A TEACHER'S GUIDE TO THE WATERSHEDS OF CAMDEN COUNTY

a guide for upper elementary and middle school teachers

Prepared by:

Delaware Valley
Regional Planning
Commission

Prepared for:

Environmental
Commission of
Camden County
and
Camden County
Board of Freeholders

A TEACHER'S GUIDE

A TEACHER'S GUIDE TO THE WATERSHEDS OF CAMDEN COUNTY

a guide for upper elementary and middle school teachers

Prepared by:

Delaware Valley
Regional Planning
Commission

Prepared for:

Environmental
Commission of
Camden County
and
Camden County
Board of Freeholders

A TEACHER'S GUIDE

The Delaware Valley Regional Planning Commission produced *A Teacher's Guide to the Watersheds of Camden County* for the Environmental Commission of Camden County. Funding for this project was provided by:

Camden County Board of Freeholders
Delaware Valley Regional Planning Commission
New Jersey Department of Environmental Protection: Office of Environmental Services

The model for this publication is the ***Teacher's Guide to the Great Swamp Watershed*** by Maureen Cremeans, Karen Parrish, and Karen Patterson, published by The Great Swamp Watershed Association, New Vernon, NJ, 2000. Much of the information, many of the illustrations, and the layout from that Guide were used in this version. The Environmental Commission of Camden County extends special thanks to the authors and to the Great Swamp Watershed Association for permission to utilize and modify their excellent publication. Additional information has been obtained from reference works, from members of the Steering Committee and other local individuals, and from websites and print materials of environmental organizations and governmental agencies (See Teacher Resources chapter.)

Steering Committee for the Project

Kevin Davis, Environmental Commission of Camden County
Robert Fonash, New Jersey–American Water Company
Carolyn Grasso, Logan Township Elementary School
Alison Hastings, Delaware Valley Regional Planning Commission
Belinda Irizarry, Great Egg Harbor Watershed Association and the Federation of Gloucester County Watersheds
Maggi Liebe, Camden County Division of Environmental Affairs
Debbie Lord, Pompeston Creek Watershed Association
Erik Mollenhauer, Educational Information and Resource Center
Dave Orleans, Camden County Department of Parks, County Naturalist
Ted Pisciotta, Environmental Commission of Camden County
Jack Sworaski, Camden County Division of Environmental Affairs
Jill Taylor, Gloucester County Department of Parks and Recreation, County Naturalist
Joyce Trout, Union Valley Elementary School, Gloucester Township, Camden County

Suzanne McCarthy, Delaware Valley Regional Planning Commission – Writer and editor

This Guide was developed for teachers of upper Elementary and Middle School classes, especially teachers of 4th through 8th grades. The printed Guide is free to Camden County teachers. The Guide is also available online and may be downloaded free of charge from the DVRPC website at www.dvrpc.org.

The Environmental Commission Of Camden County
c/o The Camden County Division of Environmental Affairs
520 N. Newton Lake Drive
Collingswood, NJ 08107
856–858–5241

Delaware Valley Regional Planning Commission
The Bourse Building, 8th Floor
111 S. Independence Mall East
Philadelphia, PA 19106–2582
215–592–1800
www.dvrpc.org

Cover photo: Big Timber Creek looking toward the Delaware River. Source: DVRPC

Table of Contents

1. INTRODUCTION

TO DO

For more information on Camden County history, resources and events, check the county website at www.co.camden.nj.us.

The Environmental Commission of Camden County, in conjunction with the Delaware Valley Regional Planning Commission (DVRPC) and several other partners, has prepared this teacher's resource guide so that area teachers can introduce their students to the natural and cultural resources of the watersheds of Camden County, helping to instill in them a sense of place and stewardship for their environment. Learning about these resources will help students see the role we all play in our watersheds, develop respect for their local environment, and learn about actions they can take to protect it.

This resource guide provides information on the following:

- Definitions of a watershed and the water cycle.
- Location of the seven watersheds that are wholly or partly in Camden County with maps and descriptions of each one
- The natural and human history of these watersheds
- A description of drinking water sources in Camden County
- Threats to the watersheds and to drinking water
- What you can do to protect Camden County water
- Teacher resources (community groups, websites, activity guides, print resources, and watershed field trip destinations), and a Glossary.
- Appendices consisting of activities and lessons that teachers can utilize in the classroom.

Many pages of the guide contain a side bar with definitions of new terms, a "TO DO" list of suggested activities that complement material on that page, and graphics that help illustrate the concepts being discussed.

Two project partners of this guide, the Camden County Division of Environmental Affairs and the Camden County Environmental Study Center, provide education and outreach programs for area students and teachers:

- The Division of Environmental Affairs offers watershed classroom programs for elementary schools (K – 6 grades).
- The Environmental Study Center (ESC), on Park Drive in Berlin, provides indoor and outdoor programs for students on water-related topics at its facility, and will conduct programs in any of Camden County's schools or parks upon teacher request.
- The ESC sponsors an annual mid-May Watershed Awareness Day for all grades, held in Haddon Lake Park in Haddon Heights, that is open to any Camden County school, free of charge.
- The ESC also offers Project WET (Watershed Education for Teachers) workshops free of charge during the school year. These workshops provide teachers with a hands-on introduction to the nationally acclaimed Project WET curriculum, which contains over 90 activities focusing on water education.

Contact the Camden County Division of Environmental Affairs at 856/833-1469.

Contact the Camden County Environmental Study Center at 856/768-1598 or dorleans@camdencounty.com.

2. THE WATER CYCLE

DEFINITIONS

Water cycle: Also known as the hydrological cycle, this refers to the paths that water takes in its various states – vapor, liquid, and solid – as it moves throughout Earth's systems (oceans, atmosphere, groundwater, streams, etc.)

Aquifer: An underground bed of saturated sediment or rock that yields significant quantities of water.

Groundwater: Water found in spaces between sediment particles underground (located in the zone of saturation).

Evapotranspiration: The return of moisture to the atmosphere by the evaporation of water from the surface and by transpiration from vegetation.

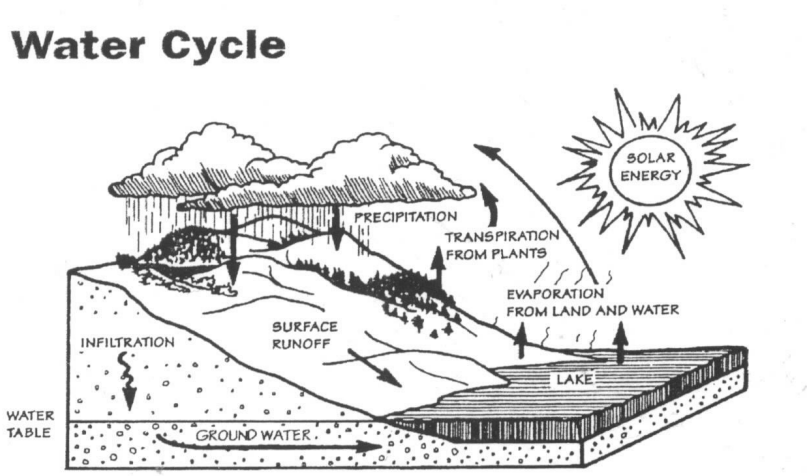
Transpiration: The process by which water that is absorbed through plant roots is returned to the atmosphere from the leaves.

TO DO

Have students participate in the *An Incredible Journey* activity (**Appendix A**) to learn how water moves through their local watershed.

The Earth's supply of fresh water is a precious, and very limited, resource. Although 75% of the Earth's surface is covered by water, less than 3% of that water is fresh, and only one half of one percent (0.5 %) is readily accessible for human use.

Water continuously moves from the atmosphere to the land to the oceans and back to the atmosphere in what is known as the hydrologic or water cycle. After precipitation falls (in the form of rain, snow or ice), it may immediately begin to evaporate from the ground surface, plants and trees, or water bodies, back into the air. A small percentage will run off into streams and rivers, eventually making its way to the oceans. Most of the water soaks into the ground, where it either replenishes shallow aquifers that sustain streams and springs, or seeps into deeper aquifers that serve as large underground reservoirs of freshwater. Water may remain in deep aquifers for centuries or millennia, gradually moving toward and into the Delaware River and the sea, where it evaporates again into the atmosphere.



Source: Project WET: Curriculum and Activity Guide, p. *119*

Despite the fact that water is constantly moving through the hydrologic cycle and thus being recycled in a sense, it is not necessarily being returned to its prior pristine state. Humans interfere with the basic processes of the water cycle in a number of ways. These interferences include depleting groundwater supplies, paving over the land surface, and releasing pollutants onto the land where they can seep into groundwater and run off into local streams. Once polluted or degraded, it is very difficult to restore water to the standards that must be met for use by humans and wildlife. Thus pollution prevention is the most efficient and effective way to protect our water quality.

3. WHAT IS A WATERSHED?

DEFINITIONS

Drainage basin: A large watershed encompassing the watersheds of many smaller rivers and streams and draining to a major river, estuary, or lake.

Watershed: The land area from which surface runoff drains into a particular stream channel, lake, river, or other body of water.

Sub-watershed: The land area draining to the point where two smaller streams combine together to form a larger, single stream.

Catchment: The smallest watershed area, usually defined as the area that drains an individual site, such as a school or small neighborhood, to its first intersection with a stream.

TO DO

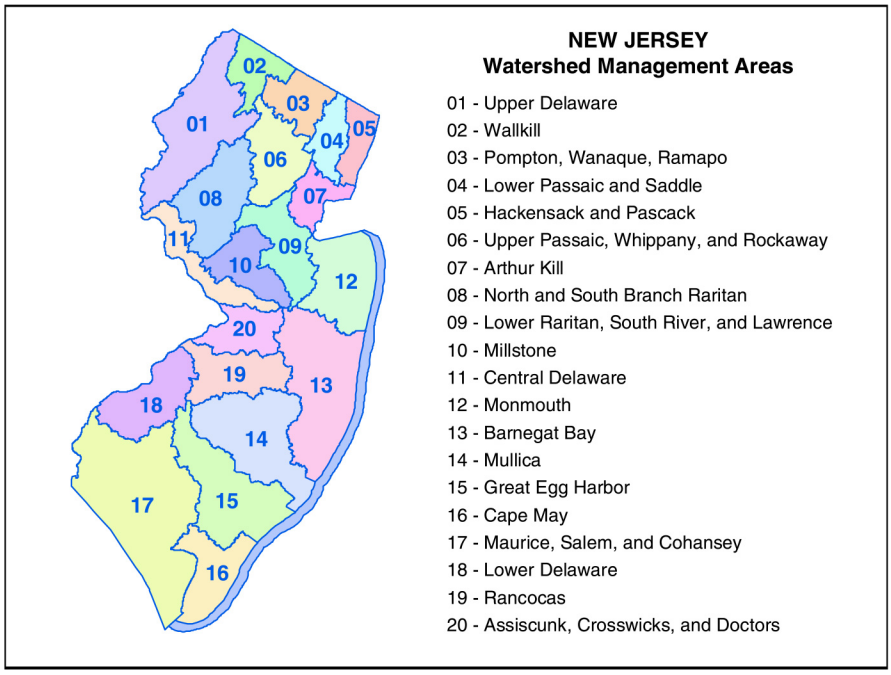
Have students create their own watershed (**Appendix B**), and/or invite the Camden County Division of Environmental Affairs or the Environmental Study Center staff to your classroom to demonstrate watersheds concepts and pollution with their 2' x 4' watershed model. For contact information, see **Teacher Resources – Local Organizations.**

A watershed is any area of land that drains into a common water body such as a stream, river, lake, or wetland. Each watershed is separated from other watersheds by high points in the terrain, such as hills and ridges. A watershed includes not only the water body or waterway itself, but also the entire land area that drains into it. A watershed may be very small, like the drainage formed by your own driveway, or very large, like the drainage basin of the Delaware or Mississippi rivers. Depending on the size of a watershed, it may be referred to as a drainage basin, watershed, sub-watershed, or catchment.

All land—including our neighborhoods, commercial and industrial areas, our forests and parklands—is in one watershed or another. Each watershed is a dynamic and unique place, where our natural resources, such as soil, water, air, plants, and animals, interact in a complex web. Yet, everyday activities can impact these resources, ultimately affecting our own health, well-being, and economic livelihood.

In New Jersey, the Department of Environmental Protection monitors and manages our natural resources on a watershed basis. The state has been divided into 20 Watershed Management Areas (WMAs). The watersheds in Camden County are part of four Watershed Management Areas:

- WMA 14 – Mullica, Wading River
- WMA 15 – Great Egg Harbor, Tuckahoe
- WMA 18 – Lower Delaware Tributaries
- WMA 19 – Rancocas Creek



4. THE WATERSHEDS OF CAMDEN COUNTY

There are seven watersheds that are wholly or partially within Camden County. Two of these consist of the land surrounding headwater streams of two large river systems that flow east to the Atlantic Ocean. These watersheds occupy 46% or 104.5 square miles of Camden territory. They are:

- The Mullica River watershed
- The Great Egg Harbor River watershed

129 miles of the Great Egg Harbor River has been designated as a National Scenic and Recreational River by the U.S. National Park Service, because of its importance to the nation's cultural and natural heritage. Such rivers are generally free flowing and relatively undeveloped and have features that are "outstandingly remarkable" for their scenic or recreational value. About 80% of the Mullica River watershed is publicly owned state park and forest land, within the Pinelands Preservation Area, and under the management of the Pinelands Comprehensive Plan administered by the Pinelands Commission.

The other five watersheds in Camden County have streams that flow westward to the Delaware River. They are part of the larger Delaware River watershed or basin. These watersheds make up 54% or 123 square miles of Camden County. They are:

- The Big Timber Creek watershed
- The Cooper River watershed
- The Newton Creek watershed
- The Pennsauken Creek watershed
- The Rancocas Creek watershed

The Delaware River watershed is 13,000 square miles in size and covers parts of four states – New York, New Jersey, Pennsylvania, and Delaware. Although the watershed occupies only 1% of the land of the United States, it supplies water to 10% of the U.S. population. Many small municipalities and large metropolitan centers get all or part of their drinking water from the river, including Philadelphia, Trenton, and New York City, which obtains its water from reservoirs located in the headwaters of the Delaware.

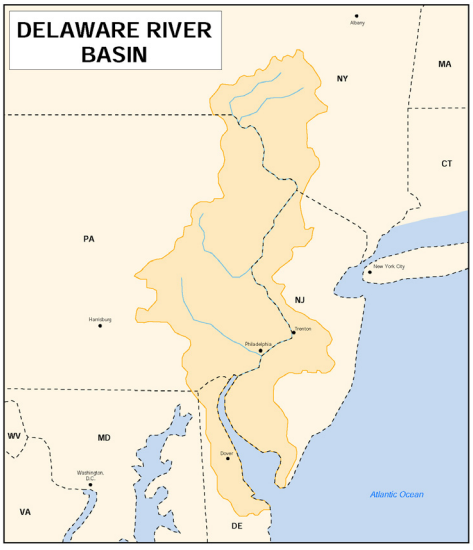
TO DO

Make photocopies of the black and white version of the map of the *Watersheds of Camden County* and of the individual watershed maps appropriate for your town/township (in **this Chapter**) and ask students to locate their "watershed address."

Students can also learn their watershed address by visiting the NJ DEP website at www.state.nj.us/dep/watershedmgt/. Click on "Surf Your Watershed."

TO DO

Have students carry out the *What's Your Watershed Address?* activity (**Appendix C**) to become familiar with their local waterways and their community.



Camden County Towns and Their Watersheds

Municipality	Watersheds	% of Acreage in Watershed
Audubon Borough	Newton Creek	100
Audubon Park Borough	Newton Creek	100
Barrington Borough	Big Timber Creek Cooper River Newton Creek	97 2 1
Bellmawr Borough	Big Timber Creek	100
Berlin Borough	Big Timber Creek Great Egg Harbor River Mullica River	23 66 11
Berlin Township	Big Timber Creek Great Egg Harbor River Mullica River Rancocas Creek	8 36 16 40
Brooklawn Borough	Big Timber Creek	100
Camden City	Cooper River Newton Creek	65 35
Cherry Hill Township	Cooper River Pennsauken Creek	72 28
Chesilhurst	Mullica River	100
Clementon Borough	Big Timber Creek	100
Collingswood Borough	Cooper River Newton Creek	38 62
Gibbsboro Borough	Cooper River Rancocas Creek	99 1
Gloucester City	Big Timber Creek Newton Creek	25 75
Gloucester Township	Big Timber Creek Great Egg Harbor River	88 12
Haddon Township	Cooper River Newton Creek	36 64
Haddonfield Borough	Cooper River Newton Creek	72 28
Haddon Heights Borough	Big Timber Creek Newton Creek	48 52
Hi-Nella Borough	Big Timber Creek	100
Laurel Springs Borough	Big Timber Creek	100
Lawnside Borough	Big Timber Creek Cooper River	32 68
Lindenwold Borough	Big Timber Creek Cooper River	70 30
Magnolia Borough	Big Timber Creek Cooper River	84 16
Merchantville Borough	Cooper River	100
Mount Ephraim Borough	Big Timber Creek Newton Creek	52 48
Oaklyn Borough	Newton Creek	100

Camden County Towns and Their Watersheds

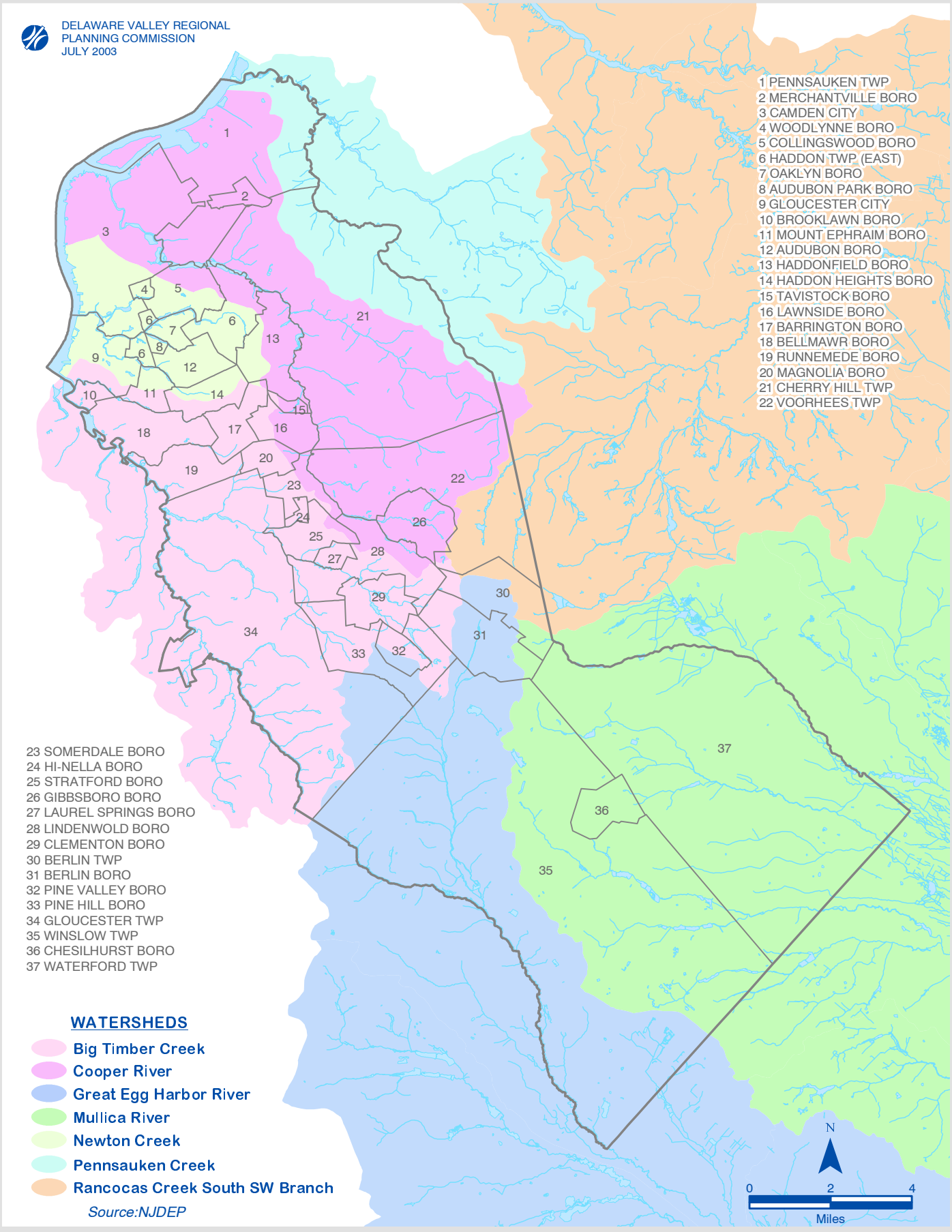
Municipality	Watersheds	% of Acreage in Watershed
Pennsauken Township	Cooper River Pennsauken Creek	75 25
Pine Hill Borough	Big Timber Creek Great Egg Harbor River	78 22
Pine Valley Borough	Big Timber Creek Great Egg Harbor River	64 36
Runnemede Borough	Big Timber Creek	100
Somerdale Borough	Big Timber Creek Cooper River	59 41
Stratford Borough	Big Timber Creek Cooper River	87 13
Tavistock Borough	Big Timber Creek Cooper River	20 80
Voorhees Township	Cooper River Rancocas Creek	65 35
Waterford Township	Mullica River	100
Winslow Township	Great Egg Harbor River Mullica River	56 44
Woodlynne Borough	Newton Creek	100

The next section of this chapter is a **map of Camden County watersheds** in two forms:

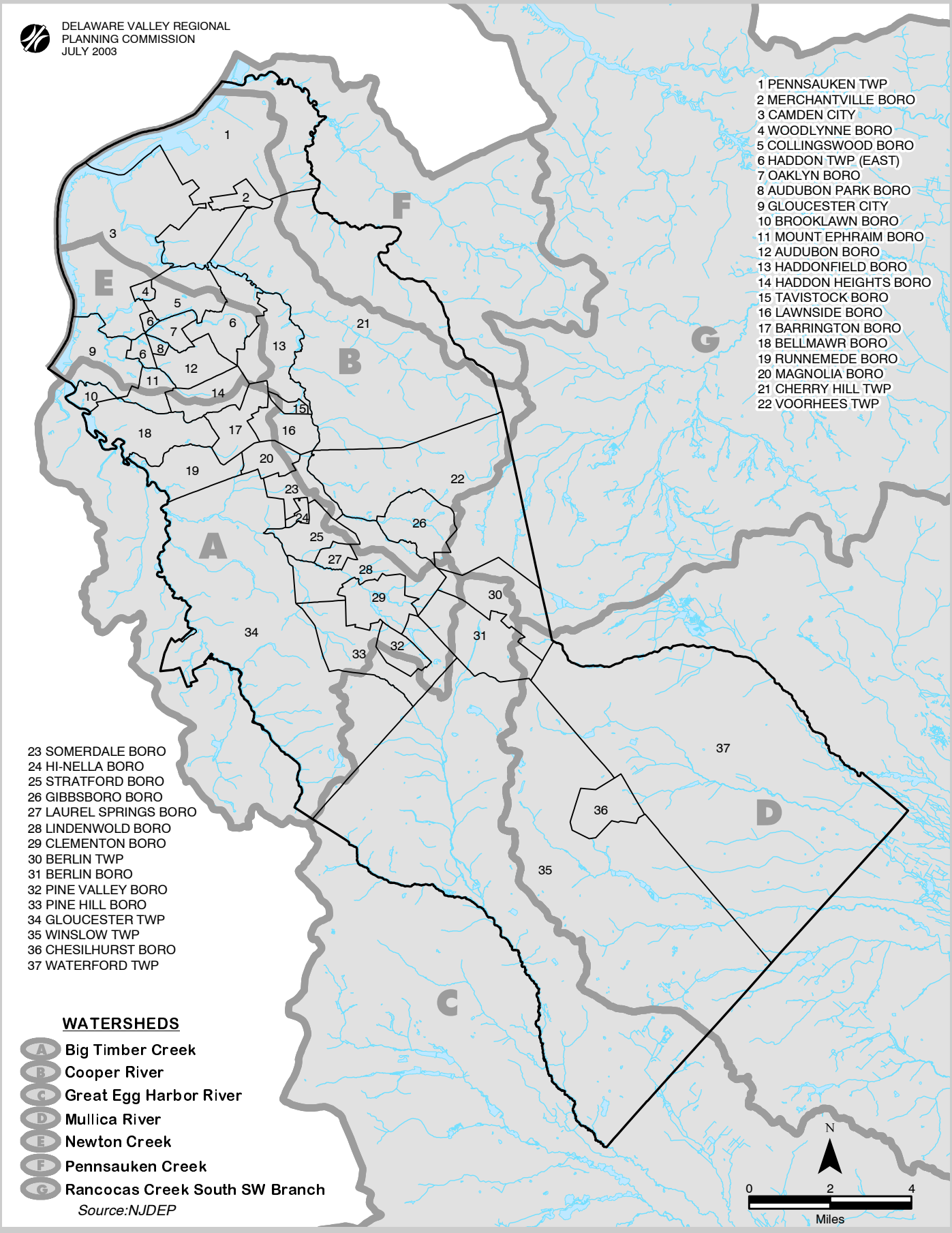
- A color version
- A version that was designed for making black and white photocopies for students (which is best copied using the "photo" setting, if possible).

Following the map is a section consisting of written **descriptions** of each watershed in Camden County, behind which are **seven individual maps** of the watersheds. These are in both color and black and white.

CAMDEN COUNTY : Watersheds



CAMDEN COUNTY : Watersheds



THE WATERSHEDS

DEFINITIONS

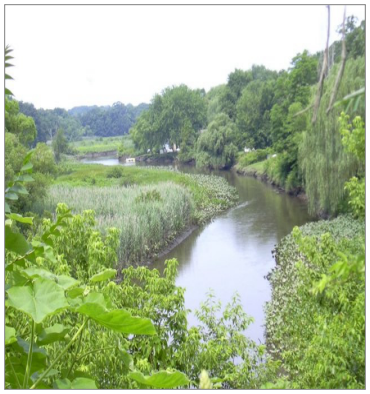
Branch: A smaller stream that flows into ("branches" off from) a larger one.

Run: A smaller stream that flows into ("runs" to) a larger stream or river.

Tributary: A stream or river that flows into a larger stream or river.

Headwaters: The small streams from which a larger creek or river "rises" or begins.

Big Timber Creek, North Branch



Source: DVRPC

Big Timber Creek Watershed (Maps – p. 19 – 20)

The Big Timber Creek Watershed drains an area of 63 square miles in Camden and Gloucester Counties. There are two branches of the Big Timber Creek: the **North Branch** and the **South Branch.** The North Branch begins in Berlin Borough in the area of Lake Worth and Sharps Corner and flows northwest toward Gloucester Township. The South Branch begins in lower Gloucester Township in Camden County and in Washington Township in Gloucester County and flows northward toward Brooklawn.

The North and South Branches of the Big Timber Creek are 10 and 11 miles long respectively and join together just east of Clements Bridge Road in Gloucester Township. From there, the main channel travels less than four miles before it empties into the Delaware River between Brooklawn Borough on the north and Westville Borough on the south. The main channel and the South Branch of the Big Timber Creek form a major portion of the border between Camden and Gloucester Counties. The creek is tidal up to Blackwood Lake in Gloucester Township.

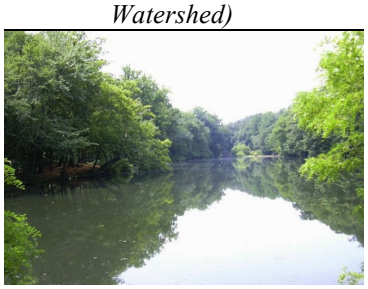
Major tributaries of the Big Timber Creek include **Otter Brook**, **Mason Run, Trout Run, Pines Run, Holly Run,** the unnamed tributary that flows through the Lakeland complex, and **Almonesson Creek** and **Bells Lake Creek** on the Gloucester County side. Major lakes are **Blackwood Lake, Grenloch Lake, Nash's Lake, Jones Lake, Almonesson Lake,** and **Bells Lake** on the South Branch and **Laurel Lake, Clementon Lake, Bottom Lake, Pillings Lake, Silver Lake** (in Clementon) and **Lake Worth** along the North Branch.

Originally named ***Timmer Kil*** by the Dutch ("Timmer" meaning "timber" and "kil" meaning "river"), the stream name later became "Great Timber Creek" and eventually "Big Timber Creek" to distinguish it from "Little Timber Creek." The **Little Timber Creek** is a separate stream within the Big Timber Creek watershed that starts in Tavistock, runs partly underground in pipes, emerges to become the boundary between Haddon Heights and Barrington and between Bellmawr and Mt. Ephraim, before joining the Big Timber Creek and emptying into the Delaware River between Gloucester City and Brooklawn.

Seventeen municipalities in Camden County and four in Gloucester County are included within the Big Timber (and Little Timber) watershed boundaries, in full or part (see *Towns and their Watersheds* for a listing of Camden County towns). The largest in area in Camden County are Gloucester Township, Barrington, Bellmawr, Clementon, and Runnemede.

Cooper River Watershed (Maps – p. 21 – 22)

Hopkins Pond (Cooper River Watershed)



Source: DVRPC

The Cooper River Watershed drains an area of 40 square miles, all in Camden County. The river is 16 miles long and empties into the Delaware River at Camden City. It is tidal up to the Cooper River Lake dam at Kaighn Avenue in Camden. The Cooper River has two main branches. The **North Branch** starts in Voorhees Township and flows northwest through Cherry Hill. The **South Branch** starts as three tributaries in Voorhees, Gibbsboro, and Lindenwold (**Nicholson Branch, Hilliard Creek,** and **Slab Cabin Branch**) and flows northward toward Camden City. It meets the North Branch at a point just west of Kings Highway in Cherry Hill to form the main channel. Other Camden towns that are partially in the watershed are Camden, Collingswood, Haddonfield, Haddon Township, Lawnside, Magnolia, Pennsauken, Stratford, Somerdale, and Tavistock. Merchantville is entirely within the Cooper River watershed.

Two of the largest tributaries of the Cooper River are **Woodcrest Creek** and **Tindale Run. T**here are also a large number of lakes along the Cooper River. Major ones are **Cooper River Lake, Evans Pond, Kirkwood Lake, Linden Lake, Bridgewood Lake, Clement Lake,** and **Silver Lake** (in Gibbsboro).

The Cooper River is named for William Cooper, who acquired land in what is now Camden City in 1682, and for his descendants who settled the land.

Included with the Cooper River, on the watershed map, is **Pochak Creek** in Pennsauken Township, which flows directly into the Delaware River. Other small streams that once ran across Pennsauken do not show on the map because they have been "ensewered." That is, they are no longer on the surface but have been diverted into stormwater pipes that empty into the Delaware. Diverting streams into storm sewers also occurred in Camden City. This was a common practice in older communities in the U.S., beginning in the early 1800s and continuing into the 20th century. By the 19th century, small streams had often become heavily polluted and noxious, and some caused flooding problems. Space was a valuable commodity in bustling, developing towns. Ensewering a stream yielded dry land for industrial, commercial, and residential development.

Great Egg Harbor River Watershed (Maps – p. 23 – 24)

Great Egg Harbor River

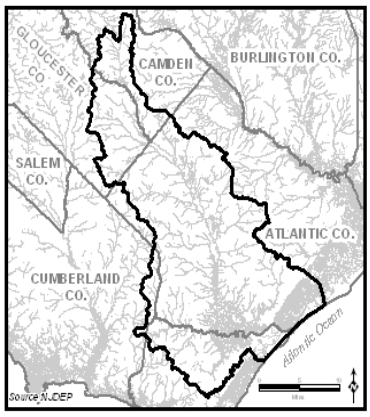
Photo: Michael A. Hogan

The Great Egg Harbor River drains an area of 304 square miles in Camden, Atlantic, and Gloucester Counties, of which 40 square miles are within Camden County. The Great Egg Harbor River is one of the longest rivers in New Jersey (59 miles in length.) It originates in southeastern Camden County and is joined by tributaries from Gloucester County before flowing southeast through the Pinelands region to the Great Egg Harbor Bay and into the Atlantic Ocean. The river is tidal downstream of the dam at Mays Landing in Atlantic County.

The Great Egg Harbor River's main channel actually begins behind the Berlin Plaza Shopping Center, which is the site of a former wetlands area that was sacrificed to create the shopping center and its parking lot. Because of the natural springs on the site, water had to be routed around the shopping center and diverted to underground pipes, where it travels below the NJ Transit railroad tracks and the White Horse Pike. It emerges from a pipe at Camden County's Berlin Park in Berlin Borough to continue its long journey to Great Egg Harbor Bay.

One tributary of the Great Egg Harbor River, **Four Mile Branch**, starts in Winslow Township and forms a portion of the boundary between Camden and Gloucester Counties. It joins the main channel east of the New Brooklyn section of Winslow Township, at the start of the Winslow Wildlife Management Area. Other large tributaries in Camden County are **Sharp's Branch** and **Big Bridge Branch**. **Penny Pot Creek**, a large tributary that joins the Great Egg farther downstream in Atlantic County, also originates in Winslow Township. **New Brooklyn Lake** in New Brooklyn Park is the principal lake along the Great Egg Harbor River in Camden County.

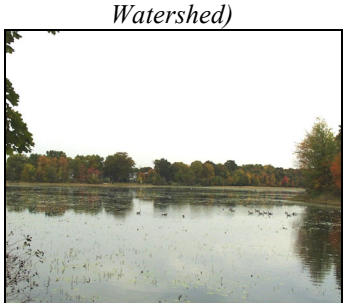
The Great Egg Harbor River Watershed



The name "Egg Harbor" comes from the Dutch "Eyer Haven." This name was applied by early navigators to the Great Egg Harbor Bay because of the immense colonies of nesting birds and their eggs that were found along the seashore. The "Great" in the name of the river was a means of distinguishing it from the Little Egg Harbor River, which is now called the Mullica River. The Little Egg Harbor was smaller in size and extent than the Great Egg. Another early name for the section of the main branch originating within Berlin was "Longacoming Branch," which was also the name of the area that is now Berlin Borough and part of Berlin Township. There are several legends about the origins of "Longacoming" but it actually derives from "Lonaconing…a Delaware (Lenape) Indian word meaning 'where many waters meet.'" [1]

Mullica River Watershed (Maps – p. 25 – 26)

Atco Lake (Mullica River Watershed)

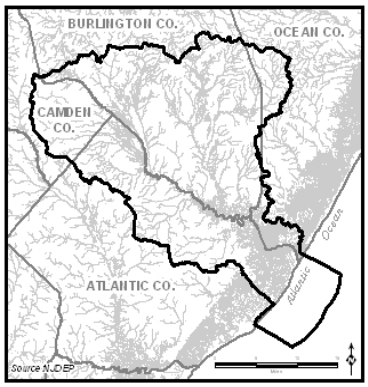


Source: DVRPC

The Mullica River watershed drains 561 square miles in Camden, Atlantic and Burlington Counties, of which 64.5 square miles are within Camden County. Nearly all of the watershed lies within the Pinelands Preservation Area and is characterized by extensive wetlands.

The Mullica River forms part of the boundary between Burlington and Camden Counties in the area of Waterford Township. The main channel originates in Camden County just east of Route 73 in Berlin Township and flows eastward through the Wharton State Forest toward Burlington County, passing through **Atsion Lake** before turning southward to form the boundary between Burlington and Atlantic Counties. The total length of the Mullica River main channel is 45 miles. The river empties into Great Bay on the Atlantic Ocean, just south of Little Egg Harbor. It is tidal up to Sweetwater in Atlantic County.

The Mullica River Watershed



There are several headwater streams flowing across Waterford and Winslow Townships and Chesilhurst Borough in Camden. **Hayes Mill Creek** meets **Cooper Branch** and together they join **Wildcat Branch** to form the **Mechescatuxin Branch**. **Price Branch** joins **Clark Branch** which meets the Mechescatuxin Branch at the Camden–Atlantic boundary, where it becomes **Sleepy Branch** (often printed on maps as "Sleeper Branch"). The long **Pump Branch** in Camden County combines with the **Blue Anchor Branch** to form **Albertsons Branch**. All of these streams, as well as the **Great Swamp Branch** in Winslow Township, flow eastward into Atlantic County where they are part of a huge wetland area called the "Great Swamp." There they join the main channel

[1] From Gannett, *Place Names in the United States*, p. 189, referenced in William R. Farr's *Waterways of Camden County. A Historical Gazetteer*. [Camden Co. Historical Society, Camden, 2002.]

of the Mullica River at Pleasant Mills near Batsto, just above where the **Batsto River** also comes in from the north. From there the Mullica flows southeast before emptying into Great Bay on the Atlantic Ocean, east of Port Republic.

Lakes along the Mullica River in Camden County include **Atco Lake**, **Beaver Dam Lake, Hobb Lake**, and **Goshen Pond**.

The Mullica River is named for Eric Mullica, a pioneer who established settlements along the river in the late 1600s.

Newton Creek Watershed (Maps – p. 27 – 28)

Newton Lake

Source: DVRPC

The Newton Creek watershed is the smallest watershed entirely within Camden County, draining an area of only 13.6 square miles. There are three branches of the Newton. The **North Branch** begins at the border between Camden City and Woodlynne and flows southwest toward Gloucester City. The **Middle** or **Main Branch** begins as unnamed tributaries in Haddonfield and Audubon and flows west toward Gloucester City. The **South Branch** begins in Haddon Lake Park in Haddon Heights and flows northwest toward Gloucester City. Together, these three branches flow through a total of 11 municipalities before joining together and then emptying into the Delaware River between Camden City and Gloucester City. Other towns either partly or wholly in the Newton Creek watershed are Audubon Park, Collingswood, Haddon Township, Mount Ephraim, and Oaklyn.

Lakes along the Newton Creek are **Audubon Lake, Haddon Lake**, **Newton Lake, and Peter's Creek Lake**.

The Newton Creek watershed was the location of the first permanent settlement in Camden County. This was a community named "Newton" that was settled by Quakers and was located on the banks of Newton Creek's main (middle) branch in what is now Haddon Township, in the area called West Collingswood.

