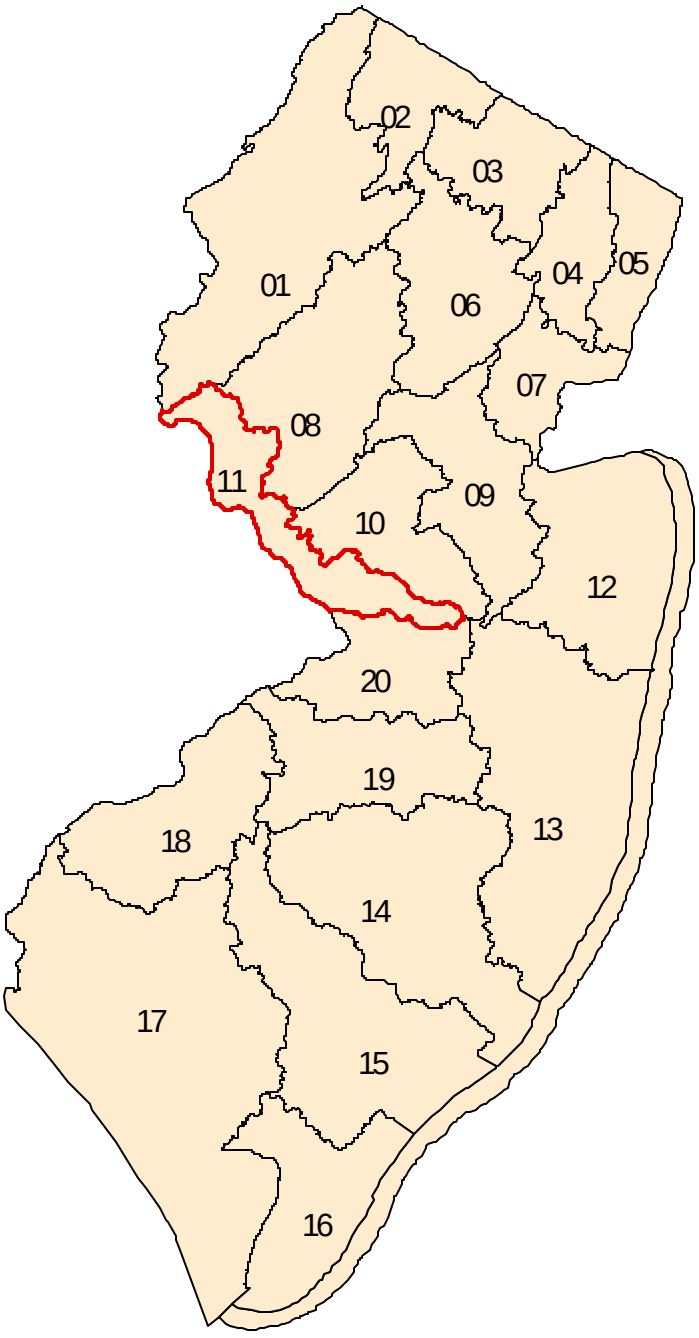
# Settings Report for the Central Delaware Tributaries Watershed Management Area 11




**Prepared by: The Regional Planning Partnership**
**Prepared for: NJDEP**
**October 15, 2001**

**TABLE OF CONTENTS**

## TABLE OF CONTENTS

## TABLE OF CONTENTS

## TABLE OF CONTENTS

## List of Figures

## List of Tables

## Acknowledgements

### Sources of Data

This Settings Report was developed from a wide range of best available current data sources. Much of the data was obtained from geographic information systems (GIS) digital information from the New Jersey Department of Environmental Protection. Data were also obtained from the New Jersey Department of Labor, Delaware River Basin Commission (DRBC) and county and municipal sources. United States Geological Survey (USGS) provided studies on subwatersheds within the study area. The Settings Report also uses data from the USGS STORET database and United States Department of Agriculture databases.

### Project Management

Project Manager: Ann Brady
The Regional Planning Partnership
870 Mapleton Rd.
Princeton, N.J. 08540 (609) 452-1717

Principal Authors: Noelle Reeve
Senior Project Planner
Regional Planning Partnership

Brian Carson
Project Specialist
Regional Planning Partnership

The Regional Planning Partnership is a non-profit organization dedicated to sound land use planning and regional cooperation.

### Characterization and Assessment Committee

The Regional Planning Partnership would like to acknowledge the contributions made to this Draft Settings Report by the members of the Central Delaware Tributaries Characterization and Assessment Committee:

Ms. C. Altomari, Lawrence Environmental Commission; Mr. T. Baxter, New Jersey Water Supply Authority; Ms. T. Carluccio, Delaware River Keeper Network and East Amwell Environmental Commission; Mr. G. Grunstein, NJ Farm Bureau; Mr. J. Haimowitz, Lambertville Sewer Authority; Mr. H. Kasabach, Hamilton Environmental Commission; Mr. R. Kertes, Omni Environmental; Mr. L. Miller, DRBC; Mr. H. Nebling, NJDEP; Mr. R. Nichols, Hopewell Environmental

Commission; Mr. E. Wengryn, New Jersey Farm Bureau; Ms. P. V'Combe, DRBC and Ewing Environmental Commission.

**Web Site**

This report is also available on the project web site www.delawaretribs.org.

## 1.0 INTRODUCTION

The *Settings Report for the Central Delaware Tributaries Watershed Management Area 11* was prepared for the New Jersey Department of Environmental Protection's (NJDEP) Division of Watershed Management, Northwest Bureau.

The report uses data form NJDEP, NJ Department of Labor, Delaware River Basin Commission unpublished data, USGS STORET database and published reports, US Department of Agriculture databases, as well as county, and municipal data. The report is intended to provide an overview of the physical, socioeconomic, and institutional conditions in the Central Delaware Tributaries Watershed Management Area. A Characterization and Assessment Report (to be produced by NJDEP) will examine these conditions in more detail to provide information necessary for the development of a watershed plan for the Central Delaware Tributaries.

## 2.0 IMPORTANCE OF WATERSHED PLANNING

Clean and adequate supplies of water are essential for ecologic health as well as economic health and, therefore, provide the basis for healthy, vibrant, livable communities.

Aquatic systems, however, extend beyond the water's edge. Certain lands within a watershed are critical for the healthy functioning of streams, rivers, and groundwater. These lands need to be identified and protected to optimize the cost-free or low cost benefits these critical areas provide by:

- keeping water clean through filtration;
- providing flood protection, and
- ensuring adequate supplies of water through recharge.

Other lands, less critical for the healthy functioning of streams, rivers and groundwater within a watershed, need to be identified as appropriate areas for development.

Protection of water quality and supply through wise land use decisions, best management practices, and public involvement is what watershed planning is all about.

## 3.0 SIGNIFICANCE OF THE CENTRAL DELAWARE TRIBUTARIES WATERSHED MANAGEMENT AREA

The significance of the Central Delaware Tributaries Watershed Management Area can be highlighted by three categories: environment, economy and transportation.

The streams of the Central Delaware Tributaries contribute to the health of the Delaware River. The section of the Delaware River receiving flow from the Central Delaware Tributaries has been recognized as having outstanding value through federal designation as a Wild and Scenic River. The Central Delaware Tributaries Watershed Management Area also contains the best example of a red shale community in the state, the Hunterdon Milford Bluff; the last contiguous forest in Central Jersey, the Sourland Mountain; a major wetland preserve, the Assunpink Wildlife Management Area, and also contains prime trout fishing habitat in the Musconetcong Mountains.

Two of the streams of the Central Delaware Tributaries contribute directly to the D&R Canal - the source of drinking water for over one million people in Central New Jersey. One stream supplies the drinking water for Lambertville. All the other tributaries drain into the Delaware River which is the drinking supply for Trenton, parts of Ewing and Hamilton, and Burlington County in New Jersey and Philadelphia and Morristown in Pennsylvania.

The Central Delaware Tributaries Watershed Management Area is rich in historical mill towns, is the Cross Roads of the Revolutionary War, and contains the state capital. The largest land use in the watershed management area is agricultural land (at 30.3% of the total land base). Employment, however, is found largely in the service industry (which includes retail, professional and other services) and provides jobs for over 70% of the workforce.

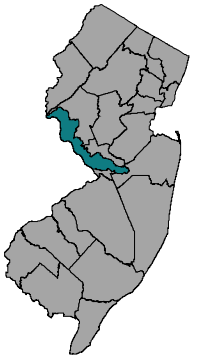
Major transportation corridors are found in the southern part of the Central Delaware Tributaries including Route 1, I-95, and 295 and the Northeast Corridor Rail Line.

## 4.0 PHYSICAL AND ECOLOGICAL CHARACTERISTICS OF THE CENTRAL DELAWARE TRIBUTARIES

### 4.1 Location

Running in a narrow band (2.5 – 11 miles wide) along the Delaware River for 41 miles, the Central Delaware Tributaries stretches from Holland Township in northern Hunterdon County through western Mercer County to Millstone Township in southwestern Monmouth County. The 272 square mile planning area covers all or part of 24 municipalities including Trenton, Roosevelt, Hamilton, Lawrence, Lambertville, Frenchtown and Milford (see Figure 1).

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01

## Municipalities & Counties in WMA 11

WMA 11

Municipalities

1 ALEXANDRIA TWP
10 WEST AMWELL TWP
11 HOPEWELL TWP
12 STOCKTON BORO
13 LAMBERTVILLE CITY
14 LAWRENCE TWP
15 WEST WINDSOR TWP
16 PENNINGTON BORO
17 EAST WINDSOR TWP
18 EWING TWP
19 MILLSTONE TWP
2 HOLLAND TWP
20 HAMILTON TWP
21 WASHINGTON TWP
22 TRENTON CITY
23 ROOSEVELT BORO
24 UPPER FREEHOLD TWP
3 FRANKLIN TWP
4 RARITAN TWP
5 MILFORD BORO
6 KINGWOOD TWP
7 FRENCHTOWN BORO
8 DELAWARE TWP
9 EAST AMWELL TWP

Counties

HUNTERDON
MERCER
MONMOUTH
WARREN

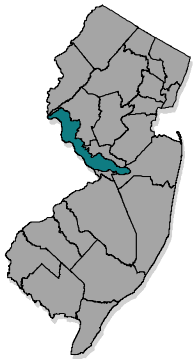
Source:
NJDEP

N

0 4 8 Miles

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01

Hakihokake Creek

Nishisakawick Creek

Harihokake Creek

Lockatong Creek

Wickecheoke Creek

Alexauken Creek

Moore Creek

Delaware River

Shipetaukin Creek

Jacobs Creek

Assunpink Creek

Miry Run

Pond Run

## Subwatersheds & Streams

- Rivers
- Lakes
- WMA 11

Subwatersheds

- Alexauken Cr/Moore Cr/Jacobs Cr
- Assunpink Creek (above Shipetaukin Ck)
- Assunpink Creek (below Shipetaukin Ck)
- Hakihokake/Harihokake/Nishisakawick Ck
- Lockatong Creek/Wickecheoke Creek

Source:
NJDEP



N

0 4 8 Miles

The Central Delaware Tributaries includes five watersheds (Figure 2) that drain into the Delaware River or Delaware and Raritan Canal. The watersheds vary greatly in character. In the north, streams slowly drop 700 feet from the Musconetcong Mountains through forests and over red shale down to join the Delaware River. In the adjacent sub-watershed streams drop more precipitously 500 feet through forests and cut through blue grey argillite on their way to the Delaware River. The sub-watersheds to the south become increasingly flatter and more populated with agricultural land giving way to suburban development and finally to the urban environment of Trenton. The two Assunpink Creek watersheds reflect this changing land use. The Assunpink Creek has its headwaters in the forests of Roosevelt Boro and meanders through the Assunpink Wildlife Management Area and farmland until the Shipetaukin Creek joins it. The Assunpink Creek watershed below Shipetaukin Creek flows through increasingly suburbanized land until it reaches Trenton where it is channeled with concrete sides.

## 4.2 Physiography and Soils

Bedrock geology and soil types are important factors in watershed planning as they determine groundwater yields and recharge capabilities.

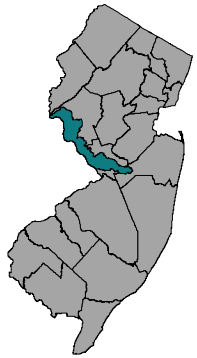
The Central Delaware Tributaries is almost entirely located within the Piedmont Physiographic Province (dominated by shale and sandstone) with the exception of: i) the most northern section which is located in the Highlands Region (comprised of gneiss and granite) and ii) the southern and eastern parts of the watershed which are located in the Inner Coastal Plain (composed of gravel, sand, silt and clay). Land elevations in the south are fairly flat beginning near sea level in Trenton within the Assunpink River Watershed and developing into rolling hills of 300 to 400 feet in the center of the watershed management area. Elevations rise to over 800 feet in the Musconetcong Mountains along the northern boundary of the watershed management area within the Hakihokake and Harihokake and Nishisakawick watersheds. (Slopes greater than 15% are shown in Figure 3.)

The Highlands portion of the watershed (the Musconetcong Mountains) contains the oldest rocks in New Jersey, formed 1.1 billion and 750 million years ago. These precambrian rocks are generally considered to be unproductive aquifers. Lakehurst-Lakewood-Atsion and Washington-Wassaic-Bartley soils are found in the upper reaches of the creeks. Penn-Reaville-Klinesville soils formed from red shale rock (but with more sand than is common in the Piedmont Plain) are found in the middle reaches. Rowland-Pope-Birdsboro make up the soils of the Delaware Bluffs found in the floodplain.

The Piedmont portion of the Central Delaware Tributaries can be separated into the Hunterdon Plateau and the Piedmont Plain. The Hunterdon Plateau is a high

# Central Delaware Tributaries

## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01

N

0 3 6 Miles

**Slopes Equal To Or Greater than 15%**

- Streams
- Rivers
- Lakes
- WMA 11

Slope

- 0 - 15
- => 15 %

Source:
NJDEP/USGS

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

plateau of slight relief with soils formed from hard argillite (commonly called “blue jingle”) and shale. The Lockatong bedrock formation underlying the Plateau is one of the lowest yielding aquifers in New Jersey. Drainage through the Quakertown-Chalfont-Lehigh soils found here is generally poor.

The Piedmont Plain comprises gently rolling hills whose soils, made up of sandstone, siltstone, conglomerate and shale, commonly have a distinctive reddish-brown color. These Penn-Bucks-Rowland soils make up the most frequently occurring class of soils in the Central Delaware Tributaries. Excessive surface drainage, flooding and siltation are common in this region. Small wetlands occur frequently but groundwater supplies are limited. The Stockton sandstone formation which runs through the center of the Wickecheoke watershed is highly erodible.

Diabase rock (which is harder than the enclosing sandstone and shale) forms the “trap rock” ridges in the Piedmont Plain. Neshaminy-Mt. Lucas-Lawrenceville soils on these ridges are well-drained.

The Inner Coastal Plain (around Trenton and the southeastern part of the Central Delaware Tributaries) is a flat, low-lying area made up of unconsolidated sediments. Well drained Downer-Evesboro-Klej soils are found along the Delaware River north of Trenton, Freehold-Collington-Adelphia soils are found around Trenton, while well drained Downer-Sassafras-Hammonton soils are found in the southeastern part of the Central Delaware Tributaries.

### 4.3 Surface Water Hydrology

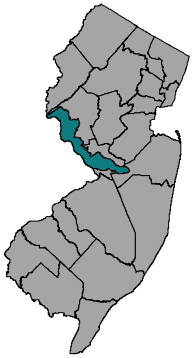
The Central Delaware Tributaries includes the following watersheds:

| Watershed | Drainage (sq. mi.) | |
|---|---|---|
| Hakihokake/Harihokake/Nishisakawick Creeks | 63 | |
| Lockatong Creek/Wickecheoke Creeks | 55 | |
| Alexauken Creek/Moores Creek/Jacobs Creeks | | 63 |
| Assunpink Creek (above Shipetaukin Ck) | 48 | |
| Assunpink Creek (below Shipetaukin Ck) | 45 | |

(see Figure 1.1-2).

Thirty nine dams are located in the Watershed Management Area (see Figure 4) with only the Lockatong, Wickecheoke and Moores creeks remaining undammed. Twelve artificial lakes located in the southern part of the Central Delaware Tributaries are created by dams. One named natural lake is found in the watershed management area – Camp Marudy Lake – on the Harihokake Creek. The Delaware and Raritan Canal begins in the Lockatong/Wickecheoke

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 3/02




**Lakes & Dams**

- Dams
- Lakes
- Streams
- Rivers
- WMA 11

Source:
NJDEP

watershed and flows through watersheds in the south of the Central Delaware Tributaries.

Forty six permitted dischargers operate in the Watershed Management Area (with a total of 54 permits). Two hundred and twenty four known contaminated sites (18 superfund sites) are found in the Central Delaware Tributaries. (More information on these impacts is provided in Section 5.)

