

## Muddy Run Pumped Storage Project American Eel Collection Facility in Octoraro Creek, 2022

**FERC Project No. 2355**



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# Table of Contents

	Page
EXECUTIVE SUMMARY.....	I
LIST OF ABBREVIATIONS .....	IV
1 INTRODUCTION.....	1
2 BACKGROUND .....	3
3 METHODS.....	5
3.1 DESIGN, CONSTRUCTION, AND INSTALLATION OF FACILITY .....	5
3.2 DATA COLLECTION .....	6
3.3 JUVENILE EEL TRANSPORT.....	6
4 RESULTS.....	7
4.1 JUVENILE EEL COLLECTION .....	7
4.2 JUVENILE EEL BIOLOGICAL DATA .....	7
4.3 JUVENILE EEL COLLECTION BY WEEK .....	7
4.4 PEAK PERIODS OF EEL COLLECTIONS.....	8
4.5 JUVENILE EEL CATCH IN RELATION TO ENVIRONMENTAL FACTORS.....	8
Creek Flow.....	8
Lunar Fraction.....	8
Water Temperature .....	9
Dissolved Oxygen .....	9
Rainfall .....	9
4.6 JUVENILE EEL TRANSPORT AND MORTALITY.....	9
Transport .....	9
Mortality .....	9
4.7 QUALITY CONTROL ACTIVITIES .....	9
4.8 OTHER SPECIES CAUGHT .....	10
5 DISCUSSION .....	11
6 REFERENCES.....	14
7 TABLES AND FIGURES .....	16
<b>APPENDICES:</b>	
APPENDIX A: WEEKLY BIOLOGICAL DATA AND ENVIRONMENTAL CONDITIONS FOR OCTORARO CREEK, 2022	
APPENDIX B: WEEKLY DATA FOR 2015-2022	
APPENDIX C: AGENCY COMMENTS ON DRAFT 2022 AMERICAN EEL COLLECTION FACILITY IN OCTORARO CREEK	

## List of Tables

	Page
Table 4.0-1: Number of Juvenile Eels Caught Daily, Octoraro Creek Eel Facility, 2022 .....	17
Table 4.2-1: Number of Juvenile Eels Captured with Length and Weight Measurements, Octoraro Creek Eel Facility, 2022 .....	18
Table 4.2-2: Juvenile Eel Length Frequency, Octoraro Creek Eel Facility, 2022 .....	19
Table 4.2-3: Juvenile Eel Weight Frequency, Octoraro Creek Eel Facility, 2022 .....	20
Table 4.2-4: Observed Injuries of Juvenile American Eels, Octoraro Creek Eel Facility, 2022 .....	21
Table 4.3-1: Juvenile Eel Collection by Week and Ranks, Octoraro Creek Eel Facility, 2022 .....	22
Table 4.5-1: USGS 01578475 - Octoraro Creek at Richardsmere, MD Gage Flows Daily Average Creek Flows (cfs), 2022.....	23
Table 4.5-2: Fraction of Moon Illumination, 2022 EST (1.0 Equals Full Moon) .....	24
Table 4.5-3: Water Temperature (°C) from the Collection Tank, Octoraro Creek Eel Facility, 2022 .....	25
Table 4.5-4: Water Quality Parameters at Associated Locations at Octoraro Creek Eel Facility, 2022 .....	26
Table 4.5-5: Rainfall (inches) Readings Taken at the Octoraro Creek Eel Facility, 2022 .....	28
Table 4.6-1: Eel Transport/Stocking Data, 2022.....	29
Table 4.7-1: Calibration of Flows (Gallons per Minute) in the Octoraro Creek Eel Facility, 2022 .....	30
Table 5.0-1: Comparison of Octoraro Creek Eel Facility, 2015-2022 .....	31

## List of Figures

	<b>Page</b>
Figure 2.0-1: Lower Octoraro Creek from Pine Grove Dam to the Mouth at the Susquehanna River, Octoraro Creek (Stone Masonry Dam also Known as Pine Grove Low-Head Dam) .....	32
Figure 3.1-1: Scaffolding and Collection Tank on top of the hill, Octoraro Creek Eel Facility, 2022 .....	33
Figure 3.1-2: T-bar supports driven through ACBs, Octoraro Creek Eel Facility, 2022 .....	34
Figure 3.1-3: Oxygen Supply System, Octoraro Creek Eel Facility, 2022 .....	35
Figure 4.1-1: Daily Eel Catch, Octoraro Creek Eel Facility, 2022 .....	36
Figure 4.2-1: Image of Hemorrhage near vent, Octoraro Creek Eel Facility, 2022.....	37
Figure 4.3-1: Percentage Eel Catch per Week, Octoraro Creek Eel Facility, 2022 .....	38
Figure 4.5-1: Daily Eel Catch and Daily Average Creek Flow (cfs, top graph) and Weekly Eel Catch and Weekly Average Creek Flow (cfs, bottom graph), Octoraro Creek Eel Facility, 2022 .....	39
Figure 4.5-2: Eel Catch and Lunar Fraction (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2022 (1.0 Equals Full Moon).....	40
Figure 4.5-3: Eel Catch to Water Temperature (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2022 .....	41
Figure 4.5-4: Comparison of Dissolved Oxygen Readings in Collection Tank and Head Pond, Octoraro Creek Eel Facility, 2022.....	42
Figure 4.5-5: Eel Catch and Dissolved Oxygen (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2022 .....	43
Figure 4.5-6: Eel Catch and Rainfall (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2022 .....	44
Figure 5.0-1: Ramp Entrance at ACB's (182 cfs ),Octoraro Creek Eel Facility, 2022.....	45
Figure 5.0-2: Weekly Catch and Average Creek Flow, Octoraro Creek Eel Facility, 2015-2022 .....	46
Figure 5.0-3: Bank Stabilization Project with Established Seed, Octoraro Creek Eel Facility, 2015-2022.....	47

## Executive Summary

Constellation Energy Generation, LLC (Constellation) received a license from the Federal Energy Regulatory Commission (FERC) on December 22, 2015, for the Muddy Run Pumped Storage Project (Muddy Run Project; FERC Project No. 2355). An American Eel Passage Plan (Eel Plan) was developed by Constellation and included as a condition of the Pennsylvania Department of Environmental Protection (PA DEP) 401 Water Quality Certification (WQC; PA DEP File No. EA 36-033 dated December 10, 2014) for the Muddy Run Project that is a condition of the FERC license for the Muddy Run Project.

Pursuant to the FERC License and the PA DEP 401 WQC, Constellation began operation of a temporary eel trapping facility at Octoraro Creek in 2015. The temporary eel trapping facility at Octoraro Creek operated for three seasons: 2015, 2016, and 2017. An annual report was developed and filed with FERC and resource agencies after each year of operation. On March 1, 2018, FERC issued a letter indicating that the temporary eel trapping facility met the requirements of the PA DEP 401 WQC and United States Department of the Interior (DOI) fishway prescription for the Muddy Run Project. Subsequently, this eel facility location has been considered permanent since 2018. Constellation completed upgrades, including a larger submersible pump, water line, manifold, collection tank, and attraction flow lines, to the permanent Octoraro Creek Eel Facility (OCEF or facility) in support of eel passage prior to the 2019 season. The remaining work left to be completed addresses aesthetics, safety (stairs), and erosion, which has been an ongoing issue due to storm events during 2018, 2019, 2020, and 2021. During each monthly Eel Passage and Restoration Group (EPAG) call, the remaining work has been communicated.

In early 2020, Chester Water Authority (CWA), which owns the property where the OCEF is located, notified Constellation of the existence of a buried, abandoned tailrace structure below the existing OCEF. The upgrades to the eel collection structure and the erosion control concerned CWA, because the design drawing showed the footers to be placed on top of or through the underground buried structure. An underground survey needed to be completed prior to installing this structure. The survey was postponed until mid-May 2020 due to the COVID-19 pandemic. The 2020 season was also delayed due to the COVID-19 pandemic. Due to the results of the 2020 underground survey, which confirmed a void under the current location of the OCEF, it was constructed at the top of the hill with agreement from the EPAG and contained one longer ramp of Enkamat substrate in 2020. The OCEF in 2021 contained two longer ramps (12.3 meters compared to 7 meters), one with Enkamat substrate and one with Milieu substrate, both of which were used from 2015 through 2019.

The Conowingo Hydroelectric Project (Conowingo; FERC Project No. 405) license was issued by FERC on March 19, 2021. Article 419 of this license required Constellation to prepare an American Eel Passage and Restoration Plan, which was developed in consultation with the U.S. Fish and Wildlife Service (USFWS), Maryland Department of Environment (MDE), and other members of the EPAG and was filed with FERC on September 16, 2021. The American Eel Passage and Restoration Plan discusses eel passage at Conowingo and on the east side of the Susquehanna River, which includes the OCEF.

Constellation conducted a topographic land survey on October 18, 2021, and developed a plan for the OCEF according to those results. The shoreline protection design was changed from riprap to

articulate concrete block (ACB) to reduce the depth of excavation and lessen the amount of weight placed over the buried structure. A shoreline stabilization project for the permanent OCEF was completed in August 2022 after the termination of an in-water work restriction due to the presence of threatened Chesapeake Logperch *Percina bimaculata* habitat at the site. This work included regrading the eroded shoreline to a suitable slope and placing ACBs throughout an approximately 2,000-square-foot area. In addition, upgrades were made to the collection platform to move it upslope to a flat, easily accessible area and to provide a larger working platform and a larger eel collection tank. The site has been seeded with a PA Piedmont Province shoreline-appropriate native grass mix. The plants will be monitored throughout the 2022-2023 winter and spring to ensure the plants become well established. In addition, Constellation is planning to enhance/replace the existing working platform with a wooden structure in the future.

Each year, American Eels *Anguilla rostrata* collected at the OCEF are transported to and held at the Conowingo West Eel Collection Facility (CWECE) and subsequently transported upriver and released at designated points in the Susquehanna River watershed.

This report provides details on the following objectives for the 2022 OCEF operational period:

- Install seasonal components of the OCEF immediately downstream of the CWA Pine Grove Low-Head Dam;
- Documentation of any modifications made to the OCEF during the season to improve functionality and eel attraction capability;
- Operate, maintain, and monitor the OCEF daily from May 1 through September 15, 2022;
- Collection of eel catch and length, water quality data, creek flow data, and moon phase data during the entire operational period;
- Transport eels collected by the OCEF to the CWECE;
- Conduct weekly quality control checks and cleaning of the OCEF to maintain proper attraction water flow.

Seasonal components of the OCEF included longer juvenile eel ramps (14.8 meters compared to the previous ramps of 12.3 meters and 7 meters), a one-horsepower submersible pump and water line, manifold, larger collection tank (1,061-liter compared to 310.4-liters, and 25 mm attraction flow lines. The seasonal components were installed and placed in service on September 5, 2022. The OCEF operated a total of 73 days from September 5 until November 20, 2022 (operations were suspended between September 10 and September 14). The eel ramp was removed when the Octoraro Creek water temperature at CWA decreased below 10.0 °C for three consecutive days.

A total of 7,159 juvenile eels were collected at the OCEF. The greatest number of juvenile eels was collected on September 8, 2022, with 2,933 eels or 41.0% of the total seasonal catch. Three collection peaks occurred during the periods of September 7-9, October 3-4, and October 18, which accounted for 5,139 of the 7,159 (71.8%) juvenile eels collected at the OCEF. Daily juvenile eel collections of less than 10 individuals were recorded on 30 of the 73 collection days (41.1%). Eel collections greater than 1,000 individuals occurred on 1 of the 73 collection days (1.4%). Volumetric estimation was used to on two days (September 8 and 9) to quantify the number of eels collected during the 2022 season at the OCEF.

Length, weight, and injuries (i.e., condition factor) were recorded from biweekly subsamples on 247 juvenile eels. Length of juvenile eels ranged from 100-219 millimeters (mm) with an average length of 123.9 mm. The average weight of juvenile eels was 2.4 grams (g) and ranged from 0.6-14.5 g. Only two of the 247 (0.8%) eels showed any form of external injury such as bruising or hemorrhaging.

All 7,159 juvenile eels collected at the OCEF were transported within 24 hours of capture either to the CWECF where they were held before transport or directly to the mainstem Susquehanna River. No eel mortality was observed in the collection tank during the 2022 season.

Cleaning and calibration of the OCEF was performed weekly. Cleaning of the screened barrel that housed the submersible pump, collection tank, screened drains, and spray bars occurred daily after all eels were removed for transport. The pump, manifold, and attraction flow lines were also cleaned as needed during the season. CWA operated their small hydroelectric facility on 26 (35.6%) of the 73 sampling days.

## **List of Abbreviations**

### **Agencies/Groups**

Constellation	Constellation Energy Generation, LLC
CWA	Chester Water Authority
CWECF	Conowingo West Eel Collection Facility
DOI	United States Department of Interior
EPAG	Eel Passage Advisory Group
FERC	Federal Energy Regulatory Commission
MDE	Maryland Department of Environment
PA DEP	Pennsylvania Department of Environmental Protection
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

### **Units of Measure**

C	Celsius
Cfs	cubic feet per second
DO	dissolved oxygen
gpm	gallons per minute
in	inches
km	kilometer
L	liter
mg/L	milligrams per liter
mm	millimeter

### **Miscellaneous**

OCEF	Octoraro Creek Eel Facility
WQC	Water Quality Certification
YSI	YSI Incorporated



## 1 Introduction

Constellation Energy Generation, LLC (Constellation), received a license from the Federal Energy Regulatory Commission (FERC) on December 22, 2015 for the Muddy Run Pumped Storage Project (Muddy Run Project; FERC Project No. 2355). An American Eel Passage Plan (Eel Plan) was developed by Constellation and included as a condition of the Pennsylvania Department of Environmental Protection (PA DEP) 401 Water Quality Certification (WQC; PA DEP File No. EA 36-033; dated 10 December 2014) for the Muddy Run Project and is a condition of the FERC license for the Muddy Run Project.

The Eel Plan required Constellation to investigate the feasibility of installing and operating a juvenile eel trapping facility on Octoraro Creek. The evaluation was conducted at a location identified on Octoraro Creek immediately downstream of the Chester Water Authority (CWA) Pine Grove Low-Head Dam. This site was approved by the PA DEP and other members of the Eel Passage Advisory Group (EPAG)<sup>1</sup>.

The Conowingo Hydroelectric Project (Conowingo; FERC Project No. 405) license was issued by FERC on March 19, 2021. Article 419 of this license required Constellation to prepare an American Eel Passage and Restoration Plan, which was developed in consultation with the United States Fish and Wildlife Service (USFWS), Maryland Department of Environment (MDE), and other members of EPAG and was filed with FERC on September 16, 2021. The American Eel Passage and Restoration Plan discusses eel passage at Conowingo and on the east side of the Susquehanna River, which includes the Octoraro Creek Eel Facility (OCEF).

American Eel *Anguilla rostrata* collected at the OCEF were transported directly to and held at the Conowingo West Eel Collection Facility (CWECF) and subsequently transported and released at designated points in the Susquehanna River watershed.

The report provides details relative to the following objectives for the 2022 field investigation:

- Installation of seasonal components to the OCEF on Octoraro Creek immediately downstream of CWA Pine Grove Low-Head Dam;
- Documentation of any modifications made to the OCEF during the season to improve functionality and eel attraction capability;
- Operation, maintenance, and monitoring of the OCEF daily from May 1 through September 15, 2022;
- Collection of eel catch and length, water quality data, creek flow data, and moon phase data during the entire operational period;
- Transportation of eels collected by the OCEF to the CWECF;
- Completion of weekly quality control checks and cleaning of the OCEF to maintain proper attraction water flow.

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<sup>1</sup> EPAG members include the Pennsylvania Department of Environmental Protection, United States Fish and Wildlife Service, Pennsylvania Fish and Boat Commission, Maryland Department of Natural Resources, Susquehanna River Basin Commission, and Exelon. Maryland Department of Environment was added to the EPAG group on March 19, 2021.

Seasonal components of the OCEF included longer juvenile eel ramps (14.8 meters compared to the previous ramps of 12.3 meters and 7 meters), a one-horsepower submersible pump and water line, manifold, larger collection tank (1,061-liter compared to 310.4-liter), and 25 mm attraction flow lines. The seasonal components were installed and placed in service on September 5, 2022 and operated until November 20, 2022.

## 2 Background

Areas of lower Octoraro Creek from the confluence with the Susquehanna river to the area near CWA's Pine Grove Low-Head Dam were surveyed over a 13-week period from June 16 through September 10, 2014, using Fyke nets, red-light headlamps, and fine mesh dip nets ([Figure 2.0-1](#) and [Normandeau Associates and Gomez and Sullivan 2014](#)). Based on the information gathered during the 2014 survey, eels were consistently found in the north corner of the spillway adjacent to the dam, whereas eels did not seem to be as abundant at the downstream sites during the same period. The report recommended that a site near the dam be considered for future juvenile eel trapping ([Normandeau Associates and Gomez and Sullivan 2014](#)). Constellation and EPAG discussed the possibility of utilizing this north corner of the spillway site for the temporary eel collection facility in 2015. However, due to concerns by the CWA relating to existing structures at the site, an alternative site along the south shore of the Pine Grove Low-Head Dam was selected and approved by the CWA and EPAG. The alternative site was located immediately downstream of the Octoraro Art Association building adjacent to the dam.

The temporary eel trapping facility adjacent to CWA's small hydroelectric site on Octoraro Creek was operated for three seasons: 2015, 2016, and 2017. An annual report was developed and filed with FERC and resource agencies after each year of operation. On March 1, 2018, FERC issued a letter indicating that the temporary eel trapping facility met the requirements of the PA DEP 401 WQC and U.S. Department of the Interior (DOI) fishway prescription for the Muddy Run Project<sup>2</sup>. The OCEF location has been considered permanent since 2018.

