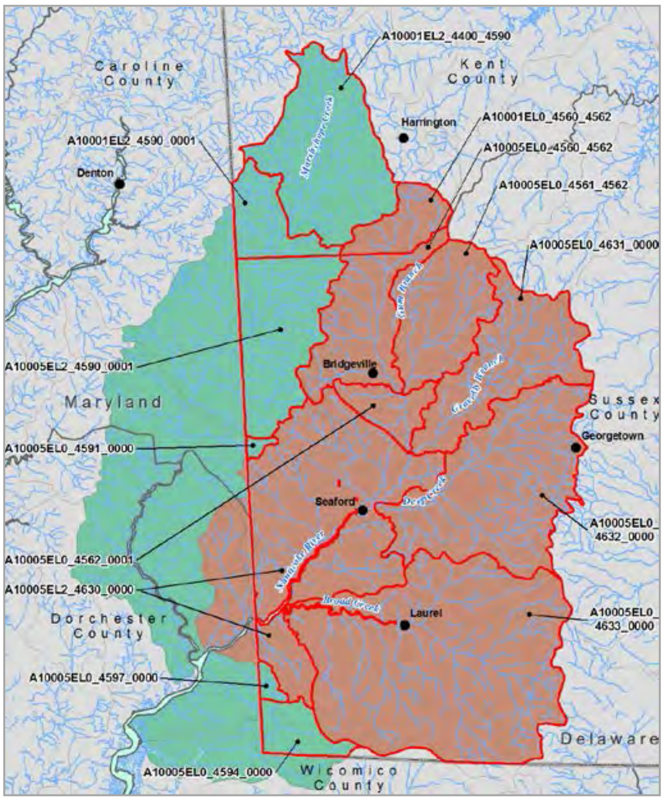
Nanticoke River Watershed Management Plan

Final Plan

November 2014



Prepared for:

Department of Natural Resources and Environmental Control (DNREC)

Prepared by:

KCI Technologies, Inc.
1352 Marrows Road
Suite 100
Newark, DE 19711

Nanticoke River
Watershed Management Plan

Final Plan

November 2014

Prepared for:

Department of Natural Resources and Environmental Control (DNREC)

Prepared by:

KCI Technologies, Inc.
1352 Marrows Road
Suite 100
Newark, DE 19711

KCI Job Order No. 17133560

Table of Contents

List of Tables

List of Figures

List of Acronyms

BMP	Best Management Practices
CAFO	Concentrated Animal Feeding Operations
CAST	Chesapeake Assessment Scenario Tool
CBP	Chesapeake Bay Program
DNREC	Department of Natural Resources and Environmental Control
USEPA	United States Environmental Protection Agency
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
SWM	Stormwater Management
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WIP	Watershed Implementation Plan
WSM	Chesapeake Bay Watershed Model
WWTP	Wastewater Treatment Plant

List of Appendices

Appendix A: WIP communications updates as of January 28, 2014.
Appendix B: State of Delaware Ambient Surface Water Quality Monitoring Program – FY 2012

1 Introduction

The Delaware Department of Natural Resources and Environmental Control (DNREC) Division of Watershed Stewardship is developing Watershed Plans to describe the conditions of major watersheds across the State and to present restoration measures aimed at meeting DNREC's watershed management goals, specifically for this current planning effort meeting the goals associated with Total Maximum Daily Loads (TMDL). Across the Delaware portion of the Chesapeake Bay watershed, TMDLs are in place related to both Bay-wide and local impairments. In 2010 and 2012, the State of Delaware completed Phase I and Phase II Watershed Implementation Plans (WIP) for the Chesapeake Bay in response to requirements for meeting the Chesapeake Bay Total Maximum Daily Load (TMDL) for nitrogen, phosphorus, and sediment. The *Nanticoke River Watershed Restoration Plan* and the *A Pollution Control Strategy for the Nanticoke River* are two comprehensive studies and management plans that are currently in place for the local impairments and associated TMDLs in the Nanticoke River watersheds (NRWG, 2009; NRTAT, 2004).

This current planning effort is designed to forward the recommendations provided in the WIPs, with greater specificity for smaller planning units, including local TMDLs, while incorporating existing data and planning efforts. The Watershed Plans will target local TMDL reductions, where applicable, and Bay TMDL reductions where local TMDLs are not currently in effect. As the WIPs are the program the State of Delaware is implementing, it will be applied to both Bay and local TMDLs. Planning units with nutrient local TMDLs will use the same planning methods and process as the Bay TMDL including unit scale, land use data, and modeling. As the effort is focused on the Chesapeake Bay, the plans include Delaware's Bay watersheds which have been grouped into the following four planning units.

- Upper Chesapeake, which includes the Elk River, C&D Canal, Bohemia Creek, and the Sassafras River;
- Chester River and Choptank River;
- Nanticoke River, which includes three major tributaries, Gum Branch, Gravelly Branch, and Deep Creek; and
- Pocomoke River and Wicomico River.

Information synthesized and incorporated into this plan for the Nanticoke Watershed has been obtained from several resources. The primary sources are:

- Delaware's Phase I Chesapeake Bay Watershed Implementation Plan – November 29, 2010, prepared by Delaware's Chesapeake Interagency Workgroup (DCIW, 2010)
- Delaware's Phase II Chesapeake Bay Watershed Implementation Plan – March 30, 2012, prepared by Delaware's Chesapeake Interagency Workgroup (DCIW, 2012)
- Pollution Control Strategy for the Nanticoke River – October, 2004 (NRTAT, 2004)
- Nanticoke River Watershed Restoration Plan – May 19, 2009 (NRWG, 2009)
- Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorous, and Sediment – December 2010 (USEPA, 2010a)
- Code 7406 TMDLs for Nutrients for the Nanticoke River and Broad Creek – December 1998 (State of Delaware, 1998)
- Total Maximum Daily Loads (TMDL) Analysis for Nanticoke River and Broad Creek Delaware – December 1998 (DNREC, 1998)

- Total Maximum Daily Loads (TMDL) Analysis for Tributaries and Ponds of the Nanticoke River and Broad Creek, Delaware – December 2000 (DNREC, 2000)
- Code 7414 TMDLs for the Marshyhope Creek Watershed in Delaware – December 2006 (State of Delaware, 2006a)
- Total Maximum Daily Loads (TMDLs) Analysis for Chesapeake Drainage Watersheds, Delaware: Chester River, Choptank River, and Marshyhope Creek. Watershed Assessment Section, Division of Water Resources, Delaware Department of Natural Resources and Environmental Control (DNREC. 2005)
- Code 7430 TMDLs for Bacteria for the Chesapeake Bay Drainage Basin, Delaware – December 2006 (State of Delaware, 2006b)
- Total Maximum Daily Loads (TMDLs) Analysis for Chesapeake Bay Drainage Basin, Delaware: Chester River, Choptank River, Marshyhope Creek, Nanticoke River, Gum Branch, Gravelly Branch, Deep Creek, Broad Creek, and Pocomoke River Watersheds - September 2006 (DNREC, 2006)

Both the Upper Nanticoke River and the Marshyhope Creek portion of the Middle Nanticoke River watersheds have a local TMDL for nitrogen and phosphorus (DNREC, 1998; State of Delaware, 1998; DNREC, 2000; DNREC 2005; State of Delaware, 2006a) and are also included in the 2006 bacteria TMDL for the Chesapeake Bay Drainage Basin (DNREC, 2006; State of Delaware, 2006b) and the 2010 Chesapeake Bay TMDL for sediments (USEPA, 2010a). Therefore, nutrient targets presented for the Upper Nanticoke and the Middle Nanticoke – Marshyhope Creek will be based on the local TMDL, bacteria targets will be based on the Chesapeake Bay Drainage Basin TMDL, and sediment targets will be based on the Bay TMDL (Table 1). The remaining watersheds of the Middle Nanticoke River are not included in the local TMDL; therefore, nutrient targets for Middle Nanticoke - Not Marshyhope Creek will be based on the 2010 Bay TMDL.

Table 1: TMDLs used for Pollutant Targets for Upper Nanticoke River and Middle Nanticoke River Watersheds

<table>
<tr><th>Watershed</th><th>Nitrogen</th><th>Phosphorous</th><th>Sediment</th><th>Bacteria</th></tr>
<tr><td>Middle Nanticoke - Marshyhope Creek*</td><td>Local TMDL</td><td>Local TMDL</td><td rowspan="2">Bay TMDL</td><td rowspan="2">Chesapeake Bay Drainage Basin TMDL</td></tr>
<tr><td>Middle Nanticoke - Not Marshyhope Creek**</td><td>Bay TMDL</td><td>Bay TMDL</td></tr>
<tr><td>Upper Nanticoke - Nanticoke River and Broad Creek</td><td>Local TMDL</td><td>Local TMDL</td><td>Bay TMDL</td><td>Chesapeake Bay Drainage Basin TMDL</td></tr>
</table>

Sources:
1) Nanticoke River and Broad Creek Local TMDL (State of Delaware, 1998)
2) Marshyhope Creek Local TMDL (State of Delaware, 2006a)
3) Bay TMDL (USEPA, 2010a)
4) Chesapeake Bay Drainage Basin TMDL (State of Delaware, 2006b)

* Includes only the Marshyhope Creek watershed within the Middle Nanticoke
** Includes the portions of the Middle Nanticoke outside of the Marshyhope Creek watershed

1.1 Goals and Objectives

The primary goal is to prepare the Nanticoke Plan in accordance with the United States Environmental Protection Agency's (EPA) nine essential elements for watershed planning. These elements, commonly called the 'a through i criteria' are important for the creation of thorough, robust, and meaningful watershed plans and incorporation of these elements is of particular importance when seeking implementation funding. The EPA has clearly stated that to ensure that Section 319 (the EPA Nonpoint Source Management Program) funded projects make progress towards restoring waters impaired by nonpoint source pollution, watershed-based plans that are developed or implemented with Section 319 funds to address 303(d)-listed waters must include at least the nine elements.

The Nanticoke Plan is organized based on these elements, which include:

a. An identification of the causes and sources that will need to be controlled to achieve the load reductions estimated in the plan and to achieve any other watershed goals identified in the plan, as discussed in item (b) immediately below.
b. An estimate of the load reductions expected for the management measures described under paragraph (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time.
c. A description of the management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above as well as to achieve other watershed goals identified in the plan, and an identification of the critical areas in which those measures will be needed to implement this plan.
d. An estimate of the amount of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.
e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the recommended management measures.
f. A schedule for implementing the management measures identified in this plan that is reasonably expeditious.
g. A description of interim, measurable milestones for determining whether management measures or other control actions are being implemented.
h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised.
i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

The outcomes of the planning effort are to provide guidance for the strategic implementation of watershed protection and restoration efforts that will advance progress toward meeting Delaware's local TMDLs and Bay TMDL pollutant loading allocations, and ultimately meeting water quality standards. Successful implementation of the plan will lead to improvements in local and Bay-wide watershed conditions and aquatic health.

1.2 Regulatory and Programmatic Environment

While many varied regulatory and volunteer programs exist to enforce environmental protection, the primary programs and regulations addressed by this plan are the Delaware local TMDLs, Chesapeake Bay TMDL, and the National Pollutant Discharge Elimination System (NPDES) permit. Under the Federal Clean Water Act (CWA), the state of Delaware is required to assess and report on the quality of waters throughout the state. Where Delaware's water quality standards are not fully met, Section 303(d) requires the state to list these water bodies as impaired waters. States are then required to develop a TMDL for pollutants of concern for the listed impaired waters. Delaware's TMDLs will be referred to as local TMDLs in this Watershed Management Plan. The *Chesapeake Bay Total Maximum Daily Loads for Nitrogen, Phosphorus, and Sediment* (USEPA, 2010a), is a result of requirements under the Clean Water Act to meet water quality standards and executive order 13508 sign by President Barack Obama in 2009 that put a renewed emphasis and focus on the Chesapeake Bay.

As a result of the renewed effort, and to ensure that progress is achieved, an accountability framework was implemented with actions that the EPA could take if Bay states did not show satisfactory progress. The first two elements of the framework included the development of Watershed Implementation Plans and two-year milestones that would identify specific targets and schedules. A third element linked the Bay TMDL to the NPDES program by calling for inclusion of meeting wasteload allocations within the NPDES permit.

Both the Upper Nanticoke River and the Marshyhope Creek portion of the Middle Nanticoke River watersheds have a local TMDL for nitrogen and phosphorus (DNREC, 1998; DNREC, 2000; DNREC 2005) and are also included in the 2006 bacteria TMDL for the Chesapeake Bay Drainage Basin (DNREC, 2006) and the 2010 Chesapeake Bay TMDL for sediments (USEPA, 2010a). Therefore, nutrient targets presented for the Upper Nanticoke and the Middle Nanticoke – Marshyhope Creek will be based on the local TMDL, bacteria targets will be based on the Chesapeake Bay Drainage Basin TMDL, and sediment targets will be based on the Bay TMDL. The remaining watersheds of the Middle Nanticoke River are not included in the local TMDL; therefore, nutrient targets for Middle Nanticoke-Not Marshyhope Creek will be based on the 2010 Bay TMDL.

1.3 Watershed Priorities

Priorities are discussed in more detail in Section 8.3: Implementation Priorities. Critical watershed issues including current 303(d) listings for biology and habitat and active nutrient TMDLs should all be considered priority areas for project implementation in the Nanticoke watersheds. The critical sources of nitrogen, phosphorus and sediment for both of the Nanticoke watersheds are cropland, animal production areas, and pervious developed land uses. Highest priority should be given to impaired segments located in headwaters. Impairments to headwater streams are carried and experienced downstream; therefore, improvements made to headwater streams will maximize the length of implementation impacts.

Current 303(d) impairments located in the Nanticoke watersheds are discussed in Section 2.4.2 and active TMDLs are discussed in Section 2.4.3. Upper Nanticoke River stream segments that should be prioritized include the mainstem and tributaries of Broad Creek in addition to tributaries of Nanticoke River including Deep Creek Branch, Gravelly Branch, Bridgeville Branch, Gum Branch, White Marsh Branch, Kent-Sussex Line Branch, Nanticoke Branch, and Grubby Neck Branch. The mainstem and tributaries of Marshyhope Creek should be prioritized for the Middle Nanticoke River.

In addition to Nanticoke River 303(d) listings, the *Nanticoke River Watershed Restoration Plan* and *A Pollution Control Strategy for the Nanticoke River* are valuable resources which should be used as guidance for implementation efforts.

2 Watershed Characteristics

2.1 Watershed Delineation and Planning Segments

Delaware lies on the Eastern shore of the Chesapeake Bay, with Bay drainage originating from each of Delaware's three Counties and including land located entirely within the Atlantic Coastal Plain Physiographic Province. The Middle Nanticoke River and Upper Nanticoke River make up two of Delaware's 11 303(d) modeled segments and 14 of the 26 land river segments, which is the primary planning unit for modeling and accounting being used by the EPA (Figure 1 and Figure 2). Two additional land river segments in the Upper Nanticoke are not being addressed in this report due to their negligible size – A10005EL2_4634_0000 and Federal segment, F10005EL2_4630_0000 (12 and 13 acres, respectively). Both the Middle and Upper Nanticoke are part of the Lower Eastern Shore Basin.

Major Basin	Minor Basin	303(d) Segment	Land River Segment	County
Eastern Shore of Chesapeake Bay	Upper Eastern Shore	Elk River (ELKOH)	A10003EU1_2981_0000	NEW CASTLE
			A10003EU1_2983_0000	NEW CASTLE
		C&D Canal (C&DOH_MD)	A10003EU0_3010_0000	NEW CASTLE
		C&D Canal (C&DOH_DE)	A10003EU0_3011_0000	NEW CASTLE
		Bohemia River (BOHOH)	A10003EU0_3201_0000	NEW CASTLE
		Sassafras River (SASOH)	A10003EU0_3361_0000	NEW CASTLE
		Upper Chester River (CHSTF)	A10003EU2_3520_0001	NEW CASTLE
			A10001EU2_3520_0001	KENT
	Middle Eastern Shore	Upper Choptank River (CHOTF)	A10001EM2_3980_0001	KENT
			A10001EM3_4326_0000	KENT
	Lower Eastern Shore	Middle Nanticoke River (NANOH)	A10001EL2_4400_4590	KENT
			A10001EL2_4590_0001	KENT
			A10005EL2_4590_0001	SUSSEX
			A10005EL0_4591_0000	SUSSEX
			A10005EL0_4594_0000	SUSSEX
			A10005EL0_4597_0000	SUSSEX
		Upper Nanticoke River (NANTF_DE)	A10001EL0_4560_4562	KENT
			A10005EL0_4560_4562	SUSSEX
			A10005EL0_4561_4562	SUSSEX
			A10005EL0_4562_0001	SUSSEX
			A10005EL0_4631_0000	SUSSEX
			A10005EL0_4632_0000	SUSSEX
			A10005EL0_4633_0000	SUSSEX
			A10005EL2_4630_0000	SUSSEX
		Pocomoke River (POCTF)	A10005EL2_5110_5270	SUSSEX
		Wicomico River (WICMH)	A10005EL0_5400_0001	SUSSEX

Figure 1: Delaware Drainage Basins and Land River Segments (DCIW, 2012)

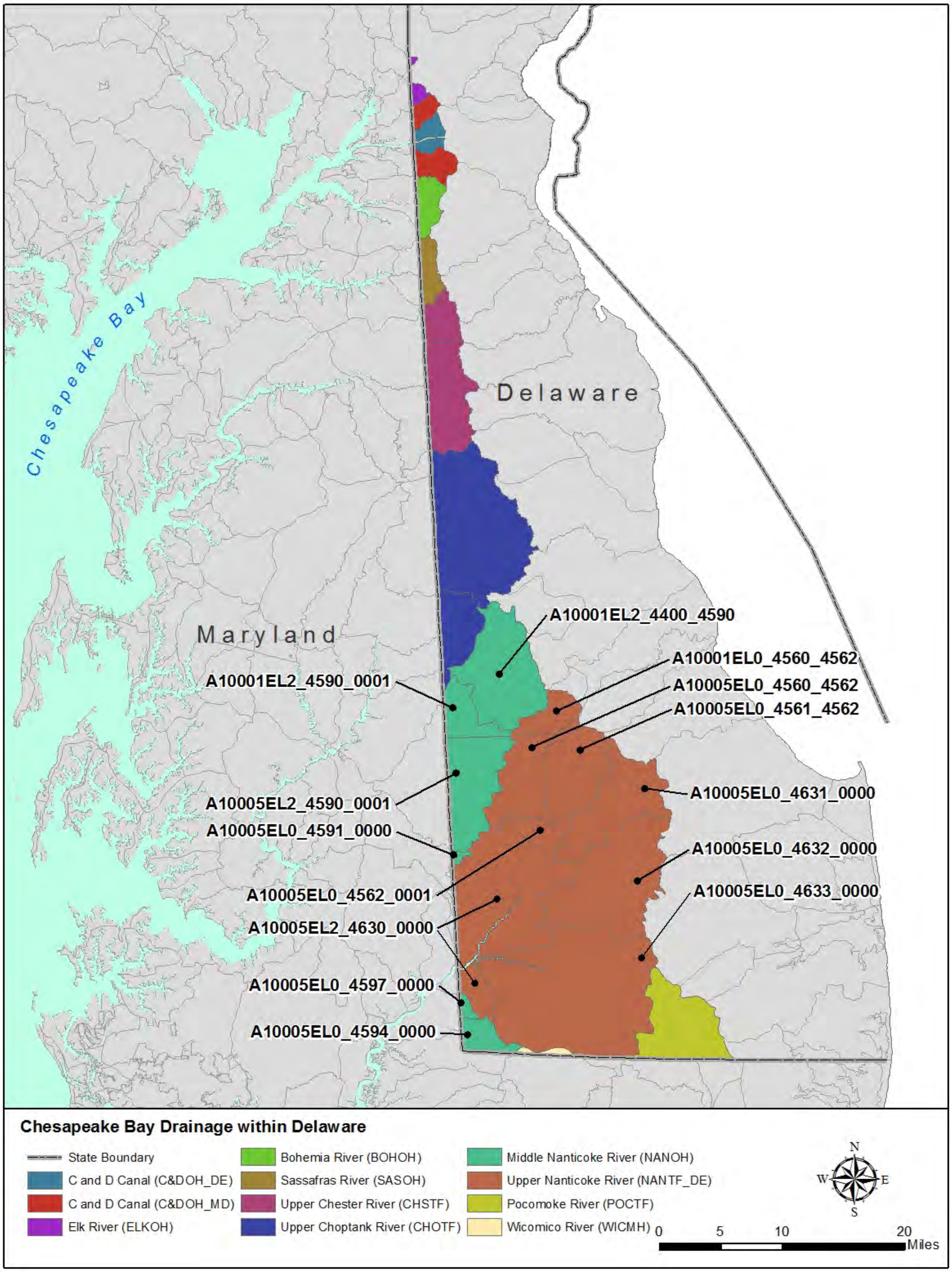


Figure 2: Delaware Chesapeake Bay Drainage and Nanticoke Planning Unit

2.2 Nanticoke River

The Nanticoke River planning unit used in this current plan includes the Middle Nanticoke and Upper Nanticoke Rivers, the majority of which originate in Sussex County, Delaware, while a portion of the Middle and Upper Nanticoke Rivers originate in Kent County, Delaware. Both rivers drain to the southwest into Maryland's eastern shore, including Caroline County, Dorchester County, and Wicomico County. The Nanticoke includes 315,890.7 acres or 493.6 square miles of land area (Table 2). Figure 3 shows the location of each of the segments within the Nanticoke River Planning unit, and each is described here.

2.2.1 Middle Nanticoke River

Middle Nanticoke River in Delaware includes a 108.8 square mile drainage area with headwaters beginning northwest of Harrington. The Middle Nanticoke River flows southwest where an additional 158.7 square miles of drainage area is split between Caroline County, Dorchester County, and Wicomico County, Maryland. Marshyhope Creek is a major tributary of the Middle Nanticoke River. For the purpose of this Watershed Plan, Middle Nanticoke – Marshyhope Creek refers to only the portion of the Middle Nanticoke within the Marshyhope Creek watershed (Land River Segments: A10001EL2_4400_4590, A10001EL2_4590_0001, and A10005EL2_4590_0001). Middle Nanticoke – Not Marshyhope Creek refers to the portion of the Middle Nanticoke outside of the Marshyhope Creek watershed (Land River Segments: A10005EL0_4591_0000, A10005EL0_4597_0000, and A10005EL0_4594_0000).

2.2.2 Upper Nanticoke River

The Upper Nanticoke River, located immediately southeast of Middle Nanticoke River, includes 246,282.0 acres, or 384.8 square miles of headwater in Delaware. The Upper Nanticoke River flows west into Dorchester and Wicomico County, Maryland, with the majority of the watershed located in Sussex County, Delaware. Headwater tributaries to the Upper Nanticoke River include Gum Branch, Gravelly Branch, Deep Creek, and Broad Creek.

Table 2: Nanticoke Watershed Drainage Area and Stream Miles

Watershed	Drainage Area (Acres)	Drainage Area (Square Miles)	Stream Miles
Middle Nanticoke River	69,608.7	108.8	314.8
Upper Nanticoke River	246,282.0	384.8	863.7
TOTAL	**315,890.7**	**493.6**	**1,178.5**

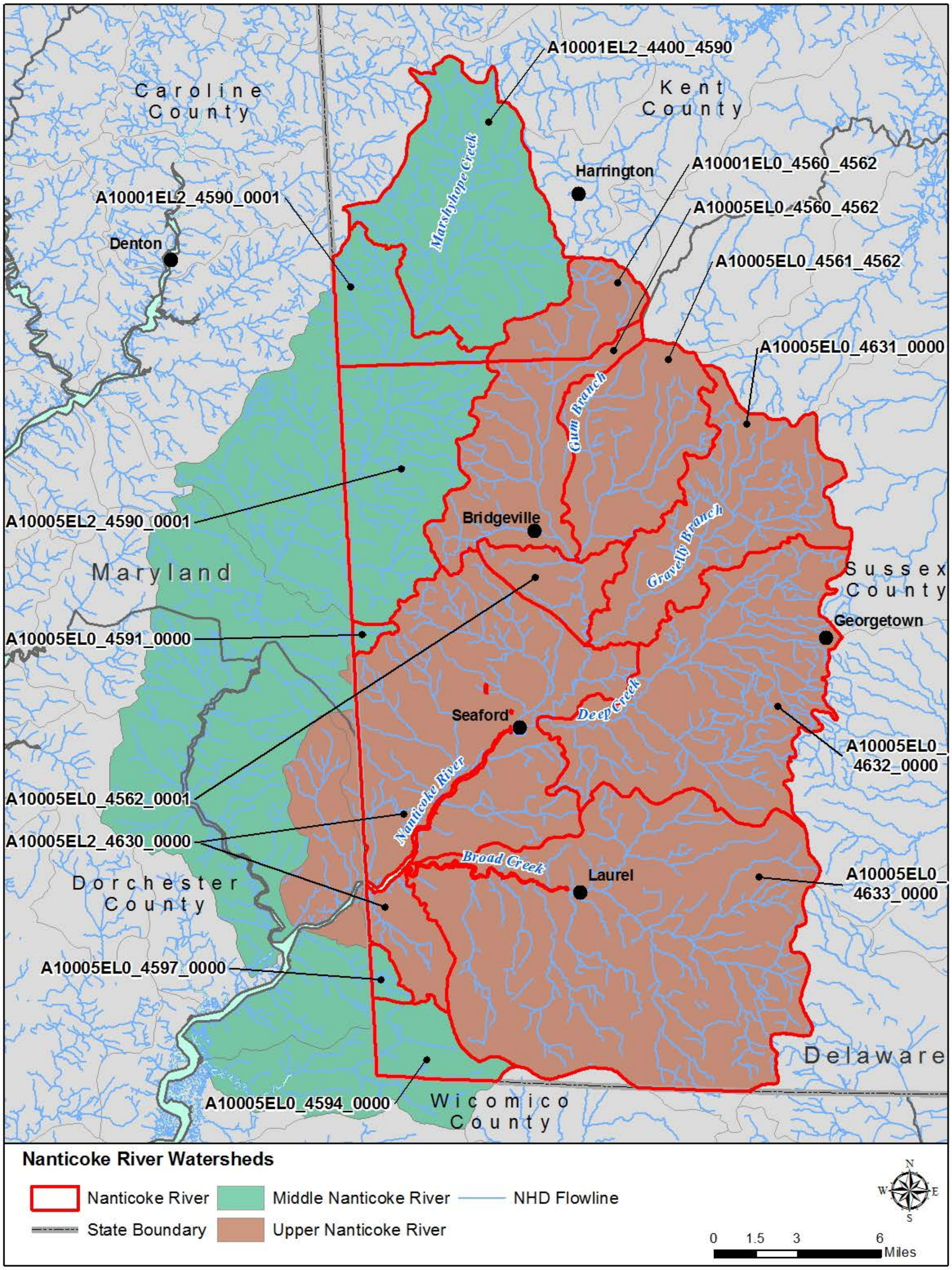


Figure 3: Nanticoke River Planning Unit Watershed Locations

2.3 Land Use

The type and density of various land uses can have a dramatic effect on water quality and stream habitat. Forested areas slow stormwater flow and allow water to gradually seep into soils and drain into streams. Vegetation and soils bind nutrients and pollutants found within stormwater—improving water quality as it infiltrates the ground. Developed areas, with a high percentage of impervious surfaces (buildings, paved roads, parking lots, etc.), do not slow stormwater flow—increasing the amount of pollutants entering streams. Increased stormflow can negatively affect stream habitat by increasing bank erosion and decreasing instream and riparian habitat. Agricultural land, if managed incorrectly, can also increase nutrients and bacteria in streams.

See Figure 4, Figure 6, Figure 8, Figure 10, and Figure 12 for aerial imagery of each subwatershed. 2007 land use data from the Delaware Office of State Planning Coordination (2008) and 2007 impervious surface data from the State of Delaware, Office of Management and Budget (2008) are presented in Figure 5, Figure 7, Figure 9, Figure 11, and Figure 13. Land use data presented in the figures below were used to show potential sources and were not used in calculations.

2.3.1 Existing Land Use

The Nanticoke as a whole is made up of a mixture of land use, primarily including agriculture and forested lands (Table 3). Approximately one-half of the Nanticoke planning unit is agriculture (47.6%) with the remaining land use largely comprised of forest (41.7%). Approximately ten percent of the watersheds consist of developed land (10.4%). Water makes up the small remainder (0.3%).

Table 3: 2010 Nanticoke Land Use

Watershed	Land Use Description							
	Agriculture		Developed		Forest		Water	
	Acres	%	Acres	%	Acres	%	Acres	%
Middle Nanticoke River	34,879.9	50.1	3,531.7	5.1	31,180.7	44.8	16.5	0.0
Upper Nanticoke River	115,481.7	46.9	29,405.4	11.9	100,470.3	40.8	924.5	0.4
Total	**150,361.6**	**47.6**	**32,937.2**	**10.4**	**131,651.0**	**41.7**	**940.9**	**0.3**

2.3.2 Imperviousness

Impervious surfaces concentrate stormwater runoff, accelerating flow rates and directing stormwater to the receiving stream. This accelerated, concentrated runoff can cause stream erosion and habitat degradation. Runoff from impervious surfaces picks up and washes off pollutants and is usually more polluted than runoff generated from pervious areas. In general, undeveloped watersheds with small amounts of impervious cover are more likely to have better water quality in local streams than urbanized watersheds with greater amounts of impervious cover. Impervious cover is a primary factor when determining pollutant characteristics and loadings in stormwater runoff.

The degree of imperviousness in a watershed also affects aquatic life. There is a strong relationship between watershed impervious cover and the decline of a suite of stream indicators. As imperviousness increases the potential stream quality decreases with most research suggesting that stream quality begins to decline at or around 10 percent imperviousness (Schueler, 1994; CWP, 2003). However, there is considerable variability in the response of stream indicators to impervious cover observed from 5 to 20 percent imperviousness due to historical effects, watershed management, riparian width and vegetative protection, co-occurrence of stressors, and natural biological variation. Because of this variability, one cannot conclude that streams draining low impervious cover will automatically have good habitat conditions and a high quality aquatic life.

Impervious surfaces make up just 2.3% of the overall Nanticoke drainage. Impervious surfaces in Middle Nanticoke River and Upper Nanticoke River are very similar and make up 1.3% and 2.6% respectively.

