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2022 Delaware River and Bay Water Quality Assessment

Technical Report No: 2023-1

Managing, Protecting and Improving
the Water Resources of the
Delaware River Basin since 1961

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UNITED STATES OF AMERICA

2022 Delaware River and Bay Water Quality Assessment

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This report was prepared by the Delaware River Basin Commission staff. Jake Bransky, aquatic biologist, was the primary author. Technical recommendations and support were provided by Namsoo Suk, Ph.D., Director, Science and Water Quality Management, John Yagecic, P.E., Manager, Water Quality Assessment, Ron MacGillivray, Ph.D., Toxicologist, and Elaine Panuccio, Water Resource Scientist.

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1. INTRODUCTION AND OVERVIEW

The 2022 Delaware River and Bay Water Quality Assessment (2022 Assessment) reports the extent to which waters of the Delaware River and Bay are attaining designated uses in accordance with Delaware River Basin Commission's Water Quality Regulations (18 CFR 410, DRBC WQR) for the period October 1, 2016 through September 30, 2021. The designated water uses to be protected within the Delaware Basin are as follows:

1. Agricultural, industrial, and public water supplies after reasonable treatment, except where natural salinity precludes such uses;
2. Wildlife, fish and other aquatic life;
3. Recreation;
4. Navigation;
5. Controlled and regulated waste assimilation to the extent that such use is compatible with other uses; and
6. Such other uses as may be provided by the Commission's Comprehensive Plan (2001).

The assessment involves comparison of several key water quality parameters with applicable DRBC water quality criteria. DRBC regulations designate public water supply, agricultural, and industrial uses for the Delaware River. Since the public water supply use is assessed and protective of the other uses, agricultural and industrial uses are not assessed separately for this report. For each designated use in each assessment unit, several water quality parameters, relevant to the use, are compared to the existing, applicable water quality criteria. Where DRBC's applicable water quality criteria are not available, basin states and/or EPA's criteria were used in this assessment. Detailed cases are described under the 'Analytical Parameters Supporting Designated Uses' section of the report.

1.1 BACKGROUND

This assessment follows previous similar efforts performed beginning in 1996 and published under the DRBC Water Quality Assessment Reports/305(b) banner of the DRBC web site at:

https://www.nj.gov/drbc/public/publications/wq-assessment-rpts.html.

DRBC's water quality assessment report has been developed every even numbered year since its initiation. While DRBC does perform a water quality assessment function consistent with Section 305(b) of the Clean Water Act, only the states list water bodies not meeting standards, as per section 303(d). The DRBC does not list but provides its assessment to the states for consideration in their listing determinations.

Pennsylvania, New Jersey, Delaware, and New York consider this assessment, in the context of their own EPA approved assessment and listing methodologies, to determine whether sections of the mainstem Delaware River should be listed on the state 303(d) list by a certain pollutant(s).

Because their methodologies differ, listing decisions for shared waters are not automatically consistent.

1.2 DELAWARE RIVER BASIN

The Delaware River is the longest undammed 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. The Delaware River is fed by 216 tributaries, 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%) (Figure 1).

Figure 1: Delaware River Basin

Approximately 13.3 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 one to two-hour drive away for about 20% 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. The population of the Delaware River Basin in 2020 stood at approximately 8.63 million people. Table 1 provides additional geographical statistics for the Delaware River Basin. The Delaware Bay and tidal reach of the Delaware River have been included in the National Estuary Program; a partnership initiative authorized by Section 320 of the Clean Water Act designed to protect estuarine systems of national significance.

Table 1: Approximate Geographical Statistics for the Delaware River Basin

Total Basin Land Area (mi^2)[a],[b]	12,700
Population (2020)	8.63 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

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, NY, downstream to Millrift, 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 approximately 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. Almost the entire non-tidal Delaware River (the portion north of the “fall line” at Trenton, NJ) 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. Most recently, on December 22, 2006, President George W. Bush signed into law the Musconetcong Wild and Scenic Rivers Act, which designates 24.2 miles of the Musconetcong River (a tributary of the Delaware River located in New Jersey) as a component of the National Wild and Scenic Rivers System.

There are numerous economic benefits from the river. The Delaware River Port Complex (including docking facilities in Pennsylvania, New Jersey, and Delaware) is the largest freshwater port in the world. According to testimony submitted to a U.S. House of Representatives subcommittee in 2005, the port complex generates $19 billion in annual economic activity. It is one of only 14 strategic ports in the nation transporting military supplies and equipment by vessel to support our troops overseas. The Delaware River and Bay is home to the third largest petrochemical port as well as five of the largest east coast refineries. Nearly 42 million gallons of crude oil are moved on the Delaware River daily. There are approximately 3,000 deep draft vessel arrivals each year and it is the largest receiving port in the United States for Very Large Crude Carriers (tank ships greater than 125,000 deadweight tons). It is the largest North American port for steel, paper, and meat imports as well as the largest importer of cocoa beans and fruit on the

east coast. Over 65% of Chilean and other South American fruits imported into the United States arrive at terminal facilities in the tri-state port complex. Wilmington, Delaware is home to the largest U.S. banana importing port, handling over one million tons of this cargo annually from Central America. According to Rear Admiral Sally Brice-O'Hara, District Commander of the Fifth Coast Guard District, "The port is critical not only to the region, but also to the nation.

In addition, Dr. Gerald Kauffman of the University of Delaware has estimated that the Delaware River Basin provides $25 billion annually in economic activity, including recreation, water quality, water supply, and hunting and fishing, $21 billion annually in ecosystem goods and services (natural capital), and $10 billion in annual wages.

2. DELAWARE RIVER WATER QUALITY ASSESSMENT

2.1 WATER QUALITY STANDARDS

Water quality standards provide a description of water body uses to be protected, as well as water quality criteria 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."