Prior to the 2019 eel season, Constellation completed upgrades to the OCEF related to eel passage, including a larger submersible pump and water line, manifold, collection tank, and attraction flow lines. Work related to facility aesthetics and safety (e.g., stairs) and erosion remains to be completed. This remaining work requires a PA DEP Chapter 105 Wetland and Waterway Obstruction and Encroachment Permit and, therefore, a signed agreement from CWA (the landowner) was necessary so that Constellation could apply for this permit. Constellation received the CWA-signed agreement on December 2, 2019, and applied for the Chapter 105 permit on December 27, 2019. On January 16, 2020, the Chapter 105 Permit application package was deemed complete by PA DEP, and the permitting public comment period closed on March 2, 2020. Constellation received a permit on May 8, 2020. Meanwhile, in March 2020, CWA reviewed the OCEF project plans again and had concerns with the proposed upgraded eel structure plans along the left bank of Octoraro Creek due to an abandoned underground buried tailrace that runs below the proposed gazebo platform. The existing OCEF was revised and improvement plans were reconsidered for safety and constructability. Constellation had an underground survey crew perform studies to identify the exact location of this structure and to determine if it created a void. In early May 2020, the underground survey was scheduled and completed, and the results of the survey were distributed to EPAG prior to a conference call on June 2, 2020. During this conference call, alternative options for the eel facility were discussed, and a decision was made and agreed to by all parties to construct a longer ramp with the collection tank and scaffolding placed at the top of the hill near the driveway. With the

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<sup>2</sup> On March 1, 2018, FERC issued a letter that stated, "Review of your filing indicates that it fulfils the pertinent WQC and fishway prescription requirements. Pursuant to the PADEP's WQC, because you have determined the Octoraro facility to be successful..." This approval was based on the OCEF being deemed successful and determining it as a permanent installation (Accession number: 20180301-3083; [FERC, 2018](#))

scaffolding at the top of the hill and the existing water line exiting the at the mid hillside level near the old scaffolding, Constellation agreed to relocate the water line and have it exit at the top of the hill near the new scaffolding. This approach was used to decrease the head loss and increase the total attraction flow of the OCEF, and this work was completed on August 13, 2021.

Constellation conducted a topographic land survey on October 18, 2021, and developed a plan for the OCEF according to those results. The original shoreline protection design was changed from riprap to articulate concrete block (ACB) to reduce the depth of excavation and lessen the amount of weight placed over the buried tailrace. The shoreline stabilization project for the permanent OCEF was completed in August 2022 after the termination of an in-water work restriction due to the presence of threatened Chesapeake Logperch *Percina bimaclulata* habitat at the site. This work included regrading the eroded shoreline to a suitable slope and placing ACBs throughout an approximately 2,000-square-foot area. In addition, upgrades were made to the collection platform to move it upslope to a flat, easily accessible area to provide a larger working platform. The site was seeded with a PA Piedmont Province shoreline-appropriate native grass mix.

The OCEF began operations on September 5, 2022, and were temporarily suspended on September 10, 2022, due to the bulging of the larger collection tank. This was remedied by supporting the collection tank with scaffolding on September 14, 2022, and the OCEF was returned to operation. The 2022 operations ceased on November 20, 2022, when the Octoraro Creek water temperature at CWA decreased below 10.0 °C for three consecutive days. The OCEF in 2022 contained two longer ramps, one with Enkamat substrate and one with Milieu substrate, which were the substrates used from 2015-2019 and 2021.

## 3 Methods

### 3.1 Design, Construction, and Installation of Facility

In 2022, the size of the scaffolding platform was increased to an eight foot by ten-foot platform to support the larger collection tank and oxygen supply system ([Figure 3.1-1](#)). The 310.4-liter collection tank that had been used in previous years was replaced by a 1,061-liter collection tank, which increased the holding capacity of the tank from 3,104 eels to 10,610 eels. This larger tank was installed to minimize holding mortality of eels during periods of high capture. The manifold and submersible pump remained the same as the previous years ([Normandeau Associates and Gomez and Sullivan 2020 and 2021](#)). The rainfall gauge was reinstalled on the corner of the scaffolding to capture and record daily rainfall events.

The longer juvenile eel ramps were constructed and installed with the entrance location near the locations from ramp installations from all previous years. The ramps consisted of two approximately 14.8 meter long by 305 millimeter (mm) wide cable trays positioned at a 28° angle, plus a continuous length of tray that was bent and shaped at a 90° angle over a 25 mm bend radius at the top of the ramp to convey juvenile eels into the collection tank. The entrances to the ramps were out of water under normal and low creek flow periods, but smooth transitions from the ramp entrances and the ACBs were created by ensuring that the material of the ramps were flush to ACBs (gaps between the ramp entrances and the blocks were minimized). The entrances were near the shoreline riprap of the tailwater. The ramps were supported by seven T-shaped metal braces evenly spread across the length of the ramps, which were driven through the ACBs and into the ground beneath the ramps ([Figure 3.1-2](#)). On both sides of these braces, a hole was drilled into the flat bar and a strap was used to fasten the ramps to the braces. The ramps were directly and entirely covered with aluminum from the upper 90° bend down to approximately the median discharge elevation of Octoraro Creek to protect juvenile eels from predation and keep the ramps dark while ascending the ramps. A hinged cover was added to the ramps over the spray bar to decrease light inside the ramp at the top of the ramp, as eels are known to be photophobic.

A 51 mm water line was attached to a 51 mm manifold with seven 25 mm ball valves that supplied water to the spray bars and additional attraction flow lines.

The collection tank was 914 mm wide and 1,829 mm long. The depth of the water in the collection tank was approximately 762 mm, with a volume of approximately 1,061 liters (L). Similar to prior years of operation, the collection tank was filled by allowing some of the spray bar flow to enter the collection tank, but a 25 mm collection tank fill line was added in 2022 to supply additional freshwater to the larger collection tank. The collection tank contained two drains comprised of a 76 mm PVC pipe with holes drilled through it which were wrapped in one mm mesh to prevent juvenile eel escapement. The collection tank drain lines were directed to the highest points of the ramps that were possible via gravity feed, which provided eel scent from the eels in the collection tank to the ramps to maximize eel attraction. The collection tank was custom fitted with a lid that was held down by clamps to prevent escapement.

The oxygen supply system, which was added in 2022, provided additional oxygen to the collection tank to minimize holding mortality. An oxygen regulator was attached to an oxygen bottle with a manifold that terminated at a micropore diffuser in the collection tank ([Figure 3.1-3](#)).

### **3.2 Data Collection**

Daily recorded sample data included date, time of sample, weather, eel counts, water temperature, dissolved oxygen (DO), and rainfall. The data was verified, tabulated, and entered in an electronic format each week as part of a quality control and quality assurance protocol. Environmental conditions such as creek discharge and lunar fraction were also recorded, verified, and entered in an electronic format.

Eel length and weight measurements, along with condition factors were recorded biweekly from a subsample of a maximum of 25 individuals (when available). Eels were measured and weighed after being anesthetized.

Water temperature and DO were measured in the collection tank and also in the head pond near the pump during each sampling event with an YSI water quality meter that was calibrated prior to each sampling event. An Onset HOBO dissolved oxygen and water temperature logger was added to the collection tank and continuously recorded data every fifteen minutes throughout the duration of the 2022 operational period.

### **3.3 Juvenile Eel Transport**

All juvenile eels captured in the OCEF were either transported to the CWECF where they were held before subsequent transport and release upriver at designated locations in the Susquehanna River watershed or were transported and released directly to the designated locations daily. The determination for these two transportation options were dependent upon current water temperatures; eels were only transported and held at the CWECF during periods when water temperatures were less than 26° Celsius. This protocol was developed to minimize holding mortality.

When less than 150 eels were collected during a daily sampling event, the eels were transported in aerated 19 L buckets with lids that contained a maximum amount of water that would maintain escapement prevention, with less than or equal to 50 eels in each bucket. When daily collections of juvenile eels were greater than 150 but less than 2,500 individuals, a small, enclosed transport tank (250 L) was used. This transport tank was filled to a maximum level that would preclude escapement and was equipped with supplemental oxygen. When daily collections of juvenile eels were greater than 2,500 individuals, a large transport truck and tank (2,500 L) that was used. This tank was filled completely to prevent sloshing and was equipped with supplemental oxygen to maintain DO levels in the tank.

## 4 Results

The OCEF commenced operation on September 5, and operation ceased on November 20, 2022. The OCEF operation was temporarily suspended from September 10-14 until the compromised collection tank was supported. No OCEF operations occurred from May 1 until September 4 (operational Weeks 1 through the start of Week 19). The installation of the eel ramp was delayed in 2022 due to the bank stabilization project to protect the eel ramp structure. No in-water work could be performed from April 1 until August 1 due to the presence of threatened Chesapeake Logperch habitat in the area. The OCEF was monitored daily during the 73-day season to ensure that it was attracting eels. A total of 7,159 juvenile eels were collected during the 2022 season ([Table 4.0-1](#)). Daily monitoring was conducted as a condition of the OCEF's permanent status.

### 4.1 Juvenile Eel Collection

A total of 7,159 juvenile American Eels were captured at the OCEF during the 2022 season ([Table 4.0-1](#)). The highest single-day collection of 2,933 juvenile eels occurred on September 8, which accounted for 41.0% of the total 2022 collection season ([Table 4.0-1](#) and [Figure 4.1-1](#)). Volumetric estimations of collected eels, which are indicative of high collection rates, were required on two days (2.7%), while individual counts were recorded the remaining 71 days of daily monitoring ([Table 4.0-1](#)). Eel collections greater than 1,000 individuals occurred on one of the 73 collection days (1.4%). Daily juvenile eel collections of less than 10 individuals were recorded on 30 of the 73 collection days (41.1%).

### 4.2 Juvenile Eel Biological Data

Biological data (length, weight, and condition factor) were recorded from biweekly subsamples. A total of 247 juvenile eels were collected from these biweekly subsamples (3.5% of total eels collected), during 17 of the 73 sample days ([Table 4.2-1](#)).

The average length of juvenile eels was 123.9 mm with a median size of 120.0 mm ([Table 4.2-1](#)). The length of juvenile eels ranged from 100-219 mm. During the 2022 season, only five eels measured greater than 175 mm ([Table 4.2-2](#)). Over 82.6% of the 247 measured eels ranged between 105-139 mm.

The average weight of juvenile eels was 2.4 grams (g), with a median weight of 2.1 g ([Table 4.2-1](#)). The weight of juvenile eels ranged from 0.6-14.5 g ([Table 4.2-3](#)). Over 93% of the 247 juvenile eels weighed between 1.0-3.9 g.

Eels from each biweekly subsample were examined for external injuries. Individual condition factors, date, and detailed biological data for these are shown on [Table 4.2-4](#). External injuries were noted on 0.8% (2 of 247 individuals) of the examined eels. These injuries were observed on October 3 and 10, 2022 and were consisted of a bruise and a hemorrhage, respectively ([Figures 4.2-1](#)).

### 4.3 Juvenile Eel Collection by Week

The majority of the juvenile eels were collected during Week 19 (September 4-9) when the OCEF collected 59.2% (4,240 individuals) of the season total ([Table 4.3-1](#) and [Figure 4.3-1](#)). Eel collections during Week 23 comprised the second greatest weekly total of 21.3% (1,526 eels) of the season

total. Weeks 20 and 27-30 each collected less than 1.0% (less than 71 eels) of the season total ([Table 4.3-1](#) and [Figure 4.3-1](#)). Weekly catch data are also provided in [Appendix A](#).

#### **4.4 Peak Periods of Eel Collections**

During the 2022 season, the OCEF had a single, large collection peak period and two less substantial peak periods. The large peak period (September 8-9) yielded 2,992 of the 7,159 juvenile eels collected, or 41.8% of the total season catch ([Table 4.0-1](#) and [Figure 4.1-1](#)). The two other peaks occurred during the periods of October 3-4 and October 18. The three peak periods accounted for 5,139 of the 7,159 (71.8%) juvenile eels collected at the OCEF.

#### **4.5 Juvenile Eel Catch in Relation to Environmental Factors**

[Appendix B](#) contains averaged weekly environmental data from the 2015-2022 operational seasons coupled with the weekly proportions of eel collections at the OCEF and the weekly sum of eels collected at the CWECF during, which are discussed further in this section.

##### **Creek Flow**

Creek flow and juvenile eel catch appeared to be correlated during the 2022 season. Daily average creek flow was taken from the United States Geological Survey (USGS) Gage 01578475 on Octoraro Creek at Richardsmere, MD, located approximately 21 kilometers (km) downstream of CWA's Pine Grove Low-Head Dam ([Table 4.5-1](#)). The highest daily average creek flow value when the OCEF was in operation occurred on October 3, 2022 (687 cubic feet per second, [cfs]), which corresponded with a small peak collection period ([Table 4.5-1](#)). Two days prior to the largest eel collection day during the 2022 season (September 8-9), a substantial rain event produced a freshet with a maximum discharge of 943 cfs, which was the highest instantaneous creek discharge recorded during the 2022 operational period

During Week 23, the highest weekly average creek flow did not coincide with the highest weekly catch ([Table 4.0-1](#) and [4.5-1](#) and [Figure 4.5-1](#)). Week 23 had an increase in flow which produced the second largest week of collection at the OCEF ([Figure 4.5-1](#) and [Appendix B](#)). The highest weekly catch occurred during Week 19 and could have been a factor of the first week of the 2022 season. Typical of most eel ladders, freshets in Octoraro Creek generally corresponded to greater numbers of eels collected during the 2022 operational period, but higher catch numbers during periods without an increase of flow may be a function of other environmental or behavioral variables.

##### **Lunar Fraction**

Juvenile eel catch did not appear to be correlated to lunar fraction during the 2022 season. The largest peak in eel capture (4,240 eels collected from September 8 and 9 [Week 19]) occurred the week after the new moon in September ([Table 4.5-2](#), [Figure 4.5-2](#) and [Appendix B, Time and Date Website, 2022](#)). Full moon is equal to 1.0 lunar fraction.

Based on average weekly lunar fraction, Weeks 26, 30, and 22 were the first, second, and third darkest weeks with a total of 345 eels (4.8%) of the 7,159 eels collected during these three weeks combined ([Appendix B](#)). Weeks 28, 24, and 19 were the first, second, and third brightest weeks, with a total of 4,464 (62.4%) of the 7,159 eels collected during these three weeks ([Appendix B](#)). Typically, the lower illuminance during lower lunar fraction periods (new moon) has been associated with increases in eel catch at eel traps ([Welsh et al. 2015](#) and [Schmidt et al. 2009](#)).



## **Water Temperature**

Water temperature and eel catch did appear to be correlated this season. Water temperatures ranged from 8.1° Celsius (C) when the OCEF shutdown on November 20 (Weeks 30) to 24.8° C on September 7, 2022 (Week 19, [Table 4.5-3](#) and [Figure 4.5-3](#)). The highest average weekly water temperature (23.8° C) occurred during Week 19, which corresponded with the highest weekly eel capture week ([Appendix B](#)). The OCEF had sustained daily water temperatures above 20.0° C from the start of the 2022 season on September 5 until September 25, 2022.

## **Dissolved Oxygen**

Eel collection numbers and DO did not appear to be correlated this season. DO was recorded as milligrams/Liter (mg/L). These data indicated that the DO readings were typically lower in the source water in the head pond above the dam than those observed in the collection tank for most of the season ([Table 4.5-4](#) and [Figure 4.5-4](#)). The oxygen supply system was added to the collection tank for the 2022 season and operated daily. Daily DO readings are presented in [Table 4.5-4](#) and displayed in [Figure 4.5-4](#). DO levels in the head pond were lower than the collection tank when the oxygen supply system was operated properly ([Figure 4.5-5](#) and [Appendix B](#)). Dissolved oxygen measurements were usually taken in the early morning when the lowest natural DO level was likely to be observed.

## **Rainfall**

Juvenile eel collection and rainfall did not appear to be correlated during the 2022 season. Rainfall was recorded in inches (in) by a rain gauge affixed to the scaffolding platform. The three largest rainfall events were recorded on September 6, October 1, and October 3, with 3.0, 1.5, and 1.5 inches recorded, respectively ([Table 4.5-5](#) and [Figure 4.5-6](#)). Recorded rainfall amounts over 1.0 inch were observed on six days during the 2022 season: once in September, four times in October, and once in November. During 69.9% of the season (51 of the 73 days), the rain gauge recorded values of 0.0 inches.

## **4.6 Juvenile Eel Transport and Mortality**

[Table 4.6-1](#) has detailed information of transport and mortality data.

### **Transport**

A total of 7,159 eels (100.0%) collected at the OCEF were transported within 24 hours of capture to the CWECF where they were held before transport ([Table 4.6-1](#)). Transport time from the OCEF to the CWECF was approximately 30 minutes. No juvenile eel mortality occurred when transferring eels from the transport vehicle into the CWECF.

### **Mortality**

No mortality was observed in the collection tank at the OCEF in 2022 ([Table 4.6-1](#)). All juvenile eels captured at the OCEF were observed to be free of fungus.

## **4.7 Quality Control Activities**

Cleaning and calibration activities were conducted weekly during the season. Scrubbing of the barrel housing the pump, along with the spray bars, was performed prior to performing any calibrations. The attraction flow lines, pump, barrel, and the manifold were cleaned as needed during the season.

Calibration of the ramp flow was executed each week after cleaning, using a 15-liter graduated bucket. Multiple locations of each ramp were checked for calibration purposes - the spray bar, the collection tank fill line, the scent line (collection tank drain), and the additional attraction flows at the entrance of the ramp. Detailed calibration records are listed in [Table 4.7-1](#).

The amount of algal growth within the hoses and spray bar was not an issue this season, which was likely due to the delayed start. In an effort to increase the flow of attraction water to the ramps, the pump, the barrel, manifold, and all the attraction flow lines were scrubbed or cleaned with a drain snake four times during the 2022 season ([Table 4.7-1](#)). The same submersible pump was used all season. The water line was rerouted to the top of the hill during the 2021 season and remained the same for the 2022 season to help increase the attraction flows to the OCEF ([Figure 4.7-1](#)).

Volumetric eel estimates were performed on two days during the season. No quality check comparison on counts occurred during the 2022 season.

#### **4.8 Other Species Caught**

Three other aquatic species were caught in addition to American Eel. One hundred eighty-five river crayfish (Cambaridae family) were found in the collection tank over 47 occasions during the season. A common Musk Turtle *Sternotherus odoratus* was captured in the collection tank on September 26, 2022, and a juvenile northern water snake *Nerodia sipedon* was observed at the apex of the ramp near the collection tank on September 27, 2022.

