WATERSHED APPROACH TO TOXICS ASSESSMENT AND RESTORATION 2018 - 2022

DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL

DIVISION OF WATERSHED STEWARDSHIP
DIVISION OF WASTE AND HAZARDOUS SUBSTANCES

September 4, 2018

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EXECUTIVE SUMMARY

WATAR, which is an acronym for Watershed Approach to Toxics Assessment and Restoration, was first conceived in 2012 as a collaboration between DNREC's Watershed Assessment and Management Section and DNREC's Site Investigation and Restoration Section (DNREC 2013). The focus of the program is to assess and restore Delaware watersheds impacted by toxic pollutants. The first five years of the program (2013 – 2017) met or exceeded its primary objectives. There is a desire to continue the effort for the next five years. This document presents a plan for implementing the WATAR program over the period 2018 through 2022.

The total cost to implement the tasks outlined in this plan is approximately $1.1 million dollars to be derived from various funding sources. The cost to implement actual remediation and restoration actions at given sites within specific watersheds is not included in this estimate.

INTRODUCTION

A watershed represents the area drained by a river, stream, or creek — in simplest terms, the area "shedding the water" (sources) to a given water body (sink). Because watersheds are defined by topographic and hydrologic boundaries, they represent the most natural and logical basis for assessing and managing the physical, chemical, and biological resources within the aquatic environment. Beginning in 1995, several programs within the Delaware Department of Natural Resources and Environmental Control (DNREC, or Department) began to utilize a watershed-based approach to assessing and managing Delaware's environment through the Whole Basin initiative. That work focused on conventional water quality parameters such as dissolved oxygen, temperature, nutrients, and bacteria, as well as improvements to physical habitat. The WATAR Team has built upon that concept by successfully applying the approach specifically to toxic substances over the past 5 years. This plan describes what the Team will complete over the course of the next 5 years.

One hallmark of the watershed approach is to consider the cumulative effect of all pollutant sources within a watershed. This not only provides a broader and more complete picture of conditions within a watershed, but the approach also permits an assessment of the relative importance of the individual sources or groups of sources which contribute to impacts. Having a more complete picture and knowing the relative importance of sources can lead to more target prioritization of resources and more effective problem solving.

Numerous programs benefitted from the Whole Basin watershed approach and continue to operate utilizing its fundamental principles and practices for assessing and managing the environment. One such program, DNRECs Total Daily Maximum Load (TMDL) program, has been utilizing the watershed approach to address the requirements of the Federal Clean Water Act (CWA) since the late 1990s. Like the Whole Basin initiative, efforts under Delaware's TMDL program have focused primarily on conventional water quality parameters. Delaware's experience with toxics TMDLs is far less extensive but noteworthy in that those TMDLs addressed long-standing, major contamination issues in Delaware waters (see text box below for examples of TMDLs for conventional and toxic pollutants in Delaware).

Noteworthy examples of the watershed approach for conventional pollutants include nutrient TMDLs for the Delaware Inland Bays, the Murderkill watershed, and the Saint Jones watershed (DNREC 1998, 2005, 2006). The Department has also participated in interstate TMDLs that also took a watershed approach for conventional pollutants. Examples of these include the low and high flow TMDLs for nutrients and oxygen-demanding substances in the tri-state (PA, DE, and MD) Christina Basin (EPA 2006a and 2006b).

With regard to toxics, the Department has established TMDLs for zinc in the Red and White Clay Creeks (DNREC 1999a, 1999b, and 2008). The Department also played a critical role in the development of the TMDL for polychlorinated biphenyls (PCBs) for the tidal Delaware River (EPA 2003) and the TMDL for PCBs for the Delaware Bay (EPA 2006c). Those TMDLs, developed jointly by the Delaware River Basin Commission (DRBC) and Basin States and formally established by the EPA, are arguably among the most scientifically robust in the United States, and are highlighted in the EPA publication "Integrating Water and Waste Programs to Restore Watersheds" (EPA 2007).

In addition to zinc and PCBs, other contaminants that have impacted Delaware surface waters include chlorinated pesticides (e.g., chlordane, DDT, and dieldrin), dioxins and furans (DxF), polynuclear aromatic hydrocarbons (PAHs), mercury, and other metals. Most of these contaminants or contaminant groups, minus PAHs and metals, are classified as persistent, bioaccumulative, and toxic (PBT). PBTs concentrate and accumulate in the aquatic food chain, thereby posing a health risk to people, birds and wildlife that consume the tainted fish and other aquatic life. Indeed, the primary line of evidence that PBTs affect Delaware's surface waters is fish tissue contaminant data. Those data have been used by the Delaware DNREC and the Delaware Department of Health and Social Services to issue fish consumption advisories (http://www.dnrec.delaware.gov/fw/Fisheries/Pages/Advisories.aspx). Those advisories, which are generally more restrictive and more prevalent in the northern, more industrialized part of the State, are used, in turn, as a basis for listing the affected waterways on Delaware's impaired waters list, also referred to as the Clean Water Act Section 303(d) list. This list is updated every two years by the DNREC Watershed Assessment and Management Section (WAMS). Delaware's most recent list was compiled in 2016, which benefited from data collected by the WATAR program.

Although it is certainly not good that our waterways are impaired by PBT contaminants, there is reason for hope. Our best available scientific information suggests that the levels of several PBTs in the environment are decreasing with time (Greene, 2006, 2008a, 2016, and 2017; Church et. al., 2006; Mason et.al. 2014; Velinsky et. al., 2007, 2010, and 2011). Radiodated sediment cores indicate that the concentration of many PBTs peaked in the late 1970s/early 1980s and that concentrations have steadily decreased since. Furthermore, Delaware has been able to make several of the fish consumption advisories less restrictive over the last half decade, signaling tangible evidence that conditions are trending in a positive direction. We believe these improvements are the result of a combination of broad-reaching statutory and regulatory bans and phase outs, source controls, site remediation, and natural attenuation/burial. There is still

much room for improvement however; hence, development of this second five-year WATAR plan.

Before laying out the work plan for the period 2018 – 2022, it is useful to review what was accomplished during the first five years of the WATAR program (2013 – 2017). Highlights appear below. Many, but not all, of these highlights are featured in a comprehensive presentation prepared in November of 2016 (Greene and Cargill 2016), and provided as Appendix A.