2.1.1 Designated Uses

The Delaware River and Bay consists of non-tidal and tidal Zones. Zones C1-8 and intrastate streams (Zones E, W1, W2, N1 and N2) are not assessed in this report as they are assessed in the Integrated Reports of the Basin States. The non-tidal main stem consists of five Water Quality Management (WQM) Zones: 1A, 1B, 1C, 1D, and 1E (Figure 2). These Zones form the boundaries for the DRBC's assessment units (AUs) in the non-tidal Zone. The Zones as defined by river mile (RM) are included in Table 2. The designated uses applicable to the non-tidal AUs include aquatic life, fish consumption, primary contact recreation, and drinking water (Table 3).

The tidal Delaware River consists of AU 2, 3, 4, and 5 (Figure 2) and extends from RM 133.4 to RM 48.2 (Table 2). Assessment unit 6 (Delaware Bay) includes multiple units that are defined in part by shellfish management areas issued by the states of Delaware and New Jersey. The uses designated in the estuary and bay are indicated in Table 3. Shellfish consumption only applies to WQM Zone 6.

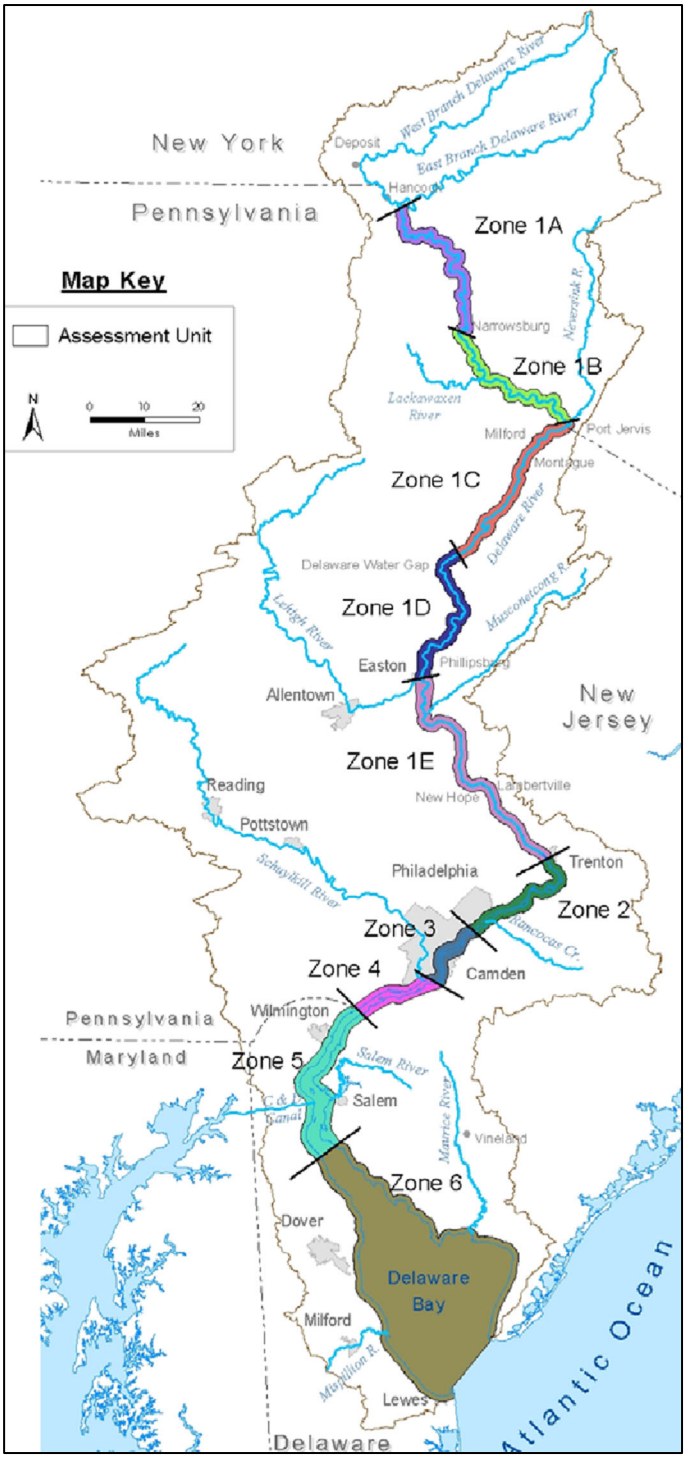

Figure 2: Delaware River Water Quality Management Zones/Assessment Units

Table 2: Delaware River Water Quality Management (WQM) Zones

WQM Zone	Location (River Mile)
1A	330.7 – 289.9
1B	289.9 – 254.75
1C	254.75 – 217.0
1D	217.0 – 183.66
1E	183.66 – 133.4
2	133.4 – 108.4
3	108.4 – 95.0
4	95.0 – 78.8
5	78.8 – 48.2
6	48.2 – 0.0

Table 3: Designated Uses by DRBC Water Quality Management Zones

Designated Use	DRBC WQM Zone or AU									
	1A	1B	1C	1D	1E	2	3	4	5	6
Aquatic Life	√	√	√	√	√	√	√	√	√	√
Drinking Water	√	√	√	√	√	√	√			
Primary Recreation	√	√	√	√	√	√		√	√	√
Secondary Recreation							√	√		
Fish Consumption	√	√	√	√	√	√	√	√	√	√
Shellfish Consumption										√

2.1.2 Criteria

Sections 3.10, 3.20, and 3.30 of DRBC's Water Quality Regulations define the "Stream Quality Objectives." From this point on, the objectives will be referred to as "Water Quality Criteria" (WQC) for the tidal and non-tidal river. Criteria are Zone-based and define the water quality necessary to protect the designated uses in those Zones. For the water quality assessments, monitored data are compared against the Zone standards for determining use attainment.