## 5 Discussion

The CWECF has one Enkamat ramp compared to the OCEF which contains one Enkamat and one Milieu ramp. The CWECF started operation on May 1, but the OCEF had a delayed commencement of September 5. The CWECF and the OCEF did operate simultaneously from September 5-10, and September 14 until November 20, 2022, but the CWECF continued after the OCEF season was complete. During the 2022 season when both ramps were simultaneously running, the CWECF captured three times the eels compared to the OCEF which captured 7,159 juvenile eels. During the 2022 season, the size range of the juvenile eels caught at the CWECF was 65-176 mm with an average length of 114.3 mm ([Normandeau Associates, Inc. 2022 \(draft\)](#)). The average size and range of the juvenile eels caught in the ramp at the OCEF were larger with a length range of 100-219 mm and an average length of 123.9 mm. Overall, the OCEF collected the larger size range, but the CWECF collected much smaller sized eels.

The collection tank was cleaned, hoses were inspected, and spray bars were examined and cleaned during each sample to ensure the facility was operating correctly. A routine (weekly) and as needed clean-out of the hoses and manifolds were performed to maintain consistent attraction flow. Minor decreases of attraction flows may also be due from the build-up of biological growth in the system. The hardiness of American Eel and its ability to adjust to parameters were evidenced by the numbers captured here. The OCEF was not shaded during the 2022 season.

Water temperature and DO readings were taken daily in the head pond at the pump level and in the collection tank. These data indicated that the water above the dam didn't stratify and those readings were lower than those observed in the collection tank for most of the season, likely due to the additional oxygen supply system added in 2022 ([Table 4.5-4](#) and [Figure 4.5-4](#)). The oxygen supply system was used when the ramp commenced and continued until the end of the season.

The average seasonal creek flow value per the USGS gage station during the 2022 season was similar to the previous years of operation (2015-2021). The average creek flow value during the operational period of May 1 through September 15, 2015-2021 was 216.2 cfs compared to the (September 5 through November 20) average creek flow value of 187 cfs in 2022 ([Normandeau Associates and Gomez and Sullivan 2015, 2016, and 2018a](#) and [Normandeau Associates 2018, 2019, 2020, and 2021](#)). During the 2022 season at OCEF, neither the daily average creek flow did not exceed 1,000 cfs. The daily average creek flow was below 100 cfs for five days compared to 24, 65, 46, 4, 13, 18, and 2 days in 2015, 2016, 2017, 2018, 2019, 2020, and 2021, respectively. CWA operated its hydropower facility on 26 of the 73 days (35.6%) this year, but no relationship was observed between eel catch and hydropower operation ([Table 4.0-1](#)). The cobble/gravel outcrop that was formed just downstream of the entrance to the eel ramps in 2018 and was still present through September 1, 2021 but after the flood in September 2021 moved much of the substrate material in the tailwater of the dam, which changed the fluid dynamics of the creek in the vicinity of the OCEF ([Normandeau Associates 2021](#)). After the bank stabilization project was complete, the entrance of the ramp was in close proximity to that of previous operational years, but was out of water under low and normal creek flow, which was unlike the previous years. The transition of the ramp entrance and the substrate became submerged when the creek flow was approximately 182 cfs, according to the USGS Gage 01578475 on Octoraro Creek at Richardsmere, MD ([Figure 5.0-1](#)). This daily average creek flow was observed to be greater than or equal to 182 cfs on 26 of the 73 operational days (35.6%), but the average creek flow for the 2022 eel season was 187 cfs ([Tables](#)

[4.5-1](#) and [5.0-1](#)). If the entrance of the ramp was to be located such that it was underwater at all creek flows then the rip-rap would have to be moved causing structural concerns for the integrity of ACBs. If the ramp were to be located such that it would span over the rip-rap, the resulting location of the ramp entrance would be farther away from the shoreline to ensure the bottom of the ramp was in contact with the creek bottom, which would increase the chances of damage to the ramp under high creek flows. The Enkamat substrate extended below the entrance of the ramp and between the riprap and the ACBs into the tailrace at all creek flows in 2022 ([Figure 5.0-1](#)).

Since 2015, typically when the creek flow has increased, the catch of juvenile eels has also increased within a few days of the flow increase. This was evident during the higher creek flows in September and October, but not during the higher flows in November 2022. [Figure 5.0-2](#) shows a comparison of 2015 through 2022 weekly catch and average creek flow data.

The number of eels collected (7,159 individuals) in 2022 was nearly the lowest annual total since the commencement of this facility, but the 2022 season missed a substantial portion of the migratory period for eels ([Table 5.0-1](#)). Although this season was the shortest season length and operated on a shifted schedule (September 5 through November 20), the facility still collected a fair number of eels (7,159 individuals). The highest average seasonal collection of eels per day prior to this season was 152.9 eels/day in 2018 when 21,094 eels were collected over a 138-day season. In 2022, the average number of eels collected per day was 99.4 during the 73-day season. The OCEF collected more than the daily average (99.4 eels per day) on 11 of the 73 days (15.1% of the season, [Tables 4.0-1](#) and [5.0-1](#)). The average size of eels (123.9 mm) captured in 2022 was nearly identical to that observed in 2021 when the average size of eels was 123.5 mm ([Table 5.0-1](#)). From 2015 to 2018, juvenile eels were measured during every sample day (up to 25 eels if available), but only biweekly subsamples of lengths were collected in 2019-2022. The OCEF has caught juvenile eels less than or equal to 100 mm every year. The magnitude of the size range of eels collected and measured in 2022 was similar to all other years when both substrate ramps were used to collect eels.

The collection tank is 914 mm wide with a length of 1,829 mm. The depth of the water in the collection tank is approximately 762 mm with a volume of approximately 1,061 Liters. The capacity of American Eels in this new, larger collection tank is 10,061 eels under the USFWS guidelines. The capacity of the collection was not exceeded in 2022.

The improvements to the OCEF prior to the start of the 2022 season helped minimize potential mortality events. These improvements of the addition of a small oxygen bottle, regulator, and micro pore diffuser helped increase the oxygen levels in the collection tank. Oxygen levels were kept close to 100% saturation and not held at extreme levels. An oxygen bottle system was added to the OCEF which did not change its footprint. Oxygen was controlled and maintained manually and was increased daily when an increase in creek flows was forecasted or when higher eel collections are being recorded. Typically, at most eel ladders, increases of eel captures occur when river flows increase or shortly after these events.

Due to the installation of the larger collection tank, the footprint of the scaffolding needed to be increased to a platform of eight feet by ten feet. An additional length of the ramp was needed to reach the new location of the scaffolding and ensure the angle of the ramp did not change. These changes to the OCEF were agreed upon by EPAG and FERC was updated on these changes.

Multiple monitoring checks on any given day were not performed in 2022 since collection of eels were not high enough to expect the potential for exceeding the holding capacity of the collection tank during any daily check.

The 2022 season commenced on September 5 after the bank stabilization project was completed. The bank stabilization project consisted of placing ACBs on the hillside and large riprap to prevent future erosion in the area of the OCEF. The bank stabilization project could not commence until after August 1 due to in-water work restrictions associated with the presence of Chesapeake Logperch habitat in Octoraro Creek.

No loss of power events occurred during the 2022 season. The oxygen bottle of the oxygen supply system lasted the entire season.

The newly placed seed along the hillside will be monitored throughout the 2022/2023 winter and spring to ensure the plants become well established ([Figure 5.0-3](#)). In addition, Constellation is planning to enhance/replace the existing working platform with a wooden structure in the future.

## 6 References

- Federal Energy Regulatory Commission. Project No. 2355-026-Pennsylvania Muddy Run Pumped Storage Project. Exelon Generation Company, LLC., March 1, 2018.
- Minkinen, S., and I. Park. 2014. American eel sampling at Conowingo Dam, 2013. USFWS Technical Report, February 2014.
- Normandeau Associates, Inc. 2022. (draft) Muddy Run Pumped Storage Project. Conowingo West Eel Collection Facility Report, FERC Project No. 2355. Prepared for Constellation.
- Normandeau Associates, Inc. 2021. Muddy Run Pumped Storage Project. Conowingo West Eel Collection Facility Report, FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. 2020. Muddy Run Pumped Storage Project. Conowingo Eel Collection Facility Report, FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. 2019. Muddy Run Pumped Storage Project. Conowingo Eel Collection Facility Report, FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. 2018. Muddy Run Pumped Storage Project. Conowingo Eel Collection Facility Report, FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. 2022. Muddy Run Pumped Storage Project. American Eel Collection Facility in Octoraro Creek, FERC Project No. 2355. Prepared for Exelon
- Normandeau Associates, Inc. 2021. Muddy Run Pumped Storage Project. American Eel Collection Facility in Octoraro Creek, FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. 2020. Muddy Run Pumped Storage Project. American Eel Collection Facility in Octoraro Creek, FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. 2019a. Muddy Run Pumped Storage Project. Evaluation of Temporary American Eel Collection Facility in Octoraro Creek, Year 5, FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. and Gomez and Sullivan. 2018a. Muddy Run Pumped Storage Project. Evaluation of Temporary American Eel Collection Facility in Octoraro Creek, Year 4, FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. and Gomez and Sullivan. 2018b. Muddy Run Pumped Storage Project. Conowingo Eel Collection Facility Report, FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. and Gomez and Sullivan. 2017. Muddy Run Pumped Storage Project. Evaluation of Temporary Eel Collection Facility in Octoraro Creek, (Year 3). FERC Project No. 2355. Prepared for Exelon.

- Normandeau Associates, Inc. and Gomez and Sullivan. 2016. Muddy Run Pumped Storage Project. Evaluation of Temporary Eel Collection Facility in Octoraro Creek, (Year 2). FERC Project No. 2355. Prepared for Exelon.
- Normandeau Associates, Inc. and Gomez and Sullivan. 2015. Evaluation of Temporary Eel Collection Facility in Octoraro Creek (Year 1). Prepared for Exelon.
- Normandeau Associates, Inc. and Gomez and Sullivan. 2014. Octoraro Creek Juvenile American Eel Trapping Evaluation. Prepared for Exelon.
- Schmidt, R.E., C.M. O'Reilly, D. Miller. 2009. Observations of American eels using an upland passage facility and effects of passage on the population structure. *North American Journal of Fisheries Management*, 29: 715-720.
- Time and Date website. 2022. Philadelphia, Pennsylvania, USA — Moonrise, Moonset, and Moon Phases. <https://www.timeanddate.com/moon/usa/philadelphia?month=5&year=2022>
- Welsh S.A., J.L. Aldinger, M.A. Braham, J.L. Zimmerman. 2015. Synergistic and singular effects of river discharge and lunar illumination on dam passage of upstream migrant yellow-phase American eels. *ICES Journal of Marine Science*. Doi:10.1093/icesjms/fws052.

## 7 Tables and Figures



Table 4.0-1: Number of Juvenile Eels Caught Daily, Octoraro Creek Eel Facility, 2022

Date	Number of Eels	Date	Number of Eels
9/5/2022	-	10/14/2022 *	80
9/6/2022	2	10/15/2022 *	47
9/7/2022	432	10/16/2022	30
9/8/2022	<b>2933</b>	10/17/2022	48
9/9/2022	<b>598</b>	10/18/2022 *	<b>451</b>
9/10/2022	275	10/19/2022 *	71
9/11/2022	DNO	10/20/2022 *	21
9/12/2022	DNO	10/21/2022 *	17
9/13/2022	DNO	10/22/2022 *	8
9/14/2022	DNO	10/23/2022 *	7
9/15/2022	4	10/24/2022 *	21
9/16/2022	10	10/25/2022	18
9/17/2022	32	10/26/2022	10
9/18/2022	8	10/27/2022 *	11
9/19/2022	12	10/28/2022 *	5
9/20/2022	10	10/29/2022 *	6
9/21/2022	21	10/30/2022 *	3
9/22/2022	10	10/31/2022 *	0
9/23/2022	16	11/1/2022 *	4
9/24/2022	14	11/2/2022 *	11
9/25/2022	23	11/3/2022 *	5
9/26/2022	18	11/4/2022	1
9/27/2022	15	11/5/2022	2
9/28/2022 *	51	11/6/2022	6
9/29/2022 *	70	11/7/2022	3
9/30/2022	60	11/8/2022	11
10/1/2022 *	35	11/9/2022	2
10/2/2022	246	11/10/2022	1
10/3/2022	<b>419</b>	11/11/2022	0
10/4/2022 *	<b>306</b>	11/12/2022	26
10/5/2022 *	254	11/13/2022	8
10/6/2022 *	100	11/14/2022	1
10/7/2022	139	11/15/2022	0
10/8/2022	62	11/16/2022	1
10/9/2022 *	16	11/17/2022	0
10/10/2022	9	11/18/2022	0
10/11/2022 *	9	11/19/2022	0
10/12/2022 *	7	11/20/2022	0
10/13/2022	7	<b>Total</b>	<b>7,159</b>

\*Days the hydroelectric facility was operating (26 days)

Volumetric estimates are in italics (2)

Bolded numbers are peak days

The peak periods are shown in boxes

**Table 4.2-1: Number of Juvenile Eels Captured with Length and Weight Measurements, Octoraro Creek Eel Facility, 2022**

	<b>Total</b>
Number eels collected	7,159
Number measured	247
Data Collection Days	17
Length Range (mm)	100-219
Average length (mm)	123.9
Median length (mm)	120.0
Weight range (g)	0.6-14.5
Average weight (g)	2.4
Median weight (g)	2.1

**Table 4.2-2: Juvenile Eel Length Frequency, Octoraro Creek Eel Facility, 2022**

<b>TL (mm)</b>	<b>Number</b>
100-104	9
105-109	28
110-114	40
115-119	44
120-124	30
125-129	22
130-134	22
135-139	18
140-144	13
145-149	6
150-154	4
155-159	5
160-164	0
165-169	0
170-174	1
175-179	3
180-184	0
185-189	0
190-194	0
195-199	0
200-204	1
205-209	0
210-214	0
215-219	1
<b>Total</b>	<b>247</b>

**Table 4.2-3: Juvenile Eel Weight Frequency, Octoraro Creek Eel Facility, 2022**

<b>Weight (g)</b>	<b>Number</b>
0.5-0.9	1
1.0-1.4	43
1.5-1.9	64
2.0-2.4	66
2.5-2.9	31
3.0-3.4	15
3.5-3.9	11
4.0-4.4	5
4.5-4.9	0
5.0-5.4	3
5.5-5.9	2
6.0-6.4	1
6.5-6.9	0
7.0-7.4	2
7.5-7.9	0
8.0-8.4	1
8.5-8.9	0
9.0-9.4	0
9.5-9.9	1
10.0-10.4	0
10.5-10.9	0
11.0-11.4	0
11.5-11.9	0
12.0-12.4	0
12.5-12.9	0
13.0-13.4	0
13.5-13.9	0
14.0-14.4	0
14.5-14.9	1
<b>Total</b>	<b>247</b>

**Table 4.2-4: Observed Injuries of Juvenile American Eels, Octoraro Creek Eel Facility, 2022**

<b>Date</b>	<b>Length (mm)</b>	<b>Weight (grams)</b>	<b>Condition Factor</b>
10/03/2022	143	3.4	Bruise mid-body
10/10/2022	142	2.7	Hemorrhage near vent

2 of 247 eels (0.8%) that were processed had injury

**Table 4.3-1: Juvenile Eel Collection by Week and Ranks, Octoraro Creek Eel Facility, 2022**

	Wk 1-18	Wk 19	Wk 20	Wk 21	Wk 22	Wk 23	Wk 24
Total	DNO	4,240	46	91	231	1,526	175
Rank		1	9	6	4	2	5
Percent Catch (%)		59.23	0.64	1.27	3.23	21.32	2.44
	Wk 25	Wk 26	Wk 27	Wk 28	Wk 29	Wk 30	
Total	646	78	26	49	10	0	
Rank	3	7	10	8	11	12	
Percent Catch (%)	9.02	1.09	0.36	0.68	0.14	0.0	

Top 2 ranked weeks are shown in boxes.

The OCEF started operation on September 5, 2022 (Week 19) because of the bank stabilization project.

Operation between September 10-September 14 was suspended due to collection tank issues

Week 30 accounted for one day

Wk 1-18: May 1 – September 3

Wk 19: September 4 – September 10

Wk 20: September 11 – September 17

Wk 21: September 18 – September 24

Wk 22: September 25 – October 1

Wk 23: October 2 – October 8

Wk 24: October 9 – October 15

Wk 25: October 16 – October 22

Wk 26: October 23 – October 29

Wk 27: October 30 – November 5

Wk 28: November 6 – November 12

Wk 29: November 13 – November 19

Wk 30: November 20

**Table 4.5-1: USGS 01578475 - Octoraro Creek at Richardsmere, MD Gage Flows Daily Average Creek Flows (cfs), 2022**

<b>Day</b>	<b>September</b>	<b>October</b>	<b>November</b>
<b>1</b>		153	150
<b>2</b>		339	146
<b>3</b>		687	119
<b>4</b>		574	87
<b>5</b>	57	634	104
<b>6</b>	564	338	115
<b>7</b>	427	227	118
<b>8</b>	216	174	114
<b>9</b>	146	165	105
<b>10</b>	117	158	104
<b>11</b>	120	152	121
<b>12</b>	183	149	205
<b>13</b>	184	179	182
<b>14</b>	169	326	138
<b>15</b>	135	235	125
<b>16</b>	118	182	348
<b>17</b>	115	198	271
<b>18</b>	112	253	182
<b>19</b>	109	193	149
<b>20</b>	105	168	137
<b>21</b>	101	160	
<b>22</b>	101	152	
<b>23</b>	105	154	
<b>24</b>	91	247	
<b>25</b>	95	229	
<b>26</b>	113	201	
<b>27</b>	112	185	
<b>28</b>	139	164	
<b>29</b>	123	152	
<b>30</b>	66	147	
<b>31</b>		145	

The operation began on September 5, 2022 when the bank stabilization project was completed.