- **Monitoring of Toxics in Water, Sediment and Fish in Impacted Watersheds:** Updated data were collected on all watersheds listed for toxics on Delaware's 303(d)-List. The updated data were, or will be, used for a variety of purposes, including: a) revised fish consumption advisories, most of which became less stringent in response to improving conditions; b) support for listing and delisting decisions for toxics on Delaware's 303(d) List; c) identification of hot spot/target areas of concern for follow-up investigation and remediation; d) providing information for trend assessments; e) providing local data for updating the Delaware Estuary PCB TMDL; f) calculation of State-specific bioaccumulation factors (BAFs) and biota-sediment accumulation factors (BSAFs), which will improve the technical basis of human health water quality criteria in Delaware; g) support for natural resource damage assessments (NRDAs), which ultimately translate to restoration projects; h) justification for continued work by permittees in implementing PCB Pollution Minimization Plans (PMPs); i) complement to ambient toxicity testing performed by the DRBC on Delaware Estuary tributary watersheds; and j) improved assessments for DNREC's Source Water Assessment and Protection Program (drinking water) in the Christina Basin.

- **Data Entry in the EQuIS™ Database:** All data collected under the WATAR program between 2013 and 2017 were successfully entered into the EQuIS™ database, which makes retrievals, custom assessments, and GIS mapping easier to perform. In addition, once fully implemented, the database will allow access of these data to all Divisions within DNREC. The data can be used to assist with making remedial and permitting decisions in other programs in DNREC that are charged with determining acceptable risk at sites as well as allowable loads of toxics from permitted facilities. The creation of a centralized database and mapping system was one of the objectives of the first 5 year plan for WATAR. However, while the implementation of EQuIS falls short of the complete vision, it does achieve the goal of sharing high resolution data with practitioners.

- **PCB Mass Loading from Delaware Waste Sites:** The WATAR team completed Phase II of a project to estimate the mass loading of PCBs from waste sites to surface water via overland flow and groundwater transport. Phase I (Brightfields 2009) was completed in 2009 and was focused on the Christina Basin and the nearby Shellpot Creek. The first phase captured 32 waste sites. Phase II (Brightfields 2015) considered the rest of the State and captured an additional 29 waste sites. The information has allowed DNREC's Site Investigation and Restoration Section to prioritize and track cleanup of sites based on magnitude of load and proximity to surface water. The information was also provided to the DRBC as part of the Stage 2 Delaware Estuary PCB TMDL development process.

The single largest ongoing release of PCB to surface water in Delaware is from the Amtrak Wilmington Shops and Maintenance Facility in Wilmington, DE. The WATAR team is working closely with Amtrak, the USEPA, and the DRBC in developing a comprehensive cleanup plan for the site that will curtail off-site release of PCBs to surface water. The analyses completed in both Phase I and Phase II will allow DNREC to quantify reductions in PCB loading to impacted waterways when remediation or best management practices are implemented at the 61 PCB source sites identified in the reports.

- **PCB Trackback Studies in the City of Wilmington (City) and New Castle County (County) Sewer System:** The WATAR team worked with the City and County as well as the DRBC to better understand, isolate and control sources of PCBs in the City and County's sewer system, which flows to the City's 100 MGD regional wastewater treatment plant, which in turn discharges to the Delaware River. This discharge was notably above the allowable load for the system. Using chemical fingerprinting techniques and knowledge of manufacturing processes, the WATAR team identified a source of inadvertent PCB production entering the sewer system. The County is working with the manufacturer to control the problem through their delegated industrial pretreatment program. The WATAR team also documented an approximate 90% reduction of PCB loading from the City's wastewater treatment plant effluent to the Delaware River over the 10-year period 2005 – 2015. The trackback program has also identified that legacy solids within the sewer system are a substantial secondary source of PCBs within the system, and has worked to remove these secondary sources to eliminate the load from the sewershed.

- **PCB in New Castle County MS4 Stormwater Runoff:** The WATAR team worked with New Castle County Special Services and the Delaware Department of Transportation in the design and implementation of a sampling plan for analysis of PCBs in regulated stormwater discharges. This work was purposely designed to complement sampling of receiving waters performed by the WATAR team within watersheds known to be impacted by PCBs. Results of this work have been provided to the DRBC so they can incorporate the new information into the Phase 2 Delaware Estuary PCB TMDL.

- **Mirror Lake Project:** In the fall of 2013, DNREC applied 79 tons of activated carbon product (Sedimite™) to 5 acres of lake bottom and connecting stream channel over a 10 day period with the goal of reducing the transfer of PCBs from the sediments to the fish. The concentration of PCB in resident bluegill was reduced by 87% based on monitoring conducted prior to application and for three years after application. This same amount of reduction would have taken 2 to 3 decades without carbon addition. This project won awards at the State, regional and national levels.

- **Little Mill Creek:** Over several years, the WATAR team provided technical assistance to New Castle County Conservation District and the U.S. Army Corps of Engineers (USACE) in characterizing and managing risks associated with toxics in the footprint of the Little Mill Creek Flood Mitigation Project (deepening and widening of the Creek between Maryland Avenue and the Amtrak Northeast Corridor rail line). As part of the overall project, a significant source of petroleum and PCBs was discovered in Meco

Ditch which flows to Little Mill Creek. Remediation of the source was expedited and residual contamination was treated in-place with activated carbon and was capped prior to work completed by the USACE. Further, the WATAR team led the sampling and assessment of approximately 21,000 cubic yards of potentially contaminated stream sediment and bank material, which was transported to appropriate disposal facilities based upon assessment of risk.

- **Red Clay Creek Zinc TMDL:** The WATAR team continues to be involved in the cleanup of the former NVF-Yorklyn manufacturing facility, which released copious amounts of zinc to the groundwater and Red Clay Creek in the past. Since late 2008, a groundwater interceptor trench and treatment system has captured zinc and prevented it from discharging to the Red Clay Creek. Zinc concentrations no longer exceed applicable water quality criteria and zinc has been delisted in the Red Clay from Delaware's 303(d) List. Cleanup of the site is nearing completion, at which point the treatment system will be decommissioned. Monitoring of zinc in the Red Clay Creek will continue through the end of 2018. One aspect of the remediation – a flood water storage wetland pond – received a national award from the EPA for creative financing of a project with multiple benefits.