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 be maintained to support drinking water (18

CFR Part 410, 3.10.3.B, 3.40.4). In Zones 2 and 3, there is additional definition of the permissible levels of specific toxicants in waters designated for both drinking water and fish consumption (due to the bioaccumulation of certain substances even at very low ambient levels).

2.1.3 Assessment Methods

Because DRBC's role is to assess shared waters in the Basin, coordination with the Basin States is important. The Integrated Listing process includes a list of waters for which TMDLs must be prepared (i.e., 303(d) list). However, the regulatory responsibility for preparing a 303(d) list rests with the States.

2.1.4 Assessment Units

Assessment units (AUs) are the spatial reaches within which data are grouped for assessment. Consistent with recent assessments, assessment units for most designated uses will consist of DRBC's Water Quality Management (WQM) Zones, as described in DRBC's Water Quality Regulations (http://www.nj.gov/drbc/library/documents/WQregs.pdf). WQM Zones include zones 1A, 1B, 1C, 1D, and 1E in the non-tidal river and Zones 2, 3, 4, and 5 in the tidal river, and Zone 6 in Delaware Bay. Zone C1-8 and intrastate streams (zones E, W1, W2, N1 and N2) are not assessed by DRBC, but rather are captured in the Integrated Reports of the Basin States. Figure 1 shows the assessment units for Delaware River and Bay, and Table 2 shows the river mile (miles from the mouth of the bay) limits for each assessment unit.

2.1.5 Data Window

For the 2022 assessment, DRBC assessed readily available data for a 5-year data window ending September 30, 2021.

Along with the notice of this methodology, DRBC published a notice in the Federal Register soliciting available data for inclusion in the 2022 assessment.

2.1.6 Data Sets

This assessment considers all readily available data. To obtain the data, DRBC queried the EPA STORET database, the USGS NWIS database, the NOAA PORTS database, as well as internal DRBC databases. We also published a data solicitation in the Federal Register. Most of the data considered is from the following monitoring programs and/or data sets:

- USGS continuous real time monitors via NWIS;
- USGS surface water monitoring programs via NWIS;
- DRBC / NPS Special Protection Waters Monitoring Program covering the Upper, Middle, and Lower non-tidal Delaware River and tributaries;
- DRBC Biological Monitoring Program;
- DRBC Boat Run monitoring program;
- DRBC Chronic Toxicity Monitoring;

- NOAA PORTS continuous data;
- PAWQN Monitoring program via STORET;
- NY Department of Environmental Conservation, Division of Water, via STORET;
- NJDEP Bureau of Freshwater and Biological Monitoring via STORET;
- Delaware Department of Natural Resources and Environmental Control via STORET;
- NJDEP Bureau of Marine Water Monitoring via STORET;
- Philadelphia Water Department Monitoring programs.

Other data sets contained in STORET were considered as well but represented a small subset of the overall available data.

In 2021, DRBC received water quality data from the tidal Schuylkill River from Bartram's Garden. This dataset included several parameters including dissolved oxygen, temperature, pH, turbidity, and bacteria (*E. coli)*. The data submission noted that sensor data may be unreliable, so dissolved oxygen, temperature, pH, and turbidity were not assessed. DRBC does not have criteria for *E. coli* , however this parameter was assessed here using EPA criteria. Results from this assessment can be seen in Appendix F.

2.2 ANALYTICAL PARAMETERS SUPPORTING DESIGNATED USES

2.2.1 Data Requirements

This section looks at the general approach for each designated use assessed relative to DRBC water quality criteria and other supporting evidence. The tables below also describe the parameter-specific data requirements. It should be noted, however, that assessments might also be made using less robust data than indicated by the data requirements, when the weight of evidence is compelling.

Listed below are cases where insufficient data (ID) are available, and the uses cannot be assessed against DRBC criteria. Such data would fail to support the designated use, but the assessment may be identified as "ID" rather than "not supported" when the following conditions exist:

a) The number of samples per AU over an assessment period or season was below data requirements as defined in Tables 4 through 9

b) Background level was not specified in DRBC WQR and cannot reasonably be determined for a particular AU.

c) The parameter was not monitored in an AU.

d) The parameter was analyzed in a matrix other than surface water.

2.2.2 Aquatic Life

Aquatic life is to be protected in all DRBC WQM zones. The assessment for aquatic life is based upon:

- dissolved oxygen (DO);
- pH;
- temperature;
- total dissolved solids (TDS);
- alkalinity;
- toxic chemicals; and
- biological monitoring.

Table 4 below shows the criteria, assessment method, and data objectives for the aquatic life use assessment.

Table 4: Aquatic Life data requirements and assessment criteria

Parameter	AU	Criteria	Assessment Method	Data Requirements
DO	All	Meet all Zone-specific instantaneous minimum, minimum 24-hour average, spawning, and seasonal criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	For instantaneous minimums, less than 1% of observations per AU fail the criteria. For 24-hour averages, less than 1% of observations per AU fail the criteria	For instantaneous minimums, at least 20 measurements over the assessment period. For 24-hour averages, at least 20 daily averages over the assessment period.
Temperature	2-6	Not to exceed Zone specific maximum temperatures listed in DRBC Water Quality Regulations, Sections 3.30 and 4.30	Less than 1% of observations per AU fail the criteria	At least 20 samples per AU over the assessment period
pH	All	Meet Zone specific pH criteria range listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of observations per AU fail the criteria unless evidence shows that pH violation are the result of natural conditions and biological communities are not impaired	At least 20 samples per AU over the assessment period
Turbidity	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of observations per AU fail the criteria	At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the

