Delaware River Basin Commission

2006 Delaware River and Bay Integrated List Water Quality Assessment

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Delaware River Basin Commission
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Introduction and Overview

This report provides an assessment of the Delaware River's support of various uses from 2002 through 2004 that are protected by the Delaware River Basin Commission's (DRBC) Water Quality Regulations, or by the federal Clean Water Act of 1972. The uses are: maintenance of aquatic life; providing a raw water source for human consumption; swimming and recreation; fish consumption; and shellfish consumption. The assessment involves comparison of several key water quality parameters with applicable DRBC water quality standards and stream quality objectives. DRBC Water Quality Regulations also designate agricultural and industrial uses for the Delaware River. However, since these two uses would require less stringent water quality criteria than the other uses discussed, they were not assessed for this report.

Assessed water bodies (assessment units) are placed into one of five categories. These are based primarily upon the totality of designated use support within those water bodies as well as the availability of data for assessing water quality in those water bodies. For each designated use, in each assessment unit, a number of water quality parameters, relevant to the use, are compared to the existing, applicable water quality criteria. The methodology used to make the assessments is presented in Part 3 of this report.

1. Summary

Table 1.1 shows the levels to which the assessed portions, or assessment units, of the non-tidal Delaware River supported their designated uses during the 2002 through 2004 monitoring seasons. Segments of the River that were assessed as not supporting the aquatic life designated use were 1A1 and 1A2, due to high pH, and 1D4 due to Total Dissolved Solids. Additionally, the recreation designated use was considered not supported in 1E3 and 1E4 due to fecal coliform. The drinking water designated use was considered supported in all assessment units for which sufficient data were available. The Fish consumption use was the most widely non-supported use, with the entire non-tidal Delaware River falling under one or more state fish consumption advisories.

Table 1.2 provides a summary of the extent of use support for the designated uses, in the different assessment units of the Delaware Estuary. The aquatic life designated use was considered not supported in 5C due to low dissolved oxygen. The recreation designated use was considered supported in all assessment units for which sufficient data were available. The drinking water designated use was considered to be supported in 2 and 3, the parts of the Estuary where drinking water is a designated use. The fish consumption designated use was considered to be not supported in any part of the Estuary, due to state fish consumption advisories that are in place.

Table 1.3 provides a summary of the extent of use support for the designated uses, in different assessment units of the Delaware Bay. The aquatic life designated use was considered to be supported in all assessment units for which sufficient data were available. The recreation designated use was not considered to be supported in 6nj8 due to high enterococcus bacteria. Fish consumption was not supported in any portion of the Bay due to the presence of state fish consumption advisories. The shellfish designated use was considered not supported in all areas closed to shellfish harvesting or where recent total coliform bacteria data showed that the use was not supported. These areas correspond to 6br1a, 6br2a, 6br2d, 6br3a, 6de2, 6de3, 6de4, 6de5, 6nj6, 6nj7, 6nj8 and 6nj9.

Tables 1.4 and 1.5 provide a summary of use support by region (Non-Tidal and Estuary/Bay), expressed in miles or square miles and percent of total miles or total square miles.

Tables 1.6 - 1.8 provide an overview of causes and sources of pollutants or conditions that created the non-support of uses as described in this report. The causes of the non-support are the chemical constituents, pollutants or conditions that created the criteria violations. The source is the activity that creates the condition or pollutant, or causes the pollutant to enter the stream. In many circumstances, professional judgment was used in identifying possible sources.

Table 1.1: Use Support in Non-Tidal River Assessment Units from 2006 Integrated Assessment

AU	River Miles*	DO	pH	Fecal Col.	TDS Aquatic Life	TDS Drinking Water	Alkalinity	Aquatic Life Assessment	Recreation Assessment	Drinking Water Assessment	Fish Consumption Assessment	Final Assessment
1A1	335.54-308.01	+	-	+	ID	ID	NA	Not Supported	Supported	ID	Not Supported	5
1A2	308.01-299.38	+	-	+	ID	ID	NA	Not Supported	Supported	ID	Not Supported	5
1A3	299.38-293.62	+	+	+	ID	ID	NA	ID	Supported	ID	Not Supported	5
1B1	293.62-281.11	ID	ID	+	ID	ID	NA	ID	Supported	ID	Not Supported	5
1B2	281.11-264.88	+	+	+	ID	ID	NA	Supported	Supported	ID	Not Supported	5
1B3	264.88-257.67	+	+	+	ID	ID	NA	ID	Supported	ID	Not Supported	5
1C1	257.67-256.53	ID	ID	ID	ID	ID	NA	ID	Probably Supported	ID	Not Supported	5
1C2	256.53-229.85	+	+	+	+	+	NA	Supported	Supported	Supported	Not Supported	5
1C3	229.85-228.13	+	+	+	ID	ID	NA	ID	Supported	ID	Not Supported	5
1C4	228.13-219.35	ID	ID	ID	ID	ID	NA	ID	Probably Supported	ID	Not Supported	5
1D1	219.35-214.70	+	+	+	ID	ID	NA	ID	Supported	ID	Not Supported	5
1D2	214.70-210.20	+	+	+	ID	ID	NA	ID	Supported	ID	Not Supported	5
1D3	210.20-200.89	+	+	+	+	+	NA	Supported	Supported	Supported	Not Supported	5
1D4	200.09-192.71	+	+	+	-	+	NA	Not Supported	Supported	Supported	Not Supported	5
1D5	192.71-185.83	ID	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	5
1D6	185.83-185.41	ID	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	5
1E1	185.41-179.02	+	+	+	+	+	+	Supported	Supported	Supported	Not Supported	5
1E2	179.02-176.16	ID	ID	ID	ID	ID	ID	Probably Supported	ID	Probably Supported	Not Supported	5
1E3	176.16-173.88	+	+	-	+	+	+	Supported	Not Supported	Supported	Not Supported	5
1E4	173.88-156.22	+	+	-	+	+	+	Supported	Not Supported	Supported	Not Supported	5
1E5	156.22-133.4	+	+	+	+	+	+	Supported	Supported	Supported	Not Supported	5

Notes:
* River miles reflect National Hydrographic Dataset mileage system, which differs slightly from DRBC river mileage system.
ID: Insufficient data to compare this parameter to current water quality criterion
+(-): This parameter meets (does not meet) DRBC's current water quality criterion
Aquatic Life Use Support Assessed by: Dissolved Oxygen, pH, Total Dissolved Solids, Alkalinity
Recreation Use Support Assessed by: Fecal Coliform
Drinking Water Use Assessed by: TDS
Fish Consumption Use Assessed by: Presence of Advisories

Table 1.2: Use Support in Estuary Assessment Units from 2006 Integrated Assessment

Parameter	**Assessment Unit (River Miles)**					
	2 (133.4-108.4)	**3 (108.4-95.0)**	**4 (95.0-78.8)**	**5A (78.8-70.0)**	**5B (70.0-59.5)**	**5C (59.5-48.2)**
Dissolved Oxygen	+	+	+	ID	ID	-
Temperature	+	+	+	+	+	+
pH	+	+	+	+	+	+
Fecal Coliform	+	+	+	+	+	+
Enterococcus	+	+	+	+	+	+
Alkalinity	+	+	+	+	+	+
Hardness	+	+	NA	NA	NA	NA
Sodium	NA	+	NA	NA	NA	NA
Chloride	+	+	NA	NA	NA	NA
TDS	+	+	NA	NA	NA	NA
Toxicity	+	+	+	ID	ID	+
Toxic Parameters	-	-	-	-	-	-
Designated Use	**Use Support Level**					
Aquatic Life	Supported	Supported	Supported	ID	ID	Not Supported
Recreation	Supported	Supported	Supported	Supported	Supported	Supported
Drinking Water	Supported	Supported	NA	NA	NA	NA
Fish Consumption	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported	Not Supported
Final Assessment Category	**5**	**5**	**5**	**5**	**5**	**5**

Notes:
NA: DRBC criterion does not apply to this water quality zone
+(-): This parameter meets (does not meet) DRBC's current water quality criterion

Table 1.3: Use Support in Delaware Bay Assessment Units from 2006 Integrated Assessment

Assessment Unit	Miles[2]	DO	Temp.	pH	Alkalinity	Fecal	Entero.	Aquatic Life	Recreation	Fish	Shellfish	Final
6brA	47.10	+	+	+	+	+	+	Supported	Supported	Not Supported	Supported	5
6brB	40.82	+	+	+	+	+	+	Supported	Supported	Not Supported	Supported	5
6brC	22.39	+	+	+	+	+	+	Supported	Supported	Not Supported	Supported	5
6br1a	2.66	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Not Supported	5
6br1b	20.61	+	+	+	+	+	+	Supported	Supported	Not Supported	Supported	5
6br2a	1.09	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Not Supported	5
6br2b	25.88	+	+	+	+	+	+	Supported	Supported	Not Supported	Supported	5
6br2c	0.31	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Supported	5
6br2d	1.52	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Not Supported	5
6br3a	16.45	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Not Supported	5
6br3b	12.63	+	+	+	+	+	+	Supported	Supported	Not Supported	Supported	5
6br3c	8.53	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Supported	5
6de1	187.24	+	+	+	+	ID	+	Supported	ID	Not Supported	Supported	5
6de2	0.72	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Not Supported	5
6de3	5.31	ID	ID	ID	ID	ID	+	ID	ID	Not Supported	Not Supported	5
6de4	5.39	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Not Supported	5
6de5	5.81	+	+	+	+	ID	+	Supported	ID	Not Supported	Not Supported	5
6nj1	268.96	+	+	ID	ID	+	+	ID	Supported	Not Supported	Supported	5
6nj2	1.65	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Supported	5
6nj3	2.96	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Supported	5
6nj4	0.65	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Supported	5
6nj5	0.82	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Supported	5
6nj6	0.69	ID	ID	ID	ID	+	ID	ID	ID	Not Supported	Not Supported	5
6nj7	7.17	ID	ID	ID	ID	+	ID	ID	ID	Not Supported	Not Supported	5
6nj8	3.23	+	+	ID	ID	+	-	ID	Not Supported	Not Supported	Not Supported	5
6nj9	1.32	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Not Supported	5
6nj10	1.00	ID	ID	ID	ID	ID	ID	ID	ID	Not Supported	Supported	5

Table 1.4: Extent of Support of Designated Uses (Non-Tidal River)

Use	Total Miles	Miles Supporting	Miles with Insufficient Data	Miles Not Supporting
Aquatic Life	202	102	56	44
Fish Consumption	202	0	0	202
Primary Contact Recreation	202	162	20	20
Drinking Water	202	93	109	0

Table 1.5: Extent of Support of Designated Uses (Estuary and Bay)

Use	Total Area (mi^2)*	Area Supporting (mi^2)	Area with Insufficient Data (mi^2)	Area Not Supporting (mi^2)
Aquatic Life	790	394	364	31
Fish Consumption	790	0	0	790
Shellfishing	693	642	0	51
Primary Contact Recreation	769	514	251	3
Secondary Contact Recreation	21	21	0	0
Drinking Water	15	0	0	15

Note: Zone 2 = 8 square miles, Zone 3 = 7 square miles, Zone 4 = 17 square miles, Zone 5 = 65 square miles, Zone 6 = 693 square miles (total area is 790 square miles)

* Areas in columns 3, 4 and 5 may not add up to Total Area due to rounding.

Table 1.6: Overview of Causes and Potential Sources of Impairments in Non-Tidal Delaware River

Assessment Unit	Use Not Supported	Causes	Potential Sources
1A1	Aquatic Life	pH	Internal Nutrient Recycling*
1A1	Fish Consumption	Mercury	Air Deposition, Source Unknown
1A2	Aquatic Life	pH	Internal Nutrient Recycling*
1A2	Fish Consumption	Mercury	Air Deposition, Source Unknown
1A3	Fish Consumption	Mercury	Air Deposition, Source Unknown
1B1	Fish Consumption	Mercury	Air Deposition, Source Unknown
1B2	Fish Consumption	Mercury	Air Deposition, Source Unknown
1B3	Fish Consumption	Mercury	Air Deposition, Source Unknown
1C1	Fish Consumption	Mercury	Air Deposition, Source Unknown
1C2	Fish Consumption	Mercury	Air Deposition, Source Unknown
1C3	Fish Consumption	Mercury	Air Deposition, Source Unknown
1C4	Fish Consumption	Mercury	Air Deposition, Source Unknown
1D1	Fish Consumption	Mercury	Air Deposition, Source Unknown
1D2	Fish Consumption	Mercury	Air Deposition, Source Unknown
1D3	Fish Consumption	Mercury	Air Deposition, Source Unknown
1D4	Aquatic Life	Total Dissolved Solids	Natural Sources, Unknown Sources
1D4	Fish Consumption	Mercury	Air Deposition, Source Unknown
1D5	Fish Consumption	Mercury	Air Deposition, Source Unknown
1D6	Fish Consumption	Mercury	Air Deposition, Source Unknown
1E1	Fish Consumption	Mercury	Air Deposition, Source Unknown
1E2	Fish Consumption	Mercury	Air Deposition, Source Unknown
1E3	Fish Consumption	Mercury	Air Deposition, Source Unknown
1E3	Primary Contact Recreation	Fecal Coliform	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
1E4	Fish Consumption	Mercury	Some Industrial Point Sources, Nonpoint Sources, Air Deposition
1E4	Primary Contact Recreation	Fecal Coliform	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
1E5	Fish Consumption	Dioxins, Mercury, PCBs	Brownfield Sites, Contaminated Sediments, Air Deposition, Source Unknown

* Excessive plant growth, if a source of pH criterion exceedence, may be caused by nutrient enrichment

Table 1.7: Overview of Causes and Potential Sources of Impairments in Delaware Estuary

Assessment Unit	Use Not Supported	Causes	Potential Sources
2	Fish Consumption	PCBs, Dioxins, Chlordane, Dieldrin, DDD, DDE, DDT, Mercury	Air Deposition, Brownfield Sites, Contaminated Sediments, Inappropriate Waste Disposal, Pesticide Application, Source Unknown
3	Fish Consumption	PCBs, Dioxins, Chlordane, Dieldrin, DDD, DDE, DDT, Mercury	Air Deposition, Brownfield Sites, Contaminated Sediments, Inappropriate Waste Disposal, Pesticide Application, Source Unknown
4	Fish Consumption	PCBs, Dioxins, Chlordane, Dieldrin, DDD, DDE, DDT, Mercury	Air Deposition, Brownfield Sites, Contaminated Sediments, Inappropriate Waste Disposal, Pesticide Application, Source Unknown
5a	Fish Consumption	PCBs, Dioxins, Chlordane, Dieldrin, DDD, DDE, DDT, Mercury	Air Deposition, Brownfield Sites, Contaminated Sediments, Inappropriate Waste Disposal, Pesticide Application, Source Unknown
5b	Fish Consumption	PCBs, Dioxins, Chlordane, Dieldrin, DDD, DDE, DDT, Mercury	Air Deposition, Brownfield Sites, Contaminated Sediments, Inappropriate Waste Disposal, Pesticide Application, Source Unknown
5c	Aquatic Life	Dissolved Oxygen	Agriculture, Habitat Modification, Municipal Point Source Discharges, Package Plant or Other Permitted Small Flows Discharges, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO)
5c	Fish Consumption	PCBs, Dioxins, Chlordane, Dieldrin, DDD, DDE, DDT, Mercury	Air Deposition, Brownfield Sites, Contaminated Sediments, Inappropriate Waste Disposal, Pesticide Application, Source Unknown

Table 1.8: Overview of Causes and Potential Sources of Impairments in Delaware Bay

Assessment Unit	Use Not Supported	Causes	Potential Sources
All Units	Fish Consumption	Chlordane, DDD, DDE, DDT, Dieldrin, Dioxin, Mercury, PCBs	Atmospheric Deposition, Brownfields, Contaminated Sediments, Wet Weather Discharges (Non-Point Source), Source Unknown
6br1a	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6br2a	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6br2d	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6br3a	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6de2	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6de3	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6de4	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6de5	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6nj6	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6nj7	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6nj8	Primary Contact Recreation	Enterococcus	On-site Treatment Systems (Septic Systems and Similar Decentralized Systems), Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6nj8	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown
6nj9	Shellfishing	Pathogens	Residential Districts, Wet Weather Discharges (Non-Point Source), Wet Weather Discharges (Point Source and Combination of Stormwater, SSO or CSO), Source Unknown

2. Background

This section gives an overview of the Delaware River Basin's water resources and other geographic statistics. A brief discussion of the various aspects of the Delaware River Basin Commission's (DRBC) water pollution control program is also provided, including how it relates to some other regulatory entities in the Basin. Finally, a description of some special issues of concern and recommendations for dealing with them is given.

2.1 An Overview of the Delaware River Basin

The Delaware is the longest un-dammed river east of the Mississippi, extending from the confluence of its East and West branches at Hancock, N.Y. to the mouth of the Delaware Bay. 216 tributaries feed the river, the largest being the Schuylkill and Lehigh Rivers in Pennsylvania. In all, the basin contains approximately 13,500 square miles, draining parts of Pennsylvania (50.3 percent of the basin's total land area); New Jersey (23.3%); New York (18.5%); and Delaware (7.9%). See Figure 2.1 for a map of the Basin. Table 2.1 provides geographical statistics for the Delaware River Basin.

Figure 2.1: Delaware River Basin

Source: 2006 DRBC Integrated List

Table 2.1: Delaware River Basin Geographic Statistics (approximate)

Total Basin Land Area (mi^2)[a,b]	12,700
Population (2000)	7.6 million
Major River Basins (HUC 8)[c]	13
River Miles (Named)[a]	9,080
Border (Shared) River Miles[a]	339
Square Miles of Public Lakes and Reservoirs[c]	140
Square Miles of Estuary/Bay[c]	783
Square Miles of Wetlands[c]	480

[a]DRBC GIS files

[b]Total Basin area minus area of Estuary and Bay

[c]National Hydrographic Dataset

Approximately 15 million people, or about 5% of the U.S. population, rely on the waters of the Delaware River Basin for drinking and industrial use and the Delaware Bay is only a day's drive away for about 40 percent of the people living in the United States. Yet the basin drains only four-tenths of one percent of the total continental U.S. land area.

Three reaches of the Delaware River have been included in the National Wild and Scenic Rivers System. One section extends 73 miles from the confluence of the river's East and West branches at Hancock, N.Y. downstream to Milrift, PA; the second is a 40-mile stretch from just south of Port Jervis, NY downstream to the Delaware Water Gap near Stroudsburg, Pa. The Lower Delaware Wild and Scenic Rivers Act, signed into law on November 1, 2000, adds about 65 miles of the Delaware and selected tributaries to the national system, linking the Delaware Water Gap and Washington Crossing, PA, just upstream of Trenton, N.J. Currently, almost the entire non-tidal Delaware River (the portion north of the “fall line” at Trenton, New Jersey) is included in the National Wild and Scenic Rivers System. In addition, 35.4 miles of the Maurice River and its tributaries in New Jersey and approximately 190 miles of the White Clay Creek and its tributaries in Pennsylvania and Delaware have been included in the national system.

The Delaware Bay and tidal reach of the Delaware River have been included in the National Estuary Program, a project set up to protect estuarine systems of national significance.

As a result of clean-up efforts in the Delaware River, shad and other fish species have increased in number. This is a strong indication of exceptionally good spawning runs when these fish return to the river as adults. A recent study of Delaware River shad fishing placed a $3.2 million annual value on this fishery alone.

There are other economic benefits from the river. According to the Coast Guard, The Delaware River Port Complex, for instance, generates $19 billion in business revenue annually, is home to the third largest east coast petrochemical port and five of the largest east coast refineries, and receives over 65% of fruit imported to the U.S. from South America. It is also the largest North American port complex for steel, paper, and meat imports.

The population of the Delaware River Basin in 2000 stood at approximately 7.8 million people. During the period 1990 to 2000, large population growth occurred in Pennsylvania's Pocono Mountain region and in the Philadelphia suburbs. The Basin provides water to approximately 7.5 million people who live outside of its boundaries.

2.2 Water Pollution Control Programs

DRBC's water pollution control program is carried out through a series of interdependent steps and provides a rational approach to protecting and restoring water quality in the Basin. The waters of the Basin are protected for designated uses with water quality objectives that specify what levels of individual parameters are appropriate, based upon a review of the current scientific understanding about the needs of those uses. DRBC's monitoring programs provide a mechanism to evaluate how those water quality objectives are being met and assessment of those monitored data provide the link to how well the designated uses are being protected. The identified impairment of interstate waters in the Basin leads to the development of TMDLs, issuing of permits and other mechanisms to reduce loading of pollutants in order to improve water quality to levels that meet the objectives. In addition, DRBC has other layers of protection (see Special Protection Waters below) that aim to maintain existing water quality where it is better than the water quality objectives.

2.2.1 Watershed Approach

Because activities that affect the water quality of the Basin's many streams can individually or cumulatively impact the water quality of the main stem River, many of DRBC's regulations and programs are based on a watershed concept and focus on those interrelationships. The following are examples of how the Commission takes a multi-faceted approach to water quality regulation.

