleshy Fall color: purple, scarlet	Light: ◐ ● Moisture: M W Soil pH: 6-7.3 Soil type: C L	lowlands and valleys	Region: C States: DE MD NY VA		
Diospyros virginiana *common persimmon*	 PLANTS 1997, PLANTS 1997	Height: 50-75' Spread: 35-50' Flowers: Jun, greenish yellow to cream Fruit: Sep-Nov, orange purple, berry Fall color: yellow or purple	Light: ☼ ◐ Moisture: D M Soil pH: 5-7 Soil type: C L	open, disturbed areas, deciduous woods	Region: M P C States: DC DE MD PA VA WV	high wildlife value	edible fruits
Fagus grandifolia *American beech*	 CM NRCS, CM NRCS	Height: 50-100' Spread: 50-75' Flowers: Apr-May, yellow-green Fruit: Sep-Nov, orange-green, nut/nut-like Fall color: yellow/ tan; retains leaves till spring	Light: ☼ ◐ Moisture: M Soil pH: 4.1-6.5 Soil type: L S	rich uplands and lowlands	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	edible nuts; attractive bark; leaves may persist into winter
Fraxinus americana *white ash*	 UWI KJS	Height: 50-100' Spread: 50-75' Flowers: Apr-May, deep purple Fruit: Aug-Feb, tan brown, winged Fall color: yellow, maroon	Light: ☼ ◐ Moisture: M Soil pH: 5-7.5 Soil type: C L S	upland slopes, valleys, coves, bottomlands	Region: M P C States: DC DE MD NY PA VA WV		fast growth; fall color
Fraxinus pennsylvanica *green ash, red ash, swamp ash*	 UWI KK	Height: 50-75' Spread: 35-50' Flowers: Apr-May, purple Fruit: Aug-Dec, tan brown, winged Fall color: yellow to orange	Light: ☼ ◐ Moisture: D M W Soil pH: 5-8 Soil type: C L S	tidal and nontidal freshwater forested wetlands; seasonally to regularly flooded or saturated	Region: M P C States: DC DE MD NY PA VA WV		tolerates drought; tolerates infrequent flooding and some salt; male and female flowers on separate plants
Ilex opaca *American holly*	 USFWS BES	Height: 15-50' Spread: 18-40' Flowers: May-Jun, white or cream Fruit: red, fleshy Fall color: evergreen	Light: ☼ ◐ ● Moisture: M Soil pH: 4-7.5 Soil type: C L	sandy woods	Region: M P C States: DC DE MD VA		birds eat berries; state tree of Delaware
Juglans nigra *black walnut, American walnut*	 PLANTS DEH	Height: 70-90' Spread: 75-100' Flowers: May-Jun, yellow-green Fruit: Aug-Sep, yellow-green, nut/nut-like Fall color: yellow	Light: ☼ Moisture: M Soil pH: 5.5-8 Soil type: L	woods, slopes, streamsides	Region: M P C States: DC DE MD NY PA VA WV		may stunt growth of nearby planst
Juniperus virginiana *eastern red cedar*	 RHW, CM NRCS	Height: 50-75' Spread: 35-50' Flowers: Mar-Apr, red purple Fruit: Jul-Mar, pale green to dark blue, cone/cone-like Fall color: evergreen	Light: ☼ Moisture: D M Soil pH: 5-8 Soil type: C L S	broad range of habitats	Region: M P C States: DC DE MD NY PA VA WV		berries consumed by over 50 species of birds; berries have culinary use

Trees

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Liquidambar styraciflua *sweet gum, red gum, sap gum*	 CM NRCS	Height: 60-100' Spread: 50-75' Flowers: Apr-May, yellow-green Fruit: Jul-Jan, brown, capsule Fall color: yellow, red	Light: Moisture: M W Soil pH: 4.5-7 Soil type: C L S	upland woods, slopes, ravines, floodplains, streambanks	Region: M P C States: DC DE MD NY VA		
Liriodendron tulipifera *tulip tree, tulip poplar, yellow poplar*	 RHW	Height: 70-100' Spread: 35-50' Flowers: Jun, greenish yellow Fruit: Aug-Nov, brown, winged Fall color: yellow	Light: Moisture: M Soil pH: 4.5-6.5 Soil type: L S	bottomland woods, mountain coves, lower slopes	Region: M P C States: DC DE MD NY PA VA WV		fast growth
Magnolia acuminata *cucumber magnolia*	 DFT DL, DFT HW, DFT HW	Height: 70-100' Spread: 35-50' Flowers: May-Jun, greenish-yellow Fruit: Sep-Nov, brown cone w/ scarlet seed, pod Fall color: ashy brown	Light: Moisture: M Soil pH: 5.2-7 Soil type: C L S	slopes, ravines, valleys, streamsides	Region: M States: MD NY VA WV		
Magnolia virginiana *sweetbay magnolia*	 RHW, USFWS BES	Height: 12-30' Spread: 12-30' Flowers: May-Jul, white to cream Fruit: Sep-Oct, red, berry Fall color: semi-evergreen	Light: ● Moisture: M W Soil pH: 5-6.5 Soil type: C L S	forested wetlands, seeps, stream and pond edges, sandy woods	Region: P C States: DC DE MD VA		semi-evergreen; fragrant flowers; tolerates occasional flooding, some salt
Malus coronaria (Pyrus coronaria) *sweet crabapple, American crabapple*	 PLANTS WSJ	Height: 10-30' Spread: 20-30' Flowers: Apr-May, pink to white Fruit: Sep-Oct, greenish, fleshy Fall color:	Light: Moisture: M Soil pH: Soil type: C L S	forest edges, rocky streams, fields	Region: M P C States: DC DE MD PA VA WV	high wildlife value	flowers fragrant; susceptible to insects and diseases; plant at least 500 feet from cedars; attracts bees and wasps; fruit sour;
Morus rubra *red mulberry, moral*	 UWI KK	Height: 35-60' Spread: 35-60' Flowers: May-Jun, greenish Fruit: Jun-Jul, red, berry Fall color: yellow	Light: Moisture: M Soil pH: 5-7 Soil type: C L S	floodplains, river valleys, hillsides	Region: M P C States: DC DE MD PA VA WV		fruit sweet
Nyssa sylvatica *black gum, sourgum, black or swamp tupelo*	 CM NRCS, RHW	Height: 30-75' Spread: 20-50' Flowers: Apr-Jun, greenish white Fruit: Sep-Oct, blue-black, fleshy Fall color: red	Light: Moisture: D M W Soil pH: 4.5-6 Soil type: L S	forested seasonal wetlands, swamp borders, upland woods, dry slopes; seasonally flooded or saturated	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	outstanding fall color
Ostrya virginiana *eastern hop-hornbeam, ironwood*	 PLANTS WSJ	Height: 25-50' Spread: 20-35' Flowers: May, red-brown Fruit: Jun-Oct, green turning brown, nut/nut-like Fall color: yellow	Light: ● Moisture: M Soil pH: 4.2-7.6 Soil type: C L S	slopes and ridges	Region: M P C States: DC DE MD NY PA VA WV		leaves may persist into winter