Parameter	AU	Criteria	Assessment Method	Data Requirements
				assessment period
TDS	1A-1E, 2-4	Not to exceed Zone specific TDS criteria listed in the DRBC Water Quality Regulations, Sections 3.20, 3.30 and 4.20.2	Less than 1% of observations per AU fail the criteria	At least 20 samples per AU over the assessment period
Alkalinity	1E, 2-6	Meet Zone specific criteria range in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of observations per AU fail the criteria	At least 20 samples per AU over the assessment period
Toxic Pollutants	2-6	Not to exceed criteria noted in DRBC Water Quality Regulations	No more than one (1) exceedance in an AU over a three-year window	Available data
	1	Not to exceed more stringent basin state criteria	No more than one (1) exceedance in an AU over a three-year window	Available data
Biological Monitoring	1	6-metric IBI not to fall below 75.6-unit threshold	No more than 30% of samples per AU below the threshold in the assessment period	At least 2 years of data with multiple sites per AU

DRBC's temperature criteria in Zones 1A through 1E are structured as allowable increases above ambient stream temperature, but ambient stream temperature is not defined. For this reason, DRBC has not historically assessed against its temperature criteria in Zones 1A through 1E. In the 2012 assessment, we investigated multiple methods of estimating ambient stream temperature using data and models, to compare observed temperatures to the allowable increase. We determined these methods to be unworkable and did not assess Zones 1A through 1E from 2012-2020. Through its interaction with the Water Quality Advisory Committee, DRBC identified Zones 1B through 1E as consistent with a warm water fishery. Zone 1A is a transitional zone exhibiting artificially lowered temperatures from reservoir releases. For this assessment, DRBC assessed Zones 1B through 1E against Pennsylvania and New Jersey ambient temperature criteria protective of warm water fisheries.

DRBC has adopted numeric toxics criteria in Zones 2 through 6. In addition, DRBC has a narrative standard requiring that:

> "the waters shall be substantially free from … substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life"

DRBC assessed data from zones 2 through 6 against its numeric toxics criteria.

Where the DRBC has not adopted numeric toxics criteria (Zones 1A through 1E), DRBC narrative toxics standard were implemented by comparing measured toxics concentrations to the most stringent of basin state standards and EPA's recommended toxics water quality criteria in Zones 1A though 1E to ensure attainment and maintenance of downstream water quality standards and to facilitate consistent and efficient implementation and coordination of water quality-related

management actions in shared interstate waters. Criteria and standards to be used in the assessment of Zone 1 are New Jersey Surface Water Quality Standards,; Title 25, Chapter 93 Water Quality Standards of the Pennsylvania Code; NYDEC Part 703: Surface Water and Groundwater Quality Standards and Groundwater Limitations and USEPA National Recommended Water Quality Criteria."

For waters protected for use by fish and other aquatic life from metals, the most stringent ambient water quality criteria for toxics will apply. Stream quality objectives for the protection of aquatic life for cadmium, chromium, copper, lead, nickel, silver and zinc shall be expressed as the dissolved form of the metal. Stream quality objectives for other metals shall be expressed as the concentration of the total recoverable form of the metal. For those stream quality objectives whose numerical value is related to hardness (cadmium, chromium III, copper, nickel silver and zinc), the actual criteria numeric value is computed with site-specific paired hardness measured concurrently with the toxic analytical parameter. When concurrent data is not available, median site-specific hardness measured at other times or at the nearest interstate control point (ICP) or boundary control point (BCP) may be used. ICPs are mainstem Delaware River monitoring points and BCPs are tributary monitoring points near their confluence with the mainstem. Where multiple sources of hardness data are available, the assessment will consider the weight of evidence for multiple derivations of the criteria.

For those stream quality objectives whose numerical value is related to pH (such as pentachlorophenol), site-specific paired pH measured concurrently with the toxic analytical parameter or median site-specific pH measured at other times or at the nearest interstate control point (ICP) or boundary control point (BCP) may be used.

Biological monitoring data will be used for the aquatic life assessment, as was done for previous reports, using an interim methodology. The DRBC initiated biological monitoring of the Delaware River above the head-of-tide in 2001 using benthic macroinvertebrate collections. Through work with the Biological Advisory Subcommittee to the WQAC, the DRBC has developed an interim methodology (Silldorff and Limbeck 2009; see https://www.nj.gov/drbc/library/documents/Bioassessment-draft-July2009rev.pdf) that uses benthic macroinvertebrate data as a direct assessment of the condition of the aquatic life use in the non-tidal Delaware River (Zones 1A to 1E). This interim methodology is based on a multi-metric index (termed Index of Biotic Integrity or IBI) that averages the standardized scores of 6 individual metrics (taxa richness, EPT richness, Shannon-Wiener diversity, biotic index, intolerant percent richness, and scraper richness). The multi-metric IBI scores can range from 0 up to 100, with higher values indicating improved aquatic life use condition. Under the current methodology, the DRBC has identified an IBI score of 75.6 units as the threshold between attainment (IBI>75.6) and non-attainment (IBI<75.6) for aquatic life use. Based on input from and discussion with the Biological Advisory Subcommittee, the DRBC limit the application of this interim methodology in the 2022 Integrated Assessment to classification of non-tidal zones to only Categories 1, 2, and 3. For zones not meeting the attainment threshold using the methodology identified in Table 3, the biological assessment will classify the aquatic life as Category 3a, "Waters of Concern."

2.2.3 Public Water Supply

The public water supply use is designated for WQM Zones 1A through 1E, 2, and 3. The parameters used for determining public water supply use support are:

1. TDS;

2. chlorides;
3. toxic substances (human health criteria for systemic toxicants and carcinogens in Zones 2 and 3 only);
4. hardness;
5. odor;
6. phenol;
7. sodium (Na); and
8. turbidity.

Since this particular use relates to human health, the assessment also takes into account information on actual impacts to the use such as frequent or extended closures of drinking water facilities due to recurring or chronic water quality concerns. Data requirements are shown in Table 5.