Special Protection Waters

Currently, portions of the Delaware River are designated by DRBC as "Special Protection Waters" (differentiated as either Outstanding Basin Waters or Significant Resource Waters) and have associated with them a variety of specific pollution prevention and reduction requirements driven by a "no measurable change" policy toward water quality. Designated reaches are comprised of (see Figures 2.2 and 2.3):

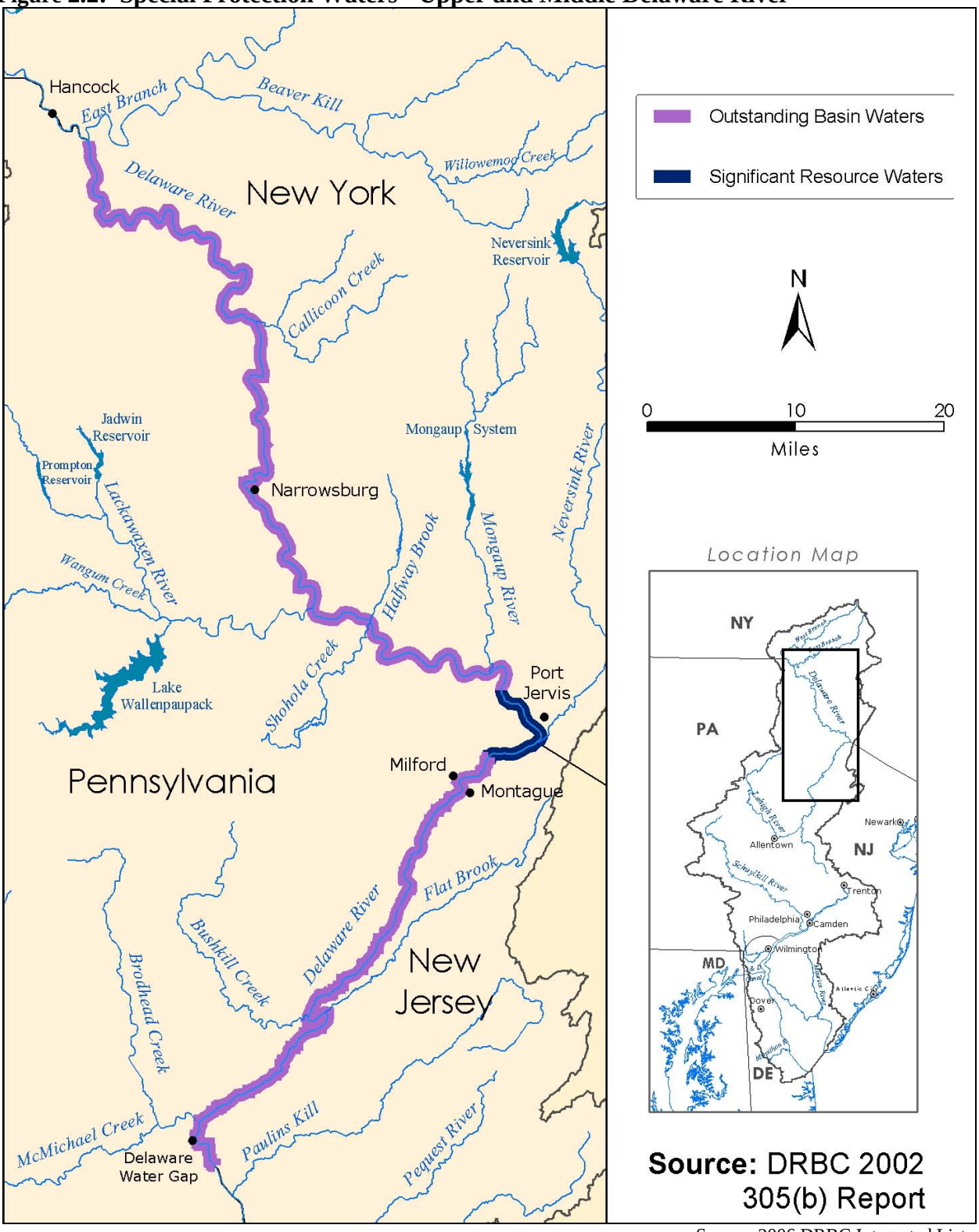
Outstanding Basin Waters

- The Upper Delaware Scenic and Recreational River from Hancock, NY to Milrift, NY (Delaware River between River Miles 330.7 and 258.4)
- Portions of intrastate tributaries located within the established boundary of the Upper Delaware Scenic and Recreational River Corridor
- The Middle Delaware Scenic and Recreational River from Milrift, NY to the Delaware Water Gap (Delaware River between River Miles 250.1 and 209.5)
- Portions of tributaries located within the established boundaries of the Delaware Water Gap National Recreation Area

Significant Resource Waters

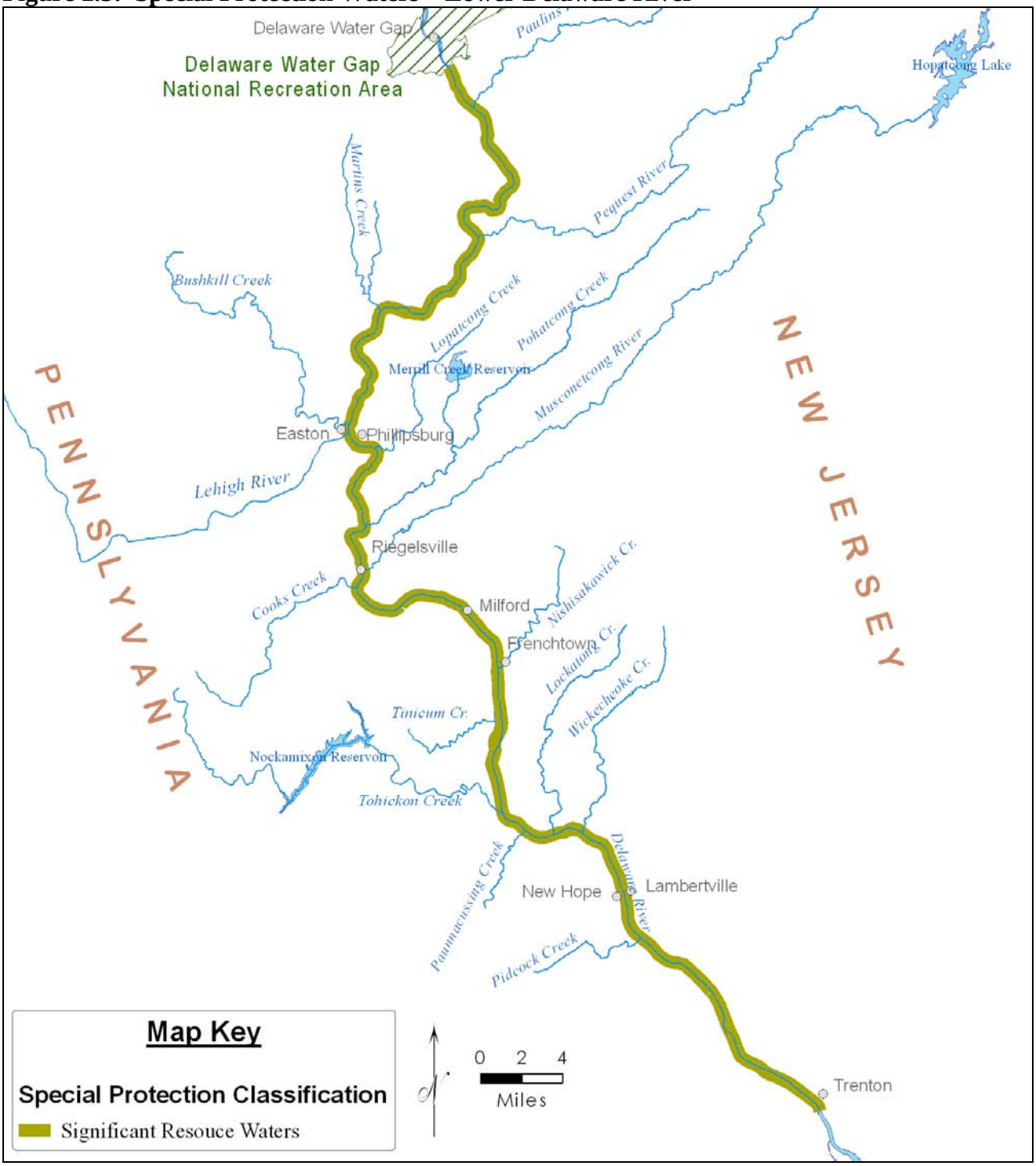
- The Delaware River from Milrift, NY to Milford, PA , River Miles 258.4 to 250.1
- The Delaware River from the Delaware Water Gap to Trenton, NJ, River Miles 209.5 to 133.4. Note that this designation has been made on an interim basis.

Figure 2.2: Special Protection Waters - Upper and Middle Delaware River



Source: 2006 DRBC Integrated List

Figure 2.3: Special Protection Waters – Lower Delaware River



Source: 2006 DRBC Integrated List

Special Protection Waters regulations take a watershed approach to antidegradation of water quality. The regulations apply to the drainage area of the designated waters. Policies provide an up-front approach to reducing or eliminating new pollutant loadings, through requirements made in the docket (permit) review process, for the purpose of maintaining "Existing Water Quality" (EWQ) in designated waters. This is accomplished, in part, by looking at the cumulative impacts of point and nonpoint sources as they may affect the designated waters, either through direct discharge or through tributary loading. EWQ is defined (in DRBC Water Quality Regulations) as "the actual concentration of a water constituent at an in-stream site or sites, as determined through field measurements and laboratory analysis of data collected over a time period determined by the Commission to adequately reflect the natural range of the hydraulic and climatologic factors which affect water quality". Numerical criteria for Special

Protection Waters EWQ are defined as "(a) an annual or seasonal mean of the available water quality data, (b) two-tailed upper and lower 95 percent confidence limits around the mean, and (c) the 10^{th} and 90^{th} percentiles of the dataset from which the mean was calculated." EWQ was defined for the above-mentioned portions of the River in 1992.

Estuary CBOD Allocations

DRBC allocates loading of carbonaceous biological oxygen demand (CBOD) among dischargers in the Delaware Estuary. Allowable loads are apportioned through the permit review process by utilizing steady-state modeling to estimate the cumulative impacts of discharges. As the assimilative capacity of a zone is reached, or when allocations existing at that time are no longer equitable, the capacity in the zone, minus a reserve, is reallocated among the waste dischargers in that zone.

Pollutant Minimization Plans

DRBC established, in 2005, requirements for the development of Pollutant Minimization Plans (PMP). These plans are developed for point and non-point discharges of polychlorinated biphenyls (PCB) in the Delaware Estuary. The goal of this program is to work toward meeting water quality standards and to eliminate fish consumption advisories due to PCBs. Because of the limited ability of dischargers to reduce their PCB loadings quickly enough to fully comply in the short term with the numeric limits that are based on water quality standards, this non-numeric approach allows the Commission to require concrete reduction steps before permits are re-issued by the states. DRBC also may require PMPs for contaminated sites, reducing non-point sources of PCB loadings to the Estuary.

Integrated Resource Planning

In 1998, DRBC amended its Southeast Pennsylvania Ground Water Protected Area (SPGWA) Regulations (adopted 1980) to include watershed-based ground water withdrawal limits for sub-basins that lie entirely or partially within the SPGWA. As required by the Regulations, those withdrawal limits may be revised by the Commission to be more protective of streams designated by the State of Pennsylvania as either "high quality" or "exceptional value", or "wild" or "scenic", or "pastoral", or to correspond to more stringent requirements in "integrated resource plans" adopted and implemented by all municipalities in the sub-basin. Integrated Resource Plans (IRPs) must assess water resources and existing uses of water; estimate future water demands and resource requirements; evaluate supply-side and demand-side alternatives to meet water withdrawal needs; assess options for wastewater discharge to subsurface formations and streams; consider storm water and floodplain management; assess the capacity of the sub-basin to meet present and future demands for withdrawal and non-withdrawal uses such as instream flows; identify potential conflicts and problems; incorporate public participation; and outline plans and programs including land use ordinances to resolve conflicts and meet needs. The development of IRPs helps focus and coordinate planning tools to consider the multiple uses of water resources and the interrelationships of water quality and quantity to meet various needs.

Basin Planning Process

In 2001, DRBC began a process to develop a "forward-looking" Water Resources Plan for the Delaware River Basin. In September, 2004, state representatives of the four Basin States, as well as federal representatives, signed a resolution showing their support for the Plan. The Plan outlines numerous mechanisms for protecting, preserving and enhancing the water resources of the Basin, on a watershed basis, through the development of desired outcomes, goals, objectives, indicators and management strategies. The Plan is multi-faceted in its approach and calls for the active involvement of a broad range of governmental and non-governmental entities in addition to DRBC.

The Plan includes such concepts as the integration of water resources considerations into land use planning and management, the development of analytical tools to evaluate water resources impacts of municipal land use plans, the preparation of all necessary TMDLs by the dates required by states, and the use of regulatory and non-regulatory approaches to maintaining and improving water quality where it is better than criteria. A link to the Water Resources Plan for the Delaware River Basin exists at http://www.state.nj.us/drbc/basinplan.htm

2.2.2 Water Quality Standards Program

Water quality standards provide a description of water body uses to be protected as well as water quality objectives necessary to protect those uses. DRBC's water quality standards program derives its authority from Section 3.2 of the Delaware River Basin Compact (1961) which directs the Commission to adopt "a comprehensive plan…for the immediate and long range development and uses of the water resources of the basin" and to adopt "a water resources program, based upon the comprehensive plan, which shall include a systematic presentation of the quantity and quality of water resources needs of the area…"; and Section 5.2 which allows the Commission to "assume jurisdiction to control future pollution and abate existing pollution in the waters of the basin, whenever it determines…that the effectuation of the comprehensive plan so requires."

Designated Uses

Water uses are paramount in determining stream quality objectives, which, in turn, are the basis for determining discharge effluent quality requirements. Water quality standards require that all surface waters of the Basin be maintained in a safe and satisfactory condition for the following uses:

- Agricultural, industrial and public water supplies after reasonable treatment, except where natural salinity precludes such uses;
- Wildlife, fish and other aquatic life;
- Recreation;
- Navigation;
- Controlled and regulated waste assimilation to the extent that such use is compatible with other uses;
- Such other uses as may be provided by the Commission's Comprehensive Plan

Designated uses have been established specifically for the interstate zones of the Delaware River, as described in Tables 2.2 and 2.3. Figure 2.4 depicts the main-stem zones in the Basin and Table 2.4 shows the application of designated uses to specific zones. Zones 1A-E (assessed for this report) and Zones E, W1, W2, N1 and N2 (not assessed for this report as they are intrastate streams assessed in the Integrated Reports of the Basin States) represent the non-tidal portions of the Delaware River. Zones 2-6 (assessed in this report) and C1-8 (not assessed in this report) represent the Estuary, or tidal portions of the River, including the tidal portions of the tributaries to the River.

Figure 2.4: Main Stem Water Quality Zones for the Delaware River

Source: 2006 DRBC Integrated List

Table 2.2: Main Stem, Shared Delaware River Water Quality Zones

Zone	Location
1A	RM 330.7 - 289.9
1B	RM 289.9 - 254.75
1C	RM 254.75 - 217.0
1D	RM 217.0 - 183.66
1E	RM 183.66 - 133.4
2	RM 133.4 - 108.4
3	RM108.4 - 95.0
4	RM 95. 0 - 78.8
5	RM 78.8 - 48.2
6	RM 48.2 - 0.0

Table 2.3: Other Interstate Delaware River Zones (not assessed in this report)

Zone	Location
E	E. Branch to RM 330.7
W1	W. Branch to RM 330.7
W2	RM 1.8 on Sand Pond Ck. to RM 10.1 on W. Branch; Cat Hollow Bk. to RM 1.05 on Sand Pond Ck.; Sherman Ck. to RM 1.8 on Sand Pond Ck.; unnamed Sherman Ck. trib. to RM 1.6 on Sherman Ck.; Starboard Ck. to RM 1.81 on Sand Pond Ck.
N1	RM 0.5 on Neversink R. to RM 253.64
N2	Clove Bk. to RM 0.5 on Neversink R.; unnamed Clove Bk. trib. to RM 1.0 on Clove Bk.; unnamed trib. to Clove Bk. trib. to RM 0.7 on Clove Bk. trib.
C1	Source to RM 16.3 on Christina River
C2	W. Branch Christina R. to RM 25.7 on Christina R.; Persimmon Run to RM 0.8 on W. Branch Christina R.; E. Branch Christina R. to RM 30.2 on Christina R.
C3	White Clay Ck. to RM 14.7 at PA-DE line
C4	RM 14.7 on White Clay Ck. to RM 10.0 on Christina R.
C5	RM 13.4 on Red Clay Ck. to RM 12.6 at PA-DE line; W. Branch Red Clay Ck. to RM 13.4 on Red Clay Ck.
C6	RM 12.6 on Red Clay Ck. at PA-DE line to RM 2.6 on White Clay Ck.
C7	RM 20.0 on Brandywine Ck. to head of tide at RM 2.0 on Brandywine Ck.; W. Branch Brandywine Ck. to RM 20.0 on Brandywine Ck.
C8	Naamans Ck. to head of tide in DE

Table 2.4: Assignment of Designated Uses to the Mainstem Delaware River

Designated Uses	Applicable Zones
Agricultural water supplies	Zones 1,2 and 3
Industrial water supplies after reasonable treatment	All Zones
Maintenance and propagation of resident fish and other aquatic life	Zones 2 and 6
Maintenance and propagation of resident game fish and other aquatic life	Zone 1
Maintenance and propagation of shellfish	Zone 6
Maintenance and propagation of trout	Zone 1A
Maintenance of resident fish and other aquatic life	Zones 3-5
Navigation	Zones 2-6
Passage of anadromous fish	Zones 2-6
Propagation of resident fish	Zone 5 (RM 70.0-48.2)
Public water supplies after reasonable treatment	Zones 1,2 and 3
Recreation	Zones 1, 2, 4 (below RM 81.8), 5 and 6
Secondary contact recreation	Zones 3 and 4 (above RM 81.8)
Spawning and nursery habitat for anadromous fish	Zones 1A-1E
Wildlife	All Zones

Ambient Water Quality Standards

Sections 3.20, 3.30, and 3.40 of DRBC's Water Quality Regulations define the "Water Quality Objectives", or ambient water quality standards for the non-tidal river, tidal river and Basin ground water, respectively. Objectives are zone-based and define the water quality necessary to protect the designated uses in those zones. For the water quality assessments in Part 3, monitored data are compared against the zone standards for determining use attainment. Table 2.5 shows the water quality objectives for the non-tidal main stem and Table 2.6 shows the objectives for the tidal portions of the Delaware River main stem and tributaries.

Table 2.5: Water Quality Objectives for Non-tidal Delaware River Zones

Parameter	Zones																	
	1A	1B	1C	1D	1E	E	W1	W2	N1	N2	C1	C2	C3	C4	C5	C6	C7	C8
BACTERIA–FECAL COLIFORM--Not to exceed 200 per 100 ml as a geometric average; samples shall be taken at such frequency and location as to permit valid interpretation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ALKALINITY--Not less than 20 mg/l					X													
DISSOLVED OXYGEN																		
Not less than 4.0 mg/l at any time		X	X	X	X				X		X	X		X		X	X	X
Not less than 5.0 mg/l at any time	X					X	X	X		X			X		X			
Not less than 7.0 mg/l in spawning areas whenever temperatures are suitable for trout spawning	X					X	X	X		X			X		X			
Minimum 24 hour average of 5.0 mg/l		X	X	X	X				X		X	X		X		X	X	X
Minimum 24 hour average of 6.0 mg/l	X					X	X	X		X			X		X			
PHENOLS --Not to exceed 0.005 mg/l unless due to natural conditions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PH																		
Between 6.0 and 8.5	X	X	X	X	X	X	X	X			X	X	X	X	X	X		X
Between 6.5 and 8.5									X	X							X	
RADIOACTIVITY--Alpha emitters not to exceed 3 pc/l (picocuries per liter); Beta emitters not to exceed 1000 pc/l	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SYNTHETIC DETERGENTS (Methylene Blue Active Substances (M.B.A.S.))--Not to exceed 0.5 mg/l	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 2.5 Continued

Parameter	Zones																	
	1A	1B	1C	1D	1E	E	W1	W2	N1	N2	C1	C2	C3	C4	C5	C6	C7	C8
TEMPERATURE																		
Not to exceed 5 degrees F (2.8 degrees C) rise above ambient temperature until stream temperature reaches 50 degrees F (10 degrees C)	X					X	X	X		X			X		X			
Not to exceed 2 degrees F (1.1 degrees C) rise above ambient temperature when stream temperature is between 50 degrees F (10 degrees C) and 58 degrees F (14.4 degrees C)	X					X	X	X		X			X		X			
Natural temperature will prevail above 58 degrees F (14.4 degrees C)	X					X	X	X		X			X		X			
Not to exceed 5 degrees F (2.8 degrees C) rise above ambient temperature until stream temperature reaches 87 degrees F (30.6 degrees C)		X	X	X	X				X		X	X		X		X	X	X
Natural temperature will prevail above 87 degrees F (30.6 degrees C)		X	X	X	X				X		X	X		X		X	X	X
TOTAL DISSOLVED SOLIDS--Not to exceed 133 percent of background, or 500 mg/l, whichever is less	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TURBIDITY																		
Unless exceeded due to natural conditions: maximum 30 day average 10 units, maximum 150 units	X	X																
Not to exceed the natural background by 10 units, or a maximum of 25 units, whichever is less											X	X	X	X	X	X	X	
Unless exceeded due to natural conditions: maximum 30 day average 20 units, maximum 150 units			X	X														
Unless exceeded due to natural conditions: maximum 30 day average 30 units, maximum 150 units					X													
Increases not to be attributable to industrial waste discharges											X	X	X	X	X	X	X	
THRESHOLD ODOR NUMBER--Not to exceed 24 units at 60 degrees C	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 2.6: Water Quality Objectives for the Tidal Delaware River Zones (Estuary)

Parameter	Zone				
	2	3	4	5	6
BACTERIA–FECAL COLIFORM					
Maximum geometric average 200 per 100 ml	X			X	X
Maximum geometric average 770 per 100 ml		X			
Above R.M. 81.8 maximum geometric average 770 per 100 ml			X		
Below R.M. 81.8 maximum geometric average 200 per 100 ml			X		
BACTERIA–ENTEROCOCCUS					
Maximum geometric average 33 per 100 ml	X				
Maximum geometric average 88 per 100 ml		X			
Above R.M. 81.8 maximum geometric average 88 per 100 ml			X		
Below R.M. 81.8 maximum geometric average 33 per 100 ml			X		
Maximum geometric average 35 per 100 ml				X	X
BACTERIA--COLIFORM, TOTAL--MPN (most probable number) not to exceed Federal shellfish standards in designated shellfish areas					X
ALKALINITY					
Maintain between 20-100 mg/l	X				
Maintain between 20-120 mg/l		X	X	X	X
DISSOLVED OXYGEN					
Not less than 5.0 mg/l at any time unless due to natural conditions					X
Minimum 24 hour average of 3.5 mg/l		X	X		
Minimum 24 hour average of 5.0 mg/l	X				
Minimum 24 hour average of 6.0 mg/l					X
Minimum 24 hour average concentration: At R.M. 78.8: 3.5 mg/l At R.M. 70.0: 4.5 mg/l At R.M. 59.5: 6.0 mg/l				X	
During the periods from April 1 to June 15 and September 16 to December 31, the dissolved oxygen shall not have a seasonal average less than 6.5 mg/l	X	X	X	X	

Table 2.6 Continued

Parameter	Zone				
	2	3	4	5	6
CHLORIDE					
Maximum 15-day average concentration of 50 mg/l	**X**				
Maximum 30-day average concentration of 180 mg/l at R.M. 98		**X**			
PHENOLS					
Not to exceed 0.005 mg/l unless due to natural conditions	**X**	**X**			
Maximum 0.02 mg/l, unless exceeded due to natural conditions			**X**		
Maximum 0.01 mg/l, unless exceeded due to natural conditions				**X**	**X**
PH --Between 6.5 and 8.5	**X**	**X**	**X**	**X**	**X**
HARDNESS					
Maximum 30 day average of 95 mg/l	**X**				
Maximum 30 day average of 150 mg/l		**X**			
RADIOACTIVITY					
Alpha emitters not to exceed 3 pc/l (picocuries per liter)	**X**	**X**	**X**	**X**	**X**
Beta emitters not to exceed 1000 pc/l	**X**	**X**	**X**	**X**	**X**
SODIUM–Maximum 30 day average concentration of 100 mg/l at R.M. 98		**X**			
SYNTHETIC DETERGENTS (Methylene Blue Active Substances (M.B.A.S.)					
Maximum 30 day average of 0.5 mg/l	**X**				
Maximum 30 day average of 1.0 mg/l		**X**	**X**	**X**	**X**

Table 2.6 Continued

Parameter	Zone				
	2	3	4	5	6
TEMPERATURE					
Shall not exceed 5 degrees F (2.8 degrees C) above the average 24-hour temperature gradient displayed during the 1961-66 period, or a maximum of 86 degrees F (30 degrees C), whichever is less	X	X	X		
Shall not be raised above ambient by more than: 1) 4 degrees F (2.2 degrees C) during September through May, nor 2) 1.5 degrees F (0.8 degrees C) during June through August;				X	X
The maximum temperatures shall not exceed 86 degrees F (30.0 degrees C)				X	
The maximum temperatures shall not exceed 85 degrees F (29.4 degrees C)					X
TOTAL DISSOLVED SOLIDS					
Not to exceed 133 percent of background, or 500 mg/l, whichever is less	X	X			
Not to exceed 133 percent of background			X		
TURBIDITY					
Unless exceeded due to natural conditions: maximum 30 day average 40 units, maximum 150 units	X	X	X	X	X
Unless exceeded due to natural conditions above R.M. 117.81 during the period May 30 to September 15, maximum 30 units	X				
THRESHOLD ODOR NUMBER --Not to exceed 24 units at 60 degrees C	X	X	X	X	X

Ambient Standards for Drinking Water Sources

Zones 1, 2 and 3 of the Delaware River are given the designated use of "public water supplies after reasonable treatment". It is the general policy of DRBC that all ground water of the Basin, as well as surface sources of drinking water, should not exceed maximum contaminant levels (MCL) given in the National Primary Drinking Water Standards. In Zones 2 and 3, there is additional definition of the permissible levels of specific toxicants in waters designated for both drinking water as well as fish consumption (due to the bioaccumulation of certain substances even at very low ambient levels). Appendix A includes tables from DRBC's Water Quality Regulations that show the toxics criteria for Zones 2 and 3.

Changes to Water Quality Standards

Ongoing Review of Water Quality Regulations

The last updates of water quality criteria in DRBC's Water Quality Regulations occurred in 1996. Currently, DRBC, through its Water Quality Advisory Committee, is developing recommendations to revise its standards under authority of Section 5.2 of the Compact which states that the Commission "may adopt and from time to time amend and repeal rules, regulations and standards" to control future pollution and abate existing pollution. A final, approved version of those rules, amended with any proposed changes, is not available at the time of this report and all water quality assessments presented here are based upon the Water Quality Regulations, as they existed during the 2002 through 2004 monitoring seasons.

Progress Toward Implementing Biocriteria

The Commission does not currently use biological criteria for 305(b) assessments or determinations of impairment, other than reports arising from fish-tissue toxics analyses and inference of aquatic life use support based upon water chemistry. However, DRBC is currently in the process of developing data, through a biomonitoring

program, to establish biocriteria for the non-tidal Delaware River. See section 3.1 of this report for more information on the Delaware River Biomonitoring Program.

