Core Creek Continuous Monitoring and Best Management Practice Planning Project

Final Report

September 15, 2022

Prepared By:

Bucks County Conservation District
1456 Ferry Road, Suite 704
Doylestown, PA 18901
www.bucksccd.org

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Final Report

PA DEP Document No. 4100071815

Project No. 1815

Prepared For:

Pennsylvania Department of Environmental Protection
Office of Water Resources Planning
Rachel Carson State Office Building
400 Market Street
Harrisburg, PA 17101

United States Environmental Protection Agency
Mid-Atlantic, Region 3
1650 Arch Street, #2
Philadelphia, PA 19103

Table of Contents

Figures:

1. Project Funding and Schedule

The Core Creek Continuous Monitoring and Best Management Practice Planning was funded by the Pennsylvania Department of Environmental Protection (PA DEP) through Section 319, the Nonpoint Source Management Program of the Clean Water Act administered by the United States Environmental Protection Agency (US EPA). The Bucks County Conservation District provided project management and agricultural outreach, while Groundwater Environmental Services provided professional services for site selection, instrument setup, database management, and training. The contract between the District and PA DEP was executed on October 1, 2017, and was completed on August 30, 2022, following two approved extensions.

The grant value was set at $108,271.00. The total spent on project tasks was $76,204.51. Pandemic-related delays and staff turnover impacted the project by cutting short agricultural outreach and best management practice planning. Supply chain delays and new hire training did not allow for the operation nor data collection by instream monitors within the grant period.

2. Project Location and Justification

Core Creek is located in Bucks County, Pennsylvania and enters Neshaminy Creek approximately 13.5 miles upstream of the Neshaminy Creek's confluence with the Delaware River. Under Public Law 566 funding, a dam was constructed across Core Creek (PA Dam 620) to provide local communities with a multi-purpose reservoir. The dam was completed in June 1976 and the reservoir, which was officially named Lake Luxembourg, was filled in the summer of 1977.

The Core Creek watershed has a surface area of 6,033 acres; almost 99% of the watershed directly drains into Lake Luxembourg (Figure 1), which has a surface area of 179 acres and is in HUC 02040201 (Crosswicks – Neshaminy, New Jersey, Pennsylvania). The lake is located entirely within Middletown Township; while the Core Creek watershed is located, with approximately equal portions, in Middletown, Lower Makefield and Newtown Townships, Bucks County. Core Creek is the main inlet and outlet of Lake Luxembourg.

Both Lake Luxembourg and Core Creek are listed on Sublist 4a of Pennsylvania draft "2018 Integrated Water Quality Monitoring and Assessment Report," indicating that both waterbodies have approved Total Maximum Daily Loads (TMDLs). Lake Luxembourg has a TMDL for nutrients, specifically total phosphorus (TP) and total suspended solids (TSS). Core Creek has a TMDL for TSS. Additionally, the Core Creek / Lake Luxembourg watershed drains to the Neshaminy Creek, which also has a TMDL for TSS.

3. Project Overview

The objective of this project was to implement a continuous monitoring program within the watershed to provide a barometer for water quality within Core Creek. Additionally, Bucks County Conservation District (BCCD) would conduct a targeted outreach campaign to the agricultural community within this watershed to plan, design, and permit agricultural best management practices.

3.1 Best Management Practice Planning

Beginning in October 2019, BCCD Agricultural Conservation Technicians conducted an initial outreach to eight agricultural operations within the watershed. The effort opened discussions with three operators, resulting in the update of one Nutrient Management Plan, three Conservation Plans, and a Manure Management Plan. These plans address surface runoff from a 14-acre equine, a 145-acre dairy operation, and a combined 73-acres of crop production in the Core Creek watershed. Gully erosion and diversion repairs identified in the plan were subsequently corrected outside of the scope of this grant.

3.2 Water Quality Monitoring

Three YSI EXO2 sondes, sensors, and field meters were purchased to support continuous monitoring of Core Creek. The sondes would be equipped with four sensors – Temperature/Conductivity, pH, Dissolved Oxygen, and turbidity. They were received by BCCD in October 2021 after numerous pandemic-related delays.

Following a staff turnover in January 2022, requests for proposals from qualified contractors were sought. The contractor selected, Groundwater Environmental Services Inc. (GES), was tasked with installation site selection, design and fabrication of supporting structures, initial setup and installation of the sondes to include a database prepared to receive the raw data. Sonde installation sites are depicted in Figure 2. GES was further tasked with preparing and delivering a training session for BCCD staff and volunteers. Photos of sonde installation sites and training events are presented in Appendix A.

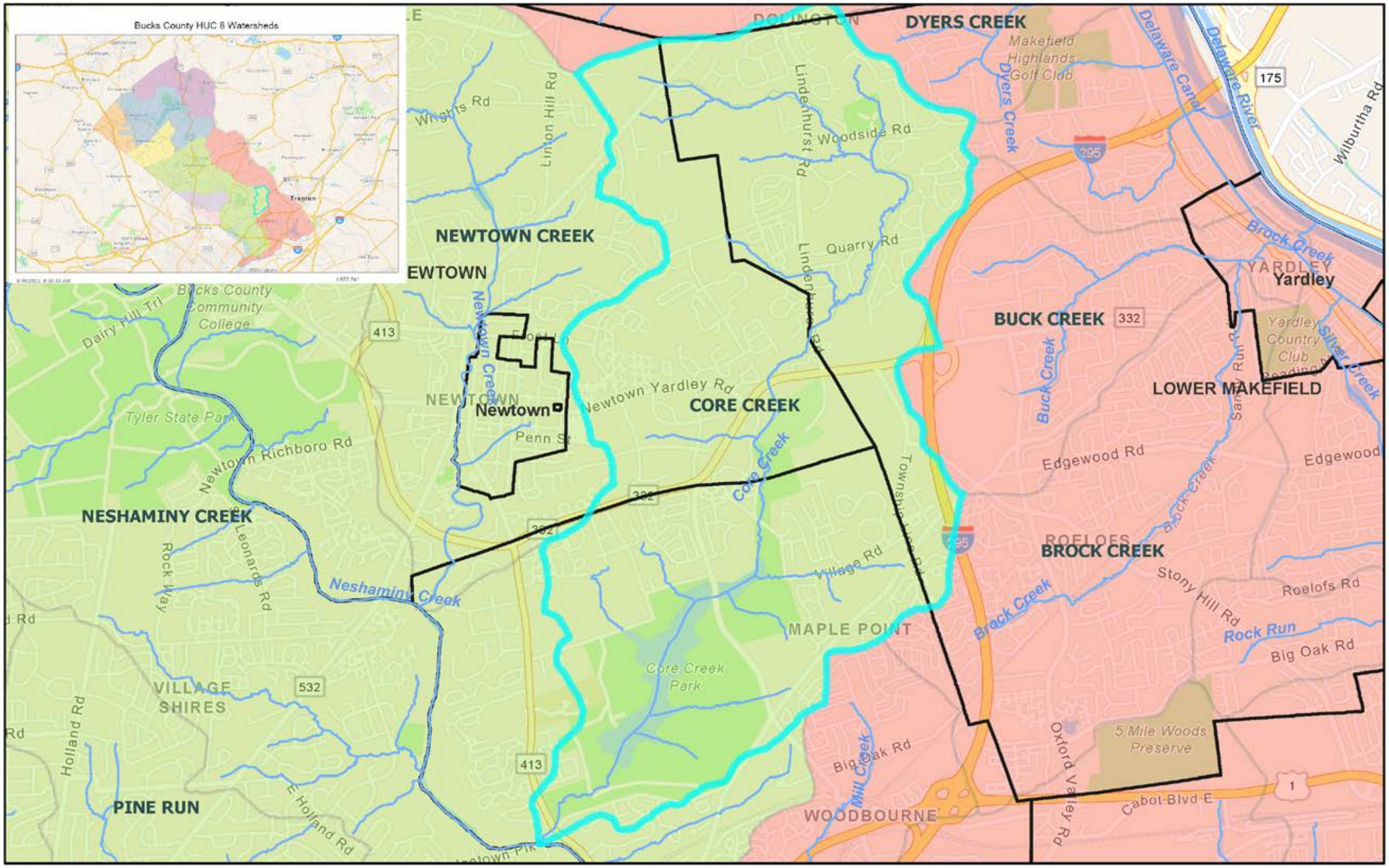
Once installation was complete and initial data downloaded, three BCCD staff members and 14 Pennsylvania State Extension Service Master Watershed Steward (MWS) volunteers were trained in the basic operation, maintenance, and calibration of the sondes. Photos of the training events are included in Appendix B. A manual of Standard Operating Procedures (SOP) was produced to support the refresh and training of current and future CIM program participants.

Concurrently, BCCD prepared and submitted a draft Quality Assurance Project Plan to Region 3, US Environmental Protection Agency. The initial review deemed the draft inadequate, comments were addressed, and a second draft was submitted on August 18, 2022. This version was approved on 9/16/2022 and is included in Appendix C.

Because side by side comparison of CIM data and that of a handheld meter is crucial for data quality assurance, BCCD used remaining grant funds to purchase a YSI ProDSS meter, equipped with the same sensors as the CIM for data quality checks as described in the QAPP. A startup supply of calibration buffers and standards was also acquired.

Pandemic related delays compounded by staff turnover pushed the deployment of the sondes to June 2022. The water level of Lake Luxembourg would be lowered starting in mid-July to initiate construction of a Regional BMP Wetland in the conservation pool (S319 #2240) where sondes were installed in each of two inflows. The hydrologic effects of the lake lowering, compounded by near-drought conditions resulted in the sondes being pulled from the streams in late August. The third sonde, installed just downstream of the lake outflow was also pulled at that time. The only representative data collected during the grant period would be from June. Since the QAPP had not been approved at that time, the data will be used only as background reference for instrument evaluation.