- **Areas of Concern:** One particularly important use of the data collected during the first five years of the WATAR program was to identify hot spots, or areas of concern (AOC), in need of follow-up, geographically-focused investigation. One AOC was identified in each of the following watersheds: the Saint Jones; the tidal Christina; the tidal Brandywine; and the Shellpot. Two possible AOCs were identified in the C&D Canal. The WATAR team has already performed extensive follow-up investigation of the AOC in the Saint Jones watershed (Greene, Cargill, Ghosh 2017). The issue there revolves around polyaromatic hydrocarbons (PAHs) in the tidal reach of the Saint Jones River between Court Street and Route 13. The WATAR team is coordinating its efforts with the Region 3 USEPA Superfund Program because the problem appears to be related to past releases from a Federal Superfund site in Dover. Follow-up investigation has also been initiated in the tidal Christina. The issue there is legacy PCB contamination in the so-called A Street Ditch in South Wilmington in the vicinity of Walnut Street. Interest in this AOC by the WATAR team and others has been elevated because it is the main conduit between the Christina River and the planned South Wilmington Wetlands Project (Brightfields 2017).

- **Chesapeake Drainage Toxics Monitoring:** The EPA Chesapeake Bay Program is placing greater emphasis on characterizing and mitigating the effect of toxic chemicals in waters of the Chesapeake Bay, including tributary watersheds. To that end, the WATAR team developed a comprehensive Quality Assurance Project Plan (QAPP) in 2017 designed to assess the status of toxics in essentially all watersheds that flow from the State of Delaware toward the Chesapeake Bay. Following six months of planning, the first year of a two-year toxics monitoring program was successfully completed in October and November 2017. This work was not part of the first five year WATAR work plan. The fact that the study design, QAPP, and first year sampling could be completed in addition to other commitments is a testament to the WATAR team's flexibility and capacity and speaks to the confidence that others have in the team.

- **Metals Assessment Based on New ICP/MS Instrument:** The WATAR team performed a comprehensive review of new surface water metals data generated by DNREC's Environmental Laboratory Section (ELS) using a more sensitive laboratory instrument (ICP/MS). That review (Greene 2017) indicates that many previous 303(d) listings for copper, among others, will be able to be removed due to the better analytical resolution of the new instrument.

- **Communication Within and Outside of DNREC:** One goal of the WATAR program was to communicate and partner with others within and outside of DNREC to raise awareness and identify synergies leading to accelerated improvement of water quality in Delaware. The WATAR team accomplished that goal by making presentations at local, regional and national meetings; preparing videos highlighting various projects; and preparing annual reports describing work accomplished. The WATAR approach was noticed and sought out by government agencies at all levels; non-governmental organizations (NGOs) such as the Partnership for the Delaware Estuary, the Delaware Nature Society, the William Penn Foundation, the Christina Conservancy, and the Center for the Inland Bays; academia and the private sector. In addition, the WATAR team was asked to provide input on the draft revision to the Delaware Estuary Comprehensive Conservation and Management Plan (CCMP) by the Partnership for the Delaware Estuary. The WATAR team was also contacted by the EPA Chesapeake Bay Program Office to share our experience in assessing toxics in Delaware watersheds.

In addition to highlighting what was accomplished by the WATAR team during the first five years of the program (2013 – 2017), it is important to also identify the things that we said we would do, but didn't. There are two such items. First, we said we would develop guidance for the assessment and management of contaminated sediments in the State under Delaware's Hazardous Substance Cleanup Act (HSCA) with implementation through the DNREC Site Investigation and Restoration Section. Although we performed numerous state-of the-science sediment quality assessments over the period, we were not able to complete an overarching guidance document to serve as a framework for modern sediment quality assessment. This task remains a critical need and will be carried over to the next five year WATAR plan.

The second item we did not perform during the first five year period of WATAR was comprehensive testing of mercury in water, sediment and biota in the Saint Jones watershed in 2017. The first five year plan said we would do so "if needed". Comprehensive fish testing performed in the Saint Jones watershed by the WATAR team in 2013 revealed that mercury concentrations in fish had dropped below the level of concern in all areas of the watershed except a limited segment of Fork Branch in the non-tidal headwaters of the watershed. DNREC and DHSS updated the fish consumption advisory for the Saint Jones watershed on July 3, 2014 (DNREC 2014). That update removed mercury as a contaminant of concern from Silver Lake and all tidal waters of the Saint Jones River out to the Delaware Bay. At the same time, a specific advisory was issued for the reach of Fork Branch between McKee Road and College Road (~2 miles) based on slightly elevated mercury concentrations in the fish. The WATAR

team will revisit this reach of Saint Jones watershed in 2019 to document any changes and to support future adjustments to the existing fish consumption advisory.

STATEMENT OF NEED

The Department has been successfully assessing ambient conditions in the State's watersheds and has been remediating hazardous substances at individual sites for over two decades. The Department's regulatory programs have met their primary charge of dealing with toxics by focusing on evaluating, maintaining and controlling contaminants of concern within the impacted site's boundaries or areas proximal to the contaminant source. The risk of exposure to hazardous substances has been significantly reduced or eliminated by remedial actions implemented at sites across the State. Therefore, the Department's efforts continue to contribute to improvements to human health, welfare and environment in upland areas, and to an extent in the waterways of the First State. The documented success of the first 5 years of WATAR has sped this progress, however, continued efforts to reduce the timeframe to restore Delaware's waterways to fishable swimmable and potable requires further work through the WATAR approach.

Just as traditional water resource management has focused heavily on individual point source discharges, traditional hazardous substance management programs have focused on remediating individual sites. Without the continued influence of the WATAR approach, both programs will individually fall short of acting on the broader cumulative effect of multiple intermingling sources discharging to water bodies. Many steps have been taken in the remediation programs to refine analytical methods to detect PBTs at sites, assess potential loading of these contaminants and implement remedial actions that address the loads. While great strides have been made, many undocumented releases still occur along with the ongoing releases from sites that are in the remedial process.

What the Department lacks is a rigorous and quantitative accounting of the links between the contamination in the State's waterways, transport pathways, and the sources within a watershed. Quantitatively linking sources with waterway receptors for toxics is not a trivial exercise. The continued evolution of existing programs towards this approach is essential to address remaining toxics problems in the State in a timely manner. The approach requires a purposeful refocusing of some program priorities, continued development of tools that will provide information useful for multiple regulatory programs, and continued monitoring of the impacts. A major goal of the WATAR approach is to remediate sources along with historically impacted waterways using a prioritized stepwise plan in order to achieve fishable, swimmable and eventually potable water in all of Delaware's waterways, in the shortest time-frame possible.