2.2.3 Point Source Control Program

DRBC uses a variety of programs to regulate point source pollutant loadings that would impact the Delaware River. These consist of docket review, pollutant allocations (including Pollutant Minimization Plans), Special Protection Waters Regulations and Basin-wide minimum treatment standards and interstate cooperative agreements.

Section 3.8 of the Compact states that "No project having substantial effect on the water resources of the basin shall hereafter be undertaken by any person, corporation or governmental authority unless it shall have been first submitted to and approved by the Commission". All discharges to waters of the Basin with a design capacity greater than or equal to 50,000 gallons per day are subject to review by the Commission. In Special Protection Waters, the review threshold is 10,000 gallons per day. Projects are reviewed for potential impacts to the waters of the Basin and for consistency with the Comprehensive Plan, which consists of the statements of policies and programs that the Commission determines are necessary to govern the proper development and use of the River Basin *(DRBC Rules of Practice and Procedure, 1997).*

DRBC also implements point source controls through its Special Protection Waters Regulations. All new or expanded discharges, for which DRBC has review authority, in Significant Resource Waters must undertake a non-discharge alternatives analysis and provide a Social and Economic Justification for a locally degrading discharge to be approved. In the case of Outstanding Basin Waters, no degrading discharge is permissible. The regulations state, "Point sources of pollutants discharged to Outstanding Basin Waters shall be treated as required and then dispersed in such a manner that complete mixing of effluent with the receiving stream is, for all practical intents and purposes, instantaneous."

Article 4 of DRBC's Water Quality Regulations identifies Basin-wide minimum treatment standards for wastewater discharges. These include:

- Removal of total suspended solids
- Minimum secondary treatment for biodegradable wastes
- BOD treatment requirements
- Disinfection requirements
- Color standards
- Dissolved substance standards
- pH standards
- Ammonia standards
- Temperature standards

DRBC maintains cooperative agreements with all four Basin States, which provide that all NPDES permits for projects that lie within the Basin must comply with these DRBC standards as well as State standards.

2.2.4 Nonpoint Source Control Program

DRBC regulates non-point pollution as part of the anti-degradation requirements of Special Protection Waters. Under DRBC's Special Protection Water regulations, all new or expanded discharges to the drainage areas of Special Protection Waters must submit for approval a Non-point Source Pollution Control Plan with their application. The plan must control the new or increased non-point source loads generated within the portion of the project's service area that is also located within the drainage area of Special Protection Waters. The plans must document the Best Management Practices to be applied to the project site. Non-point pollution from runoff of developed areas in Special Protection Waters may not be susceptible to antidegradation constraints if they are associated with an existing, non-expanding facility, such as a wastewater treatment plant that is not expanding its service area.

Non-point sources of PCBs are also regulated, on a project-specific basis, by Pollutant Minimization Plans (see Section 2.2.1) that the DRBC has begun requiring to help in reducing PCB loadings into the Delaware River.

2.2.5 Coordination with Other Agencies

The nature of DRBC's water quality management activities relies on interstate coordination and cooperation. For instance, the agency maintains agreements with all four Basin states regarding permit review, as previously described. Additionally, all new or amended DRBC regulations are ruled on by the Commission, which has representation by the four states and federal government. The Scenic Rivers Monitoring Program (SRMP) and Estuary Boat Run also rely on cooperation between DRBC and other agencies. The SRMP is a partnership between DRBC and the National Park Service, while the Boat Run is a partnership between DRBC and the Delaware Department of Natural Resources and Environmental Conservation. See Part 3 for more information on these programs.

2.2.6 Special Concerns and Recommendations

Some concerns and recommendations relative to DRBC's water pollution control programs are:

- Data Availability – Working to ensure adequate data for assessing the water quality of the Delaware River and for implementing DRBC's many water quality management programs is an ongoing issue. DRBC's EPA-approved "Water Monitoring and Assessment Strategy" (2006) outlines a number of data needs, including increasing monitoring in the Upper and Middle portions of the Delaware River as well as increased monitoring coverage of Delaware Bay near-shore waters.
- Maintaining Existing Water Quality – With growth and development pressures increasing in many parts of the Basin, preventing degradation of high quality waters is an important issue. A related issue is trying to identify the links between water quality issues in the main stem and the potential sources of pollution throughout the Basin. To that end, DRBC is evaluating alternatives for partnering with the Basin States to address watershed issues that impact main stem water quality at boundary control points.
- Identifying Natural Background Conditions – Attempting to better characterize natural conditions along the Delaware River continues to be an important topic of discussion, particularly as it applies to setting appropriate water quality goals for the River.

- Availability of Resources – Because DRBC is reliant on outside sources of money, including Section 106 Grant funds, for much of its monitoring and assessment work, the availability of resources is always an issue when planning new initiatives or expanding upon existing ones to improve water pollution control. As outlined in DRBC's Ten Elements Plan, such activities include monitoring for changes to existing water quality in the Lower Delaware River, aquatic plant surveys, PCB studies, and other special chemical and biological studies.

3. Surface Water Assessment

This section begins with a discussion of the monitoring programs utilized by DRBC and the data they provide. Those data can, among other purposes, be used to assess attainment of designated uses as described in section 2. Following this discussion are the actual assessments of use attainments for the years 2002 through 2004.

3.1 Current Monitoring Programs

The surface water quality monitoring program utilized by the Delaware River Basin Commission consists of the three programs described below:

- The upper and middle non-tidal portions of the River (RM 330.7 to 209.5) are monitored through the *Scenic Rivers Monitoring Program*, a joint National Park Service and DRBC effort.
- The lower non-tidal portions (RM 209.5 to 133.4) are monitored through the *Lower Delaware Monitoring Program*.
- The Estuary, or tidal portion of the Delaware River (RM 133.4 to the mouth of the Delaware Bay), is monitored through the *Delaware River Boat Run Monitoring Program*.

In addition, data obtained from other agencies, as available, are used to supplement data obtained through the three monitoring efforts. See Section 3.3 for more information.

3.1.1 Overview of the Monitoring Programs and Program Goals

Scenic Rivers Monitoring Program (SRMP)

In 1984, the SRMP, a joint NPS/DRBC effort, began monitoring approximately a 121mile reach of the Delaware River, from RM 330.7 to RM 209.5, which contains two portions of the National Wild and Scenic Rivers System and numerous high quality tributaries that drain portions of New York, New Jersey and Pennsylvania.

The DRBC and National Park Service (DRBC/NPS) Scenic Rivers Monitoring Program (SRMP) conducts water quality assessment activities in the northern portion of the Delaware River Basin from the lower reaches of the East and West Branches of the Delaware River downstream to the Delaware Water Gap. Participating in the program are the Delaware River Basin Commission, the NPS Upper Delaware National Scenic and Recreational River (UDSRR), the NPS Delaware Water Gap National Recreation Area (DWGNRA), and the United States Geological Survey (USGS).

In the SRMP, DRBC and NPS collect water quality measurements to convert reach-wide EWQ targets to ICP and BCP targets in UPDE and DEWA; to support water quality models for SPW implementation; and to gather sufficient water quality information to implement DRBC SPW regulations using a site-specific statistical approach to definition and assessment of changes to existing water quality.

Sufficient historical water quality data exist to develop a preliminary water quality model, but not to convert reach-wide EWQ targets to site-specific EWQ targets. Additional data are needed to refine a model and to fully and evenly populate most BCP and ICP nodes along the river with water quality data. These data are currently being collected.

Lower Delaware Monitoring Program (LDMP)

In 1998, DRBC began monitoring to characterize water quality of the Lower Delaware River, extending from Trenton, NJ (RM 133.4) to the Delaware Water Gap (RM 209.5), where few data existed to assess water quality conditions. See Figure 3.1 in Section 3.3 Assessment Methodology for a location map. In 2004, DRBC completed a five-year effort to define existing water quality and to develop a water quality management strategy that protects and improves the water quality of the Lower Delaware region. Based on LDMP monitoring results, in 2005 the Lower Delaware was declared by DRBC as significant resource waters on an interim basis until implementation issues are resolved for full Special Protection Waters designation and rulemaking.

The Goals of the LDMP are to:

- Expand and augment baseline chemical, physical, and biological data collection efforts of various federal, state, local, and citizen monitoring agencies
- Create existing water quality targets for development of an anti-degradation protection strategy for the Lower Delaware River corridor
- Enable reporting of water quality status and trends, biological response to natural and anthropogenic stressors, quantitative long and short-term physical changes to channel morphology of the river and its tributaries, and identification of key factors controlling maintenance and improvement of the ecological integrity of the river;
- Support water quality modeling and project review activities.
- Support determination of abatement priorities for point and non-point sources of pollution;
- Allow prioritization of tributaries for monitoring and watershed planning purposes;
- Expand ecological knowledge of the Lower Non-Tidal Delaware River; and
- Help to safeguard the health and safety of the river-using public.

Delaware River Biomonitoring Program (DRBP)

The Delaware River Biomonitoring Program (DRBP) includes biomonitoring and biocriteria development for the non-tidal portion of the Delaware River.

There are presently habitat, benthic macroinvertebrate and periphyton components of DRBC's biological monitoring program. Additional types of biological monitoring are anticipated for future years as resources allow, including fish, bivalves, plankton, submerged aquatic vegetation, aquatic invasive species, and riparian condition. These activities should provide a well-rounded view of ecological and water quality conditions in the Delaware River, and provide sufficient data for management decisions and criteria development.

DRBC intends to gather sufficient physical, chemical, and biological information to implement biocriteria as part of Special Protection Waters (SPW) regulations, nutrient criteria, and other water quality rules (possibly sediment criteria or other criteria using biological effect levels) for the non-tidal portion of the Delaware River. This work will target the main stem non-tidal Delaware River for the development of biocriteria.

Estuary Boat Run Program

The Boat Run Program consists of monitoring of the tidal portion of the Delaware River from the head of tide at Trenton (RM133.4) to the mouth of the Delaware Bay, delineated as a line from Cape May, New Jersey to Lewes, Delaware. See Figure 3.2 in Section 3.3 (Assessment Methodology) for a graphical depiction of the monitored area.

The goals of the Program are to:

- Provide accurate, precise, and defensible estimates of the surface water quality of the Delaware Estuary
- Allow assessment of water quality standards compliance

3.1.2 Quality Assurance and Control

For information on quality assurance and control procedures, see the following Quality Assurance Project Plans:

- Scenic Rivers Monitoring Program Quality Assurance Plan
- Lower Delaware Water Quality Monitoring Program Quality Assurance Project Plan
- Delaware River Biomonitoring Program Quality Assurance Project Plan, QA2004-002
- Boat Run Monitoring Program Quality Assurance Project Plan

3.1.3 Networks and Programs

Scenic Rivers Monitoring Program

Design Methodology

The design of the Scenic Rivers Monitoring Program is based on:

- A fixed network of monitoring locations that can be compared to one another using a control point approach to data evaluation.
- The number of samples needed for site specific Interstate Control Point assessments as well as Boundary Control Point assessments. Interstate Control Points are selected critical Delaware River locations used to establish EWQ targets, assess impacts originating from the immediate upstream reach, and to enable evaluations of longitudinal water quality changes along the river corridor. Boundary Control Points refer to sampling locations, at the mouths of tributaries that flow into the Delaware River, in order to determine their contributions of pollutant loads.
- The frequency of sampling is based on the ability to perform statistically valid assessments for showing measurable changes to existing water quality, using a 95 percent confidence interval about the central value, expressed as a mean or median.

Number and Location of Sites

See Appendix B for a listing of Baseline Scenic Rivers Monitoring Sites and Flow Measurement Monitoring Locations that are used in the Scenic Rivers Monitoring Program.

Sampled Parameters and Sampling Methods

Detailed field and laboratory procedures are contained in the DRBC/NPS Cooperative Water Quality Monitoring Program Manual (1994). Table 3 in Appendix B Contains a summary of the parameters sampled as part of this monitoring program. Note in the table that not all parameters listed have been monitored during the 2002-2004 programs. Baseline Monitoring Locations are monitored monthly unless ice or safety considerations prevent sample collections.

Use of Reference Conditions

The Scenic Rivers Monitoring Program utilizes “Boundary Control Points” to establish baseline reference conditions at the mouths of tributaries to the main stem Delaware River in this region. These monitoring locations are very useful in determining changes in water quality derived from inputs to the main stem from the adjoining watersheds. Interstate and Boundary Control Point locations are listed in Table 1 in Appendix B

Lower Delaware Monitoring Program

Design Methodology

The Lower Delaware River Water Quality Monitoring Program consists of routine baseline monitoring of water chemical and physical parameters. Sampling is conducted bi-weekly at 9 Delaware River sites and 6 tributary sites beginning in May and ending in September. A total of 10 samples per site are collected from 15 sites.

Samples are collected from bridges crossing the Delaware River or tributary to be sampled. Tributary samples are taken from the thalweg. River samples are collected from 3 points (1/3 channel, center channel, and 2/3 channel width) across the river transect and then composited into prepackaged laboratory bottles. An outside contract laboratory will measure various nutrient, bacteria, and physical parameters.

Number and Location of Sites

See Table C1 in Appendix C for a listing of the sites utilized in the Lower Delaware Monitoring Program. Sampling consists of bi-monthly chemical/physical sampling at nine bridges over the Delaware River and on six tributaries to the Delaware River between the Delaware Water Gap and Trenton, NJ. An additional two tributary sites are monitored as funding permits.

Sampled Parameters and Sampling Methods

Table C2 in Appendix C describes the parameters sampled for the Lower Delaware Monitoring Program as well as the methods and equipment used.

All field measurements are collected using a Hydrolab Quanta multiparameter sonde. Measurements are taken by lowering a sonde directly into water body and allowing it to stabilize prior to recording of data. Tributary field measurements are taken at point where sample is collected. At sites where a composite sample is taken, field measurements are taken at center channel.

All chemical/ physical samples are collected using a rope and bottle apparatus lowered from predetermined points on bridges crossing each of the water bodies to be sampled. The contract laboratory provides a packaged, labeled set of bottles for each of the samples to be collected. This package contains all the bottles necessary for collection of the correct volume for analysis. These bottles contain any preservatives required for proper analysis as described in the analytical methods for each of the parameters to be measured. This ensures proper fixation of appropriate samples and limits improper preservation and possible accidents associated with such chemical preservation methods (e.g. acid burns)

Use of Reference Conditions

During the 2002-2004 monitoring seasons, data collected from main stem and tributary sites was used as part of a larger effort to define existing water quality in the Lower Delaware River, at Boundary (tributary) and Interstate (main stem) Control Points. The goal of this effort was to develop a set of water quality targets that could be used should this section of the River receive classification as Special Protection Waters. These targets would serve as the reference conditions against which future monitoring results would be compared to determine if water quality has measurably changed.

Delaware River Biomonitoring Program

Design Methodology

Targeting the richest habitats (riffles, runs, island margins), a reference baseline of the existing biological community is being developed to quantify ecological integrity for the entire 200-mile non-tidal river. Once the reference baseline is developed, further testing of the most sensitive metrics for detecting 'measurable change' will be refined and incorporated into biological criteria useful for protecting long-term ecological integrity of the river. Numerical reference values will be proposed to set an anti-degradation level of protection for the river's aquatic life, and to provide an "existing water quality" biological baseline for assessment of long-term changes. The findings of this project, most importantly the definition of the existing condition of the biological community of the Delaware River, will serve as the backbone for future biomonitoring of tributaries and exploration of specific stressor effects. At the time of preparing this report, initial reconnaissance has been completed (2001), macroinvertebrate collection and identification has begun (2002, 2003, and 2005), and the biocriteria framework creation is underway.

Number and Location of Sites

There are 25 fixed locations for monitoring of richest targeted habitat, located from Hancock, New York to Trenton, New Jersey.

Sampled Parameters and Sampling Methods

Parameters and protocols used from 2002-2004 can be found in DRBC's current (2006) Delaware River Biomonitoring Program Quality Assurance Program Plan (QAPP). DRBC samples habitat, macroinvertebrates, periphyton, basic chemistry and physical parameters.

Macroinvertebrates are collected from Richest Targeted Habitat (RTH) using the Big River Frame Net (BFN) at each of 25 Delaware River sites. Pebble counts, velocity measurements, qualitative Rapid Bioassessment Protocol (RBP) (1999) habitat assessments and instantaneous water quality samples are collected to characterize habitat and water quality at the time of sampling. Collection occurs during the August to September index period unless conditions are unsuitable. All data collection is done by DRBC and partner agency staff trained in protocols documented here. Macroinvertebrate taxonomy is completed by trained DRBC or contract laboratory staff.

Periphyton samples are collected using the top-rock scrape method from 8 cobbles selected within RTH at the same 25 sites where macroinvertebrates are collected. Ancillary measurements include light (PAR 400-700 nm), canopy cover, nutrient concentrations during the weeks leading up to periphyton sampling, Chlorophyll *a* and Ash-Free Dry Mass, area scraped from each cobble; and depth/velocity profiles of the sampling areas.

Habitat methods are being investigated relative to applicability in free-flowing large rivers. For Delaware River assessment, DRBC has primarily used the RBP habitat method for wadeable streams. Many RBP habitat parameters seem unsuitable for rivers as large as the Delaware, and there seem to be few relationships between habitat parameters and biological metrics. For this reason, DRBC has begun to assess habitat conditions using and comparing a variety of methods: the RBP high gradient habitat protocol (Barbour et. al 1999); the Environmental Monitoring and Assessment Program (EMAP) Great Rivers field protocol (Angradi et. al 2004); EMAP habitat protocols for non-wadeable rivers and streams (Lazorchak et. al 2000); and the Qualitative Habitat Evaluation Index (Ohio EPA, Rankin 1989). The RBP presently remains DRBC's primary habitat evaluation method, but eventually DRBC expects to adopt other methods more suitable to rivers similar to the Delaware.

Data produced during this survey are compiled in Ecological Data Application System (EDAS), created by TetraTech, Inc. All metrics are calculated using EDAS, and statistical analyses are done using either Analyze-It, a Microsoft Excel add-on program, or PC-ORD, a multivariate statistical program. Data are stored at DRBC for organizational use and are uploaded onto EPA's STORET national data base for public usage.

Use of Reference Conditions

The DRBP makes use of longitudinally-based biological surveys, not watershed-wide surveys, so use of a reference condition is difficult to establish. Biological data collected over numerous years are expected to be sufficient for definition of existing biological conditions, which will be used in the future as a reference baseline. Biocriteria are expected to be applied within an antidegradation framework.

Estuary Boat Run Program

Design Methodology

A maximum of 22 locations are sampled, most under slack tide conditions. Staff from Delaware DNREC, under contract with the Commission, performs the work. Samples are collected at a depth of three feet below the water surface at low, or high water slack as designated

Number and Location of Sites

See Appendix D for a listing of the monitoring sites utilized in the Estuary Boat Run Program:

Sampled Parameters and Sampling Methods

Table 1 in Appendix D outlines the parameter categories sampled as part of the Estuary Boat Run Program and the locations at which measurements are taken. Table 2 provides the methods used, and the reporting limits for the parameters sampled.

Sampling Frequency

Samples are collected with the frequency shown in Table 3 in Appendix D. Sampling is generally performed during March through November. High water slack runs are conducted about every third run. Air and water temperature as well as pH and Secchi disk are measured, as indicated in Table 2, at time of sampling.

The period of sampling for the Estuary and River stations is once per month during the months of March, June, July and October and twice per month for the months of April, May, August and September of each calendar year. The period of sampling for the Lower Bay Stations is once per month during the periods of March, April, May, July, Aug, September and October.

Toxics Monitoring

The Estuary Boat Run Program conducts water quality sampling for three heavy metals: Copper, Chromium and Zinc. In addition, special studies have been conducted for Lead as well.

Fish Tissue Monitoring

In years 2002 and 2003, fish tissue samples were collected from three locations in the non-tidal Delaware River and from five locations in the Delaware Estuary for analysis of organic contaminants (PCBs, DDTs, HCHs, Chlordane-related compounds and pesticides) and trace metals. In 2004, additional parameters analyzed included dioxins, furans, PBDE and PFOA. Sampling locations include, in the non-tidal river, Milford, PA, Phillipsburg, NJ, and Lambertville, NJ. In the Estuary, samples were taken from Crosswicks Creek, Tacony Palmyra Bridge, Paulsboro, Deepwater and The Chesapeake and Delaware Canal. Smallmouth Bass and White Suckers are sampled from the non-tidal river and White Perch and Channel Catfish are sampled from the Estuary. Tissue data are used to determine the ambient concentrations of key toxicants in water bodies by using conversion factors that account for the accumulation of those substances in fish tissue. They do not, however, account for bioaccumulation through the food chain.

3.1.4 Coordination and Collaboration with Other Programs

The three programs discussed in this section work in concert to provide complete longitudinal coverage of the shared, interstate waters of the Delaware River. However, there are a number of other sources of data utilized for assessment purposes, as noted in section 3.3.1 of this report.

3.1.5 Program Evaluations

Scenic Rivers Monitoring Program

Updates to Monitoring Strategy

In the 2002-2004 period, locations of boundary control points in the Middle Delaware River (the Delaware Water Gap National Recreation Area) were at the NPS boundaries. Portions of the main stem and tributaries that fall within those boundaries are classified as Outstanding Basin Waters and regulations require no measurable change to existing water quality at the Park Service boundaries.

The National Park Service and U.S. Geological Survey conducted a tributary monitoring study from 2002 to 2004 that defined existing water quality for tributary Boundary Control Points. No changes were made to the Delaware River monitoring strategy, but the Delaware River data were reported to the DRBC Water Quality Advisory Committee as lacking in robustness to effectively meet program goals.

Effectiveness in Meeting Program Objectives

For the Delaware River 2000-2004 monitoring program, data are available for temperature, dissolved oxygen, conductivity, pH, turbidity and fecal coliform. A number of parameters that must be sampled for determining measurable change and to assist in making waste load allocations have historically not been sampled due to resource constraints. Until recently, many had not been monitored since 1993.

Currently, DRBC and NPS are employing a site-specific monitoring and data assessment protocol for better determining measurable change in the Upper and Middle Delaware River. Monitoring frequency has been increased at Boundary Control Points and Interstate Control Points for determining statistically valid changes to Existing Water Quality. Significant resources have been devoted to the program, and the parameters not sampled since 1993 have been restored to the program. DRBC anticipates that sufficient data will be generated by this program for site-specific water quality targets; nutrient criteria development; bacteria criteria development; and water quality model development.

Water quality in the Middle Delaware is not homogeneous, but differs significantly from north to south due to tributary inputs of pollutants. Because water quality targets based upon reach-wide water quality averages are not considered effective for meeting all assessment and planning needs. Since the 2002-2004 monitoring seasons, significant attention has been paid to reviving the Scenic Rivers Monitoring Program. DRBC is currently working with the National Park Service to expand the monitoring program to enable the development of site-specific water quality targets, as has been done for the Lower Delaware Monitoring Program.

Additional Monitoring or Data Management Tools Needed

Monitoring in the upper river has been limited to that conducted by the National Park Service since the mid-1990's. This monitoring has historically not included all of the parameters that describe Existing Water Quality due to staff and laboratory resource limitations. DRBC and NPS are currently working to address this. Additional funding is needed to provide staff and analytical services through contractor laboratories to address the need to expand monitoring in tributaries to establish and evaluate changes in water quality. These funds could also be augmented by resources of the National Park Service through cooperative agreements.

The NPS has long supported the SRMP with their resource management staff and with funds to hire Student Conservation Association (SCA) interns as field assistants, but that funding has been depleted. In order to achieve program objectives, DRBC may need to provide field staff and additional water quality laboratory support in coming years.

Lower Delaware Monitoring Program

Changes to the Program

In 2004, baseline monitoring to establish Existing Water Quality targets at 9 Interstate Control Points and 14 Boundary Control Points was completed. Data were analyzed and two reports were issued: the first was a technical report of water quality monitoring results; and the second was an assessment of the Delaware River in support of eligibility for declaration by DRBC as Special Protection Waters. The Lower Delaware River was so designated by DRBC, on an interim basis as of the issuing of this report. Future monitoring will be necessary to assess water quality against these antidegradation targets.