Figure 1: Core Creek Watershed - Lake Luxembourg



9/16/2022, 8:33:19 AM

Watersheds

- DELAWARE RIVER (SOUTH)
- NESHAMINY CREEK
- Streams
- Municipal Boundary

1:72,224

0 0.47 0.95 1.9 mi

0 0.75 1.5 3 km

Bucks County, PA, data.pa.gov, New Jersey Office of GIS, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS,

Bucks County Conservation District
via Bucks County GIS, Planning and Zoning Commission

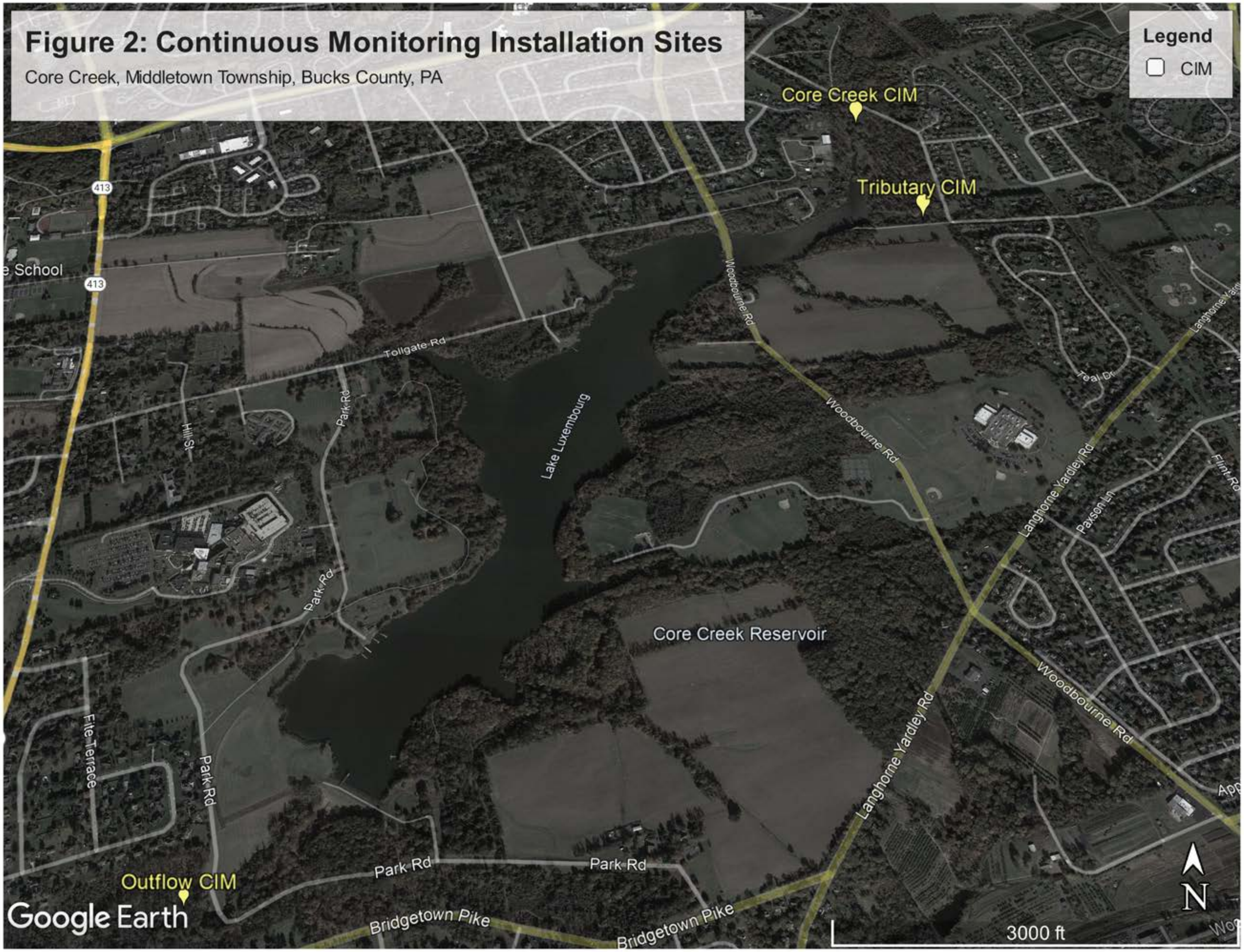


Figure 2: Continuous Monitoring Installation Sites
Core Creek, Middletown Township, Bucks County, PA
Legend
CIM
Core Creek CIM
Tributary CIM
Outflow CIM
Core Creek Reservoir
Lake Luxembourg
Tollgate Rd
Woodbourne Rd
Langhorne Yardley Rd
Park Rd
Bridgetown Pike
Hill St
Fite Terrace
Paxson Ln
Teal Dr
Flint Rd
413
N
3000 ft
Google Earth

Appendix A: Continuous Instream Monitoring Site Installations


Core Creek Inflow Site


Unnamed Tributary Inflow Site


Core Creek Outflow Site

Appendix B: Volunteer & Staff CIM Training Event

BCCD Staff and Bucks County Penn State Master Watershed Stewards learn about the support apparatus, cleaning, and maintenance of the sondes.

Two training sessions were delivered to a total of 14 participants in the summer of 2022.

Demonstration of the handheld meter used for quality assurance.

Data download and sonde calibration procedures are discussed, demonstrated, and

Appendix C: Quality Assurance Protection Plan

Quality Assurance Project Plan:
Core Creek Continuous Instream Monitoring

Project ID: 1815

Effective Date:

EPA Document Control
Number (DCN):

Bucks County Conservation District
1456 Ferry Road, Suite 704
Doylestown, PA 18901

A PROJECT MANAGEMENT

A1 Approval Sheet

Concurrence

Preparer/Author

Name: Karen Ogden Title: Watershed Specialist, Bucks County Conservation District	Signature: Date: 9/16/2022

Management/Supervisor

Name: Gretchen Schatschneider Title: District Manager, Bucks County Conservation District	Signature: Date: 09/16/2022

Quality Assurance Officer

Name: Scott Heidel Title: Water Programs Specialist Organization: PA DEP, Chesapeake Bay Prog. Office	Signature: Scott Heidel Date: 9/16/2022

EPA Region 3

Name:Steve Hohman Title: R3 Designated Project Manager Organization: Environmental Protection Agency	Signature: Hohman, Steven Date: Digitally signed by Hohman, Steven Date: 2022.09.16 15:13:34 -04'00'

Approval

EPA Region 3

Name: Elizabeth Gaige Title: R3 Delegated Approving Official Organization: Environmental Protection Agency	Signature: ELIZABETH GAIGE Date: Digitally signed by ELIZABETH GAIGE Date: 2022.09.22 08:17:20 -04'00'

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 [https://www.epa.gov/sites/production/files/2020-06/documents/r3qmp-final-r3-signatures-2020.pdf] and other applicable requirements in EPA quality regulations and policies [https://www.epa.gov/quality]. 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.

A2. Table of Contents

List of Tables

List of Figures

A2.a List of Abbreviations

BCCD	Bucks County Conservation District
BMP	Best Management Practice
COC	Chain of Custody
EPA	Environmental Protection Agency
NPS	Nonpoint Source
PADEP	Pennsylvania Department of Environmental Protection
QAPP	Quality Assurance Project Plan
QAQC	Quality Assurance/ Quality Control
TSS	Total Suspended Solids

A3. Distribution List

The following individuals will receive a copy of this Quality Assurance Project Plan (QAPP) and any subsequent revisions:

Table 1: Distribution List

Name	Project Title or Position	Organizational Affiliation	Contact Information
Karen Ogden	Project Manager	Bucks County Conservation District	kogden@buckscd.org (215)345-7577, x107 1456 Ferry Road, #704 Doylestown, PA 18901
Gretchen Schatschneider	District Manager	Bucks County Conservation District	gschatschneider@buckscd.org (215)345-7577 1456 Ferry Road, #704 Doylestown, PA 18901
Chris Cook	Sedimentation & Erosion Control Technician	Bucks County Conservation District	CCook@buckscd.org (215)345-7577 1456 Ferry Road, #704 Doylestown, PA 18901
Kathleen Connally, Jim Walter	Volunteer Coordinators	PSU Extension Service, Master Watershed Steward	Kxc30@psu.edu Jwalter881@verizon.net (267)431-1344

Additional copies of the QAPP may be requested from the QA Officer/Project Manager.

A4. Project/Task Organization

Personnel involved in project implementation are listed in Table 2. Following the table, the responsibilities of key personnel are enumerated. Lines of authority and communication are shown in the Organizational Chart in Figure 1.

Table 2: Project Implementation Personnel

Name	Role in Project, Title, Organizational Affiliation	Contact Information
Karen Ogden	Project Manager, Watershed Specialist, Bucks County Conservation District	kogden@buckscd.org (215)345-7577, x107 1456 Ferry Road, #704 Doylestown, PA 18901
Angela Nagle	Project Partner/Landowner Representative, Director, County of Bucks Parks and Recreation Department	ajnagle@buckscounty.org (215)750571 901 E. Bridgeton Pike Langhorne, PA 19047

The Project Manager will be responsible for the following activities:

- Submitting and editing QAPP and revisions
- Obtaining adequate equipment and supplies
- Coordinating volunteers/seasonal interns
- Scheduling and reporting
- Taking constructive corrective actions when required

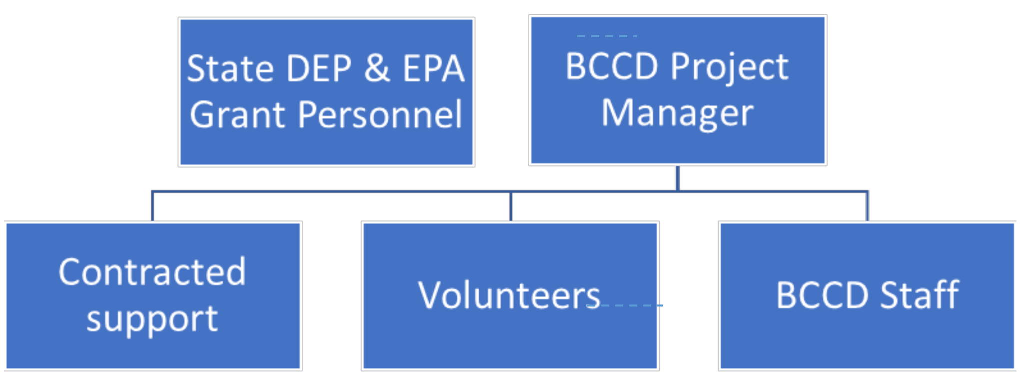
Until or unless a separate QA Officer is established, the Project Manager will also be responsible for the following activities:

- Updating and maintaining the official, approved QAPP.
- Review the procedures and data generated by this project
- Consult outside experts, including appropriate State Department of Environmental Protection and Environmental Protection Agency (EPA) staff on relevant issues.
- Ensure that every provision of the QAPP is conducted to the maximum extent practicable.
- Report problems to the monitoring program Project Manager after sampling event, and work with the Project Manager to document and correct deviations.