OBJECTIVE

The primary objective of the WATAR program is to assess and restore Delaware watersheds impacted by toxic pollutants by understanding the complex links between contaminant sources and sinks.

EXPECTED BENEFITS

Continuation of the WATAR program is expected to yield numerous benefits to the public, the Department, water purveyors, and businesses. Benefits to the public will include better access and understanding of toxics in the environment, a cleaner environment, lower exposure to toxic substances, and better health. Benefits to the Department will include greater efficiency in locating and processing environmental data and data requests, a staff with a broader perspective and expanded skills, and the ability to make long-standing, informed decisions on permits and remediation plans. Benefits to water purveyors will include cleaner surface source water and improved customer satisfaction. Businesses that are likely to benefit from WATAR include ecotourism, the fishing and boating sector, and those with processes that require high purity water.

Additional specific benefits to the Department will include:

- A broader approach to the evaluation of contaminant sources, transport pathways, and receptors with the intent on implementing management actions to mitigate and/or eliminate the levels of toxins at individual sites and the levels of toxins that individual sites release to the State's waterways;
- Completion of the link between contaminant source and sink using high resolution analyses with the intent on compelling remediation of source areas on an accelerated schedule;
- Exercising regulatory authorities and developing guidance to more readily assess and remediate legacy contaminants in sediments within the State's waterways;
- Completion of TMDLs for toxics as necessary and justified by new, comprehensive ambient and site-related data;
- A mechanism to justifiably and transparently implement restoration actions (including Natural Resource Damage restoration) based upon site prioritization that considers the level of threat to public health, welfare and the environment and the expected resulting benefit to its watershed;
- Incorporation of state-of-the-art remediation and restoration technologies and methods that provide for long-term, cost effective solutions (e.g. sediment stabilization, carbon sequestration, etc.);
- Identification and engagement of key programs and/or personnel from within and outside the Department that are needed to define success;
- A shorter timeframe for removal of fish consumption advisories throughout the State, which will serve as a positive and highly visible indicator to the public of successful Department efforts.
- Lasting partnerships between DNREC Sections, Divisions and Departments, as well as other partnering agencies, that will provide opportunity for mutually beneficial cost sharing and data sharing opportunities to achieve shared goals more efficiently.

PROJECT PARTICIPANTS

The primary participants in this project include the Division of Watershed Stewardship's Watershed Assessment & Management Section and the Division of Waste & Hazardous Substance's Site Investigation and Restoration Section. Based on additional partnerships forged during the first five year cycle of the WATAR program, the Division of Water's Environmental Laboratory Section and the Division of Fish & Wildlife's Fisheries Section are also considered active participants in and important contributors to the WATAR program. Finally, the Delaware National Estuarine Research Reserve (DNERR) has expressed an interest in participating in the work of the WATAR program, particularly within the Saint Jones River watershed where the DNERR is headquartered and where the WATAR team has focused many efforts.

Through the distribution and implementation of this work plan, we are soliciting the comprehension, interest and, participation of other groups within DNREC both with regulatory and non-regulatory roles. Even without active participation, we believe that other groups within DNREC have the potential to benefit from this collaboration.

ACTION ITEMS

Specific actions that are proposed under this work plan are described below.

1. **Complete Interpretive Data Report(s) for 2013 – 2017 WATAR Monitoring:** This action will involve summarizing the results of sampling performed during the first five years of the WATAR program. Results will be presented by watershed, analyte and media. The results from the 2013 – 2017 period will also be compared to readily available data collected prior to 2013 with fish consumption advisories as the indicator, so that trends can be assessed. Areas of concern (AOCs) will be identified along with known or suspected sources and sites.

2. **Completion of the Calculation of bioaccumulation factors (BAF) and biota sediment accumulation factors (BASF):** Building upon the 2013-2017 WATAR monitoring effort but completed as a stand-alone exercise, measures of bioaccumulation such as bioaccumulation factors (BAFs) and biota-to-sediment accumulation factors (BSAFs) will be calculated for potential use in developing State-specific water quality criteria for use in lieu of national literature based values for calculation of water quality criteria.

3. **Monitoring for Toxics Remaining on Delaware's 303(d) List:** Toxic chemicals remaining on Delaware's 303(d) list are largely associated with contaminants in fish tissue. The WATAR team has placed these contaminants into 1 of 3 categories based on a comprehensive review of current and historic data. The three categories are: i) contaminant has dropped below a level of concern in the fish and can be delisted; ii) contaminant shows long-term downward trend and is expected to drop below the level of concern within the next 5 - 10 years; or iii) contaminant remains elevated and is not expected to drop below a level of concern in the next 5 - 10 years. Contaminants in the second category will be monitored to verify continued improvement and their drop

below a level of concern. These contaminants/stream segments will not likely need a TMDL or any other specific action as they are already on a trajectory of being eliminated as a concern in the near-term. A TMDL provides little value for these cases and actually draws limited resources away from more severe cases within the third category. Contaminants in the third category will be retained for either possible TMDL development or other priority regulatory action(s) that would be expected to result in the contaminant dropping below a level of concern.

4. **Continue to Implement the Delaware Estuary PCB TMDL:** This task will involve coordinating on PCB Pollutant Minimization Plans (PMPs) for point source discharges and MS4 stormwater discharges; tracking cleanup of waste sites; monitoring PCB mass loads at the head of tide in tributaries flowing to the Delaware Estuary; and monitoring PCB levels in fish tissue and sediment. This work will be coordinated with the DRBC to ensure that the WATAR program complements, not duplicates, efforts by the DRBC. In the case of fish tissue sampling, this work will serve double-duty as "advisory follow-up" sampling to support adjustments to fish consumption advisories. Recall that existing fish consumption advisories for Delaware watersheds are driven primarily by PCBs. Hence, new fish tissue data not only helps to track progress in implementing the Delaware Estuary PCB TMDL but also helps to support adjustments to Delaware fish consumption advisories. Tentatively, fish tissue sampling is expected in the following watersheds in 2019: Saint Jones, C&D Canal, and the Red Lion. In 2020, fish tissue sampling is expected in the Army Creek watershed and Appoquinimink watershed. In 2021, fish tissue sampling is expected in the Christina Basin and Shellpot Creek watershed. Finally, in 2022, fish tissue sampling is expected in the mainstem Delaware Estuary.