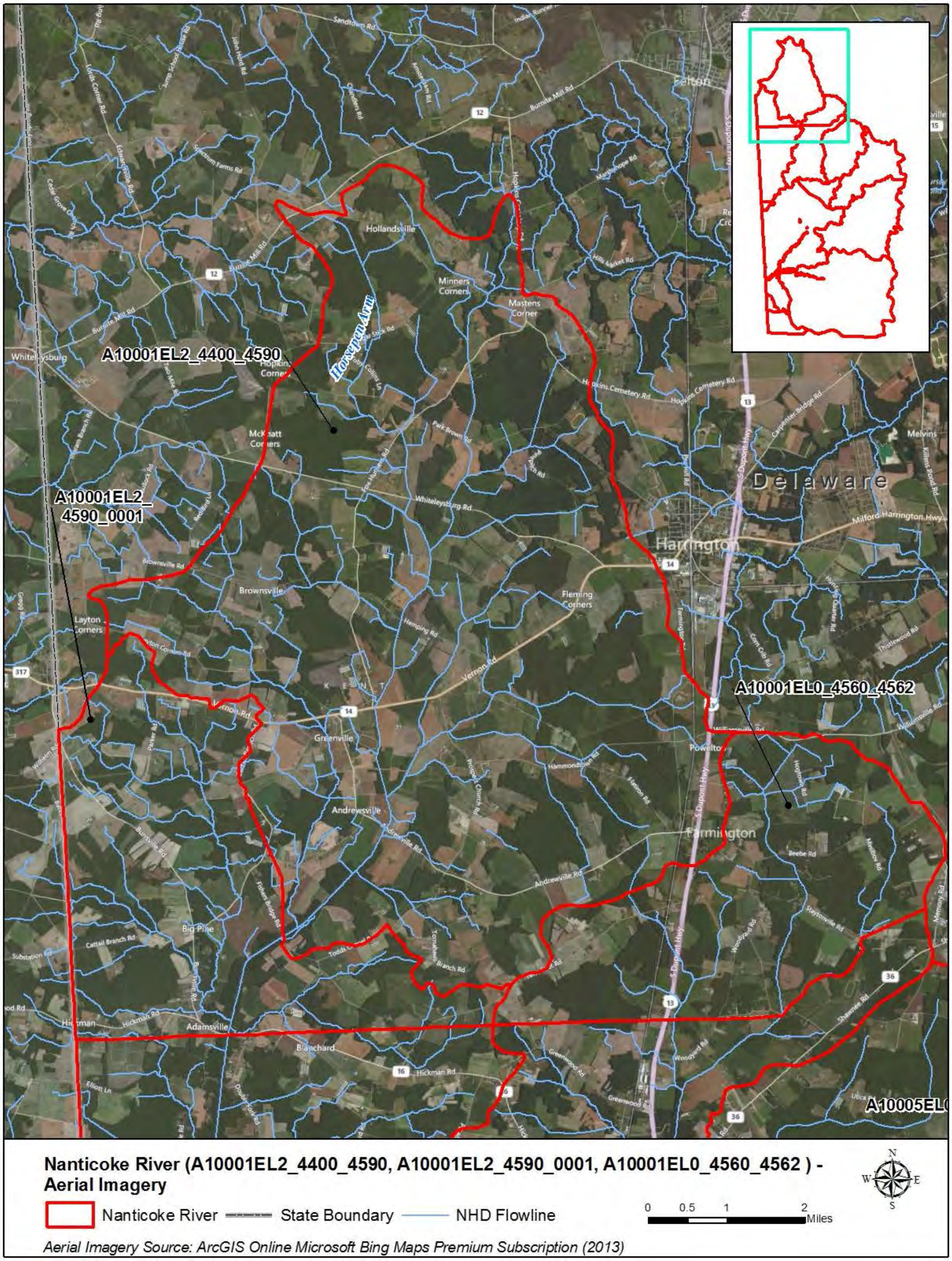


Figure 4: Nanticoke River (A10001EL2_4400_4590, A10001EL2_4590_0001, A10001EL0_4560_4562) - Aerial Imagery

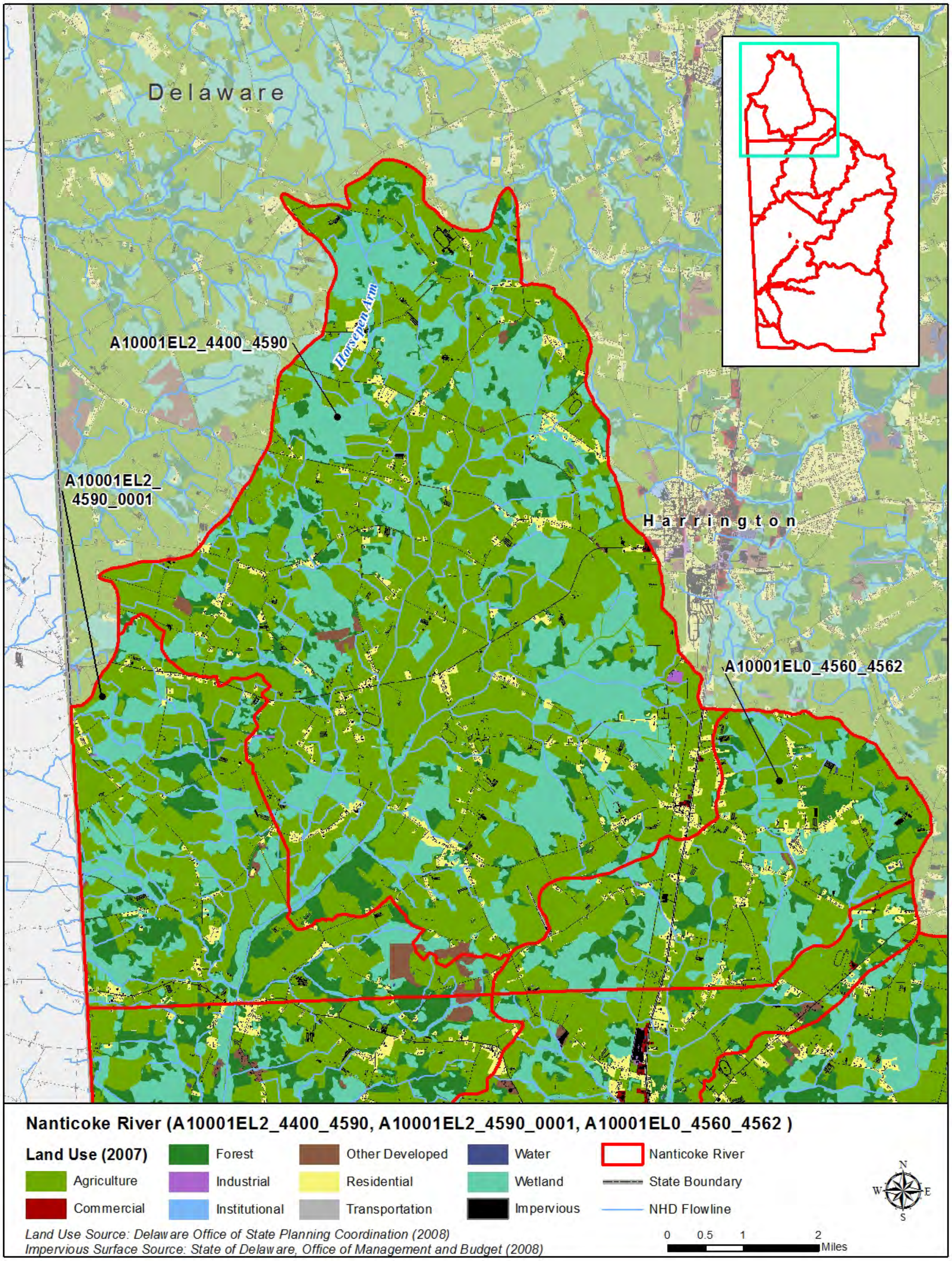


Figure 5: Nanticoke River (A10001EL2_4400_4590, A10001EL2_4590_0001, A10001EL0_4560_4562) - Land Use and Impervious Surface

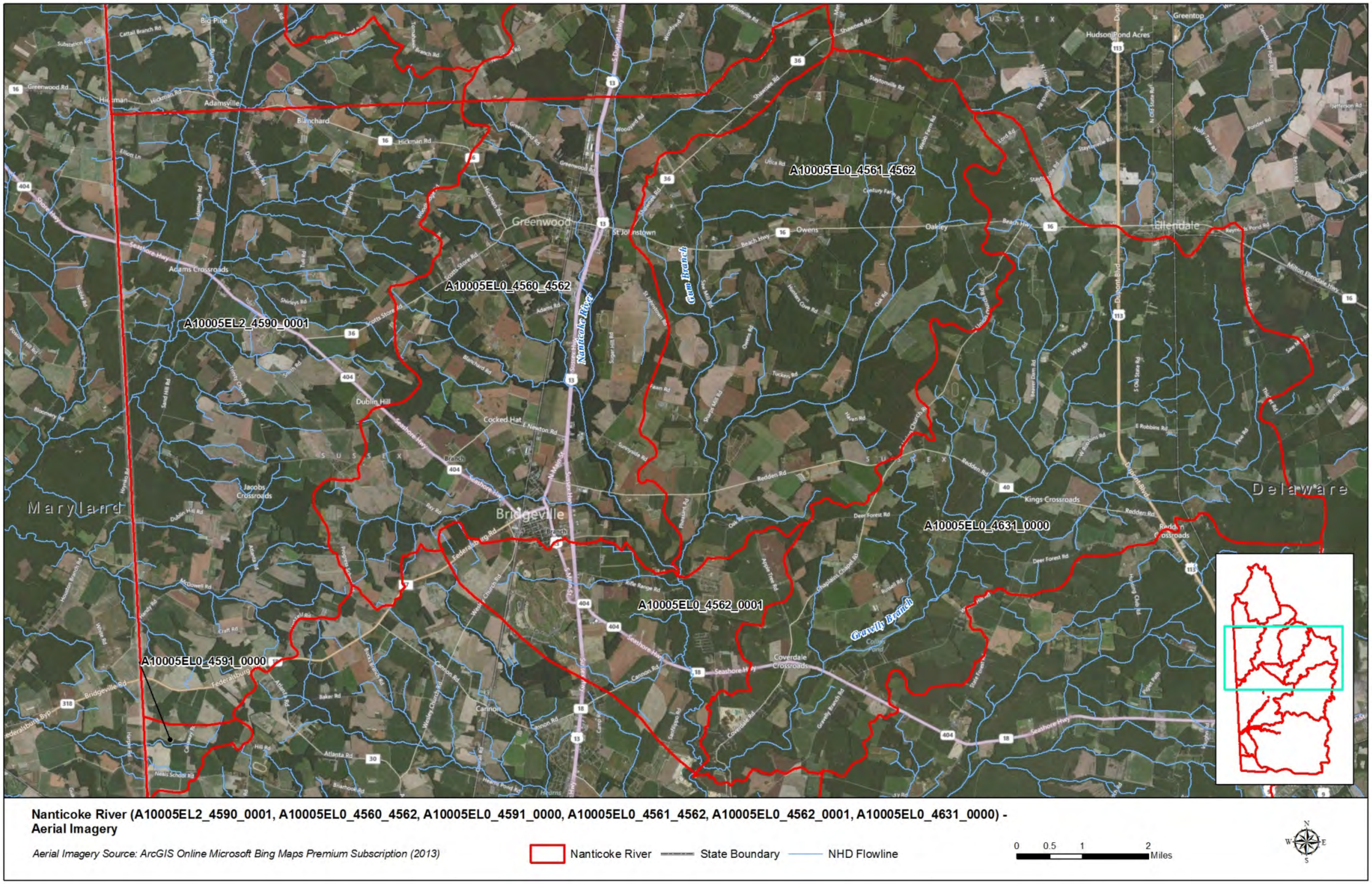


Figure 6: Nanticoke River (A10005EL2_4590_0001, A10005EL0_4560_4562, A10005EL0_4591_0000, A10005EL0_4561_4562, A10005EL0_4562_0001, A10005EL0_4631_0000) - Aerial Imagery

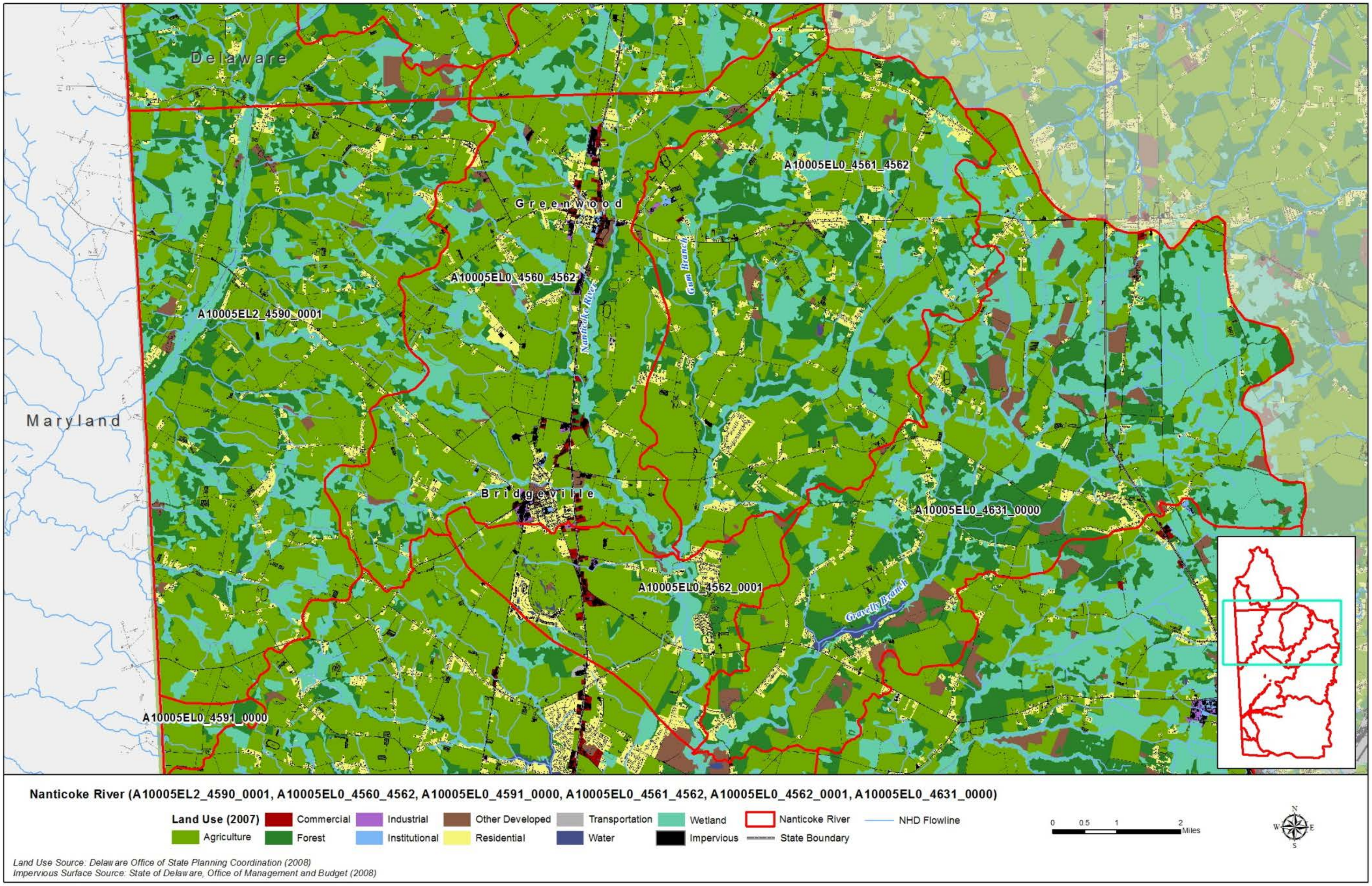


Figure 7: Nanticoke River (A10005EL2_4590_0001, A10005EL0_4560_4562, A10005EL0_4591_0000, A10005EL0_4561_4562, A10005EL0_4562_0001, A10005EL0_4631_0000) - Land Use and Impervious Surface

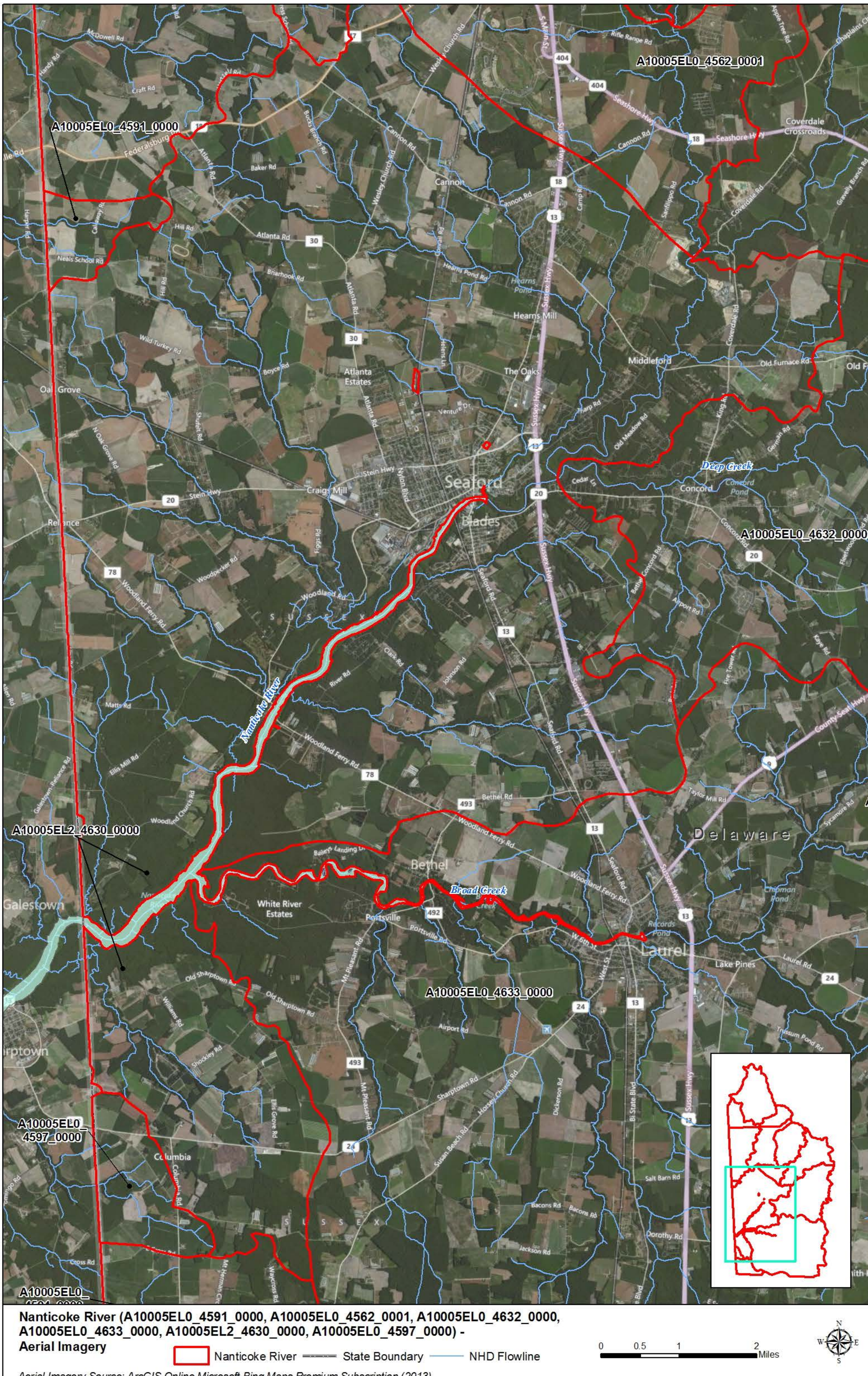


Figure 8: Nanticoke River (A10005EL0_4591_0000, A10005EL0_4562_0001, A10005EL0_4632_0000, A10005EL0_4633_0000, A10005EL2_4630_0000, A10005EL0_4597_0000) Aerial Imagery

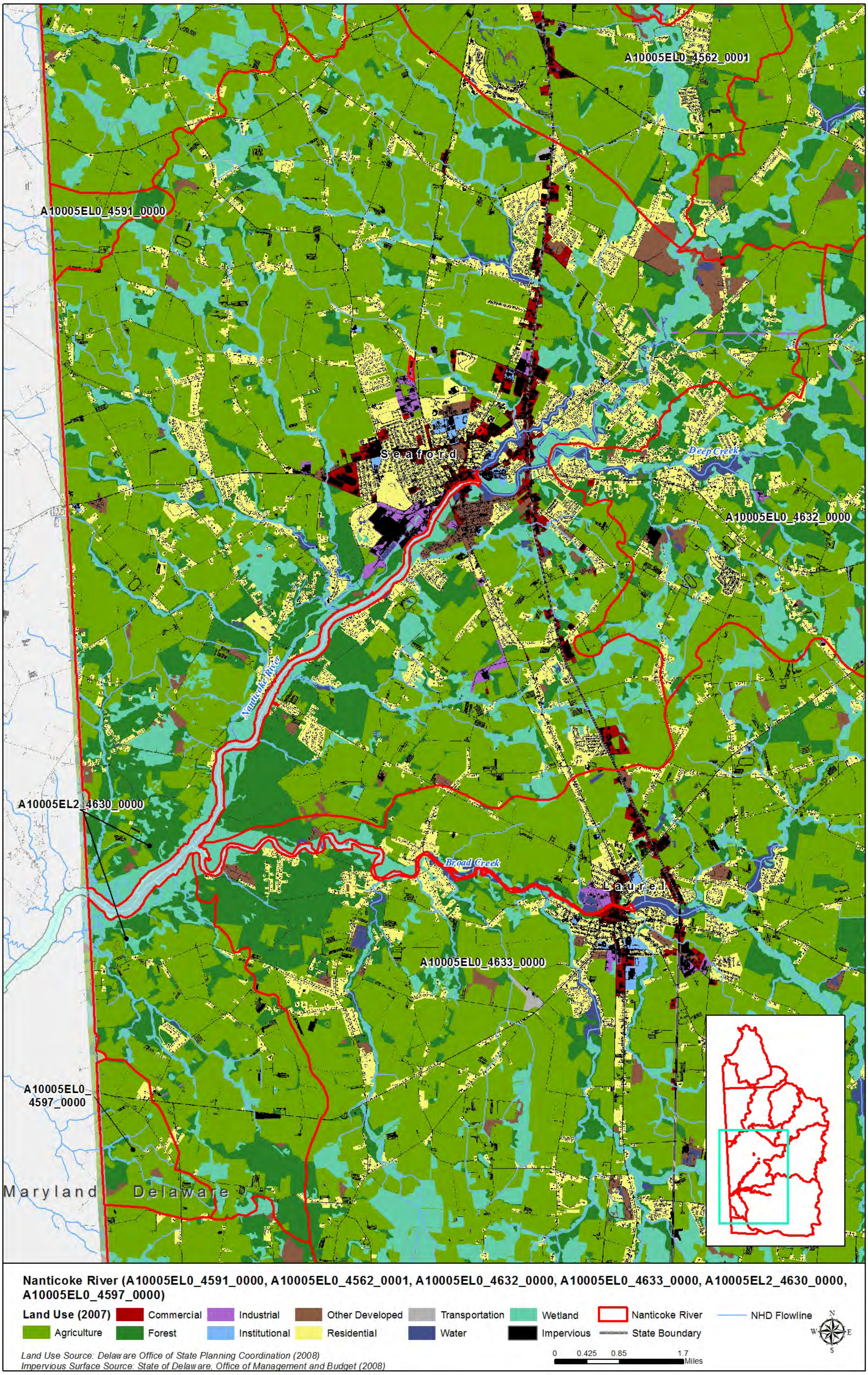


Figure 9: Nanticoke River (A10005EL0_4591_0000, A10005EL0_4562_0001, A10005EL0_4632_0000, A10005EL0_4633_0000, A10005EL2_4630_0000, A10005EL0_4597_0000) - Land Use and Impervious Surface

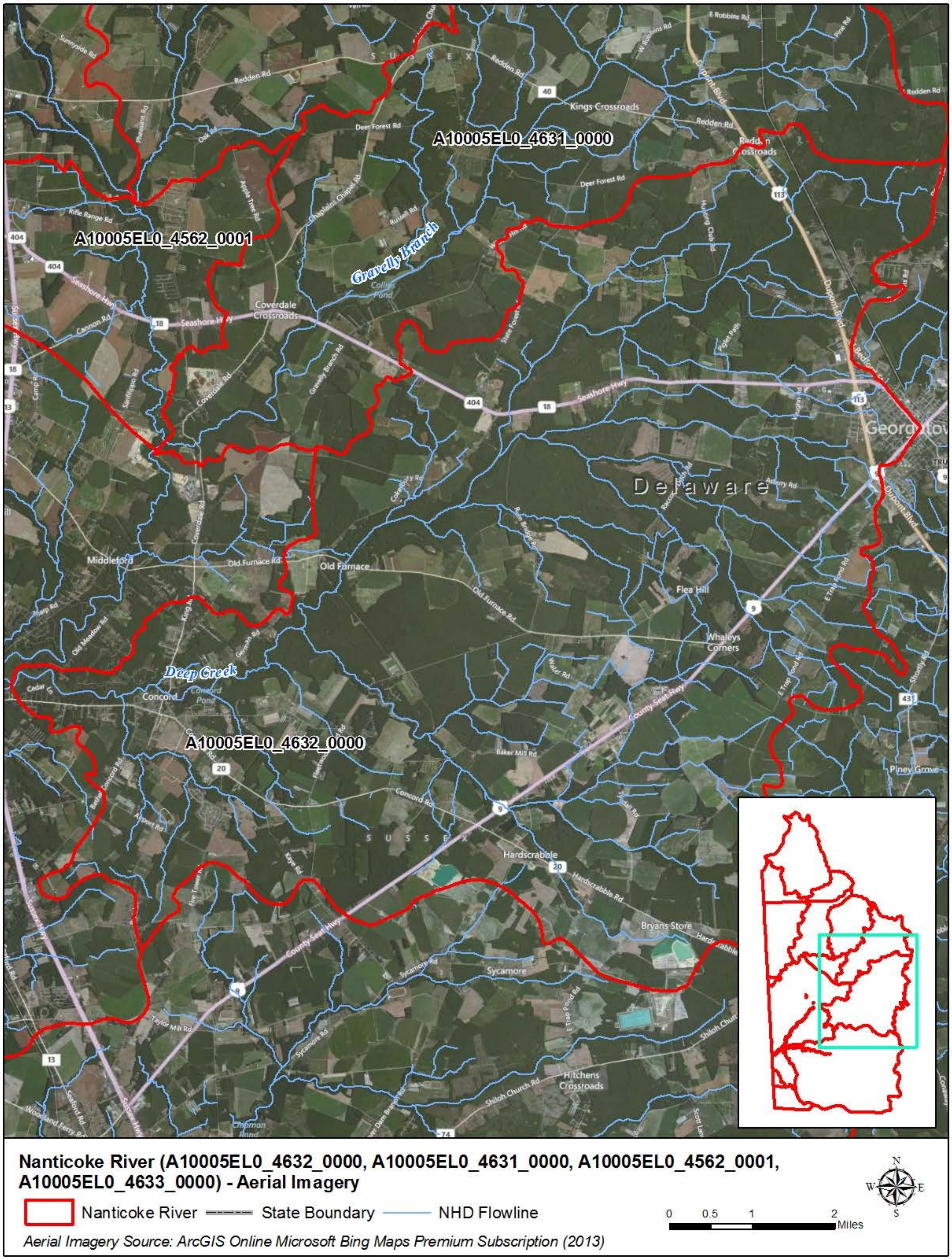


Figure 10: Nanticoke River (A10005EL0_4632_0000, A10005EL0_4631_0000, A10005EL0_4562_0001, A10005EL0_4633_0000) - Aerial Imagery

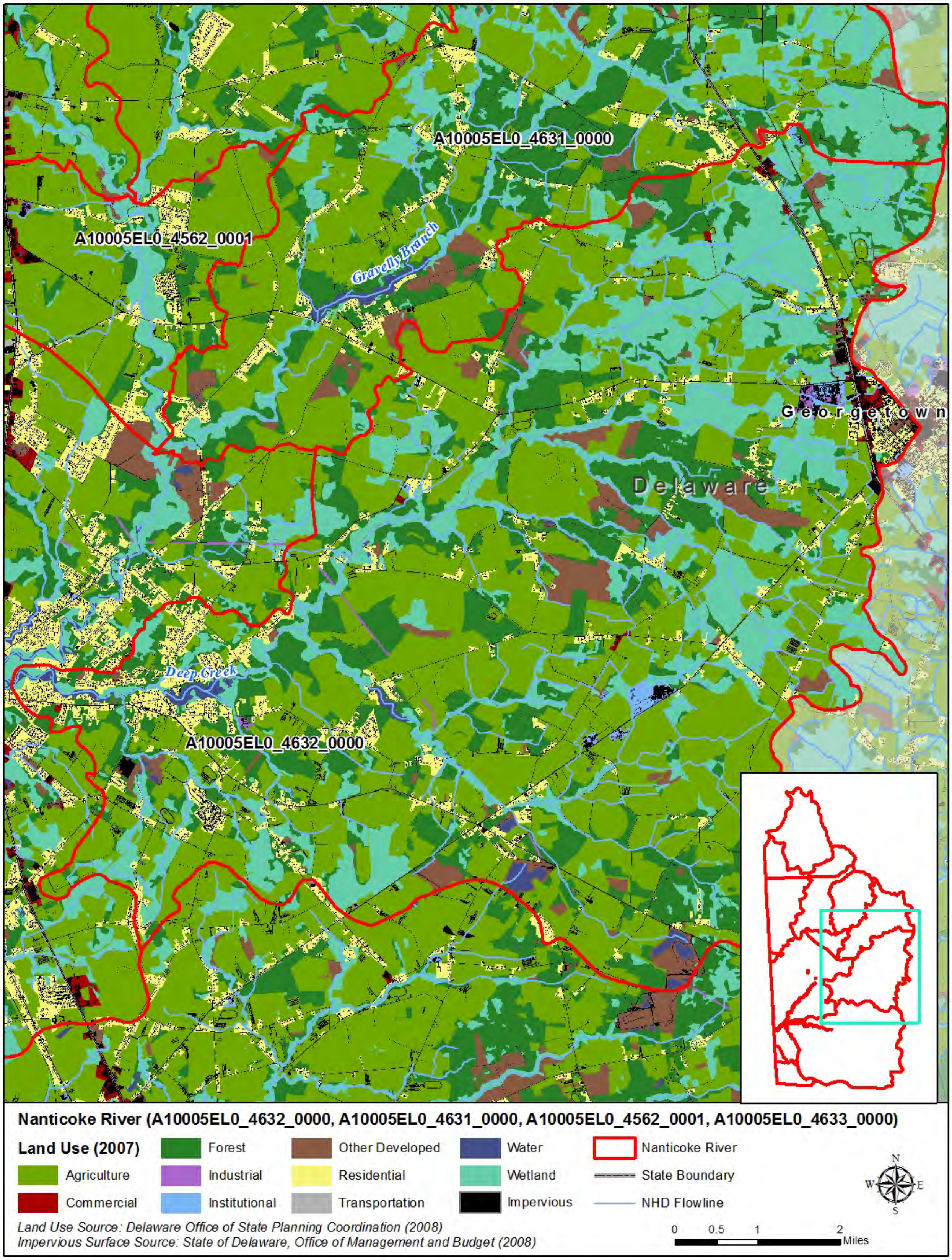


Figure 11: Nanticoke River (A10005EL0_4632_0000, A10005EL0_4631_0000, A10005EL0_4562_0001, A10005EL0_4633_0000) - Land Use and Impervious Surface