**Table 4.5-2: Fraction of Moon Illumination, 2022 EST (1.0 Equals Full Moon)**

<b>Day</b>	<b>September</b>	<b>October</b>	<b>November</b>
<b>1</b>		0.377	0.583
<b>2</b>		0.495	0.695
<b>3</b>		0.614	0.795
<b>4</b>		0.727	0.878
<b>5</b>	0.753	0.826	0.941
<b>6</b>	0.850	0.906	0.982
<b>7</b>	0.927	0.963	0.999
<b>8</b>	0.952	0.979	0.997
<b>9</b>	0.977	0.994	0.994
<b>10</b>	0.998	0.998	0.967
<b>11</b>	0.990	0.978	0.922
<b>12</b>	0.956	0.936	0.860
<b>13</b>	0.899	0.876	0.785
<b>14</b>	0.825	0.801	0.700
<b>15</b>	0.739	0.716	0.608
<b>16</b>	0.645	0.623	0.510
<b>17</b>	0.546	0.526	0.411
<b>18</b>	0.448	0.429	0.314
<b>19</b>	0.352	0.333	0.221
<b>20</b>	0.262	0.242	0.138
<b>21</b>	0.180	0.161	
<b>22</b>	0.100	0.091	
<b>23</b>	0.055	0.039	
<b>24</b>	0.018	0.008	
<b>25</b>	0.001	0.001	
<b>26</b>	0.008	0.021	
<b>27</b>	0.039	0.069	
<b>28</b>	0.094	0.142	
<b>29</b>	0.171	0.237	
<b>30</b>	0.267	0.347	
<b>31</b>		0.465	



**Table 4.5-3: Water Temperature (°C) from the Collection Tank, Octoraro Creek Eel Facility, 2022**

<b>Day</b>	<b>September</b>	<b>October</b>	<b>November</b>
1		17.3	13.0
2		17.9	13.1
3		17.1	12.8
4		15.8	12.5
5	23.9	14.9	13.4
6	22.9	14.1	13.7
7	24.8	14.2	14.5
8	24.1	15.5	13.9
9	23.4	13.3	12.8
10	23.4	13.5	12.4
11		13.4	13.5
12		13.2	13.7
13		14.1	13.6
14	22.6	14.6	12.5
15	22.6	14.1	11.8
16	22.0	13.9	11.4
17	22.0	14.8	10.9
18	21.6	14.0	9.9
19	24.8	13.2	9.1
20	22.5	12.8	8.1
21	21.9	12.2	
22	22.1	12.1	
23	20.9	12.4	
24	20.0	13.5	
25	20.3	13.7	
26	19.7	13.6	
27	19.7	13.2	
28	18.6	12.9	
29	18.3	12.6	
30	18.0	12.3	
31		12.5	

Table 4.5-4: Water Quality Parameters at Associated Locations at Octoraro Creek Eel Facility, 2022

Day	Time	Collection *		Head Pond	
		Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
9/5/2022	800	23.9	7.5	24.0	5.5
9/6/2022	815	22.9	8.09	23.3	7.6
9/7/2022	832	24.8	7.5	24.9	7.1
9/8/2022	755	24.1	6.7	24.1	6.9
9/9/2022	815	23.4	8.18	23.6	6.4
9/10/2022	801	23.4	8.06	23.5	5.7
9/11/2022					
9/12/2022					
9/13/2022					
9/14/2022	800	22.6	7.3	22.8	6.4
9/15/2022	805	22.6	6.3	22.6	5.5
9/16/2022	815	22.0	7.5	22.1	6.22
9/17/2022	815	22.0	7.5	22.0	6.15
9/18/2022	800	21.6	5.81	21.7	6.55
9/19/2022	806	24.8	7.65	24.9	6.82
9/20/2022	730	22.5	6.9	22.5	9.3
9/21/2022	820	21.9	7.61	21.9	6.2
9/22/2022	826	22.1	7.7	22.1	6.1
9/23/2022	805	20.9	8.36	21.1	6.23
9/24/2022	758	20.0	6.6	20.1	5.6
9/25/2022	757	20.3	6.1	20.3	5.3
9/26/2022	814	19.7	6.8	19.3	6.3
9/27/2022	801	19.7	7.5	19.7	5.9
9/28/2022	800	18.6	7.43	18.8	5.39
9/29/2022	740	18.3	8.72	18.4	5.62
9/30/2022	804	18.0	8.8	18.1	6.7
10/1/2022	745	17.3	8.0	16.8	7.8
10/2/2022	800	17.9	8.7	18.1	8.1
10/3/2022	930	17.1	9.85	17.7	8.87
10/4/2022	810	15.8	9.0	15.9	8.8
10/5/2022	835	14.9	10.04	14.9	10.24
10/6/2022	815	14.1	9.7	14.2	8.9
10/7/2022	755	14.2	9.38	14.2	9.62
10/8/2022	740	15.5	9.18	15.5	9.2
10/9/2022	744	13.3	8.75	13.7	8.5
10/10/2022	815	13.5	9.65	13.4	9.15
10/11/2022	812	13.4	9.2	13.5	8.8
10/12/2022	830	13.2	9.2	13.3	9.3
10/13/2022	800	14.1	9.2	14.0	8.9
10/14/2022	800	14.6	10.03	14.6	9.7
10/15/2022	755	14.1	9.84	14.2	9.67
10/16/2022	830	13.9	9.5	14.0	9.2
10/17/2022	820	14.8	8.3	14.7	8.2

(continued)

Table 4.5-4. (Continued)

Day	Time	Collection		Head Pond	
		Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
10/18/2022	745	14.0	9.0	14.2	8.06
10/19/2022	807	13.2	9.11	13.4	9.54
10/20/2022	830	12.8	9.5	12.9	8.04
10/21/2022	758	12.2	9.18	12.4	9.0
10/22/2022	840	12.1	9.26	12.2	9.0
10/23/2022	817	12.4	10.49	12.4	9.65
10/24/2022	745	13.5	9.72	13.4	9.58
10/25/2022	820	13.7	9.95	13.6	9.9
10/26/2022	820	13.6	9.86	13.5	9.78
10/27/2022	800	13.2	9.7	13.3	9.7
10/28/2022	745	12.9	9.77	13.0	9.63
10/29/2022	745	12.6	9.4	12.6	8.9
10/30/2022	830	12.3	9.9	12.4	9.81
10/31/2022	810	12.5	9.4	12.5	9.0
11/1/2022	810	13.0	9.15	12.9	8.91
11/2/2022	840	13.1	9.13	13.1	8.52
11/3/2022	755	12.8	9.1	12.9	8.75
11/4/2022	810	12.5	9.41	12.6	9.42
11/5/2022	810	13.4	9.93	13.3	9.66
11/6/2022	808	13.7	10.11	13.5	9.5
11/7/2022	820	14.5	11.0	14.4	10.75
11/8/2022	750	13.9	10.44	14.1	10.07
11/9/2022	815	12.8	9.90	13.0	9.15
11/10/2022	720	12.4	10.7	12.5	9.9
11/11/2022	917	13.5	11.9	13.4	10.2
11/12/2022	806	13.7	10.59	1.6	10.2
11/13/2022	810	13.6	10.26	13.7	9.82
11/14/2022	800	12.5	12.4	12.6	10.6
11/15/2022	920	11.8	11.86	11.9	10.68
11/16/2022	835	11.4	11.7	11.6	10.94
11/17/2022	815	10.9	13.7	11.0	10.8
11/18/2022	800	9.9	11.76	10.0	10.48
11/19/2022	810	9.1	10.4	9.2	10.5
11/20/2022	750	8.1	12.5	8.3	12.7

**Table 4.5-5: Rainfall (inches) Readings Taken at the Octoraro Creek Eel Facility, 2022**

<b>Day</b>	<b>September</b>	<b>October</b>	<b>November</b>
1		<b>1.5</b>	0.2
2		0.6	0
3		<b>1.5</b>	0
4		<b>1.0</b>	0
5	0	0.6	0
6	<b>3.0</b>	0.1	0.1
7	0	0	0.1
8	0.2	0	0
9	0	0	0
10	0	0	0
11		0	0
12		0	0.8
13		0	0
14	0.1	<b>1.0</b>	0
15	0	0	<b>1.1</b>
16	0	0	0
17	0	0	0
18	0	0.5	0
19	0	0	0
20	0	0	0
21	0	0	
22	0	0	
23	0.2	0	
24	0	0.6	
25	0	0.1	
26	0.5	0.2	
27	0	0.2	
28	0	0	
29	0	0	
30	0	0	
31		0	

Bolded values represent rainfall amounts greater than or equal to 1.0 inches

**Table 4.6-1: Eel Transport/Stocking Data, 2022**

Location of stocking	Number of Eels	No. eels died (mortality)			Removed for analysis	Remove for studies	Number stocked
		Collection Tank	Holding Tank	Transport			
Octoraro Creek Collection Tanks	7,159	0 (0.00%)					
Transported to Conowingo West Eel Collection Facility	7,159			0 (0.00%)			7,159
Conowingo Collection Tank	139,798	53 (0.04%)	<b>216 (0.15%)</b>		101	4,569	134,859
Total Transported from Octoraro Creek and Conowingo West Eel Collection Facility	142,148			35 (0.02%)			142,113

Numbers displayed are from May 1 – November 20

Italic value includes SUNY, SRBC, and efficiency studies (some of which were recaptured and transported upriver)

Bolded value is assumed all dead eels were from the CWECF (only 1 eel died after OCEF started operation)

**Table 4.7-1: Calibration of Flows (Gallons per Minute) in the Octoraro Creek Eel Facility, 2022**

	DATE					
	9/8	9/14*	9/21	9/29	10/5*	10/12
<b>Enkamat Ramp</b>						
Spray bar	9.6	6.9	6.9	6.45	6.9	7.5
Scent line	3.6	5.4	5.8	4.8	6.45	4.8
Bottom Attraction flow	18.0	20.5	18.6	19.0	19.2	17.5
<b>Milieu Ramp</b>						
Spray bar	6.6	4.2	4.5	8.1	4.65	5.7
Scent line	3.6	5.4	6.0	5.25	6.6	5.25
Bottom Attraction flow	21.0	23.0	19.8	17.5	17.4	17.5
Collection Tank Fill	6.6	7.2	8.4	5.25	8.6	5.25
Overall Attraction Flows	61.8	61.8	58.2	56.3	56.75	53.45

\* Cleaned pump, manifold, and hoses to increase flow

	DATE				
	10/19	10/26*	11/1	11/9*	11/16
<b>Enkamat Ramp</b>					
Spray bar	7.5	9.6	7.3	5.0	5.4
Collection tank drain	5.4	4.8	4.3	4.0	4.5
Bottom Attraction flow	16.2	15.9	16.5	19.8	21.0
<b>Milieu Ramp</b>					
Spray bar	5.0	6.4	5.5	4.8	5.25
Collection tank drain	5.4	4.8	5.4	4.0	4.2
Bottom Attraction flow	16.2	15.9	18.6	19.8	21.0
Collection Tank Fill	5.8	4.8	5.1	4.8	5.1
Overall Attraction Flows	50.7	52.6	53.0	54.2	57.75

\* Cleaned pump, manifold, and hoses to increase flow

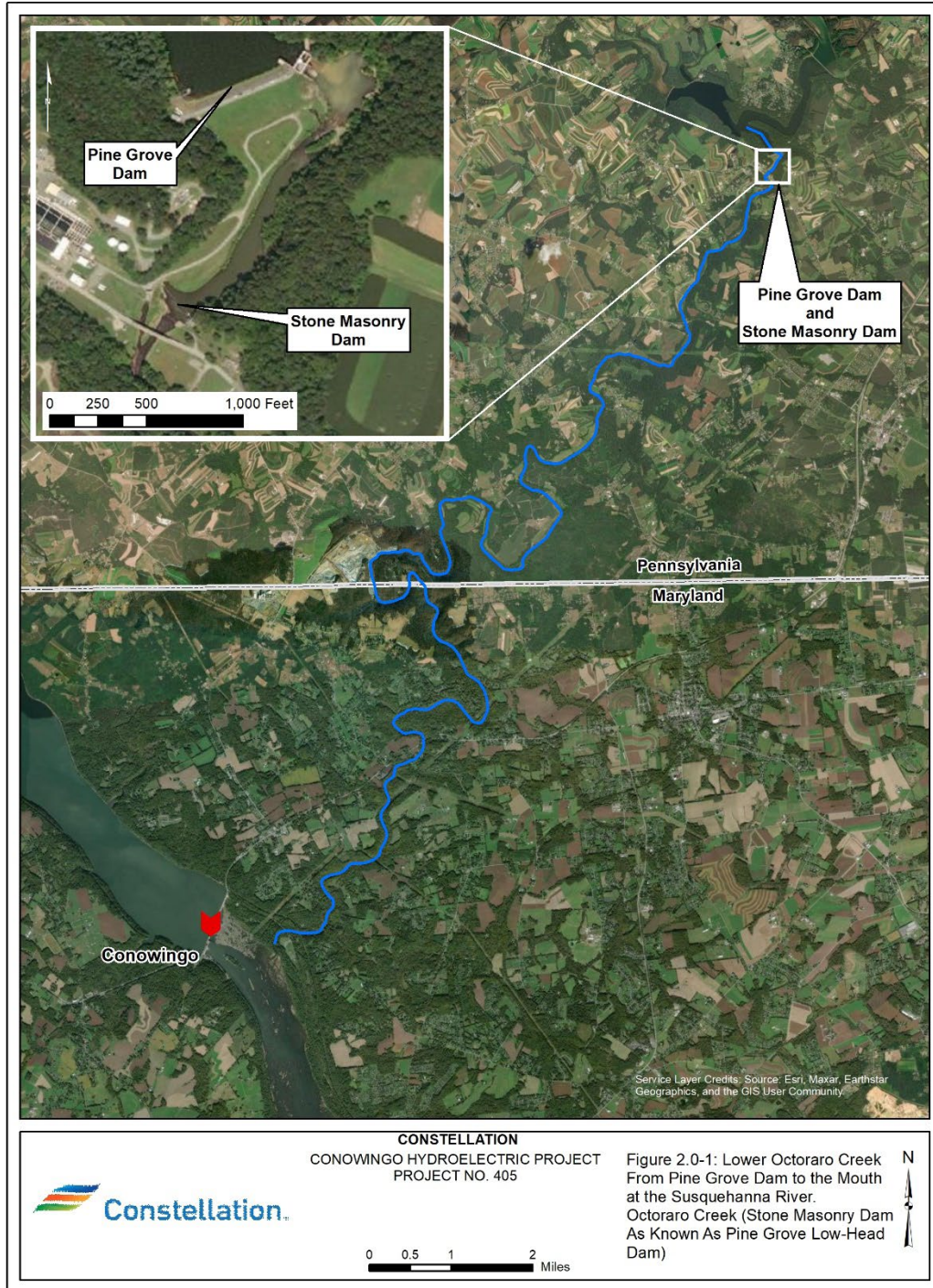
**Table 5.0-1: Comparison of Octoraro Creek Eel Facility, 2015-2022**

Watershed area 540 km<sup>2</sup>  
 Approximate Distance from Mouth of Chesapeake Bay to OCEF 341 km

	2015	2016	2017	2018	2021	2020	2021	2022 *	Average
Eels Collected	7,197	21,094	11,347	4,203	14,170	3,597	45,230	7,159	14,249.6
Average Size (mm)	129.4	130.9	135.4	141.6	129.9	125.8	123.5	123.9	130.1
Eel length range (mm)	95-232	99-202	99-245	100-259	93-252	91-170	90-190	100-219	
Days of Operation	89	138	138	135	138	95	124	73	116.3
Average eels per day	80.9	152.9	82.2	31.1	102.7	37.9	364.8	99.4	83.6
Average creek flow (cfs)	180.9	121.3	138.0	411.0	240.0	224.0	203.0	187.0	213.2
Flow range (cfs)	60-1,490	43-512	51-557	88-2,370	63-1,610	64-3,920	93-1,070	57-687	

\*Started operation on September 5, 2022 after the bank stabilization project was completed and continued operation until November 20, 2022

Figure 2.0-1: Lower Octoraro Creek from Pine Grove Dam to the Mouth at the Susquehanna River, Octoraro Creek (Stone Masonry Dam also Known as Pine Grove Low-Head Dam)