5. **Chesapeake Bay Drainage Toxics Monitoring:** This work will continue the monitoring begun in late 2017 in Delaware watersheds that flow to the Chesapeake Bay. This work will follow the EPA-approved QAPP developed by the WATAR team in 2017. This work will involve surface water, sediment and fish tissue sampling in a style similar to the work conducted in the Delaware Estuary between 2012 and 2017.

6. **Post-Remediation Sampling in Little Mill Creek/Meco Ditch:** A remedy involving a combination of soil/sediment removal, placement of sorptive mats, incorporation of activated carbon into sediments, and soil covering was implemented in Little Mill Creek/Meco Ditch in 2013 and 2014 to address elevated PCB and PAH concentrations. Follow-up sampling is planned to assess overall success of the remedy. A sampling and analysis plan (SAP) has already been prepared for this work, which is scheduled for Summer/Fall 2018.

7. **Post-Remediation Sampling of Red Clay Creek Upstream and Downstream of the Former NVF Yorklyn Site:** Remediation of the former NVF site is nearing completion. In early 2018, the groundwater zinc recovery and treatment system was turned off to conduct a "creek response test." Preliminary calculations indicate that zinc concentrations will increase in the Red Clay downstream of the NVF site but that the total maximum daily load (TMDL), wasteload allocation (WLA) for the NVF site, and

in-stream zinc water quality criteria will not be exceeded after the system is shut down. The WATAR team is overseeing monitoring of zinc concentrations in the Red Clay Creek upstream and downstream of the NVF site to verify expectations. Sampling was conducted immediately prior to treatment system shutdown and will continue monthly thereafter for a period of 1 year. Depending upon results, the treatment system may be permanently decommissioned.

8. **Post-Remediation Sampling in Mirror Lake:** As noted above, the concentration of PCBs dropped 87% in resident bluegill three years after the 2013 remediation of the sediments in Mirror Lake with activated carbon. We propose to revisit conditions in Mirror Lake during the second five year WATAR work plan. Ideally, follow-up sampling should occur in the fall of 2019, six years after remediation. At a minimum, this work will include fish tissue samples. Additional sampling may include bulk sediments, passive samplers in the sediments and water column, and select water column grab samples.

9. **Post-Remediation Sampling of the Fort Du Pont Landfill Permeable Reactive Barrier:** The USEPA conducted an "emergency removal" of lead contaminated sediments along the bank of the Delaware River south of Delaware City, DE in 2014/2015. The site is part of a former military landfill with associated elevated concentrations of lead in groundwater. Dissolved lead was moving with the groundwater toward the Delaware River. Due to budget constraints, not all of the lead could be removed above the high tide elevation. The WATAR team proposed installation of a permeable reactive barrier (PRB) composed of Apatite II (fish bones) to capture dissolved lead as it moves with the groundwater towards the Delaware River. The WATAR team proposes to collect groundwater samples from shallow wells upgradient and downgradient of the PRB to assess the effectiveness of the PRB.

10. **Revisit Areas of Concern (AOCs):** The first five years of the WATAR program focused on characterization of toxics at the watershed scale with the goal of zeroing in on sources or source areas of greatest concern. Ideally, these areas of concern are associated with known hazardous substance release sites to expedite the process of linking source to sink. Follow-up, geographically-targeted sampling will be scheduled during the second five year WATAR work plan with the intent of pinpointing source(s) of contamination, and ultimately evaluating options to remediate/mitigate/restore impacted resources.

11. **Investigation of Per- and Poly-fluorinated Substances (PFAS) in Red Clay Creek:** The WATAR team became aware of a potential source of PFAS entering the Red Clay Creek upstream of a public water supply intake in 2017. The WATAR Team, along with others from DNREC have designed a sampling and analysis plan to characterize the situation and advise on potential follow-up actions. The plan uses fundamentals of the WATAR approach to sample throughout the impacted area to determine the location of the source(s) of PFAS. The sampling will identify any point or non-point sources of PFAS and inform potentially responsible parties if need be.

12. **Complete Delaware Sediment Assessment and Remediation Guidance:** This is unfinished business from the first five year WATAR cycle. The WATAR team has the key materials it needs to complete this task. The general processes have been defined in the sampling and analysis plans along with the quality assurance project plans for the series of sampling events conducted throughout Delaware's impacted waterways between 2012 and 2017. There are also several innovative remedial approaches that have been implemented or overseen by DNREC over the past 5 years, as well. These methods can be considered "approvable" by DNREC and be considered as remedial approaches for sediment within the State. Members of the WATAR team have also been instrumental in the development of technical and regulatory guidance through the Interstate Technology and Regulatory Council (ITRC) for assessment, decision-making and remedial decision making that can be incorporated by reference into the Delaware guidance.

13. **Evaluate/Advance Sediment Remediation Projects:** The WATAR team is aware of several situations where aquatic sediments are known to contribute to elevated bioaccumulation in fish and/or to toxicity to benthic aquatic life. Examples include the Eastern Drainage Ditch on the Amtrak Wilmington property; the "A Street Ditch" in South Wilmington; Red Lion Creek wetlands, impacted by the Standard Chlorine of Delaware Superfund Site; the Saint Jones River between Court St and Rt. 13, impacted by past release from the Dover Gas Light Superfund Site; the Shellpot Creek downstream of Amtrak NPDES outfall 002; the tidal Christina River between the Peterson Wildlife Refuge and I-495, impacted historically by multiple sources; and the tidal Brandywine between approximately Market Street downstream to the confluence with the Christina. Progress has been made at several of these "sites" within the last few years. Furthermore, the WATAR team is working with the Christina Conservancy and private contractors to prepare detailed bathymetric, sedimentological and subsurface maps for the tidal Christina River and tidal Brandywine Creek. This information will inform comprehensive evaluation of sediment remediation options in the targeted areas.