Contractor (Groundwater Engineering Services, Inc) executed the following elements in June 2022:

- Site selection, initial calibration, and installation of sondes.
- Trained Project Manager, BCCD staff and volunteers in data download, inspection/cleaning of sondes, and calibration of field sensors and data loggers.
- Created a Microsoft Excel workbook for data storage, manipulation, and visualization.

Figure 1: Project Organizational Chart



A5. Problem Definition/Background

In 2005, Pennsylvania revised the 1999 Total Maximum Daily Load (TMDL) analysis of Lake Luxembourg and the Core Creek watershed. The lake exhibits signs of degraded water quality including algal blooms and high turbidity. Although long-term water quality monitoring has demonstrated improvements to the lake water quality following implementation of best management practices (BMPs) from the 1990s through 2016, continued annual loading reductions of total suspended solids and phosphorus are required to comply with the TMDL for this watershed.

The purpose of this project is to implement a continuous monitoring program within the watershed to provide a barometer for water quality within Core Creek. The water quality monitoring data gathered to date in this watershed have been largely focused on characterizing water quality of the lake through PA DEP Trophic State Index data collection. Additionally, over the past two decades, grab samples overseen by BCCD have provided a limited, seasonal perspective of conditions. Watershed-based load reduction models have been used thus far as the primary tool to estimate improvements in water quality resulting from a combination of BMP implementation and land use changes in the watershed.

Continuous data are warranted to better assess if significant loading reductions are being achieved at key locations on Core Creek. Sensor data are valuable for characterizing baseline physicochemical stream conditions and describing seasonal and diel fluctuations. These data can not only help us better evaluate what improvements have been made but can also help us enhance our effort to target areas for additional implementation.

As per the 2017 WIP Update and BMPs implemented to date, loading reductions of 502 lbs. total Phosphorus (TP) and 694,658 lbs. total suspended solids (TSS) are required to meet the TMDL goals. Implementation of the Conservation Pool wetland BMP will exceed the remaining reductions required for TP by 1,700 lbs. annually and would result in delisting Lake Luxembourg for TP. In addition, significant progress would be obtained toward the TSS TMDL goal, from 19% of the targeted reduction in 2018 to 66% of the targeted sediment reductions as established in the TMDL. (Princeton Hydro, 2018) Table 3 shows 1) Progress thus far from upstream non-point source pollution reduction projects, 2) Reductions remaining after upstream actions, and 3) projected reductions of the current BMP.

The objectives of the monitoring project are to:

- Establish continuous water quality data collection to characterize water quality within Core Creek to determine TSS, N and P loads into and exiting Lake Luxembourg.
- Establish standard training for staff and volunteers who will be participating in field monitoring and sample collection.

The continuous monitoring project is designed to deliver the following short-term, intermediate, and long-term outcomes.

Short term outcomes:

- Increased awareness of non-point pollution sources and impacts to the watershed

- Improved understanding of pollution reduction practices
- Identification of seasonal and/or storm related patterns
- Intermediate outcomes:
- Ability to identify specific parameters and/or locations in need of remediation.

Long-term outcomes:

- Provide information to help in future decision making for BMP implementation and impairment status of Core Creek and Lake Luxembourg

Table 3: Total Maximum Daily Load Past and Projected Reductions

Annual TMDL **(Total Maximum Daily Load)**	**Total** **Phosphorus (lbs)**	**Total Suspended** **Solids (lbs)**
Required TMDL Reductions (est 2005)	725	859,833
Past Project TMDL Reduction (<2016)	-223	-164,755
TMDL Remaining to be Reduced	502	695,078
Projected TMDL Reductions (this BMP)	-1,719	-332,000

A6. Project/Task Description

A6.a Work Summary

The work for this project includes the installation of three (3) continuous monitoring stations; two (2) at locations upstream of Lake Luxembourg and one (1) just downstream of the lake outlet. The sondes will continuously (15-to-60-minute intervals) measure in situ water quality data: conductivity, temperature, pH, dissolved oxygen, and turbidity. The sondes will be maintained, and data downloaded at regular intervals (6-12 weeks), dependent upon local conditions and patterns of fouling.

As part of the regular download, maintenance, and calibration routine for the sondes, discrete physiochemical data will be collected at the monitoring locations 1) to check the reasonableness of monitor readings, and 2) as a check on environmental changes during the service interval.

A6.b Schedule

This project's major tasks and timetable are outlined in Table 4 below.

Table 4: Schedule of Major Project Tasks

Task Name	Task Description	Start Date	End Date
Prepare QAPP	Prepare and organize draft of QAPP, incorporate comments for EPA review for final QAPP	2/10/2022	9/30/2022
Train Volunteers	Train and familiarize all staff and volunteers with the collection and sampling process that will be used for this project	4/15/2022	6/30/2022
Conduct sampling	Installation of sensor stations and collection of data described in the QAPP; followed by data analysis (pending QAPP approval)	6/30/2022	12/31/25
Organize data	Collect and organize all primary and secondary data used for this project in the proper physical and electronic locations specified below	9/30/22	12/31/2025
Final Report	Prepare and submit final report on findings	1/1/26	3/1/26

A6.c Project Site/ Study Area

The Core Creek watershed is a subwatershed of the Neshaminy Creek and has a surface area of 9.43 square miles. Lake Luxembourg is a 179-acre impoundment at the center of this watershed and the focal point of Core Creek County Park, one of the most visited parks in the Bucks County Park system.

In 2005, Pennsylvania revised the 1999 Total Maximum Daily Load (TMDL) analysis of Lake Luxembourg and the Core Creek watershed. Although long-term water quality monitoring has demonstrated improvements to the lake water quality following implementation of best management practices (BMPs) from the 1990s through 2016, continued annual loading reductions of total suspended solids and phosphorus are required to comply with the TMDL. Grab sample data have thus far been focused on in-lake water quality and capture discrete moments in time.

For this project, two continuous monitoring stations have beeen installed upstream of Lake Luxembourg to assess pollutant load entering the lake and one continuous monitoring station has been established near the lake outlet to assess pollutant loads downstream. The proposed monitoring stations are shown in Figure 2.

A6.d Resource and time constraints

Covid-19 project implementation delays, staff turnover, and funding programming constraints and have significantly affected the timeline of the continuous monitoring project element. The result was a condensed start-up period for the monitoring stations with emphasis on initiating data collection the month prior to construction of a Regional Wetland BMP in the project area, initiated in mid-July 2022. Initiated in late February 2022, QAPP development and coordinated EPA review was further slowed by staff turnover, resulting in another two month delay this spring.

Following contractor supported installation set-up and operation, BCCD staff and trained volunteers will be primarily responsible for device maintenance and data collection.

With Section 319 grant funding for this project closing in September 2022, operational supplies, replacement parts, calibration standards, and other miscellaneous expenses are currently unfunded. This is a priority for the project manager who will pursue grants to cover continuous monitoring expenses.

Figure 2. Continuous monitoring and supplemental discrete sampling locations

A7. Quality Objectives and Criteria

Data Quality Objectives

The Bucks County Conservation District recognizes the importance of ensuring that data are of sufficient quality to meet the needs of the project. Bucks County Conservation District is committed to collecting primary data of the highest quality possible within the constraints of project resources. To meet project objectives, Continuous Instream Monitoring (CIM) will produce a physiochemical dataset to guide further action decisions.

These data are intended to supplement previous in-lake monitoring to help quantify incremental changes in water quality associated with watershed best management practice implementation. The objective of this data collection is to contribute to use evaluations and assessments of Core Creek / Lake Luxembourg. The CIM will help determine if water quality standards are generally met, whether seasonal/weather-related exceedances occur sporadically, or if standards are consistently exceeded.

Data collection will be conducted according to PA Department of Environmental Protection (PADEP) monitoring protocols as described in *Water Quality Monitoring Protocols for Streams and Rivers* (Monitoring Book, Lookenbill and Whiteash 2021). Specifically, the protocols described in Chapter 4.3 of Lookenbill, 2021, *Continuous Physiochemical Data Collection Protocol* (Hoger, 2017) will be adhered as closely as is practicable.

Quality control for this project is described in Section B of this QAPP. An overview of controls includes the following elements:

- Sensors selected for discrete readings and continuous deployments, have a range that covers expected environmental conditions. with sufficient precision and accuracy. Optical DO sensors are installed as they have higher degrees of accuracy and hold calibration well.
- Regular field visits for data download, inspection, and cross-checking discrete measurements against CIM data will identify malfunctioning equipment. If problems are detected, field corrections, if possible, will be made.
- If corrective action is required, data collected between the last (functional) visit and the current (malfunction) visit will be evaluated for quality.
- Sensor calibration will be routine, scheduled for ten-week intervals, and as needed if measurements indicate.
- Field visits will be documented with datasheets that include collectors' information, date/time, CIM measurements alongside discrete measurements, equipment observations, and maintenance actions.

Performance Criteria

Data Quality Indicators (DQI) are used to gauge achievement of performance criteria established to minimize the possibility of erroneous conclusions or presuming certainty in estimates. Total measurement and sampling uncertainty can be determined by evaluating DQIs, a reflection of attention to precision, bias, representativeness, completeness, comparability, and sensitivity.