### 4.3.1 Hakihokake/Harihokake/Nishisakawick Creeks

The Hakihokake Creek is approximately 6.25 miles long. The creek's headwaters begin at 820 ft. in the Musconetcong Mountains in forested wetlands in Holland and Alexandria Townships and run southwest through Sweet Hollow and Little York gently dropping 710 feet to the Delaware River at Milford Boro (110 ft above sea level).

The Harihokake is approximately 7.5 miles long. Its headwaters begin at 740 ft from springs in the Musconetcong Mountains in Alexandria Township. On its way south it passes through Mt. Pleasant slowly dropping 630 feet to the Delaware River.

The Nishisakawick is approximately 7.5 miles long. Its headwaters begin at 720 ft in forested wetlands in Alexandria Township and it flows through Camp Marudy Lake, past Camp Marudy, and through Everittstown on its way southwest past farms and developed land slowly dropping 610 feet to the Delaware River at Frenchtown Boro.

The Little Nishisakawick springs from wetlands in Kingwood Township at 480 ft and flows approximately 4 miles southwest through mostly agricultural land gently dropping 370 feet to the Delaware River.

Copper Creek is approximately 3.5 miles long and rises at 480 ft from wetlands and a lake near Baptistown in Kingwood Township. It flows southwest to enter the Delaware River.

Warford Creek is 2.5 miles long and rises at 460 ft near Barbertown in Kingwood Township. It travels southwest to the Delaware River opposite Treasure Island.

There is one named lake – Camp Marudy Lake – naturally occurring.

There are 11 permitted discharges to surface water in the watershed (discussed in more detail in Section 5).

### 4.3.2 Lockatong/Wickecheoke Watershed

The Lockatong Creek is thirteen miles long and rises from springs and wetlands near Quakertown in Franklin Township. It flows south through farms and woodlands in Franklin, Kingwood and Delaware Townships falling 500 feet in elevation before emptying into the D&R Canal (and Delaware River). It drains a 27.8 sq. mi. watershed including almost 50% of Kingwood Township.

The Wickecheoke is 14 miles long and rises from wetlands in Franklin and Raritan Townships, flowing south through Delaware and Kingwood Townships to the D&R Canal and Delaware River at Prallsville Mill in Stockton. The Wickecheoke drains a 26.57 sq. mi. watershed.

The 22 mile long Delaware and Raritan feeder Canal begins its intake from the Delaware River opposite Bulls Island at Raven Rock (six miles north of Lambertville) and joins the main canal at Trenton. From Trenton it travels east seven miles before leaving the Central Delaware Tributaries and entering the Millstone River watershed management area (WMA 10) on its way to the Raritan River.

The Wickecheoke has one discharger and the Lockatong has no dischargers (see section 5).

### 4.3.3 Alexauken/Moores/Jacobs Watershed

The Alexauken is approximately five miles long and runs southwest through forest and farmland from its headwaters at 220 ft in West Amwell, through a small lake in East Amwell, providing the border between Delaware and West Amwell Townships. It parallels the Black River and Western Railroad until it enters the Delaware above Lambertville at Holcombe Island.

Swan Creek is approximately one mile long from its reservoirs to Lambertville where it crosses under Route 29 before entering the Delaware River.

Moores Creek is approximately 5.25 miles long rising from a lake southwest of Coopers Corners in Hopewell. It runs through West Amwell Township through forest and agricultural land back into Hopewell Township to drain into the Delaware River.

Fiddlers Creek is separated from Moores Creek by Strawberry Hill and Baldpate Mountain (475 ft). It rises south of Ackers Corners at 220 ft and empties into the D&R Canal just north of Titusville (at 40 ft above sea level).

Jacobs Creek also has its headwaters in Hopewell and Pennington and flows west of Pennington Mountain 7.5 miles through forest, agricultural and developed land into Somerset where it enters the Delaware River.

Woolsey Brook rises in Pennington and after flowing southwest joins Jacobs Creek just north of Somerset.

Airport Brook begins north of exit 3 on I-95 and runs three miles west passing Mercer County Airport to join Jacobs Creek north of Somerset.

Gold Run begins at a small lake in Ewing and runs two miles southwest passing the State School for the Deaf and enters the Delaware River south of Lower Ferry Road.

Seven dischargers are located in the watershed (details in section 5).

### 4.3.4 Assunpink Creek Above Shipetaukin Creek

The Assunpink Creek above the Shipetaukin rises in forested wetlands in Roosevelt and Millstone Townships. It is joined by the New Sharon Branch as it travels northwest through Washington, West Windsor, and Lawrence Townships where the Shipetaukin Creek joins it. As it travels farther northwest away from the wetlands of the Assunpink Wildlife Management Area, past Central Mercer County Park, and Bear Swamp to Whitehead Mill Pond the landscape becomes increasingly urbanized.

The New Sharon Branch rises at 110 ft from a small lake in Upper Freehold and runs 5 miles northwest through New Sharon to wetlands around Carsons Mills where it joins the Assunpink.

The Shipetaukin Creek rises at 210 ft in Hopewell near Van Kirk Road and runs five and one half miles southeast before joining the Assunpink Creek at Whitehead Mills Pond.

Bridegroom Run starts in West Windsor near Edinburg and runs two miles west before it joins the Assunpink Creek in Central Mercer County Park.

The two largest lakes in the Central Delaware Tributaries are found in this watershed: the 227 acre Assunpink Lake and a 270 acre unnamed lake (both created by dams).

Three dischargers are located in this watershed (see section 5).

### 4.3.5 Assunpink Creek Below Shipetaukin Creek

Miry Run (rising from wetlands in Washington Township) and the West Branch of the Shabakunk Creek (Ewing), the Shabakunk Creek (Hopewell), and the Little Shabakunk Creek (Lawrence) contribute to the Assunpink Creek as it flows southwest through Lawrence Township and Trenton to the Delaware River. In

total the Assunpink Creek is about 25 miles long. This part of the Central Delaware Tributaries is highly urbanized with the Assunpink channeled with concrete sides for flood control purposes.

The Little Shabakunk Creek begins in Lawrence Township near Bunkerhill Road and travels east 3.5 miles before entering the Assunpink Creek north of East Trenton Heights.

The Shabakunk Creek begins near Twin Pine Airport in Hopewell and travels 7.5 miles in total through Ewing Township (picking up flow from the two artificial lakes Ceva Lake and Sylvia Lake) before entering Lawrence Township and flowing through Colonial Lake (another artificial lake) on its way to join the Assunpink Creek at Whitehead Mills Pond.

The West Branch of the Shabakunk Creek begins north of Rambling Creek Park in Ewing Township then travels for five miles south then east into Lawrence Township where it joins the Shabakunk Creek west of Route 206.

Pond Run starts in Hamilton Square and runs four miles west through Veterans County Park, Bromley Park and rail yards before joining the Assunpink Creek just north of Olden Avenue.

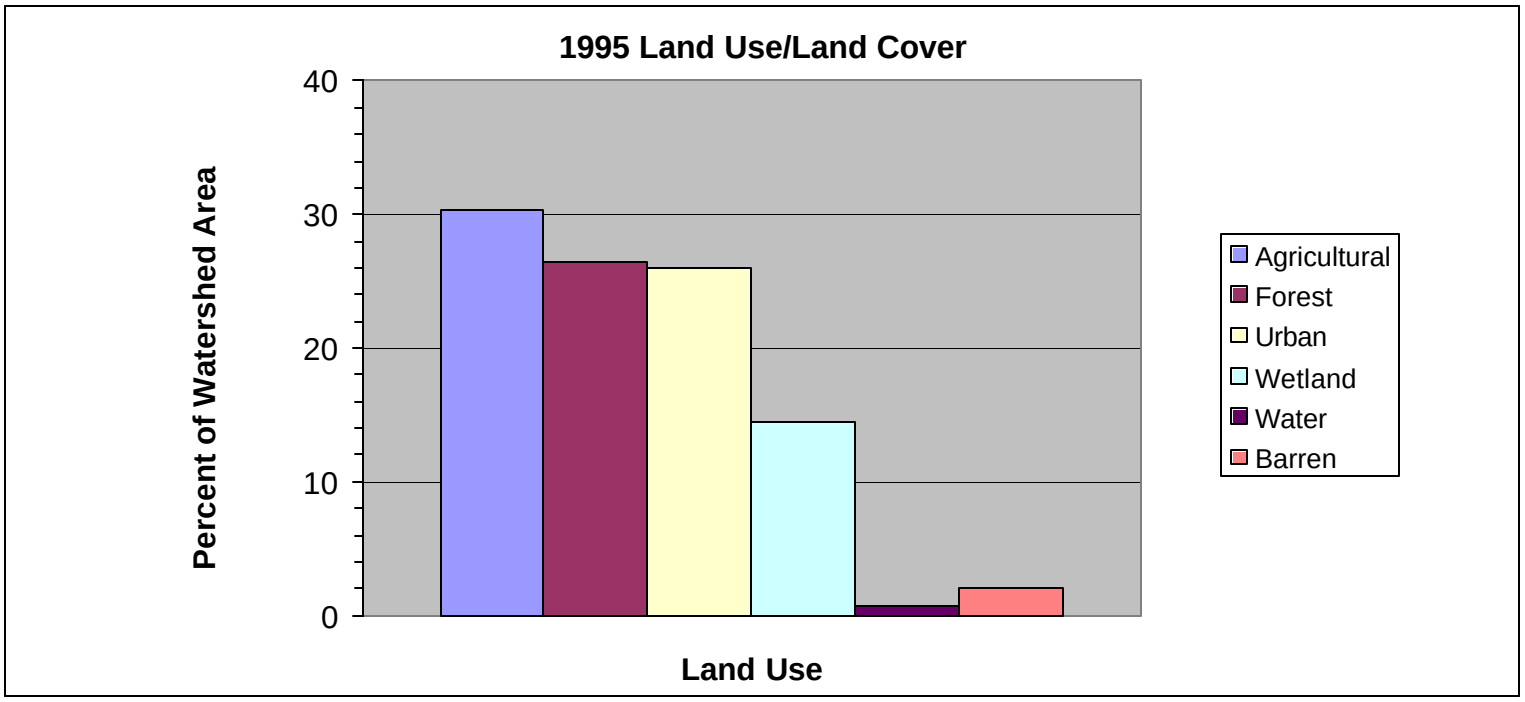
Miry Run rises in Washington Township north of the Trenton Robbinsville airport and runs 7.5 miles northwest through wetlands north of Hamilton Square to join the Assunpink Creek just east of Whitehead Rd. at Whitehead Mills Pond.

Over half of the total dischargers in the Central Delaware Tributaries are located in this watershed (see section 5 for details).

## 4.4 Land Use/Land Cover

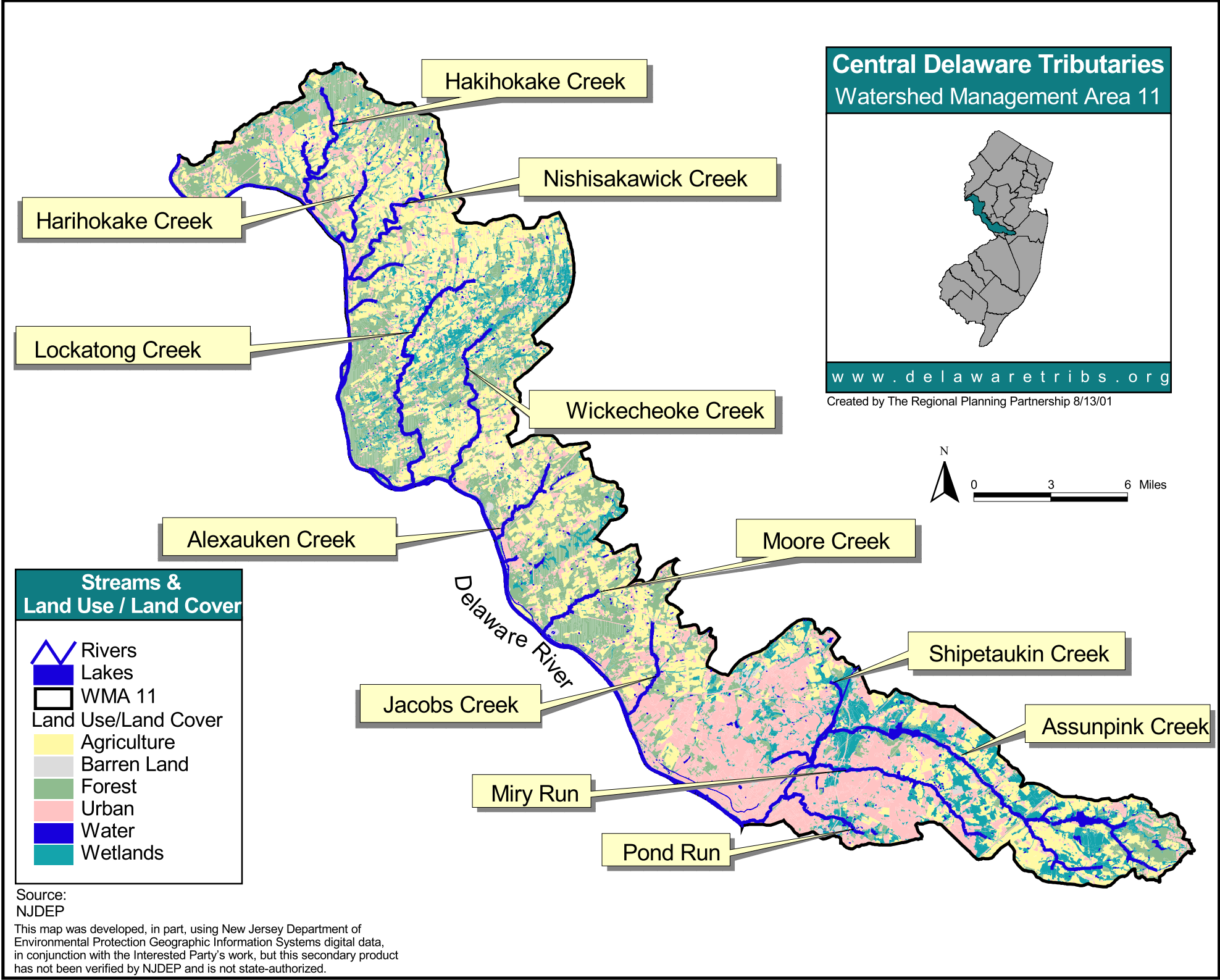
Land use in the Central Delaware Tributaries is almost evenly split among the top three categories – agricultural, forest, and urban land. Specifically, the primary land use classifications in the Central Delaware Tributaries include: 30.3% agricultural; 26.9% forested; 26% urban or built land; 14.4% wetlands; .6% barren lands and 2% water (see Table 1). Land use and land coverages for the Central Delaware Tributaries are shown in Figure 5. Between 1987 and 1995 urban land increased by 14.7% (5,796 acres ) moving the total amount of urban land up from less than one quarter of the watershed management area (22%) to over one quarter of the watershed management area (26%). The increase in urban land came principally from agricultural land.

**TABLE 1 1995 LAND USE/LAND COVER**




### 4.4.1 Agricultural Land

In his *Soils of New Jersey*, Tedrow (1986) emphasizes the importance of New Jersey agriculture, "New Jersey occupies a unique position in US food production in that most of its agricultural land is within 50 miles of the great centers of population – New York and Philadelphia". Agricultural land also provides open space, scenic, historic and economic benefits to an area as well as producing fresh food valued by local consumers at farmers stands and markets. Finally, the wooded edges of farm fields are a rich transition habitat (ecotone) which support many species of songbirds and wildlife (Roy Mann Associates, Inc., 1998).


Central Delaware Tributaries
Watershed Management Area 11
www.delawaretribs.org
Created by The Regional Planning Partnership 8/13/01
Hakihokake Creek
Nishisakawick Creek
Harihokake Creek
Lockatong Creek
Wickecheoke Creek
Alexauken Creek
Moore Creek
Delaware River
Shipetaukin Creek
Jacobs Creek
Assunpink Creek
Miry Run
Pond Run
N
0
3
6 Miles
Streams &
Land Use / Land Cover
Rivers
Lakes
WMA 11
Land Use/Land Cover
Agriculture
Barren Land
Forest
Urban
Water
Wetlands
Source:
NJDEP
This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

Agriculture is the largest land use in the Central Delaware Tributaries at 30.3%. Agricultural land is spread throughout the Central Delaware Tributaries with the exception of the suburban townships close to Trenton and Trenton itself. Hunterdon County maintains the largest number of farms and second highest amount of farmland assessed property statewide (roughly 57% of the land base is farm-qualified under New Jersey's Farmland Assessment Act (Hunterdon County Planning Board, 2000).