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Pinus echinata *shortleaf pine, shortstraw pine, southern yellow pine*	 BUG RFW	Height: 100' Spread: Flowers: Fruit: reddish brown, cone/cone-like Fall color: evergreen	Light: Moisture: D M Soil pH: 4.6-6 Soil type: C L S	dry mountain ridges, fields, floodplains	Region: M P C States: DC DE MD VA WV		best used for naturalizing
Pinus rigida *pitch pine*	 CM NRCS	Height: 50-75' Spread: 50-75' Flowers: May, red- purple Fruit: light brown, cone/ cone-like Fall color: evergreen	Light: Moisture: D Soil pH: 3.5-5.1 Soil type: L S	slopes and ridges of mountains, river valleys, and swamps	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	many birds feed on the seeds; provides winter cover; old trees are fire resistant due to thick bark
Pinus serotina *pond pine, marsh pine, pocosin pine*	 VT	Height: 50-60' Spread: Flowers: Fruit: yellowish brown, cone/cone-like Fall color: evergreen	Light: Moisture: M W Soil pH: 4.8-6.8 Soil type: L S	swamps, pocosins, bays, pond margins, flatwoods	Region: C States: DE PA VA	high wildlife value	many birds feed on the seeds; provides winter cover
Pinus strobus *white pine, Eastern white pine*	 USDA NRCS	Height: 75-100' Spread: 50-75' Flowers: May-Jul, red to purplish Fruit: Aug-Oct, green to light brown, cone/cone-like Fall color: evergreen	Light: Moisture: D M Soil pH: 4-6.5 Soil type: L	variety of habitats; does best on moist, well drained, sandy loam soils of ridges	Region: M P States: DC MD NY PA VA WV	high wildlife value	many birds feed on the seeds; provides winter cover
Pinus taeda *loblolly, old field, or North Carolina pine*	 USFWS BES	Height: 70-90' Spread: Flowers: Fruit: yellowish, cone/ cone-like Fall color: evergreen	Light: Moisture: D M W Soil pH: 4.5-7 Soil type: C L S	floodplains fields, slopes	Region: C States: DE MD VA	high wildlife value	many birds feed on the seeds; provides winter cover
Pinus virginiana *Virginia pine, scrub pine, Jersey pine*	 USDA NRCS	Height: 50-80' Spread: Flowers: Fruit: reddish brown, cone/cone-like Fall color: evergreen	Light: Moisture: D M Soil pH: 4.5-7.5 Soil type: C L S	well drained sites; often a pioneer species	Region: M P C States: DC DE MD PA VA WV	high wildlife value	many birds feed on the seeds; provides winter cover
Platanus occidentalis *American sycamore, American planetree*	 PLANTS LA, USDA NRCS	Height: 75-100' Spread: 75-100' Flowers: Apr-Jun, yellow-green Fruit: Aug-Dec, brown, achene (dry, flat seed) Fall color: yellow	Light: Moisture: M W Soil pH: 4.9-6.5 Soil type: L S	river bottoms, lake shores	Region: M P C States: DC DE MD NY PA VA WV		leafs out late spring; showy bark; leaves may persist into winter
Populus deltoides *eastern or southern cottonwood, Carolina poplar*	 UWI JK	Height: 75-100' Spread: 50-100' Flowers: Mar-Apr, red Fruit: May-Jul, yellow-green, capsule Fall color: yellow	Light: Moisture: M W Soil pH: 5.2-7.3 Soil type: C L S	along waterways	Region: P States: DC DE MD NY VA WV	high wildlife value	best used for naturalizing; grows fast but short lived

Trees

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Populus heterophylla *swamp cottonwood, swamp poplar, black cottonwood, downy poplar* VT, PLANTS 1997	Height: 80' Spread: Flowers: Mar Fruit: Apr-May, , capsule Fall color: yellow	Light: Moisture: W Soil pH: 4.6-5.9 Soil type: C L	swamps and bottomlands	Region: P States: DE MD VA		
Prunus americana *American wild plum* RHW	Height: 20-35' Spread: 20-35' Flowers: Apr-May, white Fruit: Aug-Sep, orange to red, fleshy Fall color: pale yellow	Light: Moisture: D M Soil pH: 5-7 Soil type: L S	woods, pastures, fencerows, streamsides	Region: M P States: DC DE MD NY PA VA WV	high wildlife value	edible fruit, used for making pies and jellies
Prunus pensylvanica *pin cherry, fire cherry* RHW	Height: 20-35' Spread: 20-35' Flowers: May, white Fruit: Jul-Sep, bright red, fleshy Fall color: yellow	Light: Moisture: D Soil pH: 4.3-6.6 Soil type: C L S	woods	Region: M States: MD NY PA VA WV	high wildlife value	
Prunus serotina *black or wild cherry, black chokecherry* CM NRCS, RHW	Height: 40-75' Spread: 20-35' Flowers: May-Jun, white Fruit: Aug-Sep, black, fleshy Fall color: yellow/ red	Light: Moisture: D M Soil pH: 5-7.5 Soil type: L	forests, fence rows, fields, forest edges	Region: M P C States: DC DE NY VA WV	high wildlife value	birds eat fruit
Prunus virginiana *choke cherry* RHW	Height: 25-50' Spread: 20-35' Flowers: May-Jun, white Fruit: Aug-Sep, red, black, or yellow, fleshy Fall color: dark red-purple	Light: Moisture: M Soil pH: 5.2-8.4 Soil type: C L S	open moist sites; pioneer species after fires	Region: M States: DC DE MD NY PA VA WV		fast growing, short lived; fruit sometimes used for making jelly
Quercus alba *white oak, stave oak* CM NRCS	Height: 75-100' Spread: 75-100' Flowers: Mar-May, yellow-green Fruit: Sep-Oct, brown, nut/nut-like Fall color: red	Light: Moisture: D M Soil pH: 4.5-6.8 Soil type: L S	dry to moist woods	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	acorns food for wildlife; majestic; MD state tree; leaves may persist into winter
Quercus bicolor *swamp white oak, swamp oak* PLANTS RM89, OSU	Height: 60-100' Spread: 50-75' Flowers: May, yellow-green Fruit: Sep-Oct, tan brown, nut/nut-like Fall color: red/brown	Light: Moisture: W Soil pH: 4.3-6.5 Soil type: C L S	bottomlands, swamp and stream edges	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	acorns food for wildlife
Quercus coccinea *scarlet oak, red oak, black oak* CM NRCS	Height: 40-75' Spread: 50-75' Flowers: May-Jun, yellow-green Fruit: Sep-Oct, reddish brown, nut/nut-like Fall color: scarlet	Light: Moisture: D M Soil pH: 4.5-6.9 Soil type: L S	dry uplands and slopes	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	acorns food for wildlife

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Quercus falcata *southern or swamp red oak, Spanish oak*	 DFT HW	Height: 70-80' Spread: Flowers: Apr-May Fruit: Oct, orange brown, nut/nut-like Fall color: brown	Light: Moisture: D M Soil pH: 4.8-7 Soil type: C L S	uplands	Region: C States: DC DE MD VA		acorns food for wildlife
Quercus ilicifolia *bear oak, scrub oak*	 CM NRCS	Height: 12-20' Spread: 12-20' Flowers: May-Jun, yellow-green or reddish Fruit: Sep-Jan, light brown, nut/nut-like Fall color: yellow, scarlet red to purplish	Light: Moisture: D Soil pH: 4-7.5 Soil type: C L S	barrens, balds, woods, dunes, fields	Region: M P States: PA VA WV	high wildlife value	leaves may persist into winter
Quercus marilandica *blackjack oak, Jack oak*	 CM NRCS	Height: 35-50' Spread: 35-50' Flowers: Apr-Jun, yellow-green Fruit: Sep-Oct, tan brown, nut/nut-like Fall color: yellow/brown	Light: Moisture: D Soil pH: 4.6-5.6 Soil type: L S	woods, ridges, slopes, sandy flatwoods	Region: P C States: DC DE MD VA WV	high wildlife value	acorns food for wildlife, leaves may persist into winter
Quercus michauxii (Q. montana) *swamp chestnut oak, basket oak, cow oak*	 PLANTS 1995	Height: 50-80' Spread: 75-100' Flowers: May, yellow-green Fruit: Sep-Oct, tan brown, nut/nut-like Fall color: red/ brown	Light: Moisture: M W Soil pH: 4.5-6.5 Soil type: L	bottomlands, ravine slopes, flatwoods over limestone	Region: M P C States: DE MD NY VA WV	high wildlife value	acorns food for wildlife
Quercus muehlenbergii *Chinquapin or chinkapin oak, yellow oak, chestnut oak*	 UWI KJS	Height: 35-50' Spread: 35-50' Flowers: May-Jun, yellow-green Fruit: Sep-Oct, light brown, nut/nut-like Fall color: yellow-brown	Light: Moisture: D M Soil pH: 6.5-8 Soil type: L	rich, woods, uplands, outcrops, dry bluffs, slopes	Region: M P C States: DC MD NY VA WV	high wildlife value	
Quercus nigra *water oak*	 PLANTS LA	Height: 50-80' Spread: Flowers: Apr-May Fruit: Oct, black, nut/nut-like Fall color: green persists late	Light: Moisture: M W Soil pH: 4.8-5.8 Soil type: C L	upland woods, bottomlands, hammocks, fields	Region: C States: DC DE MD VA		acorns food for wildlife
Quercus palustris *pin oak, swamp oak, Spanish oak*	 PLANTS RM91	Height: 50-80' Spread: 50-75' Flowers: Apr-May, yellow-green Fruit: Sep-Oct, light brown, nut/nut-like Fall color: red	Light: Moisture: M W Soil pH: 4.5-6.5 Soil type: C L	bottomlands or upland flats	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	popular shade tree; fall color; acorns food for wildlife; leaves may persist into winter
Quercus phellos *willow oak, pin oak, peach oak*	 USFWS BES	Height: 80-100' Spread: Flowers: Feb-May Fruit: light yellow or greenish brown, nut/nut-like Fall color: red	Light: Moisture: M W Soil pH: 4.5-5.5 Soil type: C L	bottomlands, low flatwoods, upland fields	Region: P C States: DC DE MD VA WV		acorns food for wildlife