DQI's along with Quality Assurance (QA) and Quality Control (QC) measures will be reviewed and reported in the final report and will be considered in data analysis as appropriate. Any corrections to the dataset will be excluded from reporting if they fall outside the parameters listed in Table 10 in this document.

A7.a Precision

For environmental measurements, Bucks County Conservation District will meet the precision standards achievable using EPA-approved analytical methods with proper sample collection and handling protocols. Standardization of processes and subsequent training, review, and audits will improve precision. Comparability and sensitivity will be met by applying established water quality monitoring practices and standards, as referenced in this QAPP. Finally, an accuracy rating will be established by measuring the data against the parameters described in Table 5 (Wagner, R.J., et al. 2006).

- Project staff and volunteers will be required to document data collection methods with reporting forms and photos/photo log which will be reviewed following the sampling event to evaluate data quality
- Review and provide clear, precise wording of field data reporting forms to remove ambiguity among different staff/volunteers
- Training on sonde/sensor calibration, maintenance and data retrieval will be mandatory for all project staff and volunteers.
- Regular field checks to determine need for sensor calibration (Table 5).
- Once downloaded, data will first be evaluated against water quality parameter quantitation limits (Table 6) to identify potential collection problems.

A7.b Bias

To reduce concern about self-reporting bias, Bucks County Conservation District will require specific data collection procedures to be agreed upon before data collection begins. Data will be maintained in auditable form and the Program Manager will be responsible for regularly auditing generated data. Bias will be avoided by maintaining an open and transparent data sharing environment.

A7.c Accuracy

Instream sondes will be inspected every 6-12 weeks when retrieved for downloading data. Equipment will be calibrated per standards and confirmed to meet acceptable ranges as outline in Table 5. With each visit, continuous data will be compared to discrete data collected with handheld field meters.

Table 5: Calibration Parameters

Parameter	**Acceptable Range (Error corrections NOT necessary)**
Temperature	± 0.2°C
Specific Conductance	± 5 µS/cm or 3%, whichever is greater
Dissolved Oxygen	± 0.3 mg/L
pH	± 0.2 pH unit
Turbidity	± 0.5 FNU or ± 5%, whichever is greater

Further, upon review, all continuous and discrete data is expected to fall within the quantitation limits listed in Table 6. If collected data fall outside these boundaries, further investigation and an exclusion determination will be made.

Table 6: Water Quality Parameter Quantitation Limits

Parameter	***Water Quality Standard***	Maximum daily *not to* exceed	
Temperature+	1 – 31 Jan	40 °F	4.4 °C
	1 – 29 Feb	40 °F	4.4 °C
	1 – 31 Mar	46 °F	7.8 °C
	1 – 15Apr	52 °F	11.1 °C
	16 – 30 Apr	58 °F	14.4 °C
	1 – 15 May	64 °F	17.8 °C
	16 – 31 May	72 °F	22.2 °C
	1 – 15 June	80 °F	26.7 °C
	16 – 30 June	84 °F	28.9 °C
	1 – 30 July	87 °F	30.6 °C
	1–31 Aug	87 °F	30.6 °C
	1 – 15 Sept	84 °F	28.9 °C
	16 – 30 Sept	78 °F	25.6 °C
	1 – 15 Oct	72 °F	22.2 °C
	16 – 31Oct	66 °F	18.9 °C
	1 – 15 Nov	58 °F	14.4 °C
	16 – 30 Nov	50°F	10 °C
	1 – 31 Dec	42 °F	5.6 °C
Dissolved Oxygen+	7-day average 5.5 mg/l; minimum 5.0 mg/l		
Turbidity*	Maximum 150 units		

+PA Code Title 25 Chapter 93, WWF
*DRBC standard for Zone 1E

Determinations of data accuracy in support of project objectives will be consistent with the accuracy rating system discussed in *Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: USGS Techniques and Methods* (Wagner, 2006) and represented in Table 7.

Table 7: Accuracy ratings of continuous water-quality records.[+]

Measured Parameter	Ratings of Accuracy (based on combined fouling and calibration drift corrections applied to the record)			
	Excellent	Good	Fair	Poor
Water temperature	≤ ± 0.2 °C	> ± 0.2 – 0.5 °C	> ± 0.5 – 0.8 °C	> ± 0.8 °C
Specific conductance	≤ ± 3%	> ± 3 – 10%	> ± 10 – 15%	> ± 15 %
Dissolved oxygen	≤ ± 0.3 mg/L or ≤ ± 5%, whichever is greater	> ± 0.3 – 0.5 mg/L or > ± 5 – 10%, whichever is greater	> ± 0.5 – 0.8 mg/L or > ± 10 – 15%, whichever is greater	> ± 0.8 mg/L or > ± 15%, whichever is greater
pH	≤ ± 0.2 units	> ± 0.2 – 0.5 units	> ± 0.5 – 0.8 units	> ± 0.8 units
Turbidity	≤ ± 0.5 turbidity units or ≤ ± 5%, whichever is greater	> ± 0.5 – 1.0 turbidity units or > ± 5 – 10%, whichever is greater	> ± 1.0 – 1.5 turbidity units or > ± 10 – 15%, whichever is greater	> ± 1.5 turbidity units or > ± 15%, whichever is greater
[+]From Wagner, R.J., et al. 2006. oulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at http://pubs.water.usgs.gov/tm1d3				

A7.d Representativeness

To ensure representativeness of the data, Bucks County Conservation District installed the sondes at sufficient distance from in-stream obstructions and that approach uniform conditions across the entire width of the stream. Figure 3 shows installation sites and structures for each monitoring station. The feasibility of regular cross section surveys with transect reference point will be evaluated based on volunteer capability and availability.

A benefit to representativeness of the data of continuous monitoring protocol is the ability to capture conditions during a range of flow conditions; however, large storm events can contribute to sediment fouling or potentially damage equipment. Thus, BCCD will retrieve, assess, and clean the sondes within 72 hours of large storm events to control for impacts to data collection associated with significant storm flow.

Figure 3. Continuous Instream Monitoring Site Installations

a. Core Creek Inflow

b. Tributary Inflow

c. Core Creek Outflow

A7.e Completeness

Sondes will initially be programmed to collect data on 15-minute intervals. As the dataset accumulates, the interval will be evaluated to determine if an increase, to no greater than 60 minutes, would ease data handling without compromising completeness. Field meters will be used to compare readings and notes will be made of sensor condition (e.g., extent of fouling, etc.) at the time of cleaning and data transfer. Notes describe interruptions to data collection due to extreme weather conditions or other unforeseen circumstances.

Project data will be acceptable if 85% of measurements are found to be valid.

A7.f Comparability

Comparability, or the degree to which data across multiple studies agree with one another, will be assessed qualitatively as it indicates replicability of all data. Large discrepancies in data for an identical location and time are indicative of failure in QAQC for at least one of the datasets. Faulty data will not be used in analysis or decision making unless the reason for disagreement is evident and/or the data can be quantitatively adjusted (e.g., unit disagreement).

Comparability will be achieved by following accepted water quality monitoring procedures and standards. All data units from the field meter will be reviewed to ensure they are in the correct units. Any deviations will be noted and considered during data analysis.

A7.g Sensitivity

Physiochemical measurements collected by Bucks County Conservation District will meet the sensitivity standards achievable with proper sample collection protocol using a properly maintained and calibrated instream meter. Table 8 lists the published sensor specifications

Table 8: Sensor Specifications

LOGGER SENSORS					
	Conductivity	***Temperature***	***pH***	***Dissolved Oxygen***	***Turbidity***
Calibrated Range	0 to 100,000 µS/cm	-5° to 50° C	0-14 pH units	0 to 500% air saturation	0 to 4,000 FNU
Accuracy in Calibrated Range	1% of reading, or 2 µS/cm, whichever is greater	0.2° C	0.1 within ±10°C of cal temp, 0.2 for all other temps	1% of reading or 1% saturation, whichever is greater	0.3 FNU or 3% of reading (0 to 999 FNU); 5% of reading (1000 to 4000 FNU)
Resolution	0.1 to 10 µS/cm	0.1° C	0.01 pH unit	0.1% air saturation	0.01 to 0.1 FNU
Response Time	2 seconds to 63% of change				

pH+	6-9 units
Dissolved Oxygen+	7-day average 5.5 mg/l; minimum 5.0 mg/l
Turbidity*	maximum150 units

+PA Code Title 25 Chapter 93, WWF
*DRBC standard for Zone 1E

A8. Special Training/Certification

To the extent practicable, Bucks County Conservation District and Contractor (TBD) will develop and deliver mandatory training sessions to key parties to ensure quality data. Training was initially provided by Contractor to the program manager and to the following individuals:

- Field data collection Staff/Volunteers

- Data-entry Staff/Volunteers who will be processing data from inspections and self-certification responses

Continued, periodic training will help ensure quality primary data collection. Each training session will cover proper data collection/handling and QA procedures. This will include field station visits for inspection and maintenance activities. A practice of debriefing personnel shortly after beginning tasks, to correct and clarify appropriate practices, will augment formalized training.

The Project Manager is responsible for ensuring that all personnel involved with data generation (including state personnel, contractors, and partners) have the necessary QA training to successfully complete their tasks and functions. The Project Manager will document attendance at all training sessions. Relevant records will be retained as hardcopy and digital files at the Bucks County Conservation District office. Table 9 summarizes the types of training that will be offered to staff and volunteers.

Table 9: Offered Training

Project Function	Description of Training	Training Provider	Training Recipient	Frequency
Data Download / Sonde check	Datalogger operation for download, and handheld sonde for discrete sampling.	Project Manager	Interns, Volunteers, BCCD staff	Annually-or before start of field work
Sonde Maintenance / Calibration	Battery replacement, inspection for / cleaning of fouled devices, calibration.	Project Manager	Interns, Volunteers, BCCD staff	Annually-or before start of field work
Data Management	Downloading and review of data	Project Manager	Interns, BCCD staff	Annually

A9. Documents and Records

While the project is underway, and for a period of at least seven (7) years, information will be stored in the Bucks County Conservation District office at 1456 Ferry Road, Suite 704, Doylestown PA, 18901.