The state of New Jersey, however, has lost 52% of its farmland since 1950 (usda.gov/index.html). Between 1987 – 1995 the state lost 6.9% of its agricultural land (NJWSA, 2000). In comparison, the Central Delaware Tributaries lost 11.4% (6,7961 acres) of its agricultural land between 1987 and 1995, largely to urban land development. Agricultural land in the Central Delaware Tributaries, therefore, dropped from occupying over one-third of the total land (33.7%) to occupying less than one-third of the total land (30.3%) (see Table 2).

While the loss of agricultural land has important socioeconomic ramifications, it is important to recognize that agricultural practices may be of concern to water quality. Agricultural practices can degrade water quality because of the potential for non-point source pollution from erosion, fertilizers and pesticides.

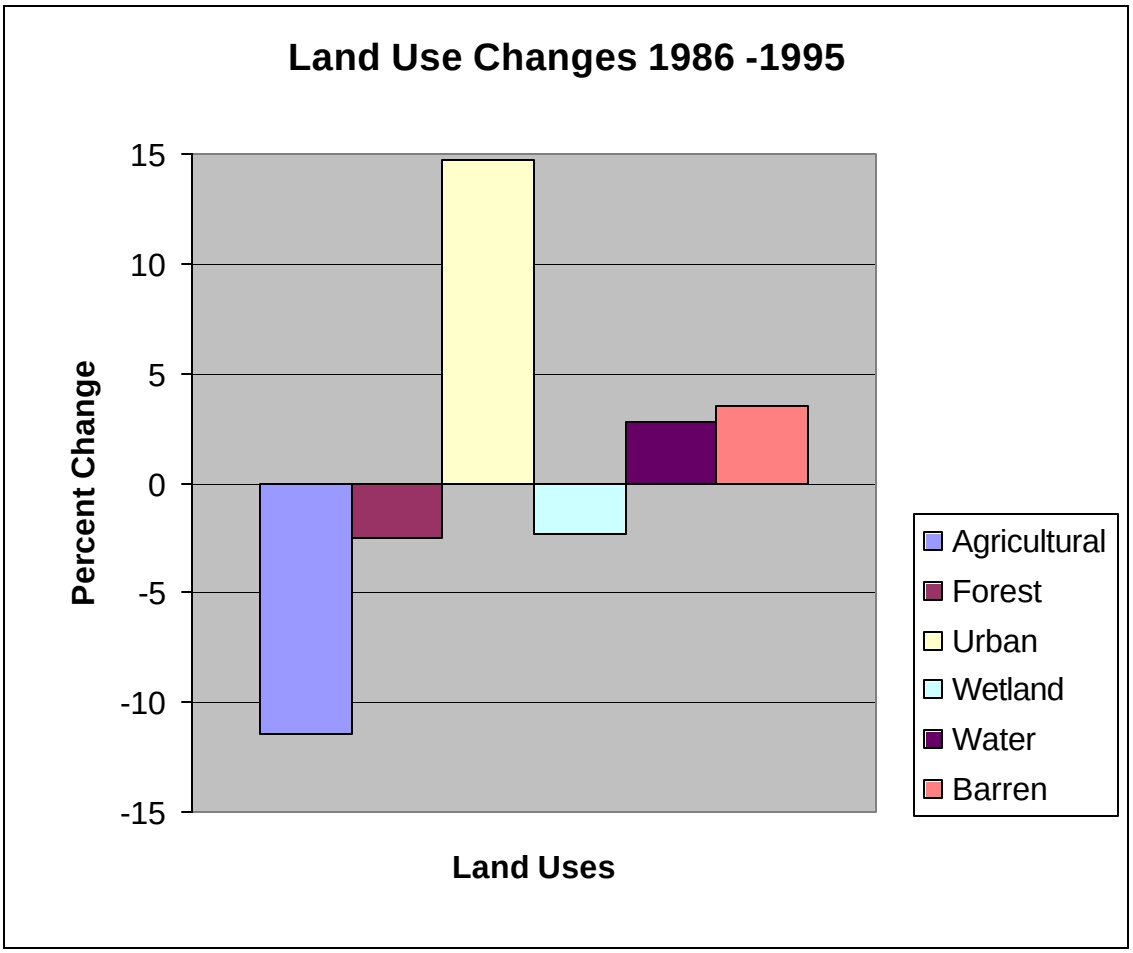



**TABLE 2 LAND USE CHANGES 1986-1995**

### 4.4.2 Forest Land

Forest land is important for watershed planning because it benefits water quality by: providing shade cover for streams (producing cool temperatures and higher dissolved oxygen levels); prevents erosion; and provides opportunities for recharge (Schueler, 1993). Forest cover also benefits air quality, and provides wildlife habitat, and recreational opportunities.

Forest land is the second largest land use in the Central Delaware Tributaries at 26.4%. Less change occurred in forest land than in agricultural land between 1987 and 1995 – 2.5% forest land was lost . Contiguous forest land occurs in areas north of Fiddlers Creek (which is itself located in the Alexauken/Moores/Jacobs Creek watershed).

The watersheds north of the Assunpink Creek are classified as Mixed Oak Forest, Northern Phase (Collins and Anderson, 1994). Typical plant species

include White Oak, Red Oak, and Black Oak. On drier slopes Chestnut and Oak may be found. In moist valleys and ravines Hemlock and mixed hardwoods are present. More fertile areas support Sugar Maple and mixed hardwoods. The two Assunpink watersheds are classified as Mixed Oak Forest, Coastal Plain Phase and typically contain White Oak and Black Oak. On more moist sites Beech and Oak may be found.

### 4.4.3 Urban and Built Lands

Studies have shown that when impervious land (roads, rooftops, graded soils for lawns) increases to 10% of a watershed water quality begins to degrade (EPA, 1994, Scheuler, 1994). Development in stream corridors is of particular concern, especially in headwaters, as it contributes to water quality degradation through: i) pollutants in stormwater runoff; ii) changes in temperature due to vegetation removal; and iii) changes in flow due to reduced recharge coupled with higher peak flows (which leads to scouring) (Arnold, 1996).

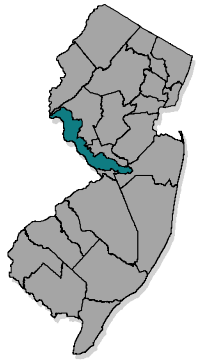
Built lands represent the third largest land use in the Central Delaware Tributaries (26%). Built lands are concentrated in the south of the Central Delaware Tributaries in townships around Trenton and in scattered centers along the Delaware (e.g., Lambertville, Stockton, Frenchtown, Milford Boros). Impervious cover in Trenton is 100% in some areas while impervious cover between 6 – 15% is scattered throughout the Central Delaware Tributaries (see figure 6).

Built lands increased by 14.7% (5,796 acres) between 1986 and 1995. The largest amount of new development occurred where it would be expected – in the suburbs east of Trenton (in the Assunpink Watershed above the Shipetaukin Creek). However, surprisingly, the second fastest growing area was located in the northern watershed with the only trout production streams of the Central Delaware Tributaries – the Hakihokake, Harihokake, Nishisakawick (see Figure 7).

### 4.4.4 Wetlands

“Wetlands are among the most productive ecosystems in the world and some types may be the highest, rivaling our best cornfields” (Tiner, 1985). Wetlands form the base of a food web that supports higher consumers – fish and animals. Wetlands can be regarded as the farmlands of the aquatic environment. In New Jersey, 64% of rare plant species are found in wetlands and endangered snakes, salamanders and turtles depend on wetlands also. Many fish, birds and animals use wetlands as reproductive and nursery grounds. Wetlands are particularly important as feeding grounds for migratory birds.

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01

N

0 3 6 Miles

**Imperviousness**

- Rivers
- WMA 11

Imperviousness (%)

- 0 - 10
- 11 - 25
- 26 - 100

Source:
NJDEP

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

Wetland values can be described using three categories:

Fish and Wildlife Values

- Fish habitat
- Waterfowl and other bird habitat
- Furbearer and other wildlife habitat

Environmental Quality Values

- Water Quality Maintenance
  - Pollution removal (nitrogen, phosphorus, metals)
  - Sediment removal
  - Oxygen Production
  - Nutrient Recycling
  - Chemical and Nutrient Absorption
- Aquatic productivity
- Microclimate regulator
- World climate (ozone layer)

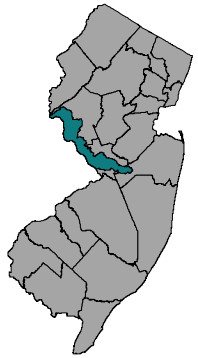
Socioeconomic Values

- Flood control
- Erosion control
- Groundwater recharge
- Water supply
- Timber and other natural products
- Energy source (peat)
- Pharmaceutical products
- Livestock grazing
- Fishing
- Hunting and trapping
- Recreation
- Aesthetics
- Education and scientific research

Wetlands are the fourth largest land use in the Central Delaware Tributaries at 14.5% (see Figure 8). Large concentrations are found in the southeast portion of the watershed management area, in the Assunpink Wildlife Management Area, with some concentrations in the Lockatong/Wickecheoke watershed and the Hakihokake/Harihokake/Nishisakawick watershed.

Nearly all the wetlands in Hunterdon county are Palustrine (marshes, bottomland forests, swamps, ponds) with deciduous forest making up 68% of the acreage. Mercer County wetlands are also largely Palustrine dominated by deciduous

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01



N

0 3 6 Miles

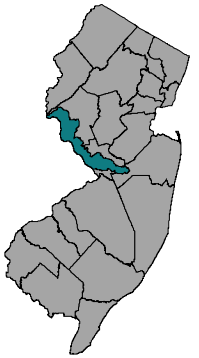
**Wetlands**

Rivers
Wetlands
WMA 11

Source:
NJDEP

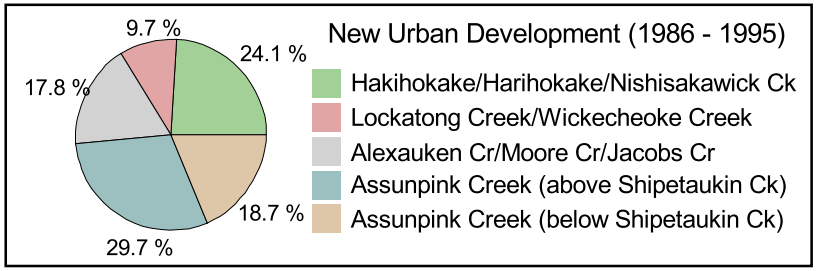
This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01




## New Urban Development

- New Urban Development (1986 - 95)
- Streams
- Rivers
- Lakes
- WMA 11

Subwatersheds

- Alexauken Cr/Moore Cr/Jacobs Cr
- Assunpink Creek (above Shipetaukin Ck)
- Assunpink Creek (below Shipetaukin Ck)
- Hakihokake/Harihokake/Nishisakawick Ck
- Lockatong Creek/Wickecheoke Creek

Source:
NJDEP

N

0 3 6 Miles

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

forest. Palustrine wetlands also dominate in Monmouth County although emergent wetlands are more important in this county than in the two mentioned previously.

Wetlands in the Central Delaware Tributaries have undergone both quantitative and qualitative changes over time. Hunterdon, Mercer, and Monmouth counties all experienced "significant wetland conversion to agriculture" (Tiner, 1985). Hunterdon lost 71% of its wetlands between 1940 and 1970. Mercer and Monmouth counties both lost 56% of their wetlands in the same time period. Wetlands in the Central Delaware Tributaries declined 2.3% between 1987 and 1995.

More subtle and difficult to detect at first glance are qualitative changes. "Elevated hydrogen ion concentrations (pH) resulting form increased nutrients and increased flooding associated with urbanization pose a particular problem for native species. Fully 25% of the species observed in pristine areas disappeared in developed basins"(Tiner, 1985).

### 4.4.5 Water

Two percent of the watershed is covered by water. Lakes larger than seven acres are all artificial manmade impoundments on streams with the exception of Camp Marudy Lake in the Nishisakawick watershed which is a natural lake.

### 4.4.6 Barren Lands

Less than one percent of the watershed management area is classified as barren lands.

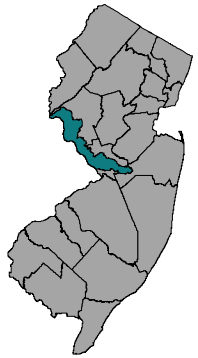
## 4.5 Natural Resources Priority Habitat

NJDEP has identified priority heritage sites throughout the state ranked from B-1 (outstanding global importance) to B-5 (significant at the state level). DEP is currently completing a GIS tool called the Landscape Project that will map priority sites in a more comprehensive manner. At the time this document was drafted the Landscape Project was not yet available. Please see Figure 9 for locations of natural heritage priority sites in the Central Delaware Tributaries.

Twelve natural heritage priority sites have been identified in the Central Delaware Tributaries, largely on the basis of the presence of rare plants. The sites in Hunterdon County include:

- Hunterdon Milford Bluffs (B-3, the remaining sites are all B4)
- Jarves Rd. Site
- Devil's Tea Table
- Byram
- Treasure Island

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 3\02



## Open Space & Priority Sites

- Priority Sites
- Preserved Ag Land
- Hunterdon Preserved Farmland
- Open Space
- Lakes
- Streams
- Rivers
- WMA 11

N

0 3 6 Miles

Source:
NJDEP
New Jersey Office of Natural Lands Management
Hunterdon County
Mercer County Planning Department
SADC

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

- Raven Rock
- Holcombe Island.

On the border of Mercer and Hunterdon Counties are two sites:
- Goat Hill
- East Amwell Grasslands (just a small piece is located in the Central Delaware Tributaries).

Mercer County contains two sites:
- Strawberry Hill
- Titusville.

## 5.0 Surface Water Quality

### 5.1 Significance of Streams and Their Corridors

Healthy aquatic ecosystems (streams and the riparian corridors along their banks) provide many benefits to communities. These benefits include:

- water supply (for drinking or other uses),
- water purification (as water percolates slowly through soils adjacent to streams),
- floodwater storage,
- aquifer recharge.

Aquatic ecosystems also provide important habitats for both upland and wetland wildlife, recreational opportunities and scenic amenities.

For a township or city, the cost of disturbing the streamside landscape can be high as public funds are expended on:

- diverting water to where it is needed (for drinking or other uses),
- water filtration and treatment,
- flood control programs,
- repeated stocking of streams with fish.

To maximize benefits and minimize economic costs to a community it is important, therefore, to understand the health of the streams flowing through a community (Kruger, p. V1-V3).

### 5.2 Federal *Clean Water Act* Requirements for Water Quality in New Jersey

The federal *Clean Water Act* requires two strategies for ensuring that Americans have clean water to drink, swim in and fish. After putting in place technology based controls on point source pollution discharges, states are required to

establish water quality standards for waterways. The water quality standards adopted by New Jersey Section are outlined below in section 2.3. The federal *Clean Water Act* requires states to identify waters that are not attaining the surface water quality standards established for their streams. Streams which fail to meet the standards (Water Quality Limited Segments or WQLS) are identified and listed on the Environmental Protection Agency's 303d List.

States are to follow up and correct these impaired stream segments by calculating Total Maximum Daily Loads (TMDLs). A TMDL identifies the amount of an identified pollutant (whether a nutrient or a toxic) a stream can accept without violating its water quality standards. All watershed sources are considered: dry air deposition, rainfall, benthic deposits, farm runoff, urban runoff and other non-point sources – not simply end of pipe permitted discharges.

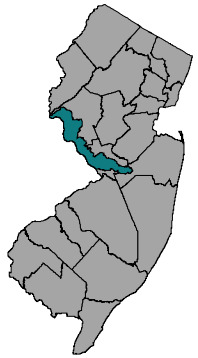
States are then required to distribute this allowable pollution load (TMDL) via load allocations and wasteload allocations to the various point and non-point source contributors. If the state does not set TMDLs, the Environmental Protection Agency is supposed to do it.

One of the focuses of the current watershed planning process will be the development TMDLs for New Jersey's waters. Section 2.8 of this report lists the streams in the Central Delaware Tributaries that are identified on the 303d list as impaired and therefore require TMDLs.

### 5.3 Surface Water Quality Standards

Water quality in New Jersey is evaluated with respect to Surface Water Quality Standards (SWQS) (N.J.A.C:9B) which set the water quality goals and uses for New Jersey's waters. Streams in the Central Delaware Tributaries have been classified by the DEP according to their intended use (see Figure 10). The designated uses in the Central Delaware Tributaries are primary and secondary contact recreation (i.e., swimable); maintenance, migration and propagation of the natural and established biota (i.e., fishable); and public potable water supply (i.e., potable). Water quality which does not meet the classification criteria (see Table 2.3-2) for the stream must be improved to meet the classification through the process of setting Total Maximum Daily Loads for pollutants.