Trees

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Quercus prinus (Q. montana) *chestnut oak, rock oak* PLANTS 1997	Height: 40-80' Spread: Flowers: May-Jun, yellowish Fruit: Sep-Oct, brown, nut/nut-like Fall color: yellow/orange	Light: ☼ ◐ ● Moisture: D Soil pH: 4.5-7 Soil type: L S	rocky ridges and slopes	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	acorns food for wildlife; fall color
Quercus rubra *northern red oak* UWI KJS	Height: 90' Spread: Flowers: Apr-May Fruit: scales reddish-brown, nut/nut-like Fall color: red or yellow	Light: ☼ ◐ Moisture: D M Soil pH: 4.3-6.5 Soil type: C L	slopes, coves, and drier ridges	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	acorns food for wildlife; hardy and long-lived; fall color
Quercus stellata *post oak, iron oak* CM NRCS	Height: 35-50' Spread: 35-50' Flowers: Apr-Jun, yellow-green Fruit: Sep-Oct, light brown to almost black, nut/nut-like Fall color: brown	Light: ☼ Moisture: D M Soil pH: 4.8-7 Soil type: C L S	upland dry ridges to moist flatwoods	Region: M P C States: DC DE MD VA WV	high wildlife value	acorns food
Quercus velutina *black oak, yellow bark oak, quercitron oak* BUG DJM	Height: 75-100' Spread: 75-100' Flowers: Apr-May, yellow-green Fruit: Sep-Oct, light red-brown, nut/nut-like Fall color: red/brown	Light: ☼ Moisture: D M Soil pH: 4.5-6 Soil type: C L S	dry upland ridges and slopes, flatwoods	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	acorns food for wildlife; leaves may persist into winter
Salix nigra *black willow, swamp willow* CM NRCS	Height: 35-50' Spread: 20-35' Flowers: Mar-Apr, yellow green Fruit: Apr-May, green yellow, cone/cone-like Fall color: yellow green	Light: ☼ ◐ Moisture: M W Soil pH: 6-8 Soil type: C L S	fresh tidal marshes and swamps, forested wetlands, floodplains, wet meadows; seasonally to regularly flooded or saturated	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	streambank stabilizer; spreads by suckers; preferred food of ruffed grouse and pine grosbeak; tolerates flooding; tolerates salinity to 0.5 ppt
Salix sericea *silky willow* CM NRCS	Height: 12' Spread: Flowers: Jun-Jul Fruit: Fall color: yellow	Light: ☼ ◐ ● Moisture: M W Soil pH: 5.2-7 Soil type: C L S	marshes, ditches, low woods	Region: M P States: DC DE MD NY PA VA WV	high wildlife value	
Sassafras albidum *sassafras* USFWS BES, RHW	Height: 35-50' Spread: 35-50' Flowers: Apr, yellow-green Fruit: Sep-Oct, dark blue, fleshy Fall color: yellow, orange, purple	Light: ☼ ◐ Moisture: D M Soil pH: 4.5-7.2 Soil type: L S	moist, open woods	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	edible and medicinal uses; provides spring and fall color
Sorbus americana (Pyrus americana) *American mountain ash* RHW, RHW	Height: 30-40' Spread: Flowers: May-Jul, white Fruit: Aug-Dec, orange, fleshy Fall color: orange, purple	Light: ☼ Moisture: M Soil pH: 5.3-6.8 Soil type: C L S	areas from borders of swamps to rocky hillsides; openings, uplands along forest edges, roadsides	Region: M States: MD VA WV	high wildlife value	slow-growing, short-lived; not drought or heat tolerant; plant at least 500 feet from cedars

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Taxodium distichum *bald cypress, cypress, swamp cypress*	Height: 50-100' Spread: 20-35' Flowers: Mar-Apr, deep purple Fruit: Oct-Dec, brown, cone/cone-like Fall color: purple to brown	Light: ☼ ◐ Moisture: W Soil pH: 4.5-6 Soil type: C L S	rivers, lake and pond margins, swamps, coastal marshes, pocosins, river bottoms	Region: C States: DE MD VA		deciduous conifer
Thuja occidentalis *arborvitae, northern white cedar*	Height: 50-75' Spread: 35-50' Flowers: May, red brown Fruit: Aug-Dec, reddish-brown, cone/cone-like Fall color: evergreen	Light: ☼ Moisture: M W Soil pH: 5.2-7 Soil type: C L S	calcareous areas	Region: M States: NY VA		prefers wet calcareous areas
Tilia americana *American basswood, linden*	Height: 70-100' Spread: 50-75' Flowers: Jun-Jul, yellow Fruit: Sep-Oct, tan brown, winged Fall color: yellow or brown	Light: ◐ ● Moisture: M Soil pH: 4.5-7.5 Soil type: L S	woods, slopes	Region: M States: DC DE MD NY PA VA WV		fragrant flowers; important pollen source for honey
Tsuga canadensis *eastern hemlock*	Height: 75-100' Spread: 35-50' Flowers: May-Jun, tan brown Fruit: Sep-Jan, light brown, cone/cone-like Fall color: evergreen	Light: ◐ Moisture: M Soil pH: 4.2-5.7 Soil type: L S	cool valleys	Region: M P States: DE MD NY PA VA WV	high wildlife value	susceptible to wooly adelgid and red spider mite; also T. caroliniana for VA
Ulmus americana *American elm, white elm, soft elm*	Height: 75-100' Spread: 75-100' Flowers: Mar-Apr, red brown Fruit: May, tan brown, winged Fall color: bright yellow	Light: ☼ ◐ Moisture: M W Soil pH: 5.5-8 Soil type: C L S	river bottoms, swamps, disturbed fields, road sides, cutover forests	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	Dutch elm disease caused decline; distinctive vase shape; favorite nesting site of Baltimore oriole
Ulmus rubra *slippery elm, red elm, soft elm*	Height: 70' Spread: Flowers: Mar-May Fruit: winged Fall color: yellow	Light: ◐ ● Moisture: D M Soil pH: 5.5-7 Soil type: C L S	moist slopes and bottomlands, drier sites on calcareous soils	Region: P States: DC DE MD NY PA VA WV	high wildlife value	

USFWS BES, USFWS BES

USFWS BES, USFWS BES

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USDA NRCS

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See also:

In the *Shrubs* section:
Hamamelis virginiana
Morella (Myrica) cerifera
Rhododendron maximum
Rhus copallina, hirta (typhina)
Viburnum prunifolium

Cornus florida

USFWS BES

A diverse forest offers food and cover throughout all seasons.

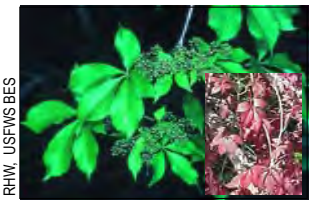
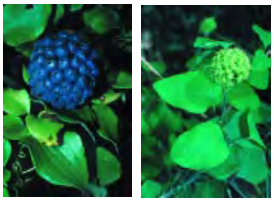
USFWS RM