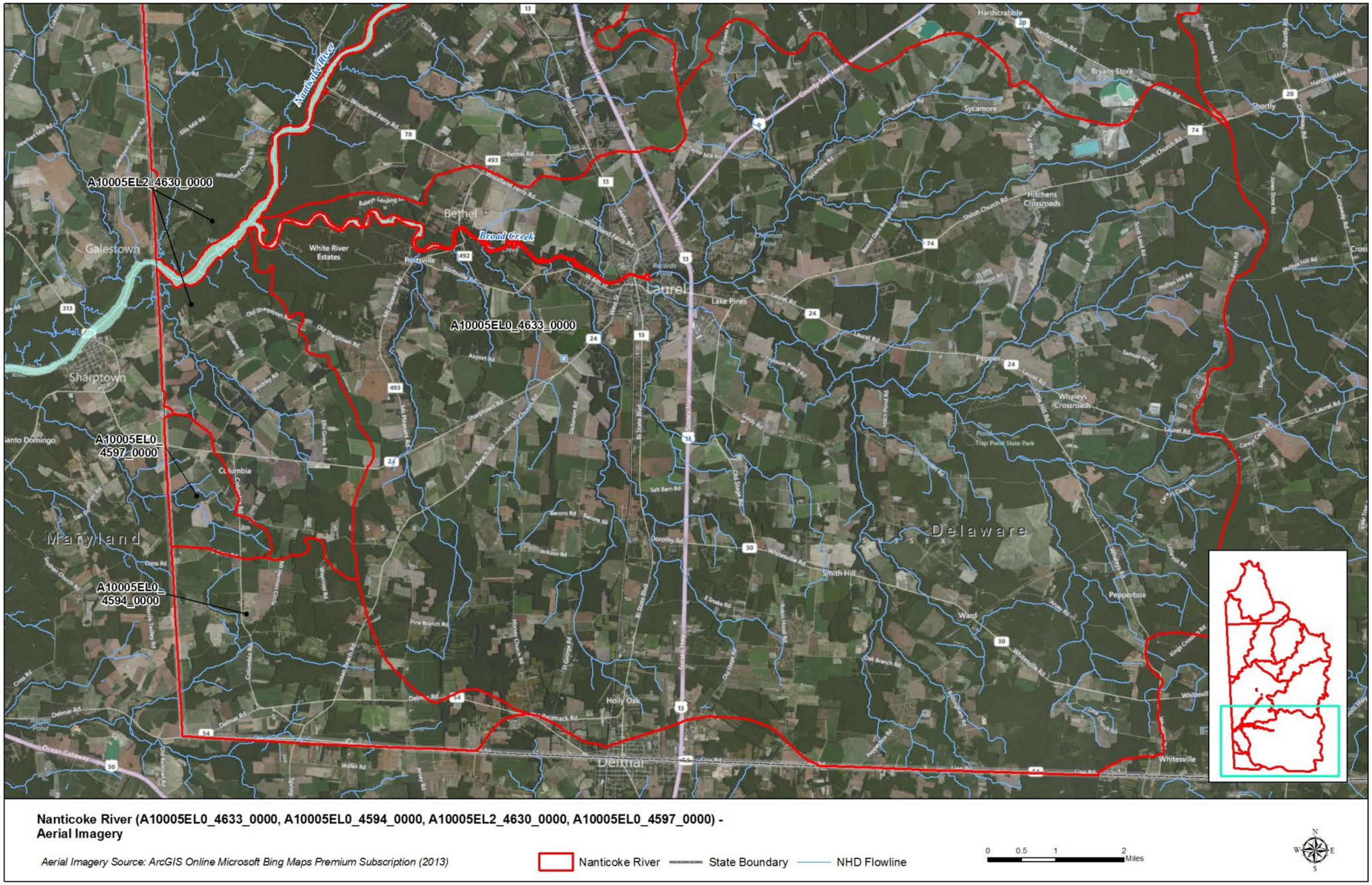


Figure 12: Nanticoke River (A10005EL0_4633_0000, A10005EL0_4594_0000, A10005EL2_4630_0000, A10005EL0_4597_0000) - Aerial Imagery

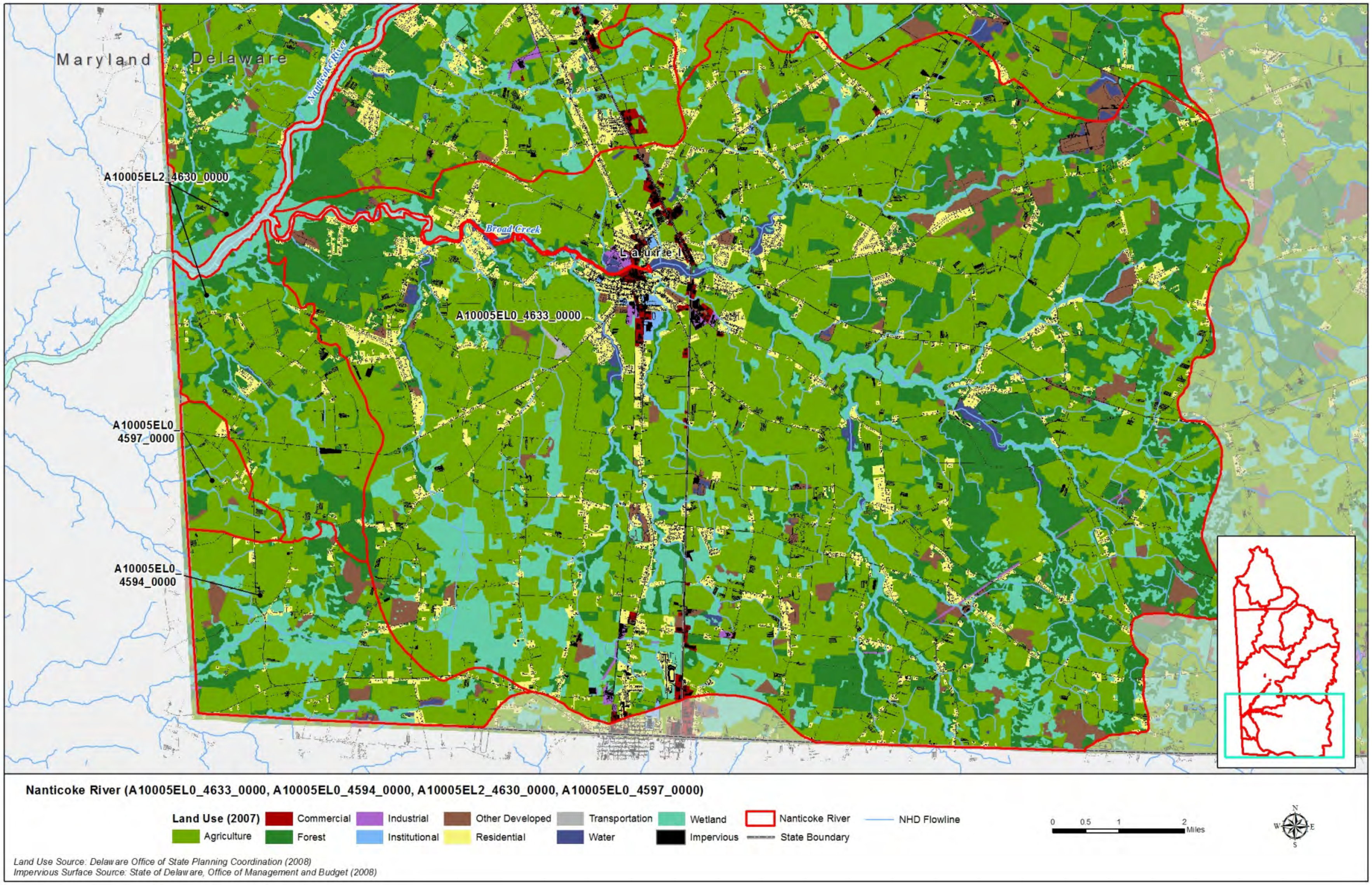


Figure 13: Nanticoke River (A10005EL0_4633_0000, A10005EL0_4594_0000, A10005EL2_4630_0000, A10005EL0_4597_0000) - Land Use and Impervious Surface

2.4 Water Quality

2.4.1 Use Designations

Following Title 7 of Delaware's Administrative Code for Natural Resources & Environmental Control (7400 Watershed Assessment Section, 7401 Surface Water Quality Standards), the Use Designations for the Nanticoke waterbodies are presented in Table 4. The designations for both the Nanticoke River and tributaries of Nanticoke River include water supply, contact recreation and aquatic life uses.

Table 4: Use Designations of Nanticoke River and Tributaries of Nanticoke River

Waterbody	Nanticoke River	Marshy-hope Creek	Gum Branch	Gravelly Branch	Deep Creek	Broad Creek	Nanticoke River
Public Water Supply Source	-	-	-	-	-	-	-
Industrial Water Supply	x	X	x	x	x	x	x
Primary Contact Recreation	x	X	x	x	x	x	x
Secondary Contact Recreation	x	X	x	x	x	x	x
Fish, Aquatic Life & Wildlife*	x	X	x	x	x	x	x
Cold Water Fish (Put-and-Take)	-	-	-	-	-	-	-
Agricultural Water Supply**	x	X	x	x	x	x	x
ERES Waters***	x	X	x	x	x	x	x
Harvestable Shellfish Waters	-	-	-	-	-	-	-

Source: http://regulations.delaware.gov/AdminCode/title7/7000/7400/7401.pdf
*waters of Exceptional Recreational or Ecological Significance
**freshwater segments only
*** Includes shellfish propagation

2.4.2 303(d) Impairments

According to Delaware's 2012 303(d) list of impaired waters (DNREC, 2012a), several segments within the Nanticoke planning unit are listed for water quality impairments. Category 5 waters for the Middle Nanticoke River watershed, which include those waters that are not meeting their use designation and require a TMDL, include the Marshyhope Creek mainstem and tributaries of Marshyhope Creek. For the Upper Nanticoke River watershed, Category 5 waters include the mainstem and tributaries of Nanticoke River including, Deep Creek Branch, Gravelly Branch, Gum Branch, and Broad Creek. With an exception to two temperature stressors listed in two tributaries to Marshyhope Creek, the majority of stressors listed include biology and habitat with non-point sources indicated as the probable source of impairment. The total stream mileage includes 44.1 miles of stream for the Middle Nanticoke River watershed and 56.6 miles of stream for the Upper Nanticoke River watershed (100.7 miles total). The target date for TMDLs for all listings is 2010.

2.4.3 TMDLs

Both the Middle Nanticoke and Upper Nanticoke have local TMDL regulations for nutrients (i.e., nitrogen and phosphorus), which were established in response to the several 303(d) listings mentioned in the previous section (Section 2.4.2). The TMDL regulations for Nanticoke Mainstem and Broad Creek (Upper Nanticoke) were established in 1998 while the TMDL regulations for Marshyhope Creek (Middle Nanticoke) were established seven years later in 2005. Both TMDL regulations include a cap of nonpoint source nitrogen and phosphorus loads for the watershed.

The Nanticoke River Tributary Action Team developed a Pollution Control Strategy for the Nanticoke River (NRTAT, 2004) to achieve nutrient reductions throughout the watershed in response to the 1998 TMDL for Nanticoke mainstem and Broad Creek.

Additionally, both the Middle Nanticoke and Upper Nanticoke are a part of the Chesapeake Bay TMDL for nitrogen, phosphorus, and sediment (USEPA, 2010a) and are included in the 2006 Chesapeake Bay Drainage Basin TMDL for bacteria (DNREC, 2006).

2.4.4 NPDES

The Federal Clean Water Act requires a NPDES permit to discharge pollutants through a point source into a "water of the United States". In Delaware, New Castle County and the Delaware Department of Transportation (DelDOT) are co-permittees on the State's only MS4 NPDES permit. Current data indicates that there are 16.1 acres of regulated impervious and 45.7 acres of pervious developed areas within the Nanticoke planning area, specifically in the Upper Nanticoke River watershed (Segment: A10005EL0_4633_0000).

2.5 Anticipated Growth

According to the Phase II WIP, future growth is expected to occur across the Chesapeake drainage dependent on local land use and planning. The majority of the Nanticoke River planning unit (420.2 square miles) is located within Sussex County, Delaware, with a smaller portion (73.4 square miles) also in Kent County, Delaware.

The Sussex County Comprehensive Plan was last updated in 2007 and approved in 2008 (DWIC, 2012). The next update of the plan is due by October 2018. In the meantime, annual reviews of the plan, which began July 2012, are being submitted to the Cabinet Committee on State Planning Issues reporting on the progress of implementing the Plan. Sussex County is considered the fastest growing area in Delaware with the highest growth rate among the three counties occurring between the 2000 U.S. Census and 2008 (15%; SCCPU, 2008). The population in Sussex County is projected to grow to 253,226 people in 2030, which is an increase of 61.7% from 2000 census data of 156,638 people. However, while the population is projected to continually increase from 2000 to 2030, the rate of increase is projected to decrease markedly every ten years (e.g., 24% population change from 2000-2010 to a 12% population change projected from 2020 to 2030; SCCPU, 2008). The primary developed areas included in this section of Sussex County are Seaford, Laurel, and Georgetown, Delaware, located in the headwaters of Upper Nanticoke River.

Sussex County has a goal to expand regional and local wastewater treatment facilities for a large portion of the Bay watershed by 2017 through a 'Short Term Wastewater Expansion' program with additional expansions occurring between 2017 and 2025 as part of the 'Long Term Wastewater Expansion' program (DWIC, 2012). The City of Seaford, Town of Laurel, and Town of Georgetown are also committed to improving water quality and plan to continue to extend wastewater treatment services to their local residents. In addition, the City of Seaford plans to incorporate new technology to accommodate future growth in the area.

Sussex County continues to utilize strategies such as promoting low impact development and implementing stormwater retrofits for water quality treatment. The County will continue to work with The Department of the Office of State Planning and Coordination to refine short and long term wastewater and septic goals, in addition to long term grown projections in order to meet Delaware's TMDL goals (DWIC, 2012).

The Kent County Comprehensive Plan was last updated in 2007 and approved in 2008. The next update of the plan is due by October 2018 with a review of the plan to be completed by October 2023 (DWIC, 2012). The primary developed area included in this section of the county is Harrington, Delaware, which is located approximately 2 miles east of the headwaters of Marshyhope Creek in the Middle Nanticoke River watershed. According to the 2000 census data, Kent County's population density was 126,697 people, which was a 13.5% increase over the 1990 census population (KCCP, 2008). The population in Kent County is projected to grow to 189,431 people in 2030, which is an increase of 49.5% from 2000. However, while the population is projected to continually increase from 2005 to 2030, the rate of increase is projected to decrease markedly every five years (e.g., 12.8% population change from 2000-2005 to a 3.6% population change projected from 2025 to 2030; KCCP, 2008).

The Kent County Comprehensive Plan expressed goals to make major capital improvements to the wastewater system including wastewater plant improvements to increase capacity and meet environmental standards (i.e., TMDL compliance), conveyance system and system capacity improvements, and sanitary sewer expansions.

3 Causes and Sources of Impairment (a)

The Nanticoke watershed has local TMDLs on two portions of the watershed, and another portion only has the Chesapeake Bay TMDL (Table 5). The Upper Nanticoke has a TMDL established in 1998 for nutrients and another in 2006 for bacteria. This Upper Nanticoke TMDL specifies that it includes the Nanticoke and Broad Creek. For clarity in this Watershed Management Plan, that portion of the Nanticoke is referenced as Upper Nanticoke - Nanticoke & Broad Creek. The Middle Nanticoke also has a TMDL for nutrients established in 2005 and bacteria in 2006 that refers to the area as Marshyhope Creek. For clarity in this Watershed Management Plan, that portion of the Nanticoke is referenced as Middle Nanticoke - Marshyhope Creek. There is a smaller portion of the Nanticoke located along the southern border of the Nanticoke that only is covered by the 2010 Chesapeake Bay TMDL for nutrients and sediment. This smaller portion is referred to as Middle Nanticoke - Not Marshyhope. Given that there are different TMDLs for each of these three areas of the Nanticoke, this Watershed Management Plan addresses the following three areas in turn. The 2006 Bacteria TMDL covered both the Upper and Middle portions of the Nanticoke, so bacteria is addressed separately at the end of this section.

Table 5: Nanticoke areas covered by a local TMDL or solely the Chesapeake Bay TMDL.

Nanticoke Watershed Area	TMDL Establishment Date	TMDL Pollutants	Additional Plans
Upper Nanticoke-Nanticoke & Broad Creek	1998/2006	Nutrients and bacteria	Pollution Control Strategy, 2004 and Watershed Restoration Plan, 2009
Middle Nanticoke-Marshyhope Creek	2005/2006	Nutrients and bacteria	NA
Middle Nanticoke-Not Marshyhope	2010	Nutrients and sediment	Watershed Implementation Plan for 2017 and 2025 and Two-Year Milestones

3.1 Upper Nanticoke - Nanticoke & Broad Creek

The Upper Nanticoke - Nanticoke & Broad Creek is 51 percent agricultural of the total land in the basin. After agriculture, land uses consist of wooded area 39%, brushland 5%, and urban areas 2.4% (DNREC, 2000). To quantify the loads, intensive monitoring was conducted in 1998 and 1999. These monitoring stations are presented in Table 6 with the STORET identification number, which is a cataloging number for EPA's STOrage and RETrieval repository. At each station, grab samples were collected 4 times a year and were analyzed for the 24 water quality parameters presented in Table 7. These water quality data were used to develop the TMDL.

Table 6: Monitoring Stations in the Upper Nanticoke - Nanticoke & Broad Creek.

Monitoring Location	Storet No.
Tussocky Branch / Portsville Pond	
1. Portsville Pond on Tussocky Branch of Broad Creek, at county road 496	307061
(lat:38 33 50.0, long: 075 37 55.0)	
2. Tussocky Branch at County Road 494, southwest of laurel	307101
(lat:38 32 30.0, long: 075 38 15.0)	
3. Tussocky Branch at Route 24 Bridge	307291
(lat: 38 31 18.0, long: 075 37 58.8)	
4. Turkey Branch at Rt. 495 Bridge	307331
(lat:38 46 34, long: 75 32 11)	
Chipman Pond Branch / Chipman Pond	
1. Chipman Pond Branch at Road 467 Bridge (below confluence of Mirey Branch and Elliot Pond Br)	307121
2. Chipman Pond, 2/3 distance from Spillway to inflow stream confluence	307131
(lat:38 34 10.8, long: 075 32 03.3)	
3. Chipman Pond Branch at Rt. 465 Bridge, down stream of Chipman Pond Spillway	307341
(lat:38 33 28, long: 075 31 51)	
4. Beaver Dam Branch at Rd. 447 Bridge (below Wileys Pond)	307111
(lat: 38 34 27.6, long: 075 31 11.9)	
Pepper Pond Branch	
1. Pepper Pond Branch at Rt. 24 Bridge	307281
(lat: 38 32 27.0, long: 075 28 25.2)	
2. Grays Branch at Rt. 62 Bridge	307351
(lat: 38 33 28, long: 75 31 51)	
3. Pepper Branch at Rt 62 Bridge	307361
(lat: 38 33 28, long: 75 31 51)	
Trap Pond Branch	
1. Thomson Branch at Rd. 72 Bridge	307221
(lat: 38 31 01.7, long.: 075 27 08.7)	
2. Racoon Prong at Racoon Pond Spillway (Road 72 Bridge)	307201
(lat:38 30 55.7, long: 075 27 39.8)	
3. Trap Pond, 200 yard above Spillway	307181
(lat:38 31 41.2, long: 075 28 49.4)	

Monitoring Location	Storet No.
4. Trap Pond on Hitch Pond Branch at County Road 449	307081
(lat: 38 31 45.0, long: 075 28 55.0)	
5. Raccoon Prong at Rd 62 Bridge	307371
(lat: 38 29 49.18, long: 75 27 06.44)	
Horsey Pond	
1. Horseys Pond, 50 yards above Spillway	307171
(lat: 38 31 54.3, long: 075 34 41.6)	
2. Meadow Branch at Road 501 Bridge	307151
(lat: 38 34 07.0, long: 075 37 11.7)	
3. Horsey Pond Overflow	307171
Record Pond / Trussum Pond	
1. James Branch, outflow of Trussum Pond at Rd. 72 Bridge	307091
(lat: 38 31 33.03, 75 30 40.84)	
2. James Branch at Rd 451 Bridge	307381
(lat: 38 30 27.80, long: 75 30 24.20)	
3. James Branch on Rt 24 Bridge	307391
(lat: 38 33 16.23, long: 75 32 19.94)	
4. Records Pond Spillway	307401
(lat: 38 33 31.47, long: 75 34 02.36)	
5. Record Pond Overflow	307011
Clear Brook / Hearns Pond / Williams Pond	
1. Herring Run at Rt. 20 Bridge before entering Williams Pond	304621
(lat: 38 39 08.82, long: 75 35 49.75)	
2. William H. Newton Ditch at Rt. 46 Bridge	304631
(lat: 38 40 32.06, long: 75 34 36.91)	
3. Clear Brook at US Rt. 13 (downstream of Hearns Pond)	304571
4. Clear Brook above DE Rt. 18 Bridge	304371
5. Clear Brooks, Bucks Branch at Rd. 546	304381
6. Hearns Pond, 100 yrd above spillway	304411
7. Williams Pond, middle of the pond at US Rt. 13	304581
8. William Pond Overflow	304321
Deep Creek / Concord Pond	
1. Baker Mill Branch at Rt. 483 Bridge	304641
(lat: 38 38 21.28, long: 75 32 18.67)	
2. Tyndall Branch at Rt. 484 Bridge at spillway of Fleetwood Pond	304651
(lat: 38 38 40.26, long: 75 30 31.70)	
3. Deep Creek above Concord Pond, near Old Furnace at Rd. 46	304591
4. Deep Creek above Concord Pond, near Cokesbury Church at DE Rt. 18	304601
5. Concord Pond Overflow	304311
Gravelly Branch	
1. Gravelly Branch downstream of the outlet of Collins Pond at Rt. 404 Bridge	316021
2. Gravelly Branch at west edge of Redden State Park, Rd. 565 Bridge	316031
3. Gravelly Branch at Rd 525	316011
Bridgeville Branch	

Monitoring Location	Storet No.
1. Bridgeville Branch at US Rt. 13 Bridge	304051
2. Bridgeville Branch at DE Rt. 404 Bridge	304271
3. Bridgeville Branch at Rd. 564 Bridge	304611
Gum Branch	
1. Gum Branch at Rd. 487 Bridge (the western intersect)	304441
2. Gum Branch at Rd. 485 Bridge	304531
Lewes Creek / Craig Pond	
1. Lewes Creek, Chapel Branch at Rt. 20	304451
2. Lewes Creek, Chapel Branch at Rd. 547	304541
3. Lewes Creek, Butler Mill Branch at Rd. 80 Bridge	304551
4. Lewes Creek, Butler Mill Branch, Horse Pen Branch at Rd. 20	304561
5. Lewes Creek, Butler Mill Branch, downstream of Craig Pond at Rd. 542A	304301

Table 7: Average water quality conditions at monitoring locations in the Upper Nanticoke - Nanticoke & Broad Creek during 1998-1999.

Trib-utary	Location	Station	Flow cfs	water Temp C	DO mg/l	CBOD 5 mg/l	Chlor-a mg/l	TKN mg/l	NH3 mg/l	NOX N mg/l	Ortho P mg/l	TP mg/l
Tussocky Br.	Head Water	307291	0.57	17.00	7.67	2.40	4.20	0.39	0.05	4.02	0.01	0.03
	Tusscky Pd &	307101	1.02	21.02	8.75	2.40	6.00	0.82	0.06	2.29	0.01	0.04
	Portsville Pd	307061		21.10	8.72	3.04	5.40	0.65	0.06	4.90	0.01	0.03
	Tributary	307331		21.90	5.80	2.40	1.00	2.82	1.82	11.70	0.00	0.02
Horsey Pond	Head Water	307151	6.76	16.48	7.94	2.40	9.25	0.64	0.06	2.96	0.02	0.10
	Horsey Pd	307171	3.47	20.90	10.14	2.98	35.80	0.83	0.05	1.81	0.01	0.08
James Br.	Record Pd	307011	23.08	20.30	8.77	2.45	12.60	0.76	0.16	3.00	0.01	0.06
	Record Pd	307401	44.71	18.75	9.35	3.58	24.00	0.82	0.04	3.24	0.01	0.04
	Mid James Br.	307391	0.00	16.94	6.96	2.40	3.40	0.71	0.05	4.24	0.02	0.05
	Trussum Pd	307091	5.25	19.42	5.58	3.88	37.80	1.85	0.07	0.70	0.01	0.11
	Head Water	307381	0.00	16.50	6.31	2.40	7.60	0.73	0.08	2.69	0.04	0.10
Hitch Pd Br.	Pepper Pd Br	307351	1.42	15.28	5.70	2.40	5.60	0.81	0.08	1.16	0.04	0.11
	Pepper Pd Br	307361	0.96	15.62	4.79	2.40	4.40	0.92	0.19	0.56	0.08	0.17
	Pepper Pd Br.	307281	3.10	16.02	6.10	2.40	4.40	0.90	0.06	3.41	0.02	0.06
	TrapPd Outfall	307081	5.09	20.25	7.15	2.40	7.50	0.99	0.09	0.52	0.09	0.18

Trib-utary	Location	Station	Flow cfs	water Temp C	DO mg/l	CBOD 5 mg/l	Chlor-a mg/l	TKN mg/l	NH3 mg/l	NOX N mg/l	Ortho P mg/l	TP mg/l
	TrapPd	307181	0.00	21.28	8.12	2.68	20.80	2.09	0.06	0.38	0.02	0.12
	Raccoon Pd	307201	0.51	17.90	4.75	2.72	30.00	1.03	0.09	0.43	0.01	0.10
	Trib.frm	307221	0.24	15.13	7.14	2.40	6.00	0.62	0.06	3.07	0.02	0.06
	HdWater	307371	0.00	20.30	4.03	3.10	53.50	2.03	0.06	1.41	0.01	0.16
Chipman P Br.	Chipman Pd	307341	8.70	19.05	9.65	2.40	6.00	0.66	0.06	3.68	0.01	0.03
	Chipman Pd	307131	0.00	20.76	9.49	3.16	20.00	0.54	0.07	4.44	0.01	0.06
	Head Water	307111	0.48	15.06	7.50	2.42	5.00	0.51	0.06	5.06	0.02	0.09
	Trib to	307121	0.00	16.44	8.71	2.40	6.60	0.51	0.07	8.26	0.02	0.05
Gum Br.	Lower Strm R3	304441	0.70	16.24	7.18	2.40	5.60	1.00	0.11	5.96	0.01	0.12
	Head Water	304531	0.81	17.04	6.79	2.42	10.60	0.66	0.17	3.01	0.01	0.08
Deep Cr.	Trib. to Concord	304641	1.28	15.08	8.00	3.03	3.00	0.41	0.03	5.11	0.01	0.03
	Trib frm Tyndall	304651	6.82	17.80	8.93	2.40	6.25	0.32	0.05	3.49	0.02	0.05
	Concord PD	304311	22.07	19.98	9.21	2.83	7.60	0.49	0.04	1.27	0.01	0.02
	MidStrm btwn	304591	0.00	16.16	5.69	5.02	312.6	1.43	0.09	0.59	0.01	0.26
	Head Water	304601	4.71	17.20	7.02	2.40	6.20	0.64	0.04	0.61	0.02	0.05
Gravelly Br.	End of Gravelly	316011	0.00	16.66	8.18	2.40	7.60	0.57	0.05	2.39	0.01	0.03
	Outfall of Collins	316021	9.42	19.62	7.03	2.47	33.80	0.80	0.06	1.26	0.02	0.03
	Head Water to	316031	0.00	18.76	6.15	2.40	7.20	0.54	0.08	0.90	0.03	0.05
Bridgeville Br.	Lower seg	304051	5.03	18.82	9.32	3.33	9.00	0.98	0.09	4.72	0.02	0.07
	Mid & Upper	304271	4.84	18.34	7.08	2.40	3.40	0.82	0.12	3.98	0.02	0.04
	HeadWater	304611	0.67	17.38	7.10	2.40	5.60	0.70	0.05	3.98	0.01	0.05
Clear Brook	Outfall	304321		21.24	9.05	2.84	43.60	0.70	0.07	1.36	0.01	0.07
	William Pd	304581	0.00	21.16	8.97	3.34	46.40	0.83	0.04	1.43	0.01	0.07
	Herring Run	304621	0.00	17.66	5.67	2.81	10.20	1.06	0.14	4.06	0.02	0.09
	Newton Ditch	304631		15.80	2.40	2.40	3.00		0.02	2.89	0.05	
	Outfall of Hearn	304571	0.00	19.82	5.11	3.86	55.40	1.45	0.23	1.64	0.02	0.16
	Outfall of	304411	0.00	20.86	9.41	4.58	102.0	1.92	0.11	1.63	0.07	0.23

Trib-utary	Location	Station	Flow cfs	water Temp C	DO mg/l	CBOD 5 mg/l	Chlor-a mg/l	TKN mg/l	NH3 mg/l	NOX N mg/l	Ortho P mg/l	TP mg/l
	Hearn											
	Bucks Br.	304381	2.46	16.40	7.36	2.68	5.50	0.73	0.11	5.54	0.04	0.14
	Head water	304371	0.00	15.63	5.10	2.40	7.25	0.87	0.21	2.01	0.11	0.22
Chapel Br.	Mid & Lower seg	304451	2.03	15.72	7.01	2.41	2.60	0.54	0.05	8.76	0.02	0.03
	Head Water	304541	0.00	16.22	4.87	2.40	4.40	0.81	0.21	2.98	0.05	0.11
Butler M Br.	Crag Pd Outfall	304301	4.17	18.80	7.35	2.40	4.00	0.61	0.10	4.35	0.01	0.03
	Mid Seg	304551	2.14	14.63	8.27	2.40	5.00	0.87	0.04	6.94	0.02	0.05
	Head Water	304561	2.49	17.98	7.42	2.40	3.83	0.69	0.08	6.73	0.04	0.07

There are five permitted wastewater facilities in the Nanticoke. Four of these are major and of those four, one is industrial. The flow and annual loads are in Table 8. The Mobile Gardens Trailer Park moved to a Rapid Infiltration Basin system and is not anticipated to have loads after 2012. Seaford uses spray irrigation and their loads are variable since the conditions for spraying are determined by hydrological factors.