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01

Hakihokake Creek

Nishisakawick Creek

Harihokake Creek

Lockatong Creek

Wickecheoke Creek

Alexauken Creek

Moore Creek

Delaware River

Shipetaukin Creek

Jacobs Creek

Assunpink Creek

Miry Run

Pond Run

N

0 3 6 Miles

## Surface Water Quality Standards - Stream Classifications

Surface Water Quality Standards
- Delaware River
- Nontrout Waters
- Trout Maintenance
- Trout Production
- WMA 11

Source:
NJDEP

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

**Table 3 SWQS Stream Classification and Stream Miles in the Central Delaware Tributaries**

| SWQ Classification | Trout Classification | Antidegradation Policy | Length (mi) |
|---|---|---|---|
| FW1 | N/A | N/A | 0 |
| FW2 | TP | C1 | 54.273 |
| FW2 | TM | C2 | 95.546 |
| FW2 | NT | C1 | 46.754 |
| FW2 | NT | C2 | 343.79 |
| FW2 | NT | NS | 0 |
| | | Total | 581.835 |

Surface water classifications are defined as follows:
**FW1:** Fresh Water 1: Fresh surface waters that are to be maintained in their natural state and not subjected to man-made wastewater discharges or increases from runoff from anthropogenic activities.
**FW2:** Fresh Water 2: General fresh surface water classification applied to fresh waters that are not FW1 or PL (Pinelands Waters).
**FW- TP**: Fresh Water - Trout Production waters are designated for trout spawning/nursery during their first year.
**FW- TM**: Fresh Water - Trout Maintenance waters are designated for the support of trout throughout the year.
**FW- NT**: Fresh Water - Non Trout: fresh surface waters that have not been designated TM or TP. These waters are generally unsuitable for trout because of their physical, chemical, or biological species, but are suitable for a wide variety of other fish species.
**C1**: Category 1 waters are designated for implementation of antidegradation policies for protection from any measurable change in water quality. C1 may be applied to any surface water classification except those designated as FW1 or PL.
**C2**: Category 2 waters are waters that are not designated as Outstanding Natural Resource Water (i.e., FW1 Or PL) or C1 for implementation of antidegradation policies.

**Table 4 Surface Water Quality Standards Criteria**

| | FW2-TP | FW2-TM | FW2-NT |
|---|---|---|---|
| DO | >7.0 ppm | >5.0 ppm | >4.0 ppm |
| FC (1) | <400/100 ml | <400/100 ml | <400/100 ml |
| NH3un-ionized (2) | <20 ppb | <20 ppb | <50 ppb |
| NO3 | <10 ppm | <10 ppm | <10ppm |
| P total (3) | <.05, <.1 ppm | <.05, .1 ppm | <.05, .1 ppm |
| pH | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 |
| TSS | <25 ppm | <25 ppm | < 40 ppm |
| Temp (4) | <20 C | <20C | 27.8C, < 30 C |

Notes:
(1) FC: <400/100 ml for any sample or <200/100 ml for geometric mean
(2) Un-ionized ammonia is calculated based on Temp., pH and Total Ammonia
(3) Total P: <.05 ppm in lakes or stream inlet into lake, <.1 ppm in streams and rivers
(4) Temp:<27.8 C for waters with yellow perch or small mouth bass, <30C for all other FW2-NT waters

Human health criteria calculate Aquatic Life Acute and Chronic
(NJDEP Division of Science and Research, 2000)

## 5.4 Surface Water Quality Monitoring

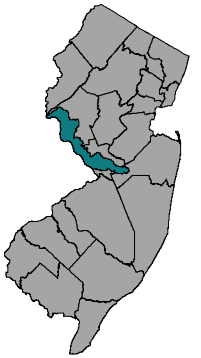
### 5.4.1 Monitoring Stations in the Central Delaware Tributaries

Various organizations including: NJ Department of Environmental Protection (NJDEP), Delaware River Basin Commission (DRBC), US Geological Survey (USGS), Environmental Commissions, AmeriCorps members, watershed associations, schools, and the Delaware River Keeper Network collect data on streams in the Central Delaware Tributaries.

The ASMN (Ambient Stream Monitoring Network) operated by the USGS and NJDEP collects data on water chemistry and sanitary quality (see Figure 11).

The NJDEP operates the AMNET (Ambient Biomonitoring Network) which provides biological assessments of in-stream benthic macroinvertebrate communities (see Figure 12). A Habitat Score (optimal 160-200; sub-optimal 110-159; marginal 60 – 109; poor 60) is included with the New Jersey Impairment Score (NJIS: no biological impairment, moderate, severe biological impairment) for each site. Forty-eight AMNET sites are located in the Central Delaware Tributaries. Two sampling events have been undertaken at these sites: one in 1992 and one in 1997.

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01



N

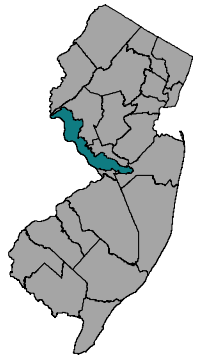
0 3 6 Miles

### Ambient Monitoring Sites

- Ambient Stream Quality Monitoring Sites
- Lakes
- Streams
- Rivers
- WMA 11

Source:
NJDEP

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01

Hakihokake Creek

Nishisakawick Creek

Harihokake Creek

Lockatong Creek

Wickecheoke Creek

Alexauken Creek

Moore Creek

Delaware River

Shipetaukin Creek

Jacobs Creek

Assunpink Creek

Miry Run

Pond Run

N

0 3 6 Miles

## Benthic Macroinvertebrate Status & Trends

1992 - 1997 Change
- Decrease in Impairment
- Increase in Impairment
- No Change
- Only One Sample

Impaired 1997
- Moderate
- None
- Severe
- Streams
- WMA 11

Source:
NJDEP
EPA

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

In 1998 DRBC began monitoring selected tributaries near their mouths at the Delaware River as part of DRBC's work arising from the inclusion of this section of the Delaware River in the federal Wild and Scenic River program.

NJDEP has used the Fish Index of Biotic Integrity to assess one stream in the Central Delaware Tributaries – Shipetaukin Creek.

The Clean Lakes Program evaluates public lakes possessing water quality problems. Assunpink Lake is the only lake in the Central Delaware Tributaries assessed under this program.

The Toxics in Biota Program evaluates contaminants in fish in terms of risk for human consumption. The Central Delaware Tributaries is affected by a statewide consumption advisory regarding mercury levels for largemouth bass and chain pickerel.

## 5.5 Surface Water Quality in the Hakihokake/Harihokake/Nishisakawick Watershed

### 5.5.1 Chemical and Sanitary Water Quality

DRBC data for 1999 indicate exceedances of FC and DO occurred, based on a single sample, only in Warsaw Creek (located near Warford Creek). However, the Harihokake Creek exhibited unusually low conductivity, and the Little Nishisakawick, Warford, Warsaw, Harihokake, and Hakihokake Creeks exhibited enterococcus concentrations above NJ freshwater standards.

USGS data for 1997 and 1998 for Nishisakawick Creek indicate that Total P, Total Nitrogen Ammonia, and DO were within limits. However, one FC exceedance for a Non-Trout stream occurred in August of 1998.

### 5.5.2 Biological Evaluation

No change from biological non-impairment was recorded between 1992 – 1997 for the three AMNET stations located on the Hakihokake Creek.

Of the two stations on the Harihokake, one remained biologically unimpaired and one improved to biologically unimpaired from its previous level of moderate biological impairment.

The three stations on the Nishisakawick Creek and one on the Little Nishisakawick Creek remained biologically unimpaired between 1992-1997.

Copper Creek remained moderately biologically impaired and Warford Creek degraded to moderate biological impairment in 1997 from biologically non-impaired in 1992. Habitat scores for Warford Creek were in the sub-optimal

range (none were marginal or poor). Additional investigations are therefore needed to evaluate potential sources of this apparent decline in biological health. Potential causes could include changes in flow, natural conditions (e.g., recent hatch) or degradation due to human activities.

Camp Marudy Lake has not been assessed by the Clean Lakes Program and its eutrophic status is not known at this time.

## 5.6 Surface Water Quality in the Lockatong/Wickecheoke Watershed

### 5.6.1 Chemical and Sanitary Water Quality

All the USGS sites in this watershed were discontinued by 1991. However, site 1461262 on Plum Brook was activated in 1998 and provides the following data: no exceedances for DO, Total P, and Total Nitrogen Ammonia. However standards for FC for a Trout Maintenance stream were exceeded in the summer months. Site NJ 02040105005200 (AN0095) on the Wickecheoke was also activated in 1998 and reported accidences for FC, pH, temperature, Total P (US EPA, 1998).

In 1999, DRBC found the Lockatong and Moores Creeks to have unusually low conductivity. No accidences for DO or FC were reported. However, the Wickecheoke exceeded the standards for enterococcus.

### 5.6.2 Biological Evaluation

In 1995 and 1996 volunteers organized by the Delaware and Kingwood Township Environmental Commissions collected macroinvertebrate samples at two locations in the Lockatong and Wickecheoke Creeks. The Kingwood Township Environmental Commission went on to conduct a more comprehensive study of the Lockatong Creek using 20 sampling sites. Results from both studies indicated that both streams were biologically unimpaired (Lockatong Wickecheoke Watershed Project, 2001).

The three AMNET sites on the lower Lockatong also indicate that the lower Lockatong has remained biologically unimpaired from 1992-1997. The upper station (AN0086) at Oak Grove indicates the Lockatong improved from moderate biological impairment to biologically non-impaired between 1992 and 1997.

However, the Wickecheoke maintained moderate biological impairment in its upper reaches; degraded to moderate biological impairment in its middle reach; and maintained no biological impairment in its lower reach. Its main tributary, Plum Brook, similarly maintained moderate biological impairment in its upper reach and degraded to moderate biological impairment just above where it joins the Wickecheoke in the middle reach of the Wickecheoke. The two Plum Brook

sites exhibit among the highest optimal habitat scores in the watershed management area indicating that some other cause of impairment needs to be determined.

## 5.7 Surface Water Quality in the Alexauken/Moores/Jacobs Watershed

### 5.7.1 Chemical and Sanitary Water Quality

DRBC data for 1999 indicate that Moores Creek had unusually low conductivity. Jacobs Creek was the only creek to have a higher FC average concentration in 1999 than in 1987. No accidences for DO or FC were reported. Jacobs, Fiddlers, Moores, Swan, and Alexauken Creeks were reported to have enterococcus concentrations above standards.

### 5.7.2 Biological Evaluation

The Alexauken Creek and an unnamed tributary maintained biological non-impairment between 1992-1997. Moores Creek maintained biological non-impairment in its upper reach and improved from moderate biological impairment to biologically unimpaired in its lower reach.

Swan Creek maintained its moderate biological impairment status between 1992-1997.

Jacobs Creek maintained its biologically unimpaired status in its upper, middle and lower reaches and improved to biologically non-impaired from moderately biologically impaired at one other sampling station in its lower reach.

Woolsey's Brook, the main tributary to Jacobs Creek, maintained its moderate biological impairment status between 1992-1997.

Gold Run maintained its biologically non-impaired status between 1992-1997.

## 5.8 Surface Water Quality in the Assunpink Creek Above Shipetaukin Creek

### 5.8.1 Chemical and Sanitary Water Quality

NJDEP's Fish Index of Biotic Integrity results for the Shipetaukin Creek (6/12/00) indicate no accidences of DO, temperature, pH, or conductivity. USGS data for the Assunpink Creek at Clarksville indicate no accidence for DO, FC in 1999.

In 1996 the Assunpink at Clarksville exceeded phosphorous limits and arsenic, cadmium, copper, iron, lead and mercury limits (US EPA, 1998).

### 5.8.2 Biological Evaluation

Moving from its headwaters to the west, the sampling station in Roosevelt improved to moderate biological impairment from severely impaired between 1992-1997. Two new stations were added – one on New Sharon Branch was moderately biologically impaired in 1997 and one on the Assunpink nearby was also moderately biologically impaired in 1997. The Shipetaukin and an unnamed tributary both improved to moderately biologically impaired from severely biologically impaired between 1992-1997. The Shipetaukin Creek received a fair Fish Index of Biotic Integrity rating (out of a range of excellent, good, fair, poor).

## 5.9 Assunpink Creek Below Shipetaukin Creek

### 5.9.1 Chemical and Sanitary Water Quality

The Assunpink station at Trenton did not exceed DO standards but did exceed FC standards in 1999 (NJDEP Division of Science and Research 1999). The Assunpink station at Peace St. reported metal accidences.

### 5.9.2 Biological Evaluation

Moving from upper to lower tributaries to the Assunpink, the Little Shabakunk Creek improved from severe biological impairment to moderate biological impairment and a new station on the Shabakunk added in 1997 also reported moderate biological impairment.

The Shabakunk Creek also improved to moderate biological impairment from severe biological impairment in its upper reach and maintained moderate biological impairment in its lower reach.

A new station in the upper reaches of Miry Run reported moderate biological impairment in 1997 and the existing station maintained moderate biological impairment between 1992-1997.

The Assunpink Creek at its Mulberry St and Willow St. sites maintained moderate biological impairment.

Pond Run has the distinction of being the only creek in the Central Delaware Tributaries to suffer from severe biological impairment in both 1992 and 1997. However, it may be that the location of the sampling site contributes to the impairment reading as it is located just below a dam.

### 5.9.3 Lake Trophic Status in the Assunpink Watersheds

The Assunpink Lake has been assessed as impaired due to algae and macrophytes (US EPA , 1998).

## 5.10 Impaired Waterbodies List

Table 5 provides the US EPA 1998 303d listed waterbodies for the Central Delaware Tributaries. However, some streams currently listed will likely not be listed in the 2000 303d report as their water quality is thought by NJDEP to have improved according to data collected more recently.

**Table 5 303d Listed Waterbodies in the Central Delaware Tributaries**

| Site Id | Waterbody | Parameter of Concern | Priority for TMDL Development |
|---|---|---|---|
| 01463620-A | Assunpink Creek | Phosphorus | Medium |
| 01463620-B | Assunpink Ck | Arsenic, Cad, Cu, Fe, Pb, Mercury | Medium |
| 01464000 | Assunpink Ck | Fecal coliform, phosphorus | Medium |
| AN0095 | Wickecheoke Ck | Fecal coliform, pH,Temp, Total P | Medium |
| AN0079 | Harihokake Ck | Biologically Moderately Impaired | Medium |
| AN0084 | Copper Ck | Biologically Moderately Impaired | Medium |
| AN0086 | Lockatong Ck | Biologically Moderately Impaired | Medium |
| AN0090 | Wickecheoke Ck | Biologically Moderately Impaired | Medium |
| AN0092 | Plum Brook | Biologically Moderately Impaired | Medium |
| AN0099 | Swan Creek | Biologically Moderately Impaired | Medium |
| AN0101 | Moores Creek | Biologically Moderately Impaired | Medium |
| AN0102 | Jacobs Ck | Biologically Moderately Impaired | Medium |
| AN0103 | Airport Brook | Biologically Moderately Impaired | Medium |

| | | | |
|---|---|---|---|
| AN0104 | Woolseys BK | Biologically Moderately Impaired | Medium |
| AN0106 | Jacobs Ck | Biologically Moderately Impaired | Medium |
| AN0110A | Shipetaukin Ck | Biologically Severely Impaired | Medium |
| AN0110B | Shipetaukin Ck Tributary | Biologically Moderately Impaired | Medium |
| AN0113 | Shabakunk Ck | Biologically Severely Impaired | Medium |
| AN0114 | Shabakunk Ck | Biologically Moderately Impaired | Medium |
| AN0115 | Miry Run | Biologically Moderately Impaired | Medium |
| AN0116 | Assunpink Creek | Biologically Moderately Impaired | Medium |
| AN0118 | Assunpink Ck | Biologically Moderately Impaired | Medium |
| AN0111 | Shipetaukin Ck | Biologically Severely Impaired | Medium |
| NJLM4312-A | Assunpink Lake | Mercury in fish tissue | Medium |
| NJLM4312-B | Assunpink Lake | Macrophytes, Algae | – |

Current TMDL planning by NJDEP is focusing on assessing the validity of historical metals data.

## 6.0 Groundwater Hydrology and Water Supply

### 6.1 Potable Water Quality

Two surface intakes supply drinking water for over 60% of the population of the Central Delaware Tributaries – the Trenton Water Co. uses water from the Delaware River and United Water Co. at Lambertville uses two small reservoirs on Swan Creek for water supply purposes. Groundwater withdrawals from 44 Public Community Wells in addition to private wells provide potable water for the communities located outside of the Trenton Water Supply Company area

(outside of Trenton, Lawrence, Ewing, and Hamilton) and Lambertville in the Central Delaware Tributaries (see Figure 13).

Although the Delaware & Raritan Canal runs through the Central Delaware Tributaries it supplies water to communities in WMA 10.