**Figure 3.1-1: Scaffolding and Collection Tank on top of the hill, Octoraro Creek Eel Facility, 2022**



**Figure 3.1-2: T-bar supports driven through ACBs, Octoraro Creek Eel Facility, 2022**



**Figure 3.1-3: Oxygen Supply System, Octoraro Creek Eel Facility, 2022**

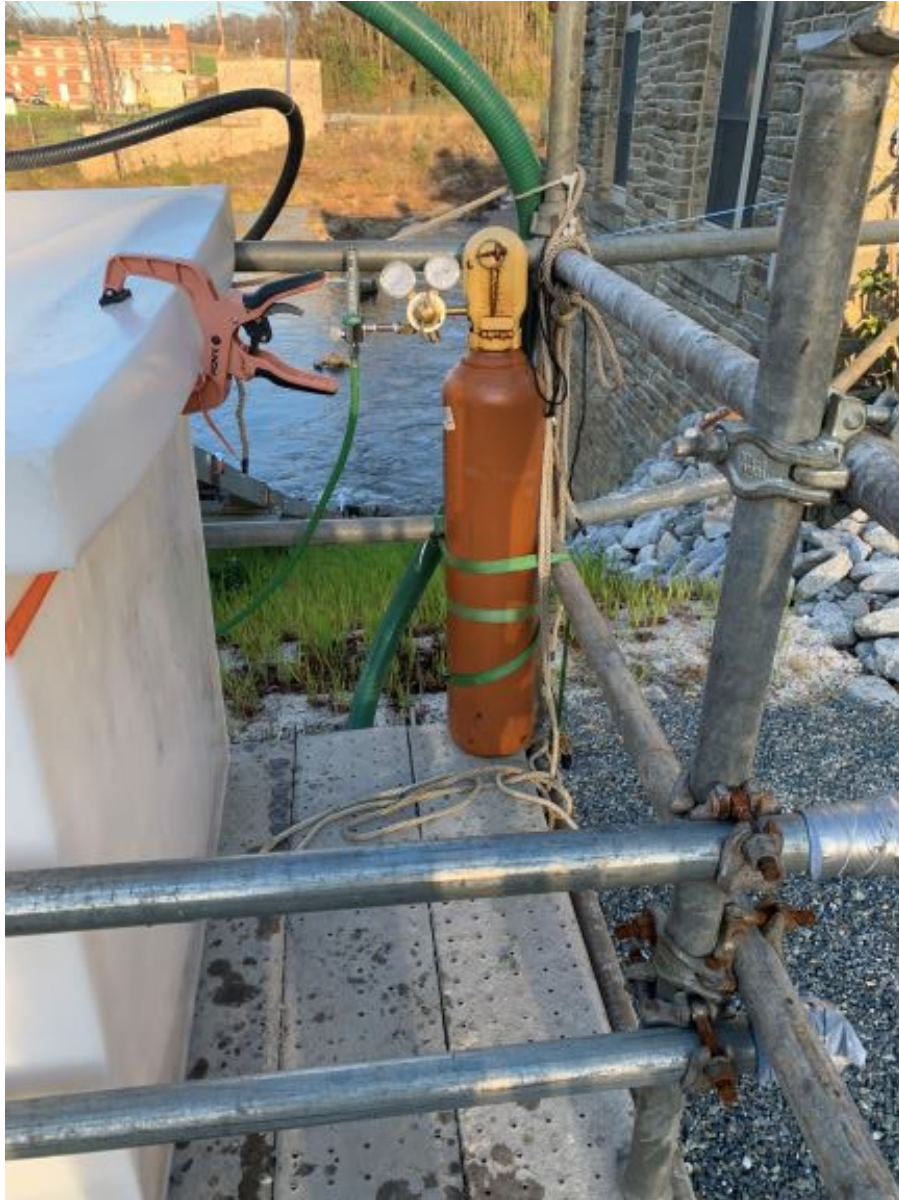


Figure 4.1-1: Daily Eel Catch, Octoraro Creek Eel Facility, 2022

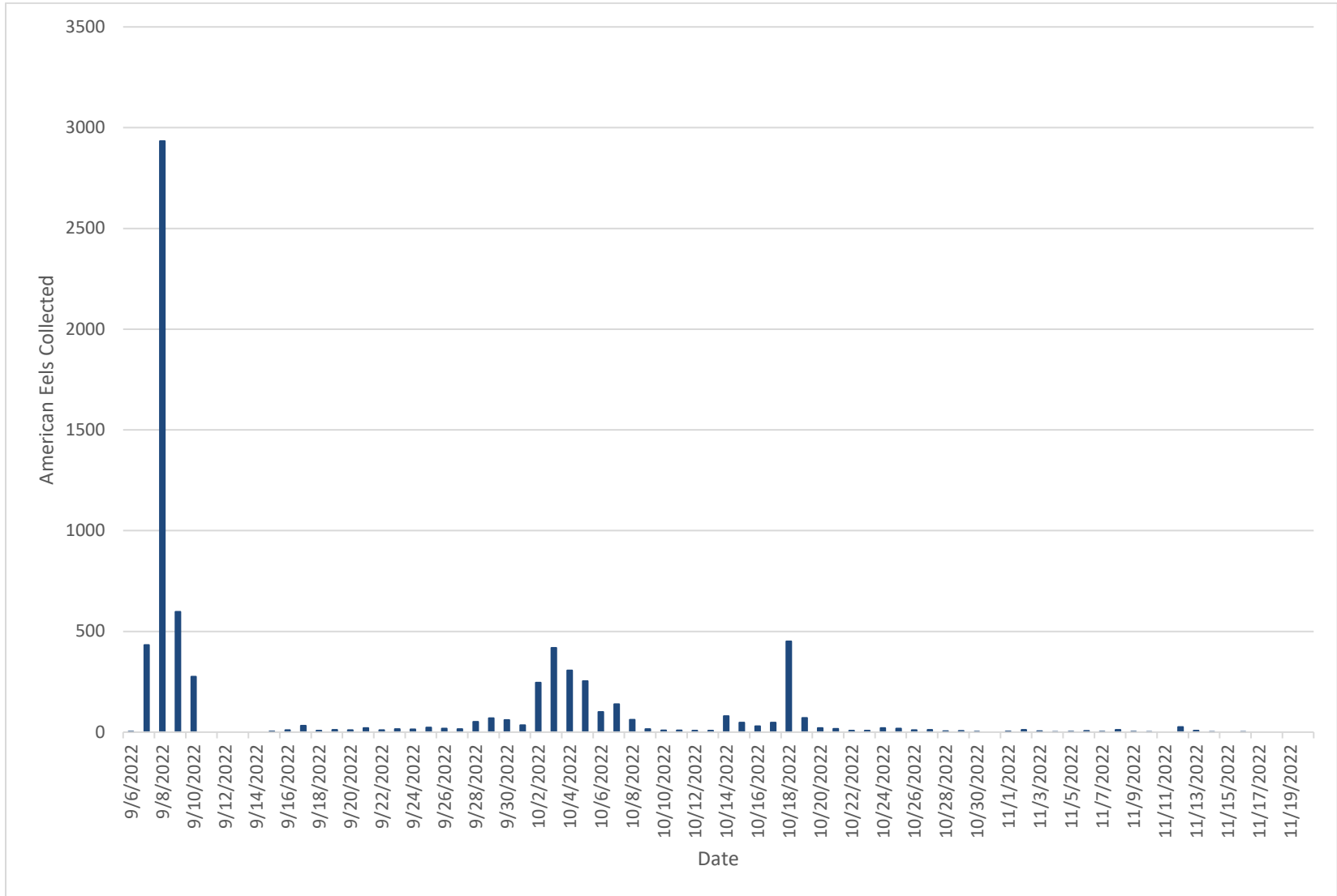


Figure 4.2-1: Image of Hemorrhage near vent, Octoraro Creek Eel Facility, 2022

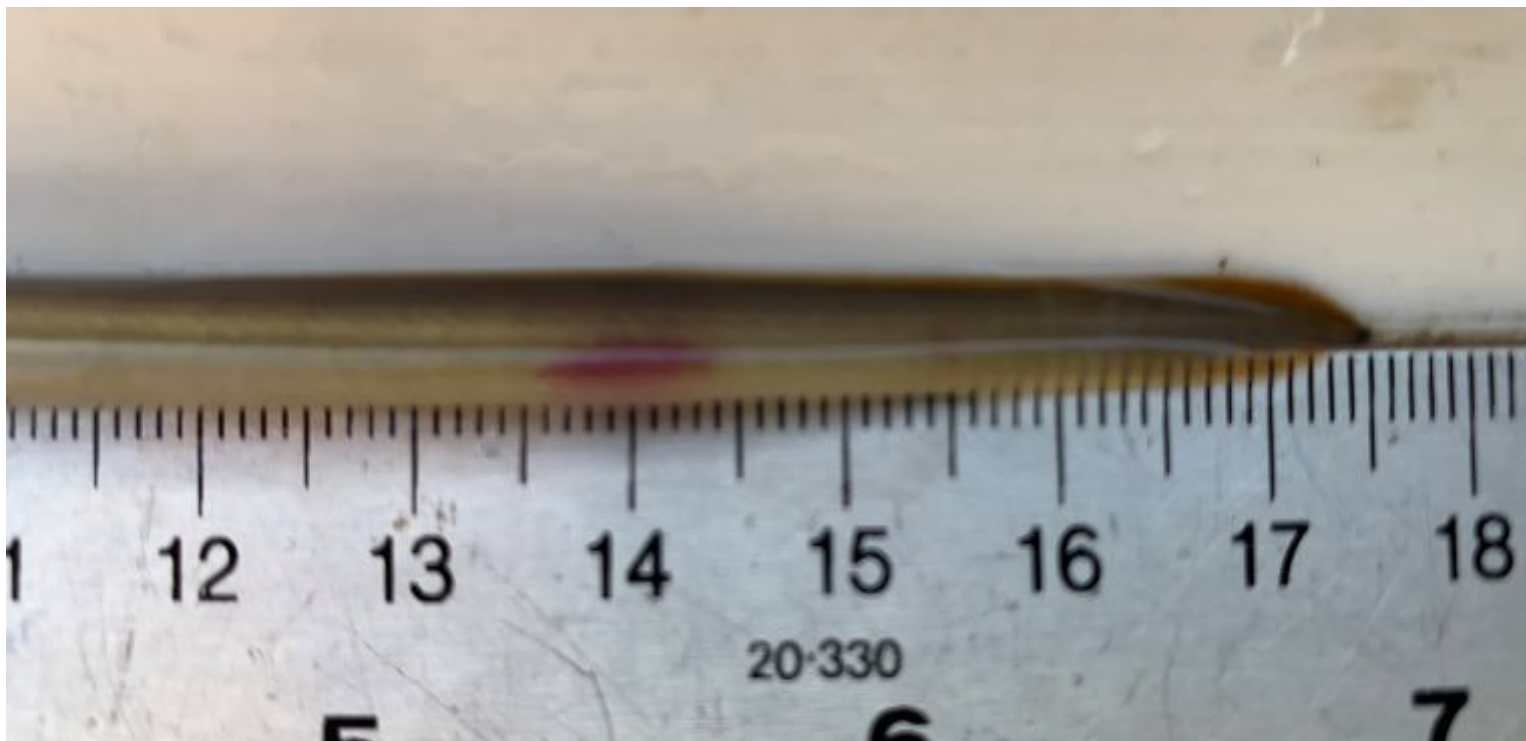
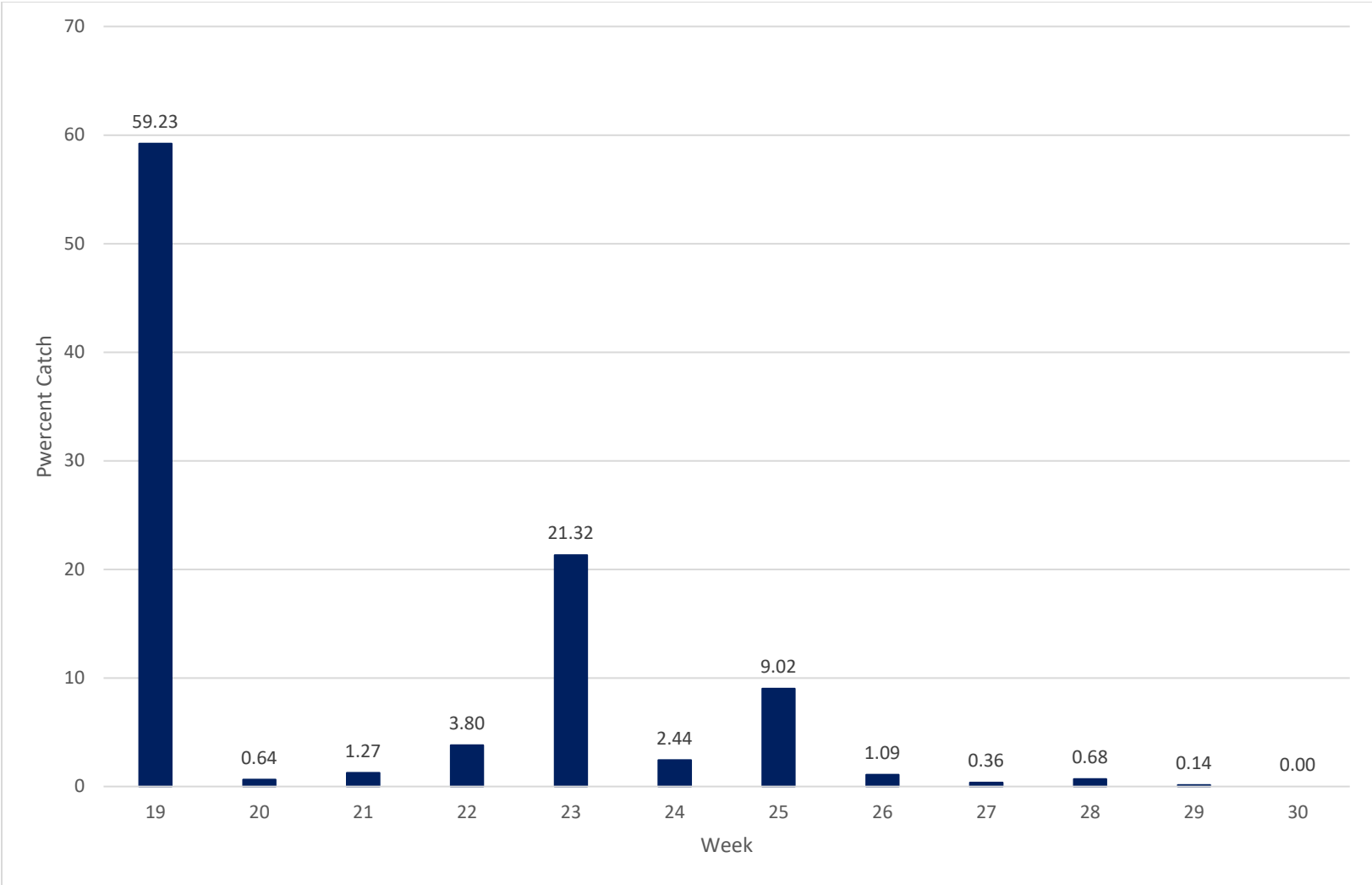


Figure 4.3-1: Percentage Eel Catch per Week, Octoraro Creek Eel Facility, 2022



**Figure 4.5-1: Daily Eel Catch and Daily Average Creek Flow (cfs, top graph) and Weekly Eel Catch and Weekly Average Creek Flow (cfs, bottom graph), Octoraro Creek Eel Facility, 2022**

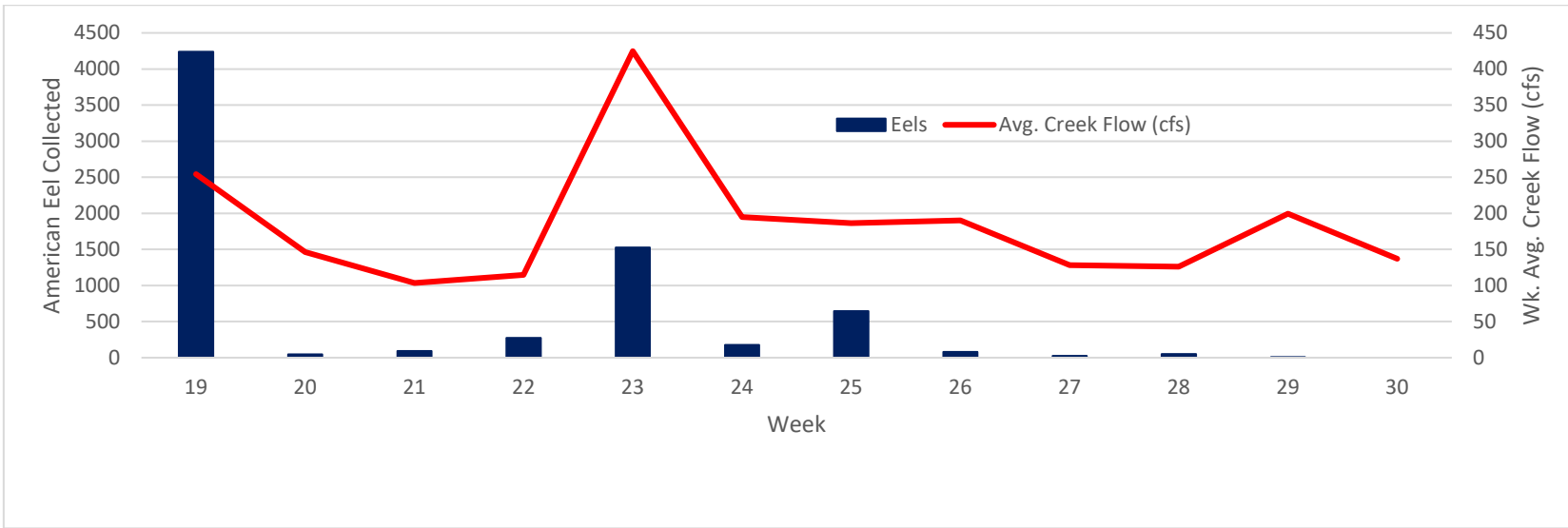
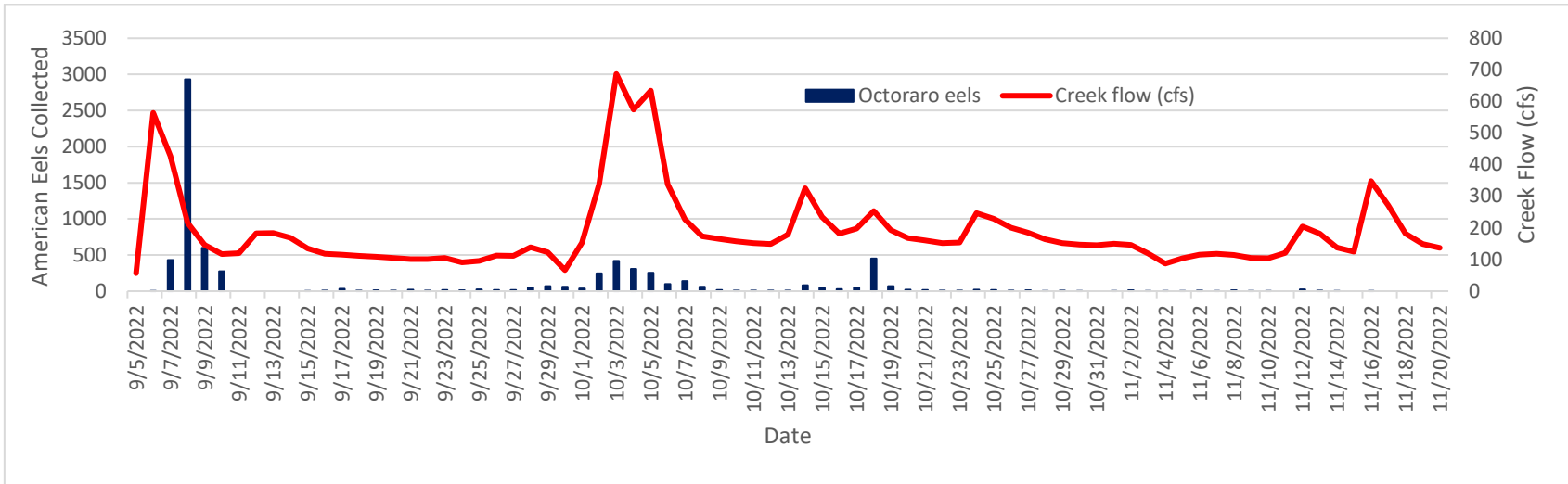
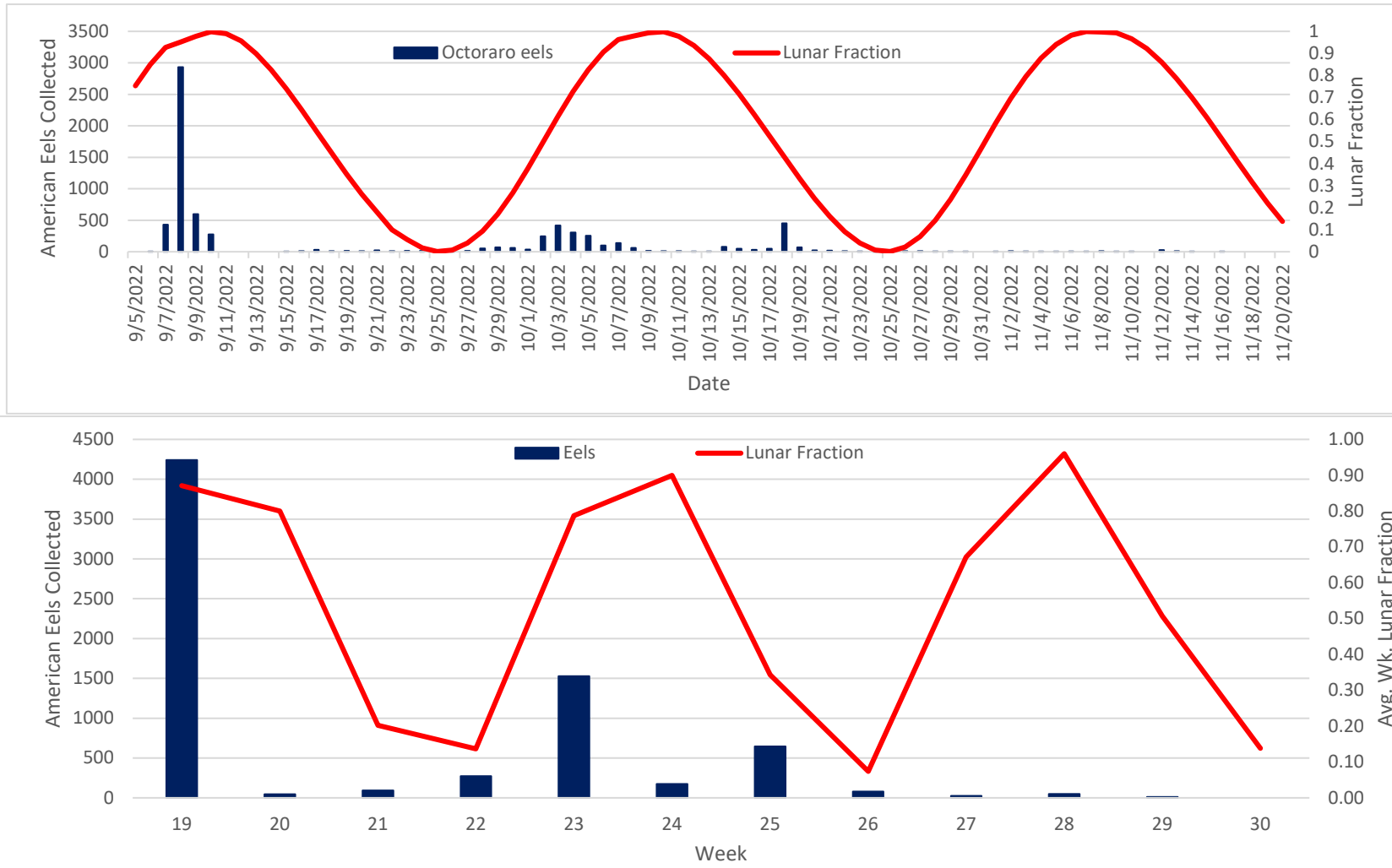