Table 8: Wastewater treatment plants in the Nanticoke as of June 30, 2012.

NPDES	Facility Name	Major	Indus-trial	Flow (MGD)	TN (lbs)	TP (lbs)	TSS (lbs)
DE0000035	INVISTA (DUPONT-SEAFORD)	Y	Y	9.71	3,782	137	1,971
DE0020125	LAUREL	Y	N	0.35	1,475	612	1,231
DE0020249	BRIDGEVILLE	Y	N	0.05	3,921	512	1,117
DE0020265	SEAFORD	Y	N	0.94	21,630	3,568	5,806
DE0050725	MOBILE GARDENS TRAILER PARK	N	N	0.02	412	125	377

3.2 Middle Nanticoke - Marshyhope Creek

The Middle Nanticoke - Marshyhope Creek is dominated by agriculture, wetlands, and forests. The detailed land use information for this watershed that was used to develop the local TMDL is based on 2002 Delaware Office of State Planning Coordination land cover data. The land use activity in the watershed is 55% agriculture; 25% wetland; 13% forest; 4% residential; commercial and industrial areas; and 3% rangeland. Farmington is the only incorporated town.

Monitoring stations are listed in Table 9. The average water quality data for the monitoring period used to establish the local TMDL is presented in Table 10. The monitoring data showed that occasional dissolved oxygen violations occurred at all four monitoring sites. Nutrient levels were relatively high in the range of 1.0 to 4.4 mg/l for total nitrogen and 0.01 to 0.47 mg/l for total phosphorus. They exceeded the State's nutrient threshold levels of 3.0 mg/l for total nitrogen and 0.2 mg/l for total phosphorus. Based on the monitoring data, Delaware's 2004 305(b) Reports (4) showed that elevated nutrient levels and low DO concentrations impaired Marshyhope Creek and its designated uses were only partially supported for aquatic life and primary contact recreation.

Table 9: Monitoring stations in the Middle Nanticoke - Marshyhope Creek

Monitoring Location	STORET No.	TMDL (active during 2001-2003)
Marshyhope Creek Watershed		
1. Marshyhope Ditch at Fox Hunters Rd. (Rd. 277)	302051	√
2. Marshyhope Creek at Hemping Rd. (Rd. 299)	302041	√
3. Marshyhope Creek at Fishers Bridge Rd. (Rd. 308)	302031	√
4. Marshyhope Creek at Hickman Rd. (Rt. 16)	302011	√
5. Marshyhope Creek at Woodenhawk Bridge (Rt. 404)	302021	√
6. Marshyhope Creek at Nobel Rd.	302061	2005 only

Table 10: Average water quality conditions at monitoring locations in the Middle Nanticoke - Marshyhope Creek during 2001-2003

Monitoring Station	Water Temp C	Field DO mg/l	BOD5 mg/l	Chlor-a ug/l	Org-N mg/l	NH3-N mg/L	NO2-N mg/l	NO3-N mg/l	TN mg/l	Org-P mg/l	Dis-P mg/l	TP mg/l
302051	15.99	7.23	2.64	21.63	1.19	0.19	0.09	0.79	2.26	0.34	0.06	0.40
302041	16.65	7.72	2.66	7.81	0.78	0.13	0.09	0.82	1.67	0.12	0.03	0.15
302031	16.87	8.76	2.40	5.41	0.87	0.12	0.20	1.83	3.02	0.12	0.04	0.16
302021	17.40	8.16	2.40	3.08	1.03	0.11	0.21	1.88	3.23	0.08	0.06	0.14
302061*	6.21	11.08	2.40	3.01	0.50	0.10	0.31	2.76	3.57	0.08	0.01	0.09

*Station 302061 was sampled during the modeling phase of the project; therefore the averages for this station are from December 2004 through April 2005.

3.3 Middle Nanticoke - Not Marshyhope

The causes and sources of impairment and expected load reductions for the Nanticoke watershed was identified using data from the Chesapeake Bay Program (CBP) Partnership Watershed Model (WSM) (USEPA, 2010b). This is the same model that was used to establish the load allocations for the 2010 Chesapeake Bay TMDL for Nitrogen, Phosphorus, and Sediment (Bay TMDL) USEPA, 2010a). There are no local TMDLs for the Middle Nanticoke - Not Marshyhope. The WSM is calibrated to multiple decades of monitoring data from hundreds of stations in the Chesapeake Bay. The monitoring stations located in DE include those in Table 11.

Table 11: Monitoring stations located in DE and used to calibrate the Watershed Model.

Station	Segment	Description
1483700	DE0_3791_0001	ST JONES RIVER AT DOVER, DE
1484100	DE0_4231_0001	BEAVERDAM BRANCH AT HOUSTON, DE
1487000	EL0_4562_0003	NANTICOKE RIVER NEAR BRIDGEVILLE, DE
1488500	EL2_4400_4590	MARSHYHOPE CREEK NEAR ADAMSVILLE, DE

The Bay TMDL was established using the initial conditions of 2010. These initial conditions include animal numbers, land use, and septic systems. The 2010 initial conditions are held constant for evaluating causes and sources, expected load reductions, and management measures. The Bay TMDL requires all new and increased loads to be offset. A change in initial conditions would result in new or increased loads. Offsetting new and increased loads is addressed in the section: Management Measures. However, there are a few BMPs that change the land use, such as forest buffers so these data are different than the pre-BMP land use presented in Section 2.

The Middle Nanticoke - Not Marshyhope has 3,563 acres of agricultural land, 2,869, acres of urban land, and 294 acres of forest, including buffered areas. Approximately 14 acres are lakes, rivers, streams, or other waterbodies. The Middle Nanticoke - Not Marshyhope does not vary significantly on a spatial basis because it is all the same physiographic region. Therefore, the analysis of causes and sources was conducted on land use. The land use is presented in Figure 14.

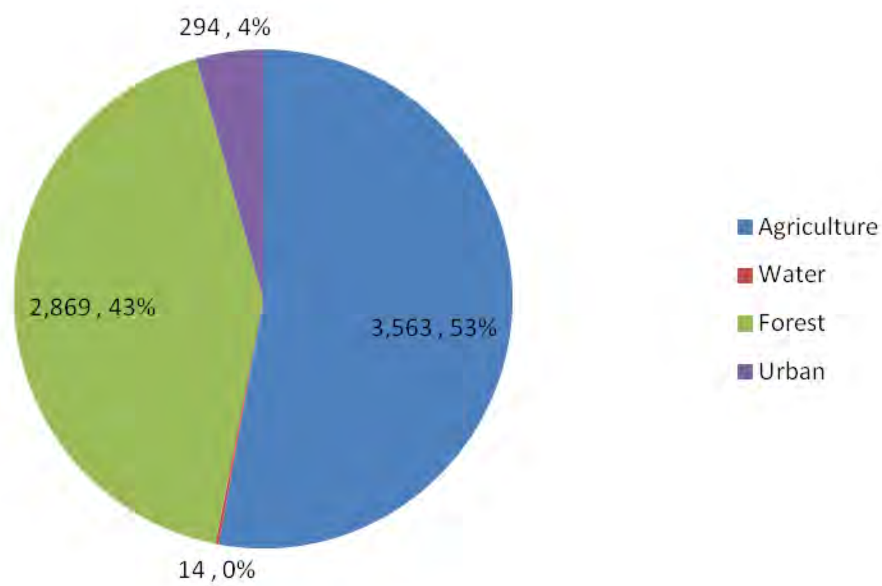


Figure 14: Land use for the Middle Nanticoke River - Not Marshyhope using the 2010 Bay TMDL land use data with BMPs applied through June 30, 2012.

The data in the following figures are presented only for the Middle Nanticoke River – Not Marshyhope and not in the previous sections 3.1 and 3.2 because the Upper Nanticoke and Middle Nanticoke River – Marshyhope watersheds have local TMDLs that do not include source sector information, unlike the Bay TMDL. To quantify the current loads from the various source sectors, loads were evaluated using the WSM included existing management measures implemented through June 30, 2012. The BMPs are from the data reported by DNREC to the Chesapeake Bay Program in the 2012 Progress Review. The loads are those that are delivered to the Chesapeake Bay. The primary source of TN, TP, and TSS is from the agricultural sector (Figure 15, Figure 16, and Figure 17). The loads are presented in tabular form in Table 12.

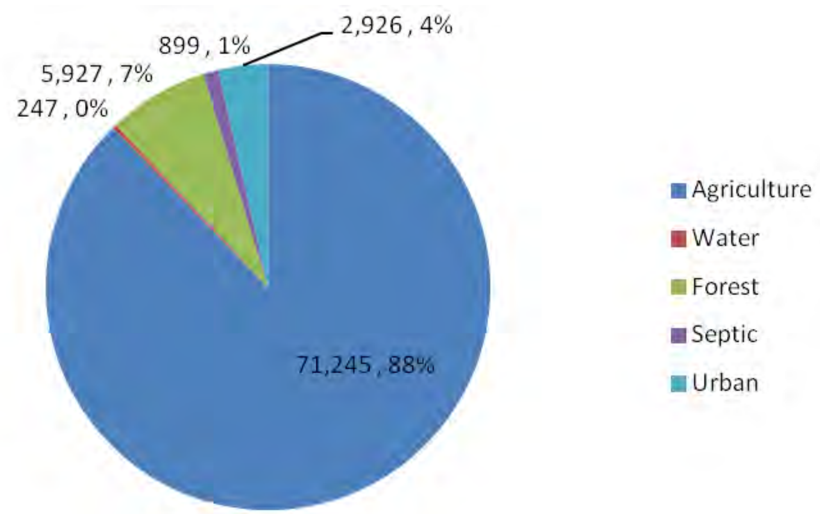


Figure 15: Total delivered nitrogen by source sector in the Middle Nanticoke River - Not Marshyhope as of June 30, 2012.

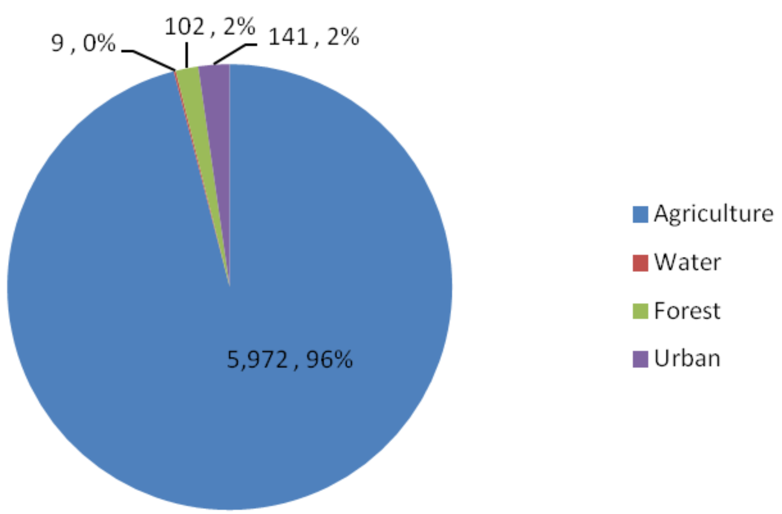


Figure 16: Total delivered phosphorus by source sector in the Middle Nanticoke River - Not Marshyhope as of June 30, 2012.

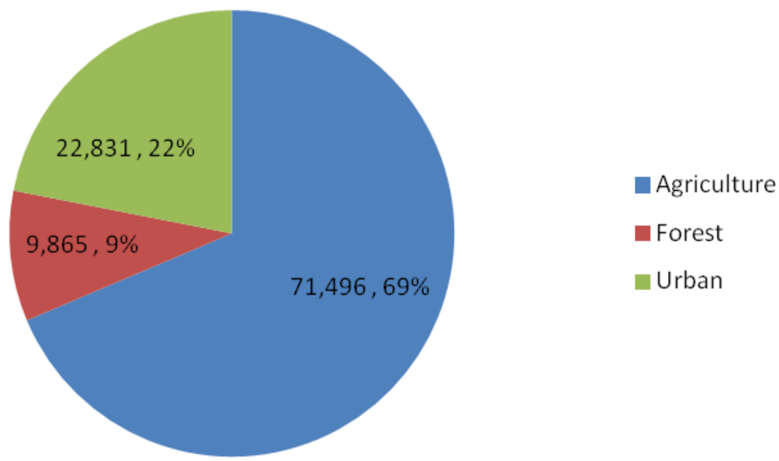


Figure 17: Total delivered suspended solids by source sector in the Middle Nanticoke River - Not Marshyhope as of June 30, 2012.

Table 12: Nitrogen, phosphorus and sediment delivered loads for the Middle Nanticoke River - Not Marshyhope as of June 30, 2012.

Sector	Total Nitrogen Delivered (lbs/year)	Total Phosphorus Delivered (lbs/year)	Total Suspended Solids Delivered (lbs/year)
Agriculture	**71,245**	**5,972**	**71,496**
crop	56,911	3,688	70,285
nursery	406	113	30
pasture/hay	769	75	1,144
Production area	13,160	2,097	38
Atmospheric Deposition	**247**	**9**	**-**
Forest	**5,927**	**102**	**9,865**
Septic	**899**	**-**	**-**
Urban	**2,926**	**141**	**22,831**
Construction	2	0	105
Impervious developed	1,119	92	17,876
Pervious Developed	1,805	48	4,850
Grand Total	**81,244**	**6,224**	**104,192**
Bay TMDL Allocation for Middle Nanticoke - Not Marshyhope	**64,216**	**4,743**	**78,327**

3.3.1 Urban

The urban sector in the Nanticoke watershed is comprised primarily of pervious developed land. The pervious developed land use can be targeted with low impact development practices (Table 12).

3.3.2 Agriculture

The agricultural land uses include crop, nursery, pasture and hay, and the animal production area. Cropland includes those high and low till areas with and without nutrient management. Nursery includes nursery operations under glass as well as outdoors. Pasture/hay includes alfalfa as well as pasture and hay. The production areas are those areas that are designated as animal feeding operations or concentrated animal feeding operations. These are the areas where the animals are located when not in pasture. The production areas receive nutrients from storage loss but do not include nutrients spread on crops.

Crop land generates 80% of the total delivered nitrogen, 62% of the total delivered phosphorus, and 98% of the total delivered suspended solids in agriculture (Table 12). The production area carries the second largest agricultural load and contributes 18% of the total delivered nitrogen, 35% of the total delivered phosphorus, and 0.1% of the total delivered suspended solids in agriculture (Table 12). Since there are many USDA cost-shared practices to control these loads, cropland and animal production areas are a critical area with a high recovery potential.

There are no permitted CAFOs in the Upper Chesapeake. However, there are numerous notices of intent under consideration. This analysis considered the number of animals, rather than the permit status of the facility.

3.3.3 Septic

Septic systems are modeled as one type of system. They are assumed solely to deliver nitrogen. When looking at all sources of total nitrogen, septic systems contribute 899 pounds per year or 1.1%.

3.3.4 Forest

The forested land is a low loading land use. Many management measures seek to convert less productive land into forest, improve forest harvesting techniques, or to add a forested buffer down slope from a higher loading land use. The TN load from forest is 7%, TP is 2%, and TSS is 9%.

3.4 Bacteria

The State of Delaware water quality standard for enterococcus bacteria is a geometric mean of 100 CFU/100 ml. Enterococci are present in fecal material and are used as an indicator organism with which a correlation to illness rates can be established. The level of risk associated with primary contact recreation in waters with an enterococcus concentration of 100 CFU/100 ml has been deemed appropriate and is the basis for the current State of Delaware water quality standards for bacteria. The bacteria concentrations in all portions of the Nanticoke consistently exceeded the 100 CFU/100 mL bacteria standard in monitoring conducted between 10/28/1995 and 10/10/2006.

The Nanticoke is predominantly agricultural in nature. It is assumed that the source of the bacteria is from animal manure. Fortunately, there are multiple management measures that target manure management so the manure can be prevented from being delivered to or deposited in waterways.

3.5 Summary

The critical sources of pollutants for the Nanticoke are cropland, animal production areas, and pervious developed land uses. These are also land uses with high recovery potential. The goals for each area of the Nanticoke are presented in the next section.

4 Expected Load Reductions (b)

The load reductions necessary to meet the local TMDLs for nutrients in the Upper Nanticoke - Nanticoke & Broad Creek and Middle Nanticoke - Marshyhope were developed using CAST. The load reductions necessary to meet the 2010 Bay TMDL, which is the only TMDL covering the Middle Nanticoke - not Marshyhope, were estimated using the Chesapeake Bay Program Partnership Watershed Model Phase 5.3.2. CAST uses the same BMP reduction methods and efficiencies as is used in the WSM.

A TMDL was established for the Nanticoke River in December 1998. A Pollution Control Strategy was prepared in October 2004 and specifies strategies to meet this TMDL. A Watershed Restoration Plan also was written in May 2009. The goal of the Restoration Plan was, "Focus restoration activities in the watershed to improve and maintain the ecological integrity of species and habitats and the functions and services they provide." Nutrients and bacteria are addressed below for each of the three areas in the Nanticoke.

4.1 Upper Nanticoke - Nanticoke & Broad Creek

A local TMDL was established in 1998 for the Upper Nanticoke - Nanticoke & Broad Creek that includes nutrients and bacteria. The TMDL was established by a model informed with monitoring data from 1992, and later reassessed with 1998 and 1999 monitoring data. Baseline loads for nitrogen and phosphorus for the Upper Nanticoke are 2,448,600 lbs/year and 70,924 lbs/year, respectively. The nitrogen load allocations are 3,799 lbs/day, or 1,387,584.8 lbs/year. The phosphorus loads allocations are 79 lbs/day, or 28,855 lbs/year. Nonpoint source bacteria are required to be reduced by 3% from a baseline load of 2.9E+11 CFU/day and point source bacteria loads are capped at the state Water Quality Standards (WQS). The load reductions required by the TMDL and the projected (i.e., planned) loads are in Table 13.

Table 13: Nutrient loads required for the Upper Nanticoke - Nanticoke & Broad Creek by the local TMDL.

Source	Pollutant	TMDL Load Allocation	Planned Load
Point	TN	538,020 Lbs/Year	31,220 Lbs/Year
Point	TP	20,894 Lbs/Year	4,954 Lbs/Year
Point	Bacteria	Capped at state WQS	Capped at state WQS
Nonpoint	TN	1,387,584.8 Lbs/Year	651,340 Lbs/Year
Nonpoint	TP	28,854.8 Lbs/Year	26,985.5 Lbs/Year
Nonpoint	Bacteria	3% reduction	2.8E+11 CFU/day

The loads proposed meet or exceed the allocations in the local, 1998 nutrient TMDL and 2006 bacteria TMDL. The management measures used to estimate these load reductions were determined by applying various BMPs at various levels. The Chesapeake Assessment Scenario Tool (CAST) calculates the annual loads under various management scenarios. The suite of BMPs that produced the loads discussed in this section is discussed in detail in Section 5: Management Measures.

The primary source of bacteria in this predominantly agricultural watershed is animal manure. Water quality samples will continue to be collected to ensure the required reductions are achieved. The specific management measures that are used to decrease bacteria are presented in the following section: Management Measures (c).

4.2 Middle Nanticoke - Marshyhope Creek

In the Middle Nanticoke - Marshyhope Creek, there is a local TMDL for nutrients that was established in 2005. In 2006, another TMDL was established for bacteria. The nutrient TMDL was informed by monitoring data collected between 2001-2003 and the bacteria TMDL was informed by monitoring conducted between 10/28/1995 and 10/10/2006. Baseline loads for nitrogen and phosphorus for the Marshyhope Creek are 981,400 lbs/year and 39,810 lbs/year, respectively. The nitrogen load allocations are 2,148 lbs/day, or 784,557 lbs/year. The phosphorus loads allocations are 78.1 lbs/day, or 28,526 lbs/year. Nonpoint source bacteria are required to be reduced by 21% from a baseline load of 3.5E+11 CFU/day. There are no point sources in the Nanticoke - Marshyhope Creek, so all reductions are for nonpoint sources. The load reductions required by the TMDL and the projected (i.e., planned) loads are in Table 14.

Table 14: Nutrient loads required for the Middle Nanticoke - Marshyhope Creek by the local TMDL.

Source	Pollutant	TMDL Load Allocation	Planned Load
Nonpoint	TN	784,557 Lbs/Year	321,347 Lbs/Year
Nonpoint	TP	28,526 Lbs/Year	23,753 Lbs/Year
Nonpoint	Bacteria	21% reduction	2.8E+11 CFU/day

The load reductions proposed in this section meet or exceed the allocations in the local, 2005 nutrient TMDL and 2006 bacteria TMDL. These load reductions were determined by applying various BMPs at various levels. The Chesapeake Assessment Scenario Tool (CAST) calculates the annual loads under various management scenarios. The suite of BMPs that produced the loads discussed in this section is discussed in detail in Section 5: Management Measures.

The primary source of bacteria in this predominantly agricultural watershed is animal manure. Water quality samples will continue to be collected to ensure the required reductions are achieved. The specific management measures that are used to decrease bacteria are presented in the following section: Management Measures (c).

4.3 Middle Nanticoke - Not Marshyhope

The load reductions for the Middle Nanticoke - Not Marshyhope were determined by downscaling the 2010 Bay TMDL to only those modeling segments in the Middle Nanticoke - Not Marshyhope. Since there is no local TMDL, the data presented are from the 2010 Bay TMDL and the Chesapeake Bay Program Partnership Watershed Model Phase 5.3.2 that was used to establish the expected loads in this Watershed Management Plan. The Watershed Model Phase 5.3.2 was informed by monitoring data from 1982 to 2005.

Projected reductions in loads are a result of applying various BMPs at various levels. The Watershed Model calculates the annual loads under various management scenarios. The suite of BMPs that produced the loads discussed in this section is discussed in detail in Section 5: Management Measures.

The expected load reductions are accurate assuming constant initial conditions. As land use changes from agriculture to developed, more of the nonpoint load will come from those developed source sectors (urban, septic). The total load cannot increase because of the requirements of the 2010 Bay TMDL which requires growth offset measures. Section 5: Management Measures addresses offsetting new and increased loads.

The load reductions proposed in this section meet or exceed the allocations for the Middle Nanticoke - Not Marshyhope in the Bay TMDL. The allocations were established to ensure that Delaware implements adequate pollution control practices to meet the Bay water quality standards. These load reductions are specific to each source. Each source is broken into various land uses, and these land uses are addressed separately. The load reduction for each subwatershed is presented for each land use at the end of the section.

By targeting the most effective BMPs to the critical areas with the greatest recovery potential, the TN agriculture load can be decreased from 71,245 to 54,295 pounds per year, or almost a quarter. The TN urban load was the second largest load and can be reduced from 2,926 to 2,626 pounds per year. The TN load from septic systems can be reduced from 899 to 858 pounds per year, mostly through septic pump outs (Figure 18). With these reductions, the Bay TMDL allocation is met.

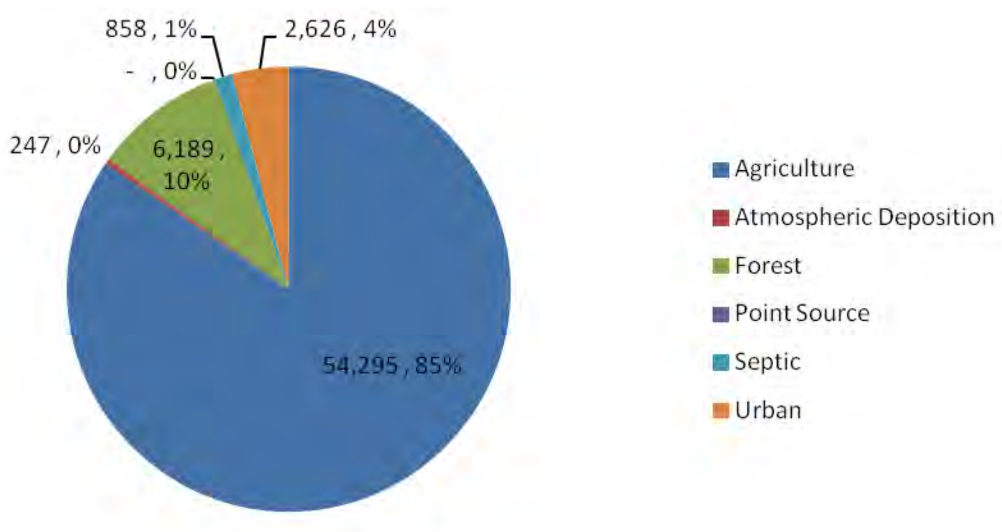


Figure 18: Expected TN delivered loads by source sector in the Middle Nanticoke - Not Marshyhope.

The agricultural TP loads in the Middle Nanticoke - Not Marshyhope can be reduced from 5,972 to 4,498 pounds per year. Urban TP loads can be reduced from 141 to 130 pounds per year (Figure 19). These significant reductions in agriculture are possible because of the management measures that can be taken to control runoff from cropland and improve manure storage on animal production areas, and are discussed in Section 5: Management Measures. With these reductions, the Bay TMDL allocation is met.

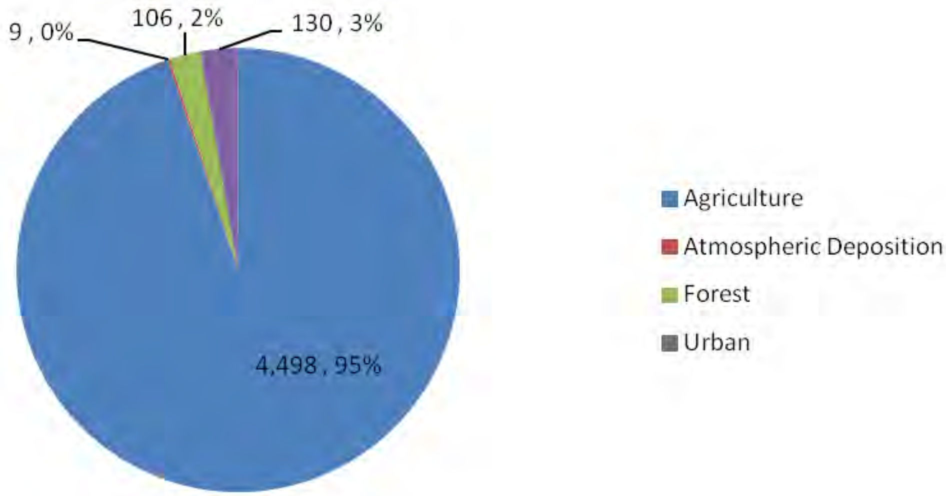


Figure 19: Expected TP delivered loads by source sector in the Middle Nanticoke - Not Marshyhope.

The TSS load from agriculture can be reduced from 71,496 to 45,907 pounds per year. The urban TSS load can be reduced from 22,831 to 22,252 pounds per year (Figure 20). With these reductions, the Bay TMDL allocation is met.

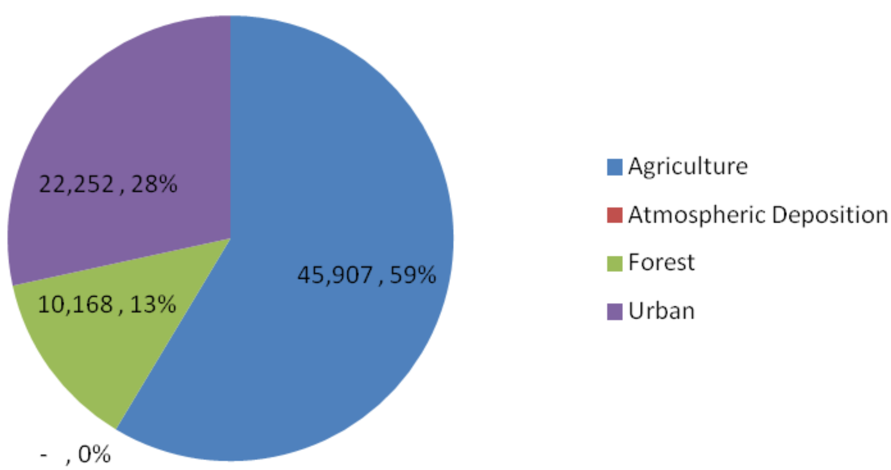


Figure 20: Expected TSS delivered loads by source sector in the Middle Nanticoke - Not Marshyhope.

Table 15 provides a summary of the projected TN, TP, and TSS pounds per year once all recommended management measures are implemented and take effect. That is, implementing a forest buffer may not take full effect for five to ten years, since the trees must approach maturity before the full nutrient and sediment reduction benefit is realized. However, the table reflects the load once the BMPs take effect. Also, there will be lag time related to groundwater and storage within the stream system. These projected loads are consistent with the Bay TMDL allocation for the Middle Nanticoke - Not Marshyhope.

Table 15: Projected loads by sector for the Middle Nanticoke - Not Marshyhope to meet the Bay TMDL.

Sector	Total Nitrogen Delivered (lbs/year)	Total Phosphorus Delivered (lbs/year)	Total Suspended Solids Delivered (lbs/year)
Agriculture	**54,295**	**4,498**	**45,907**
crop	49,153	3,741	44,052
nursery	406	113	30
pasture/hay	1,165	109	1,802
production area	3,572	535	23
Atmospheric Deposition	**247**	**9**	**-**
Forest	**6,189**	**106**	**10,168**
Septic	**858**	**-**	**-**
Urban	**2,626**	**130**	**22,252**
Construction	1	0	63
Extractive	-	-	-
Impervious developed	1,109	92	17,353
Pervious Developed	1,516	38	4,836
Grand Total	**64,216**	**4,743**	**78,327**
Bay TMDL Allocation for Middle Nanticoke - Not Marshyhope	**64,216**	**4,743**	**78,327**

In the urban sector, the majority of the load reductions will come from the pervious developed land use. This land use generally is the most cost-effective to treat. These urban loads will primarily be reduced by implementing low impact development practices.

The agricultural sector will see the majority of reductions from crop land. Some of these reductions will be by converting crop land to pasture or hay, others by cover crops. Therefore, there is an increase in the pasture/hay land use loads, but an overall reduction in agriculture.

Nitrogen load reductions from septic systems are expected by increasing pump out, inspection and utilizing advanced treatment for septic systems.

The forest sector is a low loading land use. By adding forest buffers on agricultural land, reductions are gained.

Atmospheric deposition is a source that is not planned to be addressed by Delaware. Rather, EPA's Clean Air Act is anticipated to address this load. Much of the nitrogen air deposition in Delaware is generated in other states. Delaware is focusing its efforts on increasing forest land cover which trap air-borne nitrogen so that it does not enter the waterways.