A9.a Standard Documentation

Standard Operating Procedures (SOPs), checklists, and forms include:

- Checklist of equipment necessary to have while in the field (Appendix 1)
- Field Data Form (Appendix 2)

- SOP for field visits
- Calibration Logs for Project Equipment (Continuous and Field Meter)
- Demonstration of Capability (DOC) documents for project personnel

A9.b Project Records

Documents and records to be produced by the project include:

- Field notes
- Data sheets
- Scanned copies of relevant calibration logbook pages
- Training attendance sheet
- QAPP (and any amendments, if applicable)
- Quarterly and annual progress reports to EPA
- Corrective actions(s) and results
- Project final report
- Photos
- Photo log including photo #, description, date/time, and photographer

Documents and records will be included as appendices to the project final report and retained on file at the Bucks County Conservation District for a minimum of seven (7) years post-generation.

A9.c Storage of project information

While the project is underway, project information will be stored in a central filing cabinet at Bucks County Conservation District and on the Bucks County Conservation District's secure computer server. Verified data will be uploaded to the Water Quality Exchange (WQX) on a quarterly basis.

Upon completion of the project, all hardcopy paper records will be scanned and uploaded to be stored securely in digital format. Electronic records will be stored for 7 years on the Bucks County Conservation District's computer server.

A9.d Backup of electronic files

Project personnel will scan and upload all hardcopy records (e.g., data sheets, field notes, etc.) to be stored securely on the Bucks County Conservation District server, which is backed up weekly. Data will be transferred from field meters to BCCD server within 72 hours of each field event.

A9.e QAPP preparation and distribution

This QAPP conforms to the format described in the U.S. EPA publications Requirements for Quality Assurance Project Plans, QA/R-5. QA/R-5 describe all required elements of a QAPP and state that the level of detail found in the QAPP shall be commensurate with the nature of the work being performed and the intended use of the data (“graded approach”). This QAPP shall always govern the operation of the project. Each responsible party listed in Section A4 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. All the responsible persons listed in Section A4 shall participate in the review of the QAPP. If significant changes occur that affect the scope and objectives of the project, data use, or data quality revisions to the QAPP shall be documented in a second revision or addendum. Those documented changes will then be submitted to be reviewed and approved by the EPA in the same manner as the original QAPP. All appropriate personnel will then receive the revised QAPP, or addendum once approved.

The Quality Assurance Officer is responsible for updating the QAPP, documenting the effective date of all changes made in the QAPP, and distributing new revisions to all individuals listed in A3 whenever a substantial change is made. The Quality Assurance Officer will distribute the QAPP and attempt to retrieve outdated hardcopy versions as applicable. Copies of each revision will be numbered, to make retrieval of outdated versions easier.

B DATA GENERATION AND ACQUISITION

B1. Experimental Design

To characterize water quality of agricultural- and stormwater-runoff-affected waterbodies in the Core Creek/Lake Luxembourg watershed and determine the total loads to the lake, Bucks County Conservation District will establish continuous monitoring stations to assess water quality on two (2) primary tributaries and the outlet of Lake Luxembourg in Core Creek. The station locations are depicted in Figure 2 and were selected to provide a comprehensive assessment of water quality draining to and flowing from Lake Luxembourg. Continuous monitoring was selected to assess these water quality parameters through diel and seasonal fluctuations instead of the occasional ‘snapshot’ provided by discrete sampling that has been conducted in the past and primarily in-lake.

In situ water quality measurements, specifically pH, temperature, conductivity, and turbidity will be recorded in the field with continuous sensors and verified during periods of maintenance and data transfer with an electric meter. Periodic in situ readings and discrete samples may be collected and analyzed for Total N, P, and Total Suspended Solids to supplement continuous data.

B2. Sampling Methods

Continuous Monitoring:

The S319 grant funded project for which this document is prepared establishes three continuous monitoring sites in Core Creek, Middletown Township. The instream sondes are intended to collect data to evaluate the efficacy of the Regional Wetland BMP under construction and to characterize the water quality of Lake Luxembourg with the hopes of reassessing impairment status. Prior to installation of the sondes, water quality data was collected sporadically through grab samples by PA DEP and BCCD contracted investigations.

Beginning with QAPP approval, the continuous monitoring data will be the primary water quality data source, supplemented by PA DEP assessments and contracted investigations if the need arises. In circumstances of sonde inoperability, grab samples may be collected using a contractors preferred certified laboratory.

At each sampling location shown in Figure 2, a YSI EXO2 sonde has been deployed with sensors to collect in situ measurements of temperature, pH, conductivity, dissolved oxygen, and turbidity at 15-minute intervals. The sondes are equipped with wipers to mitigate fouling. Sensors include a wiped conductivity/temperature sensor which will measure temperature in Celsius and conductivity in µS/cm and a central wiper to reduce fouling.

Monitoring will be conducted in accordance with PADEP standard protocols for continuous in-stream monitoring (PADEP 2021). Each inspection and data download will include the following elements that will be contained in a project Standard Operation Procedure (SOP):

1. Obtain/Record discrete measurements from calibrated field meter at the sonde location.
2. View/Record instream sonde measurements to datasheet (compare for abnormalities)
3. Connect, disable data collection, and upload data. Check battery levels, replace if necessary.
4. Conduct pre-cleaning initial inspection
    a. Record observations of any significant fouling or other field notes
5. Clean sensors (see B6)
6. Return sonde to the stream and conduct post-cleaning inspection
    a. Record CIM readings and time
    b. Record instream readings near the Sonde with field meter
7. If needed, remove sonde, and check calibration (see B7)
    a. Record calibration-check values
    b. Recalibrate if necessary
8. Return sonde to monitoring location and inspect anchoring equipment and shroud for deterioration and damage.
9. Conduct final readings

   a. Record monitor readings and time
   b. Observe and record readings near the Sonde with field meter
10. Restart unattended sampling at 15- 60-minute interval.

B3. Sample Handling and Custody

During each field visit and at each station, the data collection team will record the following information on a Water Quality Collection Field Form:

1. Date and time of data download
2. Initials of data collection team members
3. Current weather and previous 24-hr and 48-hr period
4. Field meter readings of pH, temperature, Conductivity, DO.
5. Sonde condition (e.g., fouling, tampering, etc.)
6. Notes on Maintenance Completed (cleaning, field recalibration)
7. Other Notes. If field re-calibration is required, calibration details will be recorded on the same sheet to minimize error/confusion.

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

Paper or digital documentation will be delivered to Project Manager, reviewed, and uploaded within 72 hours of each event.

B4. Analytical Methods

Data Evaluation

Data evaluation described below are presented in *Continuous Physiochemical Data Collection Protocol* (Hoger, 2017). Field checks comparing continuously collected data to in-situ discrete data can expose data error due to calibration drift and/or fouling. If detected, erroneous data will be flagged, described, and if appropriate, corrections may be applied. Otherwise, erroneous data where the error is larger than criterion listed in Table 10 would be removed from the final dataset.

Table 10. Correction criteria for measured field parameters

Parameter	**Acceptable Range (Error corrections NOT necessary)**	**Post-correction data allowable limits for inclusion in analysis**
Temperature	± 0.2°C	± 2.0 °C
Specific Conductance	± 5 µS/cm or 3%, whichever is greater	± 30%

Dissolved Oxygen	± 0.3 mg/L	± 2.0 mg/L or 20% whichever is greater
pH	± 0.2 pH units	± 2 pH units
Turbidity	± 0.5 FNU or ± 5%, whichever is greater	3.0 turbidity units or ±30%, whichever is greater

Total Error is represented by the following equation and will be applied to data grading:

Total Error (E_t) = $|E_f| + |E_c| + |E_u| + |E_d|$*

* *Where E = Error / f = fouling / c = calibration / u = undocumented drift / d = discrete*

Errors are identified by and calculated from the difference between downloaded data and day of visit discrete, in situ data. If, after fouling and calibration drifts are corrected, an undocumented drift is exposed, a correction may be warranted. If the difference is within parameters listed in Table 4, undocumented drift correction is not required, and the difference is considered a discrete error. Undocumented drift is indicated when:

1. Discrete, in situ data remains consistent with the subsequent downloaded data set and
2. Difference remains between that discrete data and data downloads immediately preceding

Data Correction

Data is corrected by applying a percent correction to the erroneous number. Percent correction is calculated from equation, rather than a simple difference between two values. This is distinct from the percent error which reflects the percentage difference between the raw continuous data and the corrected values. The formulas used to calculate percent correction for fouling and calibration drift errors are as follows and are described in *Continuous physicochemical data collection protocol- Chapter 4.3*. (Hoger, 2017)

Fouling Error

Fouling Error (Ef) = ($Sonde_{ac}$ – $Sond_{bc}$) – (FM_{ac} – FM_{bc})*

Percent Fouling Correction (%C_f) = 100 * (Ef / $Sonde_{bc}$)

Percent Fouling Error (%Ef) = 100 * E_f/$Sonde_{ac}$)

* where f = fouling, ac = after cleaning, FM = field meter, bc = before cleaning

Calibration Drift Error

$E_c = V_{std} - V_{sonde*}$

$\%C_{c} = 100 * [(V_{std} – V_{sonde}) / (V_{sonde})]$

$\%Ec = 100 * [(V_{std} – V_{sonde}) / V_{std})]$

* where V_{std} = value of standard or buffer, V_{sonde} = value measured by sonde

Error corrections would not be made without careful consideration. If appropriate, corrections would most often be applied in a linear, incremental fashion with no correction applied at the beginning of the period, increasing evenly to the end where the full correction is applied. Error identification, calculation, and corrections will be facilitated by database built-in formulas.