Table 5: Public Water Supply data requirements and assessment criteria

Parameter	AU	Criteria	Assessment Method	Data Requirements
TDS	1A-1E, 2-3	Not to exceed Zone specific TDS criteria listed in the DRBC Water Quality Regulations, Sections 3.20, 3.30 and 4.20.2	Less than 1% of observations per AU fail the criteria	At least 20 samples per AU over the assessment period
Hardness	2-3	Not to exceed Zone specific 30-day average criteria listed in DRBC Water Quality Regulations, Section 3.30.2 and 3.30.3	Less than 1% of observations per AU fail the criteria	At least three samples in a 30-day period At least 20 samples per AU over the assessment period
Chlorides	2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Section 3.30.2 and 3.30.3	Less than 1% of observations per AU fail the criteria	At least two samples in a 15- day period (AU 2) At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period
Odor	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of observations per AU fail the criteria	Available data
Phenols	1A-1E, 2-3	Not to exceed Zone specific criteria listed in	Less than 1% of observations per	At least 20 samples per AU over the

Parameter	AU	Criteria	Assessment Method	Data Requirements
		DRBC Water Quality Regulations, Section 3.20 and 3.30	AU fail the criteria	assessment period
Sodium (Na)	3 at or above RM 98	Not to exceed 30-day average criteria listed in DRBC Water Quality Regulations, Section 3.30.3	Less than 1% of observations per AU fail the criteria	At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period
Turbidity	1A-1E, 2-3	Not to exceed Zone specific criteria listed in DRBC Water Quality Regulations, Sections 3.20 and 3.30	Less than 1% of observations per AU fail the criteria	At least three samples in a 30-day period (AU 3) At least 20 samples per AU over the assessment period
Systemic Toxicants	2-3	Not to exceed criteria listed in DRBC Water Quality Regulations, Section 3.30	No more than one (1) exceedance in an AU over a three-year window	Available data
Carcinogens	2-3	Not to exceed criteria listed in DRBC Water Quality Regulations, Section 3.30	No more than one (1) exceedance in an AU over a three-year window	Available data
Drinking Water Closures	1A-1E, 2-3	No frequent or extended closures of drinking water facilities due to recurring or chronic water quality concerns	No closures affecting an AU over the assessment period	Administrative closures for drinking water supply over the assessment period. Information from one or more drinking water intake facility per AU.

In waters protected for public water supply, the most stringent ambient water quality criteria for human health for New York or Pennsylvania are compared to surface water data in Zones 1A and 1B. The most stringent ambient water quality criteria for human health for Pennsylvania or New Jersey will be compared to surface water data in Zones 1C, 1D, and 1E. For zones 2 and 3, maximum contaminant levels, Systemic Toxicants, and Carcinogens identified in DRBC's WQRs are compared to surface water data.

2.2.4 Contact Recreation

In the DRBC Water Quality Regulations, the "Recreation" designated use includes all water-contact sports, and thus corresponds to "primary contact" recreation. Some waters, however, are

designated as "Recreation - secondary contact" which restricts activities to where the probability of significant contact or water ingestion is minimal, encompassing but not limited to:

- boating,
- fishing,
- those other activities involving limited contact with surface waters incident to shoreline recreation.

Criteria protective of the primary contact designated use are also protective of secondary contact uses. Criteria protective of secondary contact uses are not protective of primary contact uses. Contact recreation data requirements are shown in Tables 6 (Primary Contact) and 7 (Secondary Contact).

Table 6: Primary Contact Recreation data requirements and assessment criteria

Parameter	AUA	Criteria	Assessment Method	Data Requirements
Fecal coliform	1A-1E,2,4 (below RM 81.8),5,6	Not to exceed Zone specific Fecal coliform criteria listed in the DRBC Water Quality Regulations, Sections 3.20 and 3.30	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year
Enterococcus	2,4 (below RM 81.8)	Not to exceed Zone and sub-Zone-specific Enterococcus criteria listed in the DRBC Water Quality Regulations, Section 3.30	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year
	5,6	Not to exceed Zone and sub-Zone-specific Enterococcus criteria listed in the DRBC Water Quality Regulations, Section 3.30	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year

Table 7: Secondary Contact Recreation data requirements and assessment criteria

Parameter	AUA	Criteria	Assessment Method	Data Requirements
Fecal coliform	3,4 (above RM 81.8)	Not a single geometric mean to exceed 770 / 100 ml	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year
Enterococcus	3,4 (above RM 81.8)	Not a single geometric mean to exceed 88 / 100 ml	Geometric mean of samples per AU during each assessment year	At least 5 samples per AU during each assessment year

[A]WQM Zone 4 is assessed for the parameters above RM 81.8.

2.2.4.1 PRIMARY

Primary contact recreation applies to Zones 1A-1E, 2, 4 below RM 81.8, and 5 and 6. The parameter used for determining primary contact recreation in Zones 1A-1E is fecal coliform. In addition to fecal coliform, enterococcus bacteria is used to assess primary contact recreation in the tidal Zones 2, 4, 5, and 6. Zone 4 is only assessed against primary contact standards below RM 81.8. The criteria are based on a geometric mean, with samples taken at a certain frequency and location as to permit valid interpretation.

2.2.4.2 SECONDARY

DRBC WQM Zones 3 and 4 above RM 81.8 are restricted to secondary contact recreation. Fecal coliform and enterococcus bacteria are used to assess secondary contact recreation. Zone 4 is assessed against secondary contact standards above RM 81.8. The criteria are based on a geometric mean, with samples taken at a certain frequency and location as to permit valid interpretation.