Changes Needed to Evaluate New Problems

Funding limitations prevent concurrent operation of all of DRBC's river monitoring programs. Optimally, sufficient resources would exist to operate the Scenic Rivers Monitoring Program for the river north of the Delaware Water Gap, the Lower Delaware Monitoring Program for the River from the Delaware Water Gap to Trenton, the Estuary Boat Run Program for the river south of Trenton, and the Delaware River Biomonitoring Program for biomonitoring and assessment of all of the River.

Additional Monitoring or Data Management Tools Needed

Local municipalities would benefit by having available a locally-based stream model for illustrating present strengths and weaknesses in existing or potential ordinances for water quality/quantity protection. Examples include the effects of mitigating storm water runoff and erosion, proper installation and maintenance of septic systems, pre and post-development ground and surface water evaluations, and protecting water quality and the aquatic ecosystem.

Of additional use would be the tools necessary to model the interaction of the stream and canal networks in the Lower Delaware region. This would allow for a better understanding of the locations, timing and magnitude of pollutant loadings and would help focus limited monitoring resources on identified data needs.

Delaware River Biomonitoring Program

Changes to the Program

In 2003 and 2004, flooding on the Delaware River prevented sampling of benthic invertebrates. This affected the schedule for biocriteria development, as data are still currently insufficient to characterize the benthic macroinvertebrate community.

DRBC has applied for, and received, funding through the Regionally Applied Research Effort (RARE) in EPA Region III. Funding resources from EPA Office of Research and Development are also being used to examine biological monitoring and assessment issues in the Delaware River as an example for other large, free-flowing rivers. Biological monitoring methods and a biocriteria strategy are expected results of this effort.

Changes Needed to Evaluate New Problems

The Delaware River Biomonitoring Program (DRBP) started in 2001 with a very narrow focus--to establish a baseline of existing biological conditions in the macroinvertebrate community. A biocriteria development strategy is needed, and additional biomonitoring support is necessary if nutrient criteria, ecological flow needs, and sediment criteria are to be developed. It is the intention of the DRBP to gather water quality-related information, using multiple biological assemblages, to document effects of environmental condition gradients and to use this information in rule-making for protection of aquatic life uses.

Additional Monitoring or Data Management Tools Needed

Biomonitoring has been used by DRBC since 2001 to define existing biotic condition of the Delaware River. A biocriteria strategy is still necessary to incorporate these data into future water quality and other conditions assessments. The present program monitors only the best available habitat (riffles), so additional habitats such as pools, runs, glides, and backwater sloughs may be added to the program in order to improve the representation of biological data. Adding additional assemblages would likely increase the effectiveness of assessments. To that end, monitoring of periphyton and algae has begun. Other developments that would improve the comprehensiveness of the biomonitoring program include development of habitat assessment methods for large rivers; increasing the capacity for fish community monitoring and assessment; and developing methods for monitoring submerged aquatic vegetation, mussels, aquatic invasive species, riparian condition, and sediment and channel morphology. Adding a randomization component to the program, and developing a way to incorporate reference conditions are other considerations.

3.2 Plan for Achieving Comprehensive Assessment

As identified in this report, DRBC maintains water quality monitoring programs that are intended to address its data needs, both spatially and temporally. However, some additional measures may be beneficial, such as:

- Creating a denser network of monitoring locations (including the use of outside sources of data as appropriate)
- Collecting or partnering with others to collect sufficient data on all parameters for which there are criteria
- Developing a new method for partitioning of the main stem river into assessment units that make better use of the monitoring locations available.

One example of how DRBC is attempting to improve the availability of data is through its work with the National Park Service on the Scenic Rivers Monitoring Program. As outlined in Section 3.1.5 of this report, the two agencies have begun to employ a more rigorous monitoring program to develop site-specific water quality targets, to identify changes to existing water quality and to augment the ability to assess water quality relative to criteria
.
DRBC's ability to improve and protect water quality in the Delaware River and Bay requires a better understanding of how tributary inputs contribute to main stem water quality. It is necessary to determine the sources of any pollution that is causing impairment in order to develop strategies to address that pollution. One way that DRBC has made progress toward the goal of identifying sources is through its network of Boundary and Interstate Control Points (BCPs and ICPs) monitored through the Scenic Rivers and Lower Delaware Monitoring Programs, as described in Section 3.1.3 of this report. While collecting data at these specific locations can assist in identifying watersheds of concern, it would take increased collaboration with the Basin States to develop a better understanding of specific sources within the watersheds. DRBC continues to seek opportunities for that increased collaboration.

3.3 2006 DRBC Integrated List Assessment Methodology

This assessment methodology discusses how the main stem of the Delaware River and the Delaware Bay are broken up into Assessment Units (AUs) and how data collected from within those AUs are used to evaluate designated use support. The designated uses that are assessed are Aquatic Life, Recreation (primary and secondary contact), Fish Consumption, Shellfish Consumption, and Drinking Water. Other uses for which DRBC has criteria, namely the Industrial and Agricultural Water Supply (after reasonable treatment) uses, do not have criteria set for them that differ from the universe of criteria applicable to the other uses. Additionally, criteria for those two uses would be less stringent than for the uses assessed here. This assessment methodology discusses the general and parameter-specific data requirements for making use support decisions, the method used for defining AUs in the River, the tidal River, and the Bay, the sources of data used for assessments, and the method of assigning AUs to one of five general categories for developing the Integrated List. These categories are defined under "Method For Assigning Assessment Units to Integrated List Categories" below.

3.3.1 General Data Requirements

In order to maintain accuracy and reliability in the assessments used for the Integrated Report and for other environmental decisions and regulatory programs, DRBC ensures that Quality Assurance Project Plans (QAPP) are approved annually prior to the initiation of its routine monitoring programs. Subsequently, any data used for assessment purposes must be accompanied by a QAPP that meets DRBC's requirements for monitoring data. It is assumed that data collected by State and Federal agencies have met the appropriate quality assurance requirements to be used in water quality assessments.

Data submitted to DRBC for use in water quality assessments should be in an electronic format to avoid an undue burden associated with entering large amounts of monitored data into such a format. In particular, data entered into US EPA's STORET system provides an appropriate example upon which to base the formatting of such data. Generally, spreadsheets and databases provide an appropriate format as well.

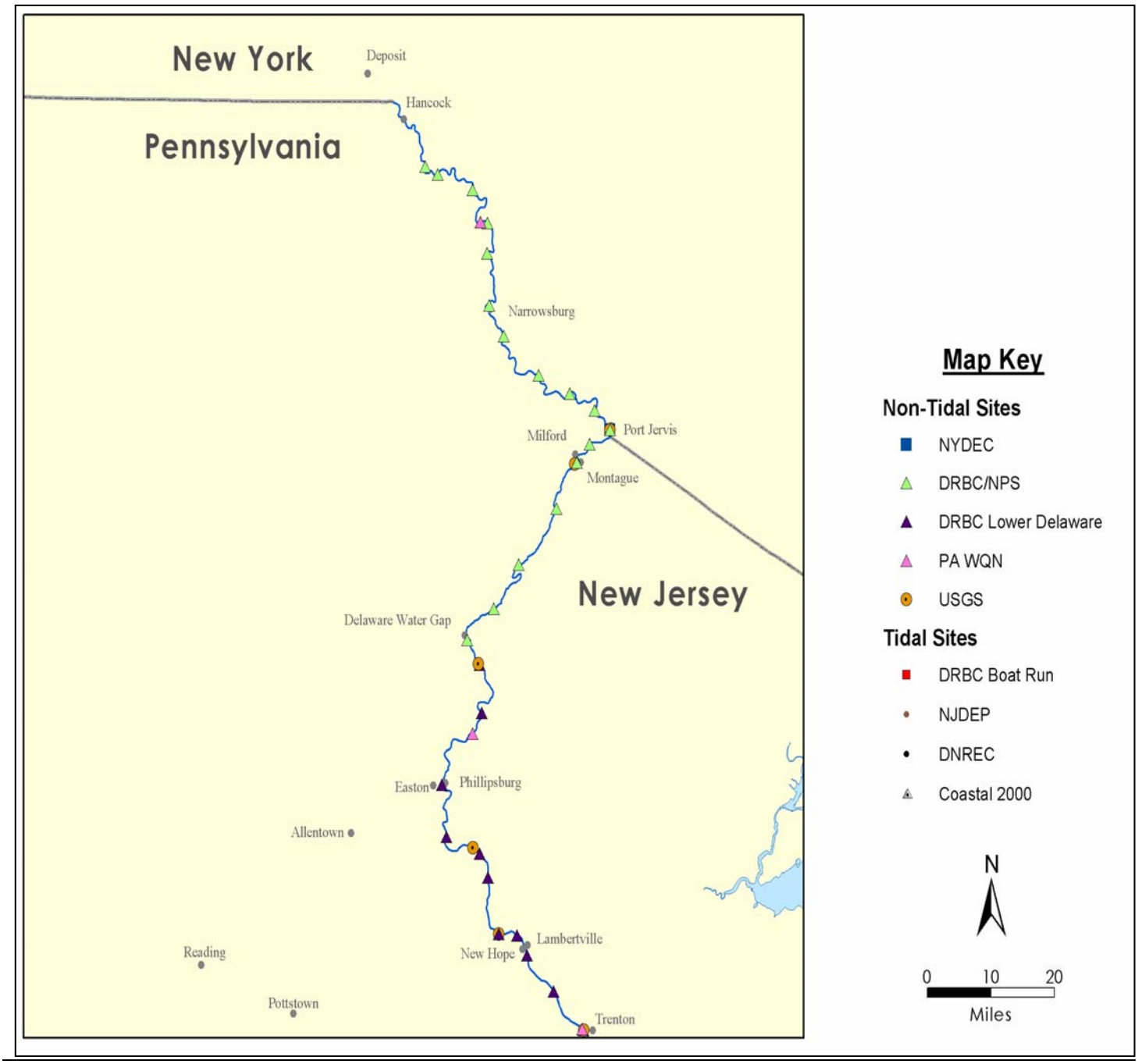
Data and Information Sources

DRBC collects a variety of water quality data from its own monitoring programs and also solicits available data from the Basin States in order to assess water quality in the Delaware River and Bay. The water quality assessments provided in this report are based upon data from the following sources:

- The National Park Service/DRBC Scenic Rivers Monitoring Program (SRMP)
- The Lower Delaware River Monitoring Program (LDMP)
- The Delaware Estuary Boat Run Program
- The Pennsylvania DEP Water Quality Network (WQN)
- The Delaware DNREC Ambient Surface Water Quality Monitoring Program
- The New Jersey DEP Ambient Surface Water Monitoring Network
- The New York State DEC Ambient Monitoring Network
- United States Geological Survey (USGS) National Water Quality Assessment Program (NAWQA) and National Water Information System (NWIS)
- DRBC/USGS Cooperative Monitoring Program (Continuous Monitors)
- Environmental Protection Agency Coastal 2002, 2003 and 2004 Programs

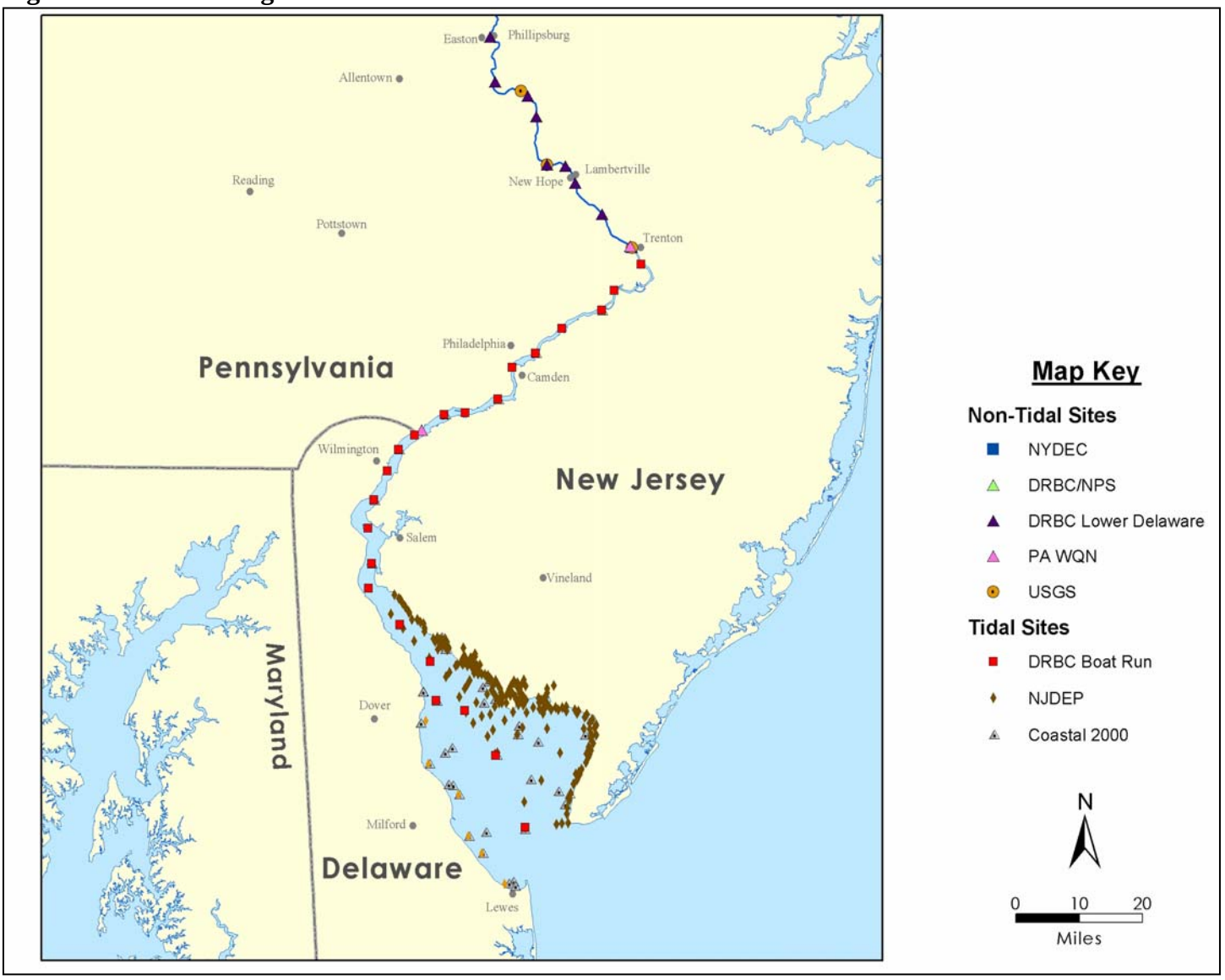
Figures 3.1 & 3.2 show the locations of the sites used in the monitoring programs listed above.

Figure 3.1: Monitoring Locations Non-Tidal



Source: 2006 DRBC Integrated List

Figure 3.2: Monitoring Locations Tidal



Source: 2006 DRBC Integrated List

3.3.2 Coordination with Basin States

Because DRBC's role is to assess shared waters in the Basin, coordination with the Basin States is important. The Integrated Listing process defines a list of waters for which Total Maximum Daily Loads (TMDLs) must be prepared (a 303(d) list). However, the regulatory responsibility for preparing a 303(d) list, represented in the Integrated List by category 5, rests with the States. DRBC does not produce a 303(d) list of its own, and thus does not require the public noticing process for publishing a 303(d) list. Further, the programmatic knowledge necessary to sub-categorize waters within Category 4 (what pollution control activities are planned for tributaries to the River, for example) also requires significant input from the states.

In order to avoid potential discrepancies between the DRBC's and States' Integrated Lists, and to ensure that the States have adequate time for their public noticing processes, it is DRBC's intent to provide a preliminary Integrated List to the States in advance of their administrative deadlines to begin the 303(d) list public noticing process. In that way, DRBC and the States would have an opportunity to coordinate and come to agreement on any outstanding data or assessment issues, and to arrive at a final list of impaired waters (Categories 4 and 5). Working within this schedule, the most recent monitoring season of data (typically May through October) that DRBC can effectively use for its assessment is the one that occurs two calendar years prior to the April 1 Integrated Report submittal date required by

U.S. EPA. The assessment utilizes data from that monitoring season and the two prior monitoring seasons. In the case of the 2006 Integrated List report, that includes monitoring seasons in 2002, 2003 and 2004.

3.3.3 Definition of AUs in Main Stem Delaware River, Delaware Estuary and Delaware Bay

Non-Tidal River Assessments

For River assessments (river miles 330.7 to 133.4), the definition of AUs is based upon DRBC Water Quality Zones (Figure 3.3), as specified in its Water Quality Regulations, but also takes into account that water quality in the main stem river is primarily a result of, and may be significantly affected by, tributary inputs. The aggregation of data in a water quality zone for assessment purposes presumes that differences in water quality, among distinct monitoring stations within the zone, are fairly small. However, in the case where a tributary supplies large inputs of one or more pollutants to the River, water quality upstream and downstream of that tributary's confluence with the River may be significantly different, with monitoring stations exhibiting higher water quality upstream of the confluence. Likewise, where a tributary provides higher quality water to a zone, monitoring stations downstream of the confluence may exhibit better water quality than those upstream of the confluence. Aggregating the data within a Water Quality Zone, without regard to this potentiality, may mask locations of either impaired water quality or water quality that is better than criteria. Therefore, AUs have been chosen to reflect the potential for water quality to change due to tributary loadings. The determination of which tributaries should be used to break up existing, programmatically defined water quality zones into more refined, hydrologically-based AUs is based upon capturing those tributaries that supply the majority of the watershed area to the main stem of the Delaware River. Those direct tributaries to the River that comprise 85% of the drainage area (each being roughly 30 square miles or greater in area) have been used to define AUs in the non-tidal portion of the River. The result is a larger, more refined set of AUs that is set up to account for the potential longitudinal changes in water quality that are likely to occur due to tributary influences.

In the relatively less-developed upper portions of the Basin, reservoir releases exert important influences on both flow and water quality in the River. This influence begins at Hancock, NY (River Mile 330.7), where the East and West Branches of the Delaware River converge. Both tributaries are regulated by reservoir releases. The 2006 Assessment focuses on the main stem River, downstream of this location. Within the assessed portion of the main stem Delaware River, those tributaries (from among those used to define AUs, as described above) that contribute reservoir releases are represented by The Lackawaxen River (Lake Wallenpaupack), Mongaup River (Rio Reservoir) and Neversink River (Neversink Reservoir).

Table 3.1 shows the AUs in the non-tidal River that are defined by the tributaries that constitute eighty-five percent of the drainage area of the non-tidal Delaware River. Also shown are the Water Quality Zone boundaries, defined in DRBC's Water Quality Regulations.

Table 3.1: Non-Tidal Assessment Units (Based on Tributary Watershed Area)

Tributary or Boundary	At RM	To RM	Assessment Unit	Tributary or Boundary	At RM	To RM	Assessment Unit
WQ1A	330.7	322.5	1A1	WQ1C/D	217.0	213.0	1D1
Equinunk Ck.	322.5	303.6	1A2	Brodhead Ck.	213.0	207.0	1D2
Callicoon Ck.	303.6	295.6	1A3	Paulins Kill	207.0	197.8	1D3
Calkins Ck.	295.6	289.9	1A4	Pequest R.	197.8	190.7	1D4
WQ1A/B	289.9	285.6	1B1	Martins Ck.	190.7	184.1	1D5
Tenmile R.	285.6	284.22	1B2	Bushkill Ck.	184.1	183.66	1D6
Masthope Ck.	284.22	277.7	1B3	WQ1D/E (Lehigh R.)	183.66	177.4	1E1
Lackawaxen R.	277.7	274.19	1B4	Pohatcong Ck.	177.4	174.6	1E2
Shohola Ck.	274.19	261.84	1B5	Musconetcong R.	174.6	173.7	1E3
Mongaup R.	261.84	254.75	1B6	Cooks Ck.	173.7	157.0	1E4
WQ1B/C	254.75	253.64	1C1	Tohickon Ck.	157.0	133.4	1E5
Neversink R.	253.64	226.9	1C2	WQ1E/WQ2	133.4		
Bush Kill	226.9	225.3	1C3				
Flat Brook	225.3	217.0	1C4				

Figure 3.3: DRBC Water Quality Zones

Source: 2006 DRBC Integrated List

Table 3.2 shows a modification of the AUs in Table 3.1 to account for reservoir releases as described above. Note that this table reflects AUs, reported to EPA, that are consistent with USGS's National Hydrographic Dataset. This system is slightly different than the DRBC river mileage system (reflected in Table 3.1), upon which its Water Quality Regulations (including water quality zones) are based. These NHD-related AUs provide the basis for the discussion of assessment results. Figure 3.4 depicts how the River AUs for water quality assessment are delineated.

Table 3.2: Modification of Non-Tidal Assessment Units (To Factor in Reservoir Release Influences)

Tributary or Boundary	At RM*	To RM*	Assessment Unit	Tributary or Boundary	At RM*	To RM*	Assessment Unit
WQ1A	335.54	308.01	1A1	WQ1C/D	219.35	214.70	1D1
Callicoon Ck.	308.01	299.38	1A2	Brodhead Ck.	214.70	210.20	1D2
Calkins Ck.	299.38	293.62	1A3	Paulins Kill	210.20	200.89	1D3
WQ1A/B	293.62	281.11	1B1	Pequest R.	200.09	192.71	1D4
Lackawaxen R.	281.11	264.88	1B2	Martins Ck.	192.71	185.83	1D5
Mongaup R.	264.88	257.67	1B3	Bushkill Ck.	185.83	185.41	1D6
WQ1B/C	257.67	256.53	1C1	WQ1D/E (Lehigh R.)	185.41	179.02	1E1
Neversink R.	256.53	229.85	1C2	Pohatcong Ck.	179.02	176.16	1E2
Bush Kill	229.85	228.13	1C3	Musconetcong R.	176.16	173.88	1E3
Flat Brook	228.13	219.35	1C4	Cooks Ck.	173.88	156.22	1E4
				Tohickon Ck.	156.22	133.4	1E5
				WQ1E/WQ2	133.4		

* River miles reflect National Hydrographic Dataset mileage system, which differs slightly from DRBC river mileage system.

Figure 3.4: Assessment Units - Nontidal

Source: 2006 DRBC Integrated List

Delaware Estuary Assessments

Table 3.3 indicates the extent of AUs within the Estuary. Assessment units for the tidal waters of the Estuary (river miles 133.4 to 48.2) have been selected on the basis of programmatically defined water quality zones in the DRBC Water Quality Regulations. Due to tidal action in the Estuary, water from the main stem river regularly moves up into the tributaries and water downstream of a tributary's confluence with the River regularly moves upstream of that confluence. While tributary loadings to these zones are an important determinant of water quality, the different hydrology in these zones, as compared to the river zones above river mile 133.4 at Trenton, makes using significant tributaries for the delineation of AUs less effective than in non-tidal river waters. As with AUs in the non-tidal Delaware River, data are aggregated within AUs. See Figure 3.5 for a depiction of AUs in the Estuary.