Pennsauken Creek Watershed (Maps –p. 29 – 30)

Pennsauken Creek

Source: DVRPC

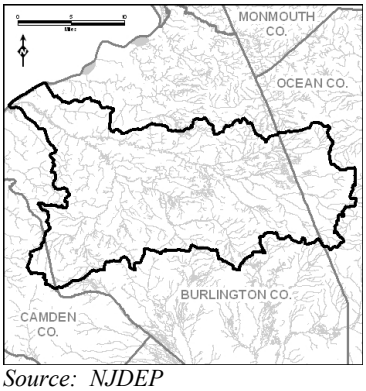
The Pennsauken Creek watershed drains an area of 33 square miles in northern Camden County and southwestern Burlington County and flows into the Delaware River between Pennsauken and Palmyra. The Pennsauken has two main branches: the **South Branch**, which forms a good portion of the border between Camden and Burlington Counties, and the **North Branch,** which is located wholly within Burlington County. The South and North Branches join together at the north end of Maple Shade in Burlington County, just east of the Rte 130 and Rte 73 interchange. The tide affects the three-mile main channel and the first few miles up the two branches.

Cherry Hill and Pennsauken are the only two townships in Camden County having areas within the Pennsauken Creek watershed. There are five communities on the Burlington County side. The only lake along the Pennsauken Creek is **Strawbridge Lake**, located on the North Branch in Burlington County. Only a few tiny ponds are found in Camden County.

The Name "Pennsauken" derives from the name of an Indian village, "Pemisoakin," possibly located where Maple Shade is now found.[2]

Rancocas Creek Watershed (Maps – p. 31 – 32)

The Rancocas Creek Watershed



Source: NJDEP

The Rancocas Creek watershed drains an area of 360 square miles. While most of it is located in Burlington County, a small portion – 3,403 acres – extends into Voorhees and Berlin Townships in Camden County. This area is drained by small tributaries that eventually run to the **Southwest Branch** of the Rancocas in Burlington County. The Rancocas Creek empties into the Delaware River between Delanco and Riverside in Burlington County.

Those tributaries found in Voorhees include **Borton Run** (listed incorrectly on many road maps as Barton's Run) and an unnamed stream (possibly Kenilworth Lake Creek), both of which flow to Borton Run in Evesham Township, Burlington County. Borton Run, in turn, becomes part of the Southwest Branch.

In eastern Berlin Township, immediately east of Cooper Road and above Maple Avenue, is the start of **Kettle Run**, which flows into Burlington County through Marlton Lakes and Taunton Lakes before joining the Southwest Branch. The Southwest Branch meets the South Branch of the Rancocas in Burlington County at Lumberton.

Lakes in Camden County include **Sunshine Park, Oles Lake, Cedar Lake, Lion Lake,** and **Kresson Lake**, all located along Borton Run in Voorhees.

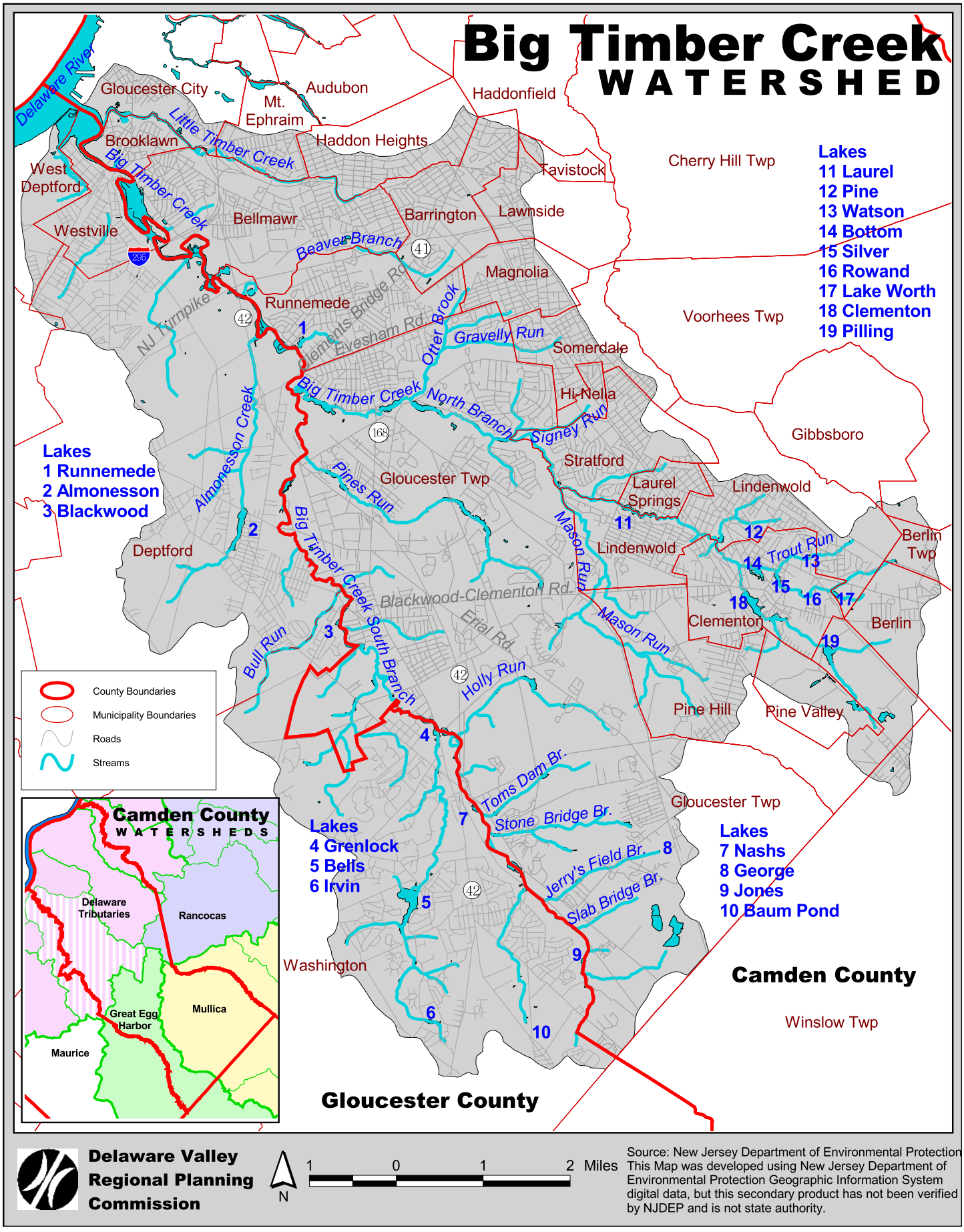
The main channel of the Rancocas is in Burlington County. The Creek is tidal as far as the dams at Mt. Holly on the North Branch, at Vincentown on the South Branch, and at Kirby Mills on the Southwest Branch.

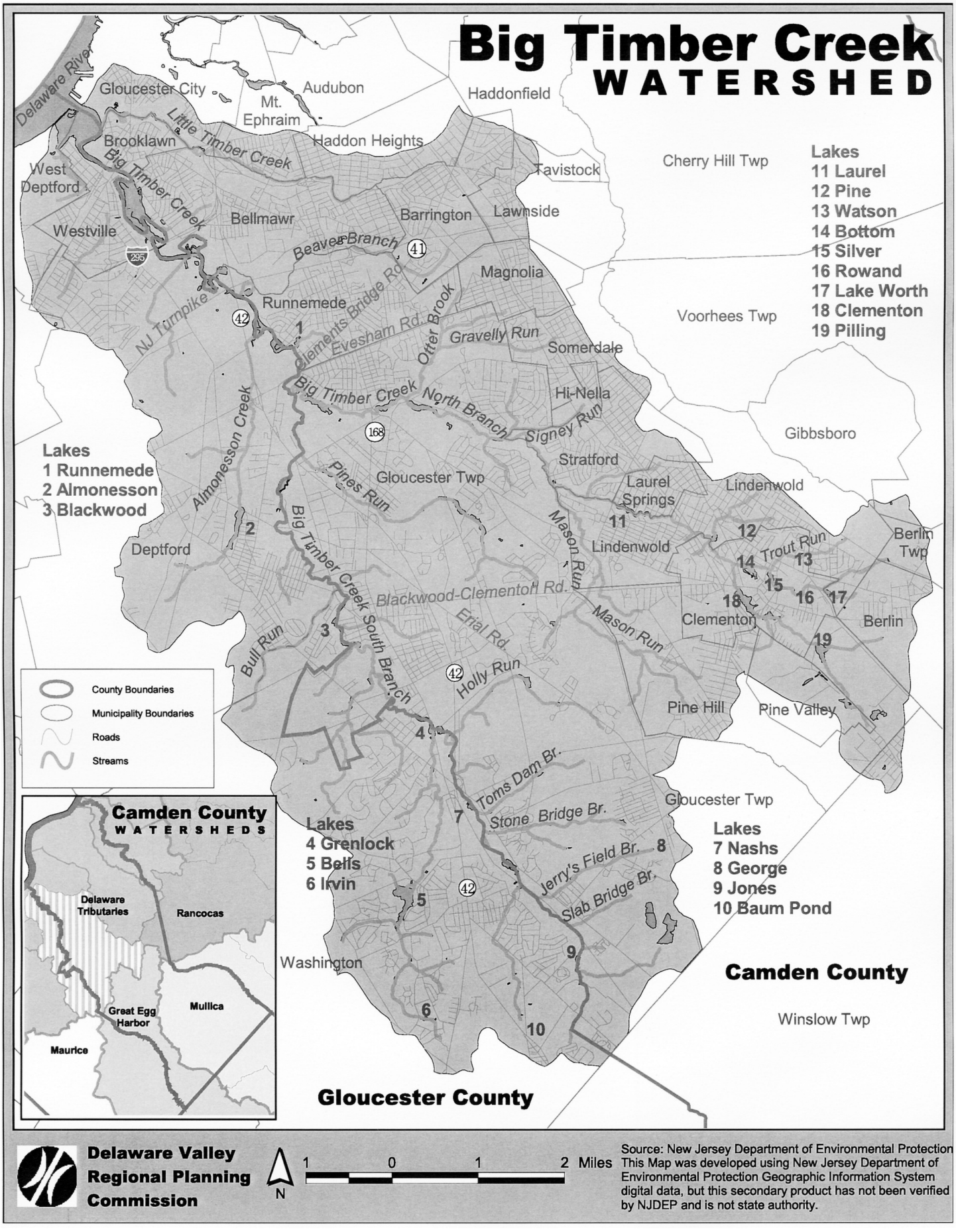
The name "Rancocas" was given to the stream by the Lenape Indians who lived in the area for hundreds of years. Rancocas means "sloping land."[3]

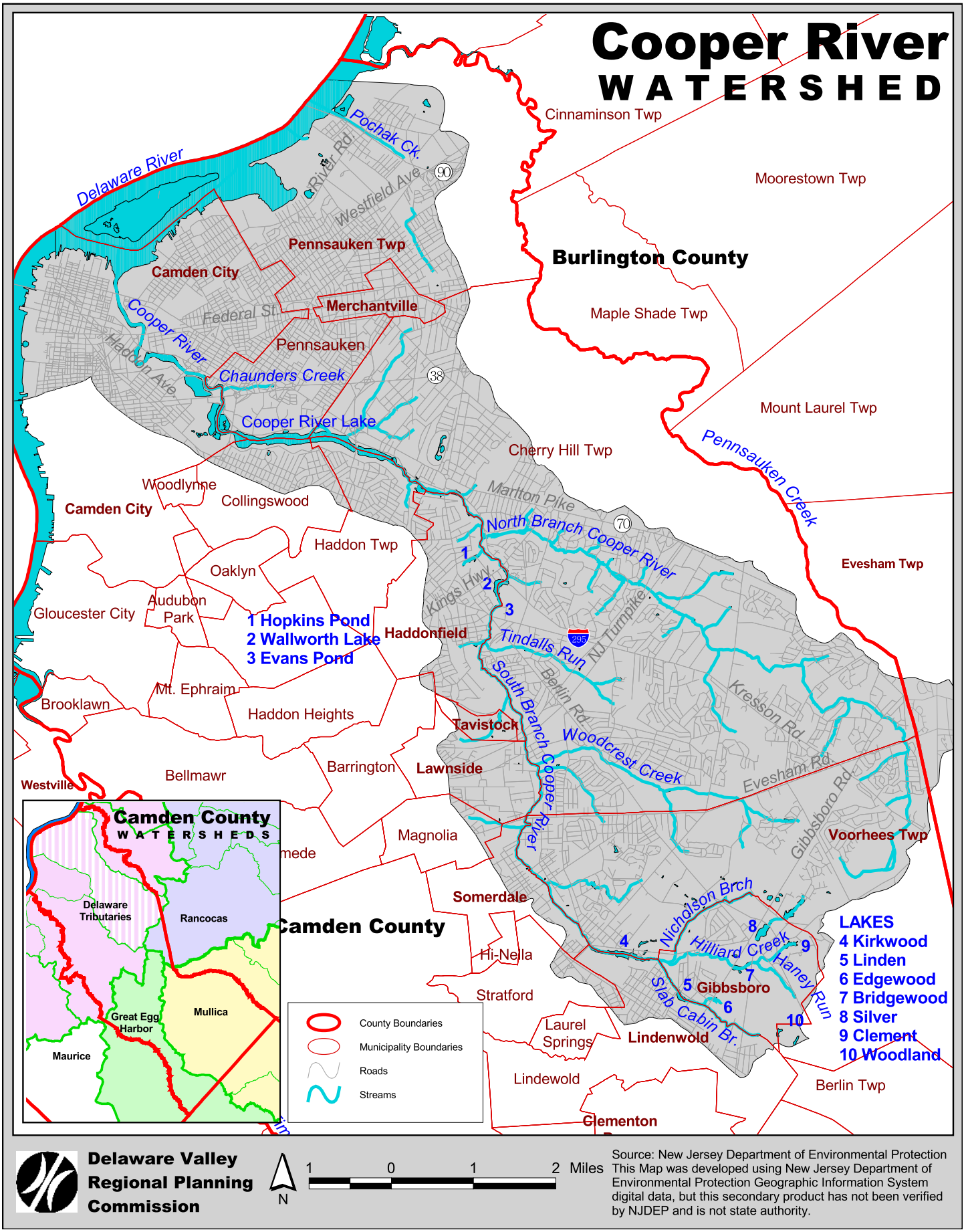
Lion Lake (Rancocas Creek watershed)

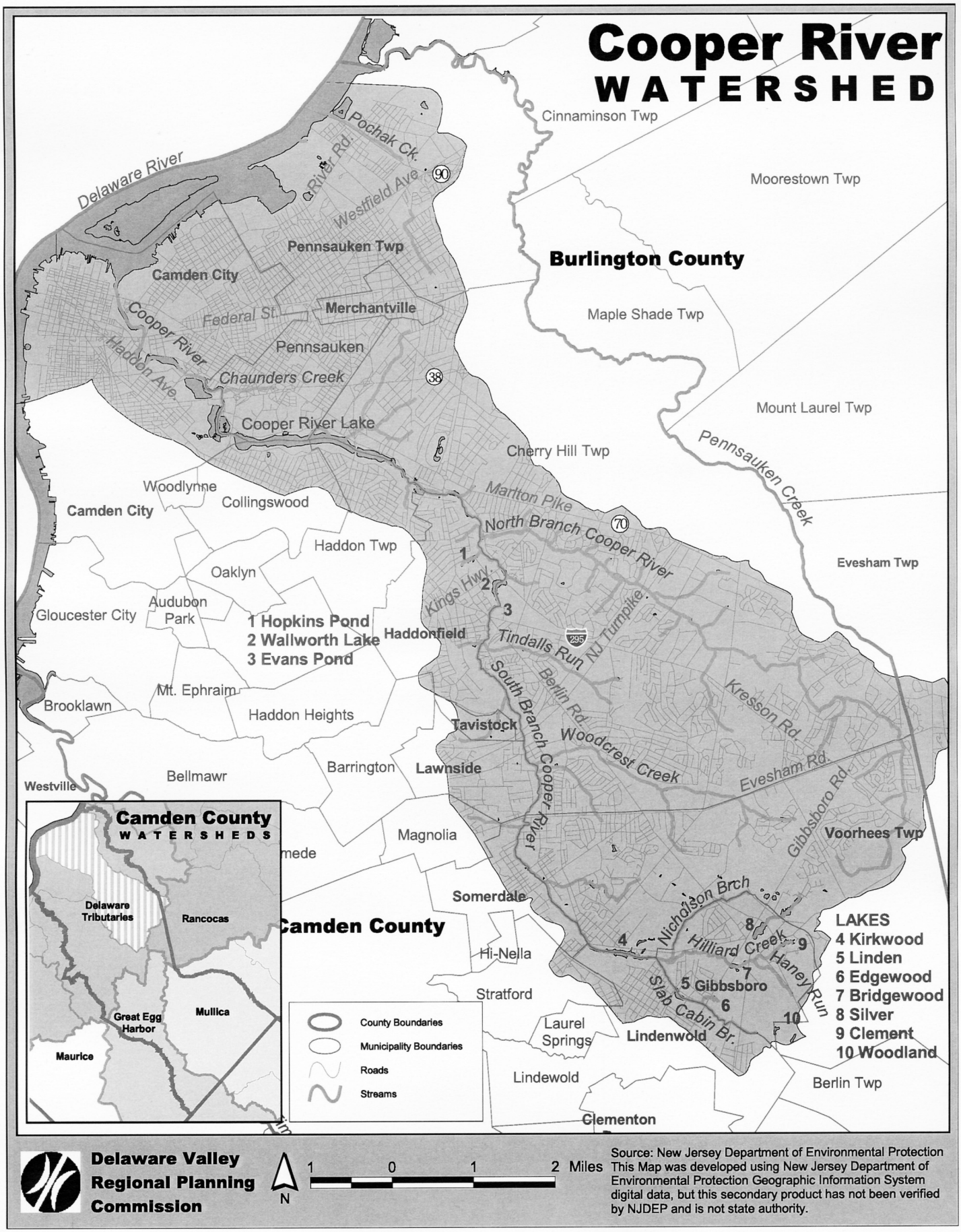
Source: DVRPC

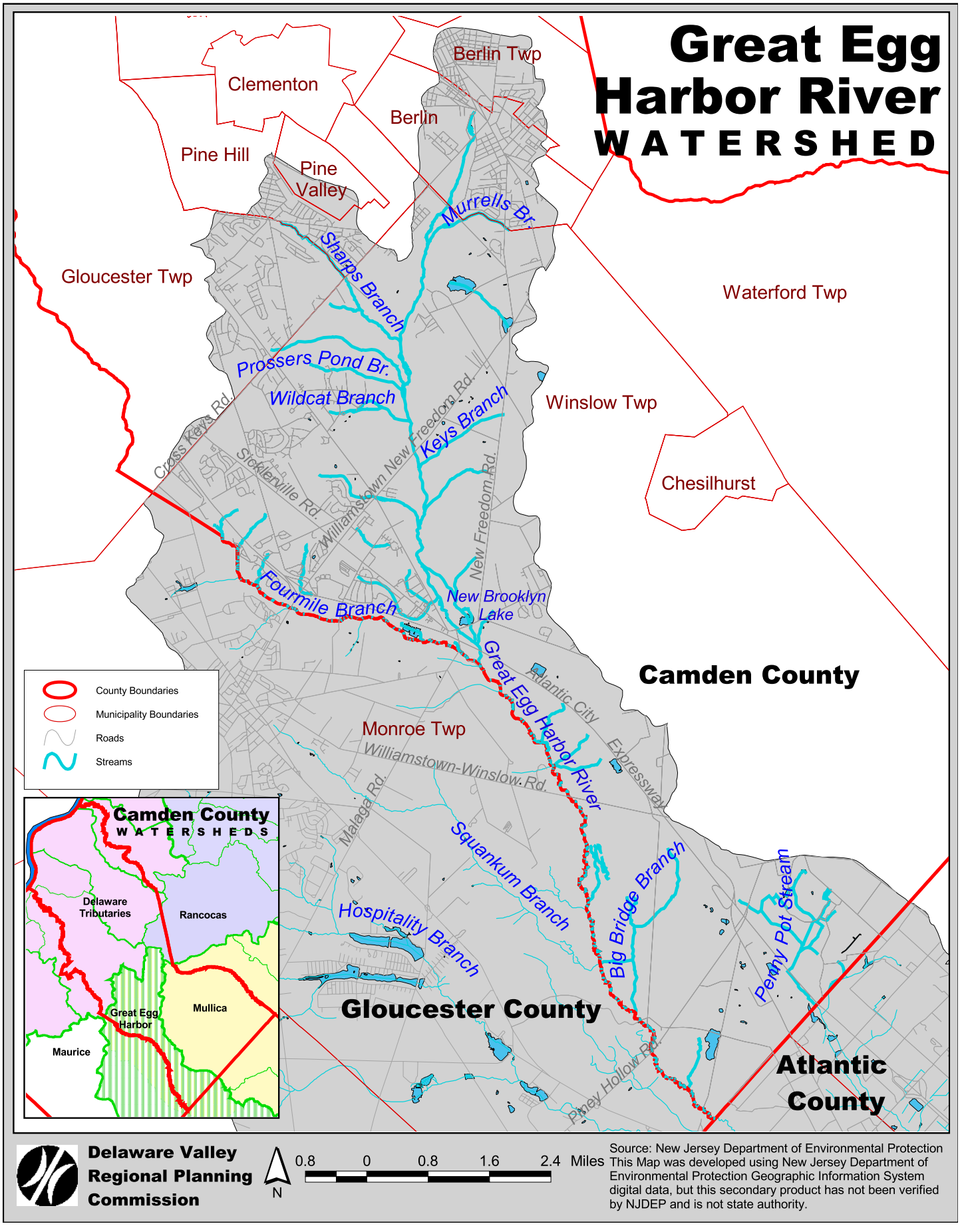
[2] Farr, William R. *Waterways of Camden County. A Historical Gazetteer.* [Camden Co. Historical Society, Camden, 2002.}
[3] From the Medford Township website: www.medfornj.com.

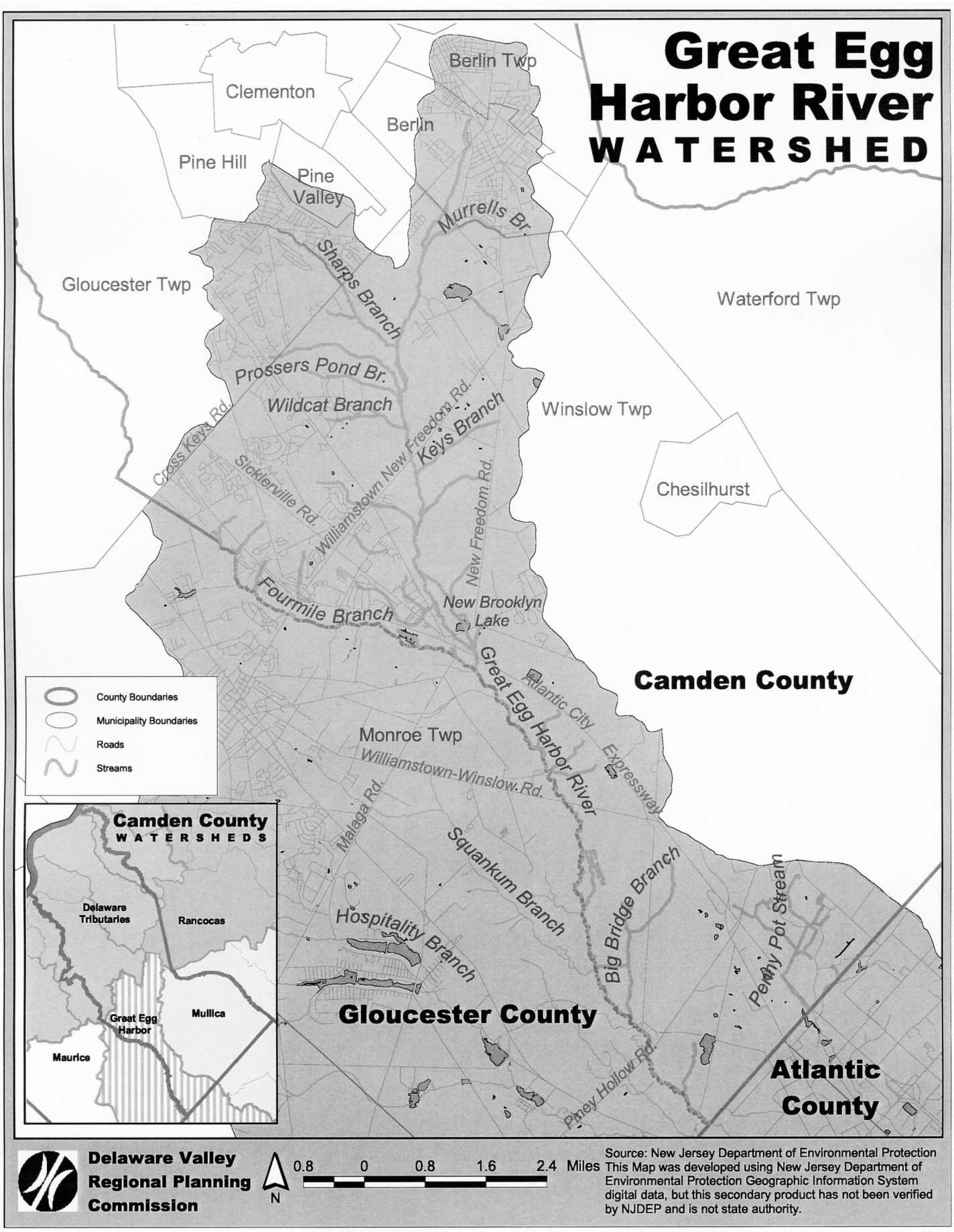

Big Timber Creek
WATERSHED
Delaware River
Gloucester City
Mt. Ephraim
Audubon
Haddonfield
Brooklawn
Little Timber Creek
Haddon Heights
West Deptford
Big Timber Creek
Tavistock
Cherry Hill Twp
Westville
Bellmawr
Barrington
Lawnside
Beaver Branch
Magnolia
NJ Turnpike
Runnemede
Clements Bridge Rd.
Evesham Rd.
Otter Brook
Gravelly Run
Somerdale
Voorhees Twp
Big Timber Creek North Branch
Hi-Nella
Signey Run
Gibbsboro
Almonesson Creek
Stratford
Pines Run
Gloucester Twp
Laurel Springs
Lindenwold
Deptford
Mason Run
Trout Run
Berlin Twp
Blackwood-Clementon Rd.
Clementon
Berlin
Big Timber Creek South Branch
Bull Run
Erial Rd.
Holly Run
Pine Hill
Pine Valley
Toms Dam Br.
Stone Bridge Br.
Jerry's Field Br.
Slab Bridge Br.
Washington
Gloucester County
Camden County
Winslow Twp
Lakes
1 Runnemede
2 Almonesson
3 Blackwood
Lakes
4 Grenlock
5 Bells
6 Irvin
Lakes
7 Nashs
8 George
9 Jones
10 Baum Pond
Lakes
11 Laurel
12 Pine
13 Watson
14 Bottom
15 Silver
16 Rowand
17 Lake Worth
18 Clementon
19 Pilling
County Boundaries
Municipality Boundaries
Roads
Streams
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
Delaware Valley Regional Planning Commission
N
1 0 1 2 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.

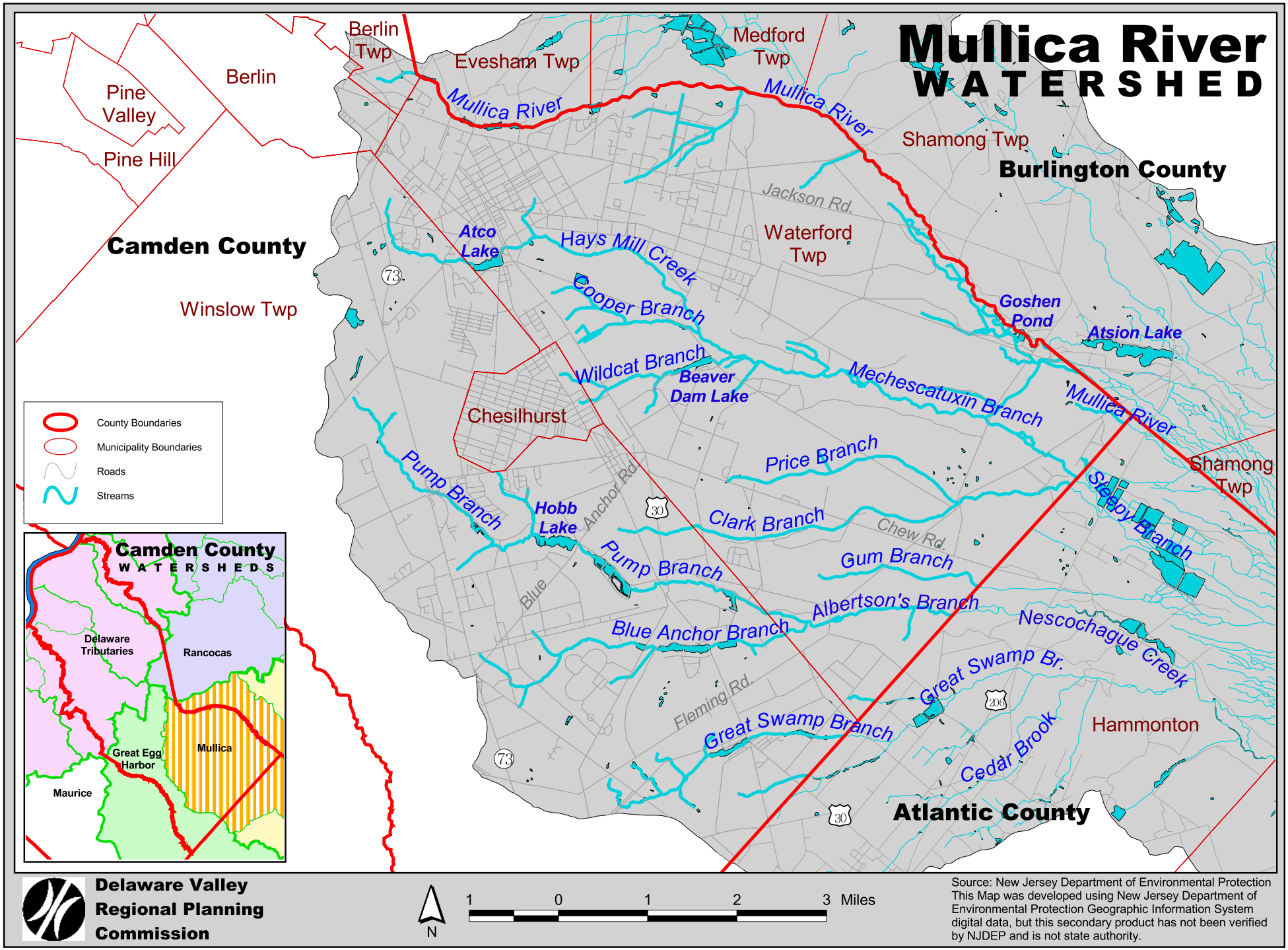

Big Timber Creek
WATERSHED
Delaware River
Gloucester City
Audubon
Mt. Ephraim
Haddonfield
Brooklawn
Little Timber Creek
Haddon Heights
Big Timber Creek
West Deptford
Tavistock
Cherry Hill Twp
Westville
Bellmawr
Barrington
Lawnside
Beaver Branch
41
295
Magnolia
Runnemede
NJ Turnpike
42
1
Clements Bridge Rd.
Evesham Rd.
Otter Brook
Gravelly Run
Somerdale
Voorhees Twp
Big Timber Creek North Branch
Hi-Nella
Signey Run
168
Gibbsboro
Stratford
Gloucester Twp
Pines Run
Laurel Springs
Lindenwold
Almonesson Creek
Mason Run
11
12
Trout Run
13
14
15
16
17
18
19
Berlin Twp
Berlin
Clementon
Lindenwold
Deptford
2
Big Timber Creek South Branch
Blackwood-Clementon Rd.
Erial Rd.
Mason Run
Bull Run
3
Holly Run
42
Pine Hill
Pine Valley
4
Toms Dam Br.
Stone Bridge Br.
7
Gloucester Twp
Jerry's Field Br.
8
Slab Bridge Br.
42
5
9
Washington
6
10
Winslow Twp
Camden County
Gloucester County
Lakes
1 Runnemede
2 Almonesson
3 Blackwood
Lakes
4 Grenlock
5 Bells
6 Irvin
Lakes
7 Nashs
8 George
9 Jones
10 Baum Pond
Lakes
11 Laurel
12 Pine
13 Watson
14 Bottom
15 Silver
16 Rowand
17 Lake Worth
18 Clementon
19 Pilling
County Boundaries
Municipality Boundaries
Roads
Streams
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
Delaware Valley Regional Planning Commission
N
1 0 1 2 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.

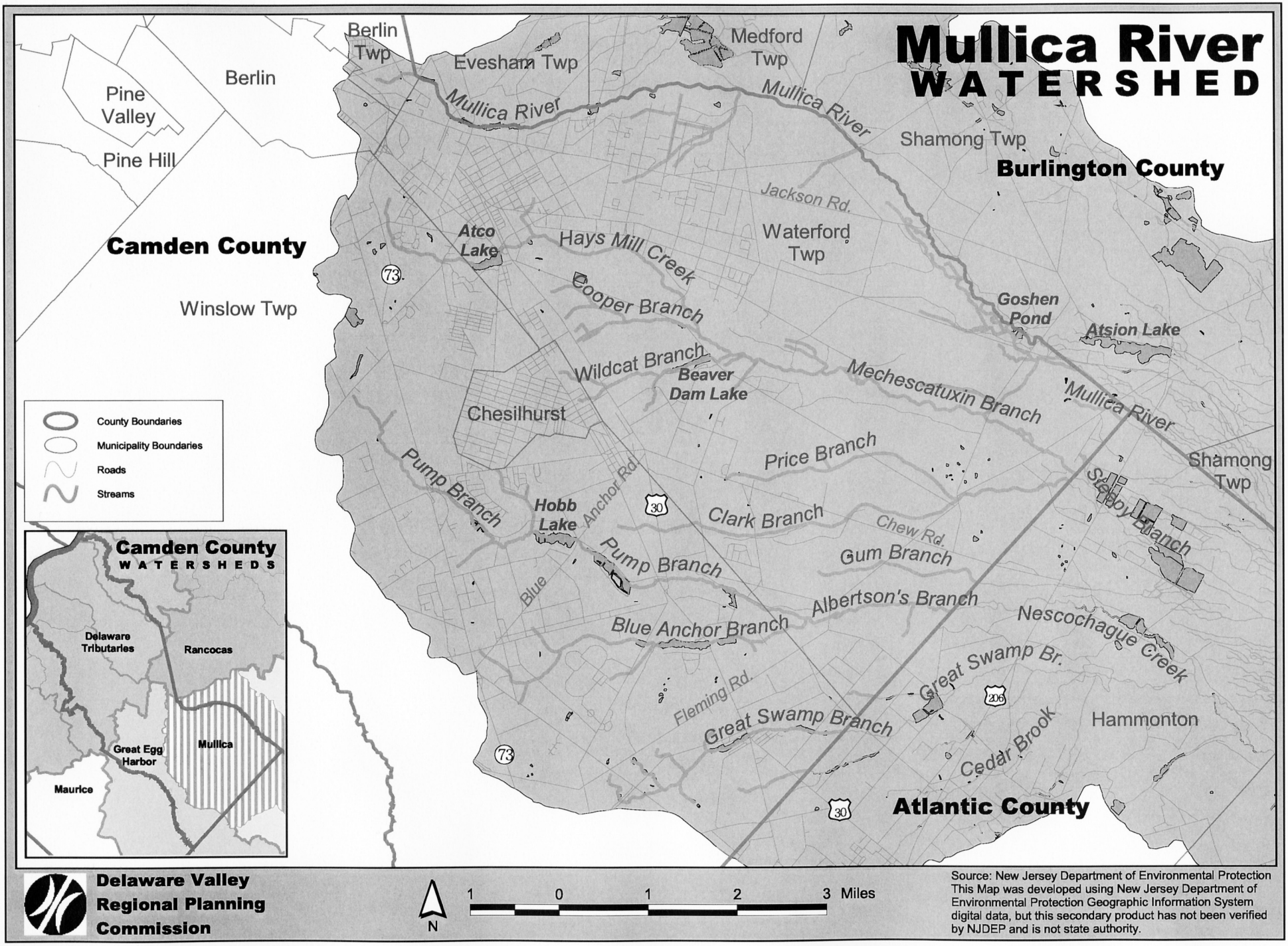

Cooper River
WATERSHED
Cinnaminson Twp
Moorestown Twp
Burlington County
Maple Shade Twp
Mount Laurel Twp
Evesham Twp
Voorhees Twp
Cherry Hill Twp
Pennsauken Creek
Delaware River
Pochak Ck.
River Rd.
Westfield Ave
Pennsauken Twp
Camden City
Merchantville
Federal St
Cooper River
Haddon Ave
Pennsauken
Chaunders Creek
Cooper River Lake
Woodlynne
Collingswood
Camden City
Haddon Twp
Oaklyn
Audubon Park
Gloucester City
Haddonfield
Brooklawn
Mt. Ephraim
Haddon Heights
Tavistock
Barrington
Lawnside
Bellmawr
Westville
Magnolia
Somerdale
Hi-Nella
Stratford
Laurel Springs
Lindenwold
Lindewold
Berlin Twp
Clementon
Marlton Pike
North Branch Cooper River
Kings Hwy.
Tindalls Run
NJ Turnpike
Berlin Rd.
South Branch Cooper River
Woodcrest Creek
Kresson Rd.
Evesham Rd.
Gibbsboro Rd.
Nicholson Brch
Hilliard Creek
Haney Run
Slab Cabin Br.
Gibbsboro
1 Hopkins Pond
2 Wallworth Lake
3 Evans Pond
LAKES
4 Kirkwood
5 Linden
6 Edgewood
7 Bridgewood
8 Silver
9 Clement
10 Woodland
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
County Boundaries
Municipality Boundaries
Roads
Streams
Delaware Valley Regional Planning Commission
N
1 0 1 2 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.