14. **Explore/Expand Collaboration:** The WATAR Team has made several presentations to wide audiences over the past 5 years. Many of these presentations, along with participation in working groups within the state, have created opportunities to work with academia and research groups. The Delaware Environmental Institute (DENIN) (a consortium of Delaware universities and colleges) has sought collaboration with DNREC and vice versa. Most recently, WATAR Team members visited the Advanced Materials Characterization Lab (ACML) at the University of Delaware to discuss the opportunity for collaboration and to support the WATAR sampling efforts using laboratory services within-Delaware while at the same time educating students about advanced techniques being utilized to characterize toxics in the environment. The ACML is currently in the process developing a water quality analysis lab and was very receptive to ideas put forth by the WATAR team. The WATAR team and others are also working on providing a "project catalog" for DENIN to consider in developing research plans. The ideas in the catalog are those research questions that DNREC may not currently have the funding or capacity to consider but that have real-world impacts for DNREC and the State of Delaware. DENIN is receptive to the concept of the

catalog with the understanding that some of the topics presented may need to be modified or that there is no assurance that a DNREC research question will be addressed immediately.

15. **Explore New Funding Opportunities:** The WATAR Team was honored to be asked to present to the Clean Water and Flood Abatement Task Force (Task Force) in November, 2015. At this meeting the WATAR Team made several compelling arguments regarding the progress that the Team had made related to toxics assessment, analysis and remediation on a limited budget in the first years of the WATAR plan. The Task Force met several times to conclude that Delaware does indeed need an injection of funding towards WATAR priority project as well as infrastructure and nutrient problems across the state. WATAR Team members also participated in a clean water fieldtrip for several elected officials. These same officials would then become the sponsors for House Bill 270 (H.B. 270) (An Act to Amend the Delaware Code Relating to Clean Water for Delaware) (Clean Water for Delaware Act) introduced by the Delaware House of Representatives, 149th General Assembly, in December 2017. H.B. 270 would create a fund from a new tax on residents in Delaware to fund the backlog of water quality and quantity projects proposed by the WATAR Team and others.

16. **Prepare for Sea Level Rise:** The Delaware Sea Level Task Force has performed a general assessment of remediation sites in the State of Delaware through multiple sea-level rise (SLR) and catastrophic inundation scenarios. It is well understood that many of the remedial actions taken within Delaware eliminate exposure to hazardous substances in order to reduce the potential for unacceptable risk. These actions may not have taken into account the potential for climate change due to the vintage of the action or a lack of appreciation of climate change during design. The WATAR Team will seek to catalog the universe of sites within the state where a failure of a remedy due to a natural disaster may have an effect and to what degree could that effect diminish water quality. The risk of inundation is not the same at all sites. As part of the WATAR Teams' interaction with DENIN, a "vulnerability assessment" will be proposed and conducted to categorize sites into High, Medium and Low potential for failure, and then potential risk from failure categories based on factors such as elevation of site; type and robustness of existing remedy (stability); type and magnitude of contamination at the site; potential consequence of partial or complete breach; and ability to implement countermeasures over the planning horizon of SLR. As DNREC does not currently have the capacity to conduct this research, reaching out to DENIN to have this project completed by students will provide DNREC with valuable information. DNREC and the WATAR Team will work together to define the variables of the project.

17. **Document Progress:** This task involves preparing annual progress report, delivering presentations at State, Regional and National forums, publishing findings, and using modern tools such as videos and drone footage to communicate details of projects. The WATAR Team will continue to work with DNRECs Public Relations office to create short videos detailing the work of the past 5 years, the Fish Consumption Advisory process, the Fish Consumption Advisory sign replacement initiative and website

information, the progress at Mirror Lake, Little Mill Creek / Meco Ditch and, the Fort DuPont metals removal and permeable reactive barrier projects, among others.

18. **Continue Tech Transfer:** With the retirement of one of the WATAR Team's key members, it is imperative to continue to pass on knowledge and information along with developing guidance in a team format. The work that the WATAR team will complete in the next 5 years will be based strongly upon the work of the first 5 years, with an emphasis on follow up and outreach to make WATAR part of the culture of DNREC. WATAR Team members will continue to promote the approach at symposia, career nights at local universities, participating in local and regional water quality organizations and, most importantly presenting to DNREC leadership as it continues to transition.

TIMETABLE

The Timetable for performing the above Action Items is listed below by calendar year, and when appropriate, by specific date or season.

- 2018
  - ✓ Begin data compilation and summary for 2013 – 2017 WATAR sampling;
  - ✓ Provide data supporting listings and de-listings for toxics for the 2018 Clean Water Act 303(d) List;
  - ✓ Re-evaluate SOPs for WATAR Sampling (sediment, surface water, fish);
  - ✓ Little Mill Creek/Meco Ditch post-remediation sampling;
  - ✓ Fort DuPont post-remediation sampling;
  - ✓ Red Clay Creek zinc TMDL/NVF Yorklyn post-remediation sampling;
  - ✓ Red Clay Creek perfluorinated compounds investigation;
  - ✓ Finalize Cleanup Plan for the Amtrak Wilmington Former Fueling Facility (including sediments within the Eastern Drainage Ditch);
  - ✓ Finalize Cleanup Plans for remaining CitiSteel (former EVRAZ-Claymont Steel) Operable Units, and remedial design plans for closure of PCB impacted cooling water pond (Operable Unit #4);
  - ✓ Second Year of Chesapeake Drainage Toxics Sampling (includes, among other items, analysis of sediment core slices and analysis of fish samples from selected public ponds);
  - ✓ Coordinate with Christina Conservancy on bathymetric, sedimentological and subsurface mapping survey of the tidal Christina and tidal Brandywine;
  - ✓ Coordinate with the City of Wilmington on the A Street Ditch and South Wilmington Wetlands site remediation;
  - ✓ Obtain funding and start planning stages of A-Street Mouth/Christina River Pilot Study (Sedimite™ with inoculant);
  - ✓ Coordinate with EPA on Saint Jones River sediment assessment and potential remediation (associated with former Dover Gas Light site);
  - ✓ Coordinate with the DRBC and USEPA on Stage 2 PCB TMDL for Delaware Estuary;

- ✓ Provide technical assistance to the City of Wilmington and New Castle County Special Serves on the City of Wilmington's PCB trackback monitoring and implementation, and coordinate with DRBC;
- ✓ Provide technical assistance to New Castle County Special Services and DelDOT on their MS4 PCB PMP trackback and implementation, and coordinate with the DRBC.
- ✓ Tech Transfer: DNREC Leadership & staff, DNERR, USEPA, ASTSWMO, ITRC, DENIN, etc; and
- ✓ Progress Report