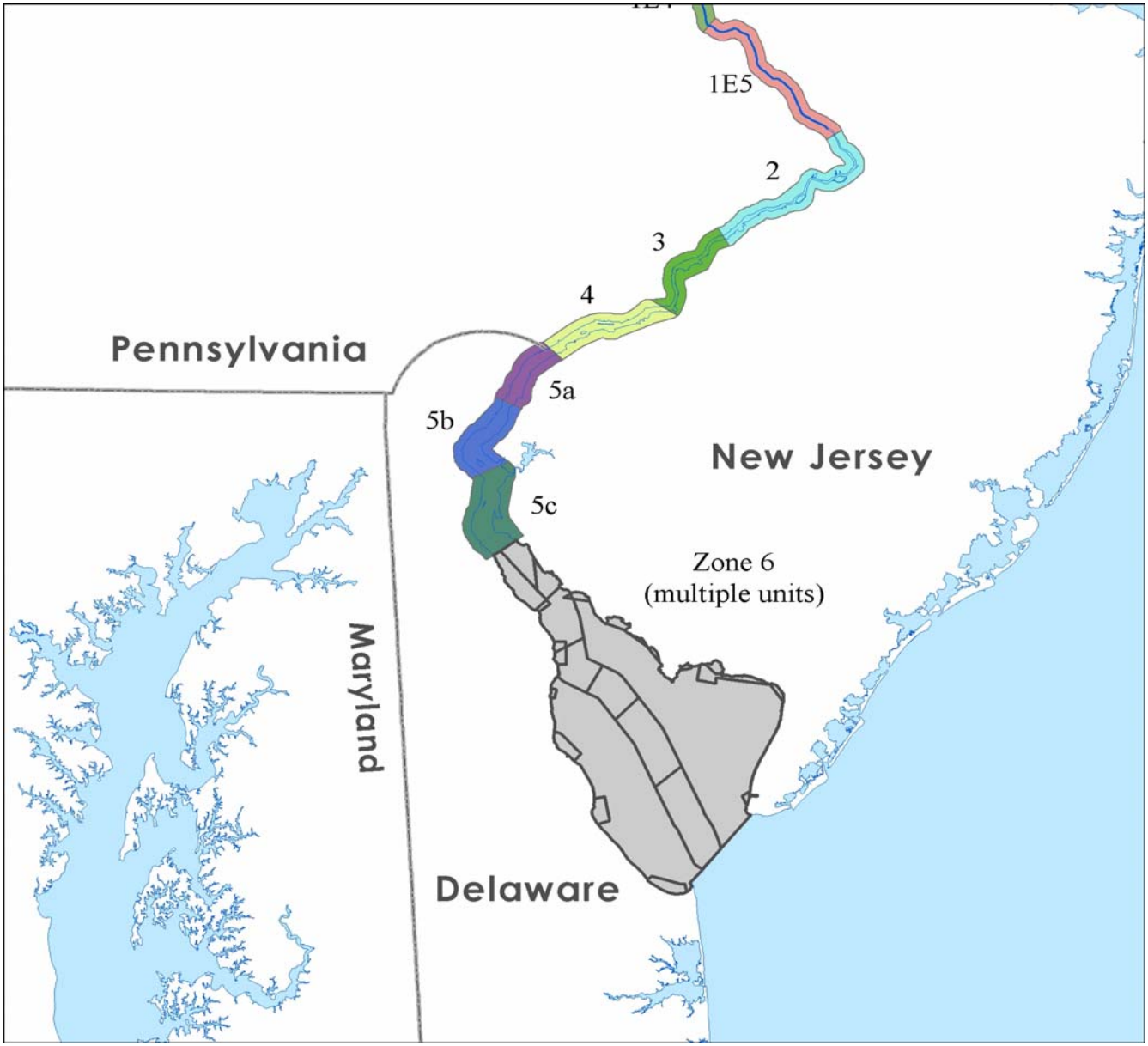
In addition to the AUs based on Water Quality Zones, note that Zone 5 has been subdivided for assessment purposes based upon changes criteria, by river mile, within the Zone itself. The Zone (RM 78.8 – RM 48.2, with an area of 65 square miles) is subdivided into three AUs, based upon changes in the dissolved oxygen criteria within the Zone. The subdivisions are 5A (RM 78.8-RM70.0, with an area of 13 square miles or approximately 20% of the Zone), 5B (RM 70.0-RM59.5, with an area of 21 square miles or approximately 32% of the Zone) and 5C (RM59.5-RM48.2, with an area of 31 square miles or approximately 48% of the Zone). These subdivisions enable a more effective assessment.

Averaging data from a group of sampling locations, for which the water quality criteria differ, could mask issues of non-attainment of those criteria.

Table 3.3: Assessment Units in Tidal River

Programmatic Boundary	At RM	To RM	Area	Assessment Unit
WQ1/WQ2	133.4	108.4	8 sq. miles	2
WQ2/WQ3	108.4	95.0	7 sq. miles	3
WQ3/WQ4	95.0	78.8	17 sq. miles	4
WQ4/WQ5	78.8	70.0	13 sq. miles	5a
	70.0	59.5	21 sq. miles	5b
	59.5	48.2	31 sq. miles	5c

Figure 3.5: Assessment Units - Tidal



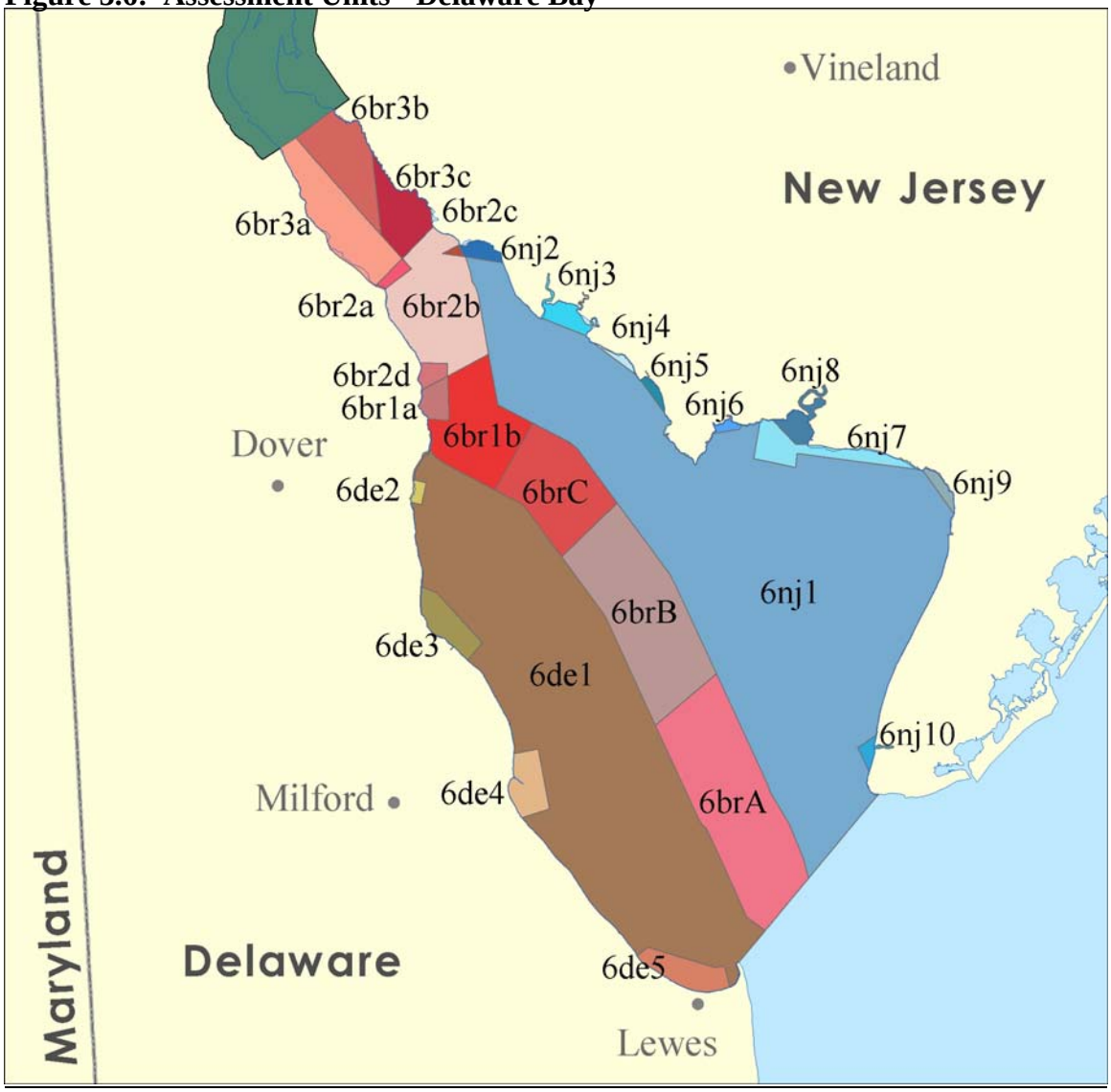
Source: 2006 DRBC Integrated List

Delaware Bay Assessments

Due to the spatial nature of the Delaware Bay (686 square miles, from River Mile 48.2 to the mouth of the Bay), individual monitoring locations were, for this report, assessed in aggregate by AUs that are based upon areas defined by the shellfish water classifications of the States of Delaware and New Jersey and upon the Delaware Estuary Boat Run program. This method was chosen to remain consistent with water body area boundaries that have already been defined for a particular designated use, namely Shellfish Consumption.

Assessment units are assessed in the Bay in much the same way that the River AUs are assessed. AUs are assessed by looking at the use support or non-support exhibited by the aggregated data from the monitoring locations present in those AUs. For example, if the data collected at all sites in an AU indicate support of the Aquatic Life designated use, then the AU is supporting the use. The methods used for making those use support decisions is described in Tables 3.4 to 3.11. Figure 3.6 shows how the Bay was partitioned into AUs.

Figure 3.6: Assessment Units - Delaware Bay



Source: 2006 DRBC Integrated List

3.3.4 Data Requirements

Tables 3.4-3.6 describe the general criteria for each parameter assessed and how that parameter is assessed relative to DRBC's Water Quality Regulations. The tables also describe the parameter-specific data requirements that are needed to enable assessments that have a higher degree of confidence associated with them. It should be noted, however, that assessments might also be made using data that is less robust than what the Data Requirements indicate. In particular, while at least two samples that do not meet a given criterion would be required to determine that the criterion is not met (and therefore the relevant designated use or uses are not considered to be supported), when less than twenty samples are available for an assessment period, if three or more samples do not meet a given criterion, then the criterion is not considered to be met for the AU and therefore the relevant designated use or uses are not considered to be supported.

Aquatic Life

The assessment of the Aquatic Life Designated Use is based upon the monitoring of chemical water quality data. The parameters used for determining use support are dissolved oxygen, temperature, pH, alkalinity, total dissolved solids (TDS) and toxics data and information.

Table 3.4: Aquatic Life Designated Use

Parameter	Criterion	Assessment Method	Data Requirements[a]
Dissolved Oxygen	Not less than numerical criterion at any time	Percent of samples in the AU less than criterion	At least 20 samples per AU over a three-year period
	24-hour average not less than numerical criterion	Percent of 24-hour averages in the AU less than criterion	At least 20 24-hour averages per AU over a three-year period; 24-hour average requires at least one daytime and one nighttime sample at a site in a 24-hour period, and samples should not be heavily weighted toward daytime or nighttime measurements.
	Seasonal average not less than numerical criterion	Departure (of seasonally relevant sample average) below criterion	In each AU, over a three-year period, at least 20 evenly-distributed (temporally[b]) samples per regulation-defined season.
Temperature	Except in designated heat dissipation areas[c], not to exceed specified increase above ambient temperature. Natural temperatures prevail where ambient temperature exceeds specified level.	Comparison of sampled 24-hour average temperature to date-specific ambient average temperature defined in Water Quality Regulations. Percent of 24-hour averages that exceed criterion.	At least 20 samples[d] per AU over a three-year period. Samples should be evenly distributed over the calendar year.
pH	Not to depart from specified range	Percent of samples in each AU that depart from specified range	At least 20 samples per AU over a three-year period
Total Dissolved Solids	Not to exceed 133% of background[e]	In each AU where background is specified in DRBC Water Quality Regulations, percent of samples in AU that exceed 133% of background level	At least 20 samples per AU over a three-year period
Alkalinity	Not less than specified criterion value, or not to depart from specified range.	Percent of samples in each AU less than specified criterion value or outside specified range, as applicable.	At least 20 samples per AU over a three-year period
Toxics Data and Information[f]	Chronic Toxicity: 1.0 Toxic Units (chronic) Acute Toxicity: 0.3 Toxic Units (acute) Ambient toxic parameters not to exceed criterion	Number of exceedences in an AU over a three-year period	At least 10 samples per AU over a three-year period[g]

[a]See Data Requirements narrative (section 3.4) for more information
[b]Using best professional judgment
[c]See DRBC Water Quality Standards (1996) 4.30.6.F.1
[d]Sample consists of 24-hour average temperature calculated from field measurements within an AU
[e]Criterion not applied below river mile 78.8
[f]Toxics criteria apply between river miles 133.4 and 48.2
[g]Based upon EPA guidelines

Drinking Water

The parameters used for determining the Drinking Water Use are total dissolved solids (TDS), turbidity, chlorides and toxic substances. Because this particular use so closely relates to human health, the assessment takes into account both the ambient chemical monitored data, which provide an indication of the suitability of the source of drinking water, as well as information on actual impacts to the use such as closures of drinking water facilities due to water quality concerns.

Table 3.5: Drinking Water Designated Use

Parameter	Criterion	Assessment Method	Data Requirements[a]
Total Dissolved Solids	Not to exceed 500 mg/l	Percent of samples in an AU that exceed 500 mg/l	At least 20 samples per AU over a three-year period
Chlorides	Maximum 30-day average concentration Maximum 15-day average concentration	Average concentration of samples in an AU Percent of samples in an AU that exceed maximum chloride criterion	At least three samples in a 30-day period At least two samples in a 15-day period At least 20 samples per AU over a three-year period
Toxic Substances[b]	Ambient toxic parameters not to exceed criterion	Number of samples in an AU that exceed criterion	At least 10 samples per AU over a three-year period[c]

[a]See Data Requirements narrative (section 3.4) for more information
[b]Toxics criteria, in waters designated for the Drinking Water use, apply between River Miles 133.4 and 95.0
[c]Based upon EPA guidelines

Primary and Secondary Contact Recreation

The parameters used for determining the Primary and Secondary Contact Recreation Uses are fecal coliform and enterococcus bacteria. The criteria are based on a geometric mean, with samples taken at such frequency and location as to permit valid interpretation. For assessment purposes, the monitoring results of samples taken in each AU are used to calculate a geometric mean for each monitoring season. Thus, each AU should, ideally, have three seasonal geometric means per assessment cycle, as the cycle covers three years of monitoring data. The calculation of geometric means will rely upon at least five samples per AU per monitoring season. If any one of the geometric means in that AU does not meet the applicable criterion, then the AU is considered to be impaired for the use. If less than three geometric means are calculated in an AU but at least one does not meet the applicable criterion, then the AU is considered to be impaired for the designated use.

Table 3.6: Primary and Secondary Contact Recreation

Parameter	Primary Contact Criterion	Secondary Contact Criterion	Assessment Method	Data Requirements[a]
Fecal Coliform Bacteria	Geometric Mean Not to Exceed 200/100ml or	Geometric Mean Not to Exceed 770/100ml	Geometric mean of samples in an AU.	At least five samples per AU during each monitoring season.
Enterococcus Bacteria	Geometric Mean Not to Exceed 33/100ml	Geometric Mean Not to Exceed 88/100ml	Geometric Mean of Samples in an AU	For Geometric Mean, at least five samples per AU during each monitoring season.

[a]See Data Requirements narrative (section 3.4) for more information

Fish Consumption

The categorization of AUs for the Fish Consumption use is based upon the presence of State fish consumption advisories in the main stem or tidal tributary portions of the River at the time of the assessment. Where no fish consumption advisories exist, the water body is supporting the use. Where limits on the number of fish meals or "do not eat" advisories exist for one or more fish species, the water body is impaired for the fish consumption use.

While all state fish consumption advisories aim to provide a high level of protection to the public with regard to the consumption of fish caught from state waters, there may be situations in which two or more states that share a water body do not post the same advisories in that water body. This may be due to a variety of causes, including different approaches to calculating the risks associated with particular contaminants or different assumptions about the amount of contaminant contained in a fish meal. This water quality assessment report categorizes AUs based upon the presence of fish consumption advisories, wherever posted.

In some cases, statewide advisories for one or more fish species may exist for one or more specific contaminants. In some cases, these advisories are based upon the presumption of a high prevalence of that contaminant in state waters, and not upon specific monitored data. Any AUs affected solely by this type of advisory are considered to have insufficient data for an assessment and will be placed in category 3. See the 2006 305(b) water quality assessment reports or Integrated Listing methodologies of Delaware, New Jersey, New York and Pennsylvania for more information about the posting of fish consumption advisories in state waters. The Web pages at the following Internet addresses provide more information:

For Delaware: http://www.fw.delaware.gov/Fisheries/Advisories.htm
For New Jersey: http://www.nj.gov/dep/dsr/njmainfish.htm
For New York: http://www.dec.state.ny.us/website/dfwmr/fish/fishregs/fishhealthadv.html
For Pennsylvania: http://sites.state.pa.us/PA_Exec/Fish_Boat/fishpub/summary/sumconsumption.pdf

Shellfish Consumption

Zone 6 (river mile 48.2 to the mouth of the Delaware Bay) is designated for the Shellfish Consumption use in DRBC's Water Quality Regulations. Both the states of Delaware and New Jersey assess for this use in their coastal waters, using procedures developed by the National Shellfish Sanitation Program (NSSP). In both states, waters classified for shellfishing may be not be open for that use at all times. In some cases, waters are open seasonally (typically in winter). In other cases, harvesting may be prohibited due to administrative closures that are based upon resource protection, upon the proximity of the water to sewer outfalls or upon land uses abutting those coastal waters. In still other cases, waters may be open to harvesting but with special treatment of the shellfish required, such as transplantation to cleaner waters, for a period of time, prior to harvest. Finally, some waters are closed to shellfish harvesting due to existing water quality concerns, as shown by monitoring. Where sufficient water quality data exist for the States to determine if the Shellfish Consumption use is supported, only those data determine the support of the use.

3.3.5 Method for Assigning Assessment Units to Integrated List Categories

When an AU is assessed against the relevant criteria for determining if all designated uses have been met, that water body is then placed into one of five categories that describe both the level of use support and the degree to which the available data can be used to accurately assess use support. The five categories into which an AU can be placed are as follows, according to the 2006 Integrated List Guidance provided by U.S. EPA:

Integrated Listing Categories (2006 Integrated List Guidance)

1: All designated uses are supported, no use is threatened;
2: Available data and/or information indicate that some, but not all of the designated uses are supported;
3: There is insufficient available data and/or information to make a use support decision;
4: Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed;
5: Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

Tables 3.7-3.10 below explain, for each of the various designated uses assessed, how an AU is considered to be supporting that use. Table 3.11 explains how an AU is assigned to Categories 2-5.

Table 3.7: Aquatic Life Designated Use – Supporting

Category	Parameter	Explanation
1	Dissolved Oxygen	• Data requirements met for at least half the applicable component criteria. • Less than 10% of samples in AU violate "not less than" criterion. • Less than 10% of 24-hour averages in AU violate "24-hour average" criterion. • No seasonal average violates "seasonal average" criterion.
	Temperature	Data requirements met. Less than 10% of samples in AU violate criterion
	pH	Data requirements met. Less than 10% of samples in AU violate criterion
	Total Dissolved Solids	Data requirements met. Less than 10% of samples in AU violate criterion
	Alkalinity	Data requirements met. Less than 10% of samples in AU violate criterion
	Toxics Data or Information	Data requirements met. For each parameter assessed, no more than one exceedence each of acute and chronic toxicity criteria over a three-year period. No more than one exceedence of ambient parameter criteria over a three-year period.

Table 3.8: Primary and Secondary Contact Recreation Use – Supporting

Category	Parameter	Explanation
1	Fecal Coliform or Enterococcus Bacteria	• Data requirements met. • In a given AU, no violations of the geometric mean criterion exist for any monitoring season in which at least five samples have been collected.

Table 3.9: Fish Consumption Use – Supporting

Category	Parameter	Explanation
1	Fish Consumption Advisories	In a given AU, no fish consumption advisories are present that are based upon monitored water quality or fish tissue data or other water body-specific information.

Table 3.10: Shellfish Consumption Use – Supporting

Category	Parameter	Explanation
1	Shellfish Harvesting Classification	In a given AU, no restrictions placed on shellfish harvesting that are due to recent, readily available data showing water quality problems or shellfish tissue contamination. Administrative restrictions or closures based on resource protection are not considered an impairment of the use.

Table 3.11: Drinking Water Use – Supporting

Category	Parameter	Explanation
1	Drinking Water Supply Closures	In a given AU, no waters affected by administrative closures for drinking water supply, due to water quality concerns, over the three-year assessment period
	Chlorides	• Data Requirements met • No more than one 30-day or 15-day average (as applicable) exceeds maximum level criterion over the three-year assessment period • Less than 10% of all samples in an AU exceed maximum level criterion over the three-year assessment period
	Total Dissolved Solids	• Data Requirements met • Less than 10% of all samples in an AU exceed maximum level criterion over the three-year assessment period
	Toxic Substances	• Data Requirements met • For each parameter assessed, no more than one exceedence of criteria over the three-year assessment period

Table 3.12: Explanation of AU Assignment to Categories 2-5

Category	Explanation
2	• Data requirements met for assessing at least one but not all uses. • No parameters for which data requirements are met indicate nonattainment of criteria. • AU is "probably supporting"[a] one or more uses and is supporting all other uses. • No parameters, for which Data Requirements are not met, indicate a high likelihood of criteria nonattainment.[b]
3	• No designated use has sufficient data for all its relevant parameters. • In the case of Fish Consumption, AUs affected by statewide or other advisories that are based upon the presumption of contaminant presence, but not based upon water quality data, are listed in this category. • In the case of Shellfish Consumption, areas affected by administrative or precautionary closures, and for which water quality data are not sufficient to determine the presence or absence of water quality concerns relating to this use, are listed in this category.
3A Waters of Concern	• One or more parameters, for which insufficient data exist, indicate a high likelihood of impairment[b] • AU is "probably not supporting" one or more designated uses[a]
3B	• AU is "probably supporting" one or more designated uses[a]. There is insufficient data to determine if the remaining uses (if any) are supported. No uses are "probably not supported".
4	• One or more water quality criteria not met, additional data or information indicate a likelihood of one or more water quality criteria not being met by the next reporting cycle. • In the case of Drinking Water use, AU is has been affected by an administrative closure due to monitored water quality data. • A TMDL is not required due to 4A, 4B or 4C.
4A	TMDL has been completed
4B	Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future
4C	Impairment is not caused by a pollutant
5	• One or more water quality criteria not met, additional data or information indicate a likelihood of one or more water quality criteria not being met by the next reporting cycle. • In the case of Drinking Water, AU has been affected by an administrative closure due to monitored water quality data during the three-year assessment period. • In the case of Fish Consumption, AU is affected by a fish consumption advisory for one or more species, based upon monitored water quality or fish tissue data. • In the case of Shellfish Consumption, area is affected by a shellfishing restriction or closure based upon recent monitored water quality or shellfish tissue data. In the absence of recent, readily available data, restricted areas will be considered impaired.

a: AU, for which insufficient data exist to assess a given use, is bounded by two AUs that have sufficient data for assessment. See below.
b: Twenty-five percent or more of samples in an AU exceed the criterion or seasonal average exceeds criterion by 25 percent or more of the criterion value. See below.

Use of Continuously Monitored Data

Data on temperature, dissolved oxygen and pH are collected continuously at a number of locations on the Delaware River. These data represent the most accurate reflection of water quality at those locations, given that all three of those parameters normally exhibit diurnal fluctuations that cannot be captured by once-daily monitoring. Continuously monitored dissolved oxygen, for instance, provides a reliable twenty-four hour average that can be used to assess that component of the DRBC water quality criteria for dissolved oxygen. In AUs where continuous data exist for temperature, dissolved oxygen and/or pH, those data are used to represent water quality conditions, for those parameters, in that AU.

Waters of Concern

The Data Requirements presented in Tables 3.4-3.6 are goals and are not used to preclude a water body from being assessed. For example, where one or more parameters, for which the data requirements have not been met, indicate that an AU exhibits a high likelihood of criteria non-attainment, the AU will be placed in Sub-Category 3 as a "Water of Concern". A high likelihood of non-attainment is considered to be:

- 25 percent or more samples not meeting the criterion for a particular parameter
- A seasonal average that does not meet the relevant criterion by at least 25 percent of the value of the criterion

Assessment Units Probably Supporting or Not Supporting a Designated Use Based Upon Adjacent Units

Where an AU, for which there are no or insufficient data for determining its support of a particular designated use, is bounded by two AUs supporting that designated use, the unit with no or insufficient data is considered to be *probably* supporting the designated use. Likewise, if bounded by AUs that are impaired for a particular use, then the unit with no or insufficient data is considered to be *probably not* supporting the use. An AU that is probably supporting one or more uses and is supporting all other uses is placed in Category 2. An AU that is probably not supporting one or more uses, but is not impaired for any use, is placed in Category 3A as a "water of concern".

If an AU, for which there are no or insufficient data on a particular use, is bounded by two AUs that differ in their support for that use, then the use is considered to have insufficient supporting information and the AU will be placed in the appropriate category, depending on the support level of the remaining uses:

- Category 2 if at least one other use is supported and the remaining uses are supported, or have insufficient data or information, with no uses "probably not supported".
- Category 3 if no other uses have sufficient data or information for assessment and no uses are either Probably Supported or Probably Not Supported
- Category 3A (Waters of Concern) if any parameters indicate a high likelihood of impairment (see above) or if any uses are "Probably Not Supported"
- Category 3B (Probably Supporting one or more uses) if one or more uses is Probably Supported but there are insufficient or no data or information on the other uses and no uses are "probably not supported"
- Category 4 or 5 if one or more other uses are not supported based upon sufficient data for assessment.