Ilex opaca

CM NRCS

Vines

		Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Aristolochia macrophylla (A. durior) *pipevine, Dutchman's pipe*	 RHW	Spread: Flowers: May-Jun, yellowish to purplish Fruit: green to brown, pod Fall color: yellow green	Light: Moisture: M Soil pH: 6.1-8.5 Soil type: L O	rich woods, streambanks	Region: M States: VA WV		occasionally escapes from cultivation; host for pipevine swallowtail butterfly
Bignonia capreolata *crossvine*	 USFWS BES	Spread: 20-35' Flowers: May-Jun, orange with red Fruit: Aug-Oct, brown, pod Fall color: semi-evergreen; reddish-purple	Light: Moisture: D M W Soil pH: 6.1-8.5 Soil type: C L S	swampy forests, calcareous river banks, cliffs, dry open woods, bogs, fence rows, rock outcrops	Region: C States: MD VA		spreads across ground and climbs any structure it meets (control by cutting); semi-evergreen GC
Campsis radicans *trumpet vine, trumpet creeper*	 USFWS BES	Spread: 20-35' Flowers: Jul-Sep, orange Fruit: Aug-Mar, brown, pod Fall color: yellow green	Light: Moisture: D M Soil pH: 6.1-7.5 Soil type: C L S	moist woods, fence rows, roadside thickets, floodplain forests, rocky hillsides, open woods, streambanks, fields	Region: M P C States: DC DE MD PA VA		thick, twisted, aged woody vines; leaves/flowers may cause dermatitis (skin irritation) GC
Celastrus scandens *American bittersweet*	 PLANTS TGB, UWI DK	Spread: 6-20' Flowers: May-Jun, greenish Fruit: Sep-Dec, orange and red, capsule Fall color: yellow	Light: Moisture: D M Soil pH: 6.1-7.5 Soil type: C L S	roadsides, forest edges, fence rows, pastures, hedges, bluffs, rocky slopes, dunes, sandy oak woods	Region: M P C States: DC DE MD NY PA VA WV		distinguished from nonnative invasive Oriental bittersweet by flowers/fruits in clusters at ends of twigs GC
Clematis viorna *leather flower, vasevine*	 RHW	Spread: Flowers: May-Aug, purple Fruit: Aug-Nov, dark brown, achene (dry, flat seed) Fall color:	Light: Moisture: D M Soil pH: Soil type:	rich wooded banks, thickets	Region: P States: DC DE MD VA WV		feathery seeds
Clematis virginiana *virgin's bower*	 USFWS BES	Spread: 6-12' Flowers: Jul-Sep, white Fruit: Aug-Nov, brown, achene (dry, flat seed) Fall color: yellow, green or purplish	Light: Moisture: D M Soil pH: 6.1-8.5 Soil type: C L S O	fencerows, riverbanks, thickets, woods edge, roadside swales, swamps, overhanging cliffs	Region: M P C States: DC DE MD NY PA VA WV		fragrant flowers; feathery seeds; young plants can be transplanted; yellow, green or purplish fall color
Lonicera sempervirens *trumpet or coral honeysuckle*	 RHW, USFWS BES	Spread: 6-12' Flowers: Apr-Oct, coral to red with yellow Fruit: Aug-Mar, red, berry Fall color: semi-evergreen	Light: Moisture: D M Soil pH: 6.1-7.5 Soil type: C L S	thickets, fence rows, open woods, dry stony woods, forest edges, cliffs	Region: M P C States: DC DE MD NY VA		flowers intermittently until frost; flowers/fruits present together; transplants well; may have aphids - hose off, snip new growth and damaged buds; semi-evergreen
Mikania scandens *climbing hempvine*	 RHW	Spread: Flowers: Jun-Oct, pink or whitish Fruit: blue Fall color:	Light: Moisture: M W Soil pH: 5.7-7.5 Soil type: C L	swamps, thickets	Region: M P C States: DC DE MD NY VA		vines herbaceous, not woody

	Characteristics	Conditions	Habitat	Native to	Wildlife	Notes
Parthenocissus quinquefolia *Virginia creeper*  RHW, USFWS BES	Spread: 25-35' Flowers: Jun-Aug, greenish white Fruit: Sep-Feb, bluish black, berry Fall color: purple to crimson	Light: ☼ ◐ ● Moisture: D M W Soil pH: 5.1-7.5 Soil type: C L S	fence rows, forest edges, open woods, ravines, bluffs, cliffs	Region: M P C States: DC DE MD NY PA VA WV	high wildlife value	bank stabilizer; control by trimming; fruits eaten by variety of wildlife; purple to crimson fall color GC
Passiflora incarnata *passionflower, Maypops* RHW	Spread: Flowers: Jun-Sep, purple and white Fruit: Sep-Oct, yellow, fleshy Fall color:	Light: ☼ Moisture: D M Soil pH: Soil type: C L S	fields, rocky slopes, thin woods, roadsides, fencerows, thickets	Region: C States: MD VA		herbaceous vine; large fleshy berry edible; fragrant
Smilax herbacea *smooth carrion flower*  RHW, RHW	Spread: Flowers: Apr-Jun, greenish-yellow Fruit: Jul-Nov, blue-black, berry Fall color:	Light: ◐ Moisture: M Soil pH: Soil type: C L S	thickets, woods, floodplains	Region: M P C States: DC DE MD NY WV		herbaceous, climbing vine, not prickly; flower malodorous; male and female plants separate
Wisteria frutescens *Atlantic wisteria, American wisteria* SMSU, SMSU	Spread: Flowers: Apr-Aug, lilac Fruit: brown, pod Fall color:	Light: ☼ ◐ Moisture: M W Soil pH: 4-7 Soil type: C L S	forest and forested swamp edges, streambanks, thickets	Region: C States: DE VA		

See also:

In the *Herbaceous Plants* section:
Clitoria mariana

Characteristic pipe-shaped flower of **Aristolochia macrophylla.**

RHW

Lonicera sempervirens may bloom year-round.

USFWS BES

Bignonia capreolata in bloom adorns a porch.

USFWS BES

Parthenocissus quinquefolia used as a groundcover.

USFWS BES

Plants With a Purpose

This section includes lists of plant combinations that can be used to mimic the natural communities of plants found in wetlands, meadows, forests, etc. They can be used to create, restore or enhance existing habitat for wildlife. Also included are plants that can be used in solving problems such as stabilizing soils, or for specific landscaping uses. No matter what the purpose, it is imperative that species are chosen to suit planting site conditions and the physiographic location of the site. None of these lists are complete – there are additional suitable plants in this guide (and even more native species not included in this publication) that would suit these purposes. This document is intended to give project planners guidance in choosing appropriate plants for various projects, and additional learning is encouraged. For the most ecologically "correct" habitat restoration projects, consultation with professionals is recommended, as there are other factors to consider that are not addressed here.

Plants For Coastal Dunes

Note: the shrubs and trees listed would occur on the inner or secondary dunes and/or on interdunal swales.

Grasses and Grasslike Plants
Ammophila breviligulata
Panicum amarum (and var. amarulum)
Spartina patens
Panicum virgatum

Herbaceous Plants
Baptisia tinctoria
Liatris pilosa v. pilosa (graminifolia)
Nuttallanthus canadensis (Linaria canadensis)
Opuntia humifusa (compressa)
Oenothera biennis
Solidago sempervirens
Yucca filamentosa (flaccida)

Shrubs
Baccharis halimifolia
Morella (Myrica) cerifera, pensylvanica
Prunus maritima
Rhus copallina
Rosa carolina

Trees
Acer rubrum
Amelanchier arborea
Diospyros virginiana
Juniperus virginiana
Pinus rigida
Prunus pensylvanica, serotina

Vines
Celastrus scandens
Parthenocissus quinquefolia

Plants For Saltwater or Brackish Water Marshes

Plants in this list can be used for marsh plantings or to stabilize tidal fresh, brackish or saltwater shorelines based on salinity and wetness tolerances. Check the salinity and moisture requirements given in this publication for each plant, so they will be planted in the appropriate conditions. Those species for use in salinity greater than 15 ppt are marked (*).

Grasses and Grasslike Plants
Ammophila breviligulata *
Distichlis spicata *
Juncus canadensis
Juncus roemerianus *
Panicum amarum (and var. amarulum) *
Panicum virgatum
Schoenoplectus pungens v. pungens (Scirpus pungens, americanus)
Schoenoplectus (Scirpus) validus
Spartina alterniflora *
Spartina cynosuroides
Spartina patens *
Spartina pectinata

Note: Although grasslike, *Distichlis, Juncus, Schoenoplectus,* and *Spartina* species information can be found in the Herbaceous Emergents section of the guide.

Herbaceous Plants
Agalinus purpurea
Limonium carolinianum
Solidago sempervirens *

Herbaceous Emergents
Hibiscus moscheutos (palustris)
Iris prismatica, versicolor, virginica
Kosteletzkya virginica
Peltandra virginica
Pontederia cordata

Shrubs
Baccharis halimifolia *
Iva frutescens *
Morella (Myrica) cerifera *, *pensylvanica* *

Plants for Freshwater Wetlands and Other Wet Sites

The following plants may be used to create or enhance freshwater marshes or swamps or to stabilize and enhance streambanks, riverbanks or pond edges.

Remember to match the plants' growth requirements with the site conditions. Wetness tolerated by these plants is provided in this guide in terms of frequency and duration of soil saturation or inundation (flooding), and depth of standing water.