- 2019
  - ✓ Continue data compilation and summary for 2013 – 2017 WATAR sampling;
  - ✓ Finalize SOPs for WATAR sampling and begin drafting HSCA Sediment Assessment and Remediation Guidance;
  - ✓ Compile toxics data summary report for samples collected from Delaware watersheds that flow toward the Chesapeake Bay (due May 31, 2019);
  - ✓ Receive and review the Amtrak West Yards Remedial Investigation Report;
  - ✓ Build partnerships and seek funding for additional Christina River cleanup objectives/goals;
  - ✓ Begin evaluation of Delaware specific bioaccumulation factors (BAFs) and biota-sediment accumulation factors (BSAFs);
  - ✓ Begin data collection efforts for possible dioxin/furan TEQ TMDL in upper St. Jones River and Silver Lake;
  - ✓ Collect consumption advisory follow-up fish tissue samples from the following watersheds: Saint Jones (including Mirror Lake), C&D Canal, and Red Lion Creek;
  - ✓ Collect "head of tide" surface water samples for the Saint Jones watershed and Red Lion Creek watershed to track progress toward DRBC PCB TMDL (target 1 dry and 1 wet event). Also collect TMDL model boundary condition surface water sample from the C&D Canal at the Delaware/Maryland border (target 1 dry and 1 wet event);
  - ✓ C&D Canal Area(s) of Concern trackback sampling (focus on sediments).
  - ✓ Continue to provide technical assistance to the City of Wilmington and New Castle County Special Services on the City's PCB trackback and implementation, and coordinate with the DRBC.
  - ✓ Provide technical assistance to New Castle County Special Services and DelDOT on their MS4 PCB PMP trackback and implementation, and coordinate with the DRBC.
  - ✓ Tech Transfer: DNREC Leadership & staff, DNERR, USEPA, ASTSWMO, ITRC, DENIN, etc.; and
  - ✓ Progress Report

- 2020
  - ✓ Continue/finalize draft HSCA Sediment Assessment & Remediation Guidance;

- ✓ For Delaware watersheds that flow toward the Chesapeake Bay, create a priority list of potential actions to address sources of toxics in need of follow-up investigation, clean-up and/or restoration (due by May 31, 2020);
- ✓ Prepare a scope-of-services for a remedial investigation/feasibility study of sediment remediation technologies in the tidal Christina and tidal Brandywine Area(s) of Concern;
- ✓ Provide data supporting listings and delistings for toxics for the 2020 Clean Water Act 303(d) List;
- ✓ Collect consumption advisory follow-up fish tissue samples from the following watersheds: Army Creek and Appoquinimink;
- ✓ Collect "head of tide" surface water samples for the Army Creek watershed and the Appoquinimink watershed to track progress toward DRBC PCB TMDL (target 1 dry and 1 wet event);
- ✓ Army Creek and Appoquinimink Area(s) of Concern sampling (focus on sediments);
- ✓ Continue to provide technical assistance to the City of Wilmington and New Castle County Special Services on the City's PCB trackback and implementation, and coordinate with the DRBC.
- ✓ Provide technical assistance to New Castle County Special Services and DelDOT on their MS4 PCB PMP trackback and implementation, and coordinate with the DRBC.
- ✓ Tech Transfer: DNREC Leadership and staff, DNERR, USEPA, ASTSWMO, ITRC, DENIN, etc.; and
- ✓ Progress Report

- 2021
  - ✓ Collect consumption advisory follow-up fish tissue samples from the following watersheds: Christina Basin and Shellpot Creek;
  - ✓ Collect "head of tide" surface water samples for the Christina Basin and Shellpot Creek to track progress toward DRBC PCB TMDL (target 1 dry and 1 wet event);
  - ✓ Shellpot Creek Area(s) of Concern sampling (focus on sediments);
  - ✓ Continue work on Christina River remediation initiative;
  - ✓ Continue to provide technical assistance to the City of Wilmington and New Castle County Special Services on the City's PCB trackback and implementation, and coordinate with the DRBC;
  - ✓ Provide technical assistance to New Castle County Special Services and DelDOT on their MS4 PCB PMP trackback and implementation, and coordinate with the DRBC;
  - ✓ Tech Transfer: DNREC Leadership and staff, DNERR, USEPA, ASTSWMO, ITRC, DENIN, etc.; and
  - ✓ Progress Report.

- 2022
  - ✓ Collect consumption advisory follow-up fish tissue samples from the Delaware River, Delaware Bay, and Slaughter Creek;

- ✓ Provide data supporting listings and delistings for toxics for the 2022 Clean Water Act 303(d) List;
- ✓ Collect Year 9 post-remediation data for Mirror Lake;
- ✓ Continue to provide technical assistance to the City of Wilmington and New Castle County Special Services on the City's PCB trackback and implementation, and coordinate with the DRBC;
- ✓ Provide technical assistance to New Castle County Special Services and DelDOT on their MS4 PCB PMP trackback and implementation, and coordinate with the DRBC;
- ✓ Tech Transfer: DNREC Leadership and staff, DNERR, USEPA, ASTSWMO, ITRC, DENIN, etc.; and
- ✓ Progress Report

BUDGET

The total cost to implement this plan is approximately $1.2 million dollars, to be derived from various funding sources over the course of the project. Funds needed to fully implement this work plan are detailed below. Table 1 lists costs associated with ambient monitoring while Table 2 lists costs for special monitoring associated with waste sites and areas of concern. Table 3 combines these monitoring costs and presents costs associated with non-monitoring actions.