Insufficient Data to Assess Criteria Based on 30-Day Averages

Where less than three samples are collected in a 30-day period (for 30-day averages) the percent of all samples collected in the AU that exceed the numeric criterion will be used. If there are less than 20 samples for a parameter in the three-year period assessed, then the AU has insufficient data for that parameter, unless three or more samples do not meet the relevant criterion.

Multi-Component Criteria

Some parameters have two or more component criteria, as with the "not-less-than", "24-hour average", and "seasonal average" components of the Dissolved Oxygen criteria. If at least one-half of the components can be assessed with sufficient data, then the parameter can be assessed, using the results of the assessed components. If less than one-half the components have sufficient data for assessment, then the parameter is considered to have insufficient data for assessment. The exception to this situation would be where any one component indicates that the criterion is not being met. For the above example, if there are insufficient data to assess the seasonal average and 24-hour average components of the Dissolved Oxygen criterion but greater than ten percent of samples taken (if 20 or more samples taken in a three-year period), or three or more samples (if less than twenty samples were taken) do not meet the relevant "not-less-than" result value, the water would be considered not to be meeting the Dissolved Oxygen criterion.

Assessing Data from Different Sources

All assessed data within an AU are considered to carry equal importance and relevance, as all sources of data used for an assessment must have been collected, analyzed and documented using the appropriate, recognized state and/or EPA quality assurance and control procedures. Therefore, data that come from different sources are assessed in aggregate by AU.

3.4 Delaware River and Bay Surface Water Quality Assessment for Years 2002-2004

The following section of the report presents the results of assessing the Delaware River and the tidal portions of its tributaries. For portions of the River and Bay that were either assessed as not supporting the designated use in question or did not have sufficient data to determine support of that designated use, the tables explain the rationale for making those assessment decisions. The figures in this section display the level of use support, as assessed, for all portions of the River and Bay.

3.4.1 Assessment of Designated Uses for Surface Waters

Aquatic Life Designated Use

The water quality parameters used in this assessment of the Aquatic Life Designated Use are pH, Temperature, Dissolved Oxygen, Alkalinity, Total Dissolved Solids or TDS and toxic parameter data (along with Chronic Toxicity) that were collected in Water Quality Zones 2-5. DRBC standards include temperature criteria for all portions of the River; however in-stream values only exist for Zones 2, 3 and 4. In other portions of the River, criteria are based upon the regulation of temperature increases, caused by effluent discharges, above background conditions. Those background conditions are not defined in Zones 1, 5 and 6.

The Aquatic Life designated use was assessed along the length of the Delaware River from Hancock, NY to the bottom of Zone 1 (202 miles), in Zones 2-5 of the Delaware Estuary (97 square miles), and in the Delaware Bay (693 square miles). Figure 3.7 depicts the level of Aquatic Life Use support in the Delaware River and Bay.

Non-Tidal River

The use was supported in 102 miles of the non-tidal river, or 50.4 %. The remaining 100 miles either had insufficient data or did not support the use. The following table explains the rationale behind the assessment decisions in those assessment units.

Table 3.13: Use Support Level for Non-Tidal River AUs - Aquatic Life Designated Use

AU	Use Support Level	Explanation
1A1	Not Supported	14.9% of samples exceeded the pH criterion
1A2	Not Supported	13.2% of samples exceeded the pH criterion
1A3	Insufficient Data	No readily-available Total Dissolved Solids data
1B1	Insufficient Data	No readily-available Total Dissolved Solids data
1B2	Supported	Data requirements are met and indicate use support
1B3	Insufficient Data	No readily-available Total Dissolved Solids data
1C1	Insufficient Data	No readily-available data
1C2	Supported	Data requirements are met and indicate use support
1C3	Insufficient Data	No readily-available Total Dissolved Solids data
1C4	Insufficient Data	No readily-available data
1D1-1D2	Insufficient Data	No readily-available Total Dissolved Solids data
1D3	Supported	Data requirements are met and indicate use support
1D4	Not Supported	15.9% of samples exceeded the Total Dissolved Solids criterion
1D5-1D6	Insufficient Data	No readily-available data
1E1	Supported	Data requirements are met and indicate use support
1E2	Probably Supported	No readily-available data but 1E1 and 1E3 support the Aquatic Life use
1E3-1E5	Supported	Data requirements are met and indicate use support

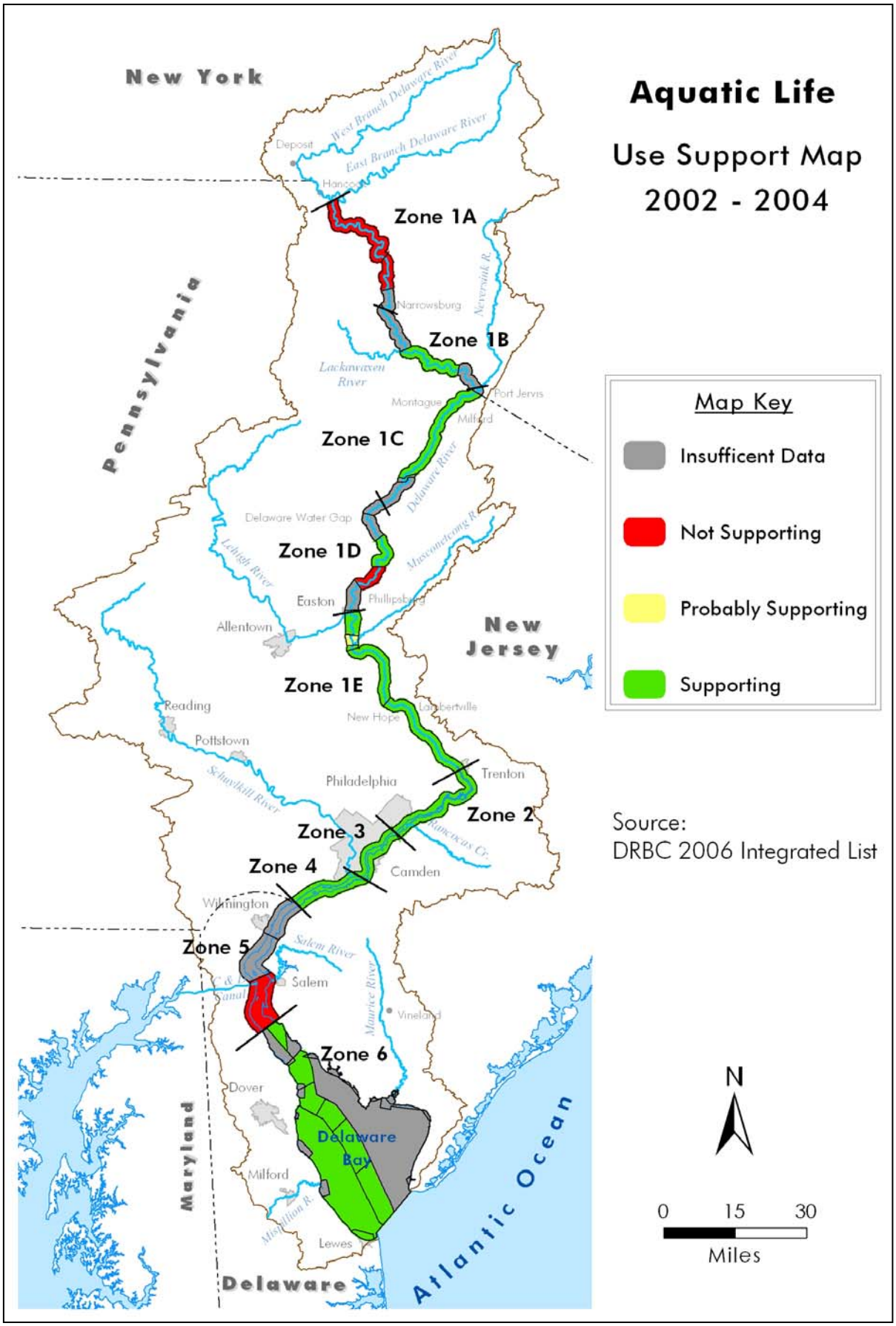
Estuary

The use was supported in Zones 2, 3 and 4 of the Estuary (32 square miles) and in 362 square miles of the Bay. The remaining 395 square miles either had insufficient data or did not support the use. The following table explains the rationale behind the assessment decisions in those assessment units.

Table 3.14: Use Support Level Explained for Estuary and Bay AUs - Aquatic Life Designated Use

AU	Use Support Level	Explanation
5a	Insufficient Data	Insufficient DO data for 24-hour averages and seasons not well-represented
5b	Insufficient Data	Insufficient DO data for 24-hour averages and seasons not well-represented
5c	Not Supported	DO criterion not met in 13% of 24-hour averages
6brA-6brC	Supported	Data requirements are met and indicate use support
6br1a	Insufficient Data	No readily available data
6br1b	Supported	Data requirements are met and indicate use support
6br2a	Insufficient Data	No readily available data
6br2b	Supported	Data requirements are met and indicate use support
6br2c-6br2d	Insufficient Data	No readily available data
6br3a	Insufficient Data	No readily available data
6br3b	Supported	Data requirements are met and indicate use support
6br3c	Insufficient Data	No readily available data
6de1	Supported	Data requirements are met and indicate use support
6de2-6de4	Insufficient Data	No readily available data
6de5	Supported	Data requirements are met and indicate use support
6nj1	Insufficient Data	Insufficient pH and Alkalinity data
6nj2-6nj7	Insufficient Data	No readily available data
6nj8	Insufficient Data	Insufficient pH and Alkalinity data
6nj9-6nj10	Insufficient Data	No readily available data

Figure 3.7: Aquatic Life Use Support in the Delaware River and Bay, 2002-2004



Fish Consumption Designated Use

The assessment of Fish Consumption is not based on zones, but rather is based upon the presence of fish consumption advisories for the main stem Delaware River and the tidal portions of its tributaries. Tables 3.14 – 3.16 below indicate the portions of the River for which such advisories exist. Figure 3.8 shows how those advisories translate into use support for fish consumption in the Delaware River. All portions of the Delaware River and Bay were found to have fish consumption advisories in place and so were assessed as not supporting the Fish Consumption use. The pollutants most commonly resulting in fish consumption advisories were PCBs, Mercury and chlorinated pesticides.

Where no advisories are in effect, the water body is supporting the Fish Consumption use. Where restrictions exist on the amount of fish consumed in a given time period, or consumption advisories exist for susceptible populations, the water body is not supporting the use. New Jersey has developed a new methodology for making these advisories that has resulted in a two-tiered approach based upon risk level. For the purposes of this assessment, however, any advisory, regardless of risk level utilized, was used to indicate non-support of the use.

In total, all 202 miles of the non-tidal, mainstem Delaware River, all 97 square miles of the Estuary and 686 square miles of the Bay were assessed for fish consumption. As described in the Assessment Methodology (see Section 3.3), only water-body specific advisories for particular contaminants are used for determining use support. Statewide advisories require more information.

Table 3.15: Fish Consumption Advisories for the Delaware River : Delaware, New York and Pennsylvania (Main Stem and Tidal Portions)

Issuing State	From RM	To RM	Locations	Species	Advisory	High Risk Advisory	Contaminant
NY[a]	330.71	253.6	Statewide (i.e., NY portion of mainstem Delaware River)	All Species	no more than 1/2 lb/week	do not eat[b]	Various
PA[c]	330.71	133.46	Source to Trenton/Morrisville Bridge	American Eel	2 meals/month		Mercury
PA	133.46	78.74	Trenton/Morrisville Bridge to PA/DE line	American Eel, Carp	Do Not Eat		PCBs
				White Perch, Striped Bass, Carp, Flathead Catfish, Channel Catfish	1 meal/month		PCBs
DE[d]	78.74	58.90	Delaware State Line to C&D Canal	All Finfish	do not eat		PCBs, Dioxin, Mercury, Chlorinated Pesticides
DE	58.90	0.00	C&D Canal to mouth of Delaware Bay	Striped Bass, Channel Catfish, White Catfish, American Eel, White Perch, Bluefish	no more than 1 8-oz. meal/year (including for Bluefish less than 24-inches. For Bluefish greater than 24-inches, do not eat.		PCBs, Mercury, Dieldrin
DE			Tidal Brandywine R., mouth to Baynard Blvd.	All Finfish	do not eat		PCBs
DE			Tidal Christina R., mouth to Smalley's Dam	All Finfish	do not eat		PCBs, Dieldrin
DE			Tidal White Clay Creek, mouth to Route 4	All Finfish	do not eat		PCBs
DE			C&D Canal, entire Canal in DE	All Finfish	do not eat		PCBs
DE			Shellpot Creek, Philadelphia Pike to Delaware River	All Finfish	do not eat		PCBs
DE			Appoquinimink River, Tidal Portions	All Finfish	no more than 1 8-oz. meal/year		PCBs, Dioxin
DE			Drawyers Creek, Tidal Portions	All Finfish	no more than 1 8-oz. meal/year		PCBs, DDT

[a] NYS Department of Health 2005-2006 Health Advisories - Chemicals in Sportfish and Game

[b] in NY, high risk individuals are women of childbearing age, infants and children under 15

[c] Commonwealth of Pennsylvania Fish Consumption Advisories-2005

[d] Delaware Division of Fish and Wildlife, Fish Consumption Advisories as of March, 2005

Table 3.16: Fish Consumption Advisories for the Delaware River: New Jersey (For PCBs and Dioxins)

From RM	To RM	Locations	Species	Advisory for 1 in 10,000 Lifetime Cancer Risk Level	Advisory for 1 in 100,000 Lifetime Cancer Risk Level	High Risk Advisory Based on a Non-Cancer Risk[b]
253.60	0.00	Statewide	American Eel	4 meals/year	1 meal/year	Do Not Eat
			Bluefish > 6lbs/24"	4 meals/year	Do Not Eat	Do Not Eat
			Bluefish < 6lbs/24"	1 meal/month	1 meal/year	Do Not Eat
			Striped Bass	1 meal/month	1 meal/year	Do Not Eat
137.60	78.74	Delaware River, Easton/Phillipsburg to PA/DE border, including tributaries to head of tide	American Eel	4 meals/year	Do Not Eat	Do not eat
			Striped Bass	4 meals/year	Do Not Eat	Do Not Eat
			Channel Catfish	1 meal every 2 months	1 meal every 2 months	Do Not Eat
78.74	58.90	Delaware River, DE/PA line to C&D Canal	All Finfish	Do Not Eat	Do Not Eat	Do Not Eat
58.90	0.00	Delaware River, C&D Canal to mouth of Delaware Bay	Striped Bass, Channel Catfish, White Catfish, American Eel, White Perch	no more than one 8-oz. meal per year	no more than one 8-oz. meal per year	no more than one 8-oz. meal per year
48.20	0.00	Delaware Bay Tributaries	American Eel	1 meal/month	4 meals/year	4 meals/year

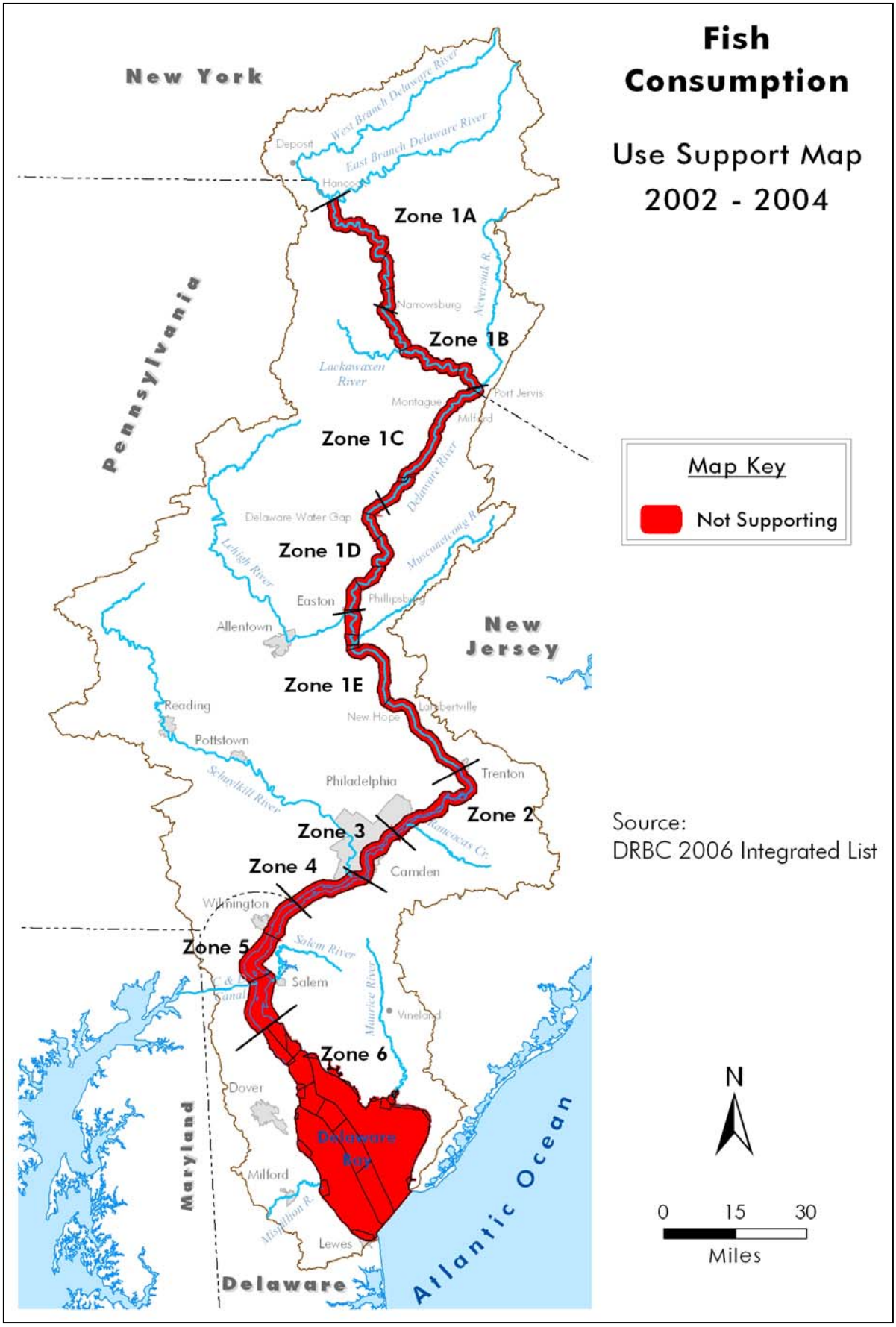
[a] A Guide to Health Advisories for Eating Fish and Crabs Caught in New Jersey Waters, 2005
[b] in NJ, high risk individuals include infants, children, pregnant women, nursing mothers and women of childbearing age.

Table 3.17: Fish Consumption Advisories for the Delaware River: New Jersey (for Mercury)[a]

From RM	To RM	Locations	Species	General Advisory	High Risk Advisory[b]
253.60	0.00	Statewide	Largemouth & Smallmouth Bass, Chain Pickerel	1 meal/week	1 meal/month
			Brown Bullhead	No Restrictions	1 meal/month
			Yellow Bullhead & Sunfish	No Restrictions	1 meal/month
253.60	209.50	Delaware River upstream of Water Gap	Smallmouth Bass	1 meal/week	1 meal/month
			Channel Catfish Muskellunge	No Restrictions	1 meal/month
209.50	184.60	Delaware River from Water Gap to Phillipsburg	White Catfish	1 meal/week	Do Not Eat
			Channel Catfish	No Restrictions	1 meal/month
			Smallmouth Bass		
			Walleye	No Restrictions	1 meal/week
184.60	131.96	Delaware River, Phillipsburg to Trenton	Channel Catfish	1 meal/week	1 meal/month
			Largemouth Bass	No Restrictions	1 meal/month
			Smallmouth Bass	No Restrictions	1 meal/week
131.96	100.12	Delaware River Trenton to Camden	Largemouth Bass & White Catfish	No Restrictions	1 meal/week
100.12	78.74	Delaware River Camden to Delaware State Line	Hybrid Striped Bass	No Restrictions	1 meal/week

[a] A Guide to Health Advisories for Eating Fish and Crabs Caught in New Jersey Waters, 2005
[b] High-risk individuals are Infants, children, pregnant women, nursing mothers and women of childbearing age

Figure 3.8: Fish Consumption Use Support in the Delaware River and Bay, 2002-2004



Shellfish Consumption Designated Use

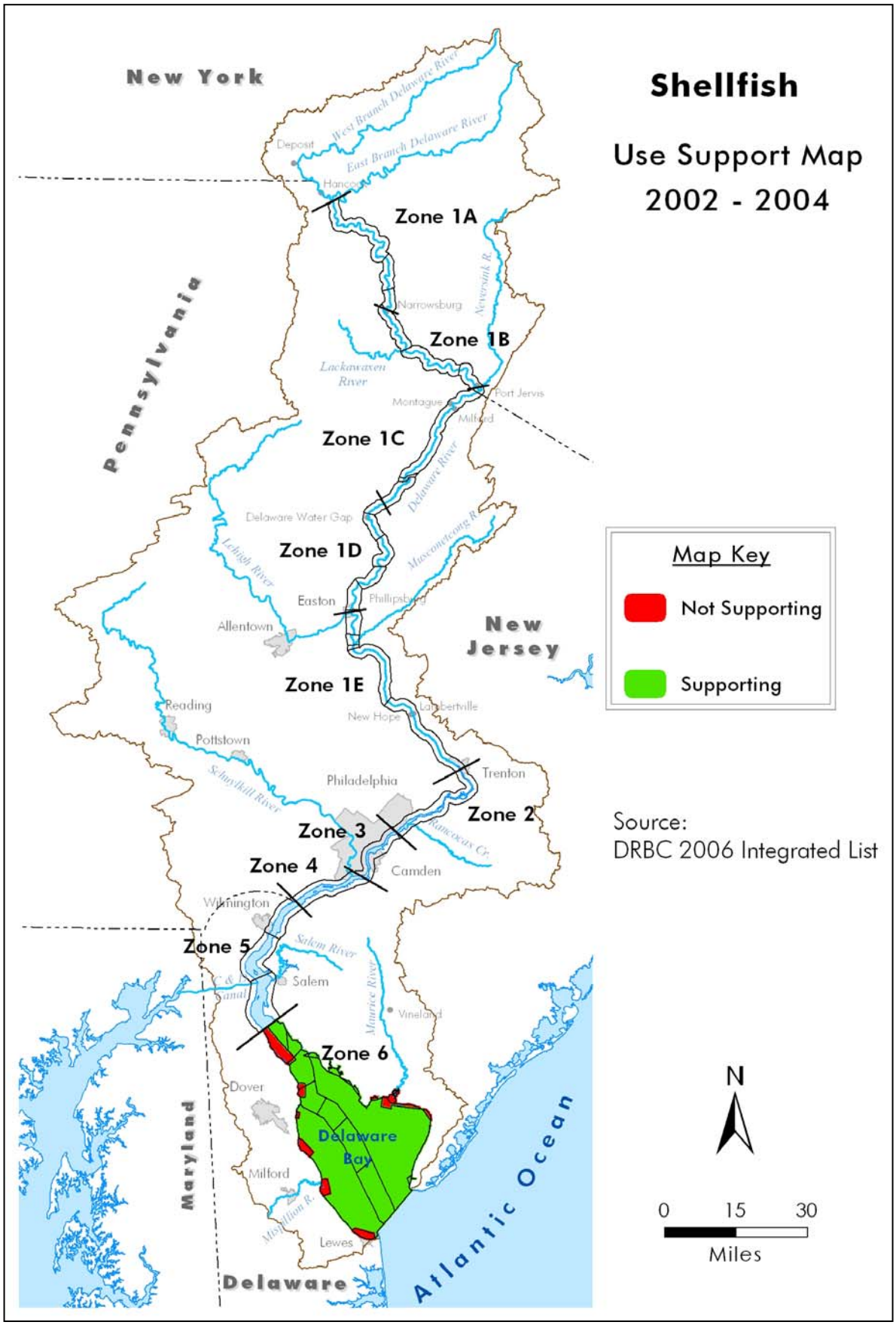
DRBC classifies only Zone 6 for the shellfish consumption use. In Zone 6, a criterion is set such that Total Coliform (Most Probable Number or MPN) is not to exceed federal shellfish standards in designated shellfish areas. Because both the states of Delaware and New Jersey monitor and assess water quality for suitability for shell fishing based upon the same set of federal guidelines (both states use Total Coliform), the reader is referred to the most recent water quality assessment reports of those states for an assessment of the shellfish consumption use.