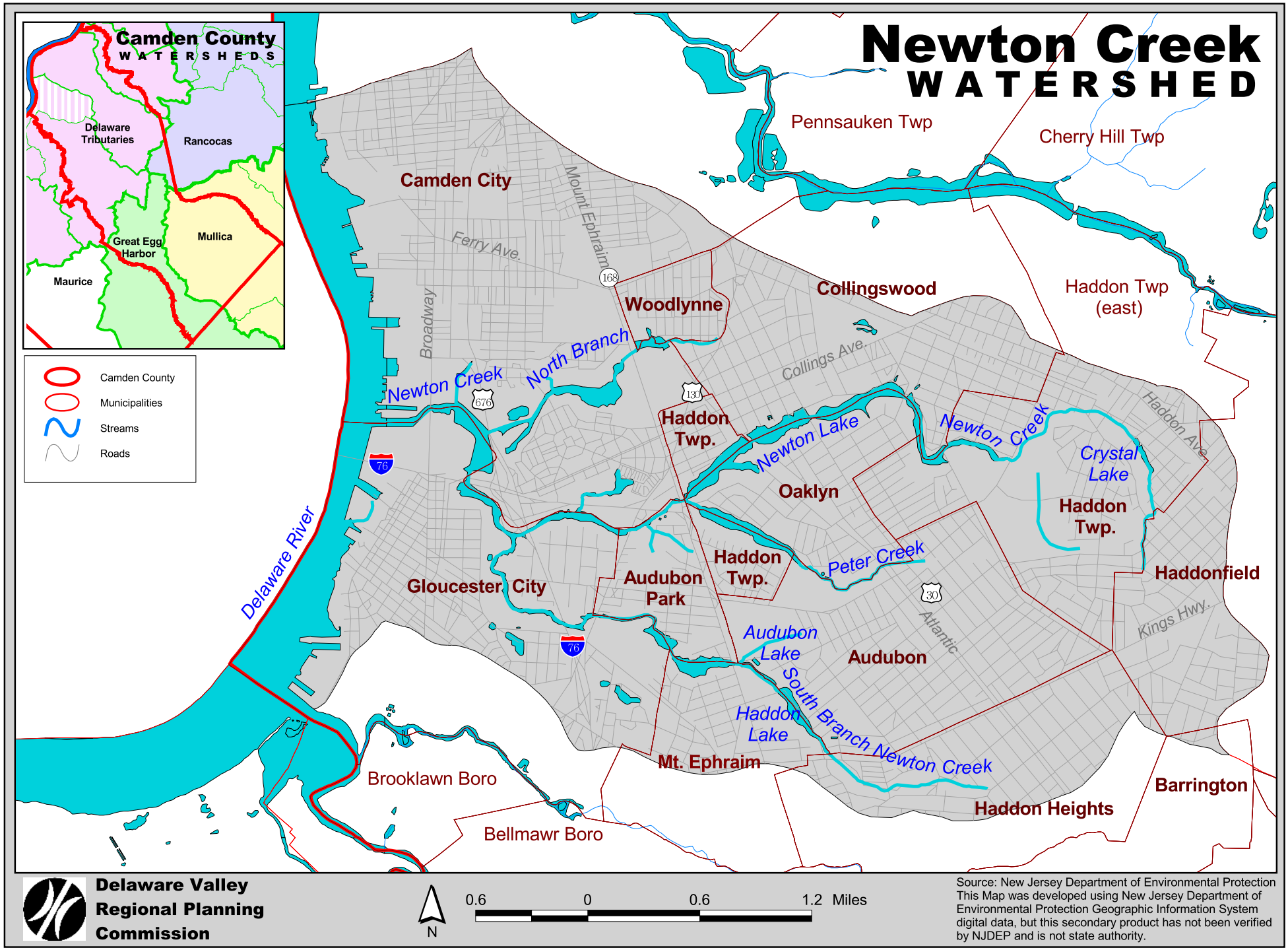

Cooper River
WATERSHED
Cinnaminson Twp
Moorestown Twp
Burlington County
Maple Shade Twp
Mount Laurel Twp
Pennsauken Creek
Evesham Twp
Cherry Hill Twp
Delaware River
Pochak Ck.
River Rd.
Westfield Ave
90
Pennsauken Twp
Camden City
Federal St.
Merchantville
Cooper River
Haddon Ave.
Pennsauken
Chaunders Creek
38
Cooper River Lake
Woodlynne
Camden City
Collingswood
Marlton Pike
North Branch Cooper River
70
Haddon Twp
Oaklyn
Audubon Park
Gloucester City
1 Hopkins Pond
2 Wallworth Lake
3 Evans Pond
Haddonfield
Kings Hwy.
Tindalls Run
NJ Turnpike
295
Kresson Rd.
Berlin Rd.
South Branch Cooper River
Mt. Ephraim
Brooklawn
Haddon Heights
Tavistock
Woodcrest Creek
Evesham Rd.
Gibbsboro Rd.
Barrington
Lawnside
Bellmawr
Westville
Voorhees Twp
Magnolia
Somerdale
Nicholson Brch
Hilliard Creek
Haney Run
Camden County
Hi-Nella
Stratford
Laurel Springs
Lindenwold
Slab Cabin Br.
Gibbsboro
Lindewold
Berlin Twp
Clementon
LAKES
4 Kirkwood
5 Linden
6 Edgewood
7 Bridgewood
8 Silver
9 Clement
10 Woodland
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
County Boundaries
Municipality Boundaries
Roads
Streams
Delaware Valley Regional Planning Commission
N
1 0 1 2 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.

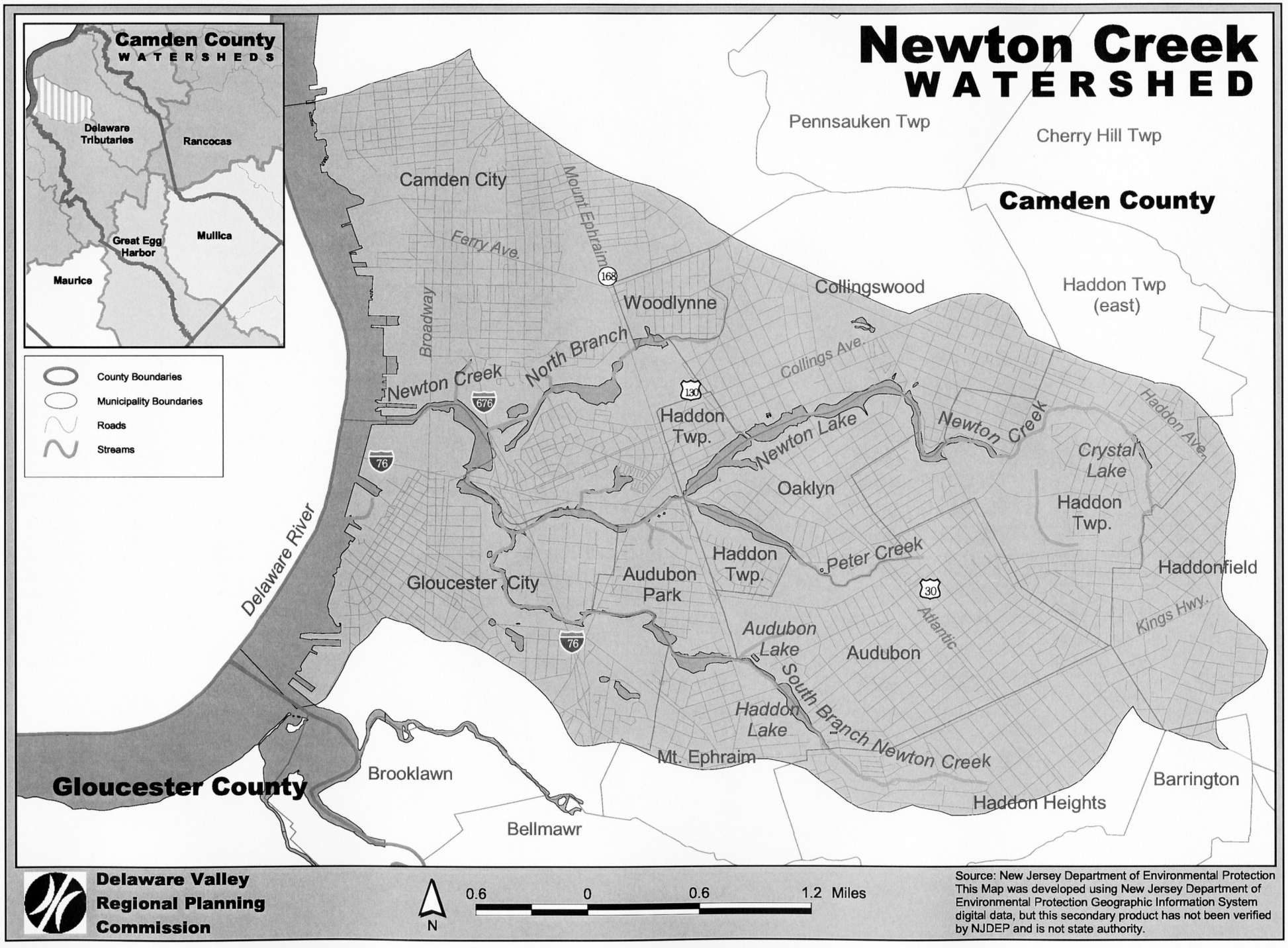

Great Egg Harbor River WATERSHED
Berlin Twp
Clementon
Berlin
Pine Hill
Pine Valley
Murrells Br.
Sharps Branch
Gloucester Twp
Waterford Twp
Prossers Pond Br.
Wildcat Branch
Keys Branch
Cross Keys Rd.
Sicklerville Rd.
Williamstown New Freedom Rd.
New Freedom Rd.
Winslow Twp
Chesilhurst
Fourmile Branch
New Brooklyn Lake
Great Egg Harbor River
Atlantic City Expressway
Camden County
Monroe Twp
Williamstown-Winslow Rd.
Malaga Rd.
Squankum Branch
Hospitality Branch
Big Bridge Branch
Penny Pot Stream
Gloucester County
Piney Hollow Rd.
Atlantic County
County Boundaries
Municipality Boundaries
Roads
Streams
Camden County WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
Delaware Valley Regional Planning Commission
N
0.8 0 0.8 1.6 2.4 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.

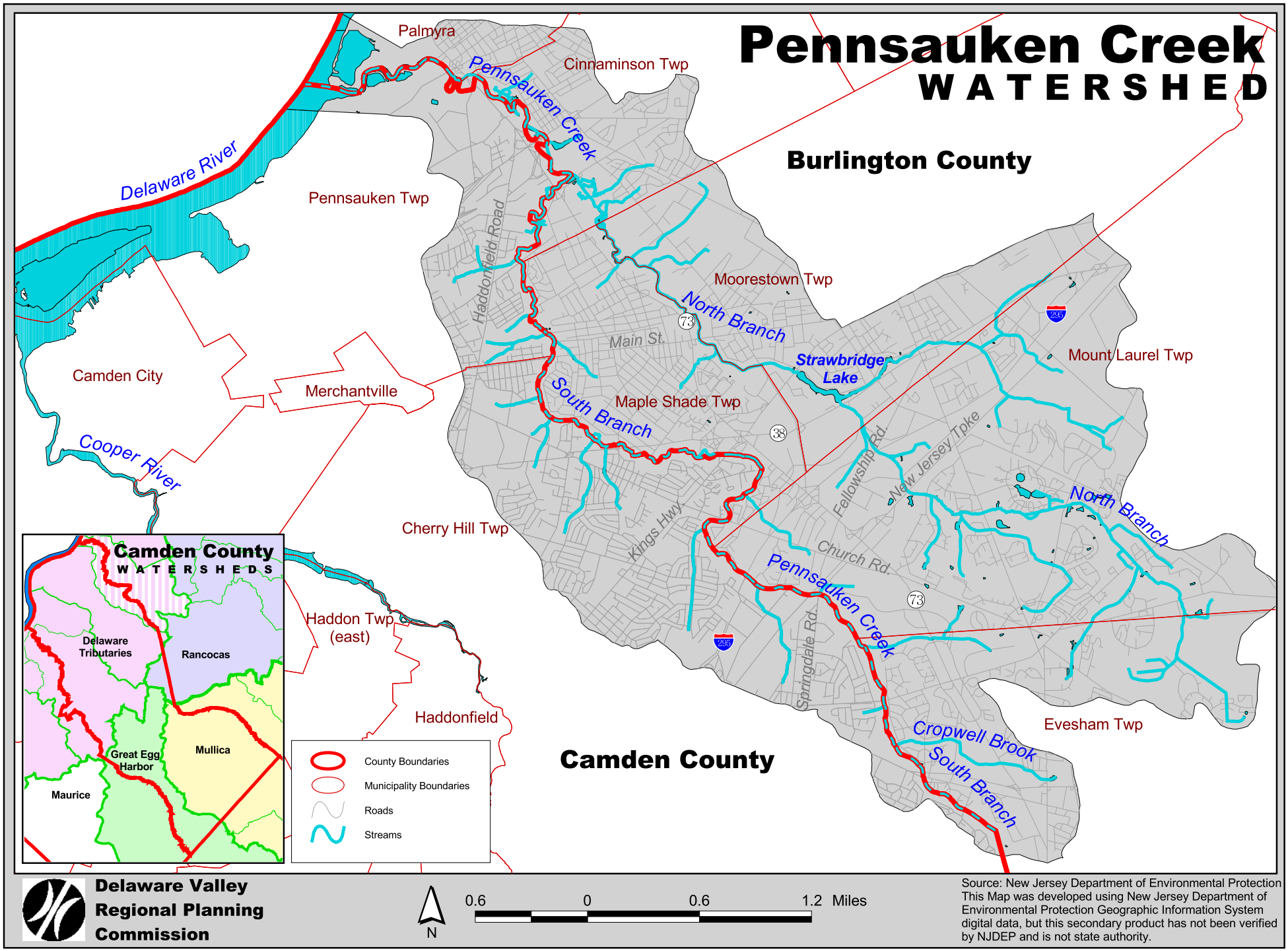

Great Egg Harbor River WATERSHED
Berlin Twp
Clementon
Berlin
Pine Hill
Pine Valley
Murrells Br.
Sharps Branch
Gloucester Twp
Waterford Twp
Prossers Pond Br.
Wildcat Branch
Cross Keys Rd.
Sicklerville Rd.
Williamstown New Freedom Rd.
Keys Branch
Winslow Twp
Chesilhurst
New Freedom Rd.
Fourmile Branch
New Brooklyn Lake
Great Egg Harbor River
Atlantic City Expressway
Camden County
County Boundaries
Municipality Boundaries
Roads
Streams
Monroe Twp
Williamstown-Winslow Rd.
Malaga Rd.
Squankum Branch
Big Bridge Branch
Penny Pot Stream
Hospitality Branch
Gloucester County
Piney Hollow Rd.
Atlantic County
Camden County WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
Delaware Valley Regional Planning Commission
N
0.8 0 0.8 1.6 2.4 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.

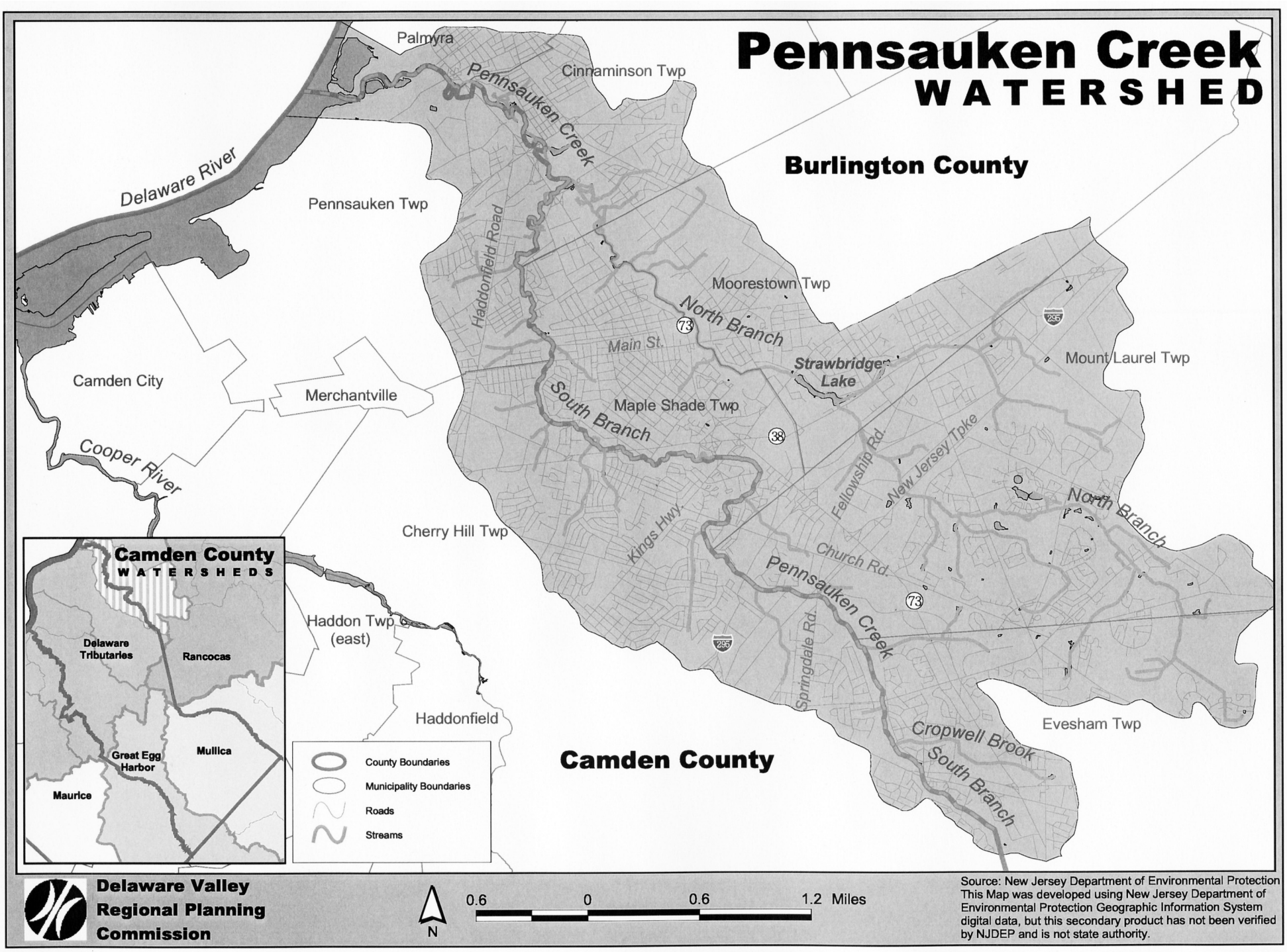

Mullica River
WATERSHED
Berlin Twp
Berlin
Pine Valley
Pine Hill
Camden County
Winslow Twp
Evesham Twp
Medford Twp
Shamong Twp
Burlington County
Waterford Twp
Jackson Rd.
Atco Lake
Hays Mill Creek
Cooper Branch
Wildcat Branch
Beaver Dam Lake
Goshen Pond
Atsion Lake
Mechescatuxin Branch
Mullica River
Chesilhurst
Price Branch
Pump Branch
Hobb Lake
Anchor Rd.
Clark Branch
Chew Rd.
Gum Branch
Sleepy Branch
Albertson's Branch
Blue Anchor Branch
Nescochague Creek
Great Swamp Br.
Fleming Rd.
Great Swamp Branch
Cedar Brook
Hammonton
Atlantic County
County Boundaries
Municipality Boundaries
Roads
Streams
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
Delaware Valley Regional Planning Commission
N
1 0 1 2 3 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.

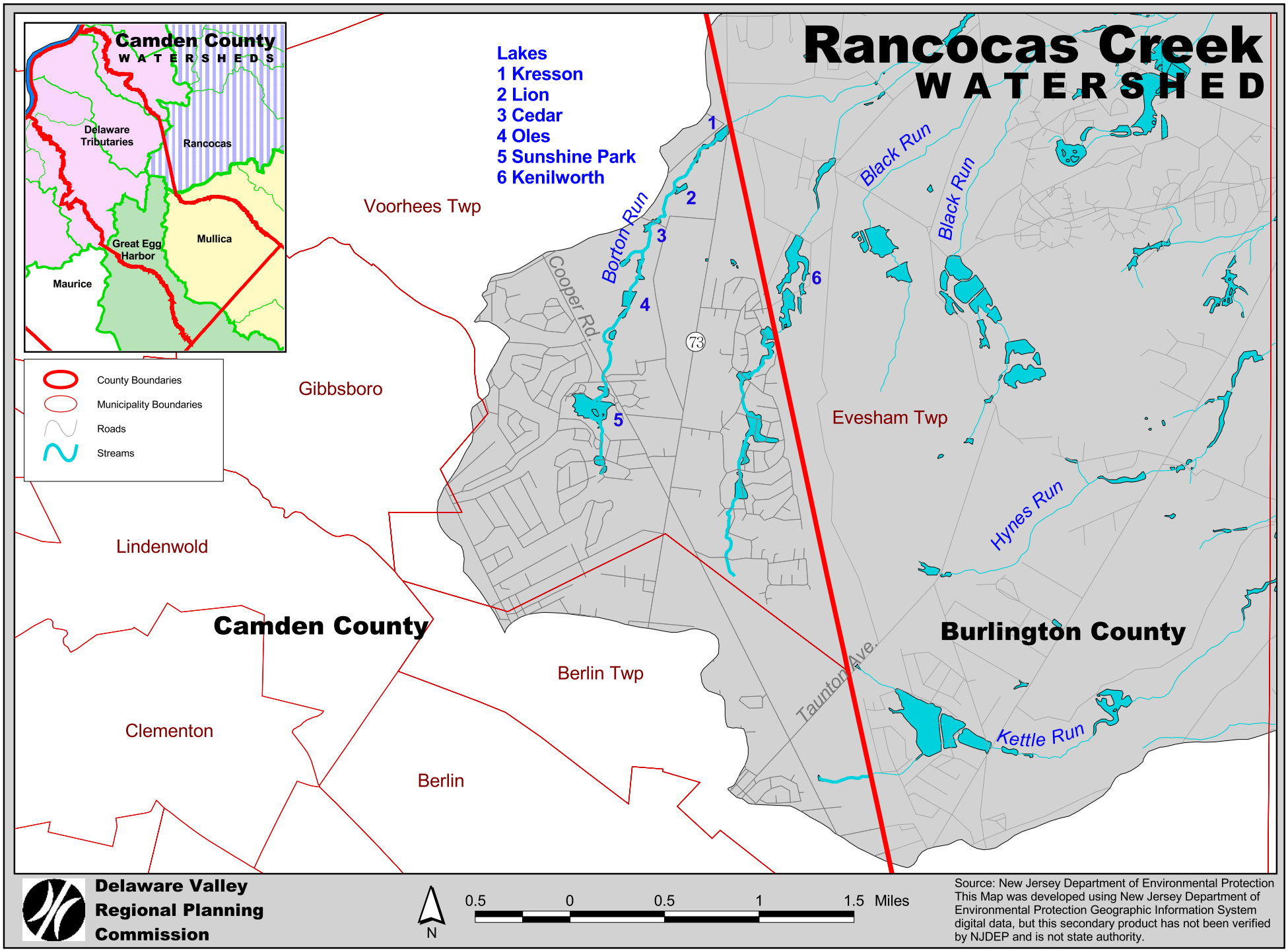

Mullica River
WATERSHED
Berlin Twp
Berlin
Pine Valley
Pine Hill
Evesham Twp
Medford Twp
Mullica River
Shamong Twp
Burlington County
Camden County
Winslow Twp
Jackson Rd.
Waterford Twp
Atco Lake
Hays Mill Creek
Cooper Branch
Goshen Pond
Atsion Lake
Wildcat Branch
Beaver Dam Lake
Mechescatuxin Branch
Chesilhurst
Price Branch
Pump Branch
Hobb Lake
Anchor Rd.
Clark Branch
Chew Rd.
Gum Branch
Albertson's Branch
Blue Anchor Branch
Nescochague Creek
Great Swamp Br.
Fleming Rd.
Great Swamp Branch
Cedar Brook
Hammonton
Atlantic County
County Boundaries
Municipality Boundaries
Roads
Streams
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
Delaware Valley Regional Planning Commission
N
1 0 1 2 3 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.

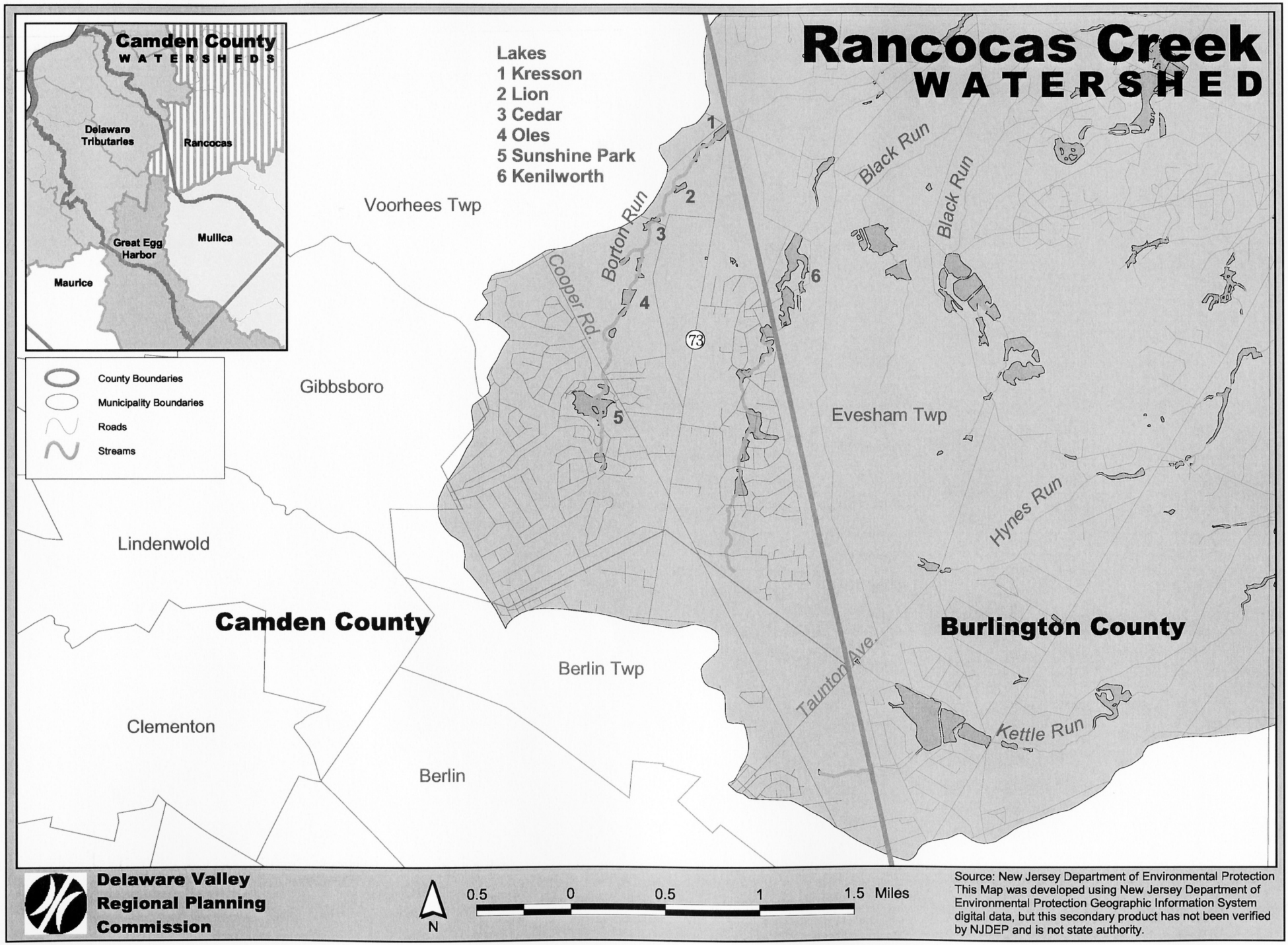

Newton Creek
WATERSHED
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
Camden County
Municipalities
Streams
Roads
Pennsauken Twp
Cherry Hill Twp
Camden City
Mount Ephraim
Ferry Ave.
Broadway
Woodlynne
Collingswood
Haddon Twp (east)
North Branch
Newton Creek
Collings Ave.
Haddon Twp.
Newton Lake
Newton Creek
Haddon Ave.
Crystal Lake
Oaklyn
Haddon Twp.
Delaware River
Haddon Twp.
Peter Creek
Haddonfield
Gloucester City
Audubon Park
Kings Hwy.
Atlantic
Audubon Lake
Audubon
South Branch Newton Creek
Haddon Lake
Mt. Ephraim
Brooklawn Boro
Barrington
Haddon Heights
Bellmawr Boro
Delaware Valley Regional Planning Commission
N
0.6 0 0.6 1.2 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.


Newton Creek
WATERSHED
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
County Boundaries
Municipality Boundaries
Roads
Streams
Pennsauken Twp
Cherry Hill Twp
Camden County
Camden City
Ferry Ave.
Mount Ephraim
Broadway
Woodlynne
Collingswood
Haddon Twp (east)
North Branch
Newton Creek
Collings Ave.
Haddon Twp.
Newton Lake
Newton Creek
Haddon Ave.
Crystal Lake
Oaklyn
Haddon Twp.
Delaware River
Peter Creek
Haddonfield
Gloucester City
Audubon Park
Haddon Twp.
Atlantic
Kings Hwy.
Audubon Lake
Audubon
South Branch Newton Creek
Haddon Lake
Mt. Ephraim
Barrington
Gloucester County
Brooklawn
Haddon Heights
Bellmawr
Delaware Valley Regional Planning Commission
N
0.6 0 0.6 1.2 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.


Pennsauken Creek
WATERSHED
Burlington County
Camden County
Palmyra
Cinnaminson Twp
Pennsauken Creek
Delaware River
Pennsauken Twp
Haddonfield Road
Moorestown Twp
North Branch
Main St.
Strawbridge Lake
Mount Laurel Twp
Camden City
Merchantville
South Branch
Maple Shade Twp
Cooper River
Fellowship Rd.
New Jersey Turnpike
North Branch
Kings Hwy.
Church Rd.
Cherry Hill Twp
Pennsauken Creek
Springdale Rd.
Haddon Twp (east)
Haddonfield
Cropwell Brook
South Branch
Evesham Twp
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
County Boundaries
Municipality Boundaries
Roads
Streams
Delaware Valley Regional Planning Commission
N
0.6 0 0.6 1.2 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.


Pennsauken Creek
WATERSHED
Burlington County
Palmyra
Cinnaminson Twp
Pennsauken Creek
Delaware River
Pennsauken Twp
Haddonfield Road
Moorestown Twp
North Branch
Main St.
Strawbridge Lake
Mount Laurel Twp
Camden City
Merchantville
South Branch
Maple Shade Twp
Cooper River
Fellowship Rd.
New Jersey Tpke
North Branch
Kings Hwy.
Cherry Hill Twp
Church Rd.
Pennsauken Creek
Springdale Rd.
Haddon Twp (east)
Haddonfield
Evesham Twp
Cropwell Brook
South Branch
Camden County
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
County Boundaries
Municipality Boundaries
Roads
Streams
Delaware Valley Regional Planning Commission
N
0.6 0 0.6 1.2 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.


Rancocas Creek
WATERSHED
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
Lakes
1 Kresson
2 Lion
3 Cedar
4 Oles
5 Sunshine Park
6 Kenilworth
County Boundaries
Municipality Boundaries
Roads
Streams
Voorhees Twp
Gibbsboro
Lindenwold
Camden County
Clementon
Berlin
Berlin Twp
Evesham Twp
Burlington County
Borton Run
Cooper Rd.
Black Run
Black Run
Hynes Run
Taunton Ave.
Kettle Run
73
1
2
3
4
5
6
Delaware Valley Regional Planning Commission
N
0.5 0 0.5 1 1.5 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.


Rancocas Creek
WATERSHED
Camden County
WATERSHEDS
Delaware Tributaries
Rancocas
Great Egg Harbor
Mullica
Maurice
Lakes
1 Kresson
2 Lion
3 Cedar
4 Oles
5 Sunshine Park
6 Kenilworth
Voorhees Twp
Gibbsboro
Lindenwold
Camden County
Clementon
Berlin
Berlin Twp
Evesham Twp
Burlington County
Borton Run
Cooper Rd.
Black Run
Black Run
Hynes Run
Taunton Ave.
Kettle Run
73
County Boundaries
Municipality Boundaries
Roads
Streams
Delaware Valley Regional Planning Commission
N
0.5 0 0.5 1 1.5 Miles
Source: New Jersey Department of Environmental Protection
This Map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state authority.

5. THE WATERSHEDS OF CAMDEN COUNTY: NATURAL AND HUMAN HISTORY

DEFINITIONS

Physiography: The study of a location in relation to its underlying geology.

Marl: A clay–sand soil with a high percentage of the mineral glauconite, which sometimes gives it a green color. Useful as a soil enricher when mixed into less fertile soils.

Floodplain: The land areas adjacent to a river or stream that are flooded during storm events.

TO DO

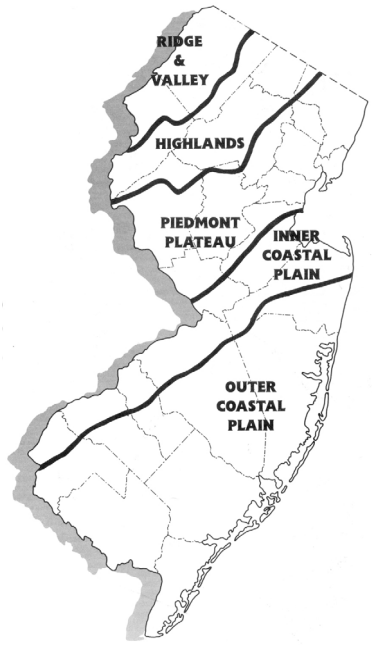
Use the *Who Am I?* game (**Appendix D**) to familiarize students with the wildlife of Camden County's watersheds.

NATURAL HISTORY

GEOGRAPHY

Camden County sits on the Atlantic Coastal Plain physiographic province of New Jersey. The state is divided into four such provinces, ranging from the rocky terrain of the Ridge and Valley Province at one extreme to the sands of the coast at the other. The Atlantic Coastal Plain is the most southerly of these four provinces in New Jersey.

The Atlantic Coastal Plain landscape is divided into Inner and Outer sections. The **Inner Coastal Plain** was formed during the Cretaceous Period (135 to 65 million years ago) by deposits of material that came from the breakdown and erosion of the Appalachian and Catskill mountains. This deposition was interrupted by layers laid down by the ocean, as the ocean shoreline advanced and receded over long stretches of time. The resulting geology is a stacking of layers of the eroded mountain rocks interspersed by marine deposits of sand and other materials. Inner Plain soils are quite fertile.



Source: NJ Audubon's Bridges to the Natural World

During the period of Inner Coastal Plain formation, dinosaurs still roamed the earth. In New Jersey the ocean shoreline came up as far as the Haddonfield area. The region probably had good habitat for plant-eating, duck-billed dinosaurs such as *Hadrosaurus foulkii*, the first dinosaur discovered in North America, which was found in a marl pit in Haddonfield. The skeleton of *Hadrosaurus foulkii* (named for its discoverer, William Foulke) is at the Academy of Natural

Sciences in Philadelphia and there is a model of the dinosaur in the State Museum in Trenton.

The **Outer Coastal Plain**, which covers all of the rest of southern New Jersey, was formed more recently than the Inner Coastal Plain. It was laid down by the ocean and consists of unconsolidated deposits of quartz sand with some areas of gravel and clay, which developed during the mid-to-late part of the Cenozoic Era, 65 million years ago to the present. Outer Coastal Plain soils are less fertile than those of the Inner Coastal Plain and don't hold water as well. They become progressively less rich as one goes east, to the poor agricultural soils of the Pine Barrens, which are sandy, acidic, and "droughty" because rainwater drains through them so rapidly.

See **Teacher Resources** for
- Additional information on natural history and
- A detailed list of potential field trip destinations with facilities that are in Camden County or close to its borders.

The dividing line between the two segments of the Coastal Plain is a belt of low hills, called a "cuesta," running northeast and southwest through southern New Jersey. These hills are the youngest of the Cretaceous formations and run from Monmouth County south to Gloucester County, becoming progressively lower in elevation from north to south. In Camden County they are found in Pine Hill and Berlin. Many towns along the cuesta derive part of their name from these hills: Mount Holly, Mount Laurel, Pine Hill, and Mullica Hill are examples.

The **Inner Coastal Plain** lies to the west of these hills, with surface waters starting in the hill area and draining towards the Delaware River. Most of the **Outer Coastal Plain** slopes more gradually to the east, with drainage toward the Atlantic Ocean, although some streams start in the Outer Coastal Plain and flow toward the Delaware. The Rancocas Creek is an example.

Pennsauken Creek

Source: DVRPC

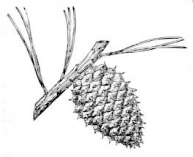
VEGETATION OF CAMDEN COUNTY

White Oak

The differences in geology within Camden County generate different kinds of soils that support characteristic vegetation. On the Inner Coastal Plain, with its more fertile soils, Camden County was once covered with a forest of mixed deciduous trees. Pockets of this forest survive, including a very old forest patch in Haddon Township within Saddler Woods (Newton Creek watershed, Haddon Township). Trees on many community streets and in parks often reflect this forest type, with its White, Black and Red Oaks, Beech trees and, in some areas, Tulip Poplar, Sweet Gum, Red Maple, Hickories, and Ash trees. However, many street and park trees today are imported varieties that have been planted because of their hardiness or attractiveness.

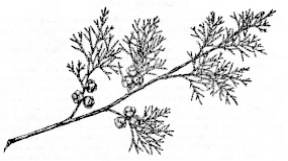
As one moves southeast across Camden County, the vegetation ranges gradually into Pineland varieties. The original forests were mixed Oak–Pine. Where fire was, or is, a key factor, they are Pine–dominated. Oak species are mixes of Black, Scarlet, and White. The principal pines are Pitch, Short-leaf and Virginia, but Pitch Pine dominates.

Pitch Pine



Wetland areas were once more abundant throughout all of the state. Draining and filling have reduced wetland habitats, which were found primarily in the floodplains of stream corridors and where the streams flowed into the Delaware River. Some wetland habitats still exist in these locations. Pineland areas of the County still have extensive wetlands, especially in the Mullica River watershed and to some extent in the Great Egg Harbor River watershed. There, Red Maples and Black Gum are most prevalent and stands of Atlantic White Cedar trees are still found. Stream water tends to be more acidic, slow moving, and shallow. The water is tinted brown by the high iron content of the soil and the leaching of roots and leaves from Cedar and Oak trees.

Atlantic White Cedar



Camden County is a world stronghold of **Swamp Pink**, *Helonias bullata*, which is a wetland plant that produces a beautiful pink flowering cluster at the top of its 12 inch stalk. Swamp Pink can only live in certain wetland habitats and its populations are easily damaged or destroyed, especially by drops in water levels within its wetland habitat resulting from increased pumping of groundwater. It is listed as an endangered plant on the New Jersey Endangered and Threatened Species list. Swamp Pink is found in Camden County in the headwater wetland areas of the Cooper River, the Pennsauken Creek, the Big Timber Creek, and in Pineland areas.

Swamp Pink

Photo: Michael A. Hogan

DEFINITION

Macroinvertebrates: Animals lacking backbones and internal skeletons (invertebrates) that are large enough to be seen by the naked eye (macro). Includes insects, crustaceans (such as crayfish), mollusks (clams, mussels and snails), and worms. Many of these animals spend all or part of their life in water. Some insects, such as dragonflies, spend their juvenile lives in water and their adult lives on land.