Ferns

Athyrium filix-femina
Dryopteris carthusiana (spinulosa), cristata, intermedia
Onoclea sensibilis
Osmunda cinnamomea, regalis
Pteridium aquilinum
Thelypteris noveboracensis, palustris
Woodwardia areolata, virginica

Grasses and Grasslike Plants

Agrostis perennans
Andropogon gerardii, glomeratus, virginicus
Calamagrostis canadensis
Carex crinita var. crinita, lurida, stricta, vulpinoidea
Dichanthelium clandestinum
Elymus riparius
Festuca rubra
Leersia oryzoides
Panicum virgatum
Saccharum giganteum (Erianthus giganteus)
Tripsacum dactyloides

Herbaceous Plants

Arisaema triphyllum
Asclepias incarnata
Caltha palustris
Chelone glabra
Conoclinium (Eupatorium) coelestinum
Doellingeria umbellata var. umbellata (Aster umbellatus)
Eupatorium dubium, perfoliatum
Gentiana clausa
Helianthus angustifolius
Heracleum maximum (lanatum)
Impatiens capensis (biflora)
Lobelia cardinalis, siphilitica
Mertensia virginica
Mimulus ringens
Monarda didyma
Packera aurea (Senecio aureus)
Phlox maculata
Rudbeckia laciniata
Saxifraga pensylvanica
Scutellaria integrifolia
Sisyrinchium atlanticum
Spiranthes cernua
Stachys tenuifolia (hispida)
Symphyotrichum (Aster) novae-angliae, novi-belgii
Symplocarpus foetidus
Thalictrum pubescens (polygamum)
Veratrum viride
Verbena hastata
Vernonia noveboracensis
Veronicastrum virginicum (Veronica virginica)
Viola conspersa, cucullata, striata

Herbaceous Emergents

Dulichium arundinaceum
Hibiscus moscheutos (palustris)
Iris prismatica, versicolor, virginica
Juncus effusus
Justicia americana
Nuphar lutea (advena)
Nymphaea odorata
Orontium aquaticum
Peltandra virginica
Pontederia cordata
Sagittaria latifolia
Saururus cernuus
Schoenoplectus (Scirpus) validus
Scirpus atrovirens, cyperinus
Sparganium americanum
Spartina pectinata
Zizania aquatica

Shrubs

Alnus serrulata
Cephalanthus occidentalis
Clethra alnifolia
Cornus amomum
Gaylussacia baccata, frondosa
Hypericum densiflorum
Ilex verticillata
Itea virginica
Kalmia angustifolia, latifolia
Leucothoe racemosa
Lindera benzoin
Lyonia ligustrina
Morella (Myrica) caroliniensis (heterophylla), cerifera, pensylvanica
Photinia (Aronia) melanocarpa, pyrifolia (arbutifolia)
Physocarpus opulifolius
Rhododendron maximum, periclymenoides, viscosum
Rosa palustris
Rubus allegheniensis
Salix humilis
Sambucus nigra ssp. canadensis (S. canadensis)
Spiraea alba v. latifolia (latifolia), tomentosa
Vaccinium corymbosum, macrocarpon
Viburnum dentatum (recognitum), nudum, nudum v. cassinoides (cassinoides), prunifolium

Trees

Acer negundo, rubrum, saccharinum
Amelanchier canadensis
Betula alleghaniensis, nigra
Carpinus caroliniana
Carya cordiformis, glabra
Celtis occidentalis
Chamaecyparis thyoides
Crataegus viridis
Fraxinus pennsylvanica
Liquidambar styraciflua
Magnolia virginiana
Nyssa sylvatica
Pinus serotina, strobus, taeda
Platanus occidentalis
Populus deltoides, heterophylla
Quercus bicolor, michauxii (montana), nigra, palustris, phellos
Salix nigra, sericea
Taxodium distichum
Thuja occidentalis
Tsuga canadensis
Ulmus americana

Vines

Bignonia capreolata
Mikania scandens
Parthenocissus quinquefolia
Wisteria frutescens

Plants Appropriate for Bogs or Bog Gardens

Ferns
Athyrium filix-femina
Onoclea sensibilis
Osmunda cinnamomea
Thelypteris noveboracensis , palustris
Woodwardia areolata

Grasses and Grasslike Plants
Calamagrostis canadensis
Carex stricta
Leersia oryzoides

Herbaceous Plants
Arisaema triphyllum
Caltha palustris
Chelone glabra
Doellingeria umbellata var. umbellate (Aster umbellatus)
Eupatorium dubium, perfoliatum
Gentiana clausa
Saxifraga pensylvanica
Scutellaria integrifolia
Spiranthes cernua
Symplocarpus foetidus
Veratrum viride
Viola cucullata

Herbaceous Emergents
Dulichium arundinaceum
Juncus effusus
Orontium aquaticum
Sagittaria latifolia
Scirpus atrovirens, cyperinus
Sparganium americanum

Shrubs
Clethra alnifolia
Gaultheria procumbens
Hypericum densiflorum
Kalmia angustifolia
Morella caroliniensis (Myrica heterophylla)
Photinia (Aronia) melanocarpa, pyrifolia (arbutifolia)
Rhododendron viscosum
Salix humilis
Spiraea alba, alba v. latifolia (latifolia)
Spiraea tomentosa
Vaccinium corymbosum, macrocarpon
Viburnum dentatum (recognitum), nudum, nudum v. cassinoides (cassinoides)

Trees
Acer rubrum
Chamaecyparis thyoides
Nyssa sylvatica

Vines
Bignonia capreolata

Plants for Dry Meadows

Grasses and Grasslike Plants
Andropogon gerardii
Danthonia spicata
Elymus canadensis, riparius, virginicus
Schizachyrium scoparium (Andropogon scoparius)
Sorghastrum nutans
Tridens flavus

Herbaceous Plants
Ageratina altissima v. altissima (Eupatorium rugosum)
Antennaria neglecta
Asclepias syriaca, tuberosa
Chamaecrista (Cassia) fasciculata
Conoclinum (Eupatorium) coelestinum
Coreopsis tripteris, verticillata
Desmodium paniculatum
Dodecatheon meadia
Erigeron pulchellus
Eupatorium hyssopifolium, purpureum
Heliopsis helianthoides
Ionactis (Aster) linariifolius
Lespedeza capitata
Liatris spicata, squarrosa
Lupinus perennis
Monarda bradburiana (fistulosa), punctata
Nuttallanthus (Linaria)canadensis
Oenothera biennis, fruticosa, perennis
Penstemon digitalis
Pycnanthemum incanum
Rudbeckia fulgida, hirta, triloba
Solidago canadensis, canadensis v. scabra (altissima), juncea, nemoralis, speciosa
Symphyotrichum (Aster) cordifolius, ericoides var. ericoides, laeve var. laeve (laevis), novae-angliae

Shrubs
Note: Listed are a few of the shorter shrubs that may appear in or at the edges of meadows. Using shrubs in a planting that is to remain as a meadow is not recommended, as they provide perching spots for birds, whose droppings will seed in unwanted plants, including trees. If the meadow is to be allowed to succeed eventually to forest, then adding shrubs is one prescribed method.

Ceanothus americanus
Comptonia peregrina
Rhus glabra
Rosa carolina
Rubus allegheniensis

Plants for Wet Meadows

Ferns
Onoclea sensibilis
Osmunda cinnamomea
Thelypteris palustris

Grasses and Grasslike Plants
Andropogon gerardii, virginicus
Calamagrostis canadensis
Carex glaucodea, stricta
Elymus riparius
Leersia oryzoides
Panicum virgatum
Tripsacum dactyloides

Herbaceous Plants
Agalinis purpurea
Asclepias incarnata
Caltha palustris
Doellingeria umbellata var. umbellata (Aster umbellatus)
Gentiana clausa
Eupatorium fistulosum, maculatum, perfoliatum
Helenium autumnale
Impatiens capensis (I. biflora)
Lilium canadense, superbum
Lobelia cardinalis, siphilitica
Mimulus ringens
Packera aurea (Senecio aureus)
Phlox maculata
Rudbeckia laciniata
Sabatia angularis
Scutellaria integrifolia
Silphium perfoliatum
Sisyrinchium atlanticum
Solidago rugosa
Spiranthes cernua
Stachys tenuifolia (hispida)
Symphyotrichum (Aster) novi-belgii
Thalictrum pubescens (polygamum)
Verbena hastata
Viola conspersa
Viola striata

Herbaceous Emergents
Iris prismatica, versicolor, virginica
Juncus effusus
Scirpus atrovirens, cyperinus
Spartina pectinata

Shrubs
Note: Listed are a few of the shorter shrubs that may appear in or at the edges of meadows. Using shrubs in a planting that is to remain as a meadow is not recommended, as they provide perching spots for birds, whose droppings will seed in unwanted plants, including trees. If the meadow is to be allowed to succeed eventually to forest, then adding shrubs is one prescribed method.