B5. Quality Control (QC)

B5.a Data Review

To the extent possible, primary data collection forms will be designed in such a way as to allow internal crosschecking of data, and such crosschecking will be automated during electronic entry of data. Field forms will be reviewed by Project Manager to identify potential problems, inconsistencies, or inadequacies. Errors caught during cross-checking will be recorded, and corrected, to the extent possible, in consultation with data collection team (e.g., trained volunteers or interns).

The project Manager and/or Contractor will check for downloaded data anomalies (e.g., missing data, data that falls 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, or 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 team (trained volunteers and/or interns) and project manager.

Quality control of CIM data incorporates multiple field visits throughout the sampling period. It is recommended that data be downloaded, equipment be cleaned and checked against calibration standards to describe the accuracy of the continuous measurements every three to six weeks. QC documentation collected during field visits will be used to aid in data management prior to making data final. Methods to perform field visits and correct data are further detailed in DEP's Continuous Physicochemical Data Collection Protocol (Hoger et al. 2017).

B5.b Quality control statistics

The Project Manager will prepare summary statistics of data quality problems at the close of the project (i.e., unresolved data anomalies as a percentage of the total number of data points) and a narrative description of problems encountered and any potential bias in the data caused by data anomalies. The Project Manager will also flag data quality indicators not within acceptable criteria. This documentation will be reviewed by the QA Officer, and the Project Manager will include this information in the data evaluation section of the final project report (see D3).

Completeness will be calculated using the formula:

$$\%C = \frac{100 * V}{N}$$

Where:	%C	=	percent completeness
	V	=	number of measurements judged valid

N = total number of measurements necessary to achieve a specific statistical level of confidence in decision making

B6. Instrument/Equipment Testing, Inspection, and Maintenance

While Sondes are deployed and collecting data, they will be assessed monthly or more frequently based on conditions to:

1. Clean to minimize fouling and associated disruption of data,
2. Ensure cleaned sensors read within calibration limits,
3. Download collected data
4. Assess battery life and replace if necessary.

Upon retrieval of the sondes, the sensors will be inspected thoroughly for any signs of damage. If no damage is noted, sensors will be cleaned per manufacturer recommendations as outlined at https://www.ysi.com/file%20library/documents/manuals/exo-user-manual-web.pdf

Field meters will be maintained and calibrated according to manufacturer’s instructions.

B7. Instrument/Equipment Calibration and Frequency

All calibrations and calibration checks will be completed with standards of known quality and selected to bracket the range of potential recorded values. All calibration equipment and supplies will be kept clean, stored in protective cases during transportation, and protected from extreme temperatures. All calibration checks will be recorded on a calibration log sheet maintained for each of the continuous monitoring sonde units.

Field calibration of instream sonde units will be performed if cleaned-sensor readings obtained during the calibration check differ by a value greater than the calibration criteria (Table 11). Spare sensors will be used to replace water quality monitors that fail calibration after troubleshooting steps have been applied. Best professional judgment will be used with values that read close to calibration criteria to facilitate data management. If substantial discrepancies persist, continuous data collection will be paused, and the instream sonde will be removed from the stream for in lab troubleshooting.

Field meters will be calibrated in the day(s) prior to field use using appropriate standards. Dissolved oxygen will be calibrated on the day it is used and at the site due to barometric pressure changes. Calibration checks will be performed when readings are inconsistent with expected conditions. Finally, field meters will undergo calibration checks at the end of the sampling day. All calibrations will be recorded on a calibration log sheet.

Table 11. Field Parameter Calibration Criteria (per PADEP 2018)

Parameter	Acceptable Range (Field recalibration is NOT necessary)

Temperature	± 0.2°C
Specific Conductance	± 5 µS/cm or 3%, whichever is greater
Dissolved Oxygen	± 0.3 mg/L
pH	± 0.2 pH units
Turbidity	± 0.5 FNU or ± 5%, whichever is greater

When calibration check or field re-calibration is being performed, sensors and calibration cup will be rinsed three times with standard solution prior to measurement check or calibration with fresh solution. Expiration dates and lot numbers for the standard solutions will be recorded and sufficient time provided for the sensor to stabilize in the solution. After the readings in the calibration standard solutions are checked and recorded, the monitor will be recalibrated, if necessary, using the appropriate calibration standard solutions and following the manufacturer's calibration procedures. The sensor readings, calibration standard values, and temperature will be recorded in the field log sheet. If an error arises that is not resolved by recalibration or a temperature adjustment the monitoring sensor will be replaced, and the backup instrument calibrated.

B8. Inspection/Acceptance for Supplies and Consumables

Field supplies and equipment checklist are listed in Attachment 1. Supplies and consumables will be inspected prior to each use and replaced if expired, damaged or otherwise unacceptable. Replacement supplies will be maintained in the BCCD laboratory space.

B9. Non-Direct Measurements (i.e., Existing Data)

Secondary data to be collected for this project, their intended uses, and their limitations are described in Table 12 below.

Table 12: Secondary Data

Data	Source	Intended Use	Limitations / Acceptance Criteria
Meteorological data	NOAA – https://www.weather.gov/wrh/climate?wfo=phi	Temperature and precipitation data from regional meteorological station	Monthly reports available for the Philadelphia/Mt. Holly station.

Data	Source	Intended Use	Limitations / Acceptance Criteria
	Weather Underground: https://www.wunderground.com/dashboard/pws/KPALANGH15?cm_ven=localwx_pwsdash	Temperature, precipitation, wind, solar radiation, humidity, dewpoint, pressure data from Personal Weather Station network.	Localized data to within one mile of Lake Luxembourg.
Hydrological data	USGS website water data - https://waterdata.usgs.gov/nwis/inventory?site_no=01465500	Hydrological data at downstream reference point on main stem Neshaminy Creek	The USGS website continuously monitors stage and translates to discharge level downstream. The website flags when data are provisional and subject to review and final approval.

B10. Data Management

The initial data evaluation of sonde data will be conducted both in the field (calibration re-check and comparison to field meter readings) and upon return to the office to verify the accuracy of data transfer, to identify erroneous data, and to confirm equipment is operating as expected. This review will be completed by the Project Manager in consultation with the data collection team.

Field sheets will be reviewed, scanned, and entered electronically within 72 hours of field visit. Sonde data will be reviewed within 72 hours of download to identify inconsistencies, assess the reasonableness of values within an expected range, flagging of erratic readings, and/or presence of diel swings or responses to changes in flow. Project Manager and QA Manager will review separately and verify the data or issue corrective action where needed.

Once data are verified and any necessary corrections made, data will be uploaded to The Water Quality Portal (**WQP**) on a quarterly basis.

C ASSESSMENT/OVERSIGHT

C1. Assessment and Response Actions

Assessments will be carried out by Bucks County Conservation District’s Project Manager to verify that all procedures performed for this project comply with this document. These assessments will be conducted on a semi-annual basis.

Staff and volunteers conducting field work will be assessed once at the end of their initial training and again during their first field sampling of the project. Beyond that point field data sheets and review of downloaded data from sondes will be used for sampling error detection.

C2. Reports to Management

The Project Manager will prepare the project final report which will analyze and interpret data, present observations, draw conclusions, identify data gaps, and describe any limitations in the way the results should be interpreted.

Table 13: Project QA Status Reports

Type of Report	Frequency	Date(s)	Preparer	Recipients
Final Project Report	Once	3/1/2026	Project Manager or Contractor TBD	EPA Project Officer

D DATA REVIEW AND EVALUATION

D1. Data Review, Verification and Validation Criteria

Project Manager will review all field checklists, sheets, calibration, and photo logs with 72 hours of each monitoring event to determine if the data meet the data quality objectives. During data review, verification, and validation, the project team will be guided by the data quality criteria listed in A7 (i.e., “collecting primary data and obtaining secondary data of the highest quality possible within the constraints of project resources,” bearing in mind the six data quality indicators discussed in that section), as well as any additional criteria discussed in B1-B8 for generation of primary data, and in B9 for acquisition of secondary data. Guidance for data review, verification, and validation will follow the protocol for validation of physicochemical data, found in DEP’s Continuous Physicochemical Data Collection Protocol (Hoger et al. 2017).

D2. Verification and Validation Methods

Instream continuous data will be verified by use of a hand-held field meter while data are being downloaded from the Sondes to QC the results. The handheld meter data will be recorded and compared to most recent Sonde measurement prior to download and reviewed to ensure that the results are within QC specifications detailed above.

The Project Manager and staff will:

- Ensure that all sampling SOPs were followed.
- Establish that all QC checks were performed and met required limits.

If at any point during verification and validation the QA Officer 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, QA Officer, and any other relevant staff will discuss corrective action. If the solution involves changes in project scope or design, an addendum or revision to the original QAPP will need to be made and resubmitted for review and approval by the EPA.

D3. Evaluating Data in Terms of User Needs

The final project report will contain an evaluation of the certainty of project results. 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.

Uncertain data will be labeled accordingly in the final project report and noted they are not for use in generalizing results.

References

Delaware River Basin Commission (DRBC). Administrative Manual – Part III: Water Quality Regulations with Amendments Through December 4, 2013. 18 CFR Part 410. 145pp.