Macroinvertebrates are relatively simple to collect from shallow stream bottoms. More species and groups are found in pristine waterways than in polluted ones.

Dragonflies

Nymph *Adult*

For information on Fish Advisories, obtain a copy of *New Jersey Fish & Wildlife Digest*, the publication of the Fish and Wildlife Division of NJDEP, or read it online at www.state.nj.us/dep/dsr/njmainfish.htm.

ANIMALS OF CAMDEN COUNTY

A surprising array of wildlife is found throughout Camden County and much of it is associated with water. Besides those species that live in water for all or part of their lives, 90% of all terrestrial (land) species visit a water body every day. **Bald Eagles** have been noted regularly hunting along the North Branch of the Big Timber Creek, the Cooper River and, most recently, on the Pennsauken Creek. **Great Blue Herons** are abundant on county ponds, lakes, and marshes. **Migrating birds** fly north in spring along the Delaware River corridor. Flights of smaller woodland species that are heading to New England and Canada to nest are often sighted in Camden City and Pennsauken. **Frogs and salamanders** breed in small ponds and remaining wetland areas in the western half of the county, and in parts of the Pineland areas in eastern townships. Important sites for endangered and threatened species such as **Bog Turtles** and certain butterflies and moths are also found in the eastern half of the county.

In **Pineland areas** of Camden County, there are species of animal life that are rare outside this ecosystem. These include some small Hair Streak and Elfin butterflies, four species of another butterfly group called "Skippers," various moth species (the Buck Moth and "underwing moth" varieties), the Pine Barrens Tree Frog, the Carpenter Frog, the Northern Pine Snake, and the Timber Rattlesnake.

Streams, lakes, and wetlands contain microscopic organisms that feed upon plant material or other smaller creatures and are fed upon, in turn, by many **small aquatic animals**. These macroinvertebrates are food sources for fish and amphibians, which are, in turn, prey for Great Blue Herons, Raccoons, Bald Eagles, and Ospreys. The diversity of the macroinvertebrate community – the number of species and the particular types – is also an important measure of water quality, because of the different species' tolerances to pollutants. These organisms are sampled by the state Department of Environmental Protection, and local watershed association water monitoring programs, as a means of assessing the health of a stream or lake.

Fish populations in Camden County have begun a slow recovery from the days when the streams flowing to the Delaware River, and the river itself, were extremely polluted. Shad numbers have increased over the past 10 years. Fish ladders established on a few lakes have allowed migrating varieties to return to their historic upstream spawning grounds. Although significant improvements in fish numbers have occurred, there are still state Health Advisories against eating many of the fish species in Camden waters, due to the concentration of contaminants in some fish from river, stream, and lake sediments. These contaminants include such human health hazards as mercury and Polychlorinated Biphenyls (PCBs).

Largemouth Bass

HUMAN HISTORY

As early as 12,000 years ago, Native Americans inhabited the watersheds of what is now Camden County, living in nomadic, hunter–gatherer communities. About 1,000 years ago, a garden-style of agriculture appeared, in which crops in small plots were dug with hoes and digging sticks. By the time the first Europeans arrived, these Lenape people, as they came to be called, were found residing in villages near the tidal portions of the streams that flow to the Delaware River. ("Lenape" is a term meaning "ordinary people.") These Delaware Indians (as they were also called) farmed in forest clearings and fished during warm seasons, moving in the winter to more inland, headwater areas for hunting. Relations between the Lenape and early Europeans were generally peaceful, although European diseases like smallpox and measles caused significant reductions in Native American communities.

Early Settlement

When the first Dutch explorers sailed up the Delaware River in 1623, they called it the Zuydt, or South River, to distinguish it from the North River, their name for the Hudson. The Swedes soon joined them and in 1638 began to settle in the area. When the English gained control of the region in 1673, they renamed the river in honor of Sir Thomas West, Lord de la Warr.

The land that the English designated as the Province of West Jersey was intended to be divided up into 10 portions, or tenths, running from the Delaware River back into the forests. These lands were to be further divided and sold to individual settlers. In 1677, the third tenth was purchased from the Indians, extending from midstream of the Pennsauken Creek to midstream of the Timber Creek. The land to the south, as far as Oldmans Creek on the Gloucester-Salem Counties border, was also purchased and was merged with it, along with all the lands to the southeast (modern Atlantic County). This became Old Gloucester County, which existed until the eastern lands separated into Atlantic County in 1837. In 1844 the Camden townships separated from Old Gloucester County and were officially established as Camden County.

Early settlers found a land with extensive freshwater marshes in the tidal portions of each small river, and large virgin (never cleared) forests on the higher ground. The streams themselves were the first highways of the area and homes and towns were established along them as far upstream as boats could travel. Many sawmills and gristmills were built by damming the creeks, which provided the water power to operate them. All southern New Jersey lakes were created in this way, although the mills that they powered are long gone. Travel by road was very difficult until bridges could be built. An early set of bridges across five streams – Pennsauken, Cooper, Newton, Little Timber (part of the Big Timber watershed), and Big Timber Creeks – was authorized along the King's Highway as early as 1687. However, most areas relied on ferry service for many decades beyond that time.

A roadside farm market

Roads and Railroads

Southern New Jersey, including Camden County, has always sustained farming that served the larger city markets. This continues even today, and is the reason New Jersey is known as the "Garden State." In the 18th and early 19th centuries, farmers relied on streams to get their produce to market. Lumberers also moved their loads of cut timber by water. Settlements developed around "landings" for boats, such as at Chew's Landing at the head of navigation on the Big Timber Creek. It wasn't until the mid-1800s that some roads were improved and then train lines were established running from the Delaware Riverfront to the interior of the county. These transportation improvements served farmers, spurred the growth of towns in the central and eastern part of the county, and supported existing and new mill industries, iron foundries, and glass works in towns such as Gibbsboro, Blackwoodtown (Blackwood), Longacoming (Berlin), and Tansboro (in Winslow Township).

Merchantville Train Station

Source: Camden County Historical Society

Railroads were also key to the growth of particular communities throughout Camden County. During the second half of the 19th century and into the 20th, the placement of railroad station stops served as the nucleus for land development projects that founded Merchantville, Collingswood, Bellmawr, Runnemede, Haddon Heights, Barrington, Clementon, and Laurel Springs, for example. Sales material promoted the healthy conditions and "clean, pure life" of these communities to residents of Philadelphia and Camden City. Recreational facilities serving these audiences were also established. Railroad stops built specifically for tourists to reach amusement parks, such as at Grenloch Lake and Clementon Park, helped initiate residential growth in those areas.

Twentieth Century Growth and Effects on Water Quality

After World War II, major road improvement projects were undertaken in Camden County which fostered suburban development in the eastern farming and Pineland areas of the county. Camden City's industrial base was eroding, due to changes in the economy, an aging infrastructure, and lack of space to expand. Funding for new houses was readily available and residents from Camden City, along with new arrivals from Philadelphia, began moving out to new developments in Cherry Hill, Voorhees, and Gloucester and Winslow Townships. Business development followed and some of these areas became almost as urbanized as the earlier riverfront settlements.

The development in the 1950s and 60s increased the amount of paved surfaces throughout the county and the need to channel stormwater into local streams, in order to prevent flooding. This began to have major impacts on stream conditions. Local sewer treatment plants which handled wastewater (sewage) could not adequately accommodate the growth. Environmental regulations, in general, were weak during this period. Many Camden streams became very polluted by sewage overflows and many lakes filled with sediment from construction runoff.

Following the adoption of the federal Clean Water Act in 1972, environmental regulations became stronger and environmental conditions began to improve. However, it was the creation of the Camden County Municipal Utility Authority (CCMUA) in 1972 that had the greatest impact on reducing the pollution of Camden's streams and lakes. From 1984 to 1996, sewer lines were laid throughout much of the county, capturing sewage pollution from residences,

businesses, and industry, and allowing the shutdown of the poorly functioning local treatment plants. Today, these lines carry all of Camden County's sewage to the CCMUA's treatment plant on the Delaware waterfront, eliminating an enormous health hazard and environmental problem.

Stormwater runoff would now be recognized as a primary source of pollution to area waterways. Reducing runoff, and the contaminants in it, is proving to be almost as difficult a challenge as the sewage and factory pollution of earlier decades. This is particularly true because reducing stormwater pollution depends on multiple factors: changing people's behavior, expensive retrofitting of stormwater systems, and better management of land.

TO DO

Have students carry out the activity, *How Does Your Watershed Grow?* (**Appendix E**.) How much has the population of their town grown since 1950 and how might the increase in population affect the watersheds?

Students will be able to find 2000 census figures for their town using American Fact Finder™ at the website: http://landview.census.gov.

1950 census figures are included in Appendix E.

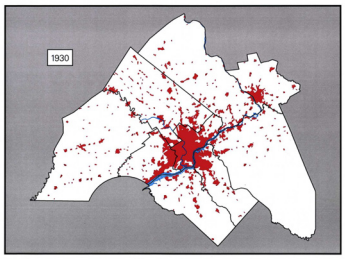
The Pinelands

In the Pineland regions at the center of south Jersey there was recognition of the need for land use management and groundwater protection as early as 1972. The Pinelands Comprehensive Management Plan, which was adopted in 1980, controls growth in all of Waterford Township and Chesilhurst Borough and in portions of Winslow Township, Berlin Borough, and Berlin Township. The Pinelands protections arose, in part, because of proposals for transporting groundwater from beneath the Pinelands to other regions for water supply. Indeed, it was a similar plan in the late 1800s – to utilize the groundwater as a source for Philadelphia – that led Joseph Wharton to acquire the extensive lands that are named for him (the Wharton State Forest). It is also the groundwater, and its closeness to the surface in this area, that is responsible for the extensive wetlands found within the Mullica and Great Egg Harbor River watersheds in Camden County, with all their rich habitat and important species.

Red Maple

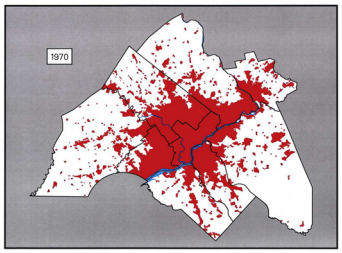
Development in the Delaware Valley

1930



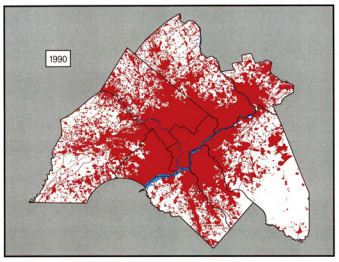
222,000 acres developed;
3.3 million people

1970



641,000 acres developed;
5.1 million people

1990



803,000 acres developed;
5.1 million people

Suburban Sprawl

Camden County is a case study in the patterns of suburban sprawl that have characterized the Delaware Valley, as well as other regions of the U.S., over the past 50 years. The decline of industrial centers, combined with the expansion of automobile corridors, has led to the growth of suburbia, which has, in turn, resulted in declining urban centers and negative effects on inner ring suburban communities. Camden County's population has grown during this period, as residents moved out of urban centers and moved into the developing rural areas of the County.

Since 1970 the population of the Delaware Valley as a whole has remained stable but the amount of developed land has expanded by almost a third. These are the defining features of "sprawl."

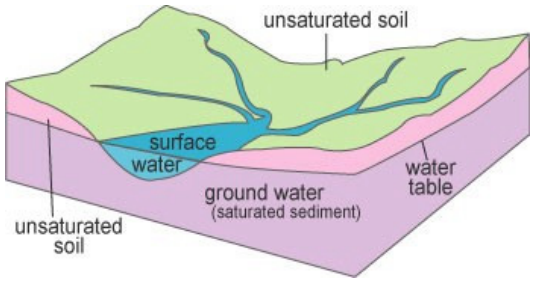
Source: DVRPC

6. DRINKING WATER

Sources

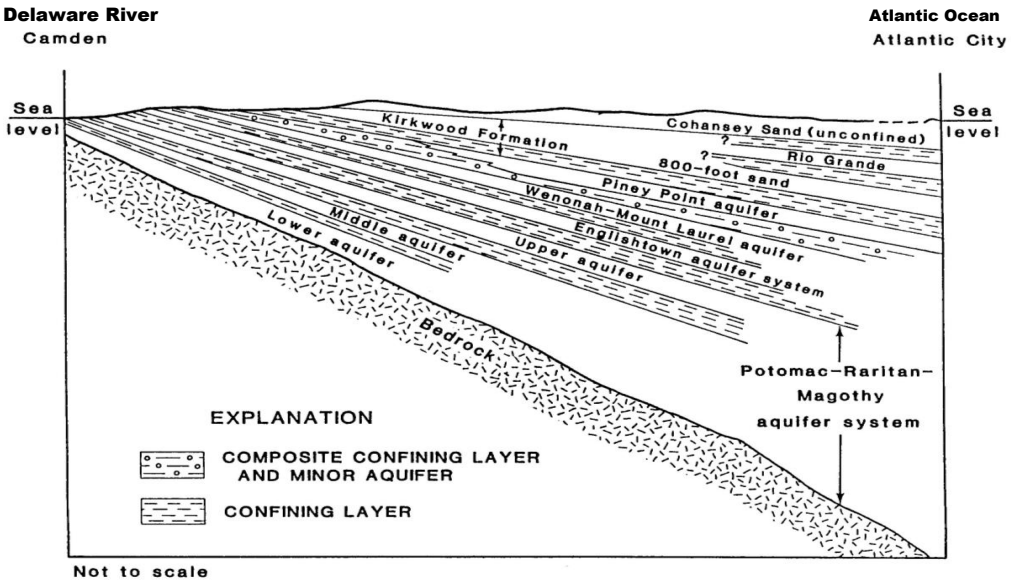
We all know that our drinking water comes out of the faucet, and that it is supplied by pipes, usually in the basement of a house or business. Depending on where you are in Camden County, these pipes are either hooked into a public water supply system – pipes running under the streets – or they come directly from an individual pump and well on the property itself.

Both the public supply system and private wells draw water from the ground. When it rains, water percolates or seeps down through the topsoil into the underlying layers of soil, gravel and sand, filling (saturating) the spaces, or pores, between the sediment particles. This water is called groundwater. There is a vast amount of groundwater found in these underlying layers.



Source: Modified from US Geological Survey

The geology of Camden County is that of a tilted "layer cake" or strata of gravels, sands, silts, and clays. The saturated gravel and sand layers, with their large pore spaces, are the aquifers, from which water is drawn through wells. The silt and clay layers, which impede the movement of water, are called confining beds.



Source: US Geological Survey

DEFINITIONS

Saturated zone: The underground area in which water is held in the pores and spaces within the sediments or rock. Sediments in southern New Jersey aquifers are made up of sand, silt, clay, and gravel particles. The water within the saturated zone is groundwater.

Unconfined aquifer: An aquifer that is close to the surface, in which the water table rises and falls freely with infiltration of rainwater. Also called a "water table aquifer."

Water table: The top of the saturated zone in an unconfined aquifer.

Outcrop: The area where an aquifer is present at or near the land surface – where it "crops out."

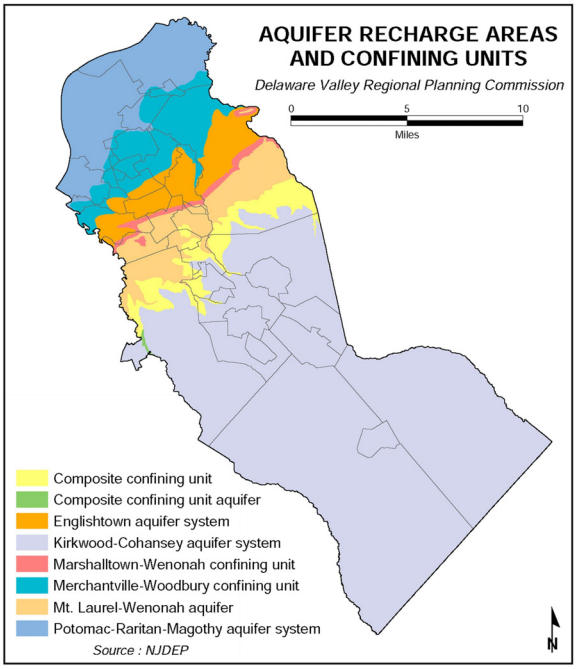
TO DO

Have students participate in the *Every Drop Counts activity* (**Appendix F**) to learn about conservation of drinking water.

Three major aquifers exist beneath Camden County. They are the Potomac–Raritan–Magothy (called the PRM), the Wenonah – Mount Laurel, and the Kirkwood –Cohansey. The first two are confined aquifers, meaning that there are layers of less permeable material (silt and clay) which generally isolate the water–bearing layers from each other. These confining layers also protect the aquifer from contamination that might seep down into the groundwater from the land surface. The Kirkwood–Cohansey is close to the surface in eastern Camden County. Because it is unconfined, rainwater can get into it easily and resupply (recharge) the aquifer. This also makes it more vulnerable to surface contamination.

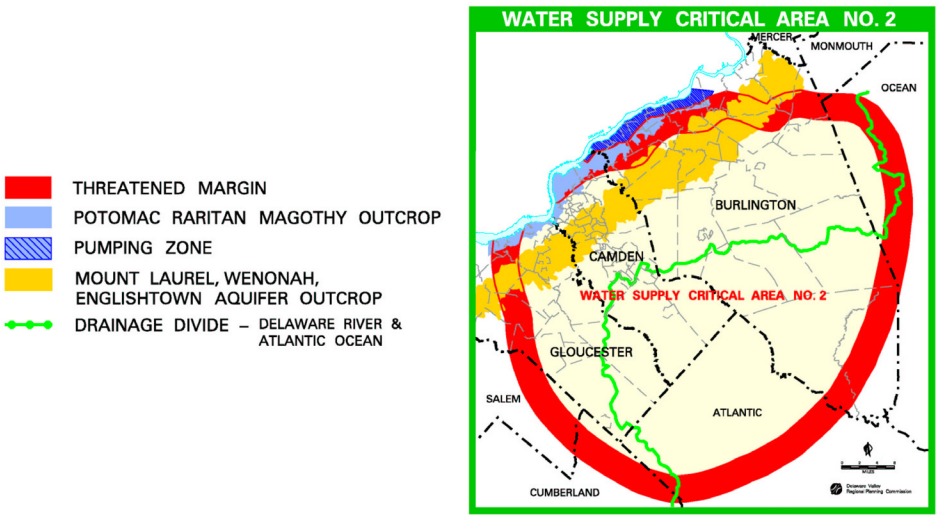
The Coastal Plain aquifers are not horizontal but tilt to the southeast, getting deeper as they cross southern New Jersey toward the Atlantic Ocean. Because of this tilting, each aquifer emerges on the land surface in a sequential manner. Water enters (recharges) each aquifer from rainfall directly on its outcrop.*

Aquifer Outcrop Areas



The PRM yields the most water of the three aquifers and is the primary water supply in the western half of Camden County, as well as in Burlington and Gloucester Counties and across the river in the heavily developed northern part of Delaware. Because it supplies drinking water to so many people, there has been a significant decline in its water levels. This became so serious that the New Jersey Department of Environmental Protection established Water Supply Critical Area #2 in 1986. All water supply companies (utilities) within Critical Area #2 were given annual limits on water withdrawals in the PRM. Usage from the PRM was cut back by over 20% and no increases in pumping were allowed.

* Information on Camden County aquifers comes from an article by Anthony S. Navoy, PhD., U.S. Geological Survey, "Gloucester County Ground–Water Resources and Issues" in the early spring Issue 2001 of *Watershed Newsletter*; issued by the Federation of Gloucester County Watersheds and the South Jersey Land Trust.

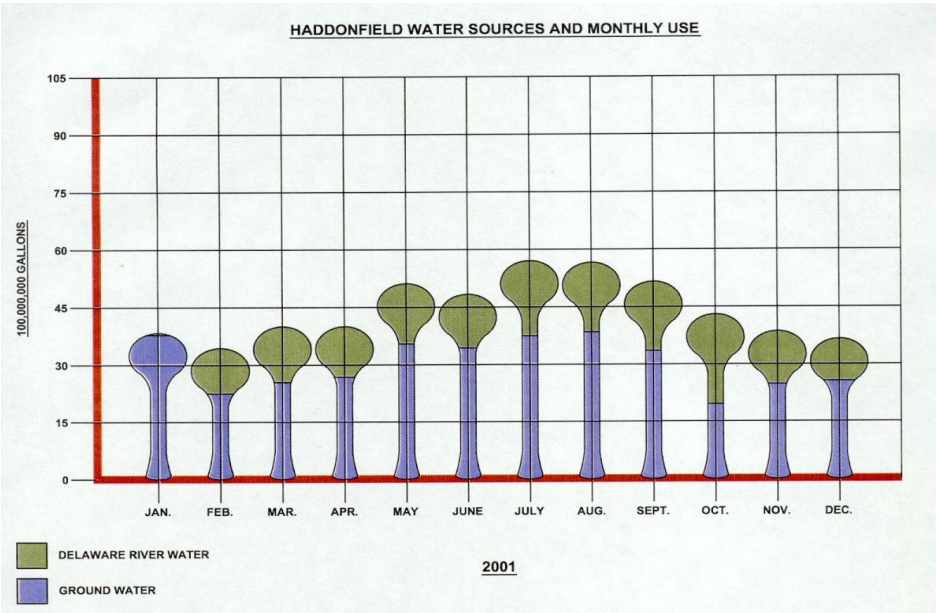


Source: DVRPC

Alternative water–supply sources were developed from the other two aquifers where possible and a pipeline was constructed by the New Jersey–American Water Company that draws water from the Delaware River. This water is thoroughly treated at the company's plant, tested for its purity, and then sent by pipes to local public water supply utilities. There it is used directly or mixed with groundwater drawn up locally and is piped along to customers.

In the course of the year, local **water usage** varies by season. Throughout the summer and into fall, as more people fill pools, wash cars, and water lawns, the usage goes up. More water is drawn from the aquifers and the percentage of treated river water mixed with groundwater also increases.

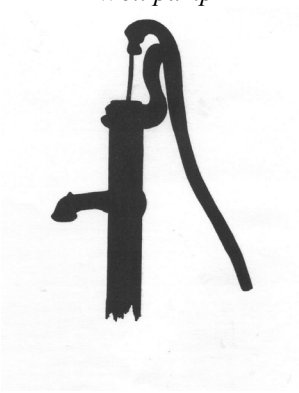
Haddonfield's water usage is typical of the 14 water supply companies in Camden County, all of which are drawing from the aquifers.



Source: New Jersey – American Water Company

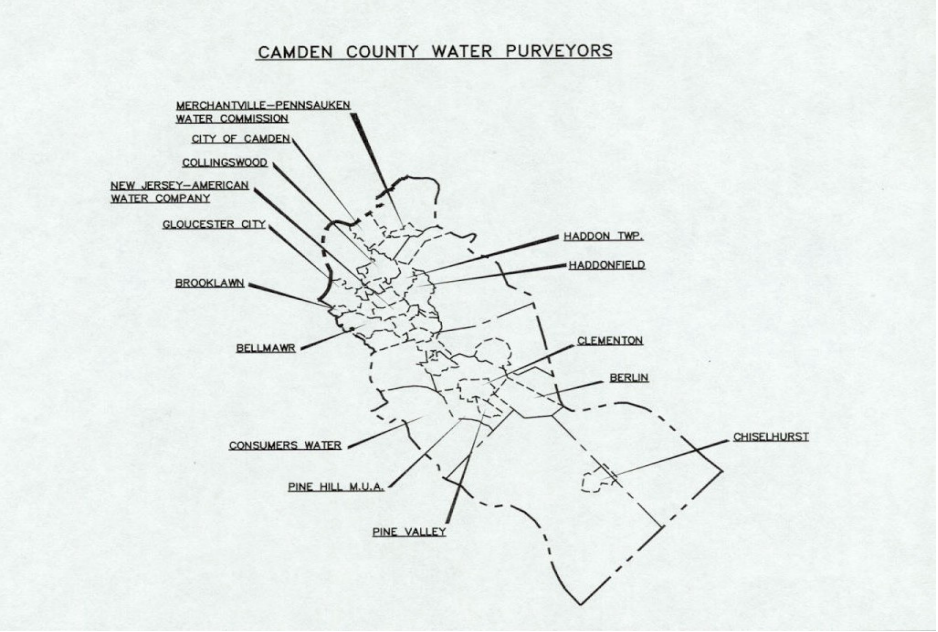
The western half of the County is served by various **public water utilities** that maintain large pumping stations. These utilities may serve one community or several. They usually pump water from several wells and often store it in a large water tank, from which it is sent by pipes to homes and businesses in the area.

An old-fashioned Well pump



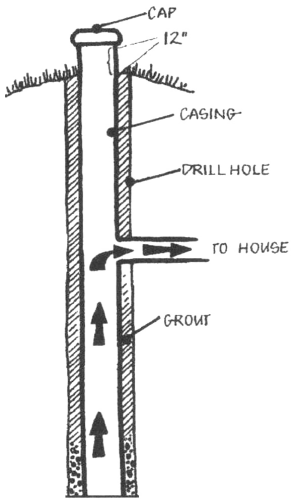
Modern well pumps are either part of the well in the ground or are separate enclosed cylinders that are attached to a water tank within the residence or business.

Water Companies in Camden County



Source: New Jersey – American Water Company

The top of a modern drilled well



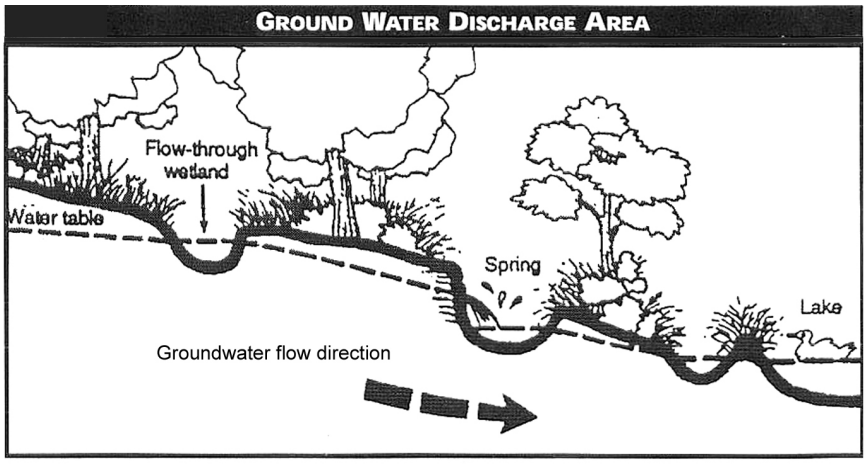
Most people living in the eastern part of Camden County, including farmers who irrigate their fields, rely on **private wells** that draw water directly from the Kirkwood–Cohansey aquifer. A well is basically a hole drilled into an aquifer. A pipe and a pump on the property are used to pull water out of the ground and must be individually maintained by the resident. Protecting the groundwater under their property is an important responsibility for individual homeowners in these communities.

Barred Owl, a forested wetland species

Groundwater And Streams:

In areas where the aquifer is close to the surface, as in the eastern half of Camden County which is underlain by the Kirkwood–Cohansey aquifer, the relationship between groundwater and streams is very direct. Infiltrating water percolates down through topsoil to the water table. The water table is the top of the water held in the sediment and sand spaces (also called the saturated zone.) Infiltrating water then begins to move with the groundwater flow, which follows a downhill, or down–slope direction. It moves very slowly, especially compared to water in streams or rivers. In eastern Camden County, the general down–slope direction is to the southeast.

When the groundwater intersects with a water body such as a lake or stream, it emerges as a spring entering into and "recharging" the water body. It can also emerge from a hillside as a spring or seep. Streams and wetlands in eastern Camden County are fed by groundwater. A large public well pulling groundwater from the same general region can diminish the flow to a local stream and may even cause it to dry up. This has happened in part of the Rancocas Creek watershed in Burlington County.



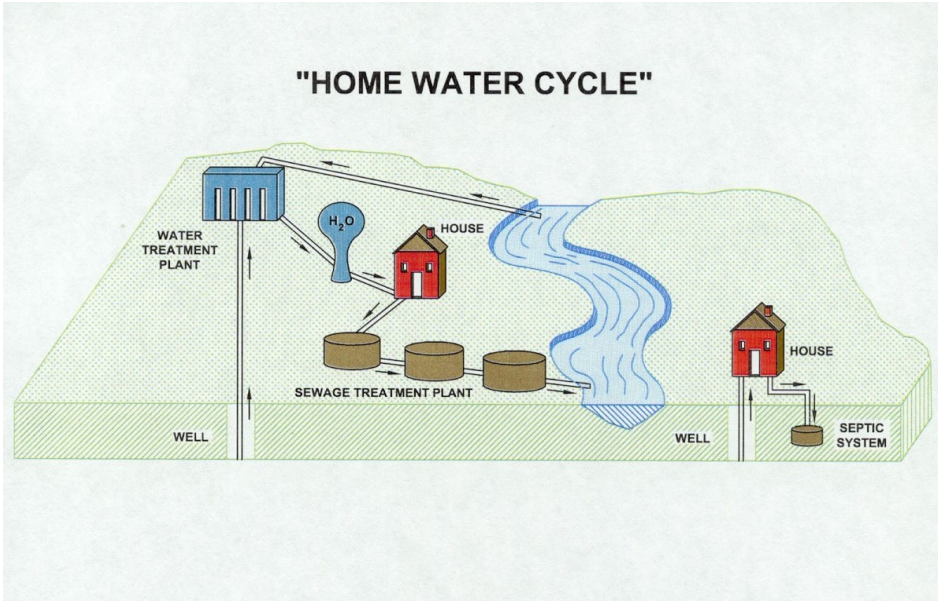
Source: Lyle S. Raymond Jr. *What is Groundwater?* Bulletin #1. Cornell University. July 1988

Northern Cricket Frog

Home Water Use Cycle

The use of water by people is cyclical in its pattern, somewhat like the natural water cycle. Water is drawn from a source – either an aquifer or a surface source such as the Delaware River. It is cleansed by a treatment plant and piped to homes, or it may be conditioned or treated by equipment within a private home. In either case it is used by residents and it becomes wastewater. This used water then either flows to a sewage treatment plant or goes into the septic system on a property. From the treatment plant it is discharged back to the surface water. From the septic system it returns to the groundwater.

The home water use cycle alters the natural cyclical pattern because treated wastewater is usually discharged at a distance from the spot where it was originally drawn. In Camden County this discharge is to the Delaware River. This means that there is a net loss of water within an area, especially from the groundwater supply. The private well and septic system usage is less consumptive. Used water from such a system is discharged close to the point of origin, which replenishes the local groundwater supply. If properly cleansed by the septic system, and if no contaminants get into it, this water will be available for future use.



Source: New Jersey – American Water Company

7. THREATS TO CAMDEN COUNTY'S SURFACE AND DRINKING WATER

Threats to Surface Water (Streams, Lakes, and Wetlands)

DEFINITIONS

Impaired waterways: Stream segments or lakes that do not meet the water quality standards set for them by federal and state agencies.

Sewage: The waste and wastewater produced by residential and commercial sources and discharged into sewers or septic systems.

TO DO

Plan a field trip: Go to the stream closest to your school, examine its condition, and have students figure out where it fits into the watershed, using the watershed maps in Chapter 4.

Look at the land use around the stream, at any outfall pipes, and at the stream banks. Are they eroded? How muddy is the water? Is there a buffer of trees and shrubs along the stream to help trap and filter stormwater runoff?

Introduction

All of the watersheds in Camden County have water bodies – stream segments or lakes – that are classified by the state of New Jersey as impaired. That is, they do not measure up to the standards required for maintenance of healthy aquatic communities of wildlife, especially of fish and the smaller creatures at the base of the food chain. In addition, all Camden County waters are designated to be of sufficient quality for certain recreational use, such as boating, and many are supposed to be swimmable, but do not meet the state standards set for this use.

The eastern section of the County, within the Mullica River watershed, has water that is generally healthier for wildlife and for people. Fewer stream sections are impaired and most lakes are in good condition. The Great Egg Harbor River sections in Camden County are impaired, however, and some are severely so.

Monitoring Water Quality

Measurement of impairments is based on monitoring done by the New Jersey Department of Environmental Protection at specific sites along the streams, which are primarily along the main channels. Waterways may have levels of nitrates, phosphorus, metals, other chemical compounds, or bacterial contamination that are above state water quality criteria (allowable limits for particular substances).

The status of lakes in Camden County is variable. Lake water quality is assessed by the Camden County Health Department if a lake is used for public swimming. Standards must be achieved or the swimming facility is closed. Few lakes in the County are in swimmable condition and some have severe impairments that have resulted in warnings to avoid direct contact with the water because of an excess level of a particular contaminant.

Causes of Impairments

There are two main reasons for water quality impairments in the County. Some waterways have sediments that were polluted by industry or accident in the past. This type of pollution can only be removed by dredging and then removing the sediments, which is often prohibitively expensive.

The other cause of water quality degradation is haphazard land development. Growth in much of the County took place at a time when waterways were considered handy conduits for sewage disposal and stormwater management. Today, although raw sewage and industrial chemicals are no longer dumped into streams, lakes, and wetlands, development still has an impact on local waterways. Development covers the natural landscape with roads and buildings. As it does, rainwater that once would have naturally filtered down into the earth becomes stormwater runoff, filling watershed streams with high quantities of pollutants from the land surface and raising their volume following rainstorms.

Source: Teacher's Guide to the Great Swamp Watershed

The potential for excess sediment to enter streams is greatest during site preparation and construction of a new development.

Older communities cannot easily alter the piping systems and impervious cover associated with earlier development. In municipalities with remaining open land areas, there is continuing extreme pressure from those who wish to develop the land for residential and commercial uses. Additional inadequately-planned development will increase water quality problems in those areas.

Land development is governed by different regulations in each municipality. However, the success of each town in protecting its environment varies widely. While some towns are very pro-active in protecting streams, wetlands, steep slopes and other sensitive environmental features, other towns are slower in recognizing the value of protecting their natural resources.

Even without further development, the water quality of Camden County is endangered by un-remediated toxic wastes and existing stormwater runoff, which pollute regional water supplies, degrade habitats, and contribute to upstream erosion and downstream flooding.

Source: Teacher's Guide to the Great Swamp Watershed

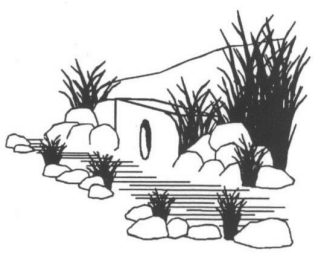
Parking lots accumulate pollutants such as oil, antifreeze, and litter, much of which is washed into storm drains during the next storm event.

DEFINITIONS

Point source pollution: Pollutants discharged from an identifiable point, including pipes, ditches, channels, sewers, and containers.

Non-point source pollution: Stormwater runoff containing pollutants; the contamination does not originate from one specific location, but is pollution discharged over a broad land area.

OUTFALLS



Non-point source pollution stormwater outfall that delivers water and pollutants from a wide area.

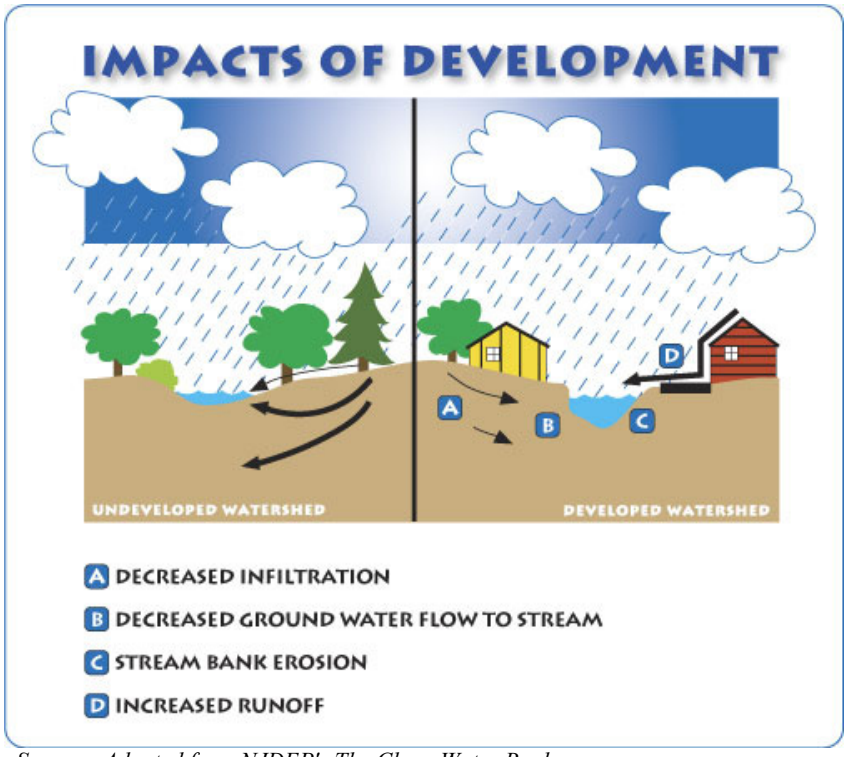
Point source pollution outfall pipe discharging industrial waste.

The following sections describe how human impacts translate into water quality and quantity problems in Camden County's watersheds.

Two Types of Water Pollution – Point Source and Non-Point Source

When we think of water pollution, we frequently picture pipes discharging chemical wastes into our rivers, or oil spills such as the Exxon Valdez. These types of pollutants are known as **point sources of pollution** because the pollutant can easily be linked back to its source, or point of origin. Point sources of pollution are stationary locations or fixed facilities such as an industry or municipality that discharge pollutants into air or surface water through pipes, ditches, lagoons, wells, or stacks. Common sources of point source pollution are sewage treatment plants, leaking landfills, and industrial factories.

Non-point source pollutants, by contrast, are difficult to track to a specific location because they come from many sources, including agriculture, household lawn care, poorly managed construction sites, and road traffic. Non-point source pollution occurs when precipitation falls and moves over and through the ground, picking up and carrying away natural and manufactured pollutants. These pollutants are then deposited into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water. Today, non-point source pollutants have surpassed point sources of pollution as the greatest threat to our nation's water quality.



Source: Adapted from NJDEP's The Clean Water Book

DEFINITIONS

Fecal coliform bacteria: A group of bacteria that are used as indicators of possible sewage or waste contamination because they are commonly found in human and animal feces.

Impervious surface coverage: Surfaces that do not allow stormwater runoff (rainwater and snow melt) to seep into the ground, such as sidewalks, roadways, driveways, and rooftops.