Figure 4.5-2: Eel Catch and Lunar Fraction (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2022 (1.0 Equals Full Moon)





**Figure 4.5-3: Eel Catch to Water Temperature (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2022**

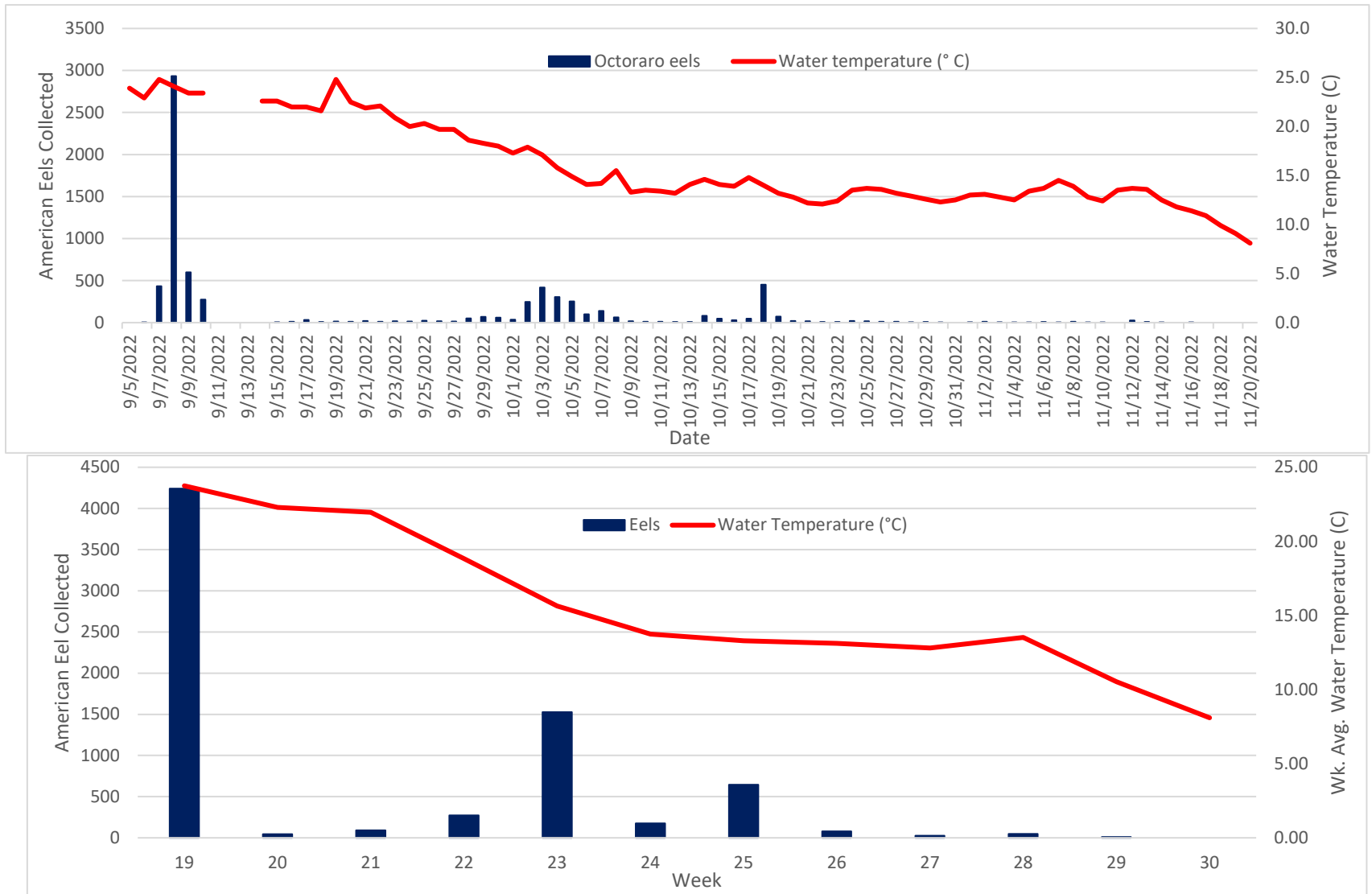


Figure 4.5-4: Comparison of Dissolved Oxygen Readings in Collection Tank and Head Pond, Octoraro Creek Eel Facility, 2022

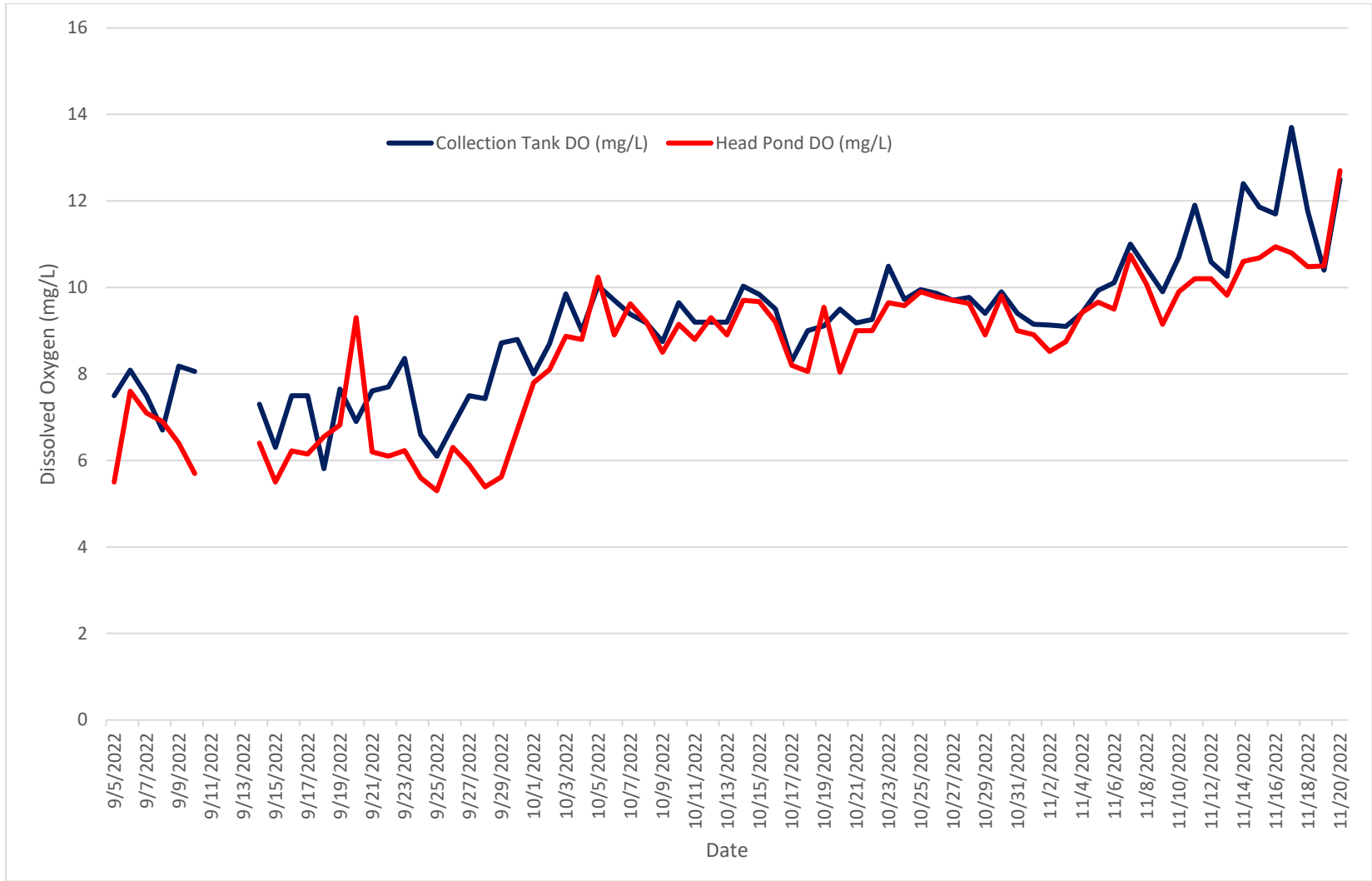
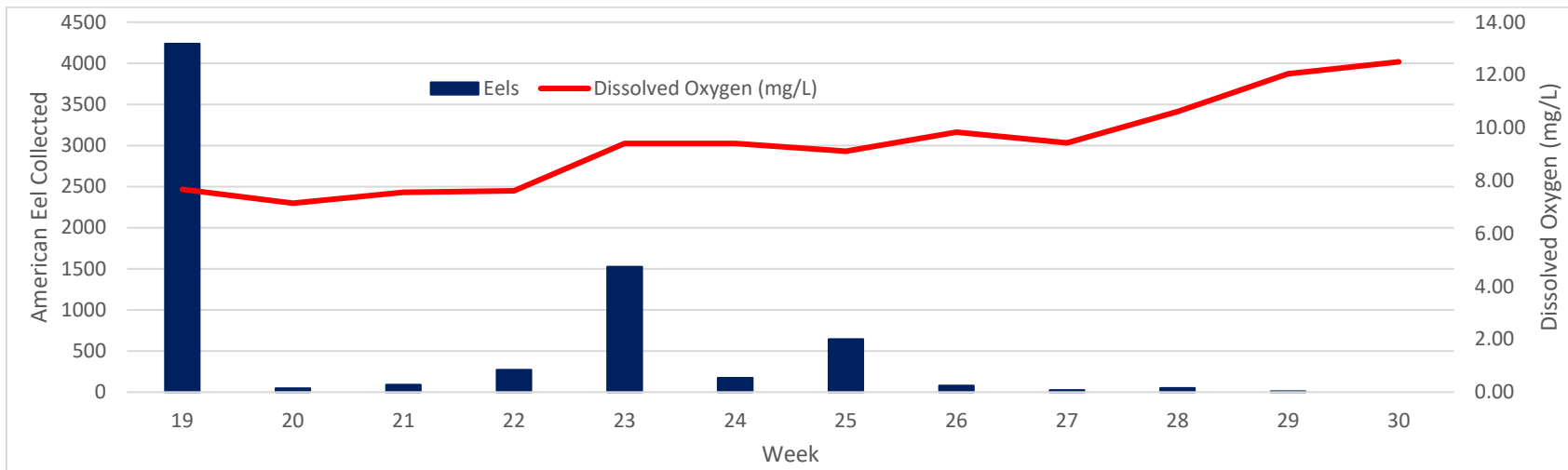
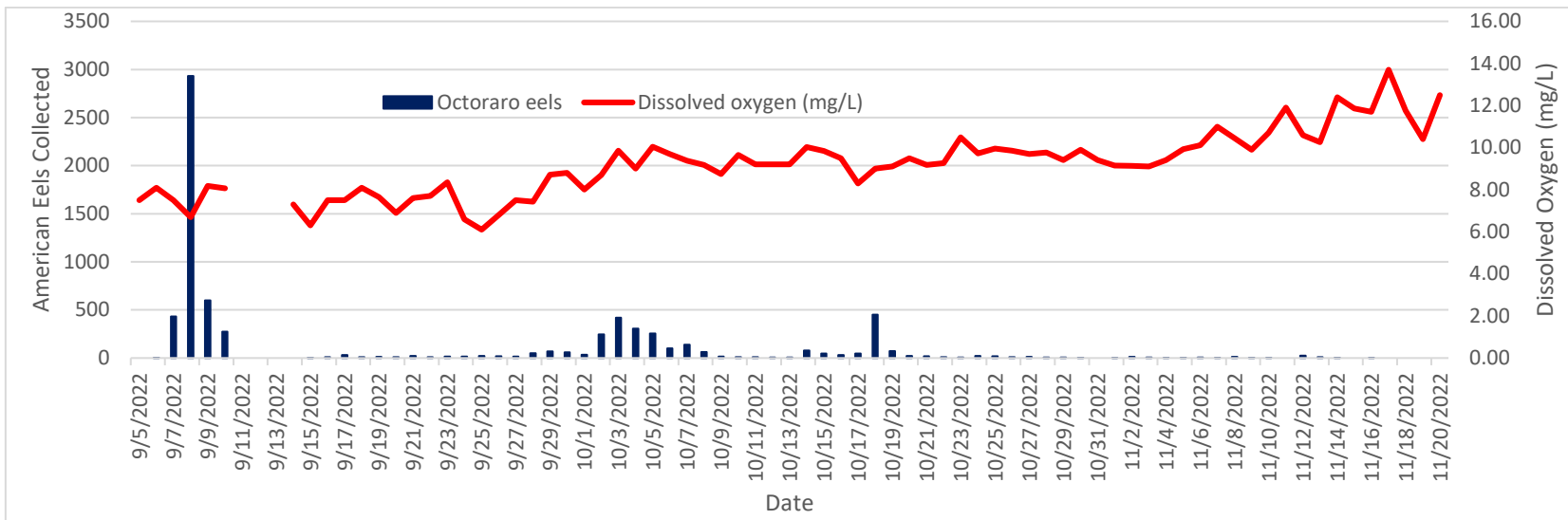


Figure 4.5-5: Eel Catch and Dissolved Oxygen (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2022