Water supply authorities are required to produce Consumer Confidence Reports annually. These reports must list accidences of MCLs (Maximum Contaminant Levels) for lead, copper, disinfection by-products, bacteria, radioactive constituents, chlorine, clarity, inorganic and organic chemicals in tap water. Of the four out of five major operator reports I have obtained (Elizabethtown Water Co.'s was unavailable), only Trenton Water Co. reported exceeding MCL standards – for lead. Four out of 110 homes were considered to have elevated levels for the year 1999. Levels were attributed to corrosion of household plumbing (Trenton Water Works, p.2).

The NJDEP also produces annual documents reporting Safe Drinking Water Act Violations. For the most recent report, 1999, Consumers NJ WC Hamilton reported violations of gross alpha particle activity which were addressed by removing the source water from service (NJDEP Bureau of Safe Drinking Water, p. A-3).

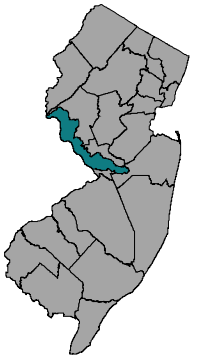
To protect the quality of potable water, NJDEP has initiated the Source Water Assessment Protection Program. In the Central Delaware Tributaries all public community wells have been located and estimates of their 2, 5, 12 year time of travel have been made. Wells will be rated by July 2002 on their vulnerability to contamination from eight contaminants. Surface water intake vulnerability will also be assessed by July 2002 based on the model USGS expects to complete for predicting the effects of land use activities on surface waters (Kreitzman personal comment).

## 6.2 Groundwater Supply

According to the *New Jersey Statewide Water Supply Plan*, the public community wells in the northern and central parts of the Central Delaware Tributaries are expected to maintain a net surplus of water (for drinking and other uses) through 2040. However, the southern portion of the watershed is projected to reach water supply capacity (for drinking and other uses) on or before 2040.

Members of the Characterization and Assessment Committee for the Central Delaware Tributaries expressed concern, however, that the state has not sufficiently assessed the water supply capacity for private wells. The committee also felt that the state has not sufficiently assessed the impacts of development on stream recharge. Woolseys Brook was identified by a member of the committee as currently being dry in the summer when it was deep enough for swimming in past decades (R. Nichols, personal comment).

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01

Lambertville

Trenton

N

0 3 6 Miles

## Surface Water Intakes & Public Community Water Supply

- Intakes
- Public Community Water Supply
- WMA 11

Source:
NJDEP
NJGS

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

Detailed information on the water budget for the Central Delaware Tributaries will be gathered by NJDEP.

## 7.0 Contributing Factors to Water Quality and Trends

Point sources of pollution (typically industrial pollution originating from a pipe or a ditch) and non-point source pollution (typically caused by people's everyday activities originating from sources spread throughout the watershed such as lawns, construction sites, farmers' fields, etc.) together affect the quality of surface water and groundwater.

## 7.1 Point Sources of Pollution in the Central Delaware Tributaries

As of 1999 there were 46 permitted dischargers with 54 NJPDES permits that discharged treated wastewater to surface waters (see Figure 14). Dischargers included: 24 industrial minor wastewater/industrial stormwater permits; 9 municipal minor wastewater permits; 5 petroleum clean up permits; 4 major industrial permits; 2 non-contact cooling water permits; and 2 municipal major permits.

### 7.1.1 Point Source Compliance

Information on enforcement actions for permitted facilities are reported annually by NJDEP in the Clean Water Enforcement Act Report.

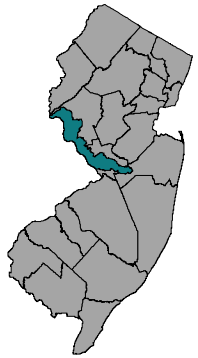
## 7.2 Non-Point Sources of Pollution in the Central Delaware Tributaries

Impervious cover due to increased urban development contributes to water quality degradation through contaminants in runoff and changes in recharge patterns. Schueler (p.) states that 10% impervious cover is the threshold at which water quality begins to decline (see Figure 1.4.3-1 for percentage of impervious cover in the Central Delaware Tributaries).

Agricultural practices are suspected to be contributors to water quality impairment in the northern part of the watershed. Septic field failure has also been cited as a cause of water quality impairment in the northern part of the watershed (NJPIRG, web-site).

Stormwater is considered a non-point source of pollution as it carries contaminants picked up from diffuse sources as it travels across the urban landscape. Urban runoff is suspected to be a contributor to water quality impairment in the southern part of the watershed as are point sources of pollution.

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01



N

0 3 6 Miles

## NJPDES Point Source Discharge Facilities

Discharge Sites
- Petroleum Cleanup
- Non-Contact Cooling Water
- Industrial Minor
- Industrial Major
- Municipal Minor
- Municipal Major
- AMNET Sites
- Streams
- Rivers
- WMA 11

Source:
NJDEP

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

## 7.3 Hakihokake/Harihokake/Nishisakawick Watershed

### 7.3.1 Point Sources of Pollution

The Harihokake Creek has no NJPDES permits associated with it. The Hakihokake Creek has one – the Milford SUA – and the Nishisakawick Creek has four municipal minor permits and one industrial minor permit. Copper Creek has one municipal minor discharger.

### 7.3.2 Non-point Sources

New urban development has occurred close to all three main streams in the north. However, much of their headwaters and adjacent land is forested which may serve to account for the biologically non-impaired status of these streams.

## 7.4 Lockatong/Wickecheoke Watershed

### 7.4.1 Point Sources of Pollution

The Lockatong Creek has no NJPDES permits associated with it. The Wickecheoke has one municipal minor permit – Delaware Township MUA.

### 7.4.2 Non-point Sources of Pollution

Agricultural practices are suspected to contribute to impairment in the upper reaches of this watershed.

## 7.5 Alexauken/Moores/Jacobs Watershed

### 7.5.1 Point Sources of Pollution

The Alexauken Creek has no NJPDES permits associated with it. Swan Creek has one industrial minor and one municipal major permit – Lambertville SA - associated with it. Moores Creek has one municipal minor and Jacobs Creek has one non-contact cooling water permit associated with it.

### 7.5.2 Non-point Sources of Pollution

Water quality in this watershed is generally non-impaired with the exception of Woolsey's Brook where agricultural practices are suspected to contribute to its moderate impairment.

## 7.6 Assunpink Above Shipetaukin Creek

### 7.6.1 Point Sources of Pollution

The Assunpink Creek above Shipetaukin Creek has one NJPDES permit – Roosevelt Borough WTP. The Shipetaukin Creek has one industrial minor permit associated with it.

### 7.6.2 Non-point Sources of Pollution

Agricultural practices are thought to contribute to impairment in the upper reaches of the Assunpink Creek while urban runoff is thought to contribute to impairment as the Creek travels farther west.

## 7.7 Assunpink Below Shipetaukin Creek

### 7.7.1 Point Sources of Pollution

This watershed has more permits than any other in the Central Delaware Tributaries. The tributaries to the Assunpink Creek in this watershed all have industrial minor permits associated with them with the exception of the Little Shabakunk Creek which has no NJPDES permits. The Shabakunk Creek and its west branch also have petroleum cleanup permits associated with them. Just south of Miry Run, the Assunpink Creek itself has one municipal major – Ewing Lawrence SA - and one non-contact cooling water permit. Pond Run has one municipal minor permit – Garden State Water Co.

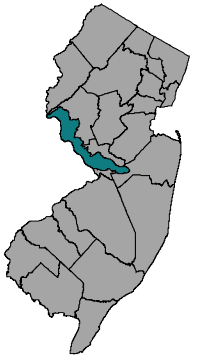
### 7.7.2 Non-point Sources of Pollution

Urban runoff is suspected to contribute to the impairment of the streams in this watershed.

## 7.8 Known Contaminated Sites in the Central Delaware Tributaries

NJDEP is currently unclear how sites on its Known Contaminated Sites List (Figure 15) may affect water quality on a watershed basis. There are 224 Known Contaminated Sites in the Central Delaware Tributaries with the bulk being located in the south of the watershed management area.

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 3/02

N

0 3 6 Miles

## Known Contaminated Sites

- Rivers
- Lakes

Known Contaminated Sites (2001)

- Single Contaminant / Soil
- Single Contaminant / Soil & Possible Groundwater
- Single Phase Remediation / Soils & Confirmed Groundwater
- Multi Phase Remediation / Unquantifiable Impacts
- Superfund Sites
- WMA 11

Source:
NJDEP

# 8 SOCIAL AND ECONOMIC CHARACTERISTICS OF THE CENTRAL DELAWARE TRIBUTARIES

## 8.1. Historic and Cultural Resources

### 8.1.1 Lenape Culture in the Central Delaware Tributaries

*Lenapehoking* is an Indian place name for the land that stretches from eastern Pennsylvania and northern Delaware to southeastern New York and western Long Island. *Lenapehoking* centered on the land we know as New Jersey today (Dowd, 1992). Spearheads from Paleo-Indians hunting in New Jersey date from 10,500 BCE. Evidence of fishing traps date from 3,000 BCE and farming the three sisters, corn, bean and squash, was established by 1,100 CE.

The Lenape, variously translated as "the People" (Dowd, 1992) or "the real or ordinary person" (Bierhorst, 1995) left a legacy of stream and place names throughout the Central Delaware Tributaries Watershed Management Area. The Alexauken River (*alexhaking* in Lenape) is translated as "barren land" and the Assunpink (*Ahsenping* in Lenape) is translated as "rocky place that is watery" (Kraft, 1991).

However, place names are largely all that remain of the Lenape in New Jersey. As Dutch and then Swedish settlers moved into New Jersey in the early 1600s the Lenape suffered terrible losses to their population from three smallpox epidemics. By 1715, fifty one years after the English conquered the Dutch in 1664, the population of the Munsee speaking (northern) Lenape is estimated to have declined by half.

"And while the Lenape were not driven out with force of arms, exodus to the west only occurred after rapid English colonization with its disruption of their traditional hunting and farming practices" (Dowd, 1992). By the 1720s many Lenape had migrated to the Ohio River region. During the Revolutionary War and after, between 1776 and 1815, the already divided Lenape broke up and re-formed into four main groups each with its own pattern of migration. The descendants of the Lenape who initially remained in New Jersey until 1801, on the Brotherton Reservation, now number approximately 600 and live on the Stockbridge-Munsee Reservation in Wisconsin.

The Lenape who moved to Ohio broke into three groups. One group of "christianized" Lenape moved to southern Ontario and established Moraviantown where approximately 400 currently live. Two groups moved farther west and south in response to pressures from European settlers. During the Civil War the Lenape were in Kansas but after the war they were forced to give up their reservation. One group was provided with Caddo and Wichita Indian land in Andarko County Oklahoma and currently over 1,000 descendants live in this county. The other group was provided with land within the Cherokee Nation.

Descendants of this group make up the largest group of present day Lenape, totaling more than 10,000, and live near Dewey, Oklahoma. (Dowd, 1992) Some Lenape are believed to have returned to live in New Jersey but census data do not distinguish among native tribes.

The Lenape way of life and patterns of land use were very different from that of the European settlers who were to come after them and therefore had a different effect on the water quality of the Central Delaware Tributaries. The Lenape were a matrilineal, matriarchal society that emphasized hospitality over material wealth. Communal living occurred in the spring and summer months as the women of a tribe worked together to raise the crops, the men hunted and fished, and everyone participated in religious rituals. However, during the fall and winter, small groups of families would move away from the tribe's village and go to separate houses.

The major impacts of the Lenape on the land were from clearing the forest for farming, and burning the brush in the Spring to increase forage for deer and make it easier to track animals. At this time, however, European settlers report that streams were healthy and fish were plentiful (Dowd, 1992).

Cultural artifacts of the Lenape (shelters, and hunting, fishing, and farming implements) have been found throughout New Jersey and a large collection is located in the State Museum in Trenton. Their cultural legacy, however, is perhaps better known through the myths they held in common with other tribes who shared the Algonquian language.

Particularly well known is the creation story where a pregnant woman is cast off from the heavens and falls to earth. There a sea turtle rises from the ocean for the woman to rest on. The earth forms on the back of the sea turtle and the woman's twin sons populate the earth (Bierhorst, 1995).

### 8.1.2 European Settlement in the Central Delaware Tributaries

With the coming of European settlers, land use patterns became fixed rather than operating in a cyclical migration. Saw mills and permanent towns were built along tributaries in the Central Delaware Tributaries Watershed Management Area. Shad runs were eliminated in tributaries as more and more industries discharged along the Delaware River and by the time World War II ended, the Delaware River was the most polluted it had ever been. (Lower Delaware Wild and Scenic River Task Force, 1997).

Looking at settlement patterns from north to south in the Central Delaware Tributaries along the Delaware River, what is now Holland Township was settled by the Dutch in 1624 and the Township remained primarily an agricultural community well into the twentieth century. The completion of Route 78 and increasing migration from New York City and the suburbs have brought changes

to the township in recent years (Hunterdon online).

The next town to the south is Milford on the Hakihokake Creek which separated from Holland Township in 1911.

Frenchtown on the Nishisakawick Creek was settled by Europeans in the mid-1700s. The village was known as Calvin's Ferry in colonial times after a ferry that crossed the Delaware and was used to transport British and Hessian prisoners from the battle of Saratoga in 1777. In 1794, Paul Henri Mallet-Prevost, a French revolutionary who supposedly fled the guillotine, purchased a mill at the mouth of the Nishisakawick Creek and brought with him other French families named Defresnoye and LaRoche (Hunterdon online).

Frenchtown was a bustling center of agricultural commerce served by its own train station. It had both grist and saw mills, a wagon wheel manufacturer and "found a niche in a lucrative peach market by both growing the fruit and manufacturing the baskets they were shipped in" (Hunterdon-online). However, Frenchtown underwent an economic decline beginning in the 1950s. Economic recovery began in the early 1980s when antique shops appeared, a federal grant was obtained to plant trees and replace cracked sidewalks with brick pavers, and the disused rail track was turned into a riverside hiking and biking path. Several buildings have been renovated to capitalize on the tourist market.

Farther south, Raven Rock is the start of the 22 mile long feeder canal for the Delaware and Raritan Canal. Construction of the canal began in 1830 and was completed in the summer of 1834 linking the Delaware River and Raritan River basins (Amon, 1989). The canal – a ditch forty-four miles long, seven feet deep and seventy-five feet wide was dug with pick and shovel, wheel barrow and horse-drawn scrapers by 4000 Irish immigrants, hundreds of whom lost their lives in a cholera epidemic (Cawley, 1971). The canal was built to facilitate the transportation of goods and coal to Philadelphia and on to New York City. At its peak in 1859 the Delaware and Raritan Canal carried more tonnage than the more famous Erie Canal in New York state (2.5 million tons a year) (Cawley, 1971).

By 1932 all commercial activity ceased and the canal took on a new role as an important water supply for central New Jersey in 1944. The canal is on the National Historic Register. In 1974 the Delaware and Raritan Canal State Park was established providing many opportunities for canoeing, fishing and recreation along the banks (Amon, 1989)

Prallsville Mill in Stockton was established in 1710. The Stockton Inn was made famous by a Rodger's and Hart song "There's a Small Hotel".

Lambertville was established in the 1700s and was initially named after various operators of ferries from New Jersey across the Delaware River to Pennsylvania,

becoming known as Coryell's Ferry after ferry owner Emmanuel Coryell until 1814. The City was then named Lambertville when the post office was established, and honored the Honorable John Lambert, a local resident.

Lambertville was the home of James Marshal, who found gold at Sutters Mill and has been credited with starting the California gold rush. The Marshal home and other Victorian homes have been maintained providing space for the many, shops, galleries and restaurants which make up Lambertville's economic base today.

Washington's Crossing is the site of George Washington's December 25, 1776 crossing of the Delaware River on his way to attack the British in Trenton. It is currently a state park and plans are being made to create a trail linking it with other sites of the Revolutionary War throughout New Jersey (Green Acres website).

Trenton is the last center of population in the Central Delaware Tributaries located along the Delaware River. The history of Trenton is associated with Washington crossing the Delaware River and winning his first victory against the British on December 26, 1776 in Trenton. However, Trenton experienced a second revolution in the Industrial Revolution. The construction of the Delaware and Raritan Canal, engineering feats of the Roeblings (who designed and built the Brooklyn Bridge) and the production of fine china by Walter Scott Lenox all contributed to Trenton's manufacturing boom. A number of homes and public buildings from this time remain including the 1792 New Jersey State House – America's second oldest state house in continuous use. Trenton suffered a manufacturing decline in the 1950s and is currently exploring steps for revitalization.

The greatest natural catastrophe suffered by towns in the Central Delaware Tributaries located along the Delaware River occurred in 1955 when hurricane Dianne caused flooding along the Delaware River to reach highest levels ever recorded. Dropping four inches of rain in 24 hours after an unprecedented ten inches earlier in the month, tributaries and the Delaware River were soon at flood stage. While no lives were lost in Hunterdon County $4 million worth of damage was suffered (Hunterdon Online).