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PADEP. 2021. Office of Water Programs, Bureau of Clean Water, Water Quality Monitoring Protocols for Streams and Rivers. Accessed 2/2/2022 from https://www.dep.pa.gov/Business/Water/CleanWater/WaterQuality/Pages/Data-Collection-Protocols.aspx

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Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at http://pubs.water.usgs.gov/tm1d3

Appendices

Appendix 1. Sampling Supplies Checklist

Field visit data recording supplies

- ☐ Waterproof Field sheets
- ☐ Tatum (Field clipboard)
- ☐ Pencils
- ☐ Cell Phone
- ☐ Site ID list
- ☐ QAPP
- ☐ Safety Plan
- ☐ Contact Info for dashboard

In Situ Water Chemistry Supplies

- ☐ Field Meter (& manual)
- ☐ Calibration logbooks
- ☐ Extra batteries
- ☐ 1413 SPC
- ☐ pH 4
- ☐ pH 7
- ☐ pH10
- ☐ Turbidity Standards: DI water, 124 FNU
- ☐ DI water
- ☐ Waste container

Supplies (Maintained in Office)

- ☐ EXO Optical DO Probe
- ☐ EXO Turbidity Probe
- ☐ EXO pH assembly, unguarded
- ☐ EXO2, Central wiper
- ☐ EXO Conductivity, Temp Sensor
- ☐ Extra batteries
- ☐ 1413 µS/cm
- ☐ pH 7
- ☐ pH10
- ☐ Turbidity Standard (124 FNU)
- ☐ DI waterAppendix 2. Field Meter Calibration Form

Appendix 2: Draft Sonde Calibration Record

Field Meter Information						
Meter / Site Name	YSI EXO2 -					
Meter S/N						
Date		Time:		Name		
Specific Conductance			**Standard Expiration Date:**			
Standard (µS/cm)	Temp (C)	Reading (initial)	Adjusted	Location of calibration (lab/field)		
1000						
Air Test (Ref. 1 – 5 µS/cm)						
pH	**pH 7. Expir. Date**			**pH 7. Expir. Date**		
pH Buffer	Temp (C)	Reading	Adjusted	Millivolts*	Location (lab/field)	
7.00						
10.00						
*If difference between pH 7 & 10 decreases to 160mV, sensor head replacement necessary						
Turbidity			**Standard Expiration Date:**			
Standard (FNU)	Temp (C)	Reading (FNU)	Adjusted (FNU)	Location (lab/field)		
0 (DI Water)						
124 FNU						
Dissolved Oxygen						
Time (24 hr)	Temp	Pressure (mmHg)	Air Value (mg/L)	Reading (mg/L)	Reading %	Location lab/field

Handheld Unit Battery Status (%) ____________ Sonde Battery Status (%) ____________

NOTES:

Appendix 3. Draft Field Data Form

Continuous Instream Monitoring Field Data Form							
Site Name:(circle)	Core Creek			Tributary			Outflow
Date:			Time:		Collector:		
Outward Appearance (Notes)							
Pre-Inspection Readings							
	Temp (C)	*SpC (µS/cm)*	*pH*	*DO mg/l*	*DO %*	*Pressure (mmHg)*	*Turbidity (FNU)*
Handheld							
CIM (Live Data)							
Post-Inspection Readings							
	Temp (C)	*SpC (µS/cm)*	*pH*	*DO mg/l*	*DO %*	*Pressure (mmHg)*	*Turbidity (FNU)*
Handheld							
CIM (Live Data)							
Maintenance Performed (X)							
PVC scrub		Debris Removal		Sensor cleaning		Securing apparatus	
Notes:							
Photos taken of sonde upon retrieval (Y / N)							

Appendix D: 319 Nonpoint Source Management Goals and Accomplishments

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
CHESAPEAKE BAY OFFICE

319 NONPOINT SOURCE MANAGEMENT GOALS & ACCOMPLISHMENTS FORM

This form represents *(choose one)*:

☐ Project Goals

☒ Project Accomplishments *(to be submitted with final report)*

Project Title: Core Creek Continuous Monitoring and Best Management Practice Planning Project

State Project Number: 1815

Contract Number: 7C-FA-28.0

Primary Subgrantee: Bucks County Conservation District

Project Manager Name: Karen Ogden
Project Manager Phone: (215) 345-7577

Grant Amount (319(h) Federal Funds)**: $**108,271.00

Project Start Date: 10/1/2017
Project End Date: 8/31/2022

Key Partners:

Partner Name* *(Add additional rows if needed)*	**Role**	**Organization Type**	**Match/Partner Contributions Amount**	**Cash or In-Kind**
		Choose an item.	$	
		Choose an item.	$	
		Choose an item.	$	
		Choose an item.	$	
		Choose an item.	$	

*Do not list individual volunteer or private land holder names.

Work Categories:

Primary	**Non-Primary**	*(Check all that apply. One must be marked primary. The rest of the applicable work categories are to be marked non-primary)*
☐	☐	**319(h) National Monitoring Project**
☐	☐	**BMP Design**
☐	☒	**BMP Effectiveness Monitoring**
☐	☐	**BMP Implementation**
☐	☐	**Education/Information**
☐	☐	**GIS/Modeling**
☒	☐	**Monitoring Design**
☐	☐	**NPS State Staff Activities**
☐	☐	**Regulatory/Enforcement**
☐	☒	**Water Quality Assessment/Monitoring**
☒	☐	**Watershed Planning**

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Sources of NPS Pollution: *(Provide **Category** percentages and check all applicable Secondary Categories.)*

%	**Agriculture**	%	**Marinas and Recreational Boating**
	☐ Aquaculture		☐ Boat Construction
	☐ Grazing Related Sources		☐ Boat Maintenance
	☐ Irrigated Crop Production		☐ Dredging
	☐ Non-Irrigated Crop Production		☐ Fueling
	☐ Pasture Grazing		☐ Other On-Vessel Discharges
	☐ Range Grazing		☐ Pumpouts
	☐ Specialty Crop Production (e.g. horticulture/citrus/nuts/fruits)		☐ Sanitary On-Vessel Discharges
%	**Animal Feeding Operations**		☐ Shoreline Erosion
	(no secondary category)	%	**Other NPS Pollution**
%	**Construction**		☐Atmospheric Deposition
	☐ Highways/Roads/Bridges		☐ Erosion From Derelict Land
	☐ Land Development or Redevelopment		☐ Forest fire/Wildfire
%	**Historical Pollutants**		☐ Groundwater Loadings
	☐ Clean Sediments		☐ Natural Sources
	☐ Contaminated Sediments		☐ Rec. & Tourism Activities (non-boating)
	☐ Other Historical Pollutants		☐ Spills
%	**Hydromodification**		☐ Wildlife
	☐ Channelization	%	**Resource Extraction**
	☐ Dam Construction		☐ Abandoned Mine Drainage
	☐ Drainage/Filling of Wetlands		☐ Dredge Mining
	☐ Dredging		☐ Mill Tailings
	☐ Flow Regulations/Modification		☐ Mine Tailings
	☐ Groundwater Withdrawal		☐ Open Pit Mining
	☐ Other Habitat Modification		☐ Petroleum Activities
	☐ Removal of Riparian Vegetation		☐ Placer Mining
	☐ Streambank or Shoreline Modification/Destabilization		☐ Sand/Gravel Mining
	☐ Upstream Impoundment		☐ Subsurface Mining
%	**Land Disposal/Storage Treatment**		☐ Surface Mining
	☐ Hazardous Waste	%	**Silviculture**
	☐ Inappropriate Waste Disposal		☐ Forest Management
	☐ Industrial Land Management		☐ Harvesting/Residue Management
	☐ Landfills		☐ Reforestation
	☐ On-site/Decentralized Wastewater		☐ Road Construction Maintenance
	☐ Septage Disposal	%	**Turf Management**
	☐ Storage Tank Leaks (above ground)		☐ Golf Courses
	☐ Storage Tank Leaks (underground)		☐ Other Turf Management
	☐ Wastewater		☐ Yard Maintenance
		%	**Urban Runoff/Stormwater**
			☐ Commercial
			☐ Dry Weather Flows
			☐ Highway/Road/Bridge Runoff
			☐ Illicit Connections/Illegal Hook-ups
			☐ Municipal
			☐ Post-Development Erosion and Sed.
			☐ Residential
			☐ Salt Storage Sites

Waterbodies:

Waterbody Name *(Add additional rows if needed.)*	**Type**	**ATTAINS ID**
Core Creek, Crosswicks-Neshaminy, Bucks County	Stream/Creek/River	PA-SCR-25480640
	Choose an item.	
	Choose an item.	

Map Location & Drainage Areas: *(Attach map(s) showing the location of the site(s).)*

Site (Land Unit) **Name** *(Add additional rows if needed.)*	**Latitude (decimal degrees)**	**Longitude (decimal degrees)**	**HUC12**
Core Creek Park, Middletown Township	40.21507346646906	-74.902120460636	Core Creek

Watershed Plan:

319 Watershed Implementation Plan (WIP) Name	**Status**
2017 Watershed Implementation Plan Update: Core Creek and Lake Luxembourg	Choose an item.

Pollutants and Load Reductions:

(Implementation projects only. Check all that apply and complete the required items.)					*Post-Implementation*	
	Pollutant *(Common pollutants are listed first.)*	**Estimated Load Reduction**	**Unit of Measure**	**Load Reduction Model***	**Load Reduction Date**	**TMDL? Yes or No**
☐	Acidity		LBS/DAY			
☐	Metals (Aluminum)		LBS/DAY			
☐	Metals (Iron)		LBS/DAY			
☐	Metals (Manganese)		LBS/DAY			
☐	Nitrogen		LBS/YR			
☐	Phosphorus		LBS/YR			
☐	Sedimentation-Siltation		TONS/YR			
☐	Algal Growth/Chlorophyll					
☐	Ammonia					
☐	Bacteria					
☐	Biochemical Oxygen Demand (BOD)					
☐	Chemical Oxygen Demand (COD)					
☐	Chlorine					
☐	Conductivity (mohms/cm @ 25 °C)					
☐	Dissolved Oxygen (Low)					
☐	Fecal coliform					
☐	Inorganics (Other)					
☐	Metals (Arsenic)					
☐	Metals (Cadmium)					
☐	Metals (Chromium)					
☐	Metals (Copper)					

☐	Metals (Lead)						
☐	Metals (Mercury)						
☐	Metals (Other)						
☐	Metals (Selenium)						
☐	Metals (Zinc)						
☐	Nitrate						
☐	Oil and Grease						
☐	Organics (Other Nonpriority)						
☐	Organics (Other Priority)						
☐	PCBs						
☐	Pathogens (Coliform)						
☐	Pathogens (E Coli)						
☐	Pathogens (Other)						
☐	Pesticides (Chlordane)						
☐	Pesticides (DDT)						
☐	Pesticides (Dianzinon)						
☐	Pesticides (Dieldrin)						
☐	Pesticides (Other)						
☐	Phosphate						
☐	Road Salt or Deicer						
☐	Sulfates						
☐	Suspended solids						
☐	Total Kjeldahl Nitrogen						
☐	Toxics (Total)						
☐	Treated Wastewater						
☐	Turbidity						

*Model used to generate load reductions should be consistent with WIP or TMDL, where applicable and appropriate.