Sedimentation: The settling of soil particles (sediment) to the bottom of a waterway.

Stormwater runoff: Precipitation that flows overland to surface streams, rivers, and lakes, either directly or through storm sewer pipes.

Some common sources of **non-point source pollutants** include:

- Excess fertilizers, herbicides, and insecticides from residential areas, farms, golf courses, and other manicured lawn areas such as office parks and ballfields.
- Oil, grease, de-icing materials (road salt), toxic chemicals from roads, parking lots, truck washing facilities, and industrial sites.
- Sediment from improperly managed construction sites and eroding streambanks.
- Bacteria and nutrients from geese, livestock, pet wastes, leaking or misconnected sanitary sewer lines, and faulty septic systems.

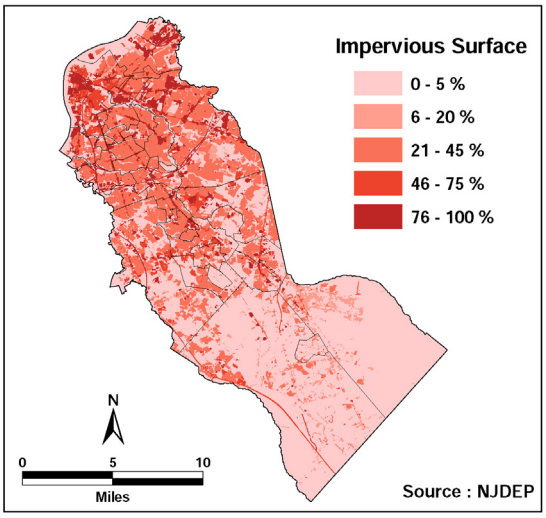
Non-Point Source Pollution of Surface Water

Non-point source pollution from stormwater runoff is the greatest challenge to the environmental health of the waterways of Camden County. The following section provides an overview of the **four main non-point sources of pollution** in Camden County's watersheds.

1. Impervious Surface Coverage and Stormwater Runoff

As a rule, the greater the amount of impervious surface coverage in a watershed, the greater the threat to water resources from non-point source pollution.[4] Impervious surfaces are those surfaces through which water cannot drain. Driveways, roads, sidewalks, and rooftops are all examples of impervious surfaces.

Impervious Surface Coverage in Camden County

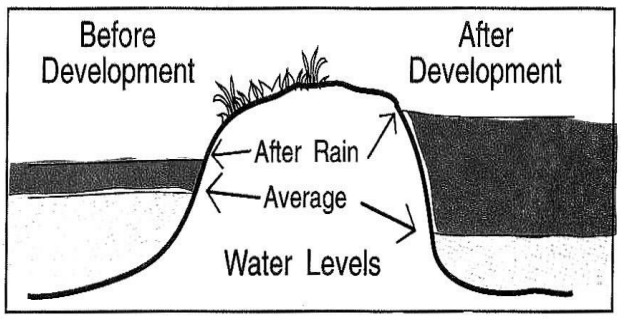


[4] Scheuler, Tom. Site Planning for Urban Stream Protection. Silver Spring, MD: The Center for Watershed Protection, 1995.

These surfaces collect pollutants that are emitted into the atmosphere, leaked from vehicles, or from other sources such as runoff from lawns. During storms, accumulated pollutants wash off and are delivered to rivers, streams, lakes, and ponds.

Imperviousness also accelerates the speed at which water runs off, increasing erosion and streambank degradation. Even relatively little impervious surface cover in a watershed can impact streams. Experts calculate that stream degradation begins at levels of only 10 to 20% imperviousness and has serious impacts at levels of 20% and above.. At present, roughly 45% of Camden County has an impervious level above 20%, according to the NJDEP's 1995/97 landuse/landcover analysis.

In parts of Camden County that were developed before the 1970's, stormwater was shunted directly to a nearby river or stream through a system of storm drains, located within the streets or curbing. These street storm drains are connected to underground pipes that empty through outfalls into a waterway. Beginning in the 1970's, regulations required the construction of detention or retention basins in new subdivisions, which hold the runoff for a time and release it gradually to the waterway in order to prevent downstream flooding. This is still the method of managing stormwater from new development in New Jersey.

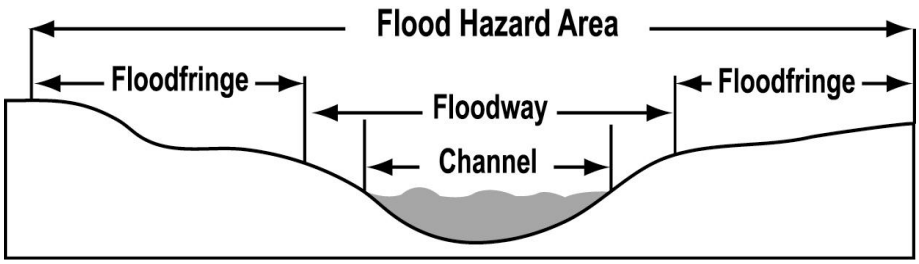


Source: The Streams of Washington Township

Neither direct discharge nor detention/retention basins control what gets into the runoff. Consequently, pollutants that wash off impervious surfaces or get dumped into a storm drain will end up in the stream or lake water.

The quantity of runoff that hits a stream is also greatly increased by the stormwater system, which concentrates water that would otherwise percolate down into the soil. As the runoff arrives at the stream after a rainfall, the force of the water can cause extensive erosion of the banks. The volume of water also temporarily alters the level of the stream, which causes major problems for the aquatic organisms that must adjust to this variability and find ways to prevent being swept away downstream. Many outfall pipes that empty into local streams have caused serious erosion that is expensive and difficult to repair.

Over time, the force and volume of stormwater has downcut stream channels and made them deeper, so that water levels become lower than the floodplains adjoining them. During a heavy storm, excess water may wash across floodplains (the floodway and floodfringe in the diagram below), which hold and even absorb some of the flow. When the channel and the floodway are no longer connected by a gradual slope, the floodplain cannot serve this function. This is also the case in areas in which buildings have been placed within the floodway or otherwise built too close to the edge of a stream or lake.



Source: The Streams of Washington Township

2. Animal Waste

Both wild and domestic animals create non-point source pollution problems through their waste products. One estimate is that an individual Canada goose can drop up to ½ pound of excrement per day, leading one local wildlife expert to comment that the handsome birds are "flying bags of Scott's Turf Builder."[5] Large groups of birds make lawns and sidewalks a slippery mess, and their droppings contribute to high coliform bacteria levels in the lake areas they inhabit. Bacterial contamination is a major cause of lakes being closed to swimming.

Residents can help reduce the problem of geese by planting shrubs instead of grass next to waterways. Geese prefer water bodies with lawns that come right to the edge, where they can enter and leave the water with a clear view of their surroundings. They dislike high grasses and shrubbery along the banks. In addition, visitors to natural areas and parks should not feed geese, as this encourages their presence and adds to the amount of waste produced.

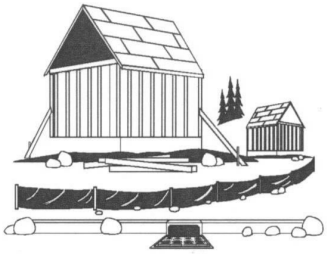
Animal manure pollutes air, water, and land resources. Degraded stream water quality and fish kills resulting from animal manures and feed wastes are reported each year. Such pollution can result from improper practices or careless management. Beyond the concern for pollution control and compliance with state and federal standards, livestock producers should be interested in animal manure's fertilizer value.

Even the family dog can contribute to pollution of the local watershed. What may seem like scant amounts of dog waste, when combined with other waste, becomes a major problem for a small receiving stream. Dropping dog waste in the storm drain may create bacterial problems in that storm sewer line and contribute to elevated fecal coliform levels downstream. Dog waste should always be "taken with you" and disposed of at home in the garbage.

[5] From the *Teacher's Guide to the Great Swamp Watershed.*

3. Sedimentation

Non-point source pollution from sedimentation occurs when water runoff transports soil particles from land into a water body such as a stream or lake. Excessive sedimentation clouds the water, reducing the amount of sunlight available to aquatic plants. It also covers fish spawning areas and clogs their gills. Other pollutants such as phosphorus, pathogens, and heavy metals attach to soil particles and are transported via these particles into water bodies.



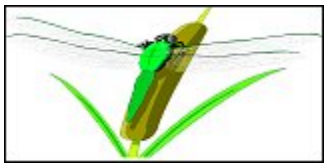
Properly installed and maintained silt fences erected around construction sites reduce the flow of sediment into nearby storm drains.

Source: Teacher's Guide to the Great Swamp Watershed

Severe soil disturbance around a storm drain. Any rainfall event will wash this sediment into the storm drain where it will then empty directly into a stream.

Municipalities can help reduce sediment runoff by enacting strong soil removal and sediment control ordinances and enforcing them, particularly around construction sites. Residents should not dig or move soil near a water body or leave bare soil exposed to the elements for extended periods of time. Farmers can reduce erosion and sedimentation by 20 to 90% by managing the volume and flow rate of runoff from their land.

4. Pesticides and Fertilizers



Adult dragonflies feed on many flying insects, especially mosquitoes

Whether they are applied in residential/commercial settings or in agriculture, pesticides and fertilizers are easily transported via rainwater into nearby streams, lakes, ponds, and even underground aquifers. In a review of studies around the nation in 1997, the US Geological Survey found that **pesticides** have been found in groundwater in most areas studied. Chemicals that result from the original pesticide's breakdown may be even more common in our drinking water. Unfortunately, current testing requirements in NJ do not tell residents if these degradation products are present. This is a problem in a state where it is estimated that at least eight million pounds of pesticides are used annually (NJ Pesticide Resource Manual for Health Professionals, 12-1).

Many pesticides are toxic to pets, other animals, fish and plants, and beneficial insects. They may easily harm wildlife habitat. Disturbingly, some of the most common herbicides in use today - Atrazine, Simazine, Alachlor, 2,4_D, and DCPA all pose a "cancer risk," and the last two have been linked to birth defects (*Drinking Water and Health: Facts on Pesticides in Drinking Water*, NJ Department of Health, 4-5). And in a National Cancer Institute study, home pesticide use has now been linked with childhood leukemia (*Journal of the National Cancer Institute* 79[1]:39-46). Residents should consider "least toxic" means to controlling lawn and household pests and should never engage in "calendar" methods of treating these problems (in which pesticides are applied on a regular schedule, rather than as needed).

For information about Integrated Pest Management (IPM) consult the Rutgers Cooperative Extension Service at 973-932-9801 or go to the website www.pestmanagement.rutgers.edu.

One method for controlling pests with minimal chemical use is called **Integrated Pest Management (IPM)**. IPM relies on a preventive approach: identifying pests when present in a building or lawn and determining a strategy for dealing with each one. This approach relies on managing pests by inspection, monitoring, site and sanitation improvements, and by mechanical, biological, and "least hazardous" chemical controls. IPM can be utilized both on individual properties and on large sites such as corporate parks and institutional grounds. Pesticide reductions of up to 90% have been achieved at federal facilities using IPM.

Fertilizers also contribute to water pollution problems in New Jersey. Excess nitrogen runoff into lakes and ponds causes "algae blooms" that cloud the water and deprive fish and other organisms of much-needed oxygen. Periodic fish "kills" throughout the state, particularly in the summer when oxygen demand is high, are the direct result of nitrogen runoff into the water. This problem begins at the level of individual homeowners, many of whom mistakenly think that "more is better" with fertilizer applications.

Source: Teacher's Guide to the Great Swamp Watershed

An ornamental pond suffering from an influx of excess nutrients, such as phosphorous and nitrogen.

Point Source Pollution of Surface Water

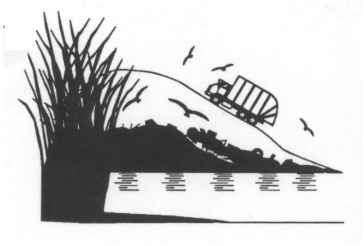
The following section describes **two main point sources of pollution**: contaminated sites and problems with sewage discharges.

1. Contaminated Sites

There are 586 sites in Camden County listed on the New Jersey *Known Contaminated Sites* List. The Contaminated Sites list includes former factory sites, landfills, locations with current or former leaking underground storage tanks, sites where chemicals or wastes were once routinely discharged, and places where accidents have resulted in spills. The contamination has affected soil, groundwater, surface water, or a combination of these. The most dangerous sites, from a human health standpoint, are listed as Superfund sites, which makes them eligible for federal cleanup funds. Other sites are handled by other programs, by the state, or by individuals.

As of September 2001, 36 of these sites required no further action; 82 were pending action; while the remaining 468 were listed as active sites (DVRPC, 2001). Of this number, 40 are Superfund sites, over half of which are located in the three townships along the Delaware River: Pennsauken Township, Camden City, and Gloucester City. The remaining Superfund sites are scattered across all of Camden County's watersheds.

Two examples of Camden County **Superfund sites** illustrate the scope of problems and the difficulty of resolving them:



a. *GEMS Landfill*

The 60-acre GEMS landfill site is located near Camden County College within the Big Timber Creek watershed and is owned by Gloucester Township. Various parties have operated the site as a landfill since it opened in the late 1950s. Records indicate that a variety of hazardous wastes including asbestos, solvents, and municipal sludge tainted with pesticides were dumped there until the state closed the landfill in 1980 over concerns about ground and surface water contamination (EPA, 2002).

In 1983, the EPA removed debris from the site and in 1985 began constructing a landfill cap and a treatment system for the groundwater beneath the landfill. It also relocated and isolated Holly Run, the stream next to the landfill. Nearby homes with wells were connected to the existing public water supply system.

As of 2002, all remedial measures had been completed including the development of a groundwater/leachate treatment system. Because of some complex problems, the on-site treatment plant was unable to bring the water up to satisfactory state pollution levels for surface discharge into Holly Run. An agreement was made with the Camden County Municipal Utilities Authority (CCMUA) to accept effluent from GEMS into its sewer system to be

further treated in Camden City, 20 miles away, and discharged into the Delaware River. Controversy erupted when unsafe levels of uranium and radium, believed to be naturally occurring, were discovered in the water

Ultimately, the case went to a federal court, which ordered CCMUA to accept the pretreated radioactive water. Currently, residents and local politicians are advocating for the passage of a state law that will prevent discharge of GEMS landfill effluent to either CCMUA or Holly Run. Instead, this group hopes to force the GEMS Landfill Trust to treat all water completely on-site, by retrofitting the facility.

b. Welsbach and General Gas Mantle Contamination

The Welsbach Company and the General Gas Mantle Company were involved in the production of incandescent gas mantles from the late 1890s to 1941. The companies used a radioactive material as a coating material on the mesh covers of gas lamps. The radioactive waste materials, or tailings, that remained after extraction were disposed of as fill material near or under residential and commercial properties as well as on open lands.

Beginning in 1991, NJDEP surveyed more than 1,100 properties in Gloucester City and Camden City. The survey revealed that 81 properties had elevated radiation, 33 of which required immediate attention. Shielding materials such as lead and concrete were placed over contaminated soil and ventilation systems were installed in the worst affected areas. A few residents and businesses were relocated as well.

Today, a $34 million remediation project is underway. Soil is being removed for off-site disposal from underneath buildings and surrounding areas, and replaced with clean fill. Some additional residents have been temporarily relocated. Work at these sites is ongoing.

Cleaning Up Contaminated Sites - Hazardous Site Remediation

The need for hazardous waste site remediation far outdistances the supply of funding and support that federal and state agencies can provide. Complicating matters is the fact that, with older sites, it is harder to determine who should be responsible for paying for cleanup, which is an essential component of the federal and state remediation programs.

There is a lot of public information about hazardous waste sites, much of which is on deposit at local libraries, as required by law. In addition, NJDEP's Site Information Program, sponsored by the Site Remediation Program, can be accessed at www.state.nj.us/dep/srp/siteinfo. Detailed information about all known contaminated sites in New Jersey is available online and indexed according to county. Every site on the New Jersey *Known Contaminated Sites* List is assigned a case manager, listed in the index, who can answer more detailed questions concerning the site.

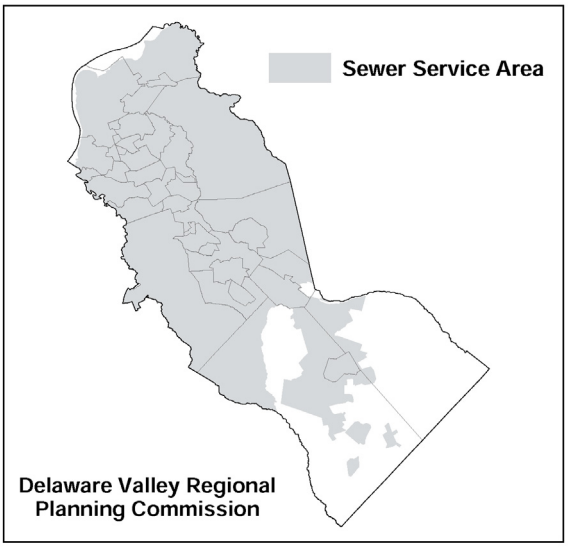
2. Sewage

TO DO

Arrange for a tour of the **Camden County Municipal Utility Authority** (the CCMUA), which is the sewage treatment plant for Camden County. Call 856-541-3700 x1230 (Mary McGinniss). The plant's website is www.ccmua.org.

In the past, household, commercial, and industrial wastes were typically disposed of directly into our nation's streams, rivers, and oceans, under the assumption that they would simply be carried away and diluted by the fresh or saltwater. However, as our knowledge of human health and sanitation grew, so did our understanding that this method of waste disposal was not only bad for human health, but for the environment as well. Today, sewage from our homes and businesses is disposed of in one of two ways: through sewage treatment plants, or through individual septic systems. Although not foolproof, the treatment of our sewage before it is released into surface waters has greatly improved the quality of our water resources.

The majority of Camden County residents and businesses are connected to a public sewer system where sewage is carried by a set of pipes to the Camden County Municipal Utility Authority (CCMUA), the treatment plant located on the Delaware River in Camden City. There it goes through a lengthy process until it is about 96% clean. The cleaned water is then discharged to the Delaware River and flows away to the ocean. The sludge – everything remaining after treatment – goes to a landfill.



Camden County's Sewer Service Areas are those regions approved by the NJ Department of Environmental Protection to have sewer service installed in the future, or which already have sewers. Sewer lines may not have been laid in some locations of the approved area.

The following section describes **two point sources of pollution from sewage**:

a. Combined Sewers

In parts of Camden and Gloucester Cities the sewer system pipes that carry wastewater (the "sanitary sewer") also serve as the stormwater sewer system. That is, stormwater on streets and roads flows into the same set of conduits that carry sewage. The combined sewage is sent through these pipes to the CCMUA

where all of it is treated and released to the Delaware River. This system works well in dry weather and during smaller storms, but does not have the capacity to absorb all the rainwater that falls during heavier storms. At that time, the excess combined sewage must be diverted out of the system in order to prevent backflows into buildings. This is done by shunting the untreated combined sewage through overflow pipes to the Delaware River.

Combined sewers thus deliver raw sewage diluted by rainwater into one of Camden County's major waterways. Requirements enacted in the past 10 years by the U.S. Environmental Protection Agency (EPA) have mandated correction of these systems throughout the nation. Work is underway in Camden and Gloucester Cities to eliminate combined sewer overflows.

b. Leaking and Misconnected Sewer Lines

Another water pollution problem that occurs throughout Camden County is that sanitary sewer lines (pipes) sometimes leak sewage, through breakage at joints or collapse of older pipes. Sewer lines are always laid at low points in the topography, so that sewage being collected from residences and businesses can be moved by gravity, wherever possible, rather than being pumped. The lowest point in any neighborhood is often in a streambed, either beside or even in the stream channel. Consequently, when sewage pipes leak, their contents can easily contaminate stream waters.

Local Utility Authorities work to replace sewer lines on a regular basis, before such breakages occur. However, given the miles of piping that exist throughout any sewer service area, it is difficult to prevent or even detect all leakages. A strong sewage smell near a stream can be evidence of such leakage, as can the presence of smelly runoff emanating from an outfall pipe on a dry day, although other causes are also possible.

Misconnections between sanitary sewer pipes and stormwater pipes are sometimes made when a homeowner or a professional plumber hooks a sewage pipe into a stormwater main pipe under the street. This is usually done accidentally, but still requires correction to prevent raw sewage from flowing to the nearest stream or lake. The EPA's recently enacted Municipal Separate Stormwater Sewer program requires that municipalities, beginning in 2004, must map all their stormwater outfall pipes, identify any sewage problems with the outfalls, and track the source of the sewage, including any pipe misconnections (called “illicit connections”). Correction of misconnections will be fully or partially at the homeowner's expense.

Big Timber Creek (Slim’s Ranch) in Gloucester Township

Source: DVRPC

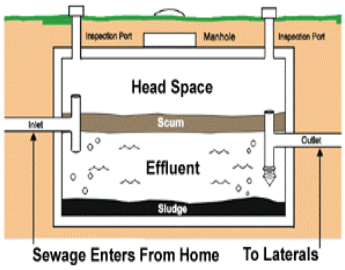
Threats to Drinking Water

Threats to Surface Aquifers

In the eastern part of Camden County drinking water is drawn from the unconfined Kirkwood-Cohansey aquifer. This is the top layer of the "layer cake" illustrated in Chapter 6 – Drinking Water. The Kirkwood-Cohansey does not have the impermeable layers above the water-holding sand and gravel strata that are found in the deeper aquifers underlying the rest of the County. Rainwater and snowmelt that enter the soil can percolate down to recharge the aquifer over a wide area.

Because of the lack of confining layers and the fact that the Kirkwood-Cohansey is closer to the surface, this aquifer is more vulnerable to the seepage of pollutants into the groundwater. These come from septic tanks, leaky underground fuel tanks, fertilizers and pesticides applied on farmland, septic tank additives, leaking landfills, and spills of contaminated substances on the land surface.

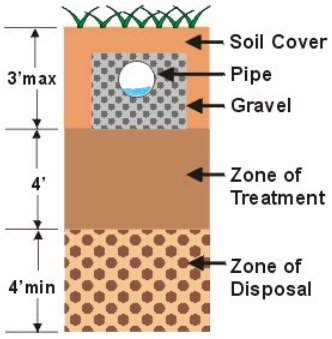
The following sections describe in greater detail **two of these threats** to the Kirkwood-Cohansey aquifer:



A septic tank needs to be pumped regularly in order to work effectively.

1. Septic Systems

In the eastern part of the county, many residents rely on septic systems located on their property. A septic system holds wastewater in a tank until the solids settle out, forming sludge on the bottom and a layer of scum on the top. The liquid part, or effluent, between these two layers moves from the tank into a dispersal bed that has pipes with holes in them, from which it percolates slowly out into the surrounding soil. The impurities and bacteria in the wastewater are filtered out in the soil as the liquid seeps downward and gradually reenters the groundwater.



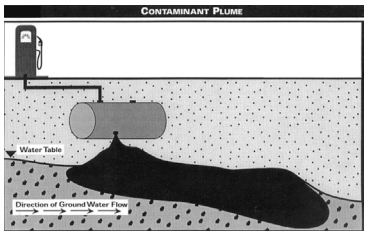
In the dispersal bed of a septic system, wastewater goes through several levels. The bottom of the bed must be at least four feet from the water table to be effective, and to prevent contamination of groundwater.

Septic systems should only be constructed in certain types of soil, which can filter the water at an appropriate rate. This is why "perc" tests are required by state laws before new septic systems are created. Septic tanks need to be pumped out at least once every 2 – 3 years in order to operate efficiently and to maintain the life of the system.

Septic systems are quite effective at cleaning wastewater as long as they are properly located and well maintained. Absolutely nothing should enter a septic system except natural (organic) wastes. Even these should be readily dissolvable. Larger particles from garbage disposals, larger wastes flushed down the toilet, and commercial "cleaning" additives can all clog or damage a septic system. No hazardous materials should be poured down the drain. These include substances such as household cleaners, bleaches, paint, oils, and greases.

2. Contaminated Sites

Leaking underground storage tanks and surface spills make up a large percentage of the listed *Known Contaminated Sites* in Camden County, described earlier in this chapter. Most of these are located at former industrial sites, old gas stations or other commercial properties, and at roadway spill and other accident spots. Documented contamination sites are slowly being eliminated and cleaned. Today, local, county, and state Emergency Management Teams are quick to respond to new accidents.



A contamination plume from a leaking underground storage tank.

Unfortunately, there are still many private homes and businesses with old, leaking fuel tanks that do not become known until a problem emerges with local groundwater. Property owners with private wells have a responsibility to themselves and to their neighbors to identify and remedy these hazards.

Threats to Deep Aquifers

Threats to the deeper confined aquifers, especially to the Potomac-Raritan-Magothy, are due to the tremendous draw on these aquifers by a large regional population, and the effects that this generates. **Two impacts** are described:

1. Overuse

Overuse has affected all of Camden County's deep aquifers, including the Wenonah-Mount Laurel and other smaller sources. It has generated the greatest changes in the Potomac-Raritan-Magothy (PRM) because that aquifer is so productive and thus so heavily used. In 1986 a New Jersey Department of Environmental Protection (NJDEP) study showed that the water level in the PRM was dropping excessively, at a rate of 2½ feet per year.

At the beginning of the 1900s, water levels had been as high as 30 feet above sea level and water flowed from the PRM into the Delaware River (see diagram, p. 41). By 1986, water levels were down as low as 90 feet below sea level. By that time, water from the Delaware River was entering and recharging the PRM, as it continues to do today, along with recharge onto its outcrop areas (see map, p. 42).

Because of the need to maintain and protect this major drinking water source, Critical Water Supply Area #2 was established by NJDEP (see map, p. 43) and limitations were placed on the amounts that could be drawn from the PRM, as well as from the thinner, less abundant Wenonah-Mt. Laurel aquifer.

Although water levels in the PRM have recovered somewhat since 1986, there is always pressure from new development to increase usage from the aquifers, especially since it is less expensive to pump groundwater than to treat and transport river water. Water conservation awareness by the public has also improved, although not to the degree that is needed.

2. Salt Water Intrusion

Another threat to Camden's deep aquifers is salt water intrusion. Salt is already found in the lowest layer of the PRM, in areas south of Camden County. It is believed that this saline groundwater is ancient sea water trapped during the glacial era. It may also be partly a result of salt water migration from the Atlantic Ocean, to which the PRM is connected at great depths on its eastern side. The extensive pumping from the PRM may have pulled this salt layer upward and westward toward Camden County.[6]

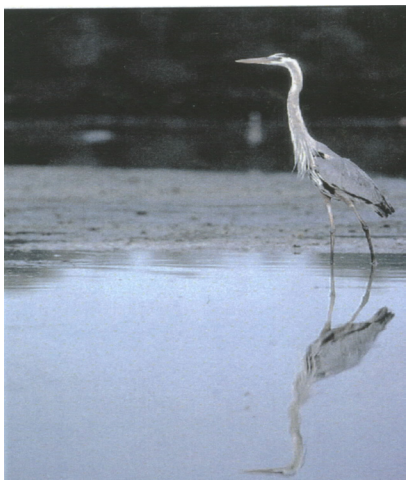
Contamination on the Land Surface

A threat to all of Camden County's aquifers comes from contamination of the land surface. Even the deeper aquifers can be affected by pollutants to the ground within their outcrop areas, where these tilted aquifers are exposed. The emergence of the upper PRM layers is near the Delaware River (map, p. 42). It is precisely in those areas where past industrial sites were most heavily concentrated and where the preponderance of the County's Superfund sites are located.

Some of the wells supplying drinking water in Camden, Pennsauken, and Collingswood, for example, were found to be contaminated by volatile organic compounds and metals. Despite efforts to treat the water, these wells in the Parkside, Puchak, and Collingswood well fields had to be shut down. The sites are now on the Superfund list and are at various stages of assessment to determine whether, or how, to clean the groundwater beneath them.

Some other Superfund sites, in Waterford, Winslow, and Chesilhurst, also involve contamination and closing of wells. These wells pumped water from the Kirkwood-Cohansey aquifer, which was easily contaminated because its entire recharge area (or outcrop) is so broad and close to the land surface.

A Great Blue Heron



Source: Teacher's Guide to the Great Swamp Watershed

[6] Information from a speech on New Jersey Critical Area No. 2 by Arthur Shearman of the NJ American Water Co. to the Water Resources Association Conference, 1998.

8. WHAT YOU CAN DO TO PROTECT THE WATERSHEDS OF CAMDEN COUNTY

TO DO

Have students work with their parents to properly dispose of any unused hazardous chemicals currently stored in their home.

Have students find out whether their home has a septic system, and when it was last pumped.

Hazardous Household Products

Many common household products are toxic to people and the environment. Some oven cleaners, furniture polish, drain cleaners, and spot cleaners are examples of potentially hazardous household products.

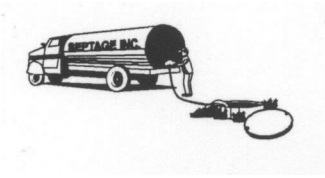
What you can do:

- Use alternative "green" products sold in many mainstream and health food stores.
- Buy only what you need or share the leftovers with others rather than storing them.
- Store materials in their original labeled containers.
- Dispose of unused materials and containers at hazardous waste disposal days (contact the Camden County Division of Environmental Affairs at 856-858-4211 for dates and locations).

Septic Systems

Many homes have septic systems to treat household wastewater. If the system is incorrectly maintained it can malfunction and pollute surface and groundwater resources.

What you can do:



- Know the location of your septic system, the tank(s), distribution box, and distribution lines.
- Do not dispose of large wastes or pour any hazardous materials, paints, solvents, grease, or oil down drains.
- Have the tank pumped every 2 - 3 years.
- Do not plant deep-rooted vegetation near the system because this could clog or crack the tank and piping.
- Do not use septic tank additives of any kind. They can cause damage and are not necessary in a properly maintained septic system.

Underground Storage Tanks

Some homes have tanks to store heating oil. Leaking tanks are a threat to ground water supplies.

What you can do:

- Homeowners should have a tank tightness test performed upon tank installation and periodically afterwards.
- Beware of leakage signs: odors in well water, petroleum smell in basement, dead vegetation near tank, or unusual increase in fuel usage.
- Opt for an above-ground tank with spill containment.

TO DO

Start a *Storm drain Stenciling* project around your school. Find out what streams the storm drain leads to, and stencil a colorful design stating "No Dumping - Drains to River." (See **Appendix G**.)

Free stencils, paint, and other equipment are available from the Camden County Division of Environmental Affairs at 856-858-5241.

TO DO

Have students test their soil for pH levels and other nutrients if it has not been tested in the past three years. Soil test kits are available from the Rutgers Cooperative Extension at 856-566-2900.

TO DO

Start a *Schoolyard Habitat* program to encourage native plant species and create beneficial wildlife habitat (see **Appendix H**.)

TO DO

Encourage students to pick up after their pets and dispose of the waste properly.

Impervious Surface Coverage

Roads, rooftops, driveways and parking lots do not allow water to infiltrate. This impervious coverage creates increased runoff into streams that can worsen flooding and streambank erosion, and will transport litter and other pollutants to them.

What you can do:

- Allow stormwater to filter into the soil by installing a gravel driveway or permeable paths and patios.
- Divert gutter down spouts into dry wells or onto lawns, or capture in a barrel or cistern for watering your garden.
- Stencil the storm drains in your neighborhood with the message "No dumping - Drains to River."

Lawn/Schoolyard Care

Home gardeners use an array of products to keep lawns and gardens green and weed-free. However, if fertilizers or pesticides are misapplied, the materials can run off during a rainstorm and contaminate local streams and lakes.

What you can do:

- Reduce the lawn size and plant ground covers and native plants that require fewer chemical inputs, using techniques such as IPM.
- Test your soil every three years for pH levels and nutrients before applying fertilizers. Your county Rutgers Cooperative Extension Service sells inexpensive soil test kits and analyzes the soil samples at their labs.
- Avoid getting fertilizer on driveways, sidewalks and streets.
- Follow instructions for using pesticides carefully, for your own safety as well as for the environment. Consider using an alternative pest control method.
- Keep litter, leaves, and debris out of street gutters and storm drains--these outlets drain directly to lakes, streams, rivers, and wetlands. This type of waste contains high levels of nutrients that disrupt the natural balance of local water bodies.

Pets and Wildlife

Animal waste from pets, wildlife, and livestock is a source of water pollution. Animal waste contains a high concentration of nutrients and also a potential for pathogens and bacteria.

What you can do:

- Clean up after your pet and dispose of waste in the trash or toilet.
- Promote and comply with "pooper-scooper" ordinances.
- Do not feed ducks and geese.

Car Care

Antifreeze, motor oil, and batteries contain toxic chemicals that must be disposed of properly.

What you can do:

- Do not dump automotive fluids down the storm drain, on the ground, or in septic systems.
- Recycle used motor oil and batteries.
- Properly maintain your vehicle.
- Wash the car at a commercial car wash that recycles its water (check on this) or on a grassy area so water can be absorbed into the soil.
- Use public transportation whenever possible.

To contact the Camden County Soil Conservation District, call 856-767-6299.

Soil Erosion

Sediment is the number one water contaminant in the nation. It can carry water pollutants, smother wildlife habitat, and clog fish gills.

What you can do:

- Plant appropriate vegetation in areas that have bare soil
- Contact your County Soil Conservation District for assistance with erosion problems.
- If you live along a stream or beside a lake, maintain or plant a buffer of shrubs and trees to filter runoff from your property.

TO DO

Encourage students to share their *Water Meter Reader* activity (**Appendix F**) with their families.

Conserve Water

Conservation of water is a voluntary activity except in drought emergencies. It needs to be practiced full time by residents if we are to have enough clean, healthy water for future uses.

What you can do:

- Monitor your own household use of water and identify ways to conserve at home, such as not allowing water to run while brushing teeth or shaving.
- Install a low flow showerhead.
- Take short showers instead of baths, when possible, since showers use less water.
- Run dishwashers only with full loads. Dishwashers use less water than hand washing when run just once a day.
- If your toilets are older, install a jug of water in each toilet tank to reduce the amount held there and used with each flush.
- Water lawns in the early morning or evening when water evaporates less.
- Consider replacing your lawn with a drought-tolerant species of grass or other ground cover so that watering is less necessary.
- Capture "gray water" – water from tubs and sinks – and utilize it for watering plants and lawns.

TO DO

Have students put together a presentation or display for your school on conserving water in the home.

Join your local Watershed Association!

See the **Teacher Resources Chapter – Local Organizations** for the names and contact information for all Camden County Watershed Associations.

There are Watershed Associations for several of the watersheds in Camden County. A watershed association is a private, non-profit citizen's organization dedicated to the protection of a stream or river and its watershed. Watershed associations educate about watershed issues, monitor water quality and quantity, advocate for legislative and regulatory changes, conduct stream and lake cleanups, and conduct restoration projects to replant stream or lake banks.

Some watershed associations have members who can work with school classes. All such groups need and welcome volunteers. Many can accommodate student participation in cleanup and restoration projects, which is rewarding work for anyone interested in Camden County's waterways.

Get Involved with your Municipal or County Environmental Commission

Several towns in Camden County have Environmental Commissions or Committees that help the municipality to identify and address environmental issues in the community. Environmental Commissions often have considerable information about local stream and lake conditions. The Commission may be able to assist class environmental projects relating to the community.

Call your township or borough to find out if there is an Environmental Commission or Committee and when they meet. Meetings are also listed in the newspaper of record for the town and all such meetings are open to the public. If your town does not have such a group, consider petitioning leaders to establish a Commission. For help in doing this, contact the Association of New Jersey Environmental Commissions (ANJEC) at 973-539-7547; website: www.anjec.org.

The Environmental Commission of Camden County is a regional group that advises County government about environmental matters and conducts programs directly. To contact the Camden County Commission, call the Camden County Division of Environmental Affairs at 856-858-5241.

Native plants attract butterflies, birds, and other wildlife and can enhance the habitats of backyards, schoolyards, community and business parks, and golf courses.

Source: Teacher's Guide to the Great Swamp Watershed

9. TEACHER RESOURCES

Local Organizations

Camden County Division of Environmental Affairs:
The Camden County Division of Environmental Affairs, a division of the Department of Parks, is responsible for a number of environmental programs and services, including **Recycling and Solid Waste Management**, **Household Special Waste Collections**, **Litter Clean-Up and Enforcement**, **Open Space and Historic Preservation**, and **Watershed Protection**: 856/858-5241 or www.camdencounty.com/government/offices/environment.

Camden County Environmental Study Center:
The Environmental Studies Center (ESC) offers a variety of educational programs and informational services to County residents. Resources and assistance are available for teachers who wish to integrate environmental lessons into curriculum, develop school-site environmental study areas, and conduct on-site nature programs. For more information, call 856/767-PARK.

Camden County Historical Society
Founded in 1899 and located on the border of Camden and Collingswood, the Historical Society regularly publishes informational books, houses an extensive research library, maintains colonial Pomona Hall and county museum, and offers public and educational programs. The Historical Society offers very affordable tours for County school groups that focus on colonial lifestyles. For more information, call 856/964-3333 or visit www.cchsnj.com.

Camden County Watershed Associations:

Cooper River Watershed Association
PO Box 503
Haddonfield, NJ 08033
Tel: 856/854-5108

Federation of Camden County Watersheds
c/o Jack Sowarski, Camden County Division of Environmental Affairs
520 North Newton Dr.
Oaklyn, NJ 08107
Tel: 856/858-5241
Fax: 856/858-3470

Great Egg Harbor Watershed Association
PO Box 900
Hammonton, NJ 08037
Tel: 609/567-4762
www.greategg.org

Mullica Watershed Forum
c/o The Nature Conservancy - Pine Barrens Program
120-134 Whitesbog Rd.
Browns Mill, NJ 08015
Tel: 609/735-2200

Newton Creek Watershed Association
c/o Mark Dill, President
P.O. Box 484
Collingswood, NJ 08108-0484
Tel: 856/858-1844 or 856/854-5693
www.macarthurwoods.com

Rancocas Creek Conservancy
37 East Central Avenue
Moorestown, NJ 08057
Tel: 856/234-2787
Fax: 856/235-2758

Delaware Riverkeeper Network
The Riverkeeper is a non-profit, membership organization founded in 1988 to strengthen citizen protection of the Delaware River and its tributary watersheds. The organization works throughout the entire 13,000 square mile watershed area, which includes portions of NY, NJ, PA, and DE. Programs include an advocacy program, restoration projects, volunteer-based monitoring programs, pollution hotlines, and enforcement task force. www.delawareriverkeeper.org or call 800/8-DELAWARE.