Cephalanthus occidentalis
Ilex verticillata
Rhododendron viscosum
Rosa palustris
Spiraea tomentosa

Plants for Forest or Woodland Plantings

Forests contain a diversity of plant types arranged in vertical layers, from the tallest (canopy or overstory) trees, through the understory of shorter trees and shrubs, to the forest floor or ground layer of low shrubs and herbaceous plants. Forest types are classified by the dominant trees present (e.g., oak-hickory-pine forest). Plant species occurring together in these different forest types are a function of the climate, altitude, geology and physiographic location, soil type, moisture, sunlight, and other conditions. So many combinations of plants occur in these different forests that space limitations prevent listing them all. Instead, the following represent plants found in a few of the more common forest types in the Chesapeake Bay watershed. These lists provide the basis for a viable forest or woodland project. Common ferns, grasses and herbaceous plants for the ground layer are listed separately, as they may occur in many of the forest types in various combinations. Remember to match the plants' growth requirements with the site conditions.

For new projects at open sites, it may take years for young trees to provide adequate shade. Consult other restoration resources and/or professionals for alternative methods of developing the ground layer, and for more comprehensive forest community information.

Forest Types, Basic Structure

Oak-Mixed Forest (Coastal Plain)
Canopy trees for well-drained sites
Carya cordiformis, tomentosa
Quercus alba, falcata, marilandica, phellos, prinus, stellata, velutina
Pinus species, occasional intermixed with the above

Canopy trees for moist sites
Acer rubrum
Fagus grandifolia
Quercus bicolor, michauxii, nigra, palustris, phellos
Liquidambar styraciflua
Liriodendron tulipifera
Nyssa sylvatica

Understory trees
Asimina triloba
Cercis canadensis
Cornus florida
Ilex opaca
Magnolia virginiana

Understory shrubs
Comptonia peregrina
Gaylussacia frondosa
Ilex glabra
Kalmia angustifolia, latifolia
Morella (Myrica) cerifera, pensylvanica
Vaccinium pallidum (vacillans), stamineum
Viburnum dentatum (recognitum), prunifolium

Pine Forest (Coastal Plain)
Overstory trees
Pinus taeda, virginiana, rigida (occasional)

Understory trees
Ilex opaca
Sassafras albidum

Understory shrubs
Clethra alnifolia
Morella (Myrica) cerifera, pensylvanica
Rhus copallina

Oak-Hickory Forest (Piedmont and Mountain, occasional on Coastal Plain)

Dominant overstory trees

Carya cordiformis, ovata
Quercus alba, prinus, rubra, velutina

Other trees

Amelanchier arborea, canadensis
Carya alba, glabra, tomentosa
Celtis occidentalis
Cercis canadensis
Cornus florida
Crataegus viridis
Fraxinus Americana
Juglans nigra
Prunus serotina
Quercus coccinea, falcata, lyrata, marilandica, muhlenbergii, stellata
Sassafras albidum
Tilia americana
Ulmus Americana

Additional trees for more moist sites

Acer rubrum
Liquidambar styraciflua
Liriodendron tulipifera
Ulmus americana

Shrubs

Kalmia latifolia
Vaccinium angustifolium, corymbosum, pallidum (vacillans), stamineum
Viburnum acerifolium

Red Oak - Mixed Hardwood Forest (Piedmont)

Dominant overstory trees

Acer rubrum
Carya ovata, tomentosa
Betula alleghaniensis (lutea), lenta
Fraxinus americana
Fagus grandifolia
Liriodendron tulipifera
Quercus alba, rubra, velutina
*Pinus strobus**
*Tsuga canadensis**

* These would be in the Hemlock-White Pine-Red Oak-Mixed Hardwood Forest (Piedmont and Mountain regions).

Understory trees and shrubs

Amelanchier species
Carpinus caroliniana
Hamamelis virginiana
Lindera benzoin
Viburnum acerifolium, dentatum (recognitum)

Hemlock-White Pine Forest (Mountain)

Dominant overstory trees

Acer saccharum
Betula alleghaniensis (lutea)
Fagus grandifolia
Pinus strobus
Tilia americana
Tsuga canadensis
also *Picea* rubens (red spruce, not included in this guide, but native in the Bay watershed in mountain region)

Other trees

Acer rubrum
Betula lenta
Liriodendron tulipifera
Quercus rubra, velutina

Shrubs

Hamamelis virginiana
Rhododendron maximum
Viburnum acerifolium

Mixed Mesophytic Forest (Mountain)

These forests are relicts of ancient mesic (moist) broadleaf deciduous forests. They can be very diverse.

Dominant overstory trees

Acer saccharum
Betula lenta
Carya ovata
Carpinus caroliniana
Fagus grandifolia
Fraxinus americana
Juglans nigra
Liriodendron tulipifera
Magnolia acuminata
Prunus serotina
Quercus rubra
Tilia americana

Understory trees and shrubs

Cercis canadensis
Hamamelis virginiana
Hydrangea arborescens
Lindera benzoin
Rhododendron maximum
Staphylea trifolia

Woodland Floor or Ground Layer Plants

These plants can also be used for gardens in or adjacent to wooded areas. Refer to specific habitat and growing conditions to match plants in appropriate groupings.

Ferns

All species included in this guide occur in woodlands.

Grasses and Grasslike Plants

Agrostis perennans
Andropogon gerardii
Carex crinita var. crinita, glaucodea, lurida, pensylvanica, vulpinoidea
Chasmanthium latifolium
Danthonia spicata
Dichanthelium clandestinum, commutatum
Elymus hystrix (Hystrix patula)
Festuca rubra
Panicum virgatum
Saccharum giganteum (Erianthus giganteus)
Schizachyrium scoparium (Andropogon scoparius)
Sorghastrum nutans
Tridens flavus
Tripsacum dactyloides

Herbaceous Plants

Actaea pachypoda
Ageratina altissima v. altissima (Eupatorium rugosum)
Aquilegia canadensis
Aralia nudicaulis, racemosa
Arisaema triphyllum
Aruncus dioicus
Asarum canadense
Campanulastrum americanum (Campanula americana)
Cardamine concatenata (Dentaria laciniata)
Caulophyllum thalictroides
Chelone glabra
Chimaphila maculata
Chrysogonum virginianum
Cimicifuga racemosa
Claytonia virginica
Delphinium tricorne
Dicentra canadensis, cucullaria, eximia
Erythronium americanum
Eurybia divaricata (Aster divaricatus)
Geranium maculatum
Helenium autumnale
Helianthus divaricatus
Heliopsis helianthoides
Hepatica nobilis var. acuta (acutiloba), var. obtusa (americana)
Heracleum maximum (lanatum)
Heuchera americana, villosa

(continued)

Hydrophyllum virginianum
Impatiens capensis (biflora)
Ionactis (Aster) linariifolius
Jeffersonia diphylla
Liatris scariosa
Lilium canadense, philadelphicum
Maianthemum canadense, racemosum (Smilacina racemosa)
Medeola virginiana
Melanthium virginicum
Mertensia virginica
Mitchella repens
Mitella diphylla
Monarda didyma
Osmorhiza longistylis
Oxalis violacea
Packera aurea (Senecio aureus)
Penstemon laevigatus
Phlox carolina, divaricata, stolonifera
Podophyllum peltatum
Polemonium reptans
Polygonatum biflorum, pubescens
Sanguinaria canadensis
Saxifraga pensylvanica, virginiensis
Scutellaria integrifolia
Sedum ternatum
Silene caroliniana, stellata, virginica
Solidago caesia, flexicaulis, rugosa
Stachys tenuifolia (hispida)
Stellaria pubera
Thalictrum dioicum, pubescens (polygamum), thalictroides (Anemonella t.)
Tiarella cordifolia
Tradescantia virginiana
Trillium erectum, grandiflorum, sessile, undulatum
Uvularia grandiflora, perfoliata, sessilifolia
Veratrum viride
Viola conspersa, hastata, pubescens (pennsylvanica), sororia (papilionacea), striata
Zizia aurea

Vines
Any of the vines included in this guide may be found in woodlands, occupying various vegetative layers, from the ground up.

Solutions for Slopes

Slopes of any kind are prone to erosion from rain, runoff; wave action, stream or river currents, and foot or lawnmower traffic. Plants with deep, spreading root systems help prevent erosion by holding soil in place. Some plants that are particularly well suited to and recommended for holding or stabilizing soils on a dry upland slope or hillsides such as a sloping yard or road embankment are listed below.

However, any plant suited to the site's sun, soil, and moisture conditions that could be planted on a flat surface could be planted on a slope, as long as the slope is accessible. Plants that naturally occur on slopes or hillsides can be found by searching the "habitat" notes provided with each plant in this guide.

For plants to use on a tidal shoreline, see the list of saltmarsh or freshwater marsh plants. For plants to use on a stream, pond or riverbank, see the list of freshwater marsh plants.