2.2.5 Fish Consumption

Fish consumption designated use applies to all DRBC WQM zones (Table 8). An assessment of "not supporting" the designated use is primarily based upon the presence of one or more consumption advisories in the main stem Delaware River and/or Estuary issued by a Basin State. For the purposes of this assessment, advisories related to the general population only are used, rather than advisories for more sensitive subpopulations. However, DRBC will review targeted consumption advisories for sensitive sub-populations in the absence of consumption advisories for the general population. The states' fish advisory reports current to the assessment period are used in the fish consumption assessment.

Monitoring data, if available, may also be used to support listed fish consumption advisories.

Table 8: Fish Consumption Data requirements and assessment criteria

Parameter	AU	Criteria	Assessment Method	Data Requirements
Fish Consumption Advisory	1A-1E, 2-6	Not a single fish advisory listed for an AU	Count of the number of fish consumption advisories per AU listed over the assessment period	NY, NJ, DE, and PA fish consumption advisories for the general population based upon the Basin states' fish tissue data

2.2.6 Shellfish Consumption

Shellfish consumption designated use only applies to DRBC WQM zone 6 (RM 48.2 to the mouth of the Delaware Bay, Table 9). New Jersey and Delaware assess this use in their coastal waters, using procedures developed by the FDA National Shellfish Sanitation Program (NSSP) (https://www.fda.gov/food/federalstate-food-programs/national-shellfish-sanitation-program-nssp). Both states use total coliform (as most probable number) as the assessment tool and compare it against federal shellfish standards.

In both states, waters classified for shellfishing may be opened for that use all year round. In some cases, the AU is opened seasonally (typically in winter). In other cases, harvesting may be prohibited due to administrative closures based upon proximity to sewer outfalls. In still other cases, waters may be open to harvesting, but with special treatment of the shellfish, such as transplantation to cleaner waters for a period of time prior to the harvesting. Finally, some waters are closed to shellfish harvesting due to existing water quality concerns.

Table 9: Shellfish Consumption data requirements and assessment criteria

Parameter	AUA	Criterion	Assessment Method	Data Requirements

Shellfish Consumption Classifications	6	No prohibitions and/or year-round closures in an AU Shellfish waters. With special conditions and temporal windows are assessed as supporting but with conditions	Determine the number of shellfish harvesting prohibitions, year-round closures, and limiting conditions per AU listed over the assessment period	DE and NJ shellfish consumption and harvesting advisories, prohibitions, closures, and limiting conditions per AU over the assessment period

[A] WQM zone 6 is subdivided into multiple units based on Shellfish Management Directives.

2.3 ASSESSMENT RESULTS

The following sections provide the 2022 assessment results for the designated uses:

1. Aquatic Life;
2. Public Water Supply;
3. Contact Recreation;
4. Fish Consumption; and
5. Shellfish Consumption.

2.3.1 Aquatic Life

The Aquatic Life Assessment results are presented in Table 10 below. The composite aquatic life assessment for 2022 yields a result of "Not supporting" for all assessment units. It is important to note, however, that this result is largely driven by exceedances of pH and temperature criteria. Some of these exceedances may be driven by natural conditions and more work is needed to define these conditions for both parameters.

Table 10: Aquatic Life Designated Use Assessment Results

Zone (Assessment Unit)	DO	pH	Turbidity	Temperature	TDS	Alkalinity	Toxic Pollutants*	Biological Assessment	2022 Assessment	2020 Assessment
1A	+	-[A]	+	N/A[C]	-[A]	N[C]	+	+	NS[E]	NS[E]
1B	+	-[A]	+	-[A,F]	-[A]	N[C]	+	+	NS[E]	NS[E]
1C	+	-[A]	+	-[A,F]	+	N[C]	+	+	NS[E]	NS[E]
1D	+	-[A]	+	-[A,F]	+	N[C]	+	+	NS[E]	NS[E]
1E	+	-[A]	+	-[A,F]	+	-[A]	+	+	NS[E]	NS
2	+	+	+	-[A, B]	+	+	+	NC	NS[E]	NS[E]
3	+	+	+	-[A, B]	+	-[A]	+	NC	NS[E]	NS[E]
4	+	+	+	-[A, B]	N/A[D]	+	+	NC	NS[E]	NS[E]
5	-[A]	+	+	-[A, B]	NC	+	+	NC	NS[E]	NS[E]
6	-[A]	-[A]	-[A]	+	NC	+	+	NC	NS[E]	NS[E]

Notes:

+	The Assessment Unit meets WQC
-	The AU does not meet WQC
A	Rate of criteria exceedance is below the historical threshold of 10%.
B	Temperature criteria exceedance may be driven, in part, by meteorological and atmospheric conditions. The proportion of temperature exceedance caused by controllable anthropogenic inputs is unknown at this time.
C	Zone 1A represents a transitional zone from cold water to warm water and was not assessed.
D	Criteria expressed relative to background, but background is undefined.
E	Based primarily on fewer than 10% exceedances of criteria
F	No applicable DRBC criteria. Temperature assessment met NJ WWF-NT criteria, but not PA WWF criteria.
NC	No criteria developed.
ID	Insufficient data to make an assessment
NS	The assessment does not support the designated use
N/A	The parameter is not applicable in this assessment unit.
*	See Toxic Pollutants Section

2.3.1.1 DISSOLVED OXYGEN

Dissolved oxygen (DO) refers to the concentration of oxygen gas incorporated in water. Oxygen enters water both by direct absorption from the atmosphere, which is enhanced by turbulence, and as a byproduct of photosynthesis from algae and aquatic plants. Sufficient DO is essential to growth and reproduction of aerobic aquatic life. Oxygen levels in water bodies can be depressed by the discharge of oxygen-depleting materials (measured in aggregate as biochemical oxygen demand, BOD, from wastewater treatment facilities and non-point source runoffs), from the decomposition of organic matter including algae generated during nutrient-induced blooms, and from the oxidation of ammonia and other nitrogen-based compounds.