Moving inland from the Delaware River and again working from north to south, small towns like Mt. Pleasant, Baptistown, Locktown are scattered through the northern part of the watershed. Sergeantsville in Delaware Township contains New Jersey's only remaining covered bridge spanning the Wickecheoke Creek. Built in 1872 atop abutments dating back to 1790 it was saved twice from the wrecking ball by history buffs – once in 1932 and again in the early 1960s (Hunterdon Online). Strimples Sawmill continues to operate on the Lockatong Creek in Delaware Township as it has for over 150 years (Goodspeed 1997)

To the south, Pennington Borough was separated from Hopewell Township in 1890 largely due to the impact of the railroad stimulating residential growth in Pennington. At this time, the village contained three general stores, two dry goods stores, one hardware store, two grocery stores, two confectionary stores, one drug store, two merchant tailoring establishments and a population of about 750. As the township moved into the 20th century, the expansion and improvement of the road systems and the automobile age brought suburban development and a corporate research center. The village center, however, retains much of its historic architecture (Pennington Community Directory online).

Ewing Township was established in 1834 although British colonists first settled here in 1699 when the area was still part of Hopewell Township. From 1719 to 1834 the area was named Trenton Township. The change in name was made to honor Charles Ewing posthumously for his work as Chief Justice of the New Jersey State Supreme Court.

In the early years of settlement Ewing was chiefly a woodland area, however, after the American Revolution Ewing began a long period of agricultural activity and was described in 1844 as having some of the richest soil in New Jersey. By the early 20th century Trenton had become a major industrial center and Ewing began to take on urban characteristics as trains and streetcars allowed people to live in Ewing and work in Trenton. However, Ewing remained predominantly rural until just before World War II when new industries such as General Motors began a period of growth for the township primarily attracted by the proximity of the Reading Railroad. After the war Ewing grew rapidly with an economy rooted in government (Naval Air Warfare Center, NJ Department of Transportation Complex), light manufacturing, and education (College of New Jersey, Marie Katzenbach NJ School for the Deaf) (www.ewingtwpnet/history.html).

Moving eastward in the Central Delaware Tributaries, Lawrence Township was founded in 1697 by Quakers as Maidenhead (after a Thames River village). The municipality was renamed Lawrence after Captain James Lawrence, commander of the frigate Chesapeake during the War of 1812.

In 1686 the Township of Nottingham was organized. It became Hamilton Township in 1847. Hamilton is dotted with houses famous for their use during the American Revolution.

In 1750, approximately 70 years after Quakers first settled in the area, King George II of Great Britain created the Township of Windsor (including all the land between Princeton and Allentown). In 1797 after residents disagreed about how to maintain public roads, the New Jersey Legislature divided Windsor Township into East Windsor and West Windsor.

Roosevelt Borough was established in 1937 under the New Deal's Resettlement Administration as a federally owned Utopian community. Conceived as a self-

sufficient industrial and agricultural unit the town included a cooperative garment factory, a cooperative retail store, communal farms and residences. Early inhabitants were predominantly Jewish garment workers from New York. The community was known as Jersey Homesteads until the death of President Franklin D. Roosevelt, when it was renamed in his honor. Over the years the community has grown into a larger, predominantly residential area associated strongly with arts and cultural events (Fund for Roosevelt).

Upper Freehold was founded in the late 1600s. Millstone Township was spun off from Freehold and Upper Freehold in 1844. Currently Millstone is experiencing a boom and more than tripled its population between 1970 and 2000.

## 8.2 Population of the Central Delaware Tributaries

Population density is usually a good indicator of potential human stress on the lands and waters of an environment. Municipal total population and population density data for census 2000 are provided in Table 6 and shown in Figure 16. Historical population change for municipalities (1930-2000) is illustrated in Figure 17 and presented in Table 7. Population change as expressed as percentages from 1970 to 2000 is presented in Table 8.

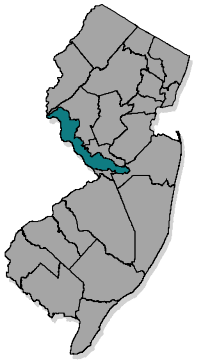
The largest concentration of population is found in the south of the Watershed Management Area in the city of Trenton, followed by Ewing, Washington, and East Windsor Townships. Other clusters of population include Lambertville, Stockton, Frenchtown, and Milford Boros in the north.

One-third of the municipalities in the Central Delaware Tributaries (largely located in the suburbs of Trenton) have experienced significant population growth – doubling, tripling or in the case of Millstone Township nearly quadrupling their populations between 1970 and 2000. Of concern for water quality is that population growth is located near the Assunpink Creek which is already suffering impairment (see Section 2 for details of impairment).

One-sixth of the municipalities in the Central Delaware Tributaries have lost population (including Trenton) while the rest have grown slowly. This growth in the north of the watershed is also of concern for water quality as much of the growth has occurred close to the northern streams.

Population projections to the year 2020 are illustrated in Figure 17 and presented in Table 9.

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01



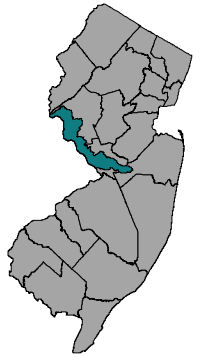

## Population Density by Municipality 2000

Population Density (2000)
[people/sq. mile]

- 0 - 500
- 500 - 1500
- 1500 - 3000
- 3000 - 6000
- 6000 - 12000

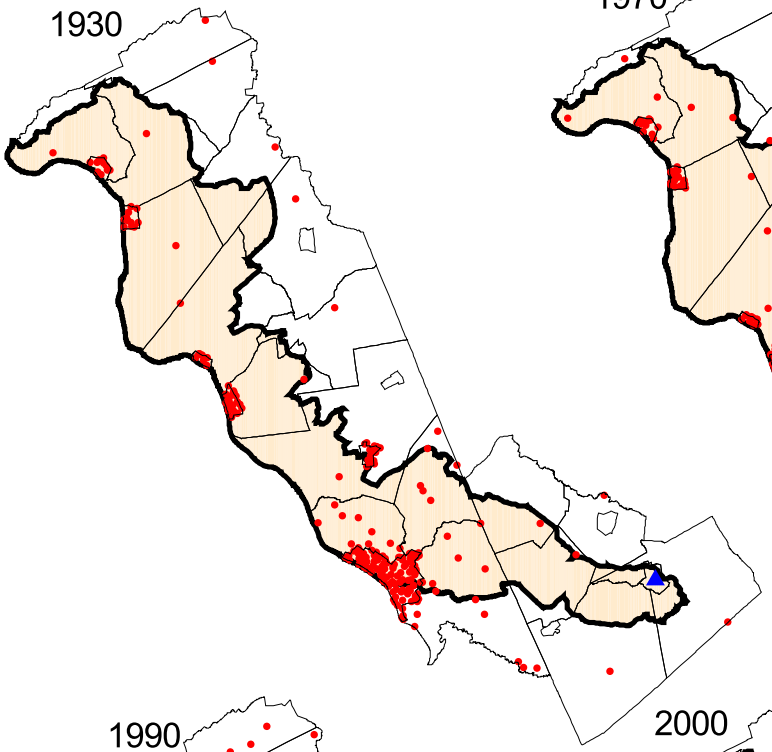
Source:
NJDEP
U.S. Census

# Central Delaware Tributaries
## Watershed Management Area 11

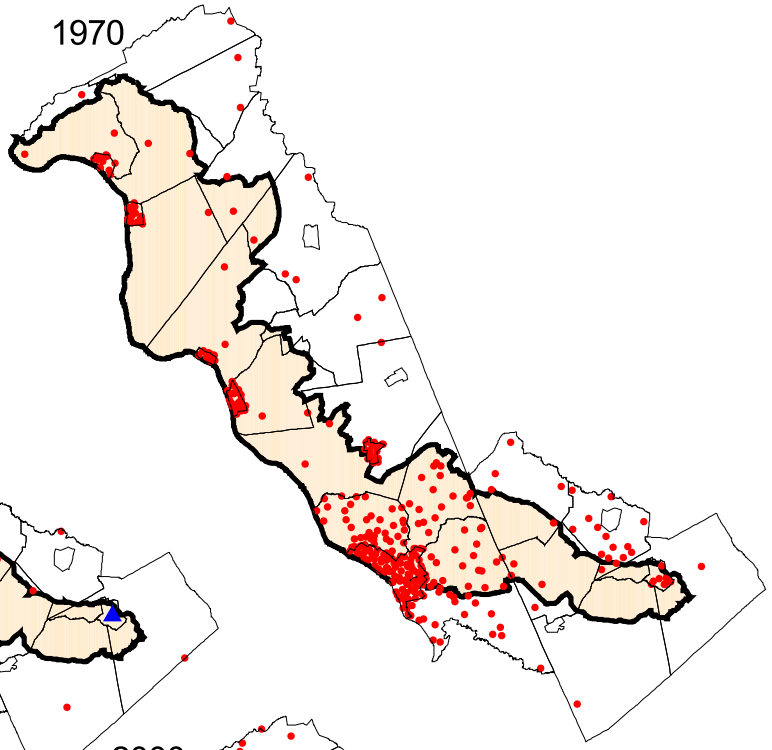


www.delawaretribs.org

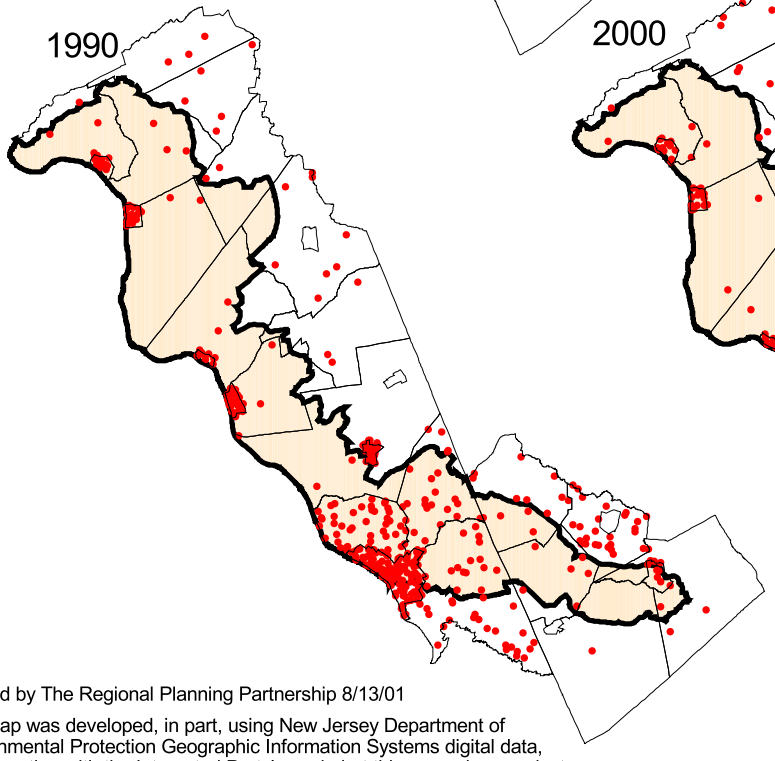
1930



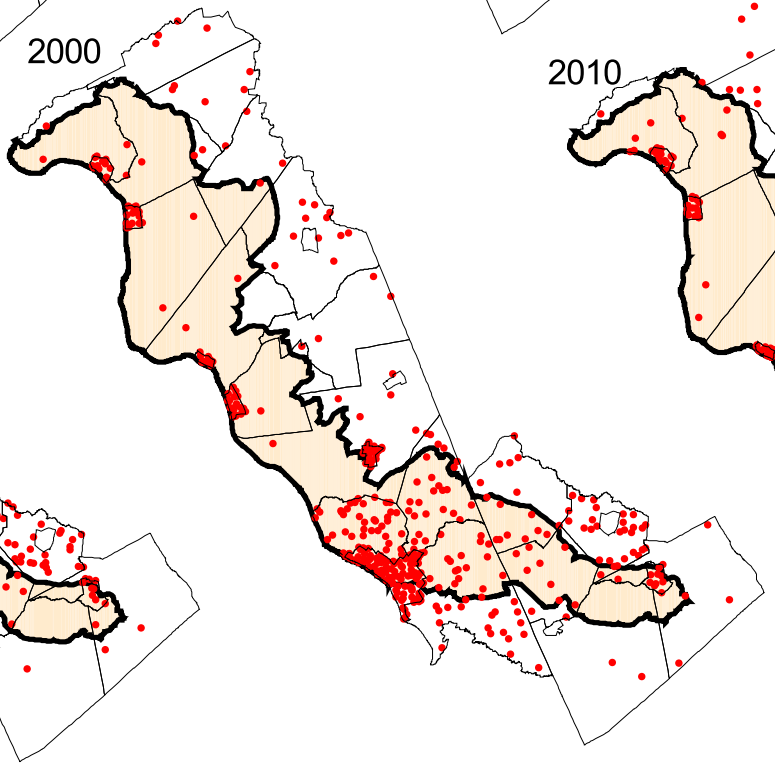
1970



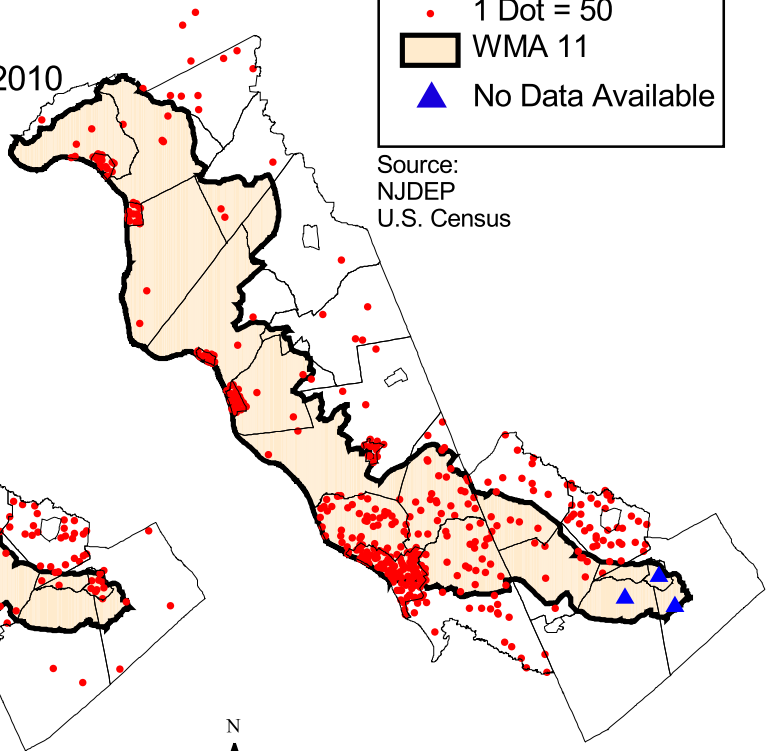
1990



2000



2010



## Population Pattern

Population Density
(people/sq mile)

- 1 Dot = 50
- WMA 11
- No Data Available

Source:
NJDEP
U.S. Census

N

0 3 6 Miles

Created by The Regional Planning Partnership 8/13/01

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

**Table 6 Municipal Total Population and Population Densities Census 2000**

| Municipality | Area_acres | Pop_2000 | Density 2000 |
|---|---|---|---|
| ALEXANDRIA TWP | 17713.82 | 4698 | 170 |
| HOLLAND TWP | 15363.97 | 5124 | 213 |
| FRANKLIN TWP | 14712.47 | 2990 | 130 |
| RARITAN TWP | 24159.22 | 19809 | 525 |
| MILFORD BORO | 795 | 1195 | 962 |
| KINGWOOD TWP | 22900.58 | 3782 | 106 |
| FRENCHTOWN BORO | 773.83 | 1488 | 1231 |
| DELAWARE TWP | 23675.4 | 4478 | 121 |
| EAST AMWELL TWP | 18327.65 | 4455 | 156 |
| WEST AMWELL TWP | 13995.78 | 2383 | 109 |
| HOPEWELL TWP | 37536.07 | 16105 | 275 |
| STOCKTON BORO | 383.66 | 560 | 935 |
| LAMBERTVILLE CITY | 791.97 | 3868 | 3127 |
| LAWRENCE TWP | 13991.13 | 29159 | 1334 |
| WEST WINDSOR TWP | 16827.63 | 21907 | 833 |
| PENNINGTON BORO | 626.13 | 2696 | 2757 |
| EAST WINDSOR TWP | 10122.96 | 24919 | 1575 |
| EWING TWP | 10136.37 | 35707 | 2255 |
| MILLSTONE TWP | 23909.54 | 8970 | 240 |
| HAMILTON TWP | 25792.72 | 87109 | 2161 |
| WASHINGTON TWP | 13197.36 | 10275 | 498 |
| TRENTON CITY | 5165.58 | 85403 | 10581 |
| ROOSEVELT BORO | 1251.17 | 933 | 477 |
| UPPER FREEHOLD TWP | 30133.67 | 4282 | 91 |