The 2010 Bay TMDL Watershed Implementation Plan (WIP) overlaps with the 2009 Restoration Plan by recommending stream restoration and buffers to protect and preserve existing forest and stream habitats. The Bay TMDL WIP also is similar to the 2004 Pollution Control Strategy by recommending nutrient management, phytase, and cover crops on agricultural land; buffers on urban land; and septic controls. The management measures presented in the following section are consistent with those proposed in both the Restoration Plan and the Pollution Control Strategy.

5 Management Measures (c)

Best management practices (BMPs) are either already implemented or are planned for implementation to achieve the TMDL load allocations as discussed in the previous section—4: Expected Load Reductions. The type and level of BMPs implementation included in this section will meet the reduction and loading goals of the local TMDLs for each area of the Nanticoke. This section discusses the planned BMPs and compares them to the baseline BMPs. Baseline BMPs are those that were implemented through June 30, 2012.

Each BMP provides a reduction for nitrogen, phosphorus, and/or suspended solids. An annual pollutant load that meets the 2010 Bay TMDL allocation is estimated for each source sector with the indicated BMPs implemented. The pollutant load was determined using the Chesapeake Bay Program Partnership Watershed Model or CAST, which uses the same methodology and BMP effectiveness values as the Watershed Model.

CAST is a model created and supported by EPA Region 3. CAST is a web-based pollutant load estimator tool that streamlines environmental planning. Users specify a geographical area, and then select BMPs to apply on that area. CAST builds the scenario and provides estimates of pollutant load reductions. The cost of a scenario is also provided so that users may select the most cost-effective practices to reduce pollutant loads. CAST allows users to understand which BMPs provide the greatest load reduction benefit, the extent to which these BMPs can be implemented, and the cost of these BMPs. Based on the scenario outputs, users can refine their BMP choices in their planning. CAST facilitates an iterative process to determine if TMDL allocations are met. Scenarios may be compared to each other, TMDL allocations, or the amount of pollutants reduced by current BMP implementation. CAST estimates of load reductions for point and nonpoint sources include: agriculture, urban, forest, and septic loading. CAST stores the geographic area, cost and implementation level associated with each BMP as well as the load for each sector and land use. With these data tables, CAST also serves as a data management system. Thus, users may quantify the impacts of various management actions while improving local management decisions.

CAST is designed to be useful to people with a general knowledge of BMPs. Knowledge of models or BMP load reduction calculations is not necessary. CAST is available on-line to users with a login and password, which may be requested from the website. More information on the sequence of BMP application is found in the CAST technical manual file posted under documentation on the website: CASTTOOL.ORG.

Data is entered into CAST in the following sequence:

- The user selects a geographic area, such as a county.
- CAST draws upon the same data sources as the Chesapeake Bay Program Partnership models to populate the parameters of the scenario based on user selections. The user can build a new scenario or import features of an existing scenario. The user may opt to share the scenario with other users on the system.
- The user establishes costs of BMPs, or can use the defaults provided.

- The user adds BMPs to the scenario using separate screens with options for urban, septic, forest, agriculture, animals, and manure transport. The user may edit the BMP selections at any time to modify the scenario.
- The user selects calculate and the loads and costs are provided on screen and in downloadable tables.
- The user also may compare scenarios.

Load reductions are not tied to any single BMP, but rather to a suite of BMPs working in concert to treat the loads. The Watershed Model calculates BMPs as a group, much like a treatment train. For those BMPs with individual effectiveness values, the load reduction can vary depending on other BMPs that are implemented. This is because some BMPs are land use change BMPs and also because some BMPs are mutually exclusive or overlapping. This section presents the level of BMP implementation. Section 9 presents information on how progress toward load reductions will be evaluated and management plans adapted on an on-going basis.

The BMPs selected are consistent with those proposed in the 2009 Restoration Plan, 2004 Pollution Control Strategy, and 2010 Chesapeake Bay Watershed Implementation Plan. The 2009 Restoration Plan recommends stream restoration and buffers to protect and preserve existing forest and stream habitats. The 2004 Pollution Control Strategy recommends nutrient management, phytase, and cover crops on agricultural land; buffers on urban land and similar practices to limit impervious cover at 20%; and septic controls. The 2010 Bay TMDL Watershed Implementation Plan (WIP) overlaps with the 2009 Restoration Plan by recommending stream restoration and buffers to protect and preserve existing forest and stream habitats. The Bay TMDL WIP also is similar to the 2004 Pollution Control Strategy by recommending nutrient management, phytase, and cover crops on agricultural land; buffers on urban land; and septic controls. To achieve the required load reductions, additional BMPs are recommended in this Watershed Management Plan.

5.1 Nutrients

5.1.1 Wastewater

There are five WWTP, CSO, or Industrial facilities in the Upper Nanticoke - Nanticoke & Broad Creek. Seaford and Laurel are operating at about 50% capacity, and can accommodate additional growth. Bridgeville is planning upgrades to the facility to reduce loads and accommodate any future growth. Invista is reducing loads by 60% to meet TMDL requirements and they are currently prohibited from having any phosphorus load. The Mobile Gardens Trailer Park moved to a Rapid Infiltration Basin system and is not anticipated to have loads after 2012. However, there is some load allocated to accommodate growth and changes. Seaford uses spray irrigation and their loads are variable since the conditions for spraying are determined by hydrological factors. Expected loads are in Table 16.

Table 16: Projected wastewater loads to meet the Bay TMDL by 2025 in the Nanticoke.

NPDES	Facility Name	Major	Industrial	Federal	FLOW (mgd)	TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)
DE0000035	INVISTA (DUPONT-SEAFORD)	N	Y	N	16.4	171,818	-	749,208
DE0020125	LAUREL	N	N	N	0.70	8,528	2,132	31,978
DE0020249	BRIDGEVILLE	N	N	N	0.80	9,746	2,436	36,547

NPDES	Facility Name	Major	Industrial	Federal	FLOW (mgd)	TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)
DE0020265	SEAFORD	N	N	N	2.00	24,364	6,091	48,729
DE0050725	MOBILE GARDENS TRAILER PARK	N	N	N	0.06	2,412	329	2,741

Delaware's Compliance and Enforcement Branch assesses wastewater treatment plants and recommends enforcement to protect surface water quality. All "major" and half of the "minor" plants are inspected annually. An audit of their monitoring records is also conduced. These are in accordance with EPA form 3560-3.

Consideration of septic hookups to an existing wastewater treatment plant may be considered to reduce septic loads, where a facility is below capacity. Growth projections will inform if this is a cost effective approach to reducing septic loads.

5.1.2 Urban

The urban sector is currently making use of eight structural BMPs to reduce nitrogen, phosphorus and sediment loads. When cost-effective, the use of these practices will be expanded and refocused to assure recovery. These BMPs were selected specifically for three reasons: 1) effectiveness for water quality improvement, 2) willingness among the public to adopt, and 3) implementable in multiple facility types without limitations by zoning or other controls. The practices include:

- **Bioretention** — An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants.
- **Bioswales** —A bioswale is a stormwater conveyance that reduces loads because, unlike other open channel designs, there is now treatment through the soil. A bioswale is designed to function similarly to bioretention.
- **Dry Ponds --** Dry Detention Ponds are depressions or basins created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. Hydrodynamic Structures are devices designed to improve quality of stormwater using features such as swirl concentrators, grit chambers, oil barriers, baffles, micropools, and absorbent pads that are designed to remove sediments, nutrients, metals, organic chemicals, or oil and grease from urban runoff.
- **Extended detention (ED) dry ponds** — Dry extended detention basins are depressions created by excavation or berm construction that temporarily store runoff and release it slowly via surface flow or groundwater infiltration following storms. Dry extended detention basins are designed to dry out between storm events, in contrast with wet ponds, which contain standing water permanently. As such, they are similar in construction and function to dry detention basins, except that the duration of detention of stormwater is designed to be longer, theoretically improving treatment effectiveness.
- **Filtering practices** (biofiltration, filter strip, filtration, forebay micropool) — Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground, perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal

for many compounds due to the increased cation exchange capacity achieved by increasing the organic matter. These systems require yearly inspection and maintenance.

- **Infiltration** — A depression to form an infiltration basin where sediment is trapped and water infiltrates the soil. No underdrains are associated with infiltration basins and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil, they are not constructed on poor soils, such as C and D soil types. Engineers are required to test the soil before approved to build is issued. Yearly inspections to determine if the basin or trench is still infiltrating runoff are planned.
- **Stream Restoration** – Stream restoration in urban areas is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape of a stream, help improve habitat and water quality conditions in degraded streams.
- **Wet ponds or wetlands** — A water impoundment structure that intercepts stormwater runoff then releases it to an open water system at a specified flow rate. These structures retain a permanent pool and usually have retention times sufficient to allow settlement of some portion of the intercepted sediments and attached nutrients/toxics. Until recently, these practices were designed specifically to meet water quantity, not water quality objectives. There is little or no vegetation living within the pooled area nor are outfalls directed through vegetated areas prior to open water release. Nitrogen reduction is minimal, but phosphorus and sediment are reduced.

Along with the structural BMPs listed above, the urban sector is also providing treatment through non-structural measures. These are treatments that rely on programs that continue throughout the year. These were selected because there is the public will to adopt, they are cost effective, and have proven success in improving water quality. Erosion and sediment control, listed below, is a major component of this plan, as it addresses construction, one of the leading sources of sediment.

- **Nutrient management —** Urban nutrient management involves the reduction of fertilizer to grass lawns and other urban areas. The implementation of urban nutrient management is based on public education and awareness, targeting suburban residences and businesses, with emphasis on reducing excessive fertilizer use. This does not account for the recent laws passed to remove P from fertilizer. As an added margin of safety providing reasonable assurance that fertilizer will be appropriately managed in the urban and suburban environment, a voluntary program known as Delaware Livable Lawns, administered through the Delaware Nursery and Landscape Association, has been developed to provide education, outreach, and certification for suburban fertilizer use and certification of lawn care companies. The Delaware Livable Lawns Program is a voluntary homeowner education and commercial lawn-care certification program.
- **Tree planting** —Urban tree planting is planting trees on urban pervious areas at a rate that would produce a forest-like condition over time. The intent of the planting is to eventually convert the urban area to forest. If the trees are planted as part of the urban landscape, with no intention to covert the area to forest, then this would not count as urban tree planting.
- **Street sweeping**. —Street sweeping should occur twice a month or 26 times a year on urban streets. This frequent sweeping of the same street will reduce nitrogen and phosphorus as well as sediment. DelDOT is planning to track sweeping by incorporating GPS into the sweepers.
- **Erosion and sediment control**. —These measures are implemented on construction sites to mitigate erosion. Construction areas are one of the critical areas with a high recovery potential. Delaware's Sediment and Stormwater Program is currently managed by the Division of

Watershed Stewardship in the Department of Natural Resources and Environmental Control. The existing Delaware Sediment and Stormwater Regulations require erosion and sediment control during construction and post-construction for water quality. The DSSR effectively cover the entire development process, from the time construction begins, through project completion, and permanent maintenance of stormwater management facilities. Unless specifically exempted, any proposed land development project that disturbs more than 5,000 square feet must comply with the DSSR. The DSSR are effective Statewide, and are applicable for new development, redevelopment, MS4s and non-MS4s. In order to comply with these regulations, projects must employ stormwater Best Management Practices (BMPs) to address both water quality as well as water quantity impacts. The Sediment & Stormwater Management Plans are vigorously reviewed by local delegated agencies and are only approved if it is deemed that they meet minimum State-wide regulatory requirements. These delegated agencies also ensure these approved plans are constructed properly in the field through a process of frequent inspections on a regular basis that ensures regulatory compliance with the DSSR that includes a final inspection and close-out process. The penalty section of the DSSR provides DNREC with the authority to pursue both civil and criminal actions should enforcement for non-compliance be necessary. The delegated agencies responsible for enforcing these regulations and their areas of responsibility are included in the Final Phase 2 CBWIP 03301012A on pages 76-77.

Table 17 compares the implementation for existing BMPs with the planned levels of implementation. This increase in implementation will achieve the loads required by the TMDLs and shown in Expected Load Reductions (b).

Table 17: Urban BMP implementation, 2012 actual and planned levels for the three Nanticoke areas.

Urban Practice	Units	2012 Actual Implementation	Planned Implementation
Upper Nanticoke - Nanticoke & Broad Creek			
Bioretention	acres	-	-
BioSwale	acres	-	-
Dry Ponds	acres	-	-
Erosion and Sediment Control	acres	-	14,336
Extended Detention Dry Ponds	acres	-	661
Filtering Practices	acres	-	5267
Infiltration	acres	-	23,711
Nutrient Management	acres	-	28,211
Stream Restoration	miles	-	0.04
Street sweeping	acres	-	9,173
Tree Planting	acres	1	2
Wet ponds and wetlands	acres	5,227	896
Middle Nanticoke - Marshyhope			
Bioretention	acres	-	<1
BioSwale	acres	-	3
Erosion and Sediment Control	acres	-	9
Extended Detention Dry Ponds	acres	-	6

Urban Practice	Units	2012 Actual Implementation	Planned Implementation
Filtering Practices	acres	-	1
Infiltration	acres	-	<1
Nutrient Management	acres	-	2,298
Street sweeping	acres	-	242
Tree Planting	acres	<1	-
Wet ponds and wetlands	acres	8	13
Middle Nanticoke - Not Marshyhope			
Bioretention	acres	-	<1
BioSwale	acres	-	<1
Erosion and Sediment Control	acres	-	<1
Extended Detention Dry Ponds	acres	-	5
Filtering Practices	acres	-	2
Infiltration	acres	-	1
Nutrient Management	acres	-	195
Street sweeping	acres	-	27
Tree Planting	acres	<1	-
Wet ponds and wetlands	acres	24	25

The measured effectiveness for each of these practices may be found in Table 18.

Table 18: Urban BMP effectiveness

BMP	Nitrogen Effectiveness (%, except where otherwise indicated)	Phosphorus Effectiveness (%, except where otherwise indicated)	Sediment Effectiveness (%, except where otherwise indicated)
Bioretention	70	75	80
Bioswale	70	75	80
Dry Ponds	5	10	10
ED Dry Ponds	20	20	60
Erosion and Sediment Control	25	40	40
Filtering Practices	40	60	80
Infiltration	85	85	95
Nutrient Management	17	22	0
Stream Restoration	0.2 lb/foot	0.068 lb/foot	54.25 lb/foot
Street Sweeping	3	3	9
Tree Planting	Land use change to forest-no effectiveness value assigned		
Wet Ponds and Wetlands	20	45	60

5.1.3 Agriculture

The agricultural sector is planning to make use of 29 BMPs to reduce nitrogen, phosphorus and sediment loads. The use of the existing practices will be expanded and in some cases refocused. Several new practices will be added to the suite of existing practices to more effectively target cropland loads. The cropland loads were among the highest loading land uses and have a high recover potential. Therefore, many of the BMPs were selected because they target cropland. These BMPs include continuous no-till, nutrient management planning, cover crops, buffers and wetland restoration. Another major source of pollution is from animal production areas. Manure control BMPs were selected to target this source of pollution. Each BMP included in this plan was evaluated to ensure that it met the following three criteria: 1) effectiveness for water quality improvement, 2) willingness among the public to adopt, and 3) implementable in a variety of types of operations. The entire suite of planned and existing practices includes:

- **Alternative Crops**—Alternative crops is a BMP that accounts for those crops that are planted and managed as permanent, such as warm season grasses. This functions as a conversion of the Watershed Model land uses that are cropland to the hay land use.
- **Animal Waste Management System**—Practices designed for proper handling, storage, and utilization of wastes generated from confined animal operations. Reduced storage and handling loss is conserved in the manure and available for land application.
- **Barnyard Runoff Control**—Includes the installation of practices to control runoff from barnyard areas. This includes practices such as roof runoff control, diversion of clean water from entering the barnyard and control of runoff from barnyard areas. Different efficiencies exist if controls are installed on an operation with manure storage or if the controls are installed on a loafing lot without manure storage.
- **Conservation Tillage** —Conservation tillage requires: (a) a minimum 30% residue coverage at the time of planting, and (b) a non-inversion tillage method.
- **Continuous No Till**—The Continuous No-Till (CNT) BMP is a crop planting and management practice in which soil disturbance by plows, disk or other tillage equipment is eliminated. CNT involves no-till methods on all crops in a multi-crop, multi-year rotation. When an acre is reported under CNT, it will not be eligible for additional reductions from the implementation of other practices such as cover crops or nutrient management planning. Multi-crop, multi-year rotations on cropland are eligible. Crop residue should remain on the field. Planting of a cover crop might be needed to maintain residue levels. The system must be maintained for a minimum of five years. All crops must be planted using no-till methods.
- **Cover Crop** —A winter crop planted at a specified time with a specified seeding method. The crop may be neither fertilized nor harvested. A commodity cover crop may be harvested.
- **Cropland Irrigation Management**—Cropland under irrigation management is used to decrease climatic variability and maximize crop yields. The potential nutrient reduction benefit stems not from the increased average yield (20-25%) of irrigated versus non-irrigated cropland, but from the greater consistency of crop yields over time matched to nutrient applications. This increased consistency in crop yields provides a subsequent increased consistency in plant nutrient uptakes over time matched to applications, resulting in a decrease in potential environmental nutrient losses. The current placeholder effectiveness value for this practice has been proposed at 4% TN, 0% TP and 0% TSS, utilizing the range in average yields from the 2002 and 2007 NASS data for irrigated and non-irrigated grain corn as a reference. The proposed practice is applied on a per acre basis, and can be implemented and reported for cropland on both lo-till and hi-till land uses that receive or do not receive manure.

- **Dairy Precision Feeding**—Dairy Precision Feeding reduces the quantity of phosphorus and nitrogen fed to livestock by formulating diets within 110% of Nutritional Research Council recommended level in order to minimize the excretion of nutrients without negatively affecting milk production.
- **Decision Agriculture**—A management system that is information and technology based, is site specific and uses one or more of the following sources of data: soils, crops, nutrients, pests, moisture, or yield for optimum profitability, sustainability, and protection of the environment. This BMP is modeled as a land use change to a nutrient management land use with an effectiveness value applied to create an additional reduction. It is intended to be more effective than regular nutrient management.
- **Forest Buffers**—Agricultural riparian forest buffers are linear wooded areas along rivers, streams and shorelines. Forest buffers help filter nutrients, sediments and other pollutants from runoff as well as remove nutrients from groundwater. The recommended buffer width for riparian forest buffers (agriculture) is 100 feet, with a minimum width of 35 feet required.
- **Grass Buffers; Vegetated Open Channel** —Agricultural riparian grass buffers are linear strips of grass or other non-woody vegetation maintained between the edge of fields and streams, rivers or tidal waters that help filter nutrients, sediment and other pollutants from runoff. The recommended buffer width for riparian forests buffers (agriculture) is 100 feet, with a minimum width of 35 feet required. Vegetated open channels are modeled identically to grass buffers.
- Irrigation water capture/reuse—
- **Land Retirement to hay without nutrients (HEL)** —Converts land area to hay without nutrients. Agricultural land retirement takes marginal and highly erosive cropland out of production by planting permanent vegetative cover such as shrubs, grasses, and/or trees. Agricultural agencies have a program to assist farmers in land retirement procedures.
- **Land Retirement to pasture (HEL)** —Converts land area to pasture. Agricultural land retirement takes marginal and highly erosive cropland out of production by planting permanent vegetative cover such as shrubs, grasses, and/or trees. Agricultural agencies have a program to assist farmers in land retirement procedures. acres
- **Loafing lot management**—The stabilization of areas frequently and intensively used by people, animals or vehicles by establishing vegetative cover, surfacing with suitable materials, and/or installing needed structures. This does not include poultry pad installation.
- **Manure transport**—Transport of excess manure in or out of a county. Manure may be of any type—poultry, dairy, or any of the animal categories.
- **Mortality Composters**—A physical structure and process for disposing of any type of dead animals. Composted material land applied using nutrient management plan recommendations.
- **Nutrient Management**—Nutrient management plan (NMP) implementation (crop) is a comprehensive plan that describes the optimum use of nutrients to minimize nutrient loss while maintaining yield. A NMP details the type, rate, timing, and placement of nutrients for each crop. Soil, plant tissue, manure and/or sludge tests are used to assure optimal application rates. Plans should be revised every 2 to 3 years.
- **Off Stream Watering without Fencing**—This BMP requires the use of alternative drinking water sources away from streams. The BMP may also include options to provide off-stream shade for livestock, and implementing a shade component is encouraged where applicable. The hypothesis on which this practice is based is that, given a choice between a clean and convenient off-stream water source and a stream, cattle will preferentially drink from off-stream water source and reduce the time they spend near and in streams and streambanks. Alternative watering facilities typically involves the use of permanent or portable livestock water

troughs placed away from the stream corridor. The source of water supplied to the facilities can be from any source including pipelines, spring developments, water wells, and ponds. In-stream watering facilities such as stream crossings or access points are not considered in this definition. The modeled benefits of alternative watering facilities can be applied to pasture acres in association with or without improved pasture management systems such as prescribed grazing or precision intensive rotational grazing.

- **Poultry Phytase** —Phytase is an enzyme added to poultry-feed that helps poultry absorb phosphorus. The addition of phytase to poultry feed allows more efficient nutrient uptake by poultry, which in turn allows decreased phosphorus levels in feed and less overall phosphorus in poultry waste.
- **Soil Conservation and Water Quality Plans**—Farm conservation plans are a combination of agronomic, management and engineered practices that protect and improve soil productivity and water quality, and to prevent deterioration of natural resources on all or part of a farm. Plans may be prepared by staff working in conservation districts, natural resource conservation field offices or a certified private consultant. In all cases the plan must meet technical standards.
- **Sorbing Materials in Ag Ditches**—The University of Maryland and the USDA Agricultural Research Service (ARS) have demonstrated through an existing research project at the University of Maryland-Eastern Shore the application of "Phosphorus-sorbing" materials to absorb available dissolved phosphorus in cropland drainage systems for removal and reuse as an agricultural fertilizer. These in-channel engineered systems can capture significant amounts of dissolved phosphorus in agricultural drainage water by passing them through phosphorus-sorbing materials, such as gypsum, drinking water treatment residuals, or acid mine drainage residuals. The proposed practice is applied on a per acre basis, and can be implemented and reported for cropland on both lo-till and hi-till land uses that receive or do not receive manure.
- **Stream Restoration** — Stream restoration is used to restore the urban stream ecosystem by restoring the natural hydrology and landscape, Restoration also helps improve habitat and water quality conditions in degraded streams by reducing erosion and sedimentation.
- **Swine Phytase**—This BMP reduces the concentration of phosphorus in manure. Less phosphorus is necessary in the feed because an enzyme feed supplement increases the amount of phosphorus absorbed by the hog.
- **Tree Planting**—Tree planting includes any tree planting, except those used to establish riparian forest buffers, targeting lands that are highly erodible or identified as critical resource areas.
- **Upland precision intensive rotational grazing**— This practice utilizes more intensive forms pasture management and grazing techniques to improve the quality and quantity of the forages grown on pastures and reduce the impact of animal travel lanes, animal concentration areas or other degraded areas of the upland pastures. PIRG can be applied to pastures intersected by streams or upland pastures outside of the degraded stream corridor (35 feet width from top of bank). The modeled benefits of the PIRG practice can be applied to pasture acres in association with or without alternative watering facilities. They can also be applied in conjunction with or without stream access control. This practice requires intensive management of livestock rotation, also known as Managed Intensive Grazing systems (MIG), that have very short rotation schedules. Pastures are defined as having a vegetative cover of 60% or greater.
- **Water Control Structures**—Installing and managing boarded gate systems in agricultural land that contains surface drainage ditches.
- **Wetland Restoration**—Agricultural wetland restoration activities re-establish the natural hydraulic condition in a field that existed prior to the installation of subsurface or surface

drainage. Projects may include restoration, creation and enhancement acreage. Restored wetlands may be any wetland classification including forested, scrub-shrub or emergent marsh.

Agricultural areas will add these new BMPs to the suite of BMPs currently used to control pollution: alternative crops, continuous no-till, crop irrigation management, decision agriculture, forest buffers, land retirement to pasture, stream restoration, tree planting, grazing practices, and water control structures. These new BMPs, in combination with refocusing existing BMPs will reduce the loads to the Bay TMDL allocations. Table 19 compares the implementation for existing BMPs and the planned levels of implementation. This increase in implementation will achieve the loads shown in Table 15. Where implementation decreases, it is so that those acres of land can have more effective BMPs applied instead. These loads are equivalent to the TMDL allocations for the Nanticoke.

Table 19: Agricultural BMP implementation, 2012 actual and planned levels, for the Nanticoke areas.

Agricultural Practices	Units	2012 Actual Implementation	Planned Implementation
Upper Nanticoke - Nanticoke & Broad			
Alternative Crops	Acres	-	60
Animal Waste Management Systems	Animal Units	15,094	Full Implementation
Barnyard Runoff Control	Acres	3	122
Conservation Tillage	Acres	69,371	45
Cover Crops	Acres	24,039	60
Crop irrigation management	Acres	-	60
Dairy Precision Feeding	Animal Units	-	Full Implementation
Forest Buffers	Acres	1,341	71,419
Grass Buffers	Acres	138	-
Irrigation Water Capture/Reuse	Acres	-	161
Land Retirement to hay without nutrients	Acres	530	-
Loafing Lot Management	Acres	-	122
Manure Transport	Tons	Limited amount	Maximum available
Mortality Composting	Animal Units	2,544	Full Implementation
Nutrient Management	Acres	109,531	221
Off stream watering without fencing	Acres	464	-
Poultry Litter Treatment (alum, for example)	Animal Units	50	-
Poultry Phytase	Animal Units	163	Full Implementation
Swine Phytase	Animal Units	-	Full Implementation
Soil and Water Conservation Plans	Acres	62,453	281
Sorbing Materials in Ag Ditches	Acres	-	120

Stream Restoration	Miles	-	463
Tree Planting	Acres	122	1
Water Control Structures	Acres	-	120
Wetland Restoration	Acres	1,990	72,086
Middle Nanticoke River - Marshyhope			
Alternative Crops	Acres	-	261
Animal Waste Management Systems	Animal Units	4,336	9,386
Barnyard Runoff Control	Acres	1	27
Conservation Tillage	Acres	16,579	23,141
Continuous No Till	Acres	-	37
Cover Crops	Acres	8,053	9,303
Crop irrigation management	Acres	-	20,398
Decision Agriculture	Acres	-	53,099
Forest Buffers	Acres	517	1,202
Grass Buffers	Acres	374	1,480
Land Retirement to hay without nutrients	Acres	329	286
Land Retirement to Pasture	Acres	-	106
Mortality Composting	Animal Units	516	512
Nutrient Management	Acres	29,448	951
Off stream watering without fencing	Acres	139	52
Poultry Litter Treatment (alum, for example)	Animal Units	100	-
Poultry Phytase	Animal Units	66	Full Implementation
Soil and Water Conservation Plans	Acres	22,439	29,247
Stream Restoration	Miles	-	2
Tree Planting	Acres	11	140
Upland Precision Intensive Rotational Grazing	Acres	-	182
Water Control Structures	Acres	-	2,127
Wetland Restoration	Acres	965	1,758
Middle Nanticoke - Not Marshyhope			
Alternative Crops	Acres	-	30
Animal Waste Management Systems	Animal Units	491	1,558
Barnyard Runoff Control	Acres	<1	3
Conservation Tillage	Acres	2,172	2,734
Continuous No Till	Acres	-	4
Cover Crops	Acres	803	1,085
Crop irrigation management	Acres	-	2,352
Decision Agriculture	Acres	-	6,114

Forest Buffers	Acres	44	123
Grass Buffers	Acres	10	144
Land Retirement to hay without nutrients	Acres	19	12
Land Retirement to Pasture	Acres	-	12
Mortality Composting	Animal Units	80	80
Nutrient Management	Acres	3,410	86
Off stream watering without fencing	Acres	14	5
Poultry Litter Treatment (alum, for example)	Animal Units	50.00	-
Poultry Phytase	Animal Units	33	Full Implementation
Soil and Water Conservation Plans	Acres	1,910	3,361
Stream Restoration	Miles	-	0.2
Tree Planting	Acres	3	16
Upland Precision Intensive Rotational Grazing	Acres	-	17
Water Control Structures	Acres	-	147
Wetland Restoration	Acres	61	199

*Nutrient management has historically been reported at 100% in DE. DE is working through a process of adapting their tracking to more accurately reflect implementation. Therefore, a reduction from 2012 represents only a correction in data. Where implementation decreases, it is so that those acres of land can have more effective BMPs applied instead.

The measured effectiveness for each of these practices may be found in Table 20.

Table 20: Agricultural BMP effectiveness

BMP	Nitrogen Effectiveness	Phosphorus Effectiveness	Sediment Effectiveness
Alternative Crops	Land use change to a lower loading land use		
Animal Waste Management Systems	Applied as a change in the manure load on the production area		
Barnyard Runoff Control	20	20	40
Conservation Tillage	Land use change to a lower loading land use		
Continuous No Till	10-15	20-40	70
Cover Crop (effectiveness varies depending on variety, plant date, and plant method and if it is commodity or not)	5-45	0-15	0-20
Cropland Irrigation Management	4	0	0
Dairy Precision Feeding	Applied as a change in the manure nutrient concentration		
Decision Agriculture (land use change to nutrient management plus efficiency)	3.5	0	0
Forest Buffers (land use change plus efficiency)	0-65	0-45	0-60
Grass Buffers; Vegetated Open Channel - Agriculture	Land use change to a lower loading land use		

BMP	Nitrogen Effectiveness	Phosphorus Effectiveness	Sediment Effectiveness
Irrigation Water Capture/Reuse	75	75	0
Land Retirement to hay without nutrients (HEL)	Land use change to a lower loading land use		
Land Retirement to pasture (HEL)	Land use change to a lower loading land use		
Loafing lot management	20	20	40
Manure transport	Applied as a change in the manure load		
Mortality composting	Applied as a change in the manure load		
Nutrient Management	Land use change to a lower loading land use		
Off Stream Watering Without Fencing	5	8	10
Poultry Litter Treatment (alum, for example)	50	0	0
Poultry Phytase	Applied as a change in the manure nutrient concentration		
Soil Conservation and Water Quality Plans	3-8	5-15	8-25
Sorbing material in Ag ditches	0	40	0
Stream Restoration	Load Reduction-not modeled with an effectiveness value		
Swine Phytase	Applied as a change in the manure nutrient concentration		
Tree Planting	Land use change to a lower loading land use		
Upland precision intensive rotational grazing	9-11	24	30
Water Control Structures	33	0	0
Wetland Restoration (land use change plus efficiency)	7-25	12-50	4-15

To provide added assurance of BMP effectiveness, Delaware has instituted a comprehensive Nutrient Management Law that controls the minimum set of management practices that are included in nutrient management plans. In regard to phosphorus in soils, it is important to note that Delaware's NMP's are phosphorus-based and have been for many years. The application of phosphorus is limited on high phosphorus soils, and utilizes a three year crop removal policy to restrict phosphorus application in certain conditions on high phosphorus soils. High phosphorus soils are determined based on the Phosphorus-Site Index analysis. In the absence of phosphorus data, yield based assessments are conducted using the four highest yield goals out of the last seven years. In addition to the phosphorus and nitrogen limiting plans, Delaware has a manure relocation program aimed at reducing phosphorus in soils. To obtain appropriate agronomic rates for application of manure, biosolids, and organic byproducts, the Nutrient Management Plan incorporates soil testing, manure testing, phosphorus index, and crop needs. Delaware allows three and one year NMPs, with the majority being one year plan. In addition, feedback from NMP writers indicates that most Delaware's producers and Nutrient Management Consultants are utilizing yearly soil test data regardless of plan length. Additional information on the enforcement of this law is specified in the Final Phase 2 CBWIP 03301012A beginning on page 154.