The State of Delaware classifies its designated shellfish waters as falling into the following categories; Approved, Seasonally Approved, Prohibited Shellfish Harvesting and Resource Protection Area, or Prohibited. New Jersey classifies shellfish waters as falling into the following categories; Unrestricted, Special Restricted, Seasonal, and Prohibited (either due to water quality or to administrative closures).

For this assessment, Prohibited waters were considered to be Not Supporting the use, unless recent, readily available data showed that water quality was sufficient to support the use and that prohibitions on harvesting were based on administrative issues, and not specific, current water quality concerns. All other harvesting areas were considered to be Supporting the use. Figure 3.9 indicates the use support for shellfishing in Zone 6. In total, 642 square miles (93% of Zone 6) were in Full Support and 51 square miles (7% of Zone 6) were Not Supporting the use. For Shellfish Consumption, the entirety of Zone 6 (693 square miles) was assessed.

It is important to note that both the States of Delaware and New Jersey do not list all prohibited or provisionally approved waters as impaired waters, as not all restrictions on shellfish harvesting are due to water quality issues. Please see Delaware's and New Jersey's 2006 Integrated List Reports for more information.

Figure 3.9: Shellfish Consumption Use Support in Delaware Bay, 2002-2004



Recreational Designated Use

The determination of Recreational Use support in this assessment is based upon bacterial data. DRBC standards for bacteria are based upon a geometric mean such that, for areas where Fecal Coliform bacteria are used as indicators, a maximum geometric mean of 200 colonies per 100 ml is permitted. Some exceptions to this criterion are present in the standards, however. In Zone 3 and Zone 4 (above RM 81.8) the limit is 770 colonies per 100 ml and secondary contact recreation is the designated use. In sections of the River where Enterococcus is another indicator (Zones 2-6), a maximum geometric mean of 33 colonies per 100 ml is the criterion for primary contact recreation in fresh waters. In marine waters (Zones 5 and 6), the Enterococcus criterion is 35 colonies per 100 ml for primary contact recreation. Secondary contact recreation in fresh waters requires no more than 88 colonies per 100ml.

Figure 3.10 shows the level of use support for Recreation, which was assessed along the length of the Delaware River from Hancock, NY to the bottom of Zone 1 (202 miles), in Zones 2-5 of the Delaware Estuary (97 square miles), and in Delaware Bay (686 square miles).

Non-Tidal River

The recreation use was supported in 162 miles (80%) of the non-tidal Assessment Units. The remaining reaches of River were either not supporting the use or had insufficient data to assess the use. Table 3.17 explains the rationale behind the assessment decisions in those assessment units.

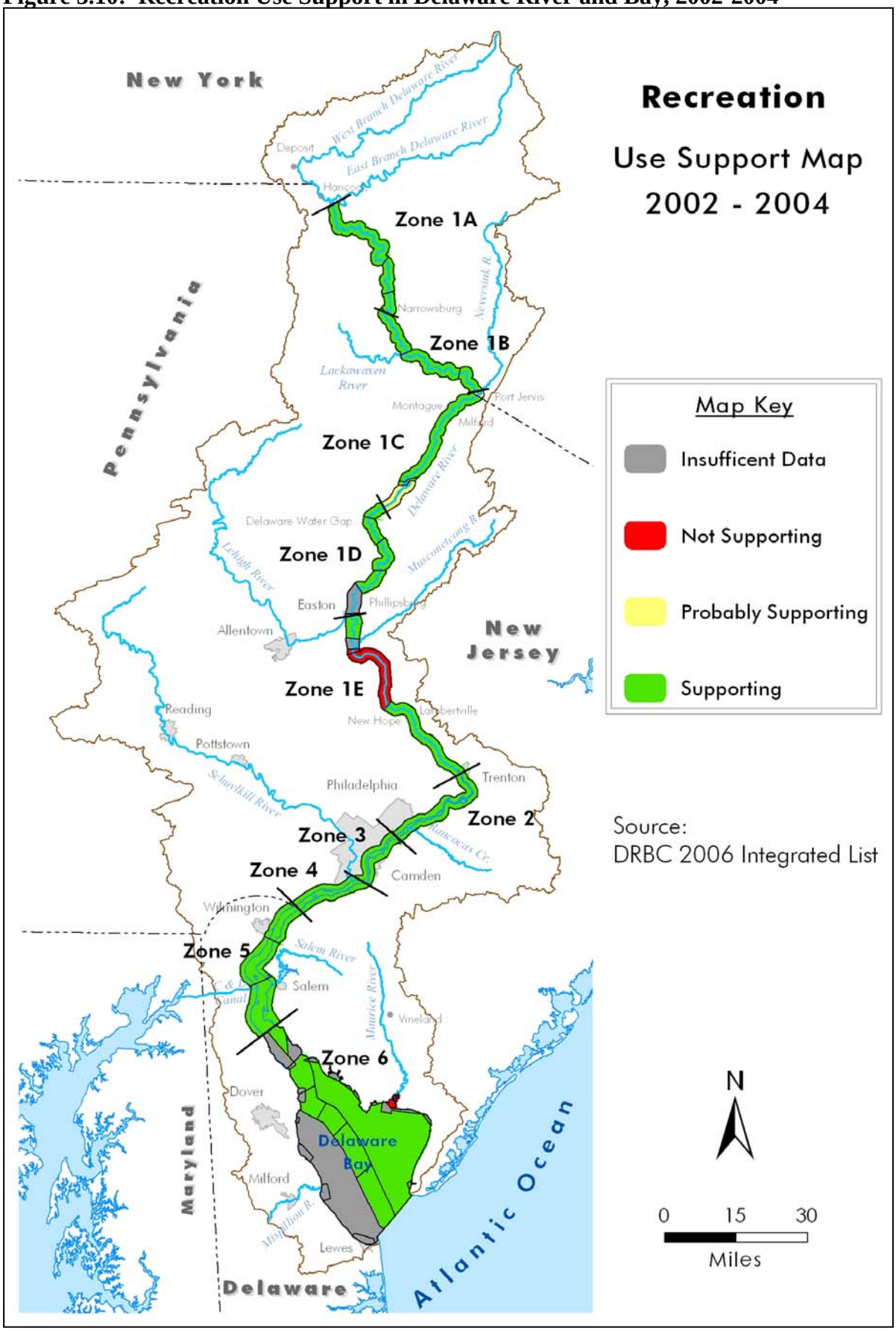
Table 3.18: Use Support Level for Non-Tidal River AUs - Recreation Designated Use

AU	Use Support Level	Explanation
1A1-1A3	Supported	Data requirements are met and indicate use support
1B1-1B3	Supported	Data requirements are met and indicate use support
1C1	Probably Supported	No readily available data, but 1B3 and 1C2 are supporting this use
1C2-1C3	Supported	Data requirements are met and indicate use support
1C4	Probably Supported	No readily available data, but 1C3 and 1D1 are supporting this use
1D1-1D4	Supported	Data requirements are met and indicate use support
1D5-1D6	Insufficient Data	No readily available data
1E1	Supported	Data requirements are met and indicate use support
1E2	Insufficient Data	No readily available data
1E3	Not Supported	Geometric mean for 2004 samples was 224/100ml
1E4	Not Supported	Geometric mean for 2004 samples was 228/100ml
1E5	Supported	Data requirements are met and indicate use support

Estuary

The use was supported in Estuary zones 2-5 (97 square miles, or 100% of the Estuary, excluding the Bay) and in all assessable portions of the Bay except for three square miles in 6nj8. In other words, the use was supported in 438 square miles, or 63% of the Bay. All other Bay assessment units could not be assessed for recreation, according to DRBC water quality standards, because of a lack of readily available Enterococcus or Fecal Coliform bacterial data.

Figure 3.10: Recreation Use Support in Delaware River and Bay, 2002-2004



Drinking Water Designated Use

The assessment of the Drinking Water designated use, in this assessment, is based upon levels of toxic substances, Total Dissolved Solids or TDS (secondary drinking water standards, or maximum of 500 mg/L applies for this use), Hardness and Chlorides. Zones 1A-E, 2 and 3 are designated for drinking water use, or a total of 202 main stem river miles and 14 square miles of Estuary.

Figure 3.11 shows the level of drinking water use attainment for the various segments of the main stem Delaware River based upon an analysis of the parameters mentioned above. Note that Alkalinity, Chlorides, and Hardness criteria are not set for Zones 1A-E in the River.

The Drinking Water designated use was assessed along the length of the Delaware River from Hancock, NY (RM 335.5) down to the bottom of Zone 1 (202 miles) and in Zones 2 and 3 (14 square miles). This is equal to 100% of the main stem River and Estuary that are designated for that use.

Non-Tidal River

In Zones 1A-E, use support was based upon Turbidity and Total Dissolved Solids data. The use was supported in all Zones except those in Table 3.18.

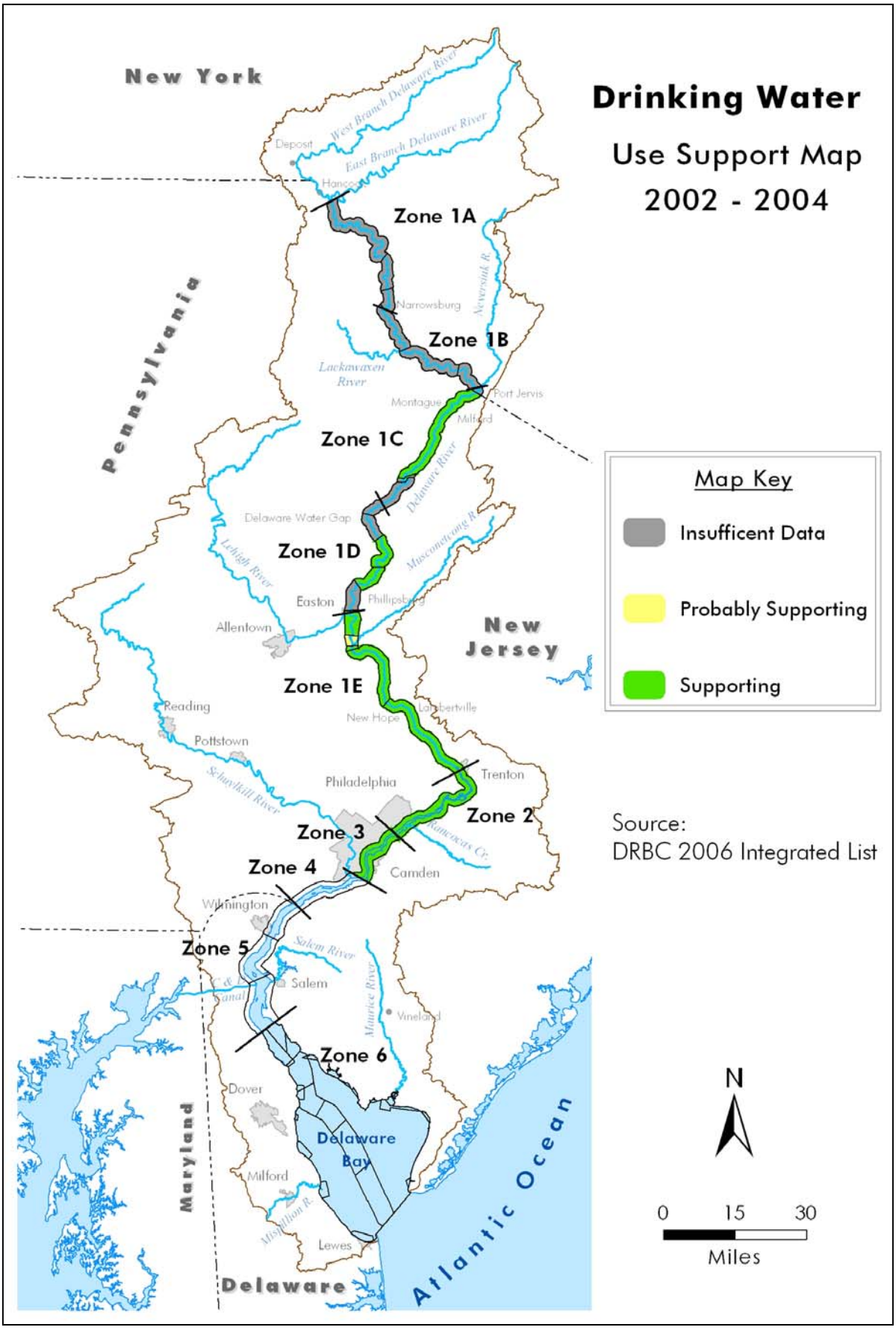
Table 3.19: Use Support Level for Non-Tidal AUs - Drinking Water Designated Use

AU	Use Support Level	Rationale
1A1-1A3	Insufficient Data	No readily available Total Dissolved Solids data
1B1-1B3	Insufficient Data	No readily available Total Dissolved Solids data
1C1	Insufficient Data	No readily available Total Dissolved Solids data
1C2	Supported	Data requirements are met and indicate use support
1C3-1C4	Insufficient Data	No readily available Total Dissolved Solids data
1D1-1D2	Insufficient Data	No readily available Total Dissolved Solids data
1D3-1D4	Supported	Data requirements are met and indicate use support
1D5-1D6	Insufficient Data	No readily available Total Dissolved Solids data
1E1	Supported	Data requirements are met and indicate use support
1E2	Probably Supported	No readily available data but 1E1 and 1E3 support this use
1E3-1E5	Supported	Data requirements are met and indicate use support

Estuary

In Zones 2 and 3 (15 square miles, or 100% of the designated area in the Estuary) the drinking water use was assessed as Supported.

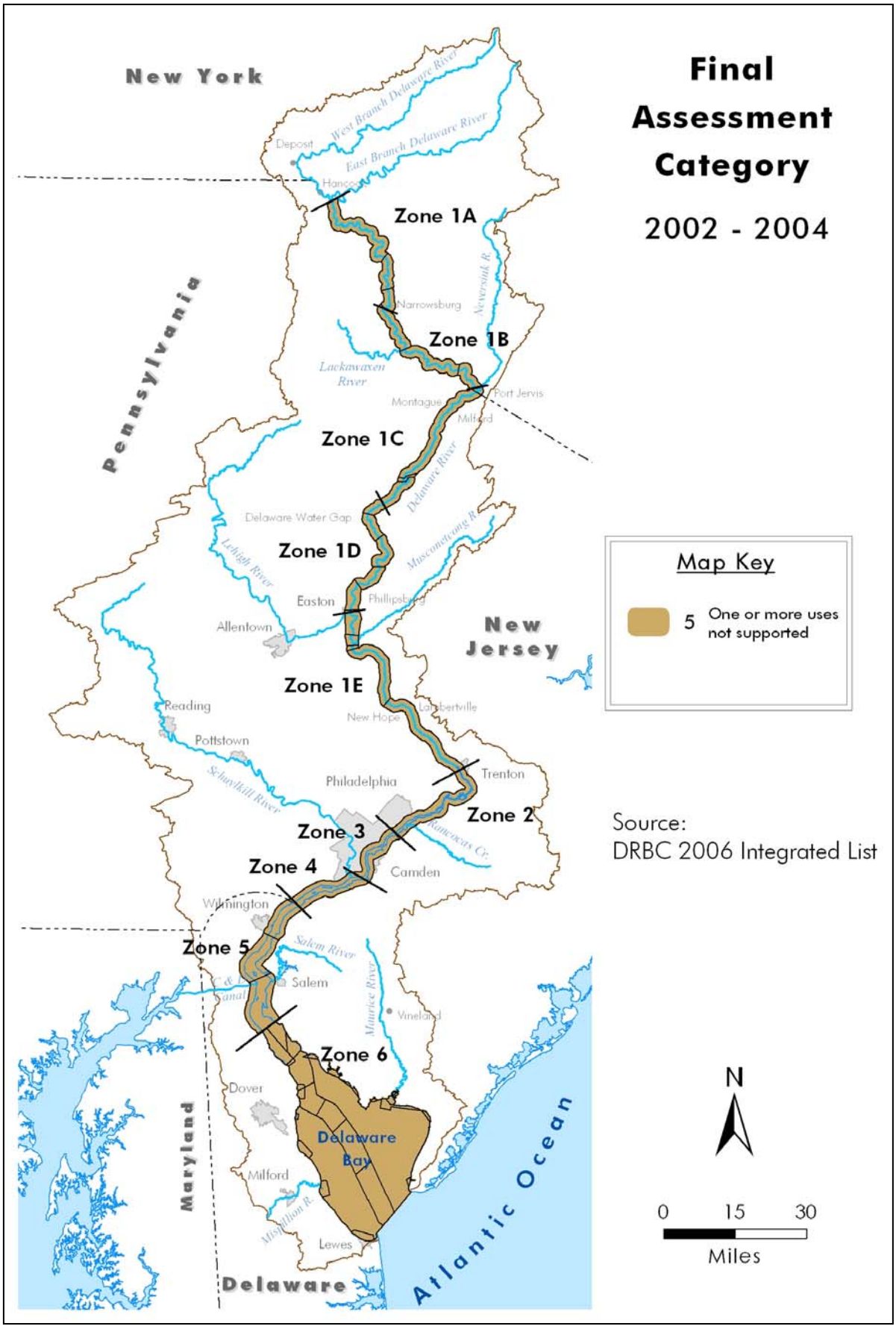
Figure 3.11: Drinking Water Use Support in Delaware River and Estuary, 2002-2004



Final Categorization of Assessment Units

Figure 3.12 represents the Integrated List categories into which each of the AUs belongs. The results of this assessment indicate that the vast majority of the Delaware River and Bay is in Category 5, not supporting one or more uses and requiring a TMDL. In some cases, non-support of the Fish Consumption designated use was the only cause of a water body being placed in Category 5. Most parts of the River and Bay are affected by fish consumption advisories.

Figure 3.12: Categorization of AUs of the Delaware River and Bay, 2002-2004



4. Ground Water Assessment

As described in Part 2, it is the general policy of DRBC that all ground water of the Basin, as well as surface sources of drinking water, should not exceed maximum contaminant levels (MCL) given in the National Primary Drinking Water Standards. Because this report focuses on the mainstem of the Delaware River, the reader is directed to the 2006 water quality assessment reports of each of the four Delaware River Basin States for an update on groundwater quality management programs and any ground water-related issues.

Some general ground water issues that are occurring in the Basin, as of the writing of this report, are as follows:

- Superfund sites - A number of these sites exist in the Basin and contribute to localized groundwater contamination. Remediation activities are ongoing throughout the Basin.
- Mercury - Natural sources exist in some geologic formations in the Basin. More importantly, air deposition of mercury from combustion activities is an issue.
- Saltwater intrusion - In areas near the Delaware Bay, pumping of groundwater leads to migration of saltwater into the aquifers that supply water for drinking and other needs.
- Naturally occurring substances - Some areas have naturally high levels (due to local geology) of radioactivity, arsenic or other substances that may require additional treatment or preclude them from serving as drinking water sources

Appendix A

DRBC Water Quality Standards for Drinking Water Sources

Table A1: Maximum Contaminant Levels to be Applied as Human Health Stream Quality Objectives in Zones 2 and 3 of the Delaware River Estuary

Parameter	Maximum Contaminant Level (µg/l)
Antimony	6
Arsenic	50
Barium	2.0 mg/l
Cadmium	5
Chromium (total)	100
Nickel	100
Selenium	50
1,2 - trans - Dichloroethene	100
1,2 - Dichloropropane	5
Ethylbenzene	700
gamma - BHC (Lindane)	0.2
1,2,4 - Trichlorobenzene	70
Total Trihalomethanes	100

Table A2: Stream Quality Objectives for Carcinogens for The Delaware River Estuary

PARAMETER	EPA CLASS.	FRESHWATER OBJECTIVES (µg/l)		MARINE OBJECTIVES (µg/l)
		FISH & WATER INGESTION (Zones 2&3)	FISH INGESTION ONLY	FISH INGESTION ONLY
Beryllium	B2	0.00767	0.132	0.0232
Aldrin	B2	0.00189	0.0226	0.00397
alpha - BHC	B2	0.00391	0.0132	0.00231
Chlordane	B2	0.000575	0.000588	0.000104
DDT	B2	0.000588	0.000591	0.000104
DDE	B2	0.00554	0.00585	0.00103
DDD	B2	0.00423	0.00436	0.000765
Dieldrin	B2	0.000135	0.000144	0.0000253
Heptachlor	B2	0.000208	0.000214	0.0000375

PARAMETER	EPA CLASS.	FRESHWATER OBJECTIVES (µg/l)		MARINE OBJECTIVES (µg/l)
		FISH & WATER INGESTION (Zones 2&3)	FISH INGESTION ONLY	FISH INGESTION ONLY
Heptachlor epoxide	B2	0.000198	0.000208	0.0000366
PCBs (Total)	B2	0.0000444	0.0000448	0.0000079
Toxaphene	B2	0.000730	0.000747	0.000131
Acrylonitrile	B1	0.0591	0.665	0.117
Benzene	A	1.19	71.3	12.5
Bromoform	B2	4.31	164.0	28.9
Bromodichloromethane	B2	0.559	55.7	9.78
Carbon tetrachloride	B2	0.254	4.42	0.776
Chlorodibromomethane	C	0.411	27.8	4.88
Chloroform	B2	5.67	471.0	82.7
1,2 - Dichloroethane	B2	0.383	98.6	17.3
1,1 - Dichloroethene	C	0.0573	3.20	0.562
1,3 - Dichloropropene	B2	87.0	14.1	2.48
Methylene chloride	B2	4.65	1,580	277
Tetrachloroethene	B2	0.80	8.85	1.55
1,1,1,2 - Tetrachloroethane	C	1.29	29.3	5.15
1,1,2,2 - Tetrachloroethane	C	0.172	10.8	1.89
1,1,2 - Trichloroethane	C	0.605	41.6	7.31
Trichloroethene	B2	2.70	80.7	14.2
Vinyl chloride	A	2.00	525.0	92.9
Benzidine	A	0.000118	0.000535	0.000094
3,3 - Dichlorobenzidine	B2	0.0386	0.0767	0.0135
PAHs				
Benz[a]anthracene	B2	0.00171	0.00177	0.00031
Benzo[b]fluoranthene	B2	0.000455	0.000460	0.000081
Benzo[k]fluoranthene	B2	0.000280	0.000282	0.000049
Benzo[a]pyrene	B2	0.0000644	0.0000653	0.0000115

PARAMETER	EPA CLASS.	FRESHWATER OBJECTIVES (µg/l)		MARINE OBJECTIVES (µg/l)
		FISH & WATER INGESTION (Zones 2&3)	FISH INGESTION ONLY	FISH INGESTION ONLY
Chrysene	B2	0.0214	0.0224	0.00394
Dibenz[a,h]anthracene	B2	0.0000552	0.0000559	0.0000098
Indeno[1,2,3-cd]pyrene	B2	0.0000576	0.0000576	0.0000101
Bis (2-chloroethyl) ether	B2	0.0311	1.42	0.249
Bis (2-ethylhexyl) phthalate	B2	1.76	5.92	1.04
Dinitrotoluene mixture (2,4 & 2,6)	B2	17.3	1420	249
1,2 - Diphenylhydrazine	B2	0.0405	0.541	0.095
Hexachlorobenzene	B2	0.000748	0.000775	0.000136
Hexachlorobutadiene	C	0.445	49.7	8.72
Hexachloroethane	C	1.95	8.85	1.56
Isophorone	C	36.3	2590	455
N-Nitrosodi-N-methylamine	B2	0.000686	8.12	1.43
N-Nitrosodi-N-phenylamine	B2	4.95	16.2	2.84
N-Nitrosodi-N-propylamine	B2	0.00498	1.51	0.265
Pentachlorophenol	B2	0.282	8.16	1.43
2,4,6 - Trichlorophenol	B2	2.14	6.53	1.15
Dioxin (2,3,7,8 - TCDD)	-	1.3×10^{-8}	1.4×10^{-8}	2.4×10^{-9}