**Table 7 Historical Population Change 1930-2000**

| Municipality | Area acres | Pop2000 | Pop1990 | Pop1980 | Pop1970 | Pop1930 |
|---|---|---|---|---|---|---|
| ALEXANDRIA TWP | 17713.82 | 4698 | 3594 | 2798 | 2127 | 1094 |
| HOLLAND TWP | 15363.97 | 5124 | 4892 | 4593 | 3587 | 994 |
| FRANKLIN TWP | 14712.47 | 2990 | 2851 | 2294 | 2154 | 1100 |
| RARITAN TWP | 24159.22 | 19809 | 15616 | 8292 | 6934 | 1823 |
| MILFORD BORO | 795 | 1195 | 1273 | 1368 | 1230 | 933 |
| KINGWOOD TWP | 22900.58 | 3782 | 3325 | 2772 | 2294 | 1218 |
| FRENCHTOWN BORO | 773.83 | 1488 | 1528 | 1573 | 1459 | 1189 |
| DELAWARE TWP | 23675.4 | 4478 | 4512 | 3816 | 3249 | 1704 |
| EAST AMWELL TWP | 18327.65 | 4455 | 4332 | 3468 | 2568 | 1210 |
| WEST AMWELL TWP | 13995.78 | 2383 | 2251 | 2299 | 2142 | 788 |
| HOPEWELL TWP | 37536.07 | 16105 | 11590 | 10893 | 10030 | 3907 |
| STOCKTON BORO | 383.66 | 560 | 629 | 643 | 619 | 556 |
| LAMBERTVILLE CITY | 791.97 | 3868 | 3927 | 4044 | 4359 | 4518 |
| LAWRENCE TWP | 13991.13 | 29159 | 25787 | 19724 | 19567 | 6293 |
| WEST WINDSOR TWP | 16827.63 | 21907 | 16021 | 8542 | 6431 | 1711 |
| PENNINGTON BORO | 626.13 | 2696 | 2537 | 2109 | 2151 | 1335 |
| EAST WINDSOR TWP | 10122.96 | 24919 | 22353 | 21041 | 11736 | 922 |
| EWING TWP | 10136.37 | 35707 | 34185 | 34842 | 32831 | 6942 |
| MILLSTONE TWP | 23909.54 | 8970 | 5069 | 3926 | 2535 | 1428 |
| HAMILTON TWP | 25792.72 | 87109 | 86553 | 82801 | 79609 | 27121 |
| WASHINGTON TWP | 13197.36 | 10275 | 5815 | 3487 | 3311 | 1347 |
| TRENTON CITY | 5165.58 | 85403 | 88675 | 92124 | 104786 | 123356 |

| | | | | | | |
|---|---|---|---|---|---|---|
| ROOSEVELT BORO | 1251.17 | 933 | 884 | 835 | 814 | |
| UPPER FREEHOLD TWP | 30133.67 | 4282 | 3277 | 2750 | 2551 | 1867 |

**Table 6.3 Percent Change in Population Densities 1970, 2000**

| Municipality | Area acres | Pop2000 | Pop1970 | % Change |
|---|---|---|---|---|
| ALEXANDRIA TWP | 17713.82 | 4698 | 2127 | 120 |
| HOLLAND TWP | 15363.97 | 5124 | 3587 | 43 |
| FRANKLIN TWP | 14712.47 | 2990 | | 39 |
| RARITAN TWP | 24159.22 | 19809 | 6934 | 186 |
| MILFORD BORO | 795 | 1195 | 1230 | -3 |
| KINGWOOD TWP | 22900.58 | 3782 | 2294 | 65 |
| FRENCHTOWN BORO | 773.83 | 1488 | 1459 | 2 |
| DELAWARE TWP | 23675.4 | 4478 | 3249 | 38 |
| EAST AMWELL TWP | 18327.65 | 4455 | 2568 | 73 |
| WEST AMWELL TWP | 13995.78 | 2383 | 2142 | 11 |
| HOPEWELL TWP | 37536.07 | 16105 | 10030 | 61 |
| STOCKTON BORO | 383.66 | 560 | 619 | -10 |
| LAMBERTVILLE CITY | 791.97 | 3868 | 4359 | -11 |
| LAWRENCE TWP | 13991.13 | 29159 | 19567 | 49 |
| WEST WINDSOR TWP | 16827.63 | 21907 | 6431 | 241 |
| PENNINGTON BORO | 626.13 | 2696 | 2151 | 25 |
| EAST WINDSOR TWP | 10122.96 | 24919 | 11736 | 112 |
| EWING TWP | 10136.37 | 35707 | 32831 | 9 |

| | | | | |
|---|---|---|---|---|
| MILLSTONE TWP | 23909.54 | 8970 | 2535 | 254 |
| HAMILTON TWP | 25792.72 | 87109 | 79609 | 9 |
| WASHINGTON TWP | 13197.36 | 10275 | 3311 | 210 |
| TRENTON CITY | 5165.58 | 85403 | 104786 | -18 |
| ROOSEVELT BORO | 1251.17 | 933 | 814 | 15 |
| UPPER FREEHOLD TWP | 30133.67 | 4282 | 2551 | 68 |

## TABLE 9 MUNICIPAL POPULATION PROJECTIONS

| | 2005 | 2010 | 2020 |
|---|---|---|---|
| East Windsor Twp | | 30,073 | 32,653 |
| Ewing Twp | | 37,090 | 36,458 |
| Hamilton Twp | | 91,472 | 90,998 |
| Hopewell Twp | | 17,192 | 19,311 |
| Lawrence Twp | | 32,485 | 37,015 |
| Pennington Boro | | 2,707 | 2,838 |
| Trenton City | | 90,720 | 91,882 |
| Washington Twp | | 9,273 | 12,516 |
| West Windsor Twp | | 25,311 | 30,702 |
| **Mercer County** | | **370,896** | **388,452** |

*Source: DVRPC w/Mercer County, 1993*

| | | | |
|---|---|---|---|
| Alexandria Twp | | 5,525 | |
| Delaware Twp | | 5,955 | |
| East Amwell Twp | | 5,775 | |
| Franklin Twp | | 3,800 | |
| Frenchtown Boro | | 1,600 | |
| Holland Twp | | 5,970 | |
| Kingwood Twp | | 4,190 | |
| Lambertville City | | 5,040 | |
| Milford Boro | | 1,515 | |
| Raritan Twp | | 2,220 | |
| Stockton Boro | | 745 | |
| West Amwell Twp | | 3,900 | |
| **Hunterdon County** | | **149,150** | |

*Source: Hunterdon County, 1990*

| | | | |
|---|---|---|---|
| Millstone Twp | 8,633 | | 11,538 |
| Roosevelt Boro | 905 | | 957 |
| Upper Freehold Twp | 3,980 | | 4,425 |
| **Monmouth County** | **654,568** | | **702,599** |

*Source: Monmouth County, 1998*

## 8.3 Economic Development in the Central Delaware Tributaries

New office, commercial or residential development can have impacts on water quality during the construction phase (as sedimentation increases while land is cleared for construction) and continuing impacts on water quality once the project is completed. Increased surface runoff from impervious surfaces associated with development (roofs, roads, grading of soil for lawns) contributes pollution and scouring damage to creeks (as their baseflows are modified) (Schueler, 1994).

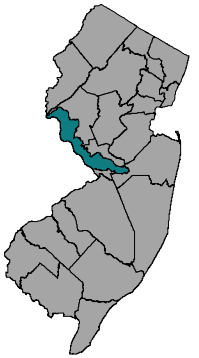
It is important for municipal officials to understand the importance of their role in determining the location of development. Some areas of a watershed are more appropriate for development than others. For example, building should be encouraged in areas already sewered (see Figure 18), designated by the State Plan as appropriate for growth (see Figure 19), and set back from stream banks. On the other hand, building should be discouraged near the headwaters of streams, in water recharge areas, and in stream corridors.

The Regional Planning Partnership has completed a build-out analysis of current zoning for Mercer County; is nearing completion of the build-out for Hunterdon; and will begin the build-out analysis for the three townships of the Central Delaware Tributaries located in Monmouth County. RPP's model, called GOZ™ –Goal-Oriented Zoning – will be used to demonstrate how build-out patterns can be changed to promote certain goals e.g., water quality protection, State plan center proposals, etc.

The economy of the Central Delaware Tributaries currently varies in emphasis from the northern to the southern sections of the watershed management area. For example, Agricultural/Forestry/Fishing occupations make up 1.3% of employment in Hunterdon County, 1.1% in Monmouth County and .9% of employment in Mercer County. However, more than 70% of employment is found in service, professional, administration or sales occupations in all three counties. Hunterdon County has the highest amount of employment in goods production 26.3%, followed by Monmouth County 18.1%, and Mercer County at 16.8% (NJ Department of Labor, Estimated and Projected Employment by Major Occupational Group, 1998-2008 online data).

In a preliminary analysis of economic development affects on Water Quality in the Central Delaware Tributaries, the Regional Planning Partnership overlaid data on growth in housing units between 1992-1997 with water quality impairment data (see Figure 20). No direct correlation was found, indicating other economic factors such as agricultural land practices, and industry wastewater practices need to be investigated for their impact on water quality in the Central Delaware Tributaries.

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01

N

0 3 6 Miles

## Sewer Service Type & Population Density

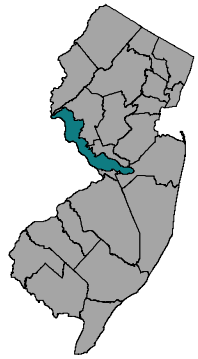
Population Density 2000
- 1 Dot = 50

WMA 11

Sewer Service Type
- Groundwater Discharge (less than 20,000 gpd)
- Groundwater Discharge (more than 20,000 gpd)
- Septic
- Surface water Discharge

Source:
NJDEP
NJOSP
US Census

# Central Delaware Tributaries
## Watershed Management Area 11



www.delawaretribs.org

Created by The Regional Planning Partnership 8/13/01



## State Planning Areas

- WMA 11

State Plan Planning Areas

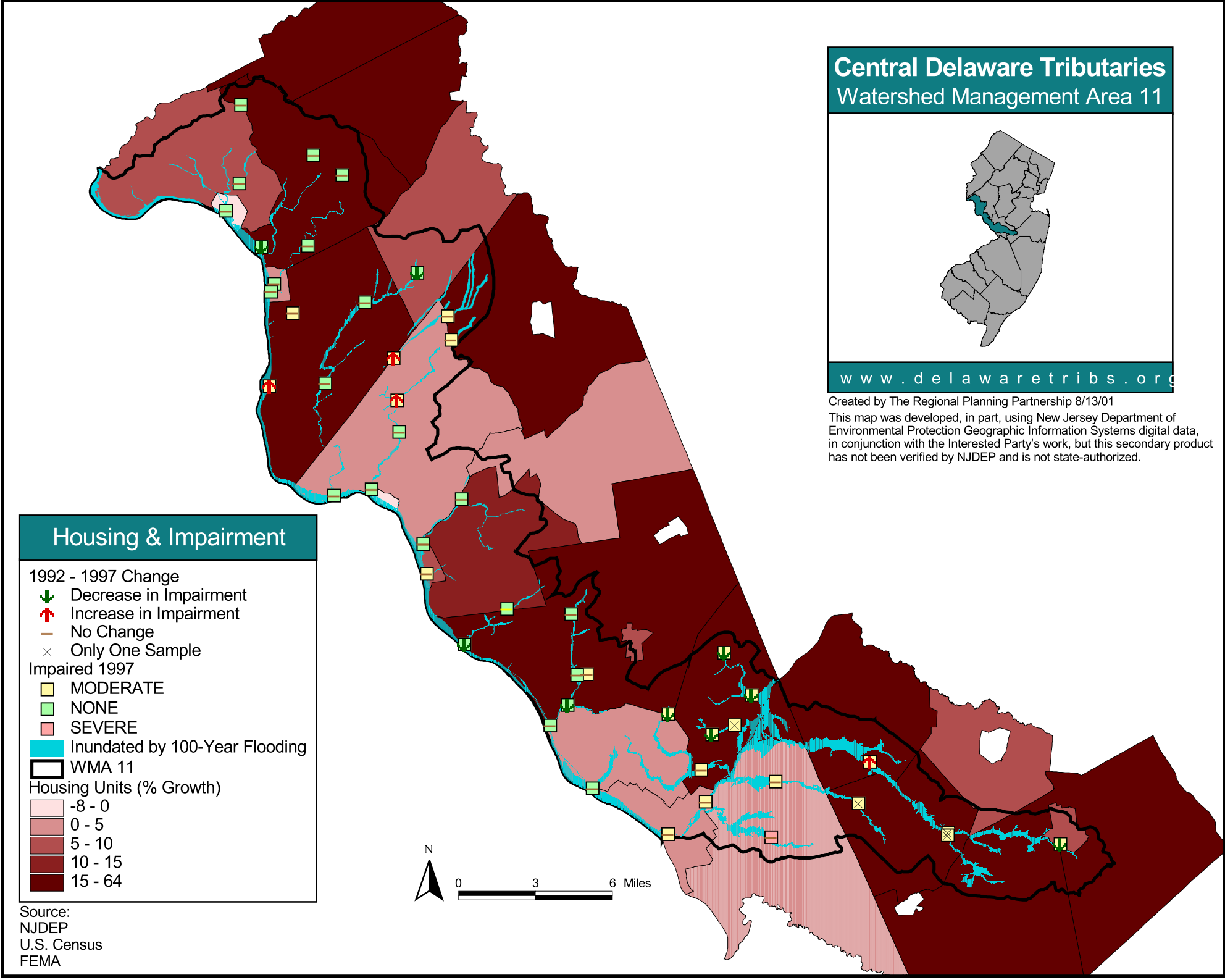
- METROPOLITAN (PA 1)
- FRINGE (PA 3)
- SUBURBAN (PA 2)
- ENVIRONMENTALLY SENSITIVE (PA 5)
- RURAL (PA 4)
- COUNTY PARK (PA 6)
- PARK 2ND PLAN (PA 6)
- STATE PARK (PA 8)
- RURAL ENV. SENSITIVE (PA 42)

N

0 4 8 Miles

Source:
NJDEP
OSP

This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.


Central Delaware Tributaries
Watershed Management Area 11
www.delawaretribs.org
Created by The Regional Planning Partnership 8/13/01
This map was developed, in part, using New Jersey Department of Environmental Protection Geographic Information Systems digital data, in conjunction with the Interested Party's work, but this secondary product has not been verified by NJDEP and is not state-authorized.
Housing & Impairment
1992 - 1997 Change
Decrease in Impairment
Increase in Impairment
No Change
Only One Sample
Impaired 1997
MODERATE
NONE
SEVERE
Inundated by 100-Year Flooding
WMA 11
Housing Units (% Growth)
-8 - 0
0 - 5
5 - 10
10 - 15
15 - 64
N
0
3
6 Miles
Source:
NJDEP
U.S. Census
FEMA

## 8.4 Transportation Infrastructure

Road networks increase impervious cover in a watershed by their surfaces and by facilitating development which in turn increases impervious cover. Sheuler (1994) has demonstrated that when impervious cover exceeds 10% of a watershed the health of streams suffers significant impairment. The Central Delaware Tributaries contains major transportation corridors in the southern part of the watershed management area including : Route 1, I-95 and I-295. The middle section of the Central Delaware Tributaries contains Route 202. Fewer major roads are found in the north. Route 29 is the north-south connector to I-95.

The use of the automobile also contributes to airborne deposition of pollutants which can adversely affect water quality. New Jersey has more miles of highway/sq. mi. and more cars/mile than any other state (Rogers et al., 1987).

## 8.5 Institutional Capability for Implementing Watershed Planning

Once a source of impairment to a stream is identified, enforcement and/or education options exist which may be able to remediate the impairment to a certain extent. However, careful land use planning can prevent or ameliorate negative impacts on water quality. Federal, state and local institutions with plans proposed or underway which will affect water quality are listed below.

### 8.5.1 Open Space Identification for Natural Resources and Recreation

Open space provides valuable habitat for wildlife, areas for recreation, and aesthetic benefits. Hunterdon County, Mercer County and Monmouth County all have open space plans that identify areas for protection. Hunterdon County has identified 50,000 acres of farmland for preservation by 2010 and a need for 12,300 additional acres of county parkland by 2020. Streams and river corridors are among the 17 parkland conservation zones identified by Hunterdon County as worth collaborating with state and federal agencies to protect (Hunterdon County Planning Board, 2000).