5.1.4 Septic

The Department's Ground Water Discharges Section is developing revisions to its statewide onsite wastewater disposal regulations. The proposed changes would require new or replacement systems within 1,000 feet of tidal waters and associated tidal wetlands to comply with a 20mg/l limit for total nitrogen. There are no additional performance requirements for individual septic systems proposed in the regulations. Under the proposed regulations, all larger onsite wastewater treatment systems would be required to meet a performance standard based on the system size, age, and location.

Individual OWTDS are required by permit conditions to have the septic tank pumped out once every three years. Any OWTDS with a design flow of 2,500 gpd and above are required by the current Regulations Governing the Design Installation and Operation of On-site Wastewater Treatment and Disposal Systems to have a licensed operator to oversee operations of the OWTDS, and submit compliance reports with monitoring data on a routine basis as established in the operating permit. All OWTDS's with a design flow of 2,500 gallons per day or greater are issued individual operating permits with a maximum 5-year term. The On-Site Regulations are currently open for review and several modifications resulting in increased nutrient reduction are being proposed on a state-wide basis. Penalties for noncompliance include but are not limited to: voluntary compliance agreements, verbal warning, manager's warning letter, non-compliance notifications, Notice of Violation (NOV), and Secretary Order, which could include fines. For voluntary and/or incentive-based programs identified in the WIP as currently controlling nutrient and sediment loads, programs verify that controls are installed and maintained through Department inspections and monitoring data (effluent, ground water, and soils). Repercussions and penalties for false reporting or improper installation or maintenance of voluntary practices are listed under chapter 60 DE code. Fines can be as high as $10,000 a day.

A three-fold approach to reducing nitrogen loss from septic systems is planned: 1) upgrades, 2) pump-outs, 3) connections. Systems within 1,000 feet of tidal waters and associated tidal wetlands will be upgraded to advanced treatment (septic denitrification) technologies. More frequent septic pump-outs are also being required. Septic pumping will be increased from 66 in 2012 to 8,042 by 2025. Septic denitrification will be increased from 17 systems in 2012 to 1,512 systems by 2025. Lastly, Delaware is planning to connect 7,661 systems to a wastewater treatment plant by 2025.

5.1.5 Forest

The Forest Service has identified ways to better sustain the forests in Delaware. In terms of water quality, an increase in forest harvesting best management practices is planned. In 2012, Delaware had 1,285 acres of forest harvested using optimal forest harvesting practices in the Nanticoke. This will be increased to 125,833 acres, allowing Delaware to meet its nitrogen, phosphorus and sediment allocation.

5.2 Bacteria

This Watershed Management Plan recommends multiple BMPs that are able to reduce bacteria through impressive removal efficiencies (Table 21). Some of these are also used to control nutrients, and the nutrient removal efficiencies are referenced in the appropriate nutrient source sector section.

Table 21: BMP Bacteria Removal Efficiencies and Source Sector Treated

BMP	Removal Efficiency	Source Sector Treated
Streamside Fencing[1]	100%	Agriculture
Improved Pasture Management[1]	50%	Agriculture
Conservation Tillage[1]	61%	Agriculture
Repaired Septic System[1]	100%	Septic
Rain Garden[1]	85%	Urban
Sand Filters[2]	36% - 83%	Urban

BMP	Removal Efficiency	Source Sector Treated
Biofiltration[2]	>99%	Urban
Pet Waste Control Program[1]	75%	Urban/Agriculture
Retention Pond[2]	44% - 99%	Urban/Agriculture
Vegetated Buffer[2]	43% - 57%	Urban/Agriculture
Constructed Wetlands[2]	78% - 90%	Urban/Agriculture/Forest

1. MapTech, Inc., "Fecal Bacteria and General Standard TMDL Implementation Plan Development for Back Creek". 2006.
2. Allison Boyer, DNREC. "Reducing Bacteria with Best Management Practices".

Manure is the dominant source of bacteria in these highly agricultural watersheds. Preventing manure from entering the waterways is in primary strategy for reducing bacteria. Septics are also a substantial source of bacteria and can be treated by septic system maintenance and replacement.

Based upon the source assessment and BMP data, it is our assumption that bacteria reductions are being met throughout the Nanticoke. DNREC will work with EPA to track bacteria load reductions from BMPs that are implemented.

5.3 Offsetting Nutrient and Sediment Loads from Future Growth

The 2010 Bay TMDL requires that any new or increased load be offset. Delaware has determined that an offset program is a cost-effective means of complying with this requirement. "Offset" means an alternate to strict adherence to the regulations including, but not limited to trading, banking, fee-in-lieu, or other similar program that serves as compensation when the requirements of these regulations cannot be reasonably met on an individual project basis.

Delaware established Sediment and Stormwater Regulations that became effective January 1, 2014. These regulations provide for an offset program with three options to offset new and increased loads:

1. Revised stormwater regulations
2. Stormwater in-lieu fee if site constraints prevent achievement of water quality goals on a specific parcel
3. Offsetting residual nutrient loads on another site within the same basin.

5.3.1 Statewide Stormwater Regulations

The Department's Sediment and Stormwater Program implemented new statewide stormwater regulations in 2013, see Chapter 7 of the regulations. The new regulations contain the following language: Stormwater in-lieu fee: Working with the Center for Watershed Protection, Delaware's Sediment and Stormwater Program has developed a "common currency" for all shortfalls equivalent to the cost of treating unmanaged runoff volume. The cost of $23 per cubic foot of runoff volume is based on land acquisition, construction and maintenance costs for unmanaged volume.

5.3.2 Establish in-lieu fee for stormwater impacts

Under current state law, the Department has the authority to establish an in-lieu fee for erosion and sediment control. The Sediment and Stormwater Program will determine which entities may collect the fees, how the fees would be collected and spent, and how projects would be prioritized and implemented. Programs may be operated and money spent at the local government or conservation district level under guidelines established by DNREC. The Department will also determine specific uses for the in-lieu fee.

5.3.3 Establish a statewide program that provides additional flexibility for offsets

Delaware's Sediment and Stormwater Regulations establish a state-wide program for offsets. EPA is currently preparing Technical Memorandums that will inform future development of this program.

Additional information on development of offset approaches is specified in the Final Phase 2 CBWIP 03301012A beginning on page 140.

5.3.4 Adaptive management

Adaptive management is a critical component of achieving the Bay TMDL and this Watershed Management plan. The two-year milestones provide interim planning targets. These are reevaluated against progress and revised to ensure that Delaware is on track to meet its goals. Progress is evaluated on an annual basis through the Chesapeake Bay Program annual review. All BMPs implemented everywhere by all people are tracked and reported.

The CAST tool is an online model that allows for immediate pollutant load estimations based on the BMPs implemented. The output is the pounds of nutrients and sediment at the edge-of-stream. These water quality indicators allow managers to determine if the BMP implementation is successful, or needs to be adapted. This tool allows for adaptions to the plans based on changes in implementation levels. This tool is more fully described at the beginning of this section. In addition, Section 9 provides additional detail about evaluating load reductions.

Moreover, the Chesapeake Bay Program provides loads for each watershed to assess how much progress is made annually. This information is used to modify the milestones. There also is a mid-point assessment scheduled for 2017. At this time, multiple lines of evidence including: several models, monitoring data, and the most recent science on BMP effectiveness and water quality response will be evaluated by the Chesapeake Bay Program Partnership. The milestones, progress, mid-point assessment and annual progress review all contribute to constant reassessment of management plans, and adapting responses accordingly. Coordination and participation with the Chesapeake Bay Program Partnership is a priority for Delaware. Delaware has members who currently serve as the lead on an expert panel evaluating poultry litter, chair of the Water Quality Goal Implementation Team, and are represented on at least 10 other workgroups, at last count. This participation is critical to Delaware because it is the work of the Bay Program that provides the resources for projecting loads under different management actions and the coordination of science that supports the management decisions critical to reducing nitrogen, phosphorus and sediment pollution.

5.4 Summary

The practices and implementation levels proposed here meet the 2010 Bay TMDL allocations which apply to all of the Nanticoke subwatersheds. The management measures outlined in this section are well within the capacity of Delaware to administer given existing funding programs, public will, and systems in place. These management measures have been reported to the Chesapeake Bay Program through a National Environmental Information Exchange Network (NEIEN) network node. Delaware also tracks implementation on various other tools, all of which feed data to NEIEN in the appropriate format. This tracking ability allows Delaware to nimbly refocus efforts and funding resources where implementation is not proceeding as planned. New technologies are continuously evaluated to determine if the new technologies allow more efficient or effective pollution control.

6 Technical and Financial Assistance Needs (d)

Technical Needs

Technical assistance to meet the reductions and goals of the WIP takes on many forms including DNREC assistance to local governments, state and local partner assistance to both DNREC and municipalities, and technical consultants contracted to provide support across a wide variety of service areas related to WIP planning and implementation.

DNREC has and will provide technical assistance to local governments through training, outreach and tools, including recommendations on ordinance improvements, technical review and assistance for implementation of best management practices at the local level, and identification of potential financial resources for implementation (DWIC, 2012).

DNREC has many partners that provide outreach to homeowners and communities in the form of technical assistance, education, and funding for implementation of best management practices within local communities. Partners include, but are not limited to the Delaware Nature Society, Delaware Forest Service, University of Delaware Cooperative Extension, Sussex Conservation District, Kent Conservation District, New Castle Conservation District, Master Gardeners/Cooperative Extension Service, Delaware Center for Horticulture. These partners provide all levels of support for various programs (DWIC, 2012).

Consultants can be contracted to provide a variety of technical services. For example, Tetra Tech has provided the Local Governments with a review of local ordinances along with a set of recommendations for consideration as they review and update ordinances. Tetra Tech has also provided model ordinances for consideration. State and local governments can contract with consultants through standard means, or through grant and funding assistance programs such as the National Fish and Wildlife Foundation's (NFWF) Technical Assistance Program. DNREC may also hire consultants to provide assistance.

Technical assistance for the Nanticoke can take all of these forms; however as the Nanticoke is primarily an agricultural watershed, and with a majority of load reductions anticipated from the agricultural section (See Section 4), it follows that technical assistance to farmers will be a focus. Support from the University of Delaware Cooperative Extension, Kent Conservation District, Sussex Conservation District, Delaware Department of Agriculture (DDA), Farm Service Agency (FSA) as well as federal assistance from the United States Department of Agriculture (USDA) Natural Resources Conservation District (NRCS) and Farm Services Agency (FSA). The DDA oversees Delaware's Nutrient Management Plan program. The state has recently updated the Nutrient Management Program State Technical Standards, and the DDA will facilitate technical assistance to develop and implement Nutrient Management Plans. In 2011, two Strategic Watershed Action Team (SWAT) planners were hired by the Sussex Conservation District as part of an agreement between the USDA - NRCS, DNREC-Division of Watershed Stewardship, and the Kent and New Castle Conservation Districts. The planners are stationed in the Sussex Conservation District office but have statewide responsibility in the Chesapeake Bay Watershed. The SWAT planners were hired to complete 112 Comprehensive Nutrient Management Plans (CNMP) in the watershed over the next two years.

Technical assistance for Public Participation and Education, and for Monitoring will also be necessary to fully implement and track progress towards meeting the goals of the WIP. These elements are discussed in sections 7 and 9 of this plan.

Financial Needs

The total projected cost to implement the management measures described in this plan for the Nanticoke is $223,995,929. Costs for capital and one-time expenses have been listed directly. For the programmatic management measures or additional staffing costs, annual costs have been converted to total costs by calculating the sum of all incremental costs from 2012 to the 2025 target. Table 22 below includes a summary of funding need per source sector. In this estimate, projected annual costs do not include current staff required for the various programs to implement programs. Anticipated BMPs and funding requirements for each sector are discussed in the sections below.

Table 22: Summary of Funding Needs per Source Sector

Source Sector	Total Cost	Total Cost Nanticoke[1]
Wastewater	$53,000,000	$53,000,000[2]
Urban	$3,392,000	$2,312,353
Agriculture	$233,374,880	$166,842,965[2]
Septic	$2,700,000	$1,840,611
Forest	$0	$0
Total, 2013-2025	**$292,466,880**	**$223,995,929**

[1]Costs for urban, septic, and forest are proportional costs based on the Nanticoke acreage in relation to the total acreage of Delaware's Chesapeake Bay watersheds. Agricultural costs were calculated using EPA's Unit Costs of Agricultural Best Management Practices (BMPs) in Watershed Implementation Plans (WIPs) for the Chesapeake Bay Jurisdictions spreadsheet (last updated 4/2/2013).

[2] Not a proportional total cost; all costs are from proposed projects in the Nanticoke watersheds

6.1 Wastewater

There are five WWTP, CSO, or Industrial facilities in the Nanticoke watershed. Projected wastewater projects and practices implemented within the Nanticoke watersheds from 2013 through 2025 are presented in Table 23. Overall, approximately $53,000,000 of funding is necessary for implementation, $24,000,000 of which will be needed for annual practices. Within the Nanticoke watershed, there is one required wastewater project in Bridgeville, three projects under consideration in the town in Greenwood, Laurel, and Seaford, and one annual practice in Seaford.

Table 23: Projected Funding Requirements, Wastewater BMPs (2013-2025)

BMP	Total Cost
Projects	
Bridgeville is required to upgrade and/or make operational improvements to their plant between 2012 and 2017	$12,000,000
Greenwood is considering building a packaged wastewater treatment facility to treat local wastewater	$3,000,000
Laurel is considering expanding their existing sewer district to account for future growth	$7,500,000

BMP	Total Cost
Seaford is considering expanding their existing sewer district to account for future growth, and/or purchasing land to eliminate or reduce direct discharge	$6,500,000
Annual Practices	
Seaford will continue annual improvements and maintenance for their current BNR system	$24,000,000
Total, 2013-2025	**$53,000,000**

6.2 Urban

Within the Chesapeake Bay Watershed communities, DNREC has determined by analyzing land use patterns, that retrofits are not the solution to reduction of pollution loading. As a result, Delaware is not currently focusing efforts on structural stormwater retrofits due to their expense. Instead, stormwater funding is focused on building capacity to meet growing demands for source reduction strategies. These include GIS data management, tracking and reporting inspections, updating regulations, and training and outreach programs. They also include activities included under the Land Use category in the WIP, which involves developed areas. Detailed cost data per individual BMP and BMP type for the urban sector are not currently available for Delaware, as opposed to the agricultural sector which has a much more refined unit cost structure; therefore Table 24 shows the overall funding requirements for the urban sector pro-rated for the Nanticoke watersheds.

Table 24: Projected Funding Requirements, Urban Stormwater BMPs (2013-2025)

BMP	Total Cost	Proportional Total Cost Nanticoke
Projects		
GIS data management and system upgrades,	$5,000	$3,409
Revised regulations for industrial storm water management	$69,000	$47,038
New and revised technical standards and Regulations for Stormwater management practices	$315,000	$214,738
Additional training program for staff, permittee, and system owners and operators	$50,000	$34,085
Outreach to system owners and operators regarding new requirements	$50,000	$34,085
Urban retrofits inventory	$150,000	$102,256
Municipal urban storm water retrofit demonstration projects, at least one per community, ten communities	$200,000	$136,342
Develop nutrient offset regulations	$105,000	$71,579
Work with local governments to develop master plans	$252,000	$171,790
Annual Practices		
Additional maintenance inspections on storm water facilities in Kent and Sussex Counties	$1,440,000	$981,659
Staff to conduct increased number of industrial compliance inspections and enforcement	$756,000	$515,371

BMP	Total Cost	Proportional Total Cost Nanticoke
Manage nutrient offset program	$840,000	$572,635
Total, 2013-2025	$3,392,000	$2,312,353

6.3 Agriculture

Projected agricultural practices implemented within the Nanticoke watersheds from 2013 through 2025 are presented in Table 25. Overall, approximately $166,842,965 of funding is necessary for implementation, $101,307,556 of which will be needed for annual practices. Annual practice BMP total units and total cost represents all acres treated by strategies implemented and the cost of all strategies implemented from 2013 through 2025.

Table 25: Projected Funding Requirements, Agricultural BMPs (2013-2025)

BMP	Unit	Unit Cost	Total Units[1,2]	Total Cost - Nanticoke[2]
Animal Waste Management Systems	Animal units	$170	Full Implementation	Full implementation costs
Barnyard Runoff Control	Acres	$822	152.0	$125,010
Alternative Crops	Acres	$18	351.0	$6,420
Dairy Precision Feeding and Forage Mgmt.	Acres	$30	Full Implementation	Full implementation costs
Soil and Water Conservation Plans	Acres	$2	32,889.0	$65,173
Forest Buffers	Acres	$177	72,744	$12,861,989
Grass Buffers	Acres	$189	1,624.0	$306,695
Irrigation Water Capture/Reuse	Acres	$971	161.0	$156,377
Land Retirement to hay without nutrients Land Retirement to Pasture	Acres	$169	416.0	$70,270
Loafing Lot Management	Acres	$1,541	122.0	$188,030
Stream Restoration	Linear feet	$7	2,453,119 (464.6miles)	$16,542,351
Manure Transport	Tons	$28	Full Implementation	Full implementation costs
Nutrient Management	Acres	-$1	1,258.0	-$1,145
Off stream watering without fencing	Acres	$30	57.0	$1,682
Tree Planting	Acres	$162	157.0	$25,395
Water Control Structures	Acres	$18	2,394.0	$42,496
Wetland Restoration	Acres	$475	74,043	$35,144,665
Annual Practices (2013 – 2025)				
Conservation Tillage	Acres	$13	1,025,477.3	$13,331,204
Continuous No-Till	Acres	$40	1,188.9	$47,554
Cover Crops	Acres	$52	227,520.6	$11,831,071
Crop Irrigation Management	Acres	$19	503,351.6	$9,597,236

BMP	Unit	Unit Cost	Total Units[1,2]	Total Cost - Nanticoke[2]
Decision Agriculture-Nutrient Management	Acres	$30	2,205,823.1	$66,174,693
Mortality Composting (applied only to dead animals, not the total number of animals)	Animal units	$377	Full Implementation	Full implementation costs
Poultry and Swine Phytase	Animal units	-$51	Full Implementation	Full implementation costs
Sorbing materials in Ag ditches	Acres	$125	120.0	$195,000
Upland Precision Intensive Rotational Grazing	Acres	$53	2,452.5	$130,797
			TOTAL COST, 2013 - 2025	$166,842,965

[1]Where "full implementation" is indicated, all animal manure or animals in the county are treated. Exact numbers of animals in the watershed are not reported because animal numbers are available only at the county scale, not the watershed scale. Total costs for these practices will be dependent on the number of animals treated.
[2]Annual practice BMP total units and total cost represents all acres treated by strategies implemented and the cost of all strategies implemented from 2013 through 2025.

6.4 Septic

The Chesapeake Bay WIP proposed several activities to reduce nutrient discharges from Onsite Wastewater Disposal Systems, including upgrades to failed systems, pumpouts, and connections to sewer systems. Funding for upgrades and maintenance is the responsibility of the system owner; however, there are additional annual costs required in order to increase inspections and manage the program. These are described in Table 26. The proportional total was derived from the proportion of developed land use in the Chesapeake Bay watersheds.

Table 26: Projected Funding Requirements, Onsite Wastewater BMPs (2013-2025)

BMP	Total Cost	Proportional Total Cost Nanticoke
Projects		
Outreach, staffing, and technical resources for permitting and inspection	$2,700,000	$1,840,611
Total, 2013-2025	**$2,700,000**	$1,840,611

6.5 Forest

Better management of forests in Delaware is the only management measure planned for the Nanticoke watershed. The effort will be managed by existing personnel and no additional costs are foreseen.

6.6 Funding Sources

Funding required to implement the WIP in the Nanticoke would represent a fraction of the overall cost. There are cost savings associated with economies of scale by staffing for areas broader than Nanticoke and also for program development that is statewide.

Funding for WIP implementation comes from sources including federal grants from EPA, USDA, and USFWS. Restoration funds are provided through grant programs such as the Chesapeake Bay Implementation Grant (CBIG) funded by the EPA, the National Fish and Wildlife Foundation (NFWF), and various agricultural cost share programs.

Examples of current funding sources are presented in Table 27.

Table 27: Summary of Sectors covered by Funding Sources

Funding Sources	Waste-water	Urban	Agricultural	Septic	Forest
Chesapeake Bay Implementation Grant (CBIG)		•	•		•
Chesapeake Bay Regulatory and Accountability Grant (CBRAP)			•		
National Fish and Wildlife (NFWF) Chesapeake Bay Stewardship Fund		•	•		•
Section 106 Grant		•	•		
Clean Water State Revolving Fund Program	•	•	•	•	•
Financial Assistance Branch of DNREC	•	•	•	•	•
The Delaware Nonpoint Source Program		•	•	•	•
Resource Conservation and Development Fund		•			
Non-Federal Administrative Account (NFAA)	•			•	
State of Delaware Conservation Cost Share Program			•		
Delaware Conservation Reserve and Enhancement Program (CREP)			•		•
Delaware Nutrient Relocation			•		
Delaware Confined Animal Feeding Operations (CAFO)			•		
New Castle Conservation District Cost-Share Program			•		•
Delaware Nutrient Management Programs			•		
Federal USDA/NRCS Technical Assistance and Cost share programs					
Chesapeake Bay Watershed Initiative (CBWI)			•		•
Agricultural Management Assistance Program (AMA)			•		•
Wetland Reserve Program (WRP)			•		•
Wildlife Habitat Incentives Program (WHIP)			•		•
Environmental Quality Incentives Program (EQIP)			•		•
Conservation Reserve Program (CRP) – USDA and FSA			•		•

Two programs are noted here in more detail. The USDA/NRCS Chesapeake Bay Watershed Initiative (CBWI) through funding from the Food, Conservation, and Energy Act of 2008 (the 2008 Farm Bill) authorized the initiative and provided $23 million in 2009. Congress authorized additional funding levels of: $43 million in 2010; $72 million in 2011; and $50 million in 2012. The initiative is delivered through the Environmental Quality Incentives Program (EQIP). The Farm Bill is currently up for reauthorization.

The Sussex Conservation District (SCD) Cost-Share Program and Kent Conservation District (KCD) Cost-Share Program provides cost-share funding, technical assistance, and outreach/educational services. The Cost-Share Programs assist landowners and land managers to design and install site-specific conservation practices, for those agricultural BMP types approved by the respective Board of Supervisors, on their property within Sussex and Kent Counties. The cost-share rates and limitations vary according to the practice; however cost-share rates range from 50-75% in Sussex County and 25-75% in Kent County.

7 Public Participation / Education (e)

Delaware's Phase II WIP describes in great detail the outreach and education components that were employed for both Phases of the WIP development process, and provides recommended outreach strategies. Because the outreach is comprehensive and applies to similar pollutants, sources, and strategies between the Bay and local TMDLs, the process achieves the goals for outreach and education for both sets of TMDL regulations. The outreach completed to date as part of the WIP process is summarized here, with the most relevant outreach and education strategies to the Nanticoke.

The Nanticoke Watershed Alliance is a collection of organizations—including representatives from local environmental, watershed, and land conservancy groups, local and state government, business and industry, farming, development, tourism, and other entities –that facilitate partnerships and progress in conserving the natural, cultural, and recreational resources of the Nanticoke River watershed through dialogue, collaborative outreach, and education. As mentioned in the Phase II WIP, the Alliance has three main goals: 1) monitor the health of the Nanticoke River through collaborative relationships with regional experts, local volunteers, and the scientific community to disseminate objective information; 2) develop and promote innovative approaches to management and conservation of the watershed, engaging partners, policy makers, and the public through outreach and education; and 3) support and promote the conservation initiatives of organizations within the Nanticoke River watershed. This group is very active in the community and will be the best first resource to implement public outreach and engagement campaigns in the Nanticoke.

In December 2010, the WIP Communications Team (WIPCT) was formed and membership was expanded from an informal team composed of staff from DNREC, DDA, and the USDA Delaware Office to include communications professionals from DNREC's Office of Planning, the Delaware Department of Transportation, and partner organizations – the Delaware Nature Society, Nanticoke Watershed Alliance, and the Delaware Home Builders Association. The goal was to communicate WIP efforts and develop communications and outreach materials.

The Team's role and responsibilities include:

- Develop key messages and education/outreach materials
- Support the education and outreach efforts of the WIP Subcommittees
- Develop a communications strategy and plan with measurable outcomes, focusing on the Delaware waterways of the Chesapeake watershed (and applicable to all of Delaware).
- Develop a watershed wide outreach program that encourages and inspires individuals to take actions for cleaner water.

- Maintain the flow of information and provide liaison between: Federal and state agencies; state and local governments; stakeholder groups; media outlets; collaborating agencies and organizations; and the general public.
- Strengthen and/or create partnerships with other agencies/stakeholders, public and private, and solicit Delaware volunteers from these partnerships (DWIC, 2012).

Public outreach during the development of the Phase I WIP included public meetings, forums and presentations with stakeholders and general public given opportunities to ask questions and voice concerns both during the meeting and following the meeting by submitting questions in writing. Forums and venues for the meetings included Town meetings (e.g. Blades, Dover, Seaford, Georgetown, Bridgetown), Conservation District Board meetings, the Positive Growth Alliance Board in Lewes, and the Nanticoke Tributary Action Team.

Outreach and education components continued during the Phase II WIP development, including preparation of fact sheet, brochures, posters, and frequently asked questions covering a wide range of WIP, water quality, and agricultural based topics. Press releases supplemented the outreach materials covering topics such as grant funding, CAFOs, stormwater regulations, and general water quality information. Public forums and workshops were held in addition to a full suite of special events aimed at raising general awareness, distributing rain barrels, providing information sharing and training among agencies and professionals, and reaching out to the agricultural community.

The DWIC identified many partners to assist in public participation and educational campaigns. The opportunities most relevant to the Nanticoke are outlined here. The Delaware Nature Society (DNS) is the pre-eminent non-profit environmental organization in the state. DNS is unique in the way it integrates education as a vital element in its role in preservation, conservation and advocacy. Currently thousands of members support this important work and/or participate in programs, while more than 1,000 volunteers assist the 32 member core staff and interns.

The DNS has extensive experience with education and outreach efforts, which will help inform residents, businesses and visitors of actions that they can take to improve water quality. The focus of the DNS as reported in the Phase II WIP is on the Nanticoke Watershed. The DNS conducted a “Choose Clean Water” presentation to 80 attendees at a Middletown Town Council Meeting.

The DNS goals for 2012, included acquiring funding for the “We Choose Clean Water” campaign to:

- Build capacity for building the base of stakeholder support.
- Shape and promote local policy,
- Expand outreach to farmers, homeowners and businesses to increase adoption of best management practices,
- Initiate and actively manage on-the-ground implementation projects.

Additionally the group is expanding the Backyard Habitat ™ certification program in the Chesapeake Bay watershed which will:

- Educate the public about the connection of land use & water quality,
- Teach sustainable gardening practices to homeowners,
- Collect measurable data on nutrient reduction through the certification program.

In addition to the DNS, the following organizations have been identified for possible partnerships for WIP communications, education and outreach for the Nanticoke.

- Master Gardeners
- Audubon Society
- Students for the Environment
- Delaware civic associations and service clubs in Chesapeake drainage areas:
  - Delaware Home Builders Assoc.
  - Alliance for The Chesapeake Bay, Inc.
  - Sierra Club – Delaware Chapter Coalition for Natural Stream Valleys, Inc.
  - Chesapeake Bay Foundation
  - Chesapeake Bay Trust
  - Delmarva Poultry Industry
  - Delmarva Power
  - Delaware Electric Cooperative
  - Delaware Farm Bureau
  - Nanticoke Watershed Preservation Committee
  - Nanticoke Watershed Conservancy, Inc.
  - Friends of the Nanticoke River
  - Nature Conservancy
  - AgroLab, Inc.
  - University of Delaware
  - Delaware State University
  - Delaware Technical and Community College

The Communications Subcommittee developed a Communications and Marketing Plan and initiated the Communications and marketing campaign in 2012. The goals of the campaign are to (1) to increase understanding by stakeholders and the general public of the need, value and regulatory elements of the WIP and (2) to increase voluntary changes in behavior that will support the overall plan goals. The Nanticoke area can tap into this resource and adapt programs and messaging as needed to reach out the general public, farmers, developers, policy-makers, legislators (local and national), businesses, educators, environmental groups, and non-profits.

The Communications and Marketing Campaign is seeking to include new messaging that will emphasize:

- Individual responsibility to improve water quality with targeting messaging
  - Responsibility relating to pesticide/fertilizer use
  - Responsibility relating to headwater forested areas

- Individual voluntary actions that will improve water quality in the watershed:
  - Installing Rain Gardens
  - Installing rain barrels
  - Creating permeable surfaces
  - Testing lawn chemistry and reducing lawn fertilizer. Pesticides
  - Switching grass lawns to Xeriscaping
  - Planting riparian buffers

Refer to Appendix A for a list of WIP communications updates as of January 28, 2014.

8 Implementation Schedule and Milestones (f & g)

This section presents the target loads and the activities required to achieve those targets based on 2-year milestones, and the 2017 and 2025 interim and final loads and implementation targets. The following schedule and milestones are approved by the CBP.

8.1 Loading Allocations and Milestone Targets

The timeline for meeting the goals and commitments of both the Bay TMDL and the local TMDLs include reductions to meet interim and final loads in 2017 and 2025, respectively. The loading targets for nitrogen, phosphorus, and sediment for Delaware (DWIC, 2012) are presented here in Table 28.

Table 28: Interim and Final Nutrient / Sediment Loads from Delaware (Phase II WIP Planning Targets)

	Nitrogen Load (lbs/yr)	Phosphorus Load (lbs/yr)	Sediment Load (lbs/yr)
Baseline Load	4,474,253	345,140	98,946,818
2017 Interim Load (60% of TMDL load)	3,824,331	304,155	99,455,089
2025 TMDL Allocated Load	3,391,050	276,832	99,793,936
Percent Reduction between Baseline and 2025	24%	20%	-1%

Baseline loads, milestone loads for 2013, planning loads for 2017, and final TMDL allocated loads for 2025 for the Nanticoke watersheds are presented in Table 29 below. Milestones for 2015 will be developed in early 2014 but are not currently available for inclusion in this plan.