Related Best Management Practices (BMPs)

Check all that apply and attach map(s) detailing BMP locations within the site(s):

	AMD Treatment/AML Practices	Planned On (date)	Implemented On (date)	Implemented Amount	Implemented Units of Measure
☐	**AMD treatment system,** ☐ subtype active				quantity
☐	**AMD treatment system,** ☐ subtype passive				quantity
☐	**land reconstruction, abandoned mined land** (NRCS 543)				acres
	Agricultural Practices	**Planned On (date)**	**Implemented On (date)**	**Implemented Amount**	**Implemented Units of Measure**
☐	**access control** (NRCS 472)				acres
☐	**access road** (NRCS 560)				feet
☐	**agrichemical handling facility** (NRCS 309)				quantity
☐	**alley cropping** (NRCS 311)				acres
☐	**animal mortality facility** (NRCS 316)				quantity
☐	**closure of waste impoundment** (NRCS 360)				quantity

☐	**composting facility** (NRCS 317)				quantity

☐	**comprehensive nutrient management plan – written** (NRCS 102)				quantity
☐	**comprehensive nutrient management plan – applied** (NRCS 103)				quantity
☐	**conservation cover** (NRCS 327)				acres
☒	**conservation crop rotation** (NRCS 328)	2020 2021		59.4 127.1	acres
☐	**continuous cover crops** (SQL02)				acres
☐	**contour buffer strips** (NRCS 332)				acres
☐	**contour farming** (NRCS 330)				acres
☒	**cover crop** (NRCS 340)	2021		12.2	acres
☐	**critical area planting** (NRCS 342)				acres
☐	**deep tillage** (NRCS 324)				acres
☒	**diversion** (NRCS 362)	2020	2020	2,637	feet
☐	**drainage water management** (NRCS 554)				acres
☐	**feed management** (NRCS 592)				animal units
☐	**fence** (NRCS 382)				feet
☐	**field border** (NRCS 386)				acres
☐	**filter strip** (NRCS 393)				acres
☒	**forage and biomass planting** (NRCS 512)	2021		137.9	acres
☒	**forage harvest management** (NRCS 511)	2021		127.1	acres
☐	**grazing land mechanical treatment** (NRCS 548)				acres
☒	**heavy use area protection** (NRCS 561)	2022		2,823.7	square feet
☐	**intercropping to improve soil quality & increase biodiversity** (SQL08)				acres
☐	**irrigation water conveyance** (NRCS 430)				feet
☐	**irrigation reservoir** (NRCS 436)				gallons
☐	**irrigation system, microirrigation** (NRCS 441)				acres
☐	**irrigation system, sprinkler** (NRCS 442)				acres
☐	**irrigation system, surface and subsurface** (NRCS 443)				acres
☐	**irrigation water management** (NRCS 449)				acres
☐	**lined waterway or outlet** (NRCS 468)				feet
☐	**livestock shelter structure** (NRCS 576)				square feet
☐	**monitoring well** (NRCS 535)				quantity
☒	**nutrient management** (NRCS 590)	2020 2021 2022	15	59.4 127.1 15	acres
☐	**pasture & hayland management**				acres
☐	**pipeline** (NRCS 516)				feet
☒	**prescribed grazing** (NRCS 528)	2021		10.8	acres
☒	**residue and tillage management, no-till/strip till/direct seed** (NRCS 329)	2020		59.4	acres
☐	**roofs and covers** (NRCS 367)				quantity
☐	**silvopasture establishment** (NRCS 381)				acres

☐	**spring development** (NRCS 574)				quantity
☐	**stormwater runoff control** (NRCS 570)				acres
☐	**stream crossing** (NRCS 578)				quantity
☐	**stripcropping** (NRCS 585)				acres
☐	**structure for water control** (NRCS 587)				quantity
☐	**subsurface drain** (NRCS 606)				feet
☐	**surface drain, field ditch** (NRCS 607)				feet
☒	**terrace** (NRCS 600)	2021		252	feet
☐	**trails and walkways** (NRCS 575)				feet
☐	**transition to organic cropping systems** (WQL20)				acres
☐	**transition to organic grazing systems** (WQL19)				acres
☐	**waste storage facility** (NRCS 313)				quantity
☐	**waste transfer** (NRCS 634)				quantity
☐	**waste treatment lagoon** (NRCS 359)				quantity
☐	**waste utilization** (NRCS 633)				quantity
☐	**water and sediment control basin** (NRCS 638)				acres
☐	**water well** (NRCS 642)				quantity
☐	**water well decommissioning** (NRCS 351)				quantity
☐	**watering facility** (NRCS 614)				quantity
	Stormwater Practices	**Planned On (date)**	**Implemented On (date)**	**Implemented Amount**	**Implemented Units of Measure**
☐	**catch basin vacuum truck or unit**				quantity
☐	**constructed wetland** (NRCS 656), ☐ subtype aerobic				acres
☐	**constructed wetland** (NRCS 656), ☐ subtype anaerobic				acres
☐	**dry extended detention basin**				acres
☐	**impervious surface removal**				square feet
☐	**infiltration basin**				acres
☐	**planter boxes**				quantity
☐	**pervious pavement**				square feet
☐	**rain garden/bio-retention**				square feet
☐	**rooftop disconnection**				acres
☐	**sediment basin** (NRCS 350)				quantity
☐	**sediment fore bay**				square feet
☐	**street sweeping**				square feet
☐	**subsurface infiltration bed**				acres
☐	**vegetated roof**				square feet
☐	**vegetated swale**				feet
☐	**water quality inserts/inlets**				quantity
	Streams/Lakes/Ponds Practices	**Planned On (date)**	**Implemented On (date)**	**Implemented Amount**	**Implemented Units of Measure**

☐	**channel bed stabilization** (NRCS 584)				feet
☐	**channel floodplain restoration**				feet
☐	**dam removal**				quantity
☐	**dredging**				acres
☐	**fish passage** (NRCS 396)				quantity
☐	**in-lake alum treatment**				acres
☐	**lake aeration**				acres
☐	**pond** (NRCS 378)				acres
☐	**pond sealing or lining, flexible membrane** (NRCS 521A)				square feet
☐	**riparian forest buffer** (NRCS 391)				acres
☐	**riparian herbaceous cover** (NRCS 390)				acres
☐	**streambank and shoreline protection** (NRCS 580)				feet
	Wetland Practices	**Planned On (date)**	**Implemented On (date)**	**Implemented Amount**	**Implemented Units of Measure**
☐	**wetland acquisition for protection**				acres
☐	**wetland creation** (NRCS 658)				acres
☐	**wetland enhancement** (NRCS 659)				acres
☐	**wetland restoration** (NRCS 657)				acres
☐	**wetland wildlife habitat management** (NRCS 644)				acres
	Forestry Practices	**Planned On (date)**	**Implemented On (date)**	**Implemented Amount**	**Implemented Units of Measure**
☐	**forest stand improvement** (NRCS 666)				acres
☐	**forest trails and landings** (NRCS 655)				acres
☐	**prescribed burning** (NRCS 338)				acres
	Miscellaneous Practices	**Planned On (date)**	**Implemented On (date)**	**Implemented Amount**	**Implemented Units of Measure**
☐	**dirt/gravel road maintenance**				feet
☐	**grade stabilization structure** (NRCS 410)				quantity
☐	**grassed waterway** (NRCS 412)				acres
☐	**hedgerow planting** (NRCS 422)				feet
☐	**integrated pest management** (NRCS 595)				acres
☐	**invasive species removal**				square feet
☐	**land reclamation, landslide treatment** (NRCS 453)				acres
☐	**land reclamation, toxic discharge control** (NRCS 455)				acres
☐	**mulching** (NRCS 484)				acres
☐	**pumping plant** (NRCS 533)				quantity
☐	**restoration and management of rare or declining habitats**				quantity
☐	**roof runoff structure** (NRCS 558)				feet
☐	**tree/shrub establishment** (NRCS 612)				acres
☐	**upland wildlife habitat management** (NRCS 645)				acres

ACCOMPLISHMENTS ONLY (Post-Grant Completion)

What differed between the final approved workplan and what was finally accomplished for this project? (eg. Clarify any amendments, project changes, deliverables.)

Two extensions to the grant period were sought and approved. The grant period ended August 30, 2022.

Task 1.3 - Continuous data were collected for 10 weeks between June - August 15, 2022, but will not be submitted to WQX because it was not generated under an approved Quality Assurance Project Plan. Data collection commencing in March 2023 will be submitted as the QAPP was approved in September 2022.

Eight agricultural operations were contacted for management planning, three particpated resulting in the update of one Nutrient Management Plan, and the generation of three Conservation Plans, and a Manure Management Plan. Comobined, the plans addresed operations on 232 acres of Core Creek watershed. BMPs planned, some implemented, are listed in the previous form.

Best Management Practices (Implementation projects only):
If applicable, please explain why Installed BMPs were different than what was stated in the final approved work plan.

While this grant did not fund any BMP implementaion projects, some that were identified here were funded and implemented through NRCS and other programs.

Deliverables:

Deliverables planned in the final approved workplan *(Add additional rows if needed.)*	**Deliverables submitted to PADEP**	**Date deliverable was submitted to PADEP**
Continuous Water Quality Monitoring	EPA approved QAPP, DEP consistent protoclols and installation site locations	Sept. 2022
Landowner Outreach	Summary of activities in Final Report	Sept. 2022
Plan and Design BMPs (+permitting)	Summary of activities in Final Report, no permitting needed	Sept. 2022
Grant Adminsitration and Reporting	Quarterly reports submitted with reimbursement requests, finaly report submitted.	Sept. 2022

If applicable, please explain why the deliverables that were submitted to PADEP were different than what was committed to in the final approved workplan.

Because no actionable projects were developed,no permit applications were submitted.