**Figure 4.5-6: Eel Catch and Rainfall (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2022**

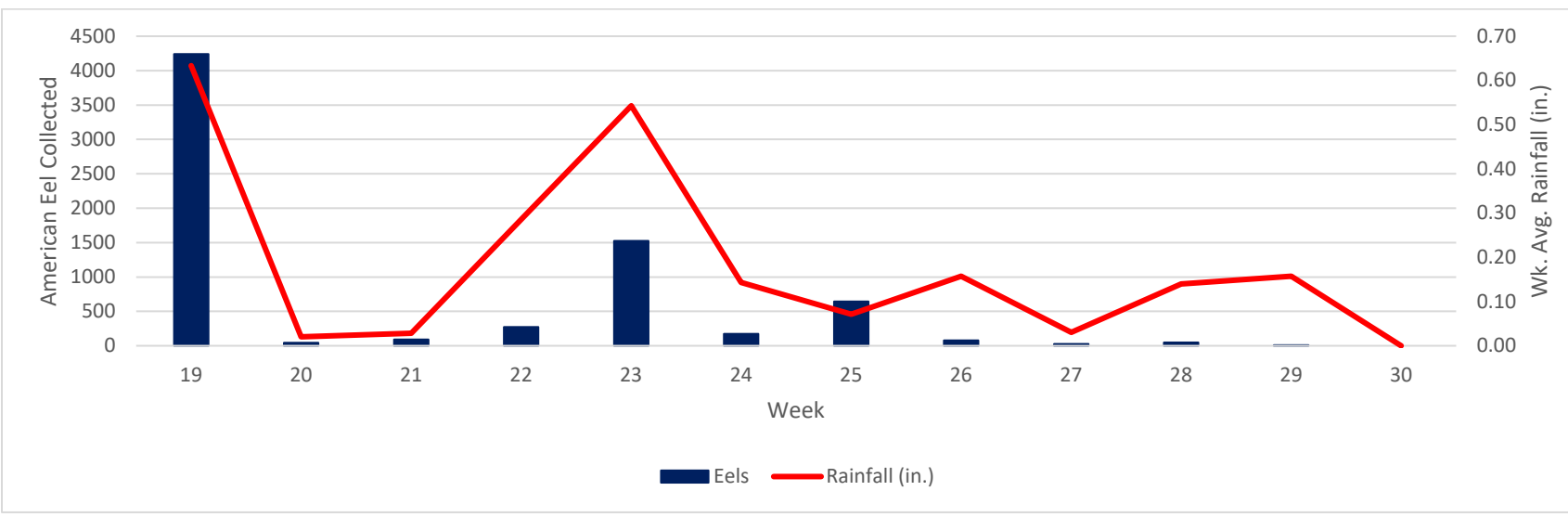
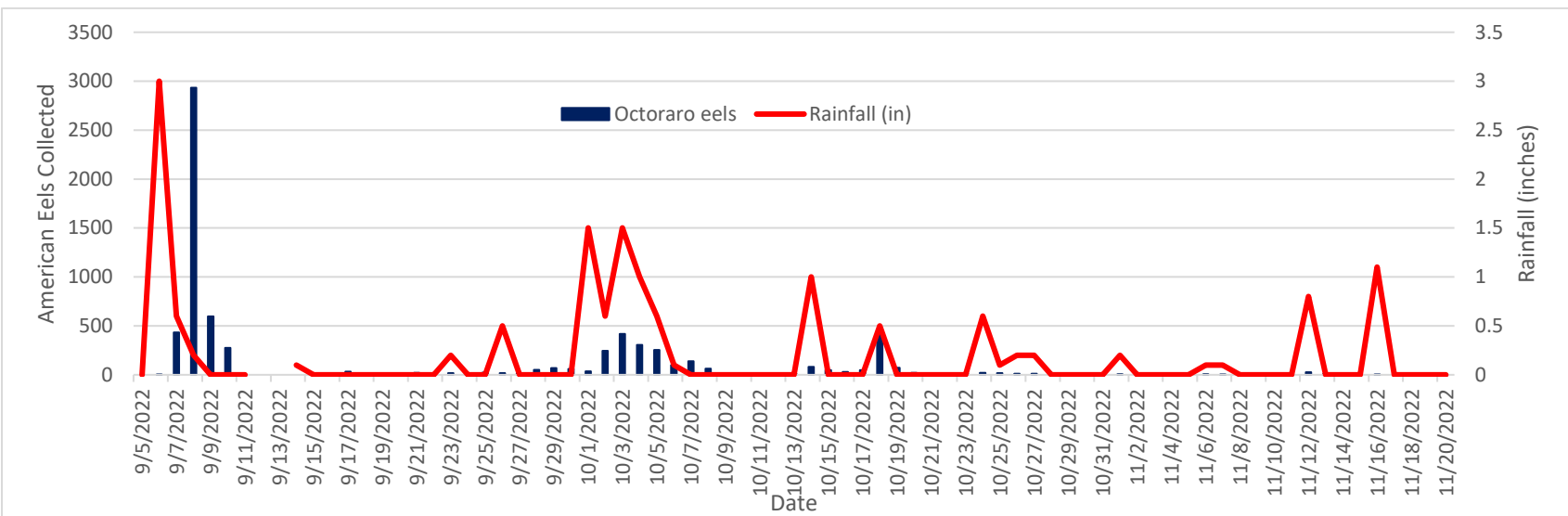


Figure 5.0-1: Ramp Entrance at ACBs (182 cfs ),Octoraro Creek Eel Facility, 2022



Figure 5.0-2: Weekly Catch and Average Creek Flow, Octoraro Creek Eel Facility, 2015-2022

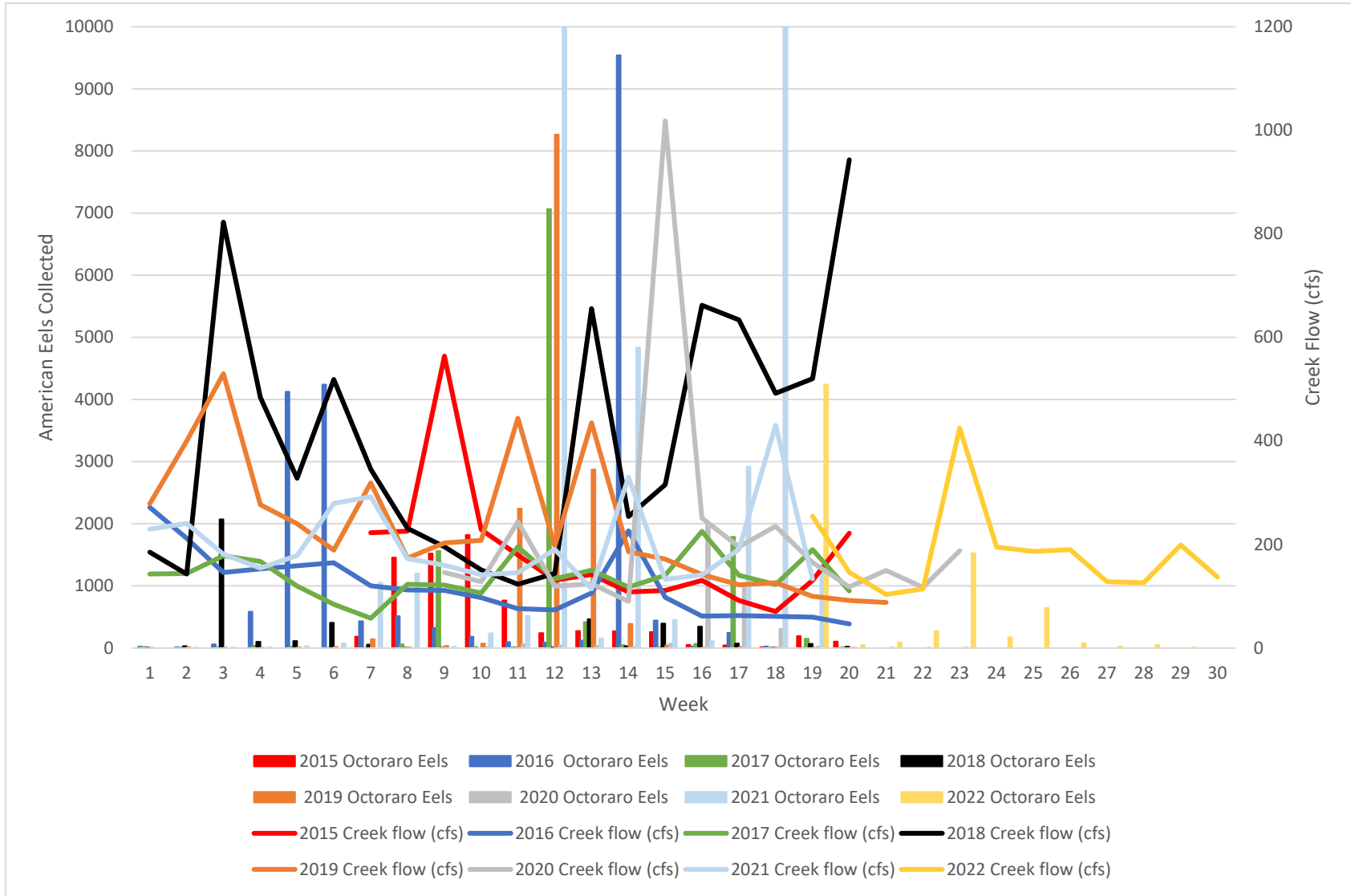


Figure 5.0-3: Bank Stabilization Project with Established Seed, Octoraro Creek Eel Facility, 2015-2022



**Appendix A:  
Weekly Biological Data and Environmental Conditions  
for Octoraro Creek, 2022**



2022 Week	1-18	19	20	21	22	23	24	25	26	27	28	29	30
2022 Octoraro Eels	0	4240	46	91	272	1526	175	646	78	26	49	10	0
2022 Creek flow (cfs)		254	146	103	115	425	195	187	190	128	126	199	137
2022 Lunar Fraction		0.87	0.80	0.20	0.14	0.79	0.90	0.34	0.07	0.67	0.96	0.51	0.14
2022 Water temp (°C)		23.75	22.30	21.97	18.84	15.64	13.74	13.29	13.13	12.80	13.51	10.53	8.10
Dissolved Oxygen (mg/L)		7.67	7.15	7.56	7.62	9.41	9.41	9.12	9.84	9.43	10.61	12.05	12.50
Rainfall (inch)		0.63	0.02	0.03	0.29	0.54	0.14	0.07	0.16	0.03	0.14	0.16	0.00
Percent of Catch		59.23	0.64	1.27	3.80	21.32	2.44	9.02	1.09	0.36	0.68	0.14	0.00
Conowingo Eels		747	11478	7353	3631	1035	665	2514	73	69	23	1	0

No collection occurred until Week 19 at the OCEF due to bank stabilization project

Wk 1-18: May 1 – September 3  
 Wk 19: September 4 – September 10  
 Wk 20: September 11 – September 17  
 Wk 21: September 18 – September 24  
 Wk 22: September 25 – October 1  
 Wk 23: October 2 – October 8  
 Wk 24: October 9 – October 15

Wk 25: October 16 – October 22  
 Wk 26: October 23 – October 29  
 Wk 27: October 30 – November 5  
 Wk 28: November 6 – November 12  
 Wk 29: November 13 – November 19  
 Wk 30: November 20

**Appendix B:  
Weekly Data for 2015-2022**

Weekly Eel Catch Data (2015-2022)

2015 Week							7	8	9	10	11	12	13	14	15	16	17	18	19	20
2015 Octoraro Eels							183	1458	1524	1819	765	240	273	271	258	50	42	13	194	107
2015 Creek flow (cfs)							222.8	225.9	564	228.6	179.7	131	141.9	108.1	111.1	130.4	91.9	70.6	130.6	221.7
2015 Lunar Fraction							0.05	0.48	0.94	0.57	0.05	0.33	0.89	0.69	0.09	0.2	0.8	0.8	0.18	0.01
2015 Water temp (°C)							25.1	23.3	22.7	24.4	24.5	25.3	25.7	25	24.3	24.3	22.8	24.9	23.3	19
Dissolved Oxygen (mg/L)							6.7	7	8.8	7.3	5.1	4.5	4.1	3.3	3.1	5.1	4.3	3.5	5.4	6.8
Percent of Catch							2.5	20.3	21.2	25.3	10.6	3.3	3.8	3.8	3.6	0.7	0.6	0.2	2.7	1.5
Conowingo Eels							2439	8200	5400	3166	4930	1794	284	190	128	327	469	267	59	
2016 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2016 Octoraro Eels	23	13	58	585	4124	4243	431	516	323	183	97	90	121	9540	443	28	247	25	2	2
2016 Creek flow (cfs)	271.7	211.9	145.9	153	158.7	164.7	120.4	112.3	111.4	97.6	76	73.7	106.1	226.3	98.1	61.6	62.7	61.4	59.7	46.6
2016 Lunar Fraction	0.1	0.27	0.85	0.86	0.24	0.15	0.74	0.93	0.35	0.08	0.6	0.95	0.48	0.05	0.45	0.94	0.6	0.06	0.31	0.83
2016 Water temp (°C)	14.5	14.9	15.8	19.3	23.9	22.7	22.8	24.3	24.5	25.7	26.2	27.2	27.7	25.4	26.7	26.7	24.3	24.8	24.8	23.4
Dissolved Oxygen (mg/L)	9.8	10	9.1	7.8	5.3	5.4	6.9	6.3	5.6	5.9	5.6	5	4.7	3	3.9	3.7	3.8	4.4	4	3.8
Percent of Catch	0.1	0.1	0.3	2.8	19.6	20.1	2.0	2.4	1.5	0.9	0.5	0.4	0.6	45.2	2.1	0.1	1.2	0.1	0.0	0.0
Conowingo Eels				5	95	100	113	353	252	247	1061	280	26	25	53	14	31	20	6	3
2017 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2017 Creek flow (cfs)	142.8	144	178.1	167.4	119.9	84.3	57.6	123.3	121.6	106.3	195.4	133.7	150.3	117.7	140.7	225.4	140.7	122.9	190.3	110.2
2017 Lunar Fraction	0.56	0.96	0.66	0.09	0.37	0.92	0.78	0.16	0.24	0.84	0.88	0.26	0.14	0.72	0.94	0.38	0.07	0.58	0.96	0.56
2017 Water temp (°C)	17.4	14.2	18.8	18.2	18.9	20.2	21.6	24.4	24.9	25.7	25.6	26.9	26.2	25.2	24.1	24	23.3	20.2	20.5	20.4
Dissolved Oxygen (mg/L)	9.5	8.3	7.5	7.5	6.4	5.7	4.4	4.9	5.1	4.5	2.3	5.1	5	4	4.5	5	3	4	6.3	5.5
Percent of Catch	0.2	0.1	0.1	0.3	0.2	0.1	0.0	0.5	13.8	0.2	0.1	62.3	3.7	0.4	0.1	0.6	15.8	0.1	1.3	0.1
Conowingo Eels	4387	151	1224	5384	2196	1761	5199	23318	8090	799	1503	1432	15435	32524	13130	2654	2931	88	51	43
2018 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2018 Octoraro Eels	5	31	2072	101	115	407	55	3	4	0	1	11	464	29	393	343	73	5	69	22
2018 Creek flow (cfs)	185	143	822.6	484.1	327.9	519	345.1	231.3	195.7	150.9	123.3	143.9	655.6	254.3	315.7	661.9	634	492.1	520.4	943
2018 Lunar Fraction	0.89	0.4	0.06	0.6	0.96	0.55	0.06	0.47	0.95	0.69	0.1	0.34	0.91	0.8	0.18	0.22	0.82	0.89	0.29	0.12
2018 Water temp (°C)	15.3	15.9	18.4	19.4	21.4	20.5	20.8	22.6	22.5	25.6	25.5	25.3	24.6	24.9	25.9	25.2	23.2	25.3	24.6	18.2
Dissolved Oxygen (mg/L)	8.8	7.7	7.5	9.4	7.9	8.1	7.4	6.8	7	6.6	6.5	7.1	7.5	6.5	6.2	6.5	5.8	6.4	6.1	10.2
Percent of Catch	0.1	0.7	49.3	2.7	2.7	9.7	1.3	0.7	0.1	0.0	0.0	0.3	11.0	0.7	9.4	8.2	1.7	0.1	1.6	0.5
Conowingo Eels	7	6443	6879	197	398	1316	462	657	1077	6020	3175	1029	7986	20965	5262	3948	1870	165	73	20

(continued)

**MUDDY RUN PUMPED STORAGE PROJECT - FERC PROJECT NUMBER 2355**

(Continued)

2019 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
2019 Octoraro Eels	1	9	5	3	9	20	144	12	36	73	2244	8266	2874	391	42	5	19	12	4	1	0
2019 Creek flow (cfs)	279	400	530	277	240	189	319	174	203	208	444	197	435	186	172	142	122	126	100	92	88
2019 Lunar Fraction	0.07	0.16	0.80	0.85	0.29	0.09	0.69	0.93	0.43	0.06	0.57	0.96	0.58	0.07	0.44	0.95	0.71	0.12	0.31	0.89	0.99
2019 Water temp (°C)	15.50	16.10	14.60	15.70	17.90	19.90	20.00	20.50	21.60	23.00	23.10	23.40	23.70	23.70	23.90	23.90	24.00	23.10	22.90	22.40	22.50
Dissolved Oxygen (mg/L)	9.73	9.36	10.18	10.05	9.26	8.75	8.29	8.52	7.14	6.32	6.13	5.72	6.17	6.29	5.89	5.41	5.87	4.69	5.13	4.93	4.63
Percent of Catch	0.01	0.06	0.04	0.02	0.06	0.14	1.02	0.08	0.25	0.52	15.84	58.33	20.28	2.76	0.30	0.04	0.13	0.08	0.03	0.01	0.00
Conowingo Eels	6	4616	2237	1774	9359	2097	1706	2187	2056	39685	3076	3141	5210	3213	1158	38115	3160	3135	192	40	18

2020 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2020 Octoraro Eels									0	15	64	44	40	20	71	1992	1005	306	22	5	5	2	6
2020 Creek flow (cfs)									146	128.1	244.1	119.3	124.2	90.2	1018.5	250.9	195.5	235.4	165.4	118	150	117.4	187.9
2020 Lunar Fraction									0.35	0.76	0.88	0.32	0.07	0.65	0.94	0.47	0.05	0.52	0.96	0.62	0.08	0.39	0.93
2020 Water temp (°C)									20.7	21.4	22.7	23.8	24.8	25.5	22.5	22.8	23.6	23.5	23.4	21.7	18.6	18.6	18.8
Dissolved Oxygen (mg/L)									7.23	6.04	6.00	5.45	5.90	5.27	6.04	6.87	6.52	7.16	7.60	6.99	6.96	9.02	7.58
Rainfall (inch)									0.01	0.01	0.49	0.00	0.13	0.04	0.62	0.00	0.11	0.25	0.11	0.07	0.00	0.09	0.30
Percent of Catch									0.00	0.42	1.78	1.22	1.11	0.56	1.97	55.38	27.94	8.51	0.61	0.14	0.14	0.06	0.17
Conowingo Eels				2290	20801	36993	10842	3773	1895	4008	15127	7509	36742	17693	29622	31905	24947	6993	2570	223	608	9	101