Table 11 below shows the assessment results for DO for all Zones. All criteria were met in Zones 1A, 1B, 1C, 1D, 1E, 2, 3, and 4. Since only daytime spot measurements were made in Zones 1B, 1C, and 1D, attainment of the 24-hour mean criteria was presumed since all measurements were above (met) that criteria. All seasonal mean criteria were met in Zones 2 through 6. Most observations met criteria in Zones 5 and 6.

Table 11: DO Assessment Results

Zone	% Observations Meeting Daily Mean Criteria	% Meeting Seasonal Criteria	% Meeting Instantaneous Minimum Criteria	Source	Notes
1a	99.7%	100%	100%	USGS_01427510	
1b	100% (presumed)	NA	100%	DRBC, PADEP	Daytime spot measurements only
1c	100%	NA	100%	USGS_01438500	
1d	100% (presumed)	NA	100%	DRBC, PADEP	Daytime spot measurements only
1e	100%	NA	100%	USGS_01458500,	

				USGS_01463500	
2	99.9%	100%	NA	USGS_014670261	
3	100%	100%	NA	USGS_01467200	
4	100%	100%	NA	USGS_01477050	
5	95.0%	100%	NA	USGS_01482800	
6	92.9% (presumed)	NA	99.4%	DNREC, DRBC, NJDEP	Daytime spot measurements only

Determining whether 24-hour criteria were met is most appropriately accomplished by comparing the daily mean DO from continuous monitors, which record data hourly or sub-hourly, and comparing these computed results to the criteria. Where only daytime spot measurements are available, we presumed that if the measured value is less than the 24-hour mean criterion, then the 24-hour mean is also likely to be below (not meet) the criterion. At the time of assessment, Zones 1B, 1D and 6 lacked continuous dissolved oxygen meters, and were assessed using daytime spot measurements only. Figure 3 below shows a comparison of daily mean DO observations at the USGS monitor at the Ben Franklin Bridge (Zone 3) to the 24-hour mean criteria.

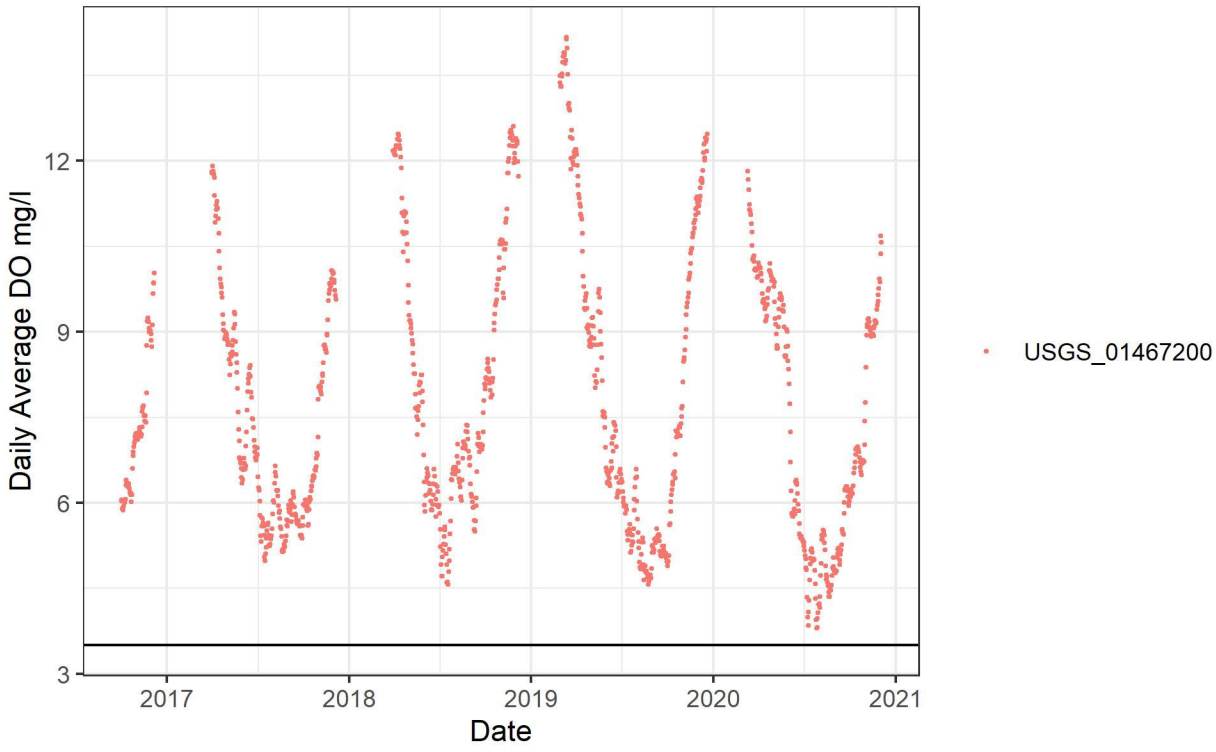

Figure 3: Daily Average DO Observations Compared to Criteria in Zone 3

2.3.1.2 PH

The pH of surface waters has long been recognized as both a natural and human-induced constraint to the aquatic life of fresh and saltwater bodies, both through direct effects of pH and through indirect effects on the solubility, concentration, and ionic state of other important chemicals (e.g., metals, ammonia). Among natural waters, both highly alkaline waters and highly acidic waters (like the NJ Pinelands) are known to severely restrict the species of plants and animals that can thrive in particular lakes and streams. Likewise, human alteration of the pH regimen for a water body can alter both the quality of that water and the aquatic life inhabiting that system. Table 12 below shows the assessment results for pH for each Zone.