Delaware Valley Regional Planning Commission
DVRPC is a governmental organization, serving nine counties in the New Jersey/Pennsylvania area. DVRPC works to foster regional cooperation between city, county, and state governments and focuses on transportation, land use, environmental and economic development issues. DVRPC also provides services and advice to member governments through planning

analysis, data collection, and mapping services. Aerial photographs, maps, and a variety of publications are available to the public and private sector. For more information, call 215/592-1800 or visit www.dvrpc.org.

Educational Information Resource Center
606 Delsea Drive
Sewell, NJ 08080
856-582-7000
EIRC is a public agency specializing in education-related programs and services for parents, schools, communities and nonprofit organizations throughout New Jersey. It offers a great many resources for teachers under one roof including a resource library, programs, and training sessions on a wide variety of topics. Their website offers lesson plans and templates directly, as well as 5000 links to lesson plans and educational resources that support national, state, and local standards for Language Arts, Science, Social Studies, and Math in the K-12 curriculum. www.eirc.org

Environmental Commission of Camden County
The Environmental Commission of Camden County is a citizen-based advisory board reporting to the County Board of Chosen Freeholders. The Commission advocates for and conducts projects to benefit Camden County's environment and is responsible for informing County citizens about environmental issues affecting their communities through informational publications and educational programs. The public is invited to attend monthly meetings usually held on the first Tuesday of every month. To confirm locations and times, contact the Division of Environmental Affairs at 856/858-5241.

NJ Department of Environmental Protection:
- To report environmental incidents, abuses, and complaints, call 1-877-WARNDEP.
- For information on water quality, visit the **Division of Water Quality** at www.state.nj.us/dep/dwq or call 609/633-1208.
- For information on the **Private Well Testing Act**, visit www.state.nj.us/dep/pwta call or 1-866/4PW-TEST.
- For information on Certified Water Testing Laboratories in New Jersey, visit http://www.state.nj.us/dep/dwq/labcert.htm.

New Jersey Watershed Management Ambassadors Program
Invite a Watershed Ambassador to your class! AmeriCorps and NJ Department of Environmental Protection sponsor the Watershed Ambassadors Program, employing individuals committed to environmental and watershed education. There are 20 ambassadors for the 20 Watershed Management Areas in New Jersey. Ambassadors do school presentations on various watershed subjects, bring students out to local water-bodies, and organize community members into River Assessment Teams (RATs) and Biological Assessment Teams (BATs). Four Watershed Ambassadors serve the watersheds of Camden County. Read more about the Watershed Management Ambassadors Program at www.state.nj.us/dep/watershedmgt/. Below is the contact information for the Ambassadors serving Camden County:

WMA 14 Mullica	c/o Edwin B. Forsythe Wildlife Refuge, 609/652-1665
WMA 15 Great Egg Harbor	c/o Atlantic County Utilities Authority, 609/272-6997
WMA 18 Lower Delaware	c/o NJDEP Southern Enforcement Office, 856/614-3657
WMA 19 Rancocas	c/o of the Rancocas Conservancy, 856/983-5665 or Rancocas@netcarrier.com

Partnership for the Delaware Estuary:
This nonprofit organization works to increase awareness and understanding of the Delaware River estuary – that portion of the Delaware River watershed that is tidal, starting at Trenton through the Delaware Bay. The Partnership offers numerous free print materials, a free bimonthly newsletter, and runs a yearly, week long Teacher Institute with stipends and professional development credits. Contact the Wilmington office at 800/445-4935 or visit www.delawareestuary.org.

Rutgers Cooperative Extension:
Rutgers University, working with County agencies, offers research-based information and advice to improve people's daily lives. Read more about improving our County at www.rce.rutgers.edu or www.co.camden.nj.us/government/offices/rutgers, or contact the Clementon office at 856/566-2910.

Teacher Resources - Websites

Adopt-A-Watershed:
Adopt-A-Watershed offers curriculum ideas that educators can focus on local environments and use to encourage service partnerships with school children. Contact Colleen Thomas, NJ Department of Environmental Protection, at 609-633-3855 for more information. www.adopt-a-watershed.org

Ben's Guide to U.S. Government for Kids
Parents, teachers, and other educators can access this guide for curriculum, informational, and activity links pertaining to U.S. Government structure and services. "Kids" are also encouraged to access this website as it is geared towards all age groups and all educational interests. www.bensguide.gpo.gov

Building Environmental Education Solutions
BEES, a non-profit organization of educators, government officials, for-profit businesses, and academic institutions, helps teachers explore environmental studies through the disciplines of history, literature, math, and health. The BEES website offers many education programs, curricula, and resources, including a "How To" guide for starting BEES programs in other communities. www.beesinc.org

Earth Force
Earth Force is a national organization striving to mobilize youth to take action in protecting their community's natural environment. While its focus is on youth, it draws upon many environmental education resources and offer links to these resources online. www.earthforce.org/resources.cfm

Education Resource Information Center – Clearinghouse for Science, Math, and Environmental Education
The Clearinghouse (CMSEE) is one of 16 in the ERIC system, which is supported by the U.S. Department of Education. Its purpose is to encourage ongoing improvement in education in all areas at all levels. An Environmental Education index links to different types of resources like journals, conferences, and online guides. http://www.ericse.org/eeindex.html.

EnviroScape™
EnviroScape is a school supplies retailer providing tools, kits, posters, and materials for environmental educators. Of special note is the "Make Your Own Watershed" Kit. www.enviroscapes.com

Environmental Concern, Inc.
Environmental Concern, a nonprofit organization dedicated to wetland education, protection, and restoration, is creator of *Project WOW*, a nationwide teacher resource guide available at www.wetland.org.

Environmental Education Link
EE Link is an online newsletter supporting Environmental Education around the nation. It highlights interesting curricula available through the internet. www.eelink.net

Geography - *My Community, Our Earth*
MyCOE invites groups of students to use geographic methods to study and propose sustainable development ideas in their own communities. This past year's projects focused on Latin American countries and environmental planning issues. Copies of projects in Spanish are available at http://www.geography.org/sustainable/index.html.

Global Rivers Environmental Education Network (GREEN): Founded by Earth Force, GREEN lists links to other watershed education websites on the Internet. Water monitoring volunteers and students can also report and record their data on this site. www.green.org

New Jersey Department of Environmental Protection

- **Division of Water Quality:** www.state.nj.us/dep/dwq
- **Division of Environmental Education:** SEEDS (State Environmental Education Directory Website) offers an introduction to and comprehensive listing of developed curriculum, environmental educators, and organizations in the state. www.state.nj.us/dep/seeds
- **Division of Fish & Wildlife:** Offers education programs, workshops related to Project WILD and Project WET (see Teacher Resources – Activity Guides), and materials. Website: www.state.nj.us/dep/fgw/educatn.
- **New Jersey Geological Survey:** Information on NJ geology, aquifers, groundwater, and wells. Website: www.state.nj.us/dep/njgs.

River Network:
River Network acts as a connection: linking individuals to organizations, and organizations to larger associations. River Network also has significant background information on streams and rivers and has developed training tools for grassroots organizing and educational outreach. www.rivernetwork.org

US Environmental Protection Agency

- **Office of Water:** www.epa.gov/safewater
- **What's Up with Our Nation's Waters:** EPA releases a National Water Quality Report entitled *What's Up with Our Nation's Waters* and available online at www.epa.gov/owow/monitoring/nationswaters or by phone at 1-800-490-9198.
- **Do-It-Yourself Home Cleaning Products:** Suggestions and recipes for nontoxic cleaning solutions, available online at http://www.epa.gov/grtlakes/seahome/housewaste/src/recipes.htm.
- **Water Sourcebook:** The Water Sourcebook offers 324 learning activities geared for specific age groups from Kindergarten to 12th grade. http://www.epa.gov/safewater/kids/wsb/
- **Curriculum Resources:** EPA's Curriculum Resources contains ideas, curricula, and activities on a variety of environmental topics. Many links to other helpful guides and activities are provided for Conservation, Human Health, Water, Ecosystems, Waste and Recycling, and Air. www.epa.gov/teachers/curriculum_resources.htm
- **Drinking Water for Kids:** This EPA Department of Water website provides on-line games and activities geared towards kids to encourage learning about drinking water. www.epa.gov/safewater/kids/wsb and www.epa.gov/OGWDW/kids
- **Wetlands, Oceans and Wetlands:** Provides information and links to teaching guides and activities, education programs, wetlands science, research, and other resources. www.epa.gov/owow

U.S. Geological Survey

- **New Jersey Water Resources:** USGS collects basic hydrologic data and makes interpretive investigations of New Jersey's water resources. The N.J. District information page describes permanent projects, publications, and ways to contact staff members about outreach activities. www.nj.water.usgs.gov. For quick facts about New Jersey's unique water resources, visit: http://water.usgs.gov/wid/html/nj.html.
- **Water Resources:** Create an attractive wall mural or bulletin board for your school or community with a message about clean water. USGS provides illustrated posters of water processes and communities, available at: www.water.usgs.ogv/outreach/OutReach.html.
- **Water Science for Schools:** USGS offers information on many aspects of water, along with pictures, data, maps, and an interactive center where you can give opinions and test your water knowledge. www.ga.water.usgs.gov/edu
- **Science in Your Watershed:** Science in Your Watershed helps you find scientific information organized by watershed. This information is coupled with observations and measurements made by watershed groups, about the status and health of a watershed. www.water.usgs.gov/wsc.

Teacher Resources - Free/Low Cost Materials

Delaware River Basin Commission
The DRBC is an inter-governmental organization focused on managing the natural resources of the Delaware River, the longest un-damned river east of the Mississippi, and its tributaries. DRBC has many projects, including a developed online education guide (ed web) concentrated on all aspects of the Delaware River watershed.
http://www.nj.gov/drbc/edweb/edweb.htm

Discovery Channel – Teacher Lesson Plans Library – "Water: Good to the Last Drop"
This lesson, developed by the Discovery Channel, uses U.S. History to show students how water has played an important role in the development of American settlements. It also illustrates the threats of pollution and importance of conservation.
http://school.discovery.com/lessonplans/programs/water/index.html

Forest Resource Education Center
Teachers can order a free copy of the *NJ Community Forestry Arbor Day Act Activity Guide*. The Guide can be easily photocopied and used in class. Call 609/633-7597.

Give-Water-A-Hand
The Give Water a Hand website features the national watershed education program designed to involve young people in local environmental service projects. You can follow steps in the Give Water A Hand Action Guide (download it for FREE!) and have your class plan and complete a community service project designed to protect and improve water resources.
http://www.uwex.edu/erc/gwah/

Great Swamp Watershed Association
This Watershed Association was created in 1981 to continue protection efforts of the Great Swamp National Wildlife Refuge. The Association has grown into a well-organized and dedicated body of watershed management professionals and wildlife enthusiasts. The Association has also developed an influential teacher's guide focused on the unique Great Swamp habitat. This guide inspired the creation of A Teacher's Guide to the Watersheds of Camden County. www.greatswamp.org

The Groundwater Foundation
The Foundation is a nonprofit organization dedicated to teaching the public about groundwater through numerous programs and publications geared towards educational levels K-12. www.groundwater.org or call 1-800-858-4844.

Izaak Walton League of America's Save Our Streams
Save Our Streams has developed educational tools for communities to employ to improve water quality in their streams, rivers, and wetlands. They also publish training resources for teachers interested in teaching about water testing methods or carrying out stream sampling. www.iwla.org/sos

National Wildlife Federation's Backyard Wildlife Habitat
The Backyard Wildlife Habitat Program teaches participants how to restore their backyards, schoolyards, and even entire communities to wildlife habitats by planting natural and indigenous vegetation. www.nwf.org/backyardwildlifehabitat

The Natural Resources Conservation Service:
The Service offers many education features, including interactive questions answered by an earthworm and suggested lesson plans for teachers. A booklet entitled *Backyard Conservation* offers ways people can apply conservation practices to land around their homes (call 1-888-LANDCARE for a copy). www.nrcs.usda.gov/feature/education

New Jersey Pinelands Commission, On-Line Curriculum Project
The Commission, an inter-governmental agency, oversees the Pinelands Natural Preserve of 1.1 million acres of forest lands in New Jersey. The Commission has recently completed an on-line curriculum guide for teachers of grades 4 through 8 that meets state educational standards. In-depth background information is supplied with the hope that teachers will adapt the content to meet different classroom needs. http://www.state.nj.us/pinelands/pinecur/

Water: A Never Ending Story
This website provides lesson plans for a two-week module on the water cycle, intended for students in 3rd and 4th grades. The module includes activities that teach students about each different phase of the water cycle. It is a comprehensive site that provides background for teachers, discussions, questions, and activities.
www-k12.atmos.Washington.edu/k12/pilot/water_cycle/teacherpage.html

Teacher Resources - Activity Guides

New Jersey Audubon Society's *Bridges to the Natural World* and *New Jersey WATERS*
The Audubon Society offers many resources and services for environmental educators. They host professional development workshops, publish teacher and nature guides, and deploy naturalists for class presentations and evaluations. Their teacher's guide, *Bridges to the Natural World*, provides extensive information on New Jersey habitats and wildlife. *New Jersey WATERS* was created in 1999 and focuses on topics and issues pertaining to watersheds, wetlands, and fresh and marine waters. Both guides meet state curriculum standards. www.njaudubon.org

The Orion Society
The Society is a pioneer of place-based education – using local knowledge to build stewardship and informed decision making. The Society works with educators to develop place-based models and interdisciplinary education and publishes educational resources, awards fellowships to teachers, and hosts regional conferences. To learn more about the Orion Society and its educational work, check their website at http://www.oriononline.org/pages/os/education/index_education.html.

Project Learning Tree
PLT is a popular environmental education program supported by the American Forest Foundation. PLT aims to teach students HOW to think, instead of WHAT to think, about the environment. Curriculum guides, complete with activities and materials, are available through the national website at www.plt.org

Project USE (Urban Suburban Environment)
Project USE is a private, nonprofit educational organization that strives to expose students to Experiential (Adventure) Education and serves the Tri-State area (New Jersey, New York, and Pennsylvania). USE runs a New Jersey Waterways program in which groups explore New Jersey's watersheds by canoe. For more information: www.projectuse.com

Project WET
Project WET (Water Education for Teachers) is a nonprofit water education program providing resources for education levels K-12. Contact: Wetlands Institute at 609/368-1211 and education@wetlandsinstitute.org. www.projectwet.org

Project WET in the City
WET in the City is an urban environmental education program funded through the Council for Environmental Education (CEE) and focuses on urban water resources in need of care and stewardship. WET in the City publishes a curriculum guide for grades K through 12 replete with activities centered around urban environmental issues. For a guide, contact info@wetcity.org. For more information on Project WET in the City: www.wetcity.org

Project WILD and Aquatic WILD
Project WILD is one of the most widely-used conservation and environmental education programs for K through 12 students. The Project emphasizes wildlife because of its intrinsic and ecological values and its importance for teaching ecosystems. *Project Aquatic WILD* is especially designed to educate on aquatic organisms and water habitats. A curriculum and activity guide is available by ordering online. For more information: www.projectwild.org

Wild School Sites A Guide to Preparing for Habitat Improvement Projects on School Grounds is a publication issued in 1993 by Project Wild that outlines the process of developing a schoolyard habitat. Based in Bethesda, MD, Project WILD can be reached by phone at 301-493-5447.

Teacher Resources - Print Sources (Sources used in this Guide)

Boyd, Howard P. *A Field Guide to the Pine Barrens of New Jersey: Its flora, fauna, ecology and historic sites*. Medford: Plexus Publishing, Inc, 1991.

Brown, Michael P. *New Jersey Parks, Forests, and Natural Areas: A Guide*. New Brunswick: Rutgers UP, 1992.

Burton, Dr. Maurice and Robert Burton, editors. *The International Wildlife Encyclopedia.* New York: Marshall Cavendish, 1969.

Caduto, Michael. *Pond and Brook: A Guide to Nature in Freshwater Environments*. Hanover: UP of New England, 1990.

Camden County Planning Department, *Water Resources and Supply Primer*, January 1972.

Donvart, Jeffery M. *Camden County New Jersey: The Making of a Metropolitan Community 1626-2000*. New Brunswick: Rutgers UP, 2001.

Fair, William R. *Waterways of Camden County: A Historical Gazetteer*. Camden: Camden County Historical Society, 2002.

Kraft, Herbert C. *The Lenape. Archaeology, History, and Ethnography*. Newark: New Jersey Historical Society, 1986.

Navoy, Anthony S., U.S.Geological Servey, "*Gloucester County Ground-Water Resources and Issues"* in *Watershed News* Early Spring 2001. The Newsletter of the Federation of Gloucester County Watersheds and the South Jersey Land Trust, Gloucester Co., April, 2001. www.sjwatersheds.org

NJ Department of Environmental Protection

- *The Clean Water Book: Lifestyle Choices for Water Resource Protection*, Trenton, NJ, 1997.
- Division of Water Quality, Bureau of Nonpoint Pollution Control, *A Homeowner's Manual for Septic Systems*, 1999.
- Division of Fish and Wildlife, *Field Guide to Reptiles and Amphibians of New Jersey*, Trenton, 2002.

Robichaud, Beryl and Murray F. Buell. *Vegetation of New Jersey: A Study of Landscape Diversity*. New Brunswick: Rutgers UP, 1983.

State of Connecticut, Department of Environmental Protection, Wildlife Division, "Endangered and Threatened Species" Fact Sheet Series, http://dep.state.ct.us/burnatr/wildlife/learn.htm.

Stokes, Donald and Lillian. *Stokes Nature Guides: A Guide to Bird Behavior Volumes I, II, and III*. New York: Little, Brown and Company, 1989.

Stokes, Donald and Lillian. *Stokes Nature Guides: Animal Tracking and Behavior*. New York: Little, Brown and Co., 1986.

Tyning, Thomas F. *Stokes Nature Guides: A Guide to Amphibians and Reptiles*. Boston: Little, Brown, and Company, 1990.
University of Wisconsin – Extension, Booklet: *Help Yourself to a Healthy Home*, 2002. Website: www.uwex.edu/healthyhome/pdf

U.S. Environmental Protection Agency, Booklet 816-K-02-003, *Drinking Water from Household Wells*, January 2002. Available as a pdf file at http://www.epa.gov/safewater/consumer/wells/household_wells.pdf

Washington Township [Gloucester County, NJ] Environmental Commission, *The Streams of Washington Township,* 1995.

Watt, Martha K. *A Hydrologic Primer for New Jersey Watershed Management*. West Trenton: US Geological Survey, Water-Resources Investigation Report 00-4140. Available as a pdf file at http//nj.usgs.gov/publications/WRIR/00–4140.pdf.

Wernert, Susan. *Reader's Digest: North American Wildlife.* Pleasantville: Reader's Digest, 1982.

Widmer, Kemble. *The New Jersey Historical Series, Vol. 19: The Geology and Geography of New Jersey.* Princeton: D. Van Nostrand Company, 1964.

Winter, Thomas, et al. U.S. Geological Survey, *Ground Water and Surface Water: A Single Resource*, Denver: 1998.

Teacher Resources - Watershed Field Trip Destinations

Below are a few ideas for taking groups out of the classroom and into natural areas that are illustrative of Camden County's watersheds and wildlife. These environmental centers are organized into geographic areas: Camden County, Delaware River, Atlantic Ocean, and the Pinelands. This listing is far from complete. Instead, we have chosen to focus on those education resources in Camden County or within about 25 miles of the County's borders.

Camden County

"Cooper River Watchable Wildlife Walk" Guide
The NJ Division of Fish and Wildlife, through its Endangered and Non-game Species Program, and the Camden County Environmental Commission have created a "Watchable Wildlife" guide and nature trail for Cooper River. In the guide, users will find detailed illustrations of wildlife that correspond with trail signs. Users can also learn about the ecosystems along Cooper River, ranging from freshwater marshland to woodlands. To obtain a copy of the guide, contact "Conserve Wildlife" at 609/292-9400 or the Camden County Parks Department at 856/216-2130.

Camden County Pond Studies
Dave Orleans, the Camden County Park Naturalist, will meet with school groups at various water bodies throughout the County to conduct water wildlife organism identification. Hopkins Pond, in Haddonfield, is one such place and a part of the Camden County Parks system. Its 16+ acres are home to many plant and animal species common to all of Camden County. The pond is a unique spot because it is tucked into a long-established semi-urban community and connects to the larger Cooper River Park. The headwaters of the Great Egg Harbor River in Berlin are another site for water testing and aquatic community studies. Mr. Orleans can also lead a localized "Watershed Investigation Walk" through schoolyards. To organize an informative trip, contact Dave Orleans at 856/768-1598 or dorleans@camdencounty.com.

Camden County Watershed Awareness Day
The Camden County Parks Department sponsors an annual Watershed Festival held in May at Haddon Lake Park (located in Audubon, Haddon Heights, and Mount Ephraim) for area schools. Regional environmental educators, non-profit groups, and water-based companies host interactive tables and teach school groups and visitors about water-related science and issues. The event concludes with an environmental-themed folk concert in the Norcross-McLaughlin Memorial Dell. For more information, contact Dave Orleans, the Camden County Park Naturalist, at 856/768-1598 or dorleans@camdencounty.com.

Canoe Trips through Camden County Rivers and Streams
The Camden County Parks Department offers periodic canoe tours through area streams, such as Cooper River and Newton Creek. A future trip may be on the Big Timber Creek. Interested persons are required to bring their own canoes and pack a lunch for the daylong journey. For more information, contact Dave Orleans, the Camden County Park Naturalist, at 856/768-1598 or dorleans@camdencounty.com.

Garden State Discovery Museum
Museum on the Move
2040 Springdale Road, Suite 100
Cherry Hill, NJ 08003
856/424-1233 ext. 309
The Discovery Museum, voted one of the best children museums in the country, offers traveling workshops for elementary-aged children (5 to 10 years old). Workshops are designed to be culminating activities that excite students about learning and are 30 to 60 minutes long. They focus on special issues relevant to New Jersey like pollution, bugs, and dinosaurs. One such workshop, "Earth & You: Finding a Pollution Problem," employs an interactive Enviroscapes™ model that teaches about area watersheds, sedimentation, and pollution. For more information, visit: www.discoverymuseum.org.

Rob-a-Riverbank – Camden County Park Clean-Up
The Camden County Parks Department organizes specific park clean-up projects throughout the county. The Parks Department provides all the clean-up supplies and refreshments for volunteers. For more information, contact Melissa Mitchell, at 856/216-2128. If you would like to organize your own park clean-up project, Camden County offers grants to assist in purchasing supplies and arranging and advertising the event. Contact Jill Freedman of the Camden County Division of Environmental Affairs at 856/858-5241 for more information on organizing a community clean-up project.

Organize Your Own Stream Clean-Up – New Jersey Community Water Watch
New Jersey Community Water Watch, a Public Interest Research Group (PIRG) and AmeriCorps partner, provides assistance in organizing, conducting, and manning stream cleanups. Water Watch recruits students from area universities (20 campus locations in New Jersey) to carry out clean-ups and teach short environmental curriculum on water issues. To organize a clean-up, contact an educator, or learn more about Water Watch and its work in your community, contact Allison Cairo, the NJ Community Water Watch Executive Director, at 732/249-4108 or allison@waterwatchonline.org. For more information on New Jersey Community Water Watch, visit: www.waterwatchonline.org/nj/index.html.

Delaware River and Delaware Bay

Palmyra Cove Nature Park
1300 Route 73 North
PO Box 6
Palmyra, NJ 08065
856/829-1900
www.palmyracove.org
The Palmyra Cove Nature Park (PCNP) is located right over the Camden County border in Burlington County. PCNP is 350 acres of preserved natural lands in a highly urbanized area on the Delaware River and is just south of the Tacony-Palmyra Bridge, which links North Philadelphia to New Jersey. PCNP protects many different natural habitats, including woodlands, wetlands, a tidal cove, and a 1.6 mile river shoreline. An environmental education center opened in May 2003 and is the focal point of the park. The park plans to host school groups and invites area teachers to be involved in creating curriculum and programs.

Maurice Wild and Scenic River
The Maurice River corridor is a pristine Atlantic Coastal river and habitat to shorebirds, songbirds, waterfowl, raptors, rails, and fish. Historically, the Maurice River is home to a rich fishing, boating, and oystering community. Over 53% of the animal species New Jersey has recognized as endangered live along or in the river. For more information, visit: http://mauriceriver.igc.org/ or http://www.nps.gov/rivers/wsr-maurice.html.

Philadelphia City Sail, Inc.
PO Box 43235
Philadelphia, PA 19129
215/271-3400
Philadelphia City Sail is a nonprofit organization with a focus on exposing economically disadvantaged youth in the Delaware Valley to sailing and the aquatic environment. City Sail uses math, science, environment, and maritime training to teach students about the area around them. Students learn teamwork, develop trust, and expand their horizons while sailing the Delaware River on the schooner *North Wind*. For more information, visit: www.citysail.org.

Parvin State Park
701 Almond Road
Pittsgrove, NJ 08318
856/358-8616
Parvin State Park, in Salem County, sponsors a nature program that aims to inform and increase people's interest in natural areas. The program is designed to cultivate participants' sense of stewardship and powers of observation. Activities

include guide walks, slide and video programs, nature crafts, scenic sketching, aquatic studies, birding seminars, and tree identification. There is no cost for this program and it can be adapted to all different age groups. For more information, contact the Park's staff.

Rancocas Nature Center
New Jersey Audubon Society
Rancocas – Mt. Holly Road
Mount Holly, NJ 08060
609/261-2495
The Nature Center, operated by the New Jersey Audubon Society, offers on- and off-site programs for camps, scout groups, and school groups between the ages of kindergarten to 8th grade. In addition to educational programs, the Nature Center is also a museum replete with self-guiding trails through parklands. For more information, visit: http://www.njaudubon.org/Centers/Rancocas/ or www.fieldtrip.com/nj.

Red Bank Battlefield, National Park, New Jersey
Red Bank Battlefield and Park is located on the Delaware River, a few miles from the City of Camden, and is maintained by the Gloucester County Parks and Recreation Department. The American Revolutionary Fort Mercer, a sister fort to Fort Mifflin in Pennsylvania, once stood on this battlefield's grounds with the primary aim to deter British supply ships from reaching Philadelphia. In 1778, a calculated battle was fought between the revolting American Colonists and the British-Hessian soldiers. The Fort was so well designed that Hessian troops could not break the compound's walls. Over 500 Hessian soldiers died while only 14 colonial troops perished during the battle. The park hosts annual battle reenactments, community gatherings, and cultural and historical festivals in its restored Whitall House. To tour this historical site with an interpretive guide, contact Kathryn Dodson, Gloucester County's Museum Curator, at 856/853-5120.

Scotland Run Nature Center
980 Academy Street
Franklinville, NJ 08322
856/881-0845 or 468-0100
The Scotland Run Nature Center, a part of the Gloucester County park system, offers educational programs such as a "Kid's Nature Center," "Nature Tots," and "Nature Detectives." The Nature Center also runs instructional teacher workshops. For more information, contact Jill Taylor, the Gloucester County Parks Naturalist, at 856/881-0845.

Atlantic

Cape May Bird Observatory
600 Route 47 North
Cape May Court House, NJ 08210
609/861-0700
The Bird Observatory was founded in 1975 by the New Jersey Audubon Society and is a leader in research, environmental education, bird conservation, and recreational birding activities. Many environmental education programs are held at the facility. There is also an example of a backyard (or schoolyard) habitat and the Observatory has information on how to create your own. To organize an educational and instructional trip to the observatory, contact Dale Rosselet, the Vice President for Education, at 609/861-0700 or dale@njaudubon.org. For more information on the Cape May Bird Observatory and its services, visit http://www.njaudubon.org/Centers/CMBO/.

Edwin B. Forsythe National Wildlife Refuge
Great Creek Road
Oceanville, NJ 08231
609/652-1665
This National Wildlife Refuge is maintained by the U.S. Fish and Wildlife Service. More than 43,000 acres of coastal habitats in South Jersey are protected and managed for migratory birds. Driving trails are accessible for visitors to explore the refuge while protecting its "wild" character.

Great Egg Harbor Scenic and Recreational River
Atlantic County Parks

Estell Manor Park, Rte. 50
Mays Landing, NJ 08330
609/645-5960
The Great Egg Harbor starts in Berlin (Camden County), New Jersey and runs to the Atlantic Ocean. Almost all of the 129 miles of river flow through the Pinelands National Reserve. For more information, visit: http://www.nps.gov/greg/index.htm

New Jersey Coastal Heritage Trail (http://www.nps.gov/neje/home.htm)
New Jersey Division of Travel and Tourism
PO Box 820
Trenton, NJ 08625-820
609/292-2470
The Heritage Trail was established in 1988 by the National Park Service and the State of New Jersey and extends from Perth Amboy to Cape May on the Atlantic Coast, and from Cape May to the Delaware Memorial Bridge in Deepwater along the Delaware Bay. The Trail has five themed paths: Maritime History, Coastal Habitats, Wildlife Migration, Historic Settlements (under development), and Relaxation and Inspiration (under development). The Trail is designed to be a driving route with significant stops along the way. For more information and trail brochures, visit: http://www.nps.gov/neje/home.htm or www.state.nj.us/travel

Pinelands Area

Bass River State Forest
762 Stage Road
New Gretna, NJ 08224
609/296-1114
Bass River State Forest was the first piece of land acquired in 1905 by the state of New Jersey for public recreation. Lake Absegami was created in the 1920s for recreational activities. The Batona Trail, a 50-mile walking trail linking Wharton, Lebanon, and Bass River State Forests, winds its way through pine forests and leads to forgotten bog iron mining towns. There are also horseback riding trails available.

Batsto Village
Batsto Village and Wharton State Forest
4110 Nesco Road
Hammonton, NJ 08037
609/561-0024
The New Jersey Department of Environmental Protection administers this historic village located in the South Central Pinelands. While Batsto Village is primarily a historic site, many environmental lessons can be learned about the people that toiled and profited in this area rich with natural resources. Area schools often schedule field trips and tours to the historic village, which is within the Wharton State Forest. For information: www.batstovillage.org.

Belleplain State Forest
County Route 550
PO Box 450
Woodbine, NJ 08270
609/861-2404
Belleplain offers many different large group camping amenities like campgrounds, lean-tos, and group cabins. There are also swimming facilities available at Lake Nummy, an interpretive center, boating and canoeing on East Creek Pond and the lake, picnic facilities, and many winter sports.

Brendan T. Byrne State Forest
PO Box 215
New Lisbon, NJ 08064
609/726-1191
The Byrne State Forest is a recovering ecosystem of Pine trees. Byrne State Forest is a part of winter swan migration routes. In the 19th century, the Lebanon Glass Works cleared the land and used the pine and oak trees to power its furnaces. This State Forest includes the historic Whitesbog Village, a cranberry– and blueberry–producing company town. Whitesbog

Village offers guided tours upon request; The Batona Trail also passes through this park. Large group campsites are available. Visit: www.whitesbog.org.

Double Trouble State Park
PO Box 175
Bayville, NJ 08721
732/341-6662
The Park includes the Cedar Creek, which provides water for cranberry cultivation, and over 5,000 acres of Pine Barrens habitats. Canoeing is possible on the Cedar Creek. Double Tree Village is a historic cranberry community that still has active bogs operated by the New Jersey Devil Cranberry Company. This State Park is also a site on the New Jersey Coastal Heritage Trail.

New Jersey Pinelands National Reserve
New Jersey Pinelands Commission
PO Box 7
15 Springfield Road
New Lisbon, NJ 08064
609/894-7300
The Pinelands National Reserve was the first of its kind in the nation and established by a Congressional act in 1978. As a Reserve, it is an area of nationally significant resources that are protected through land use management. It is also a United States Biosphere Reserve and acts as a laboratory for scientists to explore the relationship between humans and the environment. Many research, academic, governmental, and volunteer organizations study the Pinelands. The Pinelands area is in seven counties, including a portion of Camden County. For more information about visiting the Pinelands area, visit: www.state.nj.us/pinelands or http://www.nps.gov/pine/index.htm.

Rancocas State Park
c/o Lebanon State Forest
PO Box 215
New Lisbon, NJ 08064
609/726-1191
The Audubon Society (www.njaudubon.org) operates a nature center within the park and sponsors many education programs. The Powhatan Indians lease part of the park and a replica of their 1600s Indian village is under construction. There is a network of trails that meander through upland and lowland hardwood forests and along the North Branch of the Rancocas Creek.

Wharton State Forest
4110 Nesco Road
Hammonton, NJ 08037
609/561-0024
Two Headquarters:
Batsto Village on Route 542
Atsion on Route 206
Wharton State Forest is a historic, cultural, and natural area encompassing thousands of acres of pinelands. The State forest includes the historic Batsto Village, Batona Trail connecting Wharton, Lebanon, and Bass River State forests, Batsto Natural Area bordered by the Batsto and Mullica Rivers, and the Oswego River Natural Area, which is a rare bog area and home to the Pine Barrens Tree Frog. Wharton State Park also has a very popular swimming area, Atsion Lake, interpretive visitor centers, and canoeing on the Mullica, Batsto, Wading, and Oswego Rivers.

Woodford Cedar Run Wildlife Refuge
6 Sawmill Road
RR #21
Medford, NJ 08055
856/983-0326
The Wildlife Refuge is located on the western edge of the New Jersey Pine Barrens in Burlington County. On the 184-acre refuge, there are various ecosystems present, such as upland pine and oak forests, cedar swamps, and a man-made lake. The Wildlife Refuge runs many environmental education programs for families, youth groups, and school groups. For more information, visit: www.cedarrun.org or www.fieldtrip.com/nj.

10. Glossary

Aquifer: An underground bed of saturated sediment or rock that yields significant quantities of water. A **confined aquifer** has impermeable or nearly impermeable layers, formed of silts, clays, or shales, above the water-bearing strata. An **unconfined aquifer** is one that is close to the surface, in which the water table rises and falls freely with infiltration of rainwater. Also called a "water table aquifer."

Branch: A smaller stream that flows into ("branches" off from) a larger one.

Catchment: The smallest watershed area, usually defined as the area that drains an individual site, such as a school or small neighborhood, to its first intersection with a stream.

Drainage Basin: A large watershed encompassing the watersheds of many smaller rivers and streams and draining to a major river, estuary, or lake.

Ecosystem: A community of living organisms and their interrelated physical and chemical environment; also, a land area within a climate.

Evapotranspiration: The return of moisture to the atmosphere by the evaporation of water from the surface and by transpiration from vegetation.

Fecal Coliform bacteria: A group of bacteria that are used as indicators of possible sewage or waste contamination because they are commonly found in human and animal feces.

Floodplain: The land areas adjacent to a river or stream that are flooded during storm events.

Groundwater: Water found in spaces between sediment particles underground (located in the zone of saturation).

Headwaters: The small streams from which a creek or river "rises" or begins.

Hydrologic cycle: Also known as the water cycle, this refers to the paths that water takes in its various states – vapor, liquid, and solid – as it moves throughout earth's systems (oceans, atmosphere, groundwater, streams, etc.)

Impaired waterways: Stream segments or lakes that do not meet the water quality standards set for them by federal and state agencies.

Impervious surface coverage: Surfaces that do not allow stormwater runoff (rainwater and snow melt) to seep into the ground, such as sidewalks, roadways, driveways, and rooftops.

Integrated pest management (IPM): A system of reducing pest problems using environmental information along with variable pest control methods. These methods include physical, mechanical, biological, cultural, and chemical means of controlling pests.

Macroinvertebrates: Animals that lack backbones (invertebrates) and are large enough to be seen with the naked eye (macro.) Includes insects, crustaceans (such as crayfish), mollusks (clams, mussels, and snails), and worms. They are good indicators of water quality because the most sensitive can only survive in areas of high water quality.

Marl: A clay–sand soil with a high percentage of the mineral glauconite, which sometimes gives it a green color. Useful as a soil enricher when mixed into less fertile soils.

Non-point source pollution: Widespread overland runoff containing pollutants. The contamination does not originate from one specific location but is pollution discharged over a broad land area. Water pollution that cannot be traced to a specific source.

Outcrop: The area where an aquifer is present at or near the land surface – where it "crops out."

Pesticides: Chemical compounds designed to control and kill pests. The term pesticides includes herbicides (chemicals to kill weeds), insecticides (chemicals to kill insects), and fungicides (chemicals to kill fungus).

Physiography: The study of a location in relation to its underlying geology.

Point source pollution: Pollutants discharged from an identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types.

Run: A smaller stream that flows into ("runs" to) a larger one.

Saturated zone: The underground area in which water is held in the pores and spaces within the sediments or rock. Sediments in southern New Jersey aquifers are made up of sand, silt, clay, and gravel particles. The water within the saturated zone is groundwater.

Sedimentation: The settling of soil particles (sediment) to the bottom of a waterway.

Sewage: The waste and wastewater produced by residential and commercial sources and discharged into sewers or septic systems.

Stormwater runoff: Precipitation that flows overland to surface streams, rivers, and lakes, either directly or through storm sewers.

Sub-watershed: The land area draining to the point where two smaller streams combine together to form a larger, single stream.

Transpiration: The process by which water that is absorbed through plant roots is returned to the atmosphere from the leaves.

Tributary: A stream or river flowing into a larger stream or river.

Water cycle: See Hydrologic cycle.

Water table: The top of the saturated zone (see definition) in an unconfined aquifer (see definition under "aquifer").

Watershed: The land area from which surface runoff drains into a particular stream channel, lake, reservoir, or other body of water.

APPENDICES:
LESSONS AND ACTIVITIES FOR THE CLASSROOM

Correlation of Activities to New Jersey Science Standards

Activity	New Jersey Science Standards
Appendix A. "An Incredible Journey Through the" Watersheds of Camden County"	5.12.1,4 5.10.8,10 5.1.2
Appendix B. "Create Your Own Watershed"	5.2 5.10.2, 3, 5, 6, 8 5.12.2-7
Appendix C. "What's Your Watershed Address?"	5.10.1, 6 5.12.1, 2, 4, 6, 7
Appendix D. "Who Am I?"	5.12.1 5.7.1, 4, 7, 9 5.6.4, 11 5.6.2, 1
Appendix E. "How Does Your Watershed Grow?"	5.6.1, 2, 11 5.1 5.5 5.12.1-6, 9
Appendix F. "Every Drop Counts"	5.12.5, 4 5.10.3 5.2.11, 9, 4, 2 5.6.2 5.5.3, 4
Appendix G. "Storm Drain Stenciling"	5.1 5.10.2, 4 5.12.1, 2, 4, 6
Appendix H. "Starting a Schoolyard Habitat"	5.2 5.6.2, 6, 12 5.7.1-4, 7-9 5.12.7, 10

Appendix A. An Incredible Journey Through the Watersheds of Camden County

An Incredible Journey Through the Watersheds of Camden County is adapted from "The Incredible Journey" activity in the *Project WET Curriculum and Activity Guide* (see Teacher Resources section for more information on *Project WET*). In this activity, students act as water molecules, moving from one part of the water cycle to another based on clues they find at each "station."