Plants That Provide Stabilization on Dry, Sunny Slopes or Hillsides

Grasses & Grasslike Plants
Ammophila breviligulata
Andropogon gerardii
Dichanthelium clandestinum
Elymus canadensis
Panicum virgatum
Panicum amarum
Schizachyrium scoparium

Herbaceous Plants
Any of the herbaceous plants that thrive in a sunny, dry site tend to be deep-rooted and would provide good slope stabilization. See the dry meadow plants list on for additional choices.

Baptisia tinctoria
Lespedeza capitata
Chamaecrista (Cassia) fasciculata

Shrubs
Comptonia peregrina
Ceanothus americanus
Clethra alnifolia
Cornus racemosa
Gaylussacia baccata, frondosa
Hypericum densiflorum
Kalmia latifolia
Morella pensylvanica
Physocarpus opulifolius
Rhus aromatica
Rhus copallina
Rhus glabra
Rosa carolina
Rubus allegheniensis
Vaccinium angustifolium
Viburnum acerifolium

Trees
The following are some of the tree species that may occur on slopes. However, for stabilization purposes, practitioners recommend planting herbaceous plants and shrubs, as trees will appear in time through succession.

Acer rubrum, saccharum, spicatum
Amelanchier arborea
Betula lenta
Carya alba (tomentosa), cordiformis, glabra, ovata
Castanea pumila
Celtis occidentalis
Chionanthus virginicus
Cornus alternifolia, florida
Crataegus crus-galli
Fraxinus americana
Juglans nigra
Liquidambar styraciflua
Liriodendron tulipifera
Magnolia acuminata
Morus rubra
Nyssa sylvatica
Ostrya virginiana
Pinus rigida, taeda
Quercus coccinea
Quercus marilandica, michauxii, muehlenbergii, prinus, rubra, velutina
Sorbus (Pyrus) americana
Ulmus rubra

Vines
Campsis radicans
Celastrus scandens
Passiflora incarnata
Parthenocissus quinquefolia

Evergreens

Ferns
Asplenium platyneuron
Dryopteris carthusiana (spinulosa), cristata, intermedia, marginalis
Polystichum acrostichoides

Herbaceous Plants
Asarum canadense
Goodyera pubescens
Heuchera americana
Mitchella repens
Phlox carolina, stolonifera, subulata
Sedum ternatum
Silene caroliniana
Solidago sempervirens
Yucca filamentosa (flaccida)

Shrubs
Gaultheria procumbens
Ilex glabra
Kalmia angustifolia, latifolia
Morella (Myrica) caroliniensis (heterophylla), cerifera
Rhododendron maximum
Vaccinium macrocarpon

Trees
Chamaecyparis thyoides
Ilex opaca
Juniperus virginiana
Magnolia virginiana
Pinus any species in this guide
Thuja occidentalis
Tsuga canadensis

Vines
B*ignonia capreolata*
Lonicera sempervirens

Plants to use as Groundcovers

Ferns
Any species in this guide

Grasses and Grasslike Plants
Carex glaucodea, pensylvanica
Danthonia spicata
Festuca rubra

Herbaceous Plants
Aquilegia canadensis
Asarum canadense
Chimaphila maculata
Chrysogonum virginianum
Chrysopsis mariana
Coreopsis verticillata
Erigeron pulchellus
Eurybia divaricata (Aster divaricatus)
Geranium maculatum
Hepatica nobilis var. acuta (acutiloba), nobilis var. obtusa (americana)
Heuchera americana, villosa
Hylotelephium (Sedum) telephioides
Maianthemum canadense
Mitchella repens
Opuntia humifusa (compressa)
Oxalis violacea
Phlox carolina, stolonifera, subulata
Podophyllum peltatum
Polemonium reptans
Sedum ternatum
Silene caroliniana
Tiarella cordifolia
Uvularia sessilifolia
Viola conspersa, cucullata, hastata, pedata

Shrubs
Gaultheria procumbens
Vaccinium angustifolium, macrocarpon
Vaccinium pallidum (vacillans)

Vines
Bignonia capreolata
Campsis radicans
Celastrus scandens
Parthenocissus quinquefolia

Plants for Spring and Fall Color

A search through this guide will reveal literally hundreds of plants of all types that will flower or fruit in spring or fall, providing a wide variety of choices to color a native landscaping project and to offer a diversity of food for wildlife. Remember to consider trees, shrubs and vines when choosing plants for their flower color; and to include fruit color in the palette. The fall color of many plants, particularly grasses, trees, shrubs and vines adds interest to the landscape. A landscape planned for seasonal color, throughout *all* seasons of the year, can also provide year-round food, cover and nesting structure for wildlife.

Deer Resistant Plants

Gardeners challenged by browsing deer often look for a definitive list of plants that deer will leave alone. Unfortunately, deer are not quite that predictable. In areas where high populations of deer have over-browsed the woodland understory, they are likely to eat any plant they can find to survive. Gardeners and habitat restorationists are strongly encouraged to use other appropriate barriers to exclude deer, in consultation with a local wildlife agency. Plants marked with an asterisk (*) may be browsed occasionally.

The list below was compiled from Bowman's Hill Wildflower Preserve and Deer Proofing Your Yard (Hart), see references.

Grasses and Grasslike Plants
Andropogon gerardii
Panicum virgatum

Herbaceous Plants
Actaea pachypoda
Allium cernuum
Aquilegia canadensis
Arisaema triphyllum
Aruncus dioicus
*Asarum canadense **
Asclepias tuberose
Baptisia australis
Campanulastrum americanum (Campanula americana)
Coreopsis tripteris
Dicentra eximia
Geranium maculatum
Helenium autumnale
Hibiscus moscheutos (H. palustris)
Jeffersonia diphylla
*Lobelia cardinalis *, siphilitica **
Lupinus perennis
Monarda didyma
Phlox divaricata, stolonifera
*Podophyllum peltatum **
Polemonium reptans
Rudbeckia fulgida, hirta
Solidago species
Symphyotrichum (Aster) novae-angliae
Veronicastrum virginicum (Veronica virginica)

Herbaceous Emergents
Iris prismatica, versicolor, virginica

Shrubs
Aralia spinosa
Clethra alnifolia
Cornus amomum
Hamamelis virginiana
Hypericum densiflorum
Ilex glabra, laevigata, verticillata
Kalmia latifolia
Leucothoe racemosa
Lindera benzoin
Morella (Myrica) cerifera, pensylvanica
Ribes rotundifolium
Spiraea alba, alba v. latifolia (latifolia), tomentosa
Viburnum acerifolium, dentatum (recognitum), prunifolium

Trees
Acer negundo, rubrum
Amelanchier canadensis
Betula nigra
Carpinus caroliniana
Cercis canadensis
Cornus alternifolia
*Cornus florida **
Diospyros virginiana
Fagus grandifolia
Fraxinus americana, pennsylvanica
Ilex opaca
Juniperus virginiana
Magnolia acuminata, virginiana
Nyssa sylvatica
Pinus — any species in this guide
Quercus — any species in this guide
Sambucus racemosa v. racemosa (S. pubens)

Vines
Celastrus scandens
*Clematis virginiana **
Lonicera sempervirens
*Wisteria frutescens **

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Each photograph is marked with an abbreviated form for the corresponding photographer, due to space limitations. Those abbreviations are listed here in alphabetical order, followed by the full credit information.

The Bugwood Network and Forestry Images Image Archive and Database Systems, The University of Georgia-Warnell School of Forest Resources and College of Agricultural and Environmental Sciences-Department of Entomology. www.bugwood.org

BUG DJM David J. Moorhead
BUG RFW Robert F. Wittwer

BZ Bob Zuberbuhler, www.westernpawildflowers.com

CAB Carole Ann Barth, Heal Earth Gardens, Silver Spring, Maryland.

CM NRCS Christopher F. Miller, Regional Plant Materials Specialist, U.S. Department of Agriculture, Natural Resources Conservation Service, Somerset, New Jersey.

Digital Flora of Texas Vascular Plant Image Library. www.csdl.tamu.edu/FLORA/galfolks.htm, or www.texasflora.org

DFT DL David Lemke, The State University-San Marcos, Department of Biology Herbarium.
DFT HW Hugh Wilson, TAMU Herbarium, Texas A&M University.

GM ARS George McLellan, Species Study Group of the Middle Atlantic Chapter, American Rhododendron Society. tjhsst.edu/~dhyatt/azaleas/atlanticum.html

MOBOT Missouri Botanical Garden. www.mobot.org/gardeninghelp/plantfinder/service.shtml. Digital images in this database were contributed by Martha Hill, Glenn Kopp and Alan Stentz.