Table 29: Nanticoke Milestones Loads (lbs/yr) (delivered loads)

Watershed	Load	Nitrogen Load (lbs/yr)	Phosphorus Load (lbs/yr)	Sediment Load (lbs/yr)
Upper Nanticoke	Baseline Load	2,448,600	70,924	77,939,118
	2013 Milestone Load	3,078,209	210,308	64,539,874
	2017 Interim Load (60% of TMDL load)	2,135,052	58,216	78,653,264
	2025 TMDL Allocated Load	1,926,020	49,744	79,129,362
Middle Nanticoke – Marshyhope Creek	Baseline Load	981,400	39,810	6,248,295
	2013 Milestone Load	426,304	29,904	5,339,068
	2017 Interim Load (60% of TMDL load)	863,260	33,042	5,275,592
	2025 TMDL Allocated Load	784,500	28,530	4,627,123
Middle Nanticoke – Not Marshyhope Creek	Baseline Load	81,244	6,224	104,192
	2013 Milestone Load	98,633	7,056	112,231
	2017 Interim Load (60% of TMDL load)	71,027	5,335	88,673
	2025 TMDL Allocated Load	64,216	4,743	78,327

*2001 – 2003 baseline load for nutrients from Marshyhope Creek local TMDL

8.2 Implementation Milestones

To meet the loading allocations and milestones outlined in the previous section, implementation of programs and BMPs must keep pace and meet planned implementation targets. Table 30 details the implementation for each tracked BMP, segregated by urban and agricultural type with the associated unit of measure. The 2012 data reflects existing BMPs while the 2013 milestone data presents the planned levels of implementation as of 2013, as developed in 2011. The 2017, 2021, and 2025 values reflect the planned implementation for those years as of the 2010 Bay TMDL WIP.

Table 30: Nanticoke Planning Milestones for Implementation

BMP	Unit	2012 Implemen-tation	2013 Milestone	2017 Planned	2021 Planned	2025 Planned[1]
Urban						
Bioretention	acres	0	36.8	24.5	12.3	0.0
BioSwales	acres	0	299.0	200.3	101.7	3.0
Erosion and Sediment Control	acres	0	467.7	8,607.0	11,476.0	14,345.0
Extended Dry Ponds	acres	0	1,547.2	1,255.5	963.7	672.0
Filtering Practices	acres	0	244.4	3,162.0	4,216.0	5,270.0
Infiltration	feet	0	745.8	14,227.2	18,969.6	23,712.0
Nutrient Management	acres	0	4,686.8	18,422.4	24,563.2	30,704.0
Stream Restoration	miles	0	0.04	0.04	0.04	0.04
Street Sweeping	acres	0	445.0	5,665.2	7,553.6	9,442.0
Tree Planting	acres	1.0	134.8	90.5	46.3	2.0
Wet Ponds and Wetlands	acres	5,259.0	4,925.5	3,595.0	2,264.5	934.0
Agricultural						
Alternative crops	acres	0.0	276.2	301.1	326.1	351.0
Animal Waste Management Systems	Animal units	19,921.0	28,816.2	Full Imple-mentation	Full Imple-mentation	Full Imple-mentation
Barnyard Runoff Control	acres	4.0	25.9	91.2	121.6	152.0
Conservation tillage	acres	88,122.0	118,288.5	87,499.0	56,709.5	25,920.0
Continuous No-till	acres	0.0	141.9	108.3	74.6	41.0
Cover Crops-all types	acres	32,895.0	19,494.4	16,478.9	13,463.5	10,448.0
Crop irrigation management	acres	0.0	54,628.7	44,022.5	33,416.2	22,810.0
Dairy Precision Feeding	Animal units	0.0	Full Imple-mentation	Full Imple-mentation	Full Imple-mentation	Full Imple-mentation
Decision Agriculture	acres	0.0	280,144.4	206,500.6	132,856.8	59,213.0
Forest Buffers	acres	1,902.0	17,119.9	43,646.4	58,195.2	72,744.0
Grass Buffers	acres	522.0	8,805.0	6,411.3	4,017.7	1,624.0

BMP	Unit	2012 Implemen-tation	2013 Milestone	2017 Planned	2021 Planned	2025 Planned[1]
Irrigation Water Capture/Reuse	acres	0.0	0.0	96.6	128.8	161.0
Land Retire to hay without nutrients	acres	878.0	572.3	480.9	389.4	298.0
Land Retirement to pasture	acres	0.0	572.3	283.1	193.9	118.0
Loafing Lot Management	acres	0.0	0.0	73.2	97.6	122.0
Manure Transport	Tons	Limited amount	Maximum available	Maximum available	Maximum available	Maximum available
Mortality Composting	Animal units	3,140.0	2,878.0	Full Imple-mentation	Full Imple-mentation	Full Imple-mentation
Nutrient Management[2]	acres	142,389.0	3,797.0	2,950.7	2,104.3	1,258.0
Off stream watering without fencing	acres	617.0	48.8	51.5	54.3	57.0
Poultry Litter Treatment (alum, for example)	Animal units	200.0	Full Imple-mentation	Full Imple-mentation	Full Imple-mentation	0.0
Poultry Phytase	Animal units	262.0	Full Imple-mentation	Full Imple-mentation	Full Imple-mentation	Full Imple-mentation
Swine Phytase	Animal units	0.0	Full Imple-mentation	Full Imple-mentation	Full Imple-mentation	Full Imple-mentation
Soil conservation & water quality plans	acres	86,802.0	147,216.5	109,107.3	70,998.2	32,889.0
Sorbing Materials in Ag Ditches	acres	0.0	Not Reported	72.0	96.0	120.0
Stream Restoration	miles	0	1.7	278.8	371.7	464.6
Tree Planting	acres	136.0	134.8	142.2	149.6	157.0
Upland precision intensive rotational grazing	acres	0.0	178.3	185.2	192.1	199.0
Water Control Structures	acres	0.0	5,710.6	4,605.1	3,499.5	2,394.0
Wetland Restoration	acres	3,016.0	1,667.5	44,425.8	59,234.4	74,043.0
Forest						
Forest Harvest BML	acres	1,285	281.6	75,499.80	100,666.4	125,833.0

[1] Where "full implementation" is indicated, all animal manure or animals in the county are treated. Exact numbers of animals in the watershed are not reported because animal numbers are available only at the county scale, not the watershed scale.

[2] Nutrient management has historically been reported at 100% in DE. DE is working through a process of adapting their tracking to more accurately reflect implementation. Therefore, a reduction from 2012 represents only a correction in data.

8.3 Implementation Priorities

To meet the loading allocations and milestones outlined in the previous sections, implementation should be prioritized based on current 303(d) listings (i.e., categories 4a and 5) with highest priority given to listed segments located in headwaters. Impairments to headwater streams are carried and experienced downstream; therefore, improvements made to headwater streams will maximize the length of implementation impacts.

Stream segments that should be prioritized for implementation within the Nanticoke watersheds include the following (DNREC, 2012a):

Upper Nanticoke River – Nanticoke River and Broad Creek:

- Upper Nanticoke River
  - Tributary of White Marsh Branch
  - Kent-Sussex Line Branch
  - Nanticoke Branch
  - Grubby Neck Branch
  - Nanticoke River – from the start of the third order stream to the confluence with Kent-Sussex Line Branch
- Nanticoke River
  - Deep Creek Branch
  - Gravelly Branch
  - Bridgeville Branch
  - Gum Branch
- Broad Creek
  - Lower Broad Creek
  - Tussocky Branch
  - Chipman Pond Branch

Middle Nanticoke River:

- Marshyhope Creek
  - From the headwaters to the State Line
  - Tributary to Black Arm Prong
  - From the confluence of Prospect Branch to the confluence with the MD-DE line
  - From the confluence of Black Arm Prong and Marshyhope Ditch to the confluence of Prospect Branch
- Tributaries of Marshyhope Creek
  - Tributaries from the headwaters to the State line including Point Branch, Tomahawk Branch, Salisbury Creek, Prospect Branch, Green Branch, Short and Hall Ditch, Brights Branch, and Cattail Branch

In addition, the *Nanticoke River Watershed Restoration Plan* (NRWG, 2009), which was developed by members of the Nanticoke Restoration Work Group, should serve as guidance for implementation efforts. The Nanticoke Restoration Work Group was formed to develop a restoration plan for the watershed which identifies priority areas and facilitating coordination among members to implement the plan. The Work Group consists of individuals who perform or support restoration projects in Delaware and consists of expertise including restoration, wetlands, early successional habitats, soils, forestry, wildlife, plants, and agriculture.

Prioritizing Conservation Targets Based on Program Goals is a section of the Restoration Plan that focuses on the process developed to further prioritize areas that should be targeted for restoration and presents the results of this prioritization. The Work Group focused restoration efforts around three goals: 1) Water quality – improve water quality in the Nanticoke River and its tributaries, 2) Wildlife habitat – improve habitat for wetland and upland fauna and flora; and, 3) Stream habitat/biology – improve the condition or, and ultimately de-list, stream segments on the State Impaired Waters list (303(d)) for habitat and biology. Work Group members first ranked a list of variables that could be used to prioritize areas within each conservation target and then applied the ranked variables to weighted stream habitat/biology goals. Results of the prioritization exercise are summarized in a series of watershed maps depicting conservation targets for each program goal (e.g., High priority areas for restoration of channelized streams and re-establishment of riparian and tidal wetland buffers to improve water quality in the Nanticoke River watershed, DE).

Implementation should also include the recommendations outlined in the *Pollution Control Strategy for the Nanticoke River*, which was developed by the Nanticoke River Tributary Action Team (NRTAT, 2004). The Nanticoke River Tributary Action Team is a group of citizens of the Nanticoke watershed including DNREC representatives, farmers, developers, town management, conservationists, and residents with homes along the tributaries of the Nanticoke. The Tributary Action Team was established in spring 2000 to establish strategies to meet load reduction requirements in the watershed. Forum participants identified pollution control strategies for four major groups: 1) On-site wastewater disposal systems, 2) Agriculture, 3) Tributary Action Team; and, 4) Stormwater and development. Examples of some of the recommendations included in the Pollution Control Strategy are listed below:

- Increased oversight and management of on-site wastewater system discharges to reduce nitrogen and phosphorus pollution
- Agriculture Best Management Practices (BMPs) that include a combination of practices (e.g., water control structures, buffer strips, cover crops) that increase nutrient management but minimize the acreage taken out of production.
- Preservation of working lands in the watershed
- Management of future development activities for nutrient reductions consistent with TMDL load reductions; or, the use of best available technologies (BATs) in the project design where TMDL load reductions are not feasible.
- Suggestions and incentives for the use of conservation designs and alternative pervious materials and strategies in future development activities to limit the amount of impervious cover in the watershed.

9 Load Reduction Evaluation Criteria (h)

Progress evaluation will be measured through three approaches: tracking implementation of management measures, estimating load reductions through modeling, and tracking overall program success through long term monitoring.

Implementation will be measured by determining whether the targets for implementation shown in Table 30 are being met in according to the milestone schedule presented. For both urban and agricultural BMPs, the Watershed Assessment Section of DNREC currently collects this information annually.

Load reductions for the Upper Chesapeake Bay watersheds are estimated annually by the Chesapeake Bay Program using the Phase 5.3.2 Watershed Model. Updates are based on the information provided by DNREC described above. For purposes of comparison with TMDL target milestones, this is the most consistent method of estimating reductions, as the same model and input data are used. As an alternative for more frequent tracking, DNREC has the ability to generate loads and load reductions through CAST, which was created and is maintained by EPA. CAST is more fully described in Section 5 where the management measures are described.

Overall program success will be evaluated using trends identified through the long term monitoring program described below in Section 10.

TMDL compliance status will be evaluated to determine if the Watershed Management Plan needs to be updated. If the WLAs are revised during assessment of the overall Bay Program TMDL, the plan will be reevaluated and updated accordingly. If it is found during the evaluation of BMP implementation and load reductions that the milestone targets are not being met, a revision of the plan may be necessary.

Adaptive management is a critical component of achieving the Bay TMDL, local Upper Nanticoke TMDL, local Marshyhope Creek TMDL, and this Watershed Management plan. The two-year milestones provide interim planning targets. These are reevaluated against progress and revised to ensure that Delaware is on track to meet its goals. Progress is evaluated on an annual basis through the Chesapeake Bay Program annual review. All BMPs implemented everywhere by all people are tracked and reported. The Chesapeake Bay Program provides loads for each watershed to assess how much progress is made annually. This information is used to modify the milestones. There also is a mid-point assessment scheduled for 2017. At this time, multiple lines of evidence including: several models, monitoring data, and the most recent science on BMP effectiveness and water quality response will be evaluated by the Chesapeake Bay Program Partnership. The milestones, progress, mid-point assessment and annual progress review all contribute to constant reassessment of management plans, and adapting responses accordingly. Coordination and participation with the Chesapeake Bay Program Partnership is a priority for Delaware. Delaware has members who currently serve as the lead on an expert panel evaluating poultry litter, chair of the Water Quality Goal Implementation Team, and are represented on at least 10 other workgroups, at last count. This participation is critical to Delaware because it is the work of the Bay Program that provides the resources for projecting loads under different management actions and the coordination of science that supports the management decisions critical to reducing nitrogen, phosphorus and sediment pollution.

9.1 Watershed Plan Tracker

The Delaware NPS Program will enter and track implementation actions (including the number of BMPs, BMP types, and associated costs) and load reductions can be performed using EPA's Watershed Plan Tracker (WPT) at the watershed scale to accommodate the diverse nature of information contained in the watershed plans. In addition, the WPT will track data by year, action, and individual pollutants. The WPT is embedded into the existing web-based national Grants Reporting and Tracking System (GRTS). Emphasis is placed on exploring and documenting the unique aspects and valuable assets of the watershed, adherence to EPA's watershed-based plan criteria introduces valuable standardization among the plans. This standardization enables the generation of a body of information for the impaired watershed that is in need of being restored to meet an acceptable water quality. To utilize this information as a management tool, and to make strategic planning decisions, the information, once entered into a database, can easily be reviewed and monitored for timely and effective decision-making.

10 Monitoring (i)

A robust and comprehensive monitoring program will be necessary to document that implemented strategies are having the desired effect and that water quality goals are being met. Water quality monitoring has provided evidence of changes in water quality and necessary data to develop models and TMDLs to meet the Clean Water Act goals for restoring the physical, chemical, and biological properties of the Delaware's waters. Monitoring will be needed to document changes as the Delaware and Chesapeake Bay TMDLs are implemented.

Delaware's Surface Water Quality Monitoring Program (DNREC, 2012b) is the primary program to be used in monitoring TMDL compliance. The program is used to calculate annual loads and determine water quality trends over time in major water bodies. Delaware follows a five-year rotating basin scheme to monitor all surface waters of the State. During every five-year cycle, each watershed within the State is monitored monthly for two years and every other month for the remaining three years.

As DNREC's 2012 statewide monitoring plan states, because monitoring budgets are limited, the numbers and locations of monitoring sites are being prioritized based on critical needs. Sites retained from previous years, or added as funding becomes available, fall into two categories:

- C1 – high priority monthly stations co-located with USGS gages for loading analysis and long term trends, generally positioned stations at the mouth of a tidal river
- C2 – stations monitored monthly or bi-monthly on a five-year rotating basis.

Surface waters of the State, including waters within the Chesapeake Bay Drainage, are monitored for a suite of 24 parameters including nutrients, bacteria, chlorophyll a, turbidity, organics, pH, dissolved oxygen, etc. It is estimated that water quality monitoring costs for the Chesapeake basin be about $110,000 for fiscal year 2011. For fiscal years 2012, 2013, and 2014 when monitoring frequency for most stations are reduced to every other month, the monitoring cost is estimated to be about $60,000. These estimates exclude monitoring for metals that occurs at some stations in the basin and also exclude quality control sampling and other monitoring plans and programs.

In 2012, there were 15 sites that were sampled six times in the Nanticoke watersheds. Sampling locations include two sites in Nanticoke River mainstem and 13 sites in Nanticoke River tributaries (Racoon Prong, Concord Pond, Williams Pond, Bucks Branch, Records Pond, Horseys Pond, Gravelly Branch, Trap Pond on Hitch Pond Branch, Deep Creek, and Broad Creek). In addition, two sites—one in Marshyhope Creek at Fishers Bridge Road and the other in Nanticoke River at Rifle Range Road—were sampled 12 times including samples from eight storm events. Water quality monitoring is projected to continue at six times a year.

Analytical results from the stations are promptly published in the EPA STORET system and are available as part of the STORET network. More details for the Surface Water Quality Monitoring Plan (SWQMP) are available on DNREC's website.

Citizen monitoring, as reported in the Phase II WIP is conducted by the DNS and the Nanticoke Watershed Alliance. In 2006, the Nanticoke Watershed Alliance developed a bi-state river monitoring project called the Creekwatcher Citizen Water Monitoring Program, in which the Alliance trains local citizens to assess water quality at 37 locations throughout the Nanticoke watershed. Throughout April – November, volunteers collect in-situ measurements of water quality parameters including dissolved oxygen, water clarity, water depth, temperature, and salinity, and collect samples for laboratory analysis of nutrients and bacteria. As noted in the Phase II WIP, the monitoring program's Quality Assurance Project Plan has been approved by the EPA's Chesapeake Bay Program; which accepts the resulting data for use in river protection and bay cleanup efforts. Citizen collected data is used to supplement DNREC data to monitor long term trends in water quality conditions. DNREC is currently coordinating with citizen monitoring groups and is providing technical assistance. Milestones for citizen monitoring are set for 2017 and 2019, during which DNREC will assess information.

11 References

CWP. 2003. Impacts of impervious cover on aquatic ecosystems. Center for Watershed Protection, Ellicott City, Maryland. 142p.

DNREC. "Bacteria Source Tracking & Bacteria TMDLs". Allison Boyer

DNREC. "Reducing Bacteria with Best Management Practices". Allison Boyer

DNREC. 1998. Total Maximum Daily Load (TMDLs) Analysis for Nanticoke River and Broad Creek Delaware. Watershed Assessment Section, Division of Water Resources, Delaware Department of Natural Resources and Environmental Control. Dover, DE.

DNREC. 2000. Total Maximum Daily Loads (TMDL) Analysis for Tributaries and Ponds of the Nanticoke River and Broad Creek, Delaware – December 2000. Watershed Assessment Section, Division of Water Resources, Delaware Department of Natural Resources and Environmental Control. Dover, DE.

DNREC. 2005. Total Maximum Daily Loads (TMDLs) Analysis for Chesapeake Drainage Watersheds, Delaware: Chester River, Choptank River, and Marshyhope Creek. Watershed Assessment Section, Division of Water Resources, Delaware Department of Natural Resources and Environmental Control. Dover, DE.

DNREC. 2006. Total Maximum Daily Loads (TMDLs) Analysis for Chesapeake Bay Drainage Basin, Delaware: Chester River, Choptank River, Marshyhope Creek, Nanticoke River, Gum Branch, Gravelly Branch, Deep Creek, Broad Creek and Pocomoke River Watersheds. Watershed Assessment Section, Division of Water Resources, Delaware Department of Natural Resources and Environmental Control. Dover, DE.

DNREC. 2012a. State of Delaware 2012 Combined Watershed Assessment Report (305(b)) and Determination for the Clean Water Act Section 303(d) List of Waters Needing TMDLs. Delaware Department of Natural Resources and Environmental Control. Dover, DE.

DNREC. 2012b. State of Delaware Ambient Surface Water Quality Monitoring Program – FY 2012. Delaware Department of Natural Resources and Environmental Control. Dover, DE.

DNREC. 2013. Title 7 Natural Resources and Environmental Control, 5000 Division of Soil and Water Conservation. 5101 Sediment and Stormwater Regulations.

DWIC. 2010. Delaware's Phase I Chesapeake Bay Watershed Implementation Plan – November 29, 2010, prepared by Delaware's Chesapeake Interagency Workgroup

DWIC. 2012. Delaware's Phase II Chesapeake Bay Watershed Implementation Plan – March 30, 2012, prepared by Delaware's Chesapeake Interagency Workgroup.

KCCP. 2008. Kent County Comprehensive Plan – Adopted October 7, 2008. Kent County, Delaware.

MapTech, Inc. "Fecal Bacteria and General Standard TMDL Implementation Plan Development for Back Creek". Dec. 2006.

NRTAT. 2004. A Pollution Control Strategy for the Nanticoke River – October 2004, prepared by the Nanticoke River Tributary Action Team.

NRWG. 2009. Nanticoke River Watershed Restoration Plan – May 19, 2009, prepared by the Nanticoke Restoration Workgroup.

SCCPU. 2008. Sussex County Comprehensive Plan Update—Adopted June, 2008. Sussex County, Delaware.

Schueler, T. 1994. The importance of imperviousness. Watershed Protection Techniques, 1(3), 100-111.

State of Delaware. 1998. Code 7406 TMDLs for Nutrients for the Nanticoke River and Broad Creek – December 1998

State of Delaware. 2006a. Code 7414 TMDLs for the Marshyhope Creek Watershed in Delaware – December 2006

State of Delaware. 2006b. Code 7430 TMDLs for Bacteria for the Chesapeake Bay Drainage Basin, Delaware –December 2006, State of Delaware

USEPA. 2010a. Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment, December 29, 2010. U.S. Environmental Protection Agency in collaboration with Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia. Region 3 - Chesapeake Bay Program Field Office. Annapolis, MD.
http://www.epa.gov/reg3wapd/tmdl/ChesapeakeBay/tmdlexec.html

USEPA. 2010b. Phase 5.3 Chesapeake Bay Watershed Model Documentation. U.S. Environmental Protection Agency, Region 3 Chesapeake Bay Program Office, Annapolis, MD.

Appendix A: WIP Communications – 2014

WIP Communications Updates from 3/1/12 to Present

Videos

- Water Quality Monitoring on the Nanticoke (Reach: 187 and counting)
- Septics 101 (Reach: 134 and counting)
- Managing Stormwater: Roads to Rivers (Reach: 78 and counting)
- Explore Your Nanticoke (Reach: 216 and counting)
- Monitoring the Murderkill with UD DNREC and Kent County Wastewater Treatment Facility (Reach: 283 and counting)
- Certified Wildlife Habitats (Reach: 338 and counting)
- Seaford Schoolyard Habitats (Reach: 438 and counting)
- What's a septic system got to do with it? (Currently shooting)

Social Media

- New Delaware Watersheds Facebook Account
- New Delaware Watersheds Twitter Account
- New Delaware Watersheds Quarterly Newsletter
- Email Blasts
- Social Media Releases
- New Social Media monthly promotion (Rain Barrel Giveaway)
- Race for Our Rivers Facebook page for event that DNREC will now be organizing

Events, Presentations and Demonstrations

- 2012 DOWRA's Annual Conference. Presentation on Septic Rehabilitation Loan Program (Reach: 300)
- 2012 Nanticoke Riverfest exhibit and demonstrations (Reach: 60)
- 2012 Ellendale Family Fun Day (Reach: 53)
- 2012 Coast Day (Reach: 1750)
- 2012 Delmarva Chicken Festival (Reach: 60)
- 2012 Delaware State Fair exhibit and demonstrations (Reach: 25,000)
- 2012 Event to highlight funds received by Greenwood, Bethel and Laurel from the National Fish and Wildlife Foundation for WIP related projects (Reach: 40)
- 2013 Nanticoke Riverfest exhibit and demonstrations (Reach: 200)
- 2013 DNREC Rain Barrel Sale and Tree Giveaway in New Castle (Reach: 90)
- 2013 DNREC Rain Barrel Sale and Tree Giveaway in Harrington (Reach: 90)
- 2013 DNREC Rain Barrel Sale and Tree Giveaway in Lewis (Reach: 90)
- 2013 Earth Day at R&R outreach event and rain barrel sale/presenting pledge campaign (Reach: 55)

- 2013 Nanticoke River Park Festival: Demonstrations on how to reduce stormwater runoff by building rain barrels, planting rain gardens, using pervious surfaces, creating certified wildlife habitats, etc. (Reach: 65)
- 2013 Delaware State Fair exhibit and demonstrations (Reach: 25,000)
- 2013 Race for Our Rivers (Reach: 75)

Workshops

- 2012 Kickoff of event/Workshop for Septic Rehabilitation outreach initiative. (Reach: 60)
- 2012 Septic Rehabilitation Loan Program Workshop at Coverdale Community Center in Bridgeville, DE (Reach: 24)
- 2012 Septic Rehabilitation Loan Program Workshop at Coverdale Community Center at Mt Joy Civic Association in Millsboro. (Reach: 22)
- 2012 Presentation to DOWRA's planning committee (Reach: 31)
- 2013 Presented information at a Nanticoke Watershed Alliance “Homeowners workshop” on DNREC’s Septic Rehabilitation Loan Program and other efforts individuals can take to help reduce nutrient and sediment pollution entering Delaware’s waterways. (Reach: 25)
- 2013 Nanticoke Watershed Alliance Rain Barrel Workshop: Presented information on DNREC’s pledge campaign- Individuals pledge to take specific efforts to help reduce nutrient and sediment pollution entering Delaware’s waterways. (Reach: 29)
- 2013 Nanticoke Rotary Club: Presented information on DNREC’s video series as a resource for individuals looking for information pertaining to efforts that help reduce nutrient and sediment pollution entering Delaware’s waterways. (Reach: 24)
- 2013 Local Govt. Workshop- Delaware’s Chesapeake Bay Communities: Action Today for Tomorrow’s Healthy Water: Topics include funding mechanisms for local governments; sources of grant funding; matching your project concept to potential funding sources; conceiving, organizing, and costing a project; grant writing tips. (Reach: 75)
- 2013 Sussex County Strong Communities Initiative Meeting: Presented information on DNREC’s “Rain Barrel Building Workshop” opportunities and other information on reducing stormwater runoff. (Reach: 27)
- Spring and Twig Garden Club: Presentation on things people can do to reduce nutrient and sediment pollution

Promotional Materials

- 2012 Septic Rehabilitation loan program large display
- 2012 Septic Rehabilitation loan program mini display
- 2012 Septic Rehabilitation Loan Program brochure
- 2012 Septic Rehabilitation Loan Program lawn signs
- 2013 New WIP Messaging Branding Strategy developed: Delaware Watersheds brand and logo - to be used on new promotional materials and social media accounts, and for events.
- 2013 New homeowners brochure: An invitation to a healthy home and yard

- 2013 New mini display: An invitation to a healthy home and yard

Advertising

- 2012 radio advertising campaign for the Septic Rehabilitation Loan Program on WDSD 94.7
- 2012 Printed advertising campaign for the Septic Rehabilitation Loan Program: The Guide
- 2012 Printed advertising campaign for the Septic Rehabilitation Loan Program: Placemat advertising.
- 2013 Radio advertising for Septic Rehabilitation Loan Program: WDSD 94.7
- 2013 radio advertising for Septic Rehabilitation Loan Program: WXDE 105.9

WIP Committee/Subcommittee Meetings

- WIP Implementation team meets quarterly
- A WIP Communications Subcommittee meets quarterly with new partners being encouraged to attend and strengthening existing partnerships with groups such as the Nanticoke Watershed Alliance, the Delaware Nature Society, DelDOT, USDA, DE Forestry and DOA. The subcommittee is working to develop new branding strategies including a WIP mascot and slogan.
- Bi-weekly Chesapeake Bay staff meetings
- Monthly Chesapeake Bay Program Communications Workgroup meetings

Websites

- 2012 New webpage has been made to be used as an area where individuals, agriculture, businesses and organizations can find resources of information, support, and guidance for reducing nutrient and sediment pollution.
- New homepage for Watershed Stewardship (Release TBD)
- New webpage for Wetland Advisory Committee (Release TBD)
- 2013 Updates to Delaware Watersheds website
- 2013 Updates to partnering Delaware Invasive Species Council website
- 2013 Updates to Watershed Assessment and Management website

Television/Radio Interviews

- 2012 Interview by 94.7 WDSD: promotion of The Septic Rehabilitation Loan program (Reach: Delaware)
- 2013 Featured on WBOC TV's Delmarva Life discussing how individuals can help protect Delaware's waterways that lead to the Chesapeake Bay (Reach: Delmarva)
- 2013 DNREC Earth Day Event: Presented information to WBOC TV on DNREC's Septic Rehabilitation Loan Program, rain barrels, rain gardens, and other efforts individuals can take to help reduce nutrient and sediment pollution entering Delaware's waterways. (Reach: Delmarva)

Databases

- A database of available funding resources and sources for which various publics can apply has been compiled. The list is being updated continuously and will is available online and used in marketing materials and presentations.
- A database of brochures pamphlets and videos has been created, and a new webpage has been made to be used as an area where individuals, agriculture, businesses and organizations can find resources of information, support, and guidance for reducing nutrient and sediment pollution.

Pledge Campaign

- 180 pledges collected at events throughout the Chesapeake Bay Watershed
- Approximately 1,700 pledges collected at the 2013 Delaware State Fair

BMP Displays in Home Improvement stores

- How to build a rain barrel out of simple supplies from your local hardware store

Appendix B: State of Delaware Ambient Surface Water Quality Monitoring Program – FY 2012

State of Delaware Ambient Surface Water Quality Monitoring Program - FY 2012

Department of Natural Resources and Environmental Control Watershed Assessment Branch

Executive Summary

Delaware's Surface Water Quality Monitoring Program for Fiscal Year 2012 is described in this report. Delaware maintains a General Assessment Monitoring Network (GAMN) of 134 stations. GAMN stations are considered long term stations whose data is used to do long term status and trend assessments of water quality conditions or the State's surface waters and support compilation of Watershed Assessment Reports as mandated by the Clean Water Act under section 305(b). This plan implements an updated monitoring strategy that monitors 23 stations monthly, and the remaining stations either 6 or 12 times a year on a rotating basin basis. Some stations in selected watersheds are monitored for the dissolved forms of key metals in the water column.