Table 1. **Preliminary Estimates for Ambient Monitoring of Toxics under WATAR**

Watershed	**Sampling/Analysis Cost**	**Calendar Year**
Complete Year 2 of Chesapeake Drainage Sampling	$302,575	2018
Fish Advisory Follow-up Sampling: Saint Jones, C&D Canal, Red Lion Creek	$87,100	2019
Del Est PCB TMDL Head of Tide Water Samples: Saint Jones & Red Lion; Boundary Condition Water Sample: C&D Canal	$8,925	2019
Fish Advisory Follow-up Sampling: Army Creek and Appoquinimink	$56,950	2020
Del Est PCB TMDL Head of Tide Water Samples: Army Creek & Appoquinimink	$11,475	2020

Fish Advisory Follow-up Sampling: Christina Basin & Shellpot Creek	$97,150	2021
Del Est PCB TMDL Head of Tide Water Samples: Christina Basin and Shellpot Creek	$16,575	2021
Fish Advisory Follow-up Sampling: Delaware River and Bay, and Slaughter Creek	$148,950	2022

Table 2. Site-Related and AOC Sampling Costs by Watershed in Support of WATAR

Watershed	Sampling/Analysis Costs	Calendar Year
Little Mill Creek/Meco Ditch	$20,000	2018
Fort Du Pont PRB	$10,000	2018
NVF Yorklyn/Zinc TMDL	$25,000	2018
Red Clay Creek PFAS	$10,000	2018
Mirror Lake Year 6 Sampling	$35,000	2019
C&D Canal AOCs Sampling	$35,000	2019
Tidal Christina & Tidal Brandywine AOCs Sampling	$50,000	2019
Army Creek & Appoquinimink AOC Sampling	$50,000	2020
Shellpot Creek AOC Sampling	$25,000	2021
Mirror Lake Year 9 Sampling	$35,000	2022

Table 3. Funding Needs to Implement WATAR by Action Item, Program and Calendar Year

Action	2018	2019	2020	2021	2022
Toxics Monitoring					
WAMS	$302,575	$106,025	$78,425	$123,725	$163,950
SIRS	$65,000	$120,000	$50,000	$25,000	$35,000
Sediment Guidance					
WAMS					
SIRS		$25,000	$10,000		
Public Outreach					
WAMS					
SIRS	$5,000	$5,000	$5,000	$5,000	$5,000
Totals	$372,575	$256,025	$143,425	$153,725	$203,950

The total financial need for the WATAR program for the period CY2018 through CY2022 is $1,129,700. The greatest need exists in the first year. One hundred thousand of the $372,575 need in the first year is expected to come from a Chesapeake Bay Program Grant. Setting that amount aside, the annual need varies from roughly $150,000 to $250,000 per year. The relative contribution between the Watershed Assessment and Management Section and the Site Investigation and Restoration Section over the 5 year period is roughly 70% to 30%. Of course, SIRS also funds cleanups of contaminated sites that impact surface waters. Those costs are not reflected in the above table.

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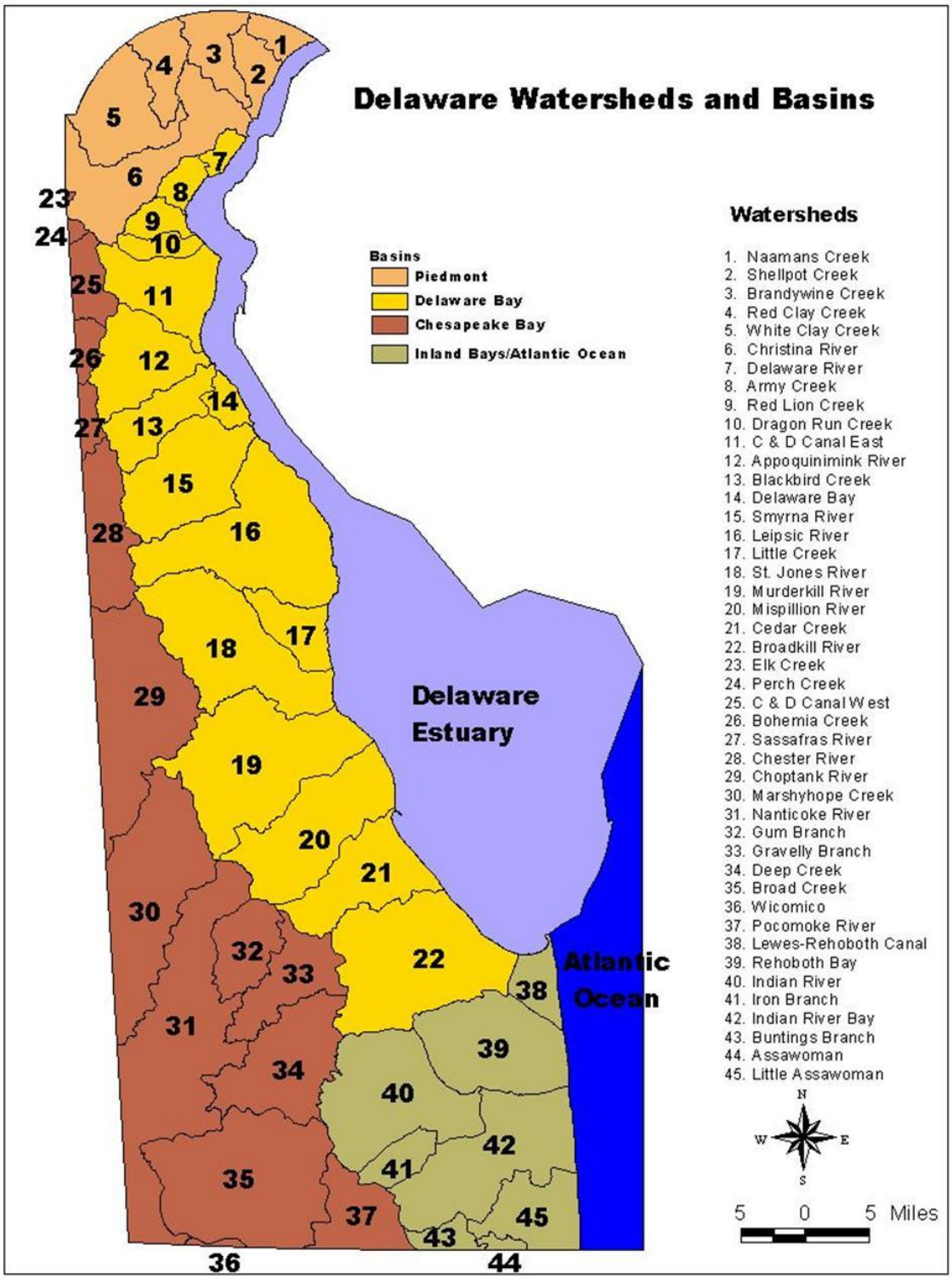

Figure 1. Delaware Watersheds and Basins

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APPENDIX A

WATAR – 5 YEARS OF PROGRESS
(Presentation Given November 15, 2016)