Table A3: Stream Quality Objectives for Systemic Toxicants for the Delaware River Estuary

PARAMETER	EPA CLASS.	FRESHWATER OBJECTIVES (µg/l)		MARINE OBJECTIVES (µg/l)
		FISH & WATER INGESTION (Zones 2 and 3)	FISH INGESTION ONLY	FISH INGESTION ONLY
Antimony		14.0	4,310	757
Arsenic	A	9.19	73.4	12.9
Beryllium	B2	165	2,830	498
Cadmium		14.5	84.1	14.8
Chromium (Trivalent)		33,000	673,000	118,000
Hexavalent chromium	A	166	3,370	591
Mercury	D	0.144	0.144	0.144
Nickel		607	4,580	805
Selenium	D	100	2,020	355
Silver	D	175	108,000	18,900
Thallium		1.70	6.20	1.10
Zinc		9110	68700	12100
Aldrin	B2	0.96	11.5	2.03
gamma - BHC (Lindane)		7.38	24.9	4.37
Chlordane	B2	0.0448	0.0458	0.00805
DDT	B2	0.100	0.100	0.0176
Dieldrin	B2	0.108	0.115	0.020
Endosulfan		111	239	42.0
Endrin	D	0.755	0.814	0.143
Heptachlor	B2	0.337	0.344	0.060
Heptachlor epoxide	B2	0.0234	0.0246	0.00433
Total PCBs	B2	0.00839	0.00849	0.00149
Acrolein		320	780	137
Ethylbenzene		3,120	28,700	5,050
Bromoform	B2	682	25,900	4,560

PARAMETER	EPA CLASS.	FRESHWATER OBJECTIVES (µg/l)		MARINE OBJECTIVES (µg/l)
		FISH & WATER INGESTION (Zones 2 and 3)	FISH INGESTION ONLY	FISH INGESTION ONLY
Bromodichloromethane	B2	693	69,000	12,100
Dibromochloromethane	C	690	46,600	8,190
Carbon tetrachloride	B2	23.1	402	70.6
Chloroform	B2	346	28,700	5,050
Chlorobenzene	D	677	20,900	3,670
1,1 - Dichloroethene	C	309	17,300	3,040
1,2 - trans - Dichloroethene		696	136,000	23,900
1,3 - Dichloropropene	B2	10.4	1,690	297
Methyl bromide		49.0	N/A	N/A
Methylene chloride	B2	2,090	710,000	125,000
1,1,2 - Trichloroethane	C	138	9,490	1,670
Tetrachloroethene		318	3,520	618
1,1,1,2 - Tetrachloroethane	C	1,000	22,400	3,940
Toluene		6,760	201,000	35,400
Acenaphthene		1,180	2,670	469
Anthracene	D	4,110	6,760	1,190
Benzidine	A	81.8	369	64.9
Bis (2-chloroisopropyl) ether		1,390	174,000	30,600
Bis (2-ethylhexyl) phthalate	B2	492	1,660	291
Butylbenzl phthalate	C	298	520	91.4
Diethyl phthalate	D	22,600	118,000	20,700
Dimethyl phthalate	D	313,000	2,990,000	526,000
Dibutyl phthalate	D	2,710	12,100	2,130
1,2 - Dichlorobenzene	D	2,670	17,400	3,060
1,3 - Dichlorobenzene	D	414	3,510	617
1,4 - Dichlorobenzene		419	3,870	677

PARAMETER	EPA CLASS.	FRESHWATER OBJECTIVES (µg/l)		MARINE OBJECTIVES (µg/l)
		FISH & WATER INGESTION (Zones 2 and 3)	FISH INGESTION ONLY	FISH INGESTION ONLY
2,4 - Dinitrotoluene		69.2	5670	996
Fluoranthene		296	375	65.8
Fluorene	D	730	1,530	268
Hexachlorobenzene	B2	0.958	0.991	0.174
Hexachlorobutadiene	C	69.4	7,750	1,360
Hexachlorocyclopentadiene		242	17,400	3,050
Hexachloroethane	C	27.3	124	21.7
Isophorone	C	6,900	492,000	86,400
Nitrobenzene	D	17.3	1,860	327
Pyrene	D	228	291	51.1
1,2,4 - Trichlorobenzene	D	255	945	166
2 - Chlorophenol		122	402	70.6
2,4 - Dichlorophenol		92.7	794	139
2,4 - Dimethylphenol		536	2,300	403
2,4 - Dinitrophenol		70	14,300	2,500
Pentachlorophenol	B2	1,010	29,400	5,160
Phenol		20,900	4,620,000	811,000

Appendix B
Scenic Rivers Monitoring Program
Site and Parameter Information

Table B1: Locations for Baseline Scenic Rivers Monitoring (43 Sites)

UPPER DELAWARE RIVER MONITORING LOCATIONS (9)	
Buckingham Access Area	Ten-Mile River NYSDEC Access Area
Lordville Bridge	Barryville Bridge
Callicoon Bridge	Pond Eddy Bridge
Callicoon NYSDEC Access Area	Millrift
Cochecton Bridge	
MIDDLE DELAWARE RIVER MONITORING LOCATIONS (7)	
Port Jervis	Bushkill Access
Northern DEWA boundary	Smithfield Beach
Milford Beach	Delaware Water Gap
Dingmans Access	
UPPER DELAWARE TRIBUTARIES (14)	
West Branch Delaware	Masthope Creek
East Branch Delaware	Beaver Brook
Equinunk Creek	Lackawaxen River
Little Equinunk Creek	Halfway Brook
Callicoon Creek	Shohola Creek
Calkins Creek	Mongaup River
Ten Mile River	Shingle Kill
MIDDLE DELAWARE TRIBUTARIES (13)	
Neversink River	Flat Brook
Vandermark Creek	Little Flat Brook
Shimers Brook	Van Campens Brook
Sawkill Creek	Shawnee Creek
Raymondskill Creek	Brodhead Creek
Bushkill Creek	Cherry Creek
Little Bushkill	

Table B2: Flow Measurement Monitoring Locations

LOCATION	**AGENCY**	**TYPE**
DELAWARE RIVER FLOW MONITORING LOCATIONS		
Callicoon Access Area	U.S.G.S.	Continuous
North of Lackawaxen	U.S.G.S.	Continuous
Port Jervis	U.S.G.S.	Continuous
Milford	U.S.G.S.	Continuous
Tocks Island	U.S.G.S.	Discontinued
UPPER DELAWARE TRIBUTARY FLOW MONITORING LOCATIONS		
West Branch Delaware	U.S.G.S.	Continuous
East Branch Delaware	U.S.G.S.	Continuous
Equinunk Creek	DRBC/NPS	Instantaneous
Little Equinunk Creek	DRBC/NPS	Instantaneous
Calkins Creek	DRBC/NPS	Instantaneous
Callicoon Creek	DRBC/NPS	Instantaneous
Tenmile River	DRBC/NPS	Instantaneous
Masthope Creek	DRBC/NPS	Instantaneous
Beaver Brook	DRBC/NPS	Instantaneous
Halfway Brook	DRBC/NPS	Instantaneous
Shohola Creek	DRBC/NPS	Instantaneous
Shingle Kill	DRBC/NPS	Instantaneous

Table B2 continued

MIDDLE DELAWARE TRIBUTARY FLOW MONITORING LOCATIONS		
Neversink River	U.S.G.S.	Continuous
Cummins Creek	DRBC/NPS	Instantaneous
Vandermark Creek	DRBC/NPS	Instantaneous
Shimers Brook	DRBC/NPS	Instantaneous
Sawkill Creek	DRBC/NPS	Instantaneous
Raymondskill Creek	DRBC/NPS	Instantaneous
Dingmans Creek	DRBC/NPS	Instantaneous
Hornbecks Creek	DRBC/NPS	Instantaneous
Toms Creek	DRBC/NPS	Instantaneous
Saw Creek	DRBC/NPS	Instantaneous
Little Bushkill Creek	DRBC/NPS	Instantaneous
Bushkill Creek	U.S.G.S.	Continuous
Flat Brook	U.S.G.S.	Continuous
Little Flat Brook	DRBC/NPS	Instantaneous
Big Flat Brook	DRBC/NPS	Instantaneous
Van Campens Brook	DRBC/NPS	Instantaneous
Shawnee Creek	DRBC/NPS	Instantaneous
Marshalls Creek	DRBC/NPS	Instantaneous
Brodhead Creek	U.S.G.S.	Continuous
Adams Creek	DRBC/NPS	Instantaneous
Dunnfield Creek	DRBC/NPS	Instantaneous
Slateford Creek	DRBC/NPS	Instantaneous
Cherry Creek	DRBC/NPS	Instantaneous

Table B3: Parameters for Scenic Rivers Monitoring Program

Parameter	Standard Methods – Number	Equipment	Min – Max	Accuracy(±)
BASELINE PARAMETERS - MONTHLY SAMPLING FREQUENCY				
Flow	See TABLE B2 for locations	Pygmy meter	0.07-3.00 fps	
Air temperature	2550 – thermometric	Thermometer	-10-110 °C	1 °C
Water temperature	2550 – thermometric	Thermometer	-10-110 °C	1 °C
		Thermistor probe (DO meter)	-5-45 °C	0.7 °C
		Thermistor probe (conductivity meter)	-2-50 °C	0.6 °C
Dissolved oxygen	4500-O C. - azide modification of Winkler titration method	Kit	0-20 mg/l	20-60 µg/l
	4500-O G. – membrane electrode	Meter	0-20 mg/l	1 % of scale
Specific conductance	2510 - platinum electrode conductivity cell	Meter	0-19,999 µmhos /cm	2 µmhos/cm
PH	4500-H+	Oakton pH meter	4-10 units	0.25 units
Turbidity	2130 B. Nephelometric	LaMotte colorimeter	5-400 NTU	.1-10 NTU
Fecal coliform	9222 D. m-FC media	Membrane filtration	> 0 colonies/100 ml	NA
Total Suspended Solids	2540 D. TSS dried at 103-105°C	Glass fiber filter system, oven, dessicator, analytical balance to 0.1 mg	2.5 -200 mg residue weight	5% of avg. weight 2.8 mg/L SD

Table B3 continued

Parameters **Not** Analyzed in 2002 through 2004 Monitoring Seasons *Some were used to define existing water quality in DRBC's Special Protection Waters rules, others form the basis of DRBC's Stream Quality Objectives for Zones 1A, 1B, 1C, and 1D of the Delaware River. Resource constraints during the 2002 and 2004 monitoring seasons prevented assessment of these against water quality standards and Special Protection Waters stream quality targets.*	
Alkalinity	2320 B. Titration. No criteria for this parameter. Deemed useful, but not funded.
Ammonia N	4500-NH3 F. Phenate Method. Special Protection Waters rules define existing water quality for this parameter. Replacement equipment has not been funded.
Biocriteria: Macroinvertebrate Shannon Diversity	Special Protection Waters rules defined existing water quality using this benthic macroinvertebrate metric as a numeric standard. Methods under development to assess this parameter's sensitivity to "measurable change", no resources allocated.
Biocriteria: Macroinvertebrate Equitability	Special Protection Waters rules defined existing water quality using this benthic macroinvertebrate metric as a numeric standard. Methods under development to assess this parameter's sensitivity to "measurable change", no resources allocated.
Biocriteria: Macroinvertebrate EPT Richness	Special Protection Waters rules defined existing water quality using this benthic macroinvertebrate metric as a numeric standard. Methods under development to assess this parameter's sensitivity to "measurable change", no resources allocated.
BOD5	5210 B. 5-Day BOD Test. Special Protection Waters rules define existing water quality for this parameter. Analysis of this parameter is not funded.
Hardness	2340 B. Calculation or 2340C – EDTA Titrimetric. Special Protection Waters rules define existing water quality for this parameter. Analysis of this parameter is not funded.
Nitrate+nitrite N	4500-NO3. No method decided. Special Protection Waters rules defined existing water quality for this parameter. Staff are averse to Cadmium Reduction method due to health and cost concerns regarding waste disposal. Alternative Zinc Reduction method not approved by U.S. EPA. Replacement equipment is not funded.
Ortho-phosphate	4500-P E. Ascorbic acid reduction. Special Protection Waters rules define existing water quality for this parameter. Replacement equipment has not been funded.
Total Dissolved Solids	2540 C. TDS dried at 180 °C. Special Protection Waters rules define existing water quality for this parameter. Analysis of this parameter is not funded.
Total Kjeldahl Nitrogen	4500-Norg A. Macro-Kjeldahl. . Special Protection Waters rules define existing water quality for this parameter. Analysis of this parameter is not funded.

DRBC BIOMONITORING – Macroinvertebrates and habitat for tributaries and Delaware River.	
Habitat Assessment (wadeable tributaries)	RBP 2nd Edition 1999, Habitat Protocols for High Gradient Streams (tributaries). Sampled as needed.
Habitat Assessment (Delaware River – special project)	USGS NAWQA Protocols (Fitzpatrick et al. 1998) in Delaware River OR Adaptation of RBP Habitat (2nd Ed., Barbour et al. 1999) to Delaware River. This is used to identify & quantify extent of riverine microhabitats for macroinvertebrates.
Macroinvertebrates (Rapid Assessment in Tributaries)	Indicator-organism field-level assessment w/ 10 point scoring system. Adapted from NYSDEC screening procedure developed by Bode et al. 1996. Assess 100 m reach upstream of fixed water quality sampling site. Sample as needed. If score < 5, call state for further investigation.
Macroinvertebrates (Delaware River Metric Development)	Best habitat (riffle, run, or island head), 33 sites, 3 replicates, 200-organism subsample of Delaware River from East & West Branches to Trenton, NJ. Index period is August-September, flow must be less than 6,000 cfs @ Trenton for access. Sampled annually.

Appendix C
Lower Delaware Monitoring Program
Site and Parameter Information

Table C1: Site List for Lower Delaware Monitoring Program

Site Number	Site Name	River Mile	Drainage Area (mi^2)	Latitude	Longitude
NJPAC01	Delaware River at Calhoun St.	134.34	6780.0	40.219722	-74.778333
NJPAC02	Delaware River at Washington Crossing	141.80	6735.0	40.295278	-74.868889
NJPAC11	Delaware River at Lambertville-New Hope	148.70	6680.0	40.365833	-74.949167
NJPAC04	Delaware River at Bulls Island	155.40	6598.0	40.407500	-75.037778
PA0015	Tohickon Creek	157.00	112.0	40.423056	-75.066667
NJPAC06	Delaware River at Milford	167.70	6381.0	40.566389	-75.098889
NJ0027	Musconetcong River	174.60	156.0	40.592500	-75.186667
NJPAC07	Delaware River at Riegelsville	174.80	6328.0	40.593889	-75.191111
NJ0027	Pohatcong Creek	177.40	57.1	40.624722	-75.186111
PA0026	Lehigh River	183.66	1364.0	40.691111	-75.204722
NJPAC08	Delaware River at Northampton St. (Easton)	183.82	4717.0	40.691111	-75.204167
PA0028	Bushkill Creek	184.10	80.0	40.695278	-75.206111
PA0031	Martins Creek	190.80	45.5	40.784722	-75.184722
NJ0033	Pequest River	197.80	157.0	40.834167	-75.061111
NJPAC09	Delaware River at Belvedere	197.84	4378.0	40.828889	-75.085000
NJ0036	Paulins Kill	207.00	177.0	40.920833	-75.088333
NJPAC11	Delaware River at Portland	207.40	4165.0	40.924170	-75.096110

Sites that are highlighted are those that will be added in if funding allows

Table C2: Parameters Sampled and Analytical Procedures Conducted as Part of the Lower Delaware Water Quality Monitoring Program

Parameter	Method	Reporting Limit	Samples Collected	Rinsate Blanks	Bottle Blanks	Field Duplicates	Total Samples Collected
Hardness, total as $CaCO_3$	EPA 130.2	2.0 mg/L	150	20	10	15	195
Chloride	EPA 300.0	0.1 mg/L	150	20	10	15	195
Alkalinity as $CaCO_3$	EPA 310.1	2.0 mg/L	150	20	10	15	195
Turbidity	EPA 180.1	0.5 NTU	150	20	10	15	195
Fecal Coliform	SM 9222 D	1 col./100mL	150	20	10	15	195
E. Coli	SM 9222 B	1 col./100mL	150	20	10	15	195
Enterococcus	SM 9230 C	1 col./100mL	150	20	10	15	195
Total Coliform	SM 9222 B	1 col./100mL	150	20	10	15	195
Nitrate as N	EPA 300.0	0.02 mg/L	150	20	10	15	195
Nitrite as N	EPA 300.0	0.02 mg/L	150	20	10	15	195
Ammonia as NH_3	EPA 350.2	0.02 mg/L	150	20	10	15	195
Phosphorus, total as P	EPA 365.2	0.02 mg/L	150	20	10	15	195
Orthophosphate (dissolved)	EPA 365.2	0.01 mg/L	150	20	10	15	195
Chlorophyll a	SM 10200 H	1.0 mg/m^3	140	20	10	14	184
Total Kjeldahl Nitrogen	EPA 351.3	0.05 mg/L	150	20	10	15	195
Total Suspended Solids	EPA 160.2	2.0 mg/L	150	20	10	15	195
Total Dissolved Solids	EPA 160.1	6.0 mg/L	150	20	10	15	195
Total Particulate Carbon	EPA 440.0	0.08 mg/L	150	20	10	15	195

Appendix D
Delaware Estuary Boat Run Program
Site and Parameter Information

Table D1: Sampling Stations Parameter Categories for the Estuary Boat Run Program

STATION	RIVER MILE	SAMPLING STATIONS FOR PARAMETER CATEGORIES			
		ROUTINE, BACTERIAL & RADIOACTIVITY	HEAVY METALS	ALGAL & ORGANIC CARBON	OXYGEN DEMAND
South Brown Shoal[1]	6.5	■	■	■	
South of Joe Flogger Shoal[1]	16.5	■	■	■	
Elbow of Crossledge Shoal[1]	22.75	■	■	■	
Mahon River	31.0	■		■	■
Ship John Light	36.6	■			
Smyrna River	44.0	■			
Liston Point–Buoy 8L	48.2	■			
Reedy Island	54.9	■			
Pea Patch Island	60.6	■	■		
New Castle	66.0	■			
Cherry Island	71.0	■	■	■	■
Oldmans Point	74.9	■			
Marcus Hook	78.1	■	■		
Eddystone, PA	84.0	■	■		
Paulsboro, NJ	87.9	■	■		
Navy Yard	93.2	■	■	■	■
Benjamin Franklin Bridge	100.2	■	■		
Betsy Ross Bridge	104.75	■	■		
Torresdale	110.7	■	■		
Burlington Bristol Bridge	117.8	■	■		
Florence Bend	122.4	■		■	■
Trenton (Biles Channel)	131.04	■	■	■	■

Table D2: Methods of Analysis for Parameters

CATEGORY OF PARAMETERS	PARAMETER	METHOD REFERENCE	REPORTING LIMIT
ROUTINE	ALKALINITY	EPA 310.1/STDMTD 18TH ed. 2320B	1.0 mg/L
	CHLORIDE	EPA 325.2/STDMTD 18TH ed. 4500-Cl	1.0 mg/L
	DISSOLVED OXYGEN	EPA 360.1/360.2/STDMTD 18TH ed. 4500-O	0.1 mg/L
	PERCENT SATURATION	CALCULATED	1%
	HARDNESS	EPA 130.2	1.0 mg/L
	pH	EPA 150.1	0.1 unit
	DISSOLVED ORTHOPHOSPHATE	EPA 365.1/STDMTD 18TH ed. 4500-P F	0.005 mg/L
	PHOSPHOROUS: TOTAL	EPA 365.1/STDMTD 18TH ED. 4500-P F	0.005 mg/L
	SODIUM	EPA 200.7	5000 ug/L
	SPECIFIC CONDUCTANCE	EPA 120.1	1.0 uS/cm
	TEMPERATURE, AIR & WATER	EPA 170.1/STDMTD 18TH ED. 2550B	N/A
	SUSPENDED SOLIDS, TOTAL & VOLATILE	EPA 160.2- .4/STDMTD 18TH ed. 2540	1.0 mg/L
	TURBIDITY	EPA 180.1	1.0 FTU
	NH_3-N	EPA 350.1/STDMTD 18TH ed. 4500-N	0.005 mg/L
	NO_2-N	EPA 354.1/ STDMTD 18TH ed. 4500-N	0.005 mg/L
	NO_3-N	EPA 353.2, 354.1/ STDMTD 18TH ed. 4500-N	0.005 mg/L
	TOTAL KJELDAHL-N	EPA 351.2	0.05 mg/L
BACTERIAL	E. COLI	EPA 1103.1	N/A
	ENTEROCOCCUS	EPA 1106.1/STDMTD 18TH ed. 9230C	N/A
	FECAL COLIFORM (MTEC)	EPA 825	N/A
ALGAL	CHLOROPHYLL A	(1) STDMTD 18TH ed. 10200H	1.0 ug/L
	PHEOPHYTIN	STDMTD 18TH ed. 10200H	1.0 ug/L
	SILICA	STDMTD 4500-Si E/D	1.0 mg/L
	PRODUCTIVITY, CARBON 14 METHOD	Procedure Developed by University of Delaware	uMC
	SECCHI DISK	N/A	N/A
	LIGHT TRANSMISSION	(2)	0.01 uM

TABLE D2 continued

CATEGORY OF PARAMETERS	PARAMETER	METHOD REFERENCE	REPORTING LIMIT
HEAVY METALS	COPPER, DISSOLVED	EPA 200.7	5 ug/L
	COPPER, TOTAL	EPA 200.7	5 ug/L
	CHROMIUM, HEXAVALENT	STDMTD 18TH ed. 3500-CR	5 ug/L
	ZINC, DISSOLVED	EPA 200.7	10 ug/L
	ZINC, TOTAL	EPA 200.7	10 ug/L
RADIOACTIVITY	ALPHA EMITTERS	(3) EPA 900.0	5 pCi/L
	BETA EMITTERS	(3) EPA 900.0	5 pCi/L
	TRITIUM	(3) EPA 906.0	500 pCi/L
ORGANIC CARBON	DISSOLVED	EPA 415.1/STDMTD 18TH ed. 5310-B	240 ug/L
	PARTICULATE	EPA 440	62 ug/L
	TOTAL	EPA 415.1/ STDMTD 18TH ed. 5310-B	240 ug/L

1.For Chlorophyll A, one split sample, for analysis at another laboratory selected by DNREC, shall be conducted.
2.Light transmission to be conducted as practical to obtain correlation with Secchi Disk readings.
3.Radioactivity analyses outsourced. All laboratory materials provided by the outsourced lab were provided to DRBC.

Table D3: Frequency of Sampling by Parameter Category for the Estuary Boat Run Program

CATEGORY OF PARAMETERS	PARAMETER	FREQUENCY
ROUTINE	ACIDITY	TWO TIMES MONTHLY (1) FOR APRIL, MAY, AUG., & SEPT. & ONCE MONTHLY FOR OCT., MAR., JUNE, JULY & OCT.
	ALKALINITY	
	CHLORIDE	
	DISSOLVED OXYGEN	
	HARDNESS	
	pH	
	PHOSPHOROUS: DISSOLVED ORTHOPHOSPHATE & TOTAL	
	SODIUM [1]	
	SPECIFIC CONDUCTANCE	
	TEMPERATURE, AIR & WATER	
	TOTAL SUSPENDED SOLIDS AND DISSOLVED SOLIDS	
	TURBIDITY	
	NH3-N, NO2-N, NO3-N & TOTAL KJELDAHL -N	
BACTERIAL	E. COLI	
	ENTEROCOCCUS	
	FECAL COLIFORM (MTEC)	
ALGAL	CHLOROPHYLL A	
	PHEOPHYTIN A	
	SILICA	
	PRODUCTIVITY, CARBON 14 METHOD	
	SECCHI DISK & LIGHT TRANSMISSION	
HEAVY METALS	COPPER, DISSOLVED & TOTAL	MONTHLY
	CHROMIUM, HEXAVALENT	
	ZINC, DISSOLVED & TOTAL	
RADIOACTIVITY	ALPHA EMITTERS	ANNUALLY
	BETA EMITTERS	
	TRITIUM	
ORGANIC CARBON	DISSOLVED	Every Survey
ULTIMATE OXYGEN DEMAND		

[1] Analyses of sodium are required only for stations above R. M. 78