Efforts to develop trails and promote other recreation uses are underway through the NJ DEP Office of Green Acres which administers the Garden State Preservation Trust. The Office of Green Acres directly purchases or assists municipalities, counties and non-profits in the purchase of open space. The Office of Green Acres buys land on behalf of the NJDEP Division of Parks and Forestry, Division of Fish and Wildlife and the Natural Lands Trust and the Delaware and Raritan Canal Commission. The Green Acres program has recommended that open space conservation include the following:

- All subwatersheds designated FW1, FW2 Trout Production or Trout Maintenance,
- All wildlife habitats which are restricted to specific known areas
- All areas designated as having high frequency occurrence of plant species.

The Office of Natural Lands Management within the NJDEP Division of Fish and Wildlife is responsible with the New Jersey Trails Plan and the Natural Heritage Priorities Sites.

Organizations such as D&R Greenway Inc., NJ Conservation Foundation, Hunterdon Land Trust Alliance, New Jersey Natural Lands Trust (under the Division of Parks and Forestry), the Nature Conservancy, etc. are also involved in projects to protect open space in the Central Delaware Tributaries (e.g., the Wickecheoke Greenway project). The Assunpink Greenway Project, sponsored by the City of Trenton, is looking at ways to reclaim open space and re-create natural riparian corridor for the currently concrete-channeled Assunpink Creek within the City of Trenton.

### 8.5.2 Protected Open Space in the Central Delaware Tributaries

Areas that are currently protected open space lands are identified in Figure 9. This Figure illustrates the overlap between Natural Heritage Priority sites and preserved open space. It is clear that not all priority sites are protected.

Hunterdon County maintains 5,389 acres of parkland in five categories: unimproved natural areas, improved natural areas, linked/greenway area, general use area, and special use area. At 8,200 acres, Hunterdon County ranks third in the state for permanently protected farmland acreage acquired through the State Farmland Protection Act (Hunterdon County Planning Board, 2000). However, this represents only 5.6 % of farmland assessed properties and 3% of the total land base of Hunterdon County. The Hunterdon County Cultural and Heritage Commission has been charged with evaluating historic facilities for their need for rehabilitation.

Areas already protected in the south of the watershed management area include the Assunpink Wildlife Management Area (protecting wetlands along the Assunpink Creek above Shipetaukin Creek).

### 8.5.3 Federal Initiatives Related to Watershed Planning in the Central Delaware Tributaries

The US Forest Service is undertaking an ecoregion assessment of the Highlands Region (which includes the northernmost watersheds in the Central Delaware Tributaries.)

USGS is building a model to assess the impacts of land use on surface water and wells.

FEMA has identified floodprone regions within the Central Delaware Tributaries.

### 8.5.4 State Initiatives Related to Watershed Planning in the Central Delaware Tributaries

The NJ State Plan has designated more than one-third of the Central Delaware Tributaries as Environmentally Sensitive (PA 5) or Rural Environmentally Lands (PA 42) (NJ State Planning Commission, map).

The D&R Canal Commission requires a permit to build an acre or more of impervious surface within 100 feet of the 100-year floodplain of the Canal's tributary streams (Goodspeed, 1997).

The Source Water Assessment and Protection Program is identifying areas requiring protection around wells to maintain drinking water quality (Kreitzman, personal comment).

### 8.5.5 County and Municipal Initiatives Related to Watershed Planning in the Central Delaware Tributaries

Municipalities have the power to enact conservation easements for stream corridor or other land use restrictions to protect water quality. Municipalities also have zoning ordinances and master plans which dictate land uses affecting water quality. See Table 10 for a preliminary assessment of the master plan elements and zoning ordinances currently adopted by the 24 municipalities of the Central Delaware Tributaries.

Millstone Township appears in the forefront of Master Plan elements and zoning ordinances related to water quality protection and could be used as a model by other municipalities in the Central Delaware Tributaries.

Hunterdon County has just received a Smart Growth Grant to develop a growth management plan. It will be essential for this initiative to be linked to the watershed planning process.

Upper Freehold and Millstone are also interested in obtaining smart growth grants.

One significant resource in protecting water quality is the presence of Soil Conservation Districts at the County level. These organizations are empowered

to work with farmers and developers to reduce the deleterious effects of sedimentation and other impacts on streams.

### 8.5.6 Non-Governmental Organizations

The Delaware River Greenway Partnership is undertaking planning related to the designation of the Delaware River flowing along the Central Delaware Tributaries as a Wild and Scenic River.

The nascent Assunpink Watershed Association and the well-established Delaware River Keeper Network are active in raising awareness about stream quality in the Central Delaware Tributaries.

## 9 Preliminary Assessment of the Physical and Ecological Characteristics of the Central Delaware Tributaries

### 9.1 Aquatic Life Use and Fishable Use Assessment

In summary, 52% (25 streams) in the Central Delaware Tributaries show no biological impairment (in New Jersey as a whole less than 35% of streams are biologically unimpaired). Forty six percent (22 streams) are moderately biologically impaired and 2% (one stream) show severe biological impairment. In the period between 1992-1997 18% of streams improved in water quality while 8% degraded.

The one Fish Index of Biotic Integrity done by NJDEP in the Central Delaware Tributaries rated the Shipetaukin Creek as fair. All freshwater bodies in New Jersey are under a mercury advisory for fish consumption.

### 9.2 Potable Water Use Assessment

Only one water supply utility in the Central Delaware Tributaries watershed management area reported exceeding the Maximum Contaminant Levels for potable water – the Trenton Water Works reported that 4 out of 110 homes are considered to have elevated levels of lead in their water. However, this result was attributed to corrosion of household plumbing and not to the quality of water entering the Trenton Water Works system.

While public community water supply has not been identified by the State Water Supply Plan as a significant issue for the northern and central parts of the Central Delaware Tributaries it has been identified as an issue for the Assunpink watersheds. However, members of the Central Delaware Tributaries Characterization and Assessment committee identified private well supply as a concern for the middle and northern sections of the watershed management

area. Water conservation as well as recharge issues, therefore, need to be included in watershed planning for the Central Delaware Tributaries.

### 9.3 Swimable Use Assessment

Based on DRBC and USGS sampling, streams in the Central Delaware Tributaries do not support the swimable use for certain parts of the summer due to fecal coliform accidences.

### 9.4 Habitat Assessment

Less than half of the priority habitats identified by NJDEP are currently protected. No stream corridors in the Central Delaware Tributaries are fully protected from encroachment.

### 9.5 Physical and Ecological Data Needs

- Evaluate factors contributing to changes in biological impairment status (USGS land use impacts project, NJDEP Source Water Assessment Program, AmeriCorps Watershed Ambassador data, etc.)
- Aquifer and recharge information (NJGS)
- Riparian corridor status (% of streams with forest cover, % of streams with less than 2 road crossings per .62 miles of stream length) (RPP GIS manipulation)
- Better aggregation of soil types based on suitability for agriculture, permeability for septic suitability, erodibility (RPP GIS manipulation)
- Water budget (NJDEP)
- Impervious cover rating for subsheds between 2-10 sq. mi.

## 10 Preliminary Assessment of the Social and Economic Characteristics of the Central Delaware Tributaries

### 10.1 Identification of Critical Lands for Protection of Water Quality

A number of plans for protection of open space and natural resources already exist for the Central Delaware Tributaries. They need to be analyzed to determine if they will adequately protect water quality if implemented. Few municipalities have given direction to developers about where development is, therefore, appropriate and should go.

### 10.2 Institutional Capability for Watershed Planning

Less than half of the municipalities in the Central Delaware Tributaries make provision for stream corridor setbacks in their Master Plans and only three

include zoning ordinances for water quality standards. More work with municipalities will be required to ensure water quality goals are met by identifying protection mechanisms (including zoning and BMPs) and by identifying areas appropriate for development.

# Watershed Preparedness Index
# WMA 11 Hunterdon County

| | Master Plan | | | | | | Land Use Ordinances | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Municipality | NRI | C | G/O | F | SC | WR | D | E | EIR | FP | NF | RTF | S | SC | SS | SL | SW | V | WL | WQ | **TOTAL** |
| Alexandria Twp | | * | * | * | * | * | | | | * | * | | | | * | * | * | * | | * | 12 |
| Delaware Twp | * | * | * | * | | | | | * | * | | | | | | * | * | | | * | 9 |
| East Amwell Twp | | * | * | * | * | * | * | | | * | | | * | | * | | | * | | | 10 |
| Franklin Twp | | * | * | * | * | * | | | | * | | | | | * | | | | | | 7 |
| Frenchtown Boro | * | * | * | | | * | | | * | | * | | | | | | | | | | 6 |
| Holland Twp | | * | * | * | | | * | | | | | | | | | | * | | | | 5 |
| Kingwood Twp | | * | * | * | | | | | | | | * | | | | | | | | | 4 |
| Lambertville City | * | | * | | | | * | | | | * | | * | | | * | | * | | | 7 |
| Milford Boro | | * | * | | * | | | | | * | * | | * | | | * | | * | | | 8 |
| Raritan Twp | | | | * | | * | * | | | | | | * | * | | | * | | | | 6 |
| Stockton Boro | * | | | | | | | | * | | | | | | * | | * | | | | 4 |
| West Amwell Twp | | * | * | * | | | | | | | * | | * | * | | * | | * | | | 8 |

# Watershed Preparedness Index
# WMA 11 Mercer and Monmouth Counties

| | Master Plan | | | | | | Land Use Ordinances | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Municipality** | NRI | C | G/O | F | SC | WR | D | E | EIR | FP | NF | RTF | S | SC | SS | SL | SW | V | WL | WQ | **TOTAL** |
| East Windsor Twp | * | * | * | | | | * | | | | * | | * | | * | | | | | | 7 |
| Ewing Twp | | | * | | | | * | | | | | | | | | | | * | | | 3 |
| Hamilton Twp | | * | | * | | | * | | | * | | | | | | | | | | | 4 |
| Hopewell Twp | * | * | * | * | * | | * | | * | * | | | * | | | | * | | | | 10 |
| Lawrence Twp | * | * | * | | | | * | * | | * | * | | * | | * | | * | * | | | 11 |
| Pennington Boro | | | * | | | | | | | | * | | | * | | | | * | | | 4 |
| Trenton City | | | | | | | | | | | | | | | | | | | | | |
| Washington Twp | * | * | * | * | * | | * | | | | * | | * | * | | | * | * | | | 11 |
| West Windsor Twp | * | * | * | | * | * | | | | * | * | * | * | | | | | * | | | 10 |
| Millstone Twp | * | * | * | * | * | * | * | * | | * | * | | * | * | * | * | * | * | * | * | 18 |
| Roosevelt Boro | | * | * | | | | * | | | * | | | * | | * | | | * | | | 7 |
| Upper Freehold Twp | | * | | * | | * | * | * | | * | * | | * | * | | | * | * | | | 11 |

| **KEY** | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Master Plan* | | | | | | *Land Use Ordinances* | | | | | | | | | | | | | | | |
| NRI - Natural Resources Inventory | | | | | | D - Drainage / Detention & Retention Fac. | | | | | | | | SC - Stream Corridor Setbacks | | | | | | | |
| C - Conservation | | | | | | E - Easements (Conservation) | | | | | | | | SS - Soil Erosion & Sedimentation Control | | | | | | | |
| G/O - Greenway / Open Space | | | | | | EIR - Environmental Impact Report | | | | | | | | SL - Slope Protection | | | | | | | |
| F - Farmland Preservation | | | | | | FP - Floodplain & Flood Hazard Area Protection | | | | | | | | SW - Stormwater Management | | | | | | | |
| SC - Stream Corridor Setbacks | | | | | | NF - Natural Features (Open Space) Pres. | | | | | | | | V - Vegetation and/or Tree Protection | | | | | | | |
| WR - Water Report (or Quality) | | | | | | RTF - Right-To-Farm | | | | | | | | WL - Wildlife Protection | | | | | | | |
| | | | | | | S - Topsoil Protection | | | | | | | | WQ - Water Quality Standards | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| **Hunterdon Avg** | **Mercer Avg** | | | **Monmouth Avg** | | | | **TOTAL AVG** | | | | **Lowest** | | | **Highest** | | | | | | |
| 7.2 | 7.5 | | | 12.0 | | | | 7.9 | (of 23) | | | Ewing (3) | | | Millstone (18) | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

Soil Conservation Districts and the Farm Bureau can be of great value in educational efforts related to Best Management Practices for reducing impacts on streams. However, members of the Central Delaware Tributaries Land Use Committee identified policies of the Farm Bureau and State Forester which appear to be in conflict with measures to protect water quality.

## 10.4 Social and Economic Data Needs

More information relating to social and economic factors impacting water quality remains to be gathered as follows:

- Municipal growth management plans
- Transportation plans
- Current zoning build out and alternative zoning options focusing on water quality protection
- Information on state policies which appear to conflict with water quality protection

## References


Amon, James C. Delaware and Raritan Canal State Park Master Plan Second Edition. D&R Canal Commission, N.J., 1989.

Bierhorst, John. Mythology of the Lenape Guide and Texts. The University of Arizona Press, 1995.

Cawley James and Margaret. Exploring the Little Rivers of New Jersey. Rutgers Press, New Brunswick. NJ, 1971.

Collins, Beryl R., Anderson, Karl H. 1994. Plant Communities of New Jersey: A Study in Landscape Diversity. Rutgers University Press, New Brunswick, N.J.

Delaware River Basin Commission. Unpublished data. 1999 Survey of the Lower Non-Tidal Delaware River and Pilot Study for a Long Term Water Quality Monitoring Network.

Dowd, Gregory E. The Indians of New Jersey. New Jersey Historical Commission, Department of State, 1992.

Fund for Roosevelt, pamphlet, 1999.

Goodspeed, M., Lockwood, S., Rawlyk B., Salamore, K., Thomas, J.M., Upmeyer, M. The Wickecheoke and the Lockatong Two Hunterdon County Creeks. Goodspeed, M., Delaware Township, NJ, 1997.

Hunterdon County Planning Board. Hunterdon County Open Space, Farmland, and Historic Preservation Trust Fund Plan. Hunterdon County, NJ, 2000.

Hunterdon Online website.

Jacobsen, E., M. Hardy, B. Kurtz. Hydrologic conditions in the Jacobs Creek, Stony Brook and Beden Brook Drainage Basins West Central New Jersey 1986-1988. USGS, West Trenton, 1993.

Kraft, Herbert, C. The Lenape or Delaware Indians. Seton Hall University Museum, 1991.

Kreitzman, Sandy. Source Water Assessment Program. Personal Comment by telephone 2001.

Kruger, Anne, L. WMA 6 Open Space Priorities, 2000.

Lower Delaware River Wild and Scenic River Study Task Force and National Park Service, Northeast Area. Lower Delaware Management Plan. National Park Service, Philadelphia, PA, 1997.

New Jersey Department of Environmental Protection (NJDEP):
NJDEP Bureau of Safe Drinking Water. Safe Drinking Water Act Violations, 1999.

NJDEP 1996. Water for the 21st Century: The Vital Resource: New Jersey Statewide Water Supply Plan. NJDEP Office of Environmental Planning.

NJDEP 2000. Exploring New Jersey's Watersheds GIS CD-ROM.

NJDEP Division of Science and Research. 1999. Water Quality Inventory 305b Report.

NJDEP Division of Science and Research. 2000. Water Quality Inventory 305b Report.

NJDEP Green Acres web site

NJ Department of Labor, Labor Markets and Demographic Research, online database.

NJPIRG website

New Jersey State Planning Commission. 2000. State Development and Redevelopment Plan. Trenton N.J.

NJ Water Supply Authority. Setting of the Raritan River Basin. 2000.

Nichols, R. personal comment, Characterization and Assessment Committee meeting August 23, 2001.

Office of Natural Lands Management 1996. New Jersey Trails Plan.

Rogers, Golden & Halpern. Environmental Elements of the New Jersey State Development and Redevelopment Plan, Philadelphia, PA, 1987.

Roy Mann Associates, Inc. The Rockaway River & Its Treasured Resources. Friends of the Rockaway River: Morris County, NJ, 1998.

Sauer, L. personal comment, Land Use Committee meeting August 29, 2001.

Schueler, T. R. 1993. Impact of Riparian Forest Cover on Mid-Atlantic Stream Ecosystems. Watershed Protection Techniques 1,1: 29.

Schueler, T.R. 1994. The Importance of Imperviousness. Watershed Protection Techniques 1,3: 100-11.

Tedrow, John. 1986. Soils of New Jersey. Rutgers, the State University of New Jersey. Robert E. Kriger Publishing Co. Malabar, FL.

Tiner, Ralph W.J. Wetlands of New Jersey. US Fish and Wildlife Service, 1985.

Trenton Waterworks. Consumer Confidence Report, 2000.

USDA National Agricultural Statistics Service (NASS). GIS Data Washington D.C.

US Environmental Protection Agency. 1998 Section 303d Water Quality Limited Waters in New Jersey. Website.

United States Geological Survey (USGS). 2000. Water Resources Data – NJ Water Quality.