Students will:

- Be able to describe the movement of water through the water cycle.
- Be able to identify the states of water as it moves through the water cycle.
- Be able to explain how water can become polluted as it moves through the water cycle.

Materials:

Clues (provided with this exercise)
Symbol Key (provided with this exercise)
12 manila envelopes
Dark colored marker
Tape
Contact paper or lamination materials to protect clue cards (optional)
Noisemaker (bell, whistle, buzzer, etc.)

To prepare the activity, cut the clues into individual squares or cards. Each clue has a station location written at the top. Label each envelope with a station name and place the relevant clues in the envelopes (e.g., all the Delaware River clues go in the Delaware River envelope). Students can illustrate the stations if they wish. Tape or place the envelopes around the room or activity area so that students can see and reach into them easily. Place a copy of the symbol key at each station.

Stations:
(1) Clouds; (2) Suburbia; (3) Lake/Pond; (4) Person; (5) Animal; (6) Wastewater treatment facility/Septic system; (7) Plant; (8) Soil; (9) Groundwater; (10) Atlantic Ocean; (11) Delaware River; (12) Stream

Procedure:
1. Tell students that they are going to become water molecules moving through the water cycle. Have the students brainstorm different places water can go within the water cycle, and the state (vapor, liquid, or ice) that water molecules would be in at different stages of the cycle. Discuss the conditions that cause water to move. Water movement depends on energy from the sun, electromagnetic energy, and gravity. Students should discuss the form in which water moves from one location to another. Most movement from one station to another will take place when water is in its liquid form. However, any time water moves to the clouds, it is in the form of water vapor, with molecules moving rapidly and apart from each other.

2. Review the various stations water can move through in this particular activity: clouds, suburbia, etc.

3. Tell students they will be demonstrating water's movement from one location to another. When they move as liquid water, they will move in pairs, representing many numerous water molecules together in a water drop. When they move to the clouds (evaporate), they will separate from their partners and move

alone as individual water molecules. When water rains from the clouds (condenses), the students will take a partner and move to the next location.

4. Have students line up at the cloud station (the starting place for this activity).

5. Have the first student in line choose a clue from the envelope. If the clue says to "stay", he or she should go to the back of the line at that station and wait his or her turn to try again. If the clue says to go to another station (named in bold lettering on the clue), the student should latch on to the next person in line (because water in its liquid or frozen state must be made up of at least two molecules) and head for that station. The next person in line then chooses a clue (each clue should be returned to the envelope before the students move on to the next station), and so on.

6. When a student or student pair arrives at a station, the same procedure is followed: The student(s) choose a clue and either stay and wait for the next turn or travel to the station named on the clue card. If a student is solo and needs to partner (to travel in the liquid state), the next student in line or the next student who arrives at the station becomes that partner and does not take a clue. If two students are partnered and need to travel singly (in the vapor state), each student of the pair pulls a clue and then travels accordingly.

7. Students should keep track of their movements. Have them keep a journal, notepad, or "water passport" to record each move they make, including stays. Alternatively, students may record their journeys by leaving behind personalized stickers at each station. Another approach has half the class play the game while the other half watches. Onlookers can be assigned to track the movements of their classmates. In the next round the onlookers will play the game, and the other half of the class can record their movements.

8. Tell students the game will run for 30 minutes and will begin and end with the sound of a bell (or buzzer, whistle, etc.). Begin the activity!

9. After the activity, have a few students read aloud their lists of locations (stations) they traveled to as a water molecule. All students could total up the number of visits they made to each location and a chart comparing these numbers could be developed on the board. To follow up further on the exercise, students might write a creative story about their journey and what it was like to move from one place to another. Or they might discuss how their journey would have differed during another season (e.g., summer versus winter).

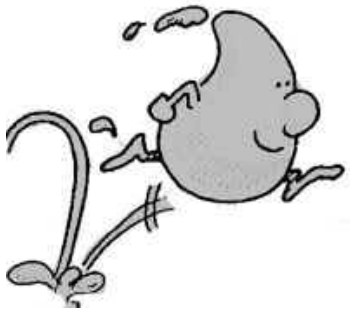
Adaptation:
Affix red stickers to the suburbia, cloud, and person clues that have been polluted with chlorine, manure, pesticides, fertilizers and oil or air pollutants to indicate pollution. If a student selects one of these clues, he or she becomes polluted (demonstrating how difficult it is to clean water once it has been polluted). Place a red sticker on those students. If a molecule (student) that has been polluted later joins up with another, unpolluted molecule, that second molecule will also become polluted and should have a red sticker placed on him or her. Students who are "polluted" and move through the wastewater treatment facility/septic system (station 6) can be "cleaned" and remove their red stickers. How many molecules (students) have been polluted by the end of the activity? How many molecules (students) visited the waste treatment facility and were cleaned?

To follow up, have students research how water becomes polluted and what opportunities exist for it to be cleaned as it moves through the water cycle.

Symbol Key for An Incredible Journey
Through the Watersheds of Camden County

One of these symbols is on each clue card. They indicate what action students should take in response to the clues. Students are instructed to stay or move (singly or in pairs).

Affix copies of these images to each station's envelope so students are reminded of the movement to make.



Move to the next station as liquid water, with your partner (or with the next student in line or the next student who arrives at the station).

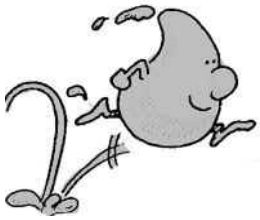
Stay at your station. Go to the end of the line, whether you are a single vapor molecule or have a partner in the liquid state.

Move to the cloud station **alone**, as a single vapor molecule.

Station 1: Clouds *(station location can be written on the back of the clues in this group)*

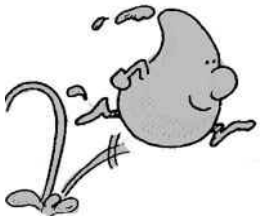
You are in a cloud:

Water condenses and falls as rain on **soil** in Camden County.



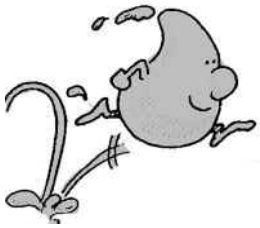
You are in a cloud:

Water condenses and falls on rooftops (in **suburbia**).



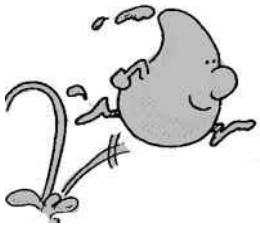
You are in a cloud:

Water condenses and falls into a **stream.**



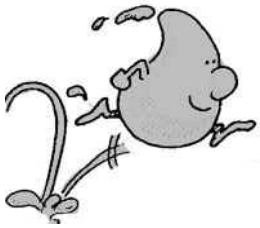
You are in a cloud:

Water condenses and falls into the **Atlantic Ocean**.



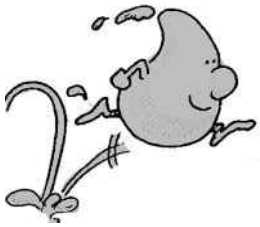
You are in a cloud:

Water condenses and falls into a **lake**.



You are in a cloud:

Water condenses and falls on rooftops (in **suburbia**).



Station 1: Clouds *(station location can be written on the back of the clues in this group)*

You are in a cloud:

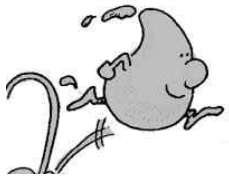
As the water evaporated, it picked up air pollution from local traffic. The polluted water **stays** in the clouds.

You are in a cloud:

The water **stays** as a droplet clinging to a dust particle.

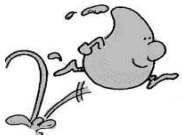
Station 2: Suburbia *(station location can be written on the back of the clues in this group)*

You are in suburbia:
Water is absorbed by a shrub (plant) on a residential lawn treated with pesticides. The pesticide pollution gets into the water and into the **plant**.

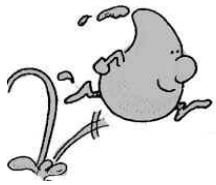


You are in suburbia:
Rain falls on a residential driveway, forming a puddle that evaporates (to a **cloud**) on a sunny afternoon.

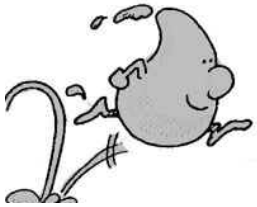
You are in suburbia:
Rain saturates ground at a Country Club recently treated with pesticides and fertilizers. The polluted water filters through the soil into groundwater and eventually goes to a **stream**.



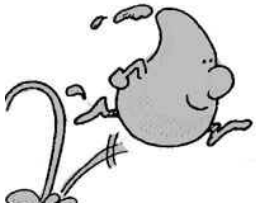
You are in suburbia:
Rain falls on the ground at a dairy farm and washes manure (pollution) into the **soil**.



You are in suburbia:
Rain saturates ground at a Golf Course recently treated with pesticides and fertilizers. The polluted water filters through the soil into **groundwater**.



You are in suburbia:
Rain falls on a paved road covered with oil spots and travels to a storm drain. The storm drainpipe carries the polluted water to a **lake.**



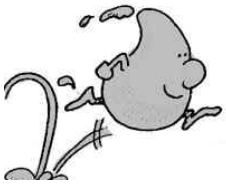
Station 3: Lake / Pond *(station location can be written on the back of the clues in this group)*

You are in a lake:

Heat energy is added to the water by the sun. The water evaporates (to a **cloud**).

You are in a lake:

Water is pulled by gravity; it filters into the soil and joins the **groundwater**.

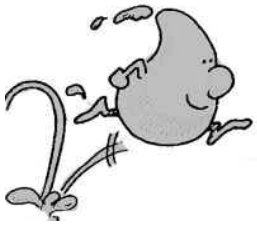


You are in a lake:

The water **stays** in the lake.

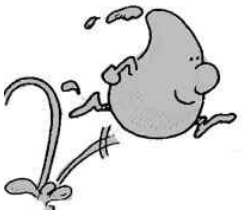
You are in a lake:

A gray squirrel (an **animal)** drinks the water.



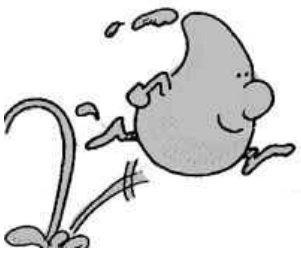
You are in a lake:

Water is absorbed by the roots of a Willow tree (**plant**).



You are in a lake:

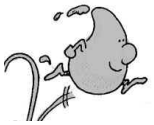
Water from the lake enters the **Delaware River**.



Station 4: Person *(station location can be written on the back of the clues in this group)*

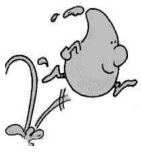
You are in a person:

People treat groundwater from wells with chlorine and use it for swimming. The used water is released into a storm drain and ends up as pollution in a **lake**.



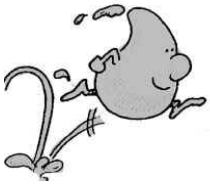
You are in a person:

Toilet water is flushed by a person and goes to a **Septic System**, which filters and cleans the wastewater.



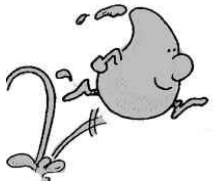
You are in a person:

Laundry water is discharged and goes to the **Wastewater Treatment Plant** where it is cleaned.



You are in a person:

A person waters the lawn. Water filters into the **soil**.

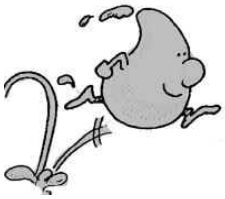


You are in a person:

Water is respired or evaporated (to a **cloud**) from a human body.

You are in a person:

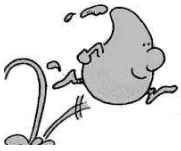
Bath water is emptied by a person and goes to the **Wastewater Treatment Plant** where it is cleaned.



Station 4: Person *(station location can be written on the back of the clues in this group)*

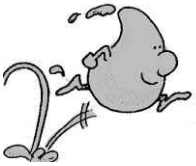
You are in a person:

Toilet water is flushed by a person and goes to a **Septic System**, which filters and cleans the water.



You are in a person:

Bath water is emptied by a person and goes to the **Wastewater Treatment Plant** where it is cleaned.



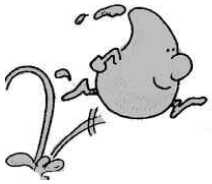
Station 5: Animal *(station location can be written on the back of the clues in this group)*

You are in an animal:

Water is respired or evaporated (to a **cloud**) from an animal's body.

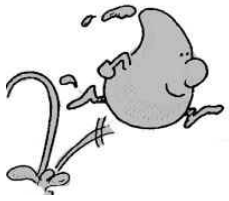
You are in an animal:

Water, excreted by an animal, seeps into the **soil**.



You are in an animal:

Water, excreted by an animal, seeps into the **soil**.



You are in an animal:

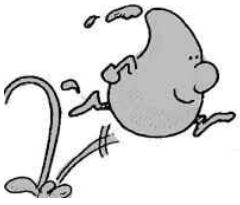
The water **stays** in the animal's body.

You are in an animal:

Water is respired or evaporated (to a **cloud**) from an animal's body.

You are in an animal:

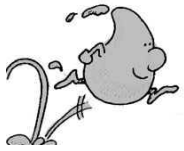
Water, excreted by an animal, seeps into the **soil**.



Station 6: Wastewater Treatment Facility/Septic System *(station location can be written on the back of the clues in this group)*

You are at a Wastewater Treatment Facility or in a Septic System:

Wastewater is treated at a Wastewater Treatment Plant and the cleaned water is released into the **Delaware River**.

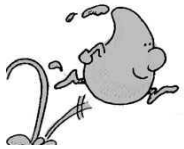


You are at a Wastewater Treatment Facility or in a Septic System:

Wastewater is treated at a Wastewater Treatment Plant and the cleaned water is released into the **Delaware River**.

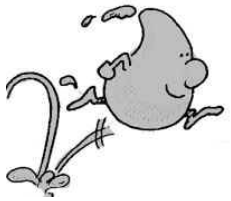
You are at a Wastewater Treatment Facility or in a Septic System:

Wastewater is treated at a Wastewater Treatment Plant and the cleaned water is released into the **Delaware River**.



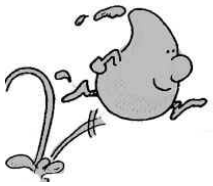
You are at a Wastewater Treatment Facility or in a Septic System:

Wastewater goes through a septic system, is filtered and cleaned, and goes into the **groundwater**.



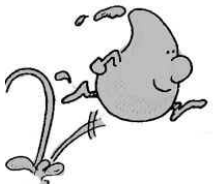
You are at a Wastewater Treatment Facility or in a Septic System:

Wastewater goes through a septic system, is filtered and cleaned, and goes into the **groundwater**.



You are at a Wastewater Treatment Facility or in a Septic System:

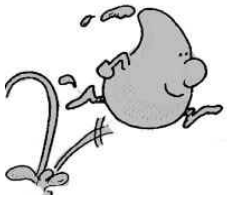
Wastewater goes through a septic system, is filtered and cleaned, and into the **groundwater**.



Station 7: Plant *(station location can be written on the back of the clues in this group)*

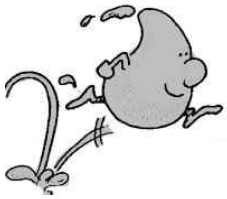
You are in a plant:

The plant is eaten by an **animal**.



You are in a plant:

The water is used by the plant to make its fruit. A **person** eats the fruit from the plant.



You are in a plant:

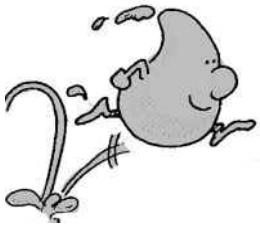
Water leaves the plant through the process of transpiration (to a **cloud**).

You are in a plant:

Water leaves the plant through the process of transpiration (to a **cloud**).

You are in a plant:

The plant is eaten by a **person**.



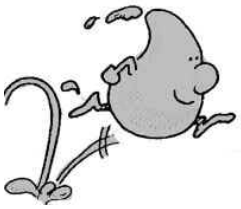
You are in a plant:

The water is used by the plant and **stays** in the plant cells.

Station 8: Soil *(station location can be written on the back of the clues in this group)*

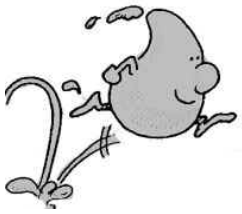
You are in soil:

Water is pulled by gravity; it filters through the soil and becomes part of the **groundwater**.



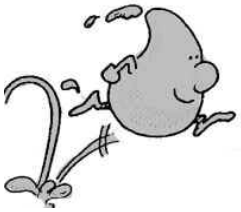
You are in soil:

The soil is so saturated that water runs off into a **stream.**



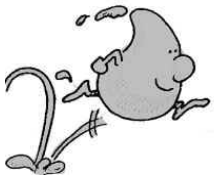
You are in soil:

Water is absorbed from the soil by the roots of a **plant**.



You are in soil:

The ground is so saturated that water runs off, carrying soil particles (pollution) to the streets of a Camden County town (in **suburbia**).

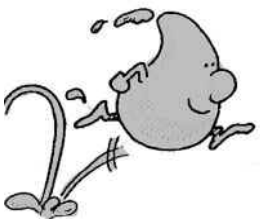


You are in soil:

Water **stays** on the surface of the soil in a puddle.

You are in soil:

The soil is so saturated that water runs off to the **Delaware River**.



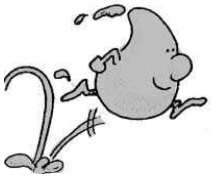
Station 9: Groundwater *(station location can be written on the back of the clues in this group)*

You are in groundwater:

The water **stays** in the groundwater.

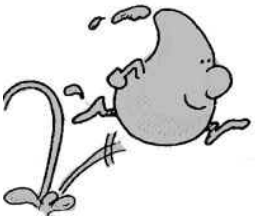
You are in groundwater:

The groundwater moves into a well and is used to water a family's lawn. A bird (an **animal**) drinks some of the water.



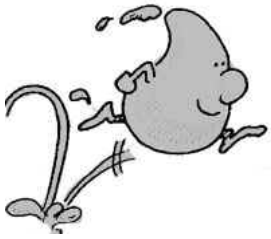
You are in groundwater:

Water filters into a **stream**.



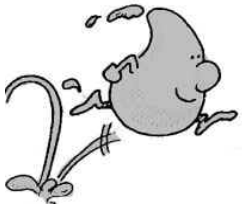
You are in groundwater:

Water filters into a **lake**.



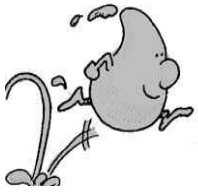
You are in groundwater:

Groundwater moves into a well and is used to wash a car in a driveway of **suburbia**.



You are in groundwater:

The groundwater moves into a well and is used as drinking water by a family. It goes into a **person**.



Station 10: Atlantic Ocean *(station location can be written on the back of the clues in this group)*

You are in the Atlantic Ocean:

Water **stays** in the ocean.

You are in the Atlantic Ocean:

Heat energy is added to the water in the ocean by the sun. The water evaporates (to a **cloud**).

You are in the Atlantic Ocean:

Water **stays** in the ocean.

You are in the Atlantic Ocean:

Water **stays** in the ocean.

You are in the Atlantic Ocean:

Heat energy is added to the water in the ocean by the sun. The water evaporates (to a **cloud**).

Station 11: Delaware River *(station location can be written on the back of the clues in this group)*

You are in the Delaware River:

Water **stays** in the Delaware River.

You are in the Delaware River:

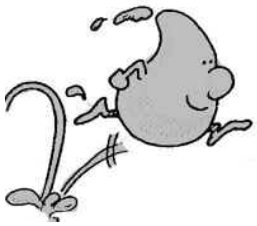
Water **stays** in the Delaware River.

You are in the Delaware River:

Heat energy is added to the water in the ocean by the Sun. The water evaporates (to a **cloud**).

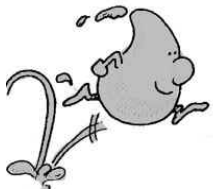
You are in the Delaware River:

Water flows to the **Atlantic Ocean**.



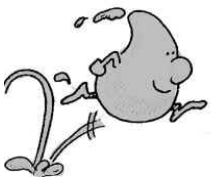
You are in the Delaware River:

Water is pulled from the river, goes through a water treatment plant, and the cleaned water is sent to a house. A **person** drinks the water.



You are in the Delaware River:

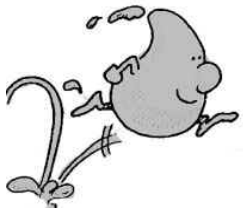
Water is pulled from the river, and goes through a **water treatment plant** where it is cleaned**.**



Station 12: Stream *(station location can be written on the back of the clues in this group)*

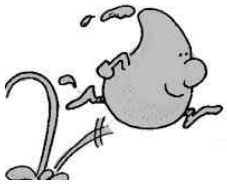
You are in a stream:

Water flows to the **Atlantic Ocean**.



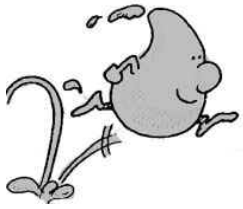
You are in a stream:

Water is absorbed by the roots of a Willow tree and enters this **plant**.



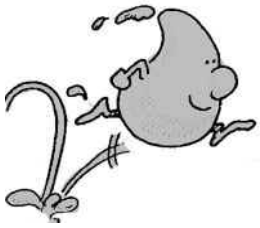
You are in a stream:

Water is pulled by gravity and filters into the **groundwater**.



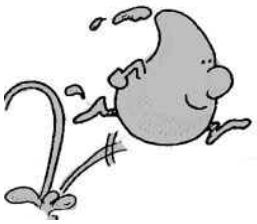
You are in a stream:

An **animal** drinks water from the stream.



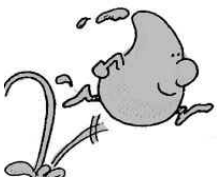
You are in a stream:

Water flows to the **Delaware River**.



You are in a stream:

The stream overflows its banks during a heavy rainstorm and the water washes onto streets in **suburbia.**



Appendix B. Create Your Own Watershed

This activity is from "A Dynamic Watershed" activity in the New Jersey Audubon Society's curriculum guide, *New Jersey WATERS* (see Teacher's Resources for more information.)

A three-dimensional model of a watershed is one of the best ways to demonstrate the watershed concept to your students. With a three-dimensional model, you can demonstrate how water runs from peaks and ridges to low points such as valleys, wetlands, and other depressions. In addition, with the use of water–soluble markers, you can demonstrate how pesticides and sediment are washed off the earth's surface during rain events and into our lakes, rivers, and streams. Prior to this activity, students should have an understanding of the water cycle.

Objective:
Students will be able to construct a landform model, identify geological and physical aspects of a watershed in relation to surface water, and observe and describe drainage patterns in a watershed.

Materials:

***Model A (Paper Watershed)**:*

- 2 sheets of paper per student or pair of students
- Masking tape
- Blue water soluble markers
- Permanent markers

Model B (Watershed in a Basin):

- Newspaper
- Aluminum pan or plastic basin (at least 16" x 24") one per group of six students
- Plastic sheeting or wide tin foil, big enough to cover the top of the container plus about 10"

For both models:

- Spray bottles with water
- Paper towels
- Maps of Camden County Watersheds (provided in chapter 4)

Select one of the following models for the students to construct:

Model A (Paper Watershed):

1. Give each student or pair of students two sheets of paper. Have students crumple one sheet of paper, open the paper, but not straighten it out completely.
2. Have students tape the edges of the crumpled paper to the surface of the other sheet of paper. The crumpled sheet resembles a relief map. The flat sheet is the base or stand for the paper model.

Model B (Watershed in a Basin):

1. Have students in each small group crumple up pieces of newspaper and place them in their aluminum pan or plastic basin. Have them leave one side or one corner without any newspaper. Explain that the newspaper pieces represent land forms and different elevation (topography.) The area without newspaper is a low point where a lake or wide river exists. (Other materials can also be used to help create the landforms: rocks, pieces of foam, paper cups turned upside down.)
2. Give each group a sheet of plastic (or wide tin foil) to lay over the entire model, representing the earth's surface. Have students "fit" and sculpt the material over the landforms, and tuck the edges into the container. If working with tin foil, warn students to work gently so as not to tear the foil.

Procedure:

1. Ask students to use their imagination and identify the different landforms represented in their watershed model. Where are the hills, mountains, valleys, plateaus, etc.?

2. Have students identify ridgelines. (Model A: have students trace these with blue, water-soluble markers.)

3. Explain the difference between "surface water" and "groundwater." Explain that the model is representative of a surface water system only, since it does not allow water to filter down into "groundwater." (These models are impervious surfaces, unlike soil.)

4. Ask the students to predict where the major rivers/streams might be and where, on their model, water would collect after a rainfall. (Model A: Have the students mark these features with permanent markers.)

5. (Model A: Put each model on newspaper, either outside or on the floor. Provide each group with spray bottles.) Instruct the students to "mist" spray their models (Model B: Add 2 – 3 drops of food coloring to the water in the spray bottles.) Discuss how the water flowed, where it accumulated, and how the simulated topography affected the drainage patterns of their model.

6. Introduce the definition of watershed as an area of land where water drains into a stream, river, lake, or other body of water. Drainage areas vary in size. Discuss how small catchment areas make up the watersheds of smaller streams, which flow into bigger streams of a larger watershed. Refer to specific Camden County watersheds to illustrate your points. Does one road in the school district regularly flood? Is there a stream or water body near the school? How does an abundance of rain affect the nearby streams?

7. Students can introduce their watershed models and discuss the different topography and the effects that pollution might have on each model. (Model B: have students line up their models on one table so all students can compare the different watersheds.)

Extension: Repeat the activity, but add the human aspect to the watershed:

1. Assume that this area (model) includes several towns. Where would be the best place to locate housing, the shopping mall, school and municipal buildings, recreation fields and parks, the water treatment plant, roads, the sewage treatment plants, landfills, etc.?

2. Model B: Place a drop of food coloring (other than blue) or colored powder (Koolaid) at each of the above sites on the model. Explain that the colored liquid (or powder) represents pollution. Ask the students to predict what will happen to water supplies the next time it rains. Spray mist the entire model and discuss the outcome and the cumulative effect of pollution. Students should be able to see quite clearly how the "pollutant" flows into the lake/wide river on the low side of their model.

Further Discussion:

1. List what the watershed's natural elements might be. (Soil, vegetation, animals, people, rocks, etc.) List what a watershed's human-made elements might be. (Buildings, roads, dams and lakes, parking lots, fences, airports, train tracks, etc.)

3. Discuss which of these watershed elements would shed water and which would use and/or absorb water. (Those that shed water would include the human-made elements, rocks, and some compacted soils; those that use and/or absorb water would be most soils, animals, and vegetation.)

4. Ask students: If this were your watershed, where would you like to live? Why? Where would your drinking water come from? Where would your wastewater go?

Appendix C. What's Your Watershed Address?

Most people are accustomed to thinking of their address as the street they live on, or the town they reside in, or maybe even the county. However, we all have a watershed address, as well. We might identify with a very large watershed, such as the entire Delaware River watershed, which covers over 13,000 square miles in New Jersey, New York, Pennsylvania, and Delaware, or we can identify with a smaller watershed such as the Big Timber Creek in Camden County. Within Camden County there are 7 different watersheds. This activity will introduce your students to the concept of a watershed address, and help them figure out in which watershed they reside.

Students will:

- Define a watershed
- Locate their town on a Camden County watershed map and on specific watershed map(s)
- Identify and describe their watershed
- Describe possible sources of pollution
- Become familiar with their local waterways

Materials:

- Copies of Camden County-wide watershed map and specific watershed maps in which the entire school district is located (provided in the curriculum guide)
- Copies of Camden County Road Maps
- Copies of questions for narrative
- Pencil and writing paper

Procedure:

1. Provide students with a copy of the **Camden County watershed map**. Have them locate their town on this map and determine what watershed(s) their town is in.

2. Provide students with the relevant **maps of specific watersheds** (Big Timber Creek, Egg Harbor River, etc) for your school district. Have them locate streams and rivers on the map and note where the streams and rivers flow together and/or merge into larger ones.
Streams in Camden County use various names such as: Run, Branch, Brook, or Creek (i.e., Otter Branch, Tindale Run, Newton Creek). Runs and Branches usually "run" into Creeks which "run" into Rivers. In Camden County, all streams (creeks) flow towards the Delaware River/Bay or to the Atlantic Ocean. So either the Delaware River/Bay or the Atlantic Ocean would be downstream of any stream in the County.

3. Have the students locate the town where they live on a **Camden County road map**. They should be able to find their street and location of the school. These other landmarks will help them identify these same locations on the **watershed** maps. Have students mark their home and school locations on the individual watershed maps.

4. Using the **specific watershed maps,** have students find the stream closest to where they live and follow its pathway in both directions. The streams that run into each other and the surrounding land are all part of the Watershed. The land "sheds" water into local streams and lakes during rain, snow melt, or when water goes down a storm drain.

5. Have students identify land use from a **Camden County road map** (ie: industrial parks, residential areas, etc.).

Watershed Story

Using the following questions as a guide, write a description of where you live according to the closest stream in your watershed. (Questions do not have to be answered in order, but all questions should be addressed in the narrative.)

Watershed questions (use the watershed maps and the Camden County road map):

1. What streams are closest to or in your town?
2. What other towns are upstream and downstream?
3. What other streams are connected?
4. Which watershed do you live in? Which watershed is your school in? Do you have to cross a watershed boundary to go from your home to your school?

About your neighborhood (use the Camden County road map):

1. What kinds of land uses (shopping malls, industrial parks, businesses, forests, recreation sites) are in your neighborhood?
2. Could any of the activities in your neighborhood or in your home affect your local stream?
3. If the activity affects your stream, can it affect the water downstream? Give examples.

Optional Follow-Up Activity:

Visit the stream nearest your home with your parents. (Many streams run through local parks or can be viewed from roadways that cross over them.)

Answer the following questions:

1. If you have never seen the stream before, is it what you expected? How is it different?
2. If you have visited the stream before, how has it changed since the last time you saw it?

Appendix D. Who Am I?

This activity is adapted from the "Water Address" activity in the *Project WET: Curriculum and Activity Guide* and the *Great Swamp Watershed's Teacher's Guide* (See the Teacher Resources section for more information on *Project WET*). Every living organism needs water in one or more forms to survive. Some plants and animals have adapted to an abundance of water, such as those that actually live in streams, lakes, or oceans. Others survive with only minimal amounts of water, such as animals and plants living in deserts or other arid areas of the world. Often you can learn a lot about the habitats of animals or plants by the mechanisms or characteristics they utilize to deal with the amount of water they have available to them.

Objective:
The following activity will introduce students to some of the animals that live in Camden County and its various watersheds. The ultimate objective of this activity is for students to recognize water-related adaptations of some animals.

To prepare students for this activity, a general introduction to animal groups should be given. Fact sheets are provided for further information on each animal highlighted in the "Who Am I?" cards. After students take part in the activity, have them research how these organisms take advantage of the ecosystem that surrounds us.

Materials:
One set of ***Camden County "Who Am I?" cards*** for each group of students (these cards may be mounted on cardboard or laminated for durability)
Pencils and paper for scorekeeping
Pictures of organisms listed on the ***Camden County Who Am I? cards*** (provided, though optional)
Map of Camden County and its watersheds (provided, though optional)
Encyclopedia or computer (optional)

Procedure:
1. To begin, discuss the importance of water to all life, particularly human beings. Some questions to ask students are: How long can an individual last without water? What percentage of our body is made up of water? How do people in different parts of the world adapt to arid climates or excessively wet climates? What are some examples of plants or animals that have very distinct adaptations (such as cacti or camels in arid climates)? How many different ecosystems can students list with differing levels of water availability (e.g. deserts, rainforests, polar areas, etc.)? What kinds of special adaptations do animals that live in Camden County develop?

2. Tell students they are going to play a riddle game in which they must guess an animal's identity. Divide the students into small groups.

3. Hand out a set of ***Camden County Who Am I? cards*** to each group. Instruct students not to look at the cards before the game starts.

4. Explain that each card lists four clues (some involving water, some not) for a certain animal. Based on the clues, students will try to guess the name of the animal.

5. Each group should initially pick one student as a "reader." This student will read clues, one clue at a time, until someone in the group can guess the animal. Answers are listed at the bottom of each card.

6. The group receives points based on the number of clues that were read by the time a group member was able to guess the organism (e.g. 1 for 1 clue, 2 for 2 clues, etc). The group with the lowest number of points at the end of the activity "wins."

7. The student who correctly guesses the animal becomes the reader and moves on to the next clue card. If the group cannot guess the identity, it can choose to pass and must add 4 points to its score. Continue the activity until all cards have been read.

8. This activity can be structured into rounds, with the teacher or facilitator signaling for the next card to be read, or students can move on to the next card on their own.

Extensions:
1. Have each student pick one of the animals listed on a card and research that organism's adaptation to water.

2. Have each student write a creative story about an imaginary organism that has recently been discovered living in a Camden County stream or river. What water adaptations does this organism have that makes Camden County a good place for it to live?

Camden County "Who Am I?" Cards

WHO AM I? Card 1

1. I live in a variety of habitats including wooded areas, open fields, and marshes. I also coexist with humans and am often seen in Camden County backyards.

2. I breed quite often and have four litters each year, consisting of three to eight young. I leave my young in a nest in the ground and return several times a day to nurse them.

3. In the summer, I eat grass, herbs, and crops. In the winter I eat bark, twigs, and buds. I've been known to destroy backyard gardens.

4. Some researchers think that when I thump my large hind foot on the ground, I am communicating with other members of my species.

Answer: **Rabbit**
The Eastern Cottontail Rabbit, *Sylvilagus floridanus*, is often seen in the upland forest areas of Camden County as well as throughout our parks and backyards.

WHO AM I? Card 2

1. I have bumpy warty skin in a color pattern that allows me to blend into the background around me.

2. I breed in swamps and ponds in April and May, but I spend the rest of the year in trees, which confuses predators, as well as observers.

3. I have suction pads on my toes that enable me to cling to leaves and bark.

4. I start life in one form, in water, looking somewhat like a fish. I then grow legs, lose my tail, and become a leaping land–dweller.

Answer: **Tree Frog**

The Northern Gray Tree Frog, *Hyla versicolor*, is common in parts of Camden County and closely related to the Southern Gray Tree Frog, which is only found in the acidic water of the Pine Barrens outside of Camden County. Gray Tree Frogs breed in pools of water but can spend their adult life in a variety of land habitats.

WHO AM I? Card 3

1. Although I am a member of the rodent family, I build my nest with twigs and leaves in tree branches.

2. I eat a diet consisting mostly of nuts.

3. I can adapt to almost any environment and I thrive in an urban setting.

4. I am easily recognized by my grayish-brown fur and bushy tail.

Answer: **Squirrel**

The Eastern Gray Squirrel, *Sciurus carolinensis,* prefers upland forests but adapts to any environment. When few hollow trees are available, squirrels construct large, dry leaf nests in high tree branches, which are easily seen by observers. Gray Squirrels are common in Camden County parks, forests, and neighborhoods.

WHO AM I? Card 4

1. In the wild, I build my burrow at the base of trees. In an urban setting, I take up residence under porches, houses, decks, and sheds.

2. I am known for my shiny black coat and large white marking.

3. I have very few predators because I am armed with a chemical defense.

4. My scientific name means odor.

Answer: **Skunk**

Striped skunks, *Mephitis mephitis*, are fairly common but rarely seen. Like many mammals, they are more active at night.

WHO AM I? Card 5

1. My name is attributed to the sound of my rapidly beating wings.

2. To stay alive, I must visit thousands of flowers each day.

4. I am the only species of my kind to live east of the Mississippi River.

3. I can fly backwards, beat my wings over 100 times per second, and hover in the air, usually over flowers.

Answer: **Hummingbird**

The Ruby-Throated Hummingbird, *Archilocus colubris*, is the only hummingbird that lives in Camden County or the Eastern U.S. They can be viewed in the warmer seasons. Hummingbirds migrate in the fall to their wintering grounds in Mexico. Ruby-throats are only 3 inches long and weigh less than one ounce. The population is increasing at a rate of 1.5% per year.

WHO AM I? Card 6

1. My cousin is the beaver; but I am slightly smaller.

2. Like beavers, I am adapted to aquatic environments. I have waterproof fur and webbed feet, but a skinnier tail than a beaver.

3. I like to live in marshes and at the edge of ponds, lakes, and open bodies of water.

4. I build mound-shaped homes on the bank or burrows with underwater entrances.

Answer: **Muskrat**

The Muskrat, *Ondatra zibethicus,* is abundant where water is present. Muskrats can be found by looking for dome-like homes.

Camden County "Who Am I?" Cards

WHO AM I? Card 7

1. I am a popular "big game" animal in North America.

2. I rub the bark off the lower trunks of trees.

3. I am the most common large mammal species (other than humans) in Camden County.

4. I get my name from the color of my tail.

Answer: **Deer**

Whitetail deer, *Odocolileus virginanus*, are very abundant in parts of Camden County. They are mostly seen in the early morning and evening. New antler growth has a tender velvet covering. Bucks rub their antlers on trees to assist the process of shedding the velvet and to mark their territory.

WHO AM I? Card 8

1. I am the only marsupial (pouched animal) found in North America. My cousins are the koalas and kangaroos.

2. I am a slow runner. I escape from predators by climbing trees. My hind paws look like human hands with thumbs.

3. My tail is strong enough to support my weight, but I rarely hang from it.

4. I am known for my behavior of playing dead to trick predators.

Answer: **Opossum**

Opossum, *Didelphis virginiana*, are commonly seen near streams and marshes that are located along or in forests. They eat plants and insects and will scavenge, feeding on dead animal remains. Because they move rather slowly, they are often struck by cars.

WHO AM I? Card 9

1. I spawn in salt water, though my offspring mature in fresh water.

2. I have long narrow dorsal (top) and caudal (bottom) fins that run more than half the length of my body.

3. Although I am actually a fish, I look somewhat like a snake and I move snake-like through swampy waters.

4. I am very slippery and extremely hard to hold.

Answer: **Eel**

The American Eel, *Anguilla rostrate*, inhabits streams and rivers in Camden County. Eels prefer to live in the murky, muddy bottoms of fresh water bodies like the Big Timber Creek. Although eels rely on water, they have the capacity to travel over moist, muddy land to get from one stream to another. Eels migrate back to the ocean to mate and lay eggs. Young eels then travel back to freshwater streams.