MP Dan Tanaglia, Missouriplants. www.missouriplants.com

NYNHP Stephen M. Young, New York Natural Heritage Program. www.dec.state.ny.us/website/dfwmr/heritage

OSU Scott Biggs, Ohio State University. http://PlantFacts.osu.edu

PLANTS **USDA-NRCS. 2003. The PLANTS Database,** plants.usda.gov/plants. National Plant Data Center. Baton Rouge, LA 70874-4490 USA. PLANTS Database images that were used in this guide were contributed by the following:
PLANTS 1995 U.S. Department of Agriculture Natural Resources Conservation Service. 1995 Midwestern Wetlands Flora.
PLANTS 1997 U.S. Department of Agriculture Natural Resources Conservation Service. 1997 Northeastern Wetlands Flora.
PLANTS DEH Herman, D.E. et.al. 1996 North Dakota Tree Handbook. USDA NRCS. ND State Soil Conservation Committee. NDSU Extension and Western Area Power Administration. Bismark, ND.
PLANTS DL Douglas Ladd. U.S. Department of Agriculture Soil Conservation Service. 1989 Midwest Wetland Flora: Field Office Illustrated Guide to Plant Species. Midwest National Technical Center, Lincoln, NE.
PLANTS GAM Gary A. Monroe
PLANTS GFR George F. Russell
PLANTS JA Jennifer Anderson
PLANTS JS Jim Stasz
PLANTS JSP J.S. Peterson
PLANTS LA Larry Allain
PLANTS RM89 Robert H. Mohlenbrock. U.S. Department of Agriculture, Soil Conservation Service. 1989 Midwest Wetland Flora: Field Office Illustrated Guide to Plant Species. Midwest National Technical Center, Lincoln, NE.
PLANTS RM91 Robert H. Mohlenbrock. U.S. Department of Agriculture, Soil Conservation Service. 1991 Southern Wetland Flora: Field Office Guide to Plant Species. South National Technical Center, Fort Worth, TX.
PLANTS RM95 Robert H. Mohlenbrock. U.S. Department of Agriculture,Natural Resources Conservation Service. 1995 Northeast Wetland Flora: Field Guide to Plant Species. Northeast Technical Center, Chester, PA.
PLANTS TGB Thomas G. Barnes
PLANTS WSJ William S. Justice

RHW R. Harrison Wiegand, Maryland Department of Natural Resources, Wildlife and Heritage Service. www.dnr.state.md.us

RS MNPS Rod Simmons, Maryland Native Plant Society. www.mdflora.org

SMSU Paul Redfearn, Ozarks Regional Herbarium, Southwest Missouri State University. biology.smsu.edu/Herbarium

UCONN Mark Brand, UConn Plant Database, University of Connecticut. www.hort.uconn.edu/plants/about.html

USDA NRCS **U.S. Department of Agriculture, Natural Resources Conservation Service,** National Plant Materials Center, Beltsville, MD. www.plantmaterials.nrcs.usda.gov/mdpmc
USDA JE John Englert
USDA JK Jennifer Kujawski
USDA MG Martin van der Grinten

USFWS **U.S. Fish and Wildlife Service Chesapeake Bay Field Office,** Annapolis, MD 21401. www.fws.gov/r5cbfo
USFWS BES Britt Slattery
USFWS RL Randy Loftus
USFWS RM Rich Mason
USFWS RS Rich Starr

University of Wisconsin, Wisconsin State Herbarium, Madison, WI 53706-1381. www.botany.wisc.edu/herbarium
UWI AH Andrew Hipp, University of Wisconsin-Madison.
UWI DK Darrin Kimbler, University of Wisconsin-Madison.
UWI DWW Dennis W. Woodland, Andrews University.
UWI EJJ Emmet J. Judziewicz University of Wisconsin-Stevens Point and Madison.
UWI JK John Kohout, donated to Wisconsin Department of Natural Resources.
UWI JRS James R. Sime, Middleton, Wisconsin.
UWI JS Janice Stiefel, Bailey's Harbor, Wisconsin.
UWI KJS Kenneth J. Sytsma, University of Wisconsin-Madison.
UWI KK Kitty Kohout, donated to Wisconsin Department of Natural Resources.
UWI MC Michael Clayton, University of Wisconsin-Madison.
UWI MRB Merel R. Black, University of Wisconsin-Madison.
UWI RRK Robert R. Kowal, University of Wisconsin-Madison.
UWI RWF Robert W. Freckmann, University of Wisconsin-Stevens Point.
UWI TK Tim Kessenich, Wisconsin Department of Natural Resources.

VT Virginia Tech (Virginia Polytechnic Institute and State University), College of Natural Resources, Forest Biology and Dendrology Educational Sites. www.cnr.vt.edu/dendro/wwwmain.html

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APPENDIX G. BEST MANAGEMENT PRACTICES FOR OCCUPIED OSPREY NESTS IN PENNSYLVANIA

BEST MANAGEMENT PRACTICES for
OCCUPIED OSPREY NESTS in Pennsylvania

Osprey nests typically occur over or adjacent to water in areas with high fish populations. Following are three management zones based on the osprey tolerance for disturbance and the Best Management Practices (BMP) for each zone. The distances for each zone are consistent with guidance provided by other states and Canadian provinces (Naylor, 2004). The zones are general guidance and every project with a potential impact must be reviewed by the PGC on a project by project basis.

Zone 1 consists of the area within 300 feet of the nest that is essential to maintain in order to promote current and future nesting. This zone may be reduced if a direct line of sight prohibits the activity from being observed by the nesting osprey while on the nest.

No permanent habitat alterations that could jeopardize the future existence of the nesting osprey.
No permanent habitat alterations that could jeopardize the existence of the stream, lake, or wetland that is adjacent or underneath the nest.
No significant tree removal or commercial logging operations. Super canopy trees (large trees providing the highest canopy) should not be removed.
Herbicide or pesticides should not be sprayed within Zone 1 during the nesting season (March 25 to July 31).
No human activities (with the exception of monitoring and research) during the active nesting season.
Special Use Permits, issued by the PGC, may be required for some projects within Zone 1 when the impacts may cause reduced nesting success.

Zone 2 is the area that extends from 300 to 500 feet from the nest and or the habitat area that certain disturbances could affect nesting success. Some activities may be permitted within this zone depending on the current level of disturbance that the birds are habituated to. For example, an existing road with consistent traffic and pedestrians currently exists in Zone 2 and that may indicate the birds are habituated to similar activities.

Some permanent habitat alterations could occur provided the amount of disturbance is not of a magnitude that could cause abandonment of the nest area by the osprey.
A limited amount of permanent habitat alterations may be acceptable to streams, lakes, or wetlands so long as the overall integrity of the systems remains intact.
A limited amount of tree removal may be acceptable outside of the nesting season (March 25 to July 31). Super canopy trees should be maintained.
Limited and infrequent human activity of a low impact might be acceptable.
Herbicide or pesticides should not be sprayed within Zone 2 during the nesting season (March 25 to July 31).

Zone 3 is the area extending from 500 feet to 800 feet of the nest that supports the future existence of the habitat that surrounds the nest.

Generally, this zone should be maintained in a natural habitat condition with minimal to no permanent fragmentation.
Logging can occur in this zone outside of the nesting season (March 25 to July 31). Super canopy trees should be maintained.
A limited amount of permanent habitat alterations may be acceptable to streams, lakes, or wetlands so long as the overall integrity of the systems remains intact.

Best Management Practices for all Zones:
Wetland creation in the area would be encouraged.
Fisheries management that encourages high fish density in shallow water.
Stabilization of the nest tree, if needed, and provide secondary nesting structures and dead trees.
Maintain a buffer of trees for roosting or nesting around streams and wetlands.
Reduction of disturbance from human activity.
Conservation easements can be used to protect the osprey nest and the appropriate buffer around it.
Hydrology to existing streams, lakes, and wetlands should be protected in order to maintain the wetlands and the foraging areas for osprey.
Zoning osprey nests and the associated wetlands as critical and unique habitat as non-development areas/open space.
Prevent acid mine drainage from impacting streams, lakes, and wetlands and treat existing discharges.
Prevent sedimentation in streams, lakes, and wetlands in the area.

Attachment P

Conowingo Hydroelectric Project
(FERC Project No. 405)

Bog Turtle Protection Plan

Filed as Privileged Information

Attachment Q

Conowingo Hydroelectric Project
(FERC Project No. 405)

Northern Map Turtle Protection Plan

Filed as Privileged Information

Attachment R

Conowingo Hydroelectric Project
(FERC Project No. 405)

Waterfowl Nesting Protection Plan

Filed as Privileged Information