Ambient Surface Water Quality Monitoring Program - FY 2012

The purpose of the Ambient Surface Water Quality Monitoring Program is to collect data on the chemical, physical and biological characteristics of Delaware's surface waters. The information that is collected under this Program is used to:

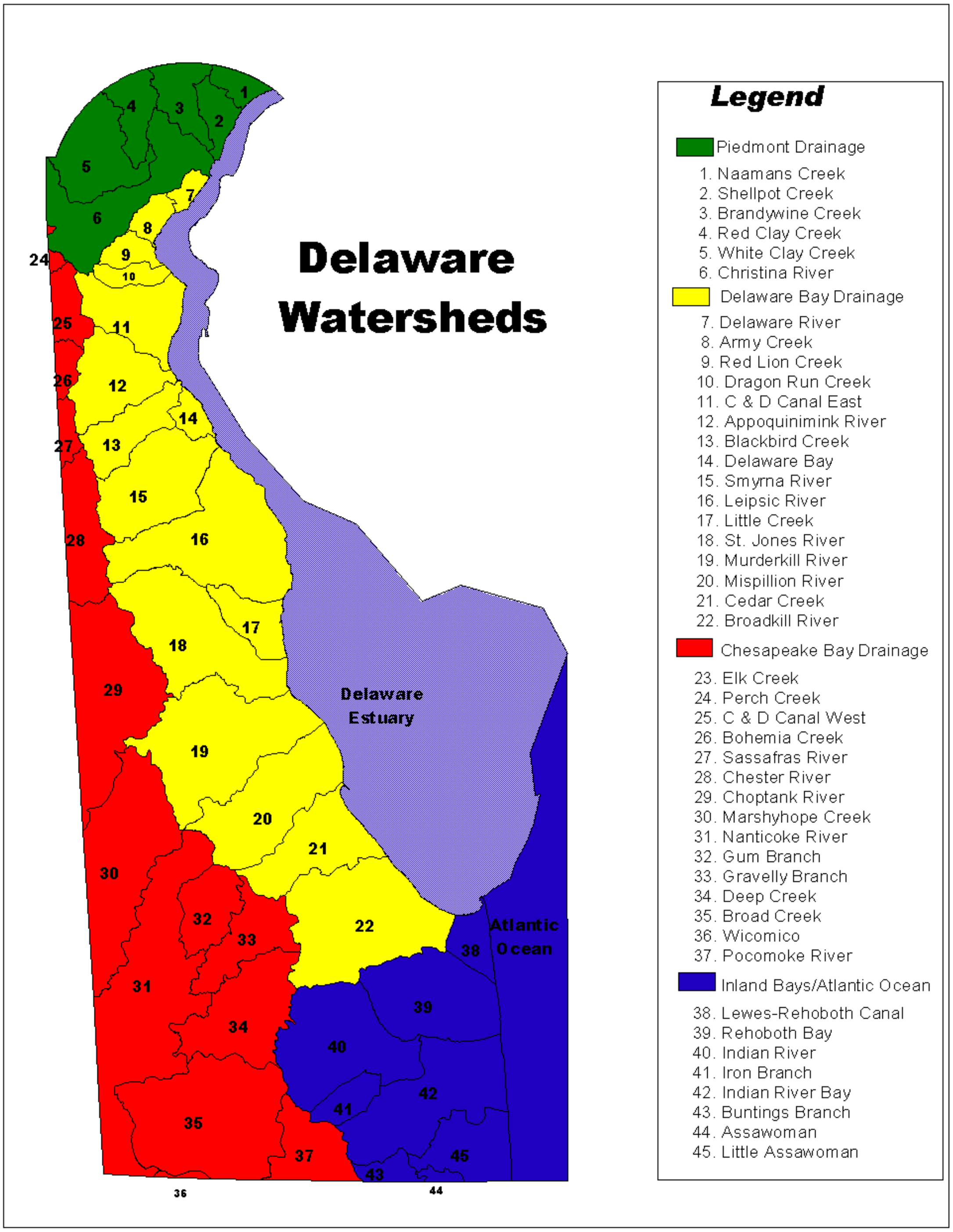
- Describe general surface water quality conditions in the State;
- Identify long term trends in surface water quality;
- Determine the suitability of Delaware surface waters for water supply, recreation, fish and aquatic life, and other uses;
- Monitor achievement of Surface Water Quality Standards;
- Identify and prioritize high quality and degraded surface waters;
- Calculate annual nutrient loads and track progress toward achieving Total Maximum Daily Loads (TMDLs) targets; and
- Evaluate the overall success of Delaware's water quality management efforts.

There are four major components to Delaware's Surface Water Quality Monitoring Program:

- General Assessment Monitoring
- Biological Assessment Monitoring
- Toxics in Biota Monitoring
- Toxics in Sediment Monitoring

This report discusses the General Assessment Monitoring and Biological Assessment Monitoring. Current Toxics in Biota and Sediment Monitoring plans are available on request.

Figure 1. State of Delaware Basins



Part I The General Assessment Monitoring Network (GAMN)

The General Assessment Monitoring Network (GAMN) provides for routine water quality monitoring of surface waters throughout Delaware. Each station is monitored for conventional parameters such as nutrients, bacteria, dissolved oxygen, pH, alkalinity, and hardness. Some stations are monitored for dissolved metals. See tables 2 and 3 for parameters and methods. See Appendix A for a sampling schedule and estimated costs for the surface water component. The data from this monitoring is entered into the STORET database, is reviewed and then analyzed in assessing the water quality of each basin for the Watershed Assessment Report (CWA Section 305 (b) Report). The Department anticipates co-operating with EPA in migrating from the STORET platform to the new WQX platform.

The plan provides for monitoring at stations within each watershed in the state. The network was recently reviewed and updated. The review is discussed in section I.1. See also Table 1: FY 2012 Monitoring Plan and Schedule.

I.1 Changes for Surface Water Quality Monitoring Plan

Over the past several years, a main objective of the Watershed Assessment Section's Ambient Surface Water Quality Monitoring Program was to collect water quality data that could be used for developing and calibrating hydrodynamic and water quality models. These models were used to establish Total Maximum Daily Loads (TMDLs) for nutrients and bacteria in impaired waters of the State.

Now, with the establishment of nutrient and bacteria TMDLs for most impaired waters of the State, a major objective of the Ambient Surface Water Quality Monitoring Program is to collect appropriate data that can be used to track water quality changes and to determine if TMDL requirements are being met.

Considering this (and other emerging) needs, and since the Department's monitoring budget is limited, surface water quality monitoring plan has been prepared with the following changes: Monitoring stations in earlier monitoring plans were reviewed to determine which stations were critical to meet data needs and which could be dropped. The retained stations fall into 2 categories;

Stations were assigned to one of the following categories:

a. C1 – Category 1 stations are high priority stations that will be used for calculating annual loads and/or long-term trends. These stations are generally co-located with a USGS stream gaging station, or are located at the mouth of a tidal river. Because of importance of these stations, monitoring at these stations will be conducted monthly, regardless of priority basin schedule (23 stations)
b. C2 – The remaining stations are part of Category 2 stations and monitoring frequency at these stations follow Priority Basin schedule.

2. A Rotating Basin Monitoring Plan is implemented. In this scheme of monitoring, the State is divided into 5 Monitoring Basins. Every year, two of the Basins are considered "Priority Basins" and all stations in a Priority Basin are monitored

monthly. Monitoring frequency for stations in other basins are conducted bimonthly. Priority Basin monthly monitoring will be conducted according to the following schedule:

a. FY 2009 – Lower Delaware River/Bay, Piedmont
b. FY 2010 – Piedmont, Chesapeake
c. FY 2011 – Chesapeake, Inland Bays
d. FY 2012 – Inland Bays, Upper Delaware River/Bay
e. FY 2013 – Upper Delaware, Lower Delaware River/Bay

I.2 Objectives

The objective of this monitoring is to collect water quality data for status and trends assessment on all basins within Delaware. The data will also be compared to water quality standards to assess designated use support, as mandated by Section 305(b) of the Clean Water Act. In addition, the data will be used to calculate annual nutrient loads and to track progress toward achieving TMDL targets.

I.3 Scope of Monitoring

Table 1 provides a listing of all stations to be monitored during FY 2012, and predicted sampling needs for upcoming fiscal years.

Table 2 provides a listing of parameters that will be monitored at all stations in the network. Stations shown for metals testing in Table 1 shall be sampled according to the specifications in Table 3.

Part II Special Project Monitoring

Special project monitoring is needed from time to time in specific watersheds to address specific concerns. These projects are generally short term in nature. The Department is not conducting any special projects during the FY 2012 monitoring year.

II.1 Special Surveys

The purpose of special survey monitoring is to collect data that are not obtained using other monitoring activities and are needed for modeling purposes as described above. Special surveys include deployment of continuous monitors (YSI Data Sondes) and sediment sampling. No special survey sediment sampling is called for in this monitoring year.

II.2 Continuous Monitoring

The Department is implementing a network of continuous water quality monitoring stations to collect data for dissolved oxygen and other parameters several times each day using YSI (or similar) datasondes. The Department is cooperating with Delaware Geological Survey (DGS) and the United States Geological Survey (USGS) in operating a number of continuous monitors in the State. The information from these continuous monitoring sites are available on real-time basis via the USGS website and via the Delaware Environmental Observing System (DEOS) website. The Department had also put into place a special highly sophisticated on-site monitoring station/automated lab device to collect and analyze samples for nutrients and other parameters at the outlet to Millsboro Pond. The data from this station were used to assess nutrient loads leaving the pond and entering the Delaware Inland Bays and thereby monitor TMDL implementation progress. It is planned to move this automatic data analyzer to the Nanticoke River Watershed during FY 2012 and deploy it at the Bridgeville stream flow gaging site.

Boat run surveys

Boat run surveys should be conducted within one day of tributary sampling in the watershed.

Part III Field and Laboratory Procedures

Field procedures for sample collection activities are detailed in the Quality Assurance Management Plan, Environmental Laboratory Section. Method references, STORET codes and reporting levels for parameters listed in Table 2 are from an Access database maintained by the Environmental Laboratory Section. Any deviation from standard field, laboratory procedures, or this sampling plan shall be documented with a complete description of the alteration.

Part IV Quality Assurance, Documentation, Data Usage and Reporting

The quality assurance objectives and quality control procedures for these surveys are documented in the Quality Assurance Management Plan, Environmental Laboratory Section. A duplicate water column sample will be collected and analyzed on 10% of the samples from this project. All analytical results from the duplicate analyses shall be reported with the other data.

All analytical results shall be reported to the Watershed Assessment Section digitally and on paper (using standard Environmental Laboratory Section data report forms).

Table 1 Station Locations, Descriptions Parameters and Sampling Frequency

STATION INFORMATION - FY 2012	***STORET #***	***Cu, Pb & Zn***	***As***	***Fe***	***DIN & DIP***	***Storm Events***	***No. of Samples in 2011***
PIEDMONT DRAINAGE							
Brandywine Creek							
Brandywine Creek @ Foot Bridge in Brandywine Park	104011	✓					6
Brandywine Creek @ New Bridge Rd. (Rd. 279)(USGS gage 01481500)	104021	✓				3 storms	12
Brandywine Creek @ Smith Bridge Rd. (Rd. 221)	104051	✓					6
Christina River							
Christina River beneath Rt. 141 in Newport off Water St.	106021	✓					6
Little Mill Creek @ DuPont Rd.	106281	✓					6
Christina River @ Conrail Bridge (USGS tide gage 01481602)	106291	✓					12
Christina River @ Nottingham Rd. (Rt. 273) above Newark	106191	✓					6
Christina River @ Sunset Lake Rd. (Rt. 72) (USGS 01478000 at Cooches bridge)	106141	✓				3 storms	12
Smalleys Dam Spillway @ Smalleys Dam Rd.	106031	✓					6
Red Clay Creek							
Red Clay Creek @ W. Newport Pike (Rt. 4) Stanton (USGS gage 01480015)	103011	✓					6
Burrough's Run @ Creek Rd. (Rt 82)	103061	✓					6
Red Clay Creek @ Barley Mill Rd. (Rd. 258A) Ashland	103041	✓					6
Red Clay Creek @ Lancaster Pike (Rt. 48) Wooddale (USGS gage 01480000)	103031	✓				3 storms	12
White Clay Creek							
White Clay Creek @ Delaware Park Blvd. (Race Track) (USGS gage 014790000)	105151	✓				3 storms	12
White Clay Creek @ McKees Lane	105171	✓					6
White Clay Creek @ Chambers Rock Rd. (Rd. 329)	105031	✓					6
Naamans Creek							
Naaman Creek @ State Line near Hickman Rd.	101021						6
Naaman Creek @ RR crossing in Steel Plant	101041						6
Naamans Creek at Rt 3 (Marsh Road)	101061						6
Shellpot Creek							
Shellpot Creek @ Hay Rd. (Rd. 501)	102041			✓			6
Rt. 13 Bus (Market Street) Bridge, USGS station is located about 700 ft downstream.	102051					3 storms	12
Shellpot Crk at Carr Road Bridge	102081						6
CHESAPEAKE BAY DRAINAGE							
Chester River							
Sewell Branch @ Sewell Branch Rd. (Rd. 95)	112021						6
Choptank River							
Cow Marsh Creek @ Mahan Corner Rd. (Rd. 208)	207021						6
Tappahanna Ditch @ Sandy Bend Rd. (Rd. 222)	207081						6
Culbreth Marsh Ditch @ Shady Bridge Rd. (Rd. 210)	207091						6
White Marsh Branch @ Cedar Grove Church Rd. (Rd. 268)	207111						6

STATION INFORMATION - FY 2012	STORET #	Cu, Pb & Zn	As	Fe	DIN & DIP	Storm Events	No. of Samples in 2011
Marshyhope Creek							
Marshyhope Creek @ Fishers Bridge Rd. (Rd. 308)	302031					8 storms	12
Nanticoke River							
Nanticoke River @ buoy 45 (near state line)	304071	✓					6
Nanticoke River @ buoy 66 (confluence with DuPont Gut)	304151	✓					6
Nanticoke River Tributaries							
Racoon Prong @ Pepperbox Rd. (Rd. 66)	304671	✓					6
Nanticoke River @ Rifle Range Rd. (Rd. 545)	304191	✓				8 storms	12
Concord Pond @ German Rd. (Rd. 516)	304311	✓					6
Williams Pond @ East Poplar St. (across from Hospital)	304321	✓					6
Bucks Branch @ Conrail Rd. (Rd. 546)	304381	✓					6
Nanticoke River @ Rt. 13	304471	✓					6
Records Pond @ Willow St.	307011	✓					6
Horseys Pond @ Sharptown Rd. (Rt. 24)	307171	✓					6
Gravelly Branch @ Coverdale Rd. (Rd. 525)	316011	✓					6
Trap Pond on Hitch Pond Branch @ Co. Rd. 449 or Trap Pond Rd	307081	✓					6
Deep Creek above Concord Pond, near Old Furnace at Rd. 46	304591	✓					6
Gravelly Branch at Deer Forest Road (Rd 565) on west edge of Redden State Forest Jester Tract	316031	✓					6
Broad Creek at Main Street in Bethel (Rd 493)	307031	✓					6
Nanticoke River at Beach HWY (Ellendale Greenwood HWY) on east edge of Greenwood	304681	✓					6
Pocomoke River							
Pocomoke River @ Bethel Rd. (Rd. 419)	313011						6
DELAWARE BAY DRAINAGE							
Appoquinimink River							
Drawyer Creek off DuPont Parkway. (Rt. 13) at parking area	109071	✓					12
Shallcross Lake @ Shallcross Lake Rd. (Rd. 428)	109191	✓					12
Noxontown Pond @ Noxontown Rd. (Rd. 38)	109131	✓					12
Appoquinimink River @ DuPont Prkwy. (Rt. 13)	109041	✓					12
Appoquinimink River @ MOT Gut (west bank)	109171	✓					12
Deep Creek Br of Appoquinimik River at Rt. 71 Bridge (Middletown Natural Area), duplicate with 109081	109251	✓				3 storms	12
Appoquinimink River @ Silver Run Rd. (Rt. 9) NE side	109121	✓					12
Appoquinimink River @ confluence with Delaware River	109091	✓					12
Army Creek							
Army Creek @ River Rd. (Rt. 9)	114011						12
Chesapeake & Delaware Canal							
C & D Canal @ DuPont Pky. (Rt. 13) St. Georges Bridge	108021						12
Lums Pond @ Boat ramp	108111						12
Dragon Run							

STATION INFORMATION - FY 2012	STORET #	Cu, Pb & Zn	As	Fe	DIN & DIP	Storm Events	No. of Samples in 2011
Dragon Creek @ Wrangle Hill Rd. (Rt. 9)	111011						12
Dragon Creek @ S. DuPont Hgwy. (Rt. 13)	111031						12
Red Lion Creek							
Red Lion Creek @ Bear Corbitt Rd. (Rt. 7)	107011						12
Red Lion Creek @ Rt. 9	107031						12
Blackbird Creek							
Blackbird Creek, Road 463 East of RR Tracks. USGS gage	110011					3 storms	12
Blackbird Landing Rd 455	110031						12
Blackbird Creek @ Taylors Bridge Rd. (Rt. 9)	110041						12
Leipsic River							
Garrisons Lake @ DuPont Highway (Rt. 13)	202021						12
Leipsic River @ Denny St. (Rt. 9)	202031						12
Upstream of Masseys Millpond at Rt. 15	202191						12
Little River							
Little River @ Bayside Dr. (Rt.9)	204031						12
Little River @ N. Little Creek Rd. (Rt. 8)	204041						12
Smyrna River							
Mill Creek @ Carter Rd. (Rd. 137)	201021						12
Smyrna River @ Rt. 9 (Flemings Landing)	201041						12
Duck Creek @ Smyrna Landing Rd. (Rd. 485)	201051						12
201011 Mill Creek at Rt. 13	201011						12
Providence Creek @ Duck Creek Rd. (Rt.15)	201161						12
Broadkill River							
Ingram Branch, Savanah Ditch @ Rd. 246	303011						6
Ingram Branch @ Rd. 248	303021						6
Rt. 5 Bridge	303031					3 storms	12
Rt. 1 Bridge (Mainstem)	303041						6
Broadkill River 0.10 Miles From Mouth of Broadkill	303061						12
Red Mill Pond at Rt. 1	303051						6
Beaverdam Creek at Rd. 88	303171						6
Beaverdam Creek above Rd. 259, Hunters Mill Pond	303181						6
Round Pole Branch at Rd. 88	303311						6
Waples Pond at Rt. 1	303331						6
Pemberton Branch at Rt. 30 above Wagamons Pond	303341						6
Cedar Creek							
Swiggetts Pond @ Cedar Creek Rd. (Rt. 30)	301021						6
Cedar Creek @ Coastal Hgwy. (Rt. 1)	301031						6
Cedar Creek @ Cedar Beach Rd. (Rt. 36)	301091						6
Mispillion River							
Mispillion River @ Rt. 1	208021						6
Mispillion River/Cedar Creek confluence @ Lighthouse	208061						12
Mispillion River @ mouth of Fishing Branch	208121						6
Abbotts Pond @ Abbotts Pond Rd. (Rd. 620)	208181						6
Silver Lake @ Maple Ave.	208211						6
Beaverdam Branch @ Deep Grass Ln. (Rd. 384)	208231						6
Delaware Bay							
Roosevelt Inlet, Mouth	401011						6

STATION INFORMATION - FY 2012	STORET #	Cu, Pb & Zn	As	Fe	DIN & DIP	Storm Events	No. of Samples in 2011
Murderkill River							
Murderkill River @ confluence of Black Swamp Creek at Rt. 13	206011	✓				3 storms	12
Browns Branch @ Milford - Harrington Hwy. (Rt. 14)	206041	✓					6
Murderkill River @ Bay Rd. (Rt. 1/113)	206091	✓					6
Murderkill River @ Bowers Beach Wharf (mouth)	206101	✓					12
Murderkill River near levee @ Milford Neck Wildlife Area (3.25 miles from mouth)	206141	✓					6
Murderkill River @ confluence of Kent County WWTF discharge ditch	206231	✓					6
McColley Pond @ Canterbury Rd. (Rt. 15)	206361	✓					6
Coursey Pond @ Canterbury Rd. (Rt. 15)	206451	✓					6
Double Run @ Barretts Chapel Rd. (rd. 371)	206561	✓					6
St. Jones River							
St. Jones River @ Barkers Landing	205041						12
St. Jones River @ Rt. 10	205091						12
Fork Branch @ State College Rd. (Rd. 69)	205151						12
Moores Lake @ S. State St.	205181						12
Silver Lake @ Spillway (Dover City Park)	205191					3 storms	12
St. Jones at Bowers Beach, mouth to Del.Bay.	205011						12
Derby Pond @ Rt. 13A	205211						12
INLAND BAYS DRAINAGE							
Tributary Stations							
Burton Pond @ Rt. 24	308031	✓	✓		✓		12
Millsboro Pond @ Rt. 24	308071	✓	✓		✓	3 storms	12
Pepper Creek @ Rt. 26 (Main St.)	308091	✓	✓		✓		12
Blackwater Creek @ Omar Rd. (Rd. 54)	308361	✓	✓		✓		12
Dirickson Creek @ Old Mill Bridge Rd. (Rd. 381)	310031	✓	✓		✓		12
Bunting Branch							
Buntings Branch @ Rt. 54 (Polly Branch Rd.)	311041	✓	✓		✓		12
Guinea Creek							
Guinea Creek @ Banks Rd. (Rd. 298)	308051	✓	✓		✓		12
Iron Branch							
Whartons Branch @ Rt. 20 (Dagsboro Rd.)	309041	✓	✓		✓		12
Lewes & Rehoboth Canal							
Lewes & Rehoboth Canal @ Rt. 9	305041	✓	✓		✓		12
Little Assawoman Canal							
Little Assawoman Bay @ Rt. 54 (The Ditch)	310011	✓	✓		✓		12
White Creek @ mouth of Assawoman Canal	312011	✓	✓		✓		12
Love Creek							
Bundicks Branch @ Rt. 23	308371	✓	✓		✓		12
Miller Creek							
Beaver Dam Ditch @ Beaver Dam Rd. (Rd. 368)	310121	✓	✓		✓		12
Stockley Branch/Cow Bridge							
Cow Bridge Branch @ Zoar Rd. (Rd. 48)	308281	✓	✓		✓		12
Swan Creek							
Swan Creek @ Mount Joy Rd. (Rd. 297)	308341	✓	✓		✓		12
Vines Creek							
Ocean Boundary Stations							

STATION INFORMATION - FY 2012	***STORET #***	***Cu, Pb & Zn***	***As***	***Fe***	***DIN & DIP***	***Storm Events***	***No. of Samples in 2011***
Lewes & Rehoboth Canal @ Rt. 1	305011	✓	✓		✓		12
Indian River Inlet @ Coast Guard Station	306321	✓	✓		✓		12
Boat Run Stations							
Rehoboth Bay @ Buoy 7	306091	✓	✓		✓		12
Masseys Ditch @ Buoy 17	306111	✓	✓		✓		12
Indian River Bay @ Buoy 20	306121	✓	✓		✓		12
Indian River @ Buoy 49 (Swan Creek)	306181	✓	✓		✓		12
Indian River @ Island Creek	306331	✓	✓		✓		12
Island Creek upper third	306341	✓	✓		✓		12
Little Assawoman Bay Mid-bay (Ocean Park Lane)	310071	✓	✓		✓		12

Table 2 Water Quality Parameters to be analyzed at all Stations in the Monitoring Network, FY 2012

Parameter	***Method Reference (EPA)***	***Reporting Level***[1]
Water Column Nutrients		
Total Phosphorus	EPA365.1 M	0.005 mg/l P
Soluble Ortho-phosphorus	EPA365.1	0.005 mg/l P
Ammonia Nitrogen	EPA350.1	0.005 mg/l N
Nitrite+Nitrate N	EPA353.2	0.005 mg/l N
Total N	SM 4500 NC	0.08 mg/l N
Carbon and Organics		
Total Organic Carbon	EPA415.1	1 mg/l
Dissolved Organic Carbon	EPA415.1	1 mg/l
Chlorophyll-a (Corr)	EPA 445.0	1 µg/l
Biochemical Oxygen Demand		
BOD_5, N-Inhib (CBOD)	$SM20^{th}$ed-5210B	2.4 mg/l
BOD_{20}, N-Inhib (CBOD)	$SM20^{th}$ed-5210B	2.4 mg/l
General		
Dissolved oxygen – Winkler[2]	EPA360.2	0.25 mg/l
Dissolved oxygen – Field	EPA360.1	0.1 mg/l
Total Suspended Solids	EPA160.2	2 mg/l
Alkalinity	EPA310.1	1 mg/l
Hardness	EPA130.2	5 mg/l
Field pH	EPA150.1	0.2 pH units
Conductivity – Field	EPA120.1	1 µS/cm
Salinity	$SM20^{th}$ed-2520B	1 ppt
Temperature	EPA170.1	^{o}C
Secchi Depth[3]	EPA/620/R-01/003	meters
Light Attenuation[4]	EPA/620/R-01/003	%
Turbidity	EPA180.1	1 NTU
Chloride	EPA325.2	1 mg/l
Bacteria		
Enterococcus	$SM20^{th}$ed-9230C	1 cfu/100 ml

[1] As documented in the ELS Quality Assurance Management Plan, the ELS defines the Limit of Quantitation (LOQ) as the lowest standard in the calibration curve or, in instances where a standard curve is not specified by the procedure, LOQ represents the limitations of the method. For those tests where reference spiking material exists, the ELS measures Method Detection Limit (MDL), as defined in the Federal Register 40 CFR Part 136 Appendix B. MDL values are generated or verified once per year. Results less than the MDL are considered to be not detected and "< MDL" is reported. Results greater than the MDL but less than the LOQ are qualified with a J to indicate a result that is extrapolated or estimated. For tests where MDL is not applicable, results less than the LOQ are reported as "< LOQ", ELS MDLs meet or exceed (i.e. are lower than) the reporting level requirements listed in Table 3.

[2] Secchi Depth to be measured at designated stations.

[3] Light attenuation to be conducted as practical to obtain correlation with Secchi disk readings

Table 3 Metals Parameters

Dissolved Metals (dissolved and total)	***Method Reference (EPA)***	***Reporting Level***
Copper	EPA 200.7 M	5.0 ug/l
Lead	EPA 200.7 M	3.0 ug/l
Zinc	EPA 200.7 M	10 ug/l
Iron	EPA 200.7 M	100 ug/l

Appendix A: FY 2012 Surface Water Monitoring Schedule & Cost Estimate

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
Northern Piedmont	Brandywine Creek	3		3		3		3		3		3		120	$36,480	$7,200	$300	$9,000	$52,980
	Christina River	6		6		6		6		6		6							
	Red Clay Creek	4		4		4		4		4		4							
	White Clay Creek	3		3		3		3		3		3							
	Duplicates + Field Blanks	4		4		4		4		4		4							
UD Farm	University of Delaware Farm	6	6		6	6		6	6		6	6		56	$8,176	$0	$0	$0	$8,176
	Duplicates + Field Blanks	1	1		1	1		1	1		1	1							
Northeast Piedmont	Naaman's Creek	3		3		3		3		3		3		48	$14,592	$540	$300	$4,500	$19,932
	Shellpot Creek	3		3		3		3		3		3							
	Duplicates + Field Blanks	2		2		2		2		2		2							

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
Piedmont Monthly	Piedmont Monthly		6		6		6		6		6		6	48	$14,592	$2,520	$300	$4,500	$21,912
	Duplicates + Field Blanks		2		2		2		2		2		2						
North Delaware Bay Drainage	Army Creek	1	1	1	1	1	1	1	1	1	1	1	1	108	$32,832	$0	$600	$9,000	$42,432
	C & D Canal	2	2	2	2	2	2	2	2	2	2	2	2						
	Dragon Creek	2	2	2	2	2	2	2	2	2	2	2	2						
	Red Lion Creek	2	2	2	2	2	2	2	2	2	2	2	2						
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
Appoquinimink River	Appoquinimink	8	8	8	8	8	8	7	7	8	8	8	8	118	$35,872	$7,080	$600	$12,375	$55,927
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
Delaware Bay Drainage	Blackbird Creek	3	3	3	3	3	3	3	3	3	3	3	3	180	$54,720	$0	$600	$9,000	$64,320

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
	Leipsic River	3	3	3	3	3	3	3	3	3	3	3	3						
	Little River	2	2	2	2	2	2	2	2	2	2	2	2						
	Smyrna River	5	5	5	5	5	5	5	5	5	5	5	5						
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
St. Jones River	St. Jones River	7	7	7	7	7	7	7	7	7	7	7	7	108	$32,832	$0	$600	$9,000	$42,432
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
Murderkill River	Murderkill								7		9		9	33	$10,032	$1,980	$150	$4,425	$16,587
	Duplicates + Field Blanks								2		3		3						
Murderkill River Profiles	Murderkill		17		17		17							63	$19,152	$3,780	$150	$5,513	$28,595
	Duplicates + Field Blanks		4		4		4												

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
Delaware Bay Monthly	Broadkill River Monthly	2		2		2		2		2		2		42	$12,768	$1,440	$300	$4,500	$19,008
	Mispillion River Monthly	1		1		1		1		1		1							
	Murderkill Monthly	2		2		2		2		2		2							
	Duplicates + Field Blanks	2		2		2		2		2		2							
South Delaware Bay Drainage	Cedar Creek		3		3		3		3		3		3	66	$20,064	$0	$300	$4,500	$24,864
	Mispillion River		6		6		6		6		6		6						
	Duplicates + Field Blanks		2		2		2		2		2		2						
Broadkill River	Broadkill River		11		11		11		11		11		11	78	$23,712	$0	$300	$4,500	$28,512
	Duplicates + Field Blanks		2		2		2		2		2		2						
Inland Bays	Inland Bays	24	24	24	24	24	24	19	19	24	24	24	24	362	$136,648	$26,250	$600	$34,875	$198,373

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
	Delaware Bay	1		1		1		1		1		1							
	Pocomoke River	1		1		1		1		1		1							
	Duplicates + Field Blanks	6	6	6	6	6	6	6	6	6	6	6	6						
Nanticoke River	Nanticoke River		15		15		15		13		15		15	112	$34,048	$6,720	$300	$10,688	$51,756
	Duplicates + Field Blanks		4		4		4		4		4		4						
Chesapeake Bay Nontidal	Chesapeake Bay Nontidal	2	2	2	2	2	2	2	2	2	2	2	2	48	$14,592	$0	$600	$9,000	$24,192
	Duplicates + Field Blanks	2	2	2	2	2	2	2	2	2	2	2	2						
Chesapeake Bay Drainage	Chester River		1		1		1		1		1		1	30	$9,120	$0	$300	$4,500	$13,920
	Choptank River		4		4		4		4		4		4						
Chesapeake Bay Nontidal Storm	Storm Sites	2		2	2		2	2		2	2		2	32	$12,256	$0	$400	$6,000	$18,656

Project	Basin/ Sub-basin/ Watershed	Number of Samples												Cost					
		Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	# Samples	Analytical Chemistry	Metals	WQX	Field Costs	Total
	Duplicates + Field Blanks	2		2	2		2	2		2	2		2						
Statewide Storm	Storm Sites	11			11						11			45	$14,364	$1,980	$150	$4,500	$20,994
	Duplicates + Field Blanks	4			4						4								
TOTALS														1697	$536,852	$59,490	$6,850	$150,375	$753,567
Shellfish & Recreational Waters																			$21,000
Grand Total																			***$774,567***

KCI

KCI Technologies, Inc.
1352 Marrows Road, Suite 100
Newark, DE 19711