WHO AM I? Card 10

1. Unlike other reptiles, my young are born alive, rather than hatched from eggs.

2. I do not have ears, but I "smell" my surroundings with my tongue.

3. When I eat prey larger than me, I unhinge my jaw and swallow things whole.

4. I am often found in gardens, which causes people to misinterpret my common name.

Answer: **Snake**

The Eastern Garter Snake, *Thamnophis sirtalis*, is common in moist forests, fields and marshes, including those in Camden County. An average nest of this snake consists of 50 to 60 young. If a young garter snake survives to adulthood, it can live for 12 years. Garter snakes are named for the elastic bands, or garters, that women once used to hold up their leg stockings.

Camden County Who Am I? Cards

WHO AM I? Card 11

1. I like to spend my days basking by the water in the sun to maintain a constant body temperature.

2. I lay my eggs (1-6 at a time) in a two-inch cavity dug in the bank, covered by clumps of vegetation for protection.

3. I am the smallest native species of my type in the United States.

4. Although I have a hard outer protection, I rely more on diving into water and swimming away, or burying myself in the muddy bottoms of streams, to escape from predators.

Answer: **Turtle**

The Bog Turtle, *Clemmy muhlenbergii*, is an endangered species that makes its home in parts of Southern Camden County. Bog Turtles are rare but do occur in bogs and swampy areas. They are very secretive and difficult to view. The carapace is the top half of a turtle's shell. The plastron is the bottom of the shell.

WHO AM I? Card 12

1. Unlike my cousin, the frog, I am never a tadpole. My body shape does not change; I only grow bigger.

2. I am cold-blooded like other amphibians, and have a smooth, slippery skin.

3. I mate and lay eggs in ponds in January and February.

4. . If you turn over a rock by a stream, you might find me. I like to live in dark, cool, somewhat moist places.

Answer: **Salamander**

The Eastern Tiger Salamander, *Ambystoma tigrinum tigrinum,* is an endangered species. While development has threatened salamander populations, some species benefit from human-made ponds, which they inhabit during breeding season.

WHO AM I? Card 13

1. I get my name from the way I look when seen flying at a distance. I have a white head and brown body when I am an adult.

2. I am classified as a raptor because I hunt, especially for fish.

3. I soar through the air with my wings held horizontally.

4. I am the symbol of a large North American nation, and appear on almost all forms of that country's currency.

Answer: **Bald Eagle**

Bald Eagles, *Haliaeetu leucocephalus*, are an endangered species, although their population is increasing in New Jersey. They have been sighted near all the streams and rivers of Camden County. Bald Eagles soar with their wings held horizontally, compared to vultures which raise their wings.

WHO AM I? Card 14

1. I can fly from tree to tree but I am not a bird or bat.

2. I live in tree holes or bird boxes. I scramble up and down trees.

3. I feed mostly at night on nuts but also on seeds, fruit, fungi, and insects

4. You've seen my cousins very often and I look very similar with gray fur and a white underbelly. I have furry skin that extends from my front leg to my back leg that helps me glide.

Answer: **Flying Squirrel**

The Flying Squirrel, *Glaucomys volans*, is common in large forested areas of Camden County, but rarely seen because it is nocturnal.

Camden County "Who Am I?" Cards

WHO AM I? Card 15

1. My call is very difficult for the human ear to detect. When I am hunting in the air near humans, they might hear a clicking sound.

2. I am found roosting in trees, tree cavities, and under leaves throughout most of North America.

3. I am nocturnal, I fly, and I have poor eyesight.

4. I use a type of radar (sonar) to hunt insects such as mosquitoes.

Answer: **Bat**

Little Brown Bats, *Myotis lucifugus*, are numerous in parts of Camden County but are rarely seen due to their nocturnal nature.

WHO AM I? Card 16

1. My paws resemble human hands, which give me agility and can get me into trouble.

2. I am an omnivore. I eat plants and animals. My diet includes fruits, vegetables, small birds, and insects. In an urban or suburban setting, I eat garbage.

3. I have been seen "washing" my food. But I really just enjoy the feeling of water running over my paws.

4. I am famous for the coloring around my eyes, which makes me look like a "bandit."

Answer: **Raccoon**

Raccoons, *Procyon lotor,* are abundant throughout the forested and suburban areas of Camden County.

WHO AM I? Card 17

1. Although I am a waterfowl, I often perch in branches. I nest in tree holes near the water.

2. The male of my species has a very brilliant color pattern to attract female mates.

3. You will only see me on ponds or lakes in or near forested areas and not in urban or suburban ponds and lakes.

4. You might expect me to quack but my call is more like a squeal.

Answer: **Duck**

Wood Ducks, *Aix sponsa*, nest in tree holes and nest boxes in parts of Camden County. They are most abundant in the spring, summer and fall.

Appendix D. "Who Am I?"
Animal Fact Sheets

Photo courtesy of Inch in a Pinch

Card 1: Eastern Cottontail Rabbit

- The Cottontail Rabbit is often seen in swampy forests, upland thickets, and farmlands.
- Cottontails live above ground, not in underground burrows. The children's storybook character, Peter Rabbit, is a European rabbit, which makes its home underground.
- These rabbits thump the ground with their hind legs to warn others of threats.
- To avoid predators, Rabbits will run in a zigzag pattern at 20 mph.
- Cottontails can live longer in captivity than in the wild. Over 85% die within the first year of their lives.
- These rabbits do not often make sounds, unless caught by a predator, at which time they will emit a piercing scream.

Photo Courtesy of the Pennsylvania Herp Atlas Project

Card 2: Northern Gray Tree Frog

- The Northern and Southern Gray Tree Frogs are identical except for their different calls. Observers can only tell the difference when their calls are recorded and then digitally slowed. The Southern Gray Tree Frog is an endangered species in New Jersey.
- They grow to be one to two inches in size.
- Gray Tree Frogs slow their calls when the weather is cool.
- The Northern species is found throughout the entire state. The Southern Tree Frog is found only in Cape May, Cumberland, Ocean, and Atlantic Counties in NJ.

Photo Courtesy of the State of Texas Department of Parks and Wildlife

Card 3: Eastern Gray Squirrel

- This common squirrel resides in hardwood or mixed forests with nut trees, throughout the Eastern U.S. (It was recently introduced to San Francisco, CA and Seattle, WA.)
- Squirrels are often seen in the morning and evening hours, when they are most active.
- Eastern Gray Squirrels do not hibernate and brave the cold to hunt for nuts under snow.
- Squirrels find nuts and then bury them in another location. They rely on sniffing out buried nuts rather than on memory to find them. Squirrels will only recover about 85% of the nuts they bury. The remaining 15% usually sprouts into young trees.
- The Squirrel uses its tail to balance in trees, but it also uses it to act as a sunshade, an umbrella, a blanket, and a rudder when swimming. The tail gives lift when the squirrel leaps from branch to branch and slows descent should the squirrel fall.

Photo Courtesy of John Hasse at Rutgers University for the South Harrison Electronic Natural Resource Inventory

Card 4: Skunk

- Skunks live about 7 years in the wild and 8-10 years in captivity.
- Skunks are a carrier of rabies, but the spray does not carry the virus.
- The skunk sprays its smelly musk as a defense from predators. Its scent glands mature at less than 1 month of age. The spray is aimed at the predator's face and causes severe irritation, especially to eyes.
- The skunk uses spraying as a last resort against predators because producing the substance takes valuable time and energy. Faced with a predator, it will first try to run away. If it is cornered or trapped, it will stamp its front feet and move backward. It will growl and hiss. Finally, the skunk will lift its tail, bend its rear towards the would-be predator, and spray.

Photo Courtesy of Wildbirds.com

Card 5: Ruby-Throated Hummingbird

- There are over 330 species of Hummingbirds but the Ruby-throated is the most widely distributed species.
- Hummingbirds are only found in the Western Hemisphere.
- Hummingbirds normally beat their wings about 60-80 times per second while flying. Their hearts beat 250 times per minute at rest and 1,220 per minute while flying.
- Most hummingbirds die within their first year of life due to the difficulty of migration, predators, and bad weather.
- A hummingbird needs about 10 calories of food a day to survive and finds nourishment in flower nectar, tiny insects, and spiders.

Photo Courtesy of Save the Prairie Society

Card 6: Muskrat

- Muskrats are a part of the rodent family, weigh between 3 and 4 pounds, and have webbed feet for swimming.
- They are often seen swimming in streams, ponds, and other wetland habitats.
- They prefer marshes that have an abundance of freshwater for swimming and sanitation. They dig at the marsh's bottom and create underground tunnels and runways.
- Their dens are above ground, although the entrances are underwater.
- If threatened, a muskrat can remain underwater for 17 minutes. Under normal conditions, it will swim underwater for 2-3 minutes.
- Muskrats are omnivores and will eat small animals like turtles, salamanders, and slow-moving catfish, as well as certain marsh vegetation.

Photo Courtesy of Darmouth College

Card 7: Whitetail deer

- Deer are territorial animals, establishing a home area and never leaving it.
- Deer can live up to 11 years in the wild.
- Without the threat of animal predators or hunting, deer populations can double in size every year.
- Some researchers believe that high deer populations result in a high incidence of Lymes disease among humans.
- Due to human encroachment (resulting in the loss of animal habitat) and unregulated hunting, deer populations were at dangerously low levels in the 1890s. Now, due to strict game laws, the lack of natural predators, and the availability of suburban vegetation as food, there is an excess of whitetail deer. This is a detriment to farm crops and has increased auto accidents.
- Whitetail deer have highly developed senses of sight, smell, and hearing to escape from predators.

Photo courtesy of the Wildlife Center of Silicon Valley

Card 8: Opossum

- The Opossum is the only marsupial mammal in North America.
- The female carries and nurses her young in her marsupium (pouch) until they are about 2-3 months old. Then, the young travel on her back for an additional 1-2 months.
- These animals travel alone and are usually slow moving. When frightened and unable to flee they fall into a shock-like state ("playing 'possum.")
- While the Opossum is often depicted as hanging from a tree by its tail, it rarely does this. It uses its prehensile tail to stabilize its body while climbing.
- Few opossums live beyond 1 year, though they can live up to 10 years in captivity. Many animal predators including dogs, cats, and owls kill them. Motorists in suburban areas often strike them.

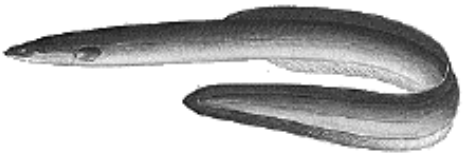


Photo courtesy of State of Connecticut Department of Environmental Protection

Card 9: The American Eel

- American eels are the only fish on the East Coast to return to the ocean to spawn. They live most of their lives in freshwater. Once they make this trip to the sea, they never return to freshwater, having lived out their lives. Young eels travel from the ocean to freshwater rivers and streams in Camden County.
- Juvenile eels (called elvers) are transparent, and some people along the New Jersey coast have dubbed them "glass eels."
- Eels feed mainly at night and eat almost any animal food. Cannibalism has been observed in crowded conditions.
- "Glass eels" are considered a delicacy in some Asian countries. Over 2,500 juvenile eels equal one pound. Once a juvenile eel has eaten its first meal, it loses its market price as a gourmet food.

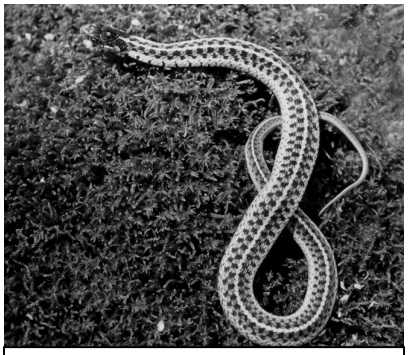


Photo courtesy of Virginia Tech

Card 10: Eastern Garter Snake

- The Eastern Garter Snake lives in a wide range of habitats, such as meadows, marshes, woodlands, hillsides, along streams, and in drainage ditches. It can even be found in city parks and cemeteries.
- As an adult, this snake can grow to be 3-4 feet long.
- Some male snakes possess a seminal odor that is inserted into the female during the mating process. This odor repels other male suitors.
- Garter Snakes are born alive, not from eggs.
- When startled, these snakes withdraw their head and neck under leaves or tree roots.
- Garter Snakes sometimes hunt around the edge of a pond, preying on tadpoles, which are most vulnerable at this stage.
- Garter Snakes are active daytime hunters and will eat earthworms, insects, frogs, salamanders, birds, and small mammals.

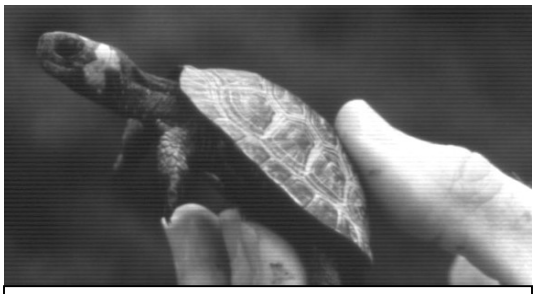


Photo courtesy of the State of Maryland Department of Natural Resources

Card 11: Bog Turtle

- The Bog Turtle is an endangered species in many eastern states, including New Jersey.
- It is one of the most difficult animals to find, as it is rare, elusive, and often dwelling on swamp bottoms. Its habitats are dwindling as wetlands are destroyed for human settlement.
- The greatest numbers of Bog Turtles are found in the wetland areas of agricultural lands in northwestern and southwestern New Jersey.
- The Bog Turtle eats mostly insects, and some seeds and berries.
- During the winter months, bog turtles hibernate underwater in deep areas of bogs in about 6 - 18 inches of mud. The turtles reemerge in late March and April.
- Bog Turtles only feed during the day, but are inactive during the hottest and coldest parts of the day.

Photo courtesy of the Conserve Wildlife Foundation of New Jersey

Card 12: Eastern Tiger Salamander

- The Tiger Salamander is the largest land salamander in the world and a state endangered species in New Jersey.
- There are many subspecies of Tiger Salamanders in North America. Agricultural practices and urban development threaten populations and many states have put this salamander on their state endangered species list.
- It breeds in vernal (seasonal) ponds in January and February and then migrates upland in June to spend most of its life underground in burrows or underneath rocks.
- Salamanders can easily lose their tails to escape tenacious predators. Scientists choose to measure salamanders from their snouts to the beginning of the tail, which is called the “vent.”
- Tiger Salamanders cannot dig, so to avoid drying out (called desiccation), they try to stay under rotten logs or rocks and they also inhabit other animals’ abandoned underground dens.

Photo courtesy of the Associated Press

Card 13: Bald Eagle

- The Bald Eagle is a national endangered species. While conservation efforts have helped the national population to increase, the birds are still recovering from overhunting, the weakening of eggshells from exposure to pesticides, and the encroachment of development on breeding habitats.
- Eagles are territorial and choose nesting areas close to water that is rich with fish. Eagles will attack intruders (other predatory birds) by diving at them until they leave.
- Eagles usually are monogamous and enter into long-term relationships. However, if one partner dies, the other will usually find another mate. Eagle pairs stay together throughout the year.
- Female Eagles tend to lay 1-2 egg clutches. The parents split the incubation duty, sharing day and night shifts in the nest.
- The first-born nestling (baby eagle) dominates and competes with the second born nestling. If food is scarce that year, the second born may die due to starvation.
- The bald eagle can fly 20 - 40 mph in normal flight and can dive at speeds over 100 mph.
- The bald eagle is our national symbol. When it became threatened with extinction in the 1960s due to pesticide use, habitat loss, and other problems created by humans, people took notice. For years the bald eagle was listed as endangered under the Endangered Species Act. Now the number of bald eagles has increased so much that in June 1994 the U.S. Fish and Wildlife Service proposed that they be downgraded from endangered to the less urgent status of threatened in all but three of the lower 48 states. The success of the bald eagle is a tribute to the Endangered Species Act and is an incentive for increased awareness and conservation everywhere.

Photo courtesy of kidsworld.net

Card 14: Flying Squirrel

- There are 37 species of the Flying Squirrel, of which only one is found in North America. The North American Flying Squirrel is also the most thoroughly studied.
- Flying Squirrels are omnivores and their diets consist of nuts, seeds, fruits, lichen, fungi, bark, and insects. They have been known on occasion to eat birds' eggs and small birds. The North American species is known to be a heavy water drinker and usually locates near water.
- The North American Flying Squirrel does not hibernate. It will hoard nuts throughout the year to create a winter supply.
- During colder months, Flying Squirrels are known to rest in groups of two dozen to keep warm and to cooperate in hoarding food.

Photo courtesy of Yahoo! Kids

Card 15: Little Brown Bat

- The Little Brown Bat is the longest living mammal of that small size. It can live to about 32+ years.
- A single little brown bat can catch up to 1,200 insects in one hour.
- Bats have been known to adopt orphaned young bats.
- Plants important to humans, including bananas, breadfruit, mangoes, cashews, dates, and figs, depend on bats for pollination and seed dispersal in tropical habitats.
- Bats survive the highest and lowest temperatures of any American mammal. Red bats can hibernate at 23°F and Little Brown Bats can rear young at 122°F.
- A hibernating little brown bat can reduce its heart rate to just 20 beats per minute and can stop breathing for 48 minutes at a time.
- It is a common misconception that bats are blind although they do have poor eyesight. They rely on sonar - emitting sound waves, which hit objects and bounce back, to determine distance and location of objects, including their prey.

Photo courtesy of the National Wildlife Foundation

Card 16: Raccoon

- Raccoons are only found in North and Central America.
- The Raccoon is a medium-sized mammal with a black, mask-like pattern on its face and a long bushy tail ringed with dark and light stripes.
- Colonial explorer, Captain John Smith (of Pocahontas fame), named the creature after the Indian name Aroughcun, which means, “He scratches with his hands.”
- The scientific name for the most common North American raccoon is *Procyon lotor*. Lotor is Latin for “washer” and the raccoon has been observed by many to “wash” its food.
- An adult raccoon usually lives up to 6 years in the wild, but some may be as old as 13 years. Adults weigh about 20-25 pounds.
- Raccoons do not really hibernate but go into dormant periods during cold winter months.
- Raccoons can carry diseases, like rabies, that cats, dogs, and humans can contract. It is important to avoid physical contact with raccoons and discourage them from eating human garbage or pet food.
- Raccoons tend to create their dens near permanent water sources.
- When traveling from one spot to another looking for food, Raccoons tend to use fixed routes. Over time, these routes become narrow worn trails.
- Raccoons prefer to make dens in tree cavities. In urban and suburban areas, they may use chimneys.

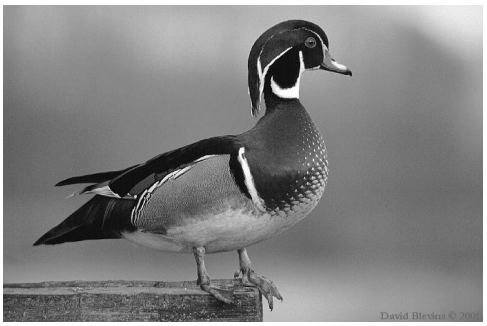


Photo courtesy of the University of British Columbia

Card 17: Wood Duck

- The Wood Duck is the only native "perching" duck in North America.
- The population of American wood ducks declined during European settlement as mature forests were cleared. Since the 1930s, conservationists and wildlife enthusiasts have encouraged the wood duck population to increase by providing nest boxes. Now, replanted forests are maturing, providing more hollow trees for nests.
- Some female ducks will "dump" their eggs in other ducks' nests (lay their eggs in a nest when the owner is away.) Researchers believe that this may be a strategy to ensure offspring survive. These ducks do not "have all of their eggs in one basket."
- The Wood Duck is considered to be "shy" compared to other ducks such as mallards. Therefore, sightings are more difficult.

Sources

Burton, Dr. Maurice and Robert Burton, editors. *The International Wildlife Encyclopedia: Vol. 5.* New York: Marshall Cavendish, 1969.

Caduto, Michael. *Pond and Brook: A Guide to Nature in Freshwater Environments*. Hanover: UP of New England, 1990.

State of Connecticut, Department of Environmental Protection, Wildlife Division, "Endangered and Threatened Species" Fact Sheet Series, http://dep.state.ct.us/burnatr/wildlife/learn.htm.

Stokes, Donald and Lillian. *Stokes Nature Guides: A Guide to Bird Behavior Volume III*. New York: Little, Brown and Company, 1989.

Stokes, Donald and Lillian. *Stokes Nature Guides: Animal Tracking and Behavior*. New York: Little, Brown and Company, 1986.

Tyning, Thomas F. *Stokes Nature Guides: A Guide to Amphibians and Reptiles*. Boston: Little, Brown, and Company, 1990.

Wernert, Susan. *Reader's Digest: North American Wildlife.* Pleasantville: Reader's Digest, 1982.

Appendix E. How Does Your Watershed Grow?

Comparing population sizes over time provides a sense of Camden County's growth. From this, students may better understand why waterways in the County are affected by pollution from stormwater runoff in developed areas.

Procedure:

1. Have students research the population trends in their hometowns, school district, or in the entire County. Students can find population figures from the year 2000 from the United States Census website: www.census.gov

2. Have students compare the year 2000 population to the year 1950 population (provided here).

3. Ask students:
   - Which towns grew in population? Which towns lost population?
   - How might the increase in population threaten a town's watershed? For example, Gloucester Township, located in the Big Timber Creek watershed, had a 1950 population of 7,700. In the year 2000, the Township's population was over 9 times larger with 64,350 residents.

4. To extend this activity into a project, have students research historic reasons why people moved out of cities and into new suburban communities.

City or Town	1950 Population
Audubon	9,500
Audubon Park	1,850
Barrington	2,550
Bellmawr	5,100
Berlin Boro	2,400
Berlin Township	2,000
Brooklawn	2,250
Camden City	124,500
Cherry Hill Township*	64,400
Chesilhurst	330
Clementon	3,170
Collingswood	15,700
Gibbsboro	900
Gloucester City	14,300
Gloucester Township	7,700
Haddonfield	10,500
Haddon Heights	7,500

City or Town	1950 Population
Haddon Township	12,600
Hi-Nella	240
Laurel Springs	1,540
Lawnside	1,290
Lindenwold	2,500
Magnolia	1,890
Merchantville	4,180
Mt. Ephraim	4,470
Oaklyn	3,880
Pennsauken Township	22,550
Pine Hill	2,550
Runnemede	4,100
Somerdale	1,450
Stratford	2,400
Voorhees	2,700
Waterford Township	3,990
Winslow Township	5,200
Woodlynne	2,760

* No 1950 population data available for Cherry Hill Township. 1970 was the first year such data was available. 1970 population is listed here.

Appendix F. Every Drop Counts

Every Drop Counts is adapted from various sources, including the "Every Drop Counts" activity in the *Project WET Curriculum and Activity Guide*. The "Water Meter Reader" activity is from the US EPA's educational outreach website (see Teacher Resources for more information). In this combined activity, students will learn the value of water conservation and groundwater purity. This is a three-part activity intended for more than one class session.

Students will:

- Determine how water conservation practices save water.
- Identify water conservation habits that individuals can change or adopt.
- Recognize that water conservation is important.

Materials:
Part 1: "Water Meter"

- Copies of "Water Meter Reader" student handout (provided)
- Copies of "Water Conservation Primer" student handout (provided)

Part 2: "Conservation Capers"

- Noisemaker (bell, buzzer, horn, whistle, etc.)
- Tape

Part 3: "Constructing a Water Flow Cup"

- Large paper cups (about 32 oz or 1 liter)
- Heavy tape
- Stop watches
- Pins
- Nails
- 1/16-inch diameter nail

Background:

Earth has a finite amount of fresh, usable water. Fortunately, water is naturally recycled (collected, cleansed, and redistributed) through the hydrologic cycle. Humans have developed the technology to speed this process. However, because of diverse factors (drought, flood, population growth, aquifer contamination, pollution, etc.) water supplies may not adequately meet a community's needs. Conservation of water can ensure that supplies of fresh water will be available for everyone, today and tomorrow.

Water conservation involves changing habits. Since many of these habits evolved over a lifetime, they can be difficult to alter. The simplest habits involve turning off water whenever it is not being used. For example, when water is needed for rinsing dishes, it can be held in a sink rather than allowing it to flow unused down the drain. Other conservation efforts may initially require more effort and funds, but in the long run will save money and resources. For example, households can install low-flow showerheads with smaller holes that reduce water flow and increase pressure. A capped bottle weighted with stones and placed in a toilet tank reduces the amount of water used for flushing.

Some regions of the United States and other parts of the world do not perceive a need to conserve because water is plentiful. However, using water efficiently has both environmental and economic benefits. Environmentally, conserving water helps ensure that ample water will be available and reduces the amount of wastewater that must be processed. Economically, water saved (or not wasted) is water that does not have to be purchased or pumped. Water conservation programs can help a municipality avoid or delay building or upgrading new drinking-water or wastewater treatment plants, potentially saving millions of dollars.

Procedure:

PART 1: "Water Meter Reader" (Intended for 1-2 weeks)

1. Ask students to keep track of the water they and their families use over a one-week period using the "Water Meter Reader" handout. Students can convert this handout into a chart, recording how many gallons of water they use. Ask students: Did you use water wisely? Did you ever waste water? During this week, did you use less water because you thought about water?

2. Discuss reasons water should not be wasted. Do students consider future water availability? How have the recent years of drought affected Camden County?

3. Using the "Water Conservation Primer" handout as a guide, ask students to identify three to five water conservation habits they can individually adopt. Ask them to write these down. For the next week, they can practice these habits and monitor their progress with a new "Water Meter Reader" journal. How did their choices reduce water? How much water did they save?

PART 2: "Conservation Caper"
This activity is more appropriate for younger students or as a quick exercise with older ones, to be done in the same class period as Part 3.

Objective: Students will understand how much water toilets use. Students will demonstrate the difference in amounts of water used by a toilet with a weighted water bottle in the tank (Toilet A) versus one with a full tank of water (Toilet B).

1. Divide the classroom into two sides – Toilet A (or Bathroom A) and Toilet B (or Bathroom B). Toilet A uses 3 gallons of water. Toilet B uses 5 gallons of water.

2. All students stand up in the back of the room. They will each represent one gallon of water. The back of the room is a source of water for the local community.

3. Ask two students to volunteer to be water meters (one for each side). They will count the number of students (gallons) that pass through the toilet. They can record their observations on the chalkboard in the front of the classroom.

4. Construct the activity into rounds. Each round is equivalent to the two toilets flushing. In each round, three students move to side A and five students move to side B "flushing" out the students who came before. As each round passes, the students at each "side" move to the front of the room, which represents a wastewater treatment plant. Continue the process until all students have moved to the front of the room.

5. Have students compare the number of gallons needed by each toilet. If a household was limited to a specified amount of water, which toilet would make that supply last longer? Which toilet would contribute a higher water bill? Which would produce less wastewater?

PART 3: "Constructing a Water Flow Cup"

1. Organize students into small groups.

2. Have students use a nail to punch five holes into the bottom of a large paper cup. Have students use a pin to punch five holes into a second cup. The location of the holes should be the same for each cup. Cover the holes of each cup with sturdy tape.

3. Have students fill the cup with the large holes with water.

4. Have one student remove the tape and another student, with a stopwatch, time how long it takes for the water to pour out of the cup. Instruct the students not to squeeze the cup. Repeat the procedure two more times; make sure the water level is the same for each trial. Calculate the average time.

5. Repeat the procedure for the second cup (timing the flow three times and calculating the average).

6. Compare the flow rates of the two cups.

7. Have students answer the following questions:

- What is the difference in the drainage times of the two cups?
- How do these streams of water from the cups compare?
- Would one cup make a better showerhead than the other?
- How could you use the flow restrictor data from this activity to help your family save water?

Water Conservation Primer

Turn Off Water:

- Turn off the water when it is not in use. Don't leave it running when brushing your teeth. Turn off the water between soaps and rinses while you are washing your hands.
- Limit shower time to 10 minutes or less. Take showers instead of baths or, when taking baths, limit the amount of water used.
- When washing dishes by hand, use a sink full of rinse water rather than letting the water run.

Water-Saving Devices:

- Dishwashers use less water than washing dishes by hand. Make sure to run a dishwasher with a FULL load.
- Run a washing machine only with a FULL load.
- Install a low-flow showerhead.
- Install a low-flow toilet.

Plan Ahead:

- Keep a bottle of cold drinking water in the refrigerator instead of running water until it becomes cold.
- Water lawns in the mornings or evenings when water will not evaporate as quickly. Make sure the water lands on vegetation and not on streets or sidewalks. If possible, save rainwater in barrels for watering lawns.
- If you need to run water before it becomes hot, store the cool running water in a bottle for future use. Unheated water can be used for rinsing dishes, and washing vegetables by hand.

Quick Fixes:

- Fill up a ½ gallon milk jug with water or a container with marbles and place in the toilet tank to reduce water use.
- Fix leaks!

Don't Abuse Water:

- Do not use the toilet as a trash can.
- Use a broom instead of a hose to clean sidewalks and driveways.
- When washing the car, use a hose with an on/off nozzle or use buckets of rinse water.

Name _____

Water Meter Reader

Directions: List how much water is used in your home. Indicate how many times each activity occurred for each of your family members and how much water was used. For example, if there are four people in your family, including yourself, and all four people take a shower some time during the day, write down "4" showers in the space provided. Compute a total for each day and then for the entire seven days.

Day 1 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Day 2 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Day 3 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Day 4 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Day 5 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Day 6 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Day 7 – Date _____

Shower (25 Gal)	X _____	Showers	= _____ gallons
Bath (35 Gal)	X _____	Baths	= _____ gallons
Dishwasher (15 Gal)	X _____	Loads	= _____ gallons
Wash dishes by hand (35 Gal)	X _____	Sink full	= _____ gallons
Laundry (20 Gal)	X _____	Loads	= _____ gallons
Brush Teeth (1 Gal of water runs)	X _____	Brushings	= _____ gallons
Toilet (4 Gal)	X _____	Flushes	= _____ gallons
Meals (8 Gal per day)			= 8 gallons
	Total gallons		= _____

Appendix G. Storm Drain Stenciling

Storm drains, or catch basins, are the square metal grates at the side of streets, usually next to or in the curb. They are designed to collect stormwater so streets and properties do not flood.

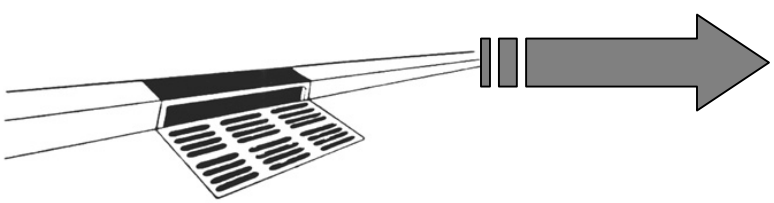
When it begins to rain, the first drops soak into the ground. But once the soil is saturated, or if the soil has been replaced by paving or a building, the rain runs along the surface until it comes to a storm drain.

Every storm drain is connected by a pipe to the nearest stream or lake.

Any debris or garbage from driveways, backyards, and streets that is picked up by the rainwater will go into the storm drains and then **into the stream or lake.**

Anything dumped into these storm drains, such as oil, paint, pool water, soapy water, or home, driveway, and lawn contaminants, **goes directly into streams and lakes**, too.

The principle cause of polluted water today is stormwater runoff.



Stencil storm drains with a "keep clean" message:

NO DUMPING DRAINS TO RIVER

The **Camden County Division of Environmental Affairs** makes available stenciling kits for interested community groups and school classes. The County will supply instructions, stencils, paint, informational door hangers, and all needed equipment **FREE OF CHARGE** to carry out storm drain stenciling.

To organize a stenciling project for your class or group, **contact**:

Maggi Liebe
Camden County Division of Environmental Affairs
856-833-1469.

Appendix H. Starting a Schoolyard Habitat

This activity is adapted from *"I'd like to start an outdoor classroom. Where do I begin?"* by Miriam Dunne of New Jersey's Division of Fish and Wildlife and was included in the *Teacher's Guide to the Great Swamp Watershed.*

Since each school is a unique community of learners and each schoolyard is a unique community of animals and plants, no one approach works for all. Here is a basic guide to get a schoolyard habitat started.

Tie the schoolyard habitat into appropriate curriculum:
Should you use the existing setting for environmental education? Or should you make physical improvements so that your curriculum and wildlife benefit? There are good arguments for either approach. It is less expensive to use the habitat "as is" (with no improvements or modifications), and perhaps, the site will be integrated with the curriculum as it slowly evolves. On the other hand, a developed outdoor classroom can be the focal point of and catalyst for new environmental education curriculum. Either way, be sure that the site and project ties into the curriculum and helps meet the state curriculum standards. Patti Howely, a Winfield teacher and facilitator for New Jersey Audubon Society's "Bridges to the Natural World," offers the following objectives for starting an outdoor classroom.

Start with observation:
1. Pick a site on the school grounds and get permission for it to go uncultivated (or remove the sod to deter the growth of invasive plant species).
2. Allow the plants in this area to grow freely. It should become a natural community of grasses and wildflowers.
3. Have your students use a KWL sheet (what we **know**, what we **want** to learn, and what we **learned**). Have them observe the site, write what they see and then fill in what they would like to know. They can compare what they observed in their first visit to what they observe in their subsequent visits.
4. Consistent observation is key. The plot should be examined as often as possible. Students can keep a journal or use photography to record changes. Keep a chart with recorded changes in the classroom to keep interest piqued.

Take a workshop:
The use and creation of an outdoor classroom should be viewed first and foremost as a learning experience. As a teacher, your education experience is also evolving. It is highly recommended that you begin by taking a "Bridges" (NJ Audubon Society), WILD (Project WILD), or PLT (Project Learning Tree) workshop. The Division of Fish and Wildlife also offers WILD School Sites workshops. These multi-hour workshops provide a wealth of resources, insights, and ideas on how to get started as well as introducing participants to a network of educators who can be called upon as projects progress.

Your site is unique:
Just as you and your students are individuals with strengths and limitations, your site has its own strengths and limitations. Work with your strengths. Don't expect to recreate a project at another school. There is no right way to undertake a schoolyard habitat project. Go for what seems to make sense with your faculty, administration, students, parents, and natural environment.

Developing your planning team:
If you take on a project by yourself, set up a solid framework in case you leave. Working with a team of teachers is strongly recommended to ensure the success of a schoolyard habitat. The support of the administration, custodial staff, parents, community members, and students is critical. Make the process democratic and inclusive; it may go in a direction you do not expect or anticipate.

Let your students do the research:
What plants attract butterflies? What are natural plants in your area? How does one build a pond? It is okay if you don't know. Let your students do the research. Their learning is more important than the actual habitat itself. Teams of students can design the project, write letters requesting donations, and make presentations to the School Board or other administrative or community groups. Empowering students from the outset will ensure the project is a success.

Enlist the help of specialists:
The New Jersey Coalition for Schoolyard Habitat is a corps of mentors founded by the Alliance for New Jersey Environmental Education. Experienced educators are available to provide advice on planting, design, curriculum connections, team building, and other aspects of the schoolyard habitat. They can help you take the initial steps -- attending a workshop; creating a team; and connecting to environmental education curriculum. To contact a mentor, call Liz Jackson at 908-637-4125.

The New Jersey Audubon Society also has naturalists on hand to help identify suitable sites for a schoolyard habitat. Naturalists can teach you and your students about which plants are appropriate for your area and which animals will be attracted to your new habitat. Visit the website http://www.njaudubon.org/education for services and contact information for their nine education centers in New Jersey.

Money isn't everything (but it sure does help):
Money to implement projects is always cited as a barrier to move forward. The USDA Natural Resources Conservation Service manages the Wildlife Habitat Incentive Program (WHIP) and offers $2,500 in matching funds for schoolyard habitats. To apply for a matching grant, a school or nature center must have at least one staff member participate in a WILD School Site workshop. For more information, contact Liz Jackson at 908-637-4125.

The Alliance for New Jersey Environmental Education (ANJEE) offers funding resources for teachers on its website: http://www.anjee.net/teachers/index.html.

Stay connected:
The New Jersey Coalition for Schoolyard Habitat is devoted to networking. Through the mentoring program, it is trying to build more links. Coalition events like workshops help to strengthen information channels. Other online organizations include: US Department of Agriculture's Backyard Conservation - www.ncrs.usda.gov; American Birding Association's Conservation tips - www.amercanbirding.org; National Wildlife Federation's Backyard Wildlife Habitat Program - www.nwf.org/backyardwildlifehabitat; and National Gardening's planting advice - www.garden.org.

For more information about any of these schoolyard habitat resources, contact:

Liz Jackson, Public Information Assistance
NJ DEP Division of Fish and Wildlife
Project WILD/WILD School Site Coordinator
Pequest Trout Hatchery
605 Pequest Road
Oxford, NJ 07863
908-637-4125

Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty and intercity agency that provides continuing, comprehensive and coordinated planning to shape a vision for the future growth of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties, as well as the City of Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester and Mercer counties in New Jersey. DVRPC provides technical assistance and services; conducts high priority studies that respond to the requests and demands of member state and local governments; fosters cooperation among various constituents to forge a consensus on diverse regional issues; determines and meets the needs of the private sector; and practices public outreach efforts to promote two-way communication and public awareness of regional issues and the Commission.

Our logo is adapted from the official DVRPC seal, and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole, while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey department of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for its findings and conclusions, which may not represent the official views or policies of the funding agencies.

Title of Publication: **A Teacher's Guide to the Watersheds of Camden County**

Publication No.: 03023

Date Published: July, 2003

Geographic Area Covered: Camden County

Key Words: environmental education, water cycle, watershed, drinking water, aquifer, pollution, non–point source pollution, stormwater, water conservation.

Abstract

This publication explores the local watershed environment in Camden County, New Jersey. With teachers of upper elementary and middle schools as the primary audience, it presents educational information on the water cycle, the specific watersheds in the county, the county's natural and human histories, groundwater and surface water, drinking water quantity, water quality, pollution and other threats to water, and water conservation. It includes extensive resource information for teachers, and an Appendix with lessons and classroom activities that fulfill the State of New Jersey Science Standards. This publication's objectives are to motivate and enhance classroom instruction and to instill local knowledge and understanding by the public, in order to increase stewardship of Camden County's water resources.

Delaware Valley Regional Planning Commission
The Bourse Building – 8th Floor
111 South Independence Mall East
Philadelphia, PA 19106-2582
Phone: 215-592-1800
Fax: 215-592-9125
Internet: www.dvrpc.org

Staff Contact: Suzanne McCarthy, Senior Regional Planner
Direct Phone: 215-238–2934
Email: smccarthy@dvrpc.org