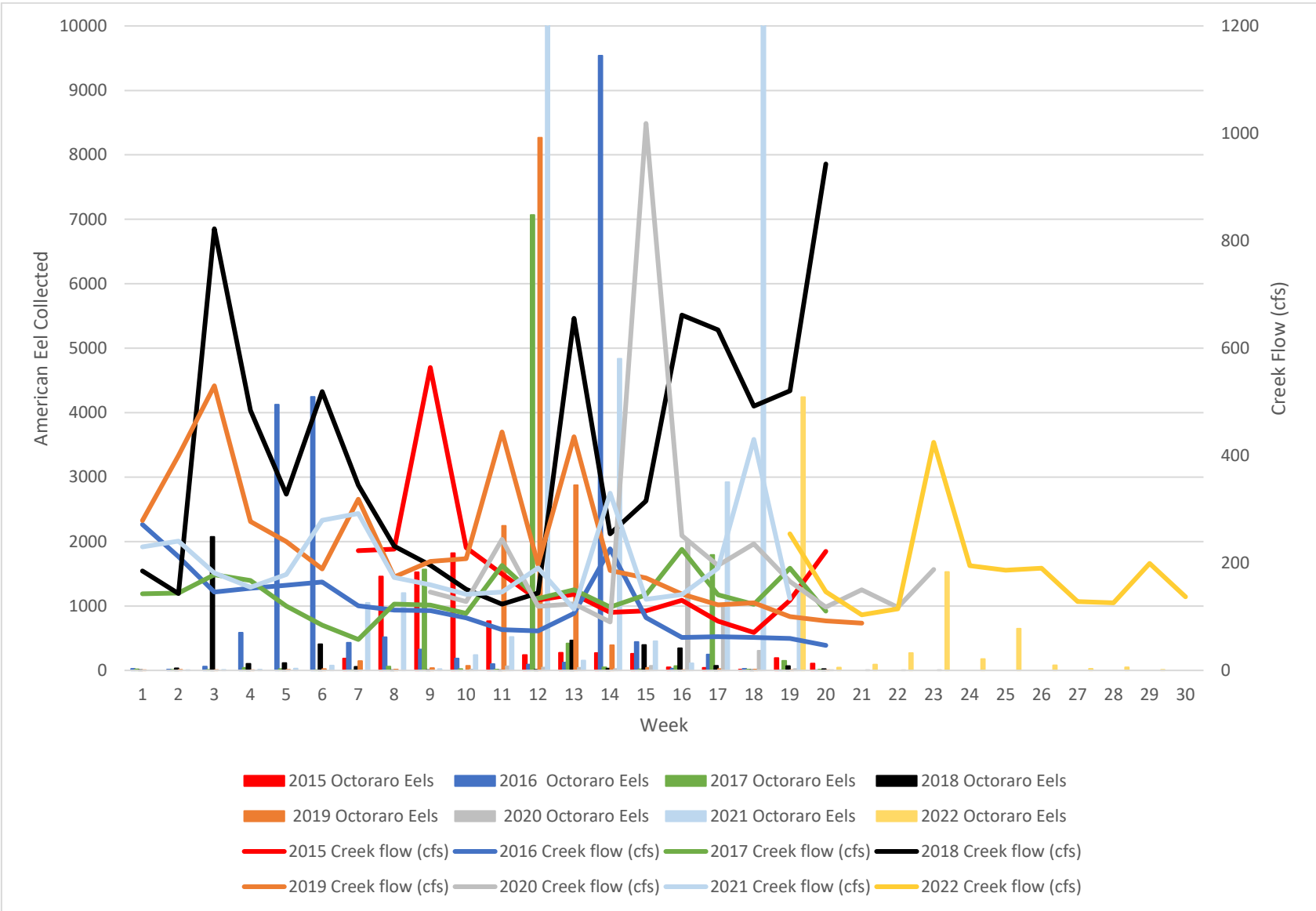
2021 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2021 Octoraro Eels	0	5	9	13	29	77	1050	1201	21	238	519	14925	154	4836	452	112	2920	17350	1319
2021 Creek flow (cfs)	230	240.6	181.3	154.6	178.6	279.4	292.1	172.9	159.7	141.7	145.7	190.7	114.3	330.0	132.4	141.4	190.4	430.2	133.7
2021 Lunar Fraction	0.76	0.35	0.05	0.52	0.96	0.49	0.04	0.39	0.94	0.64	0.09	0.26	0.89	0.77	0.18	0.16	0.81	0.88	0.44
2021 Water temp (°C)	14.4	15.84	15.04	16.46	18.57	18.61	22.10	21.07	21.69	23.10	23.89	25.89	25.27	24.33	23.83	24.44	25.66	24.96	25.00
Dissolved Oxygen (mg/L)	9.90	9.18	9.40	9.63	8.55	7.28	7.11	7.10	6.81	6.52	6.35	4.48	6.03	5.38	6.30	6.50	6.46	4.25	6.02
Percent of Catch	0.00	0.31	0.03	0.00	0.28	0.38	0.20	0.15	0.40	0.13	0.00	0.19	0.74	0.28	0.33	0.48	0.04	0.48	0.18
Conowingo Eels	5	46640	15851	17528	42848	29424	23335	18176	2711	5659	75609	63442	59128	50982	26007	12628	3747	19265	58774

**MUDDY RUN PUMPED STORAGE PROJECT - FERC PROJECT NUMBER 2355**

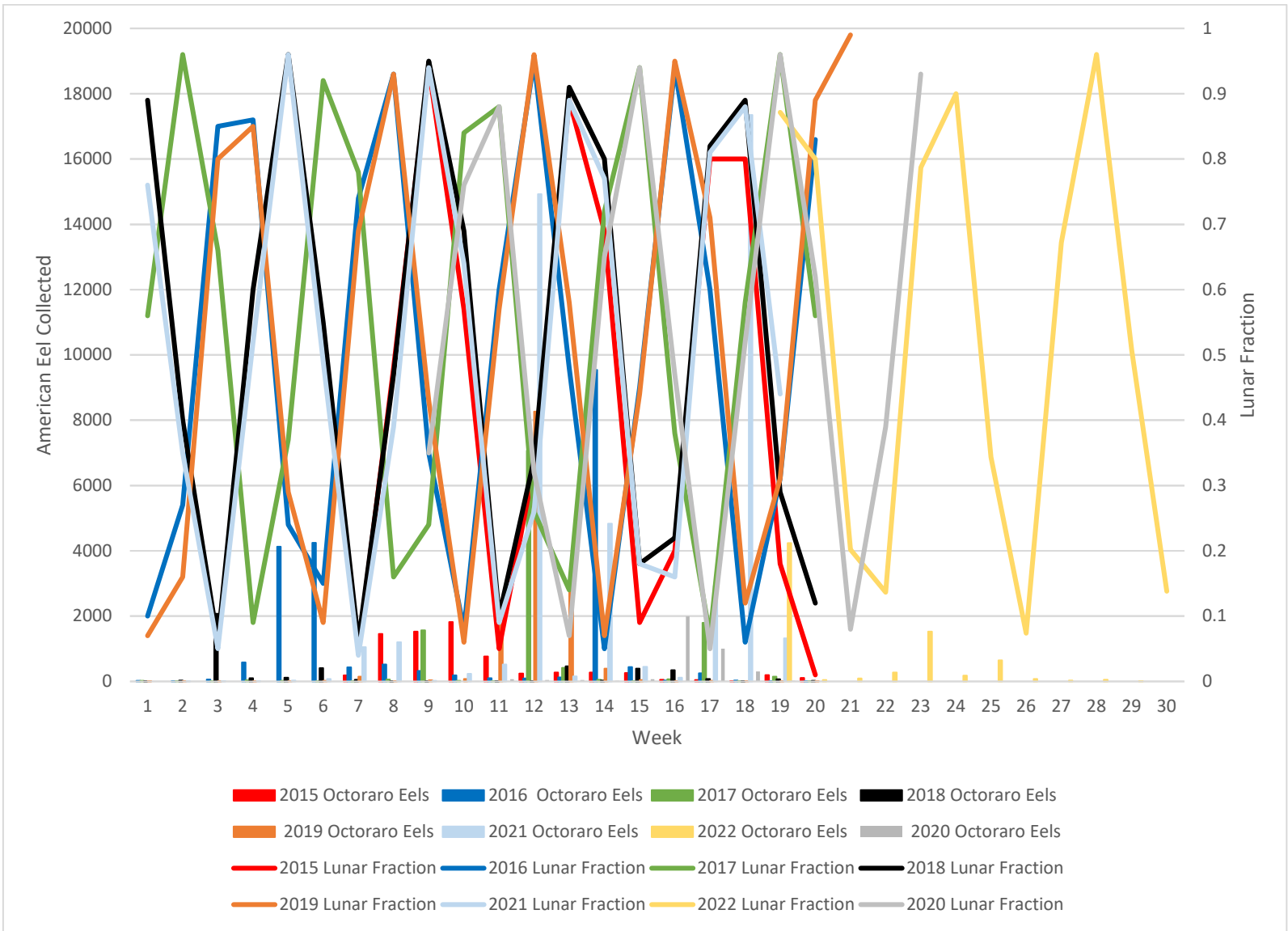
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<b>2022 Week</b>	<b>1 - 18</b>	<b>19</b>	<b>20</b>	<b>21</b>	<b>22</b>	<b>23</b>	<b>24</b>	<b>25</b>	<b>26</b>	<b>27</b>	<b>28</b>	<b>29</b>	<b>30</b>
2022 Octoraro Eels	0	4240	46	91	272	1526	175	646	78	26	49	10	0
2022 Creek flow (cfs)		254	146	103	115	425	195	187	190	128	126	199	137
2022 Lunar Fraction		0.87	0.80	0.20	0.14	0.79	0.90	0.34	0.07	0.67	0.96	0.51	0.14
2022 Water temp (°C)		23.75	22.30	21.97	18.84	15.64	13.74	13.29	13.13	12.80	13.51	10.53	8.10
Dissolved Oxygen (mg/L)		7.67	7.15	7.56	7.62	9.41	9.41	9.12	9.84	9.43	10.61	12.05	12.50
Rainfall (inch)		0.63	0.02	0.03	0.29	0.54	0.14	0.07	0.16	0.03	0.14	0.16	0.00
Percent of Catch		59.23	0.64	1.27	3.80	21.32	2.44	9.02	1.09	0.36	0.68	0.14	0.00
Conowingo Eels	112209	747	11478	7353	3631	1035	665	2514	73	69	23	1	0

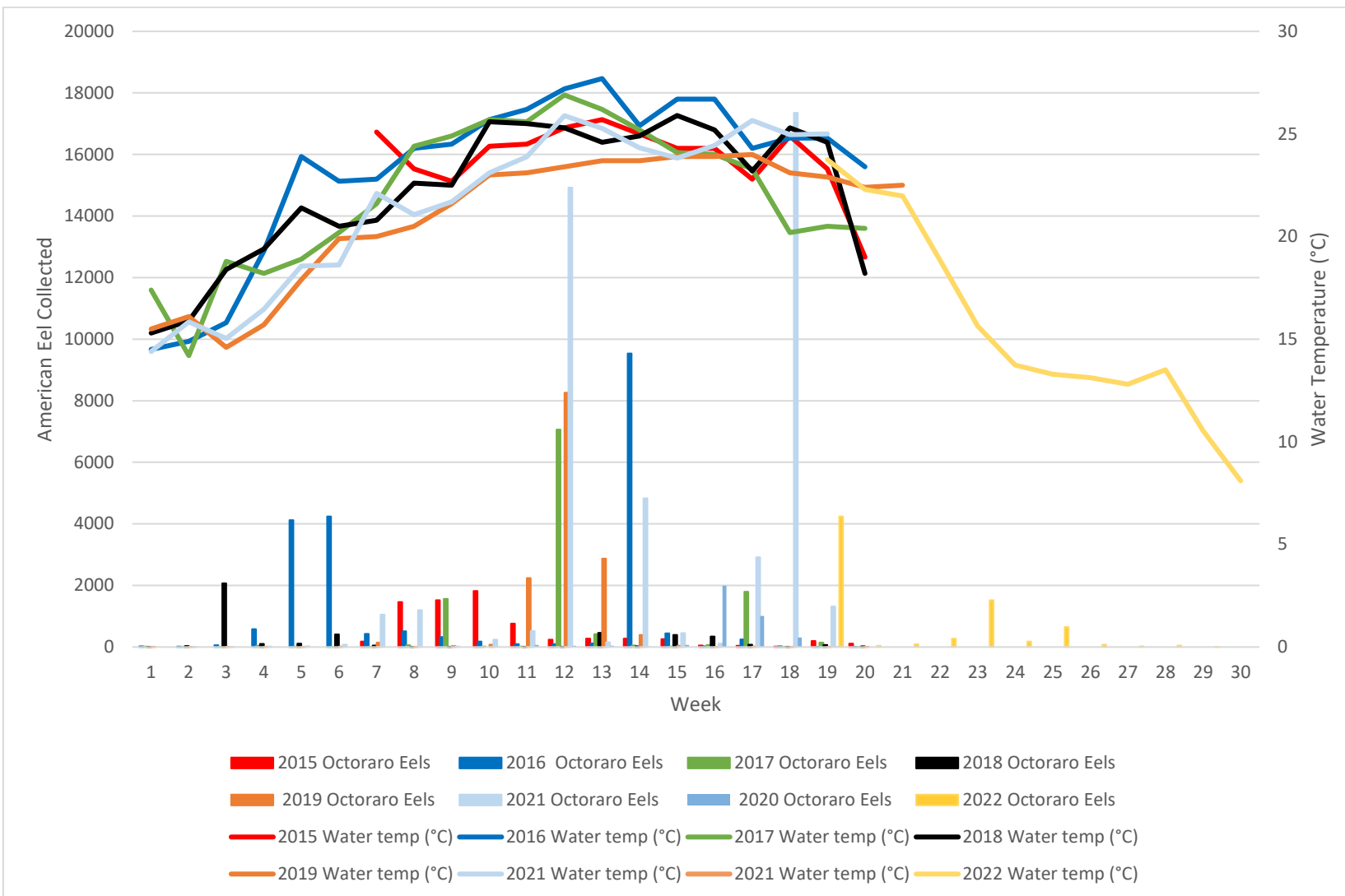
Eel Catch (Collection) to Creek Flow (2015-2022)



### Eel Catch (Collection) to Lunar Fraction (2015-2022)



**Eel Catch (Collection) to Water Temperature (2015-2022)**





**Appendix C:  
Agency Comments on Draft 2022 American Eel  
Collection Facility in Octoraro Creek**

<b>2022 Octoraro Creek Eel Facility Report Comments Received by Resource Agency and Date</b>	
<b>Resource Agency</b>	<b>Date of Receipt by Constellation</b>
Susquehanna River Basin Commission	Monday, January 9, 2023
Pennsylvania Fish and Boat Commission	
United States Fish and Wildlife Service	Tuesday, December 20, 2022
Maryland Department of the Environment Maryland Department of Natural Resources	Thursday, January 5, 2023
Pennsylvania Department of Environmental Protection	Wednesday, January 4, 2023

Responses to Resource Agency Comments for the Muddy Run Pumped Storage Project  
Octoraro Creek Eel Facility Report, 2022

SRBC

- No comment

USFWS

- Section 3.1, paragraph 2: This paragraph states that the eel ramp entrances do not reach the water under normal and low flow periods. The Service is concerned that eels may not have full access to the passage facility under most flow conditions. The Service plans to conduct an inspection of the facility in spring 2023 with particular focus on ramp entrance conditions to ensure access for eel under all flow conditions at the site.

Constellation response: Additional language was added to Section 5.0, paragraph 4 explaining the reason for the ramp not extending into the water under normal and low flow periods. Waiting on 2023 Octoraro Creek Eel Facility inspection results.

PFBC

MDE

- Please explain why the ramp does not extend into the water at low and normal creek flows?

Constellation response: Additional language was added to Section 5.0, paragraph 4 explaining the reason for the ramp not extending into the water under normal and low flow periods. Waiting on 2023 Octoraro Creek Eel Facility inspection results.

- At what discharge is the end of the ramp in the water and what was the discharge on the day of the picture.

Constellation response: The entrance of the ramp is in the water at 182 cfs Language was added to the report in Section 5.0, paragraph 4 indicating the percent of daily average creek flows above the 182 cfs value and what the average creek flow was for the 2022 season., Figure 5.0-1 was added to the report at this creek flow.

- What are the options to maintain the end of the ramp in the water at all creek discharges?

Constellation response: Additional language was added to Section 5.0, paragraph 4. Waiting on 2023 Octoraro Creek Eel Facility inspection results.

PA DEP

- Section 3.1, PADEP is concerned with the eel ramp entrance being out of water during low-normal flow conditions, potentially reducing eel accessibility. PADEP plans to observe the entrance of the ramp during the annual spring FWS fishway inspections and make any recommendations afterwards.

Constellation response: Additional language was added to Section 5.0, paragraph 4 explaining the reason for the ramp not extending into the water under normal and low flow periods. Waiting on 2023 Octoraro Creek Eel Facility inspection results.

- Table 4.7-1; Calibration of Flows (Gallons per Minute) in the Octoraro Creek Eel Facility, 2022. The overall attraction flow was lower than the recommended 70 gallons per minute (gpm). PADEP recommends Constellation look into methods to increase the overall attraction flow at the facility. PADEP look forward to future discussions with Constellation in regard to the overall attraction flow.

Constellation response: No changes were made to this report. Looking into how to increase attraction flows to the Octoraro Creek eel facility.

Possible Overall Water attraction flow issues:

- Submersible pump could need to be clean or replaced for greater flow rates
- Season operated later in the year, could be die off from growth, although outside of barrel was cleaned daily
- Underground water line could have growth
- When the forebay is lower due to low flows (like in 2022), increased head occurs causing a drop in flow rates to the facility

Possible fixes:

- Install new submersible pump, although this is the greatest flow rate of a 2" outlet on a 110 V pump
  - The current pump has the greatest flow rate of any 110 Volt, 2" outlet pump
  - Only power at the facility is 110 volts
- In 2023, the OCEF will be operating during the normal season (May 1 to September 15) not during biological growth die off season
- Continue to clean screen barrel daily
- Explore how to clean out underground water line prior to the start of the season
- Explore options for installing additional pump in forebay,  
Additional equipment includes:
  - 2 submersible pumps
  - 2 screened barrels
  - 2- 2" suction hoses joined to one existing 2" underground water line
  - 2" "Y" connection

Concerns to this system:

- Would 2-2" suction hoses to 1-2" suction hose cause back pressure or over pressure of the hoses or pumps
- Only one two plug - 110 Volt outlet supplies power at the facility, no redundancy – if power issue occurs, both pumps stop.