Table 12: pH Assessment Results

Zone	% Observations Meeting Criteria	Source	Notes
1a	95.9%	USGS_01427510	Most violations were higher than the pH maximum (8.5). Few violations observed below the pH minimum (6.5).
1b	95.3%	DRBC, PADEP	Daytime spot measurements only
1c	93.5%	USGS_01438500	Daytime spot measurements only
1d	98.5%	DRBC, PADEP, USGS_PAWSC	Daytime spot measurements only
1e	93.4%	USGS_01458500,USGS_01463500	All violations were higher than the pH maximum (8.5). No violations observed below the pH minimum (6.5).
2	100%	USGS_014670261	
3	100%	USGS_01467200	
4	100%	USGS_01477050	
5	100%	USGS_01482800	
6	96.8%	DNREC, DRBC, NJDEP	Daytime spot measurements only

In December 2013, the Commission adopted revised pH criteria applying to all zones of the Delaware River and Bay. That revised criteria require that pH be between 6.5 and 8.5 inclusive, unless outside this range due to natural conditions.

As shown in Table 12, pH criteria were met in Zones 2, 3, 4, and 5. Criteria for pH were mostly met in Zones 1A, 1B, 1C, 1D, 1E, and 6. In Zones 1B, 1D, and 6, pH assessment is hampered by the lack of continuous monitors at the time of assessment. Like DO, pH has a diel cycle due to photosynthesis, with the lowest pH values expected in the early morning hours or pre-dawn, and the highest pH values expected in the mid to late afternoon. Monitoring programs that rely on spot measurements are far more likely to capture daytime high values and miss pre-dawn low values.

Figure 4 below shows that the upper-level criterion (8.5) was routinely violated in Zone 1E. Although the criteria allow exceedances if due to natural conditions, the Commission has not

defined what would constitute demonstration of natural conditions. Natural conditions, for the application of pH criteria, should be defined for future assessments.

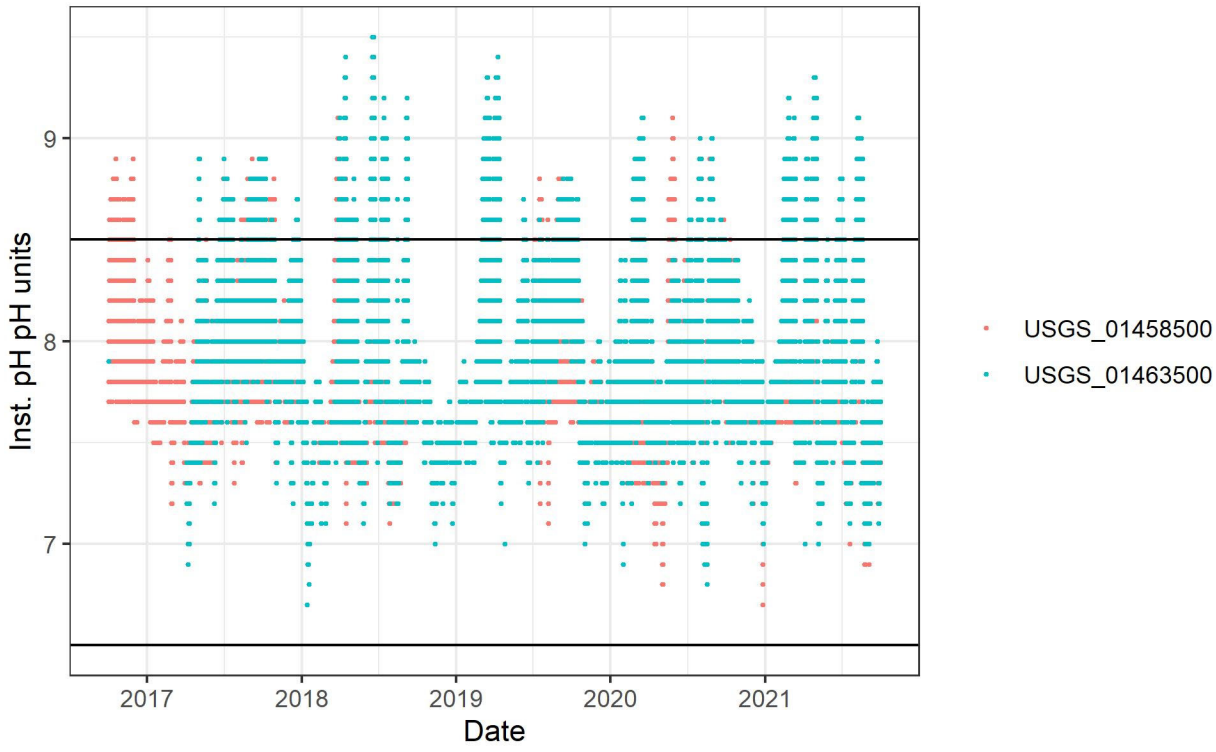

Figure 4: pH Observations Compared to Criteria in Zone 1E.

2.3.1.3 TURBIDITY

According to Standard Methods (2005), "Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted with no change in direction or flux level through the sample." From an observational perspective, water with low turbidity appears clear, while higher turbidity waters are cloudy or muddy. Table 13 below shows the assessment results for each Zone relative to DRBC's turbidity criteria.

Table 13: Turbidity Assessment Results

Zone	% Observations Meeting Max Criteria	% Meeting 30- day Average Criteria	Source	Notes
1a	100%	NA	DRBC, PADEP	Spot measurements only.
1b	100%	NA	DRBC, NYSDEC	Spot measurements only.
1c	100%	NA	DRBC, USGS_NJWSC	Spot measurements only
1d	100%	NA	DRBC, PADEP, USGS_PAWSC	Spot measurements only
1e	99.9%	100%	USGS_01463500	
2	100%	100%	USGS_014670261	
3	99.7%	NA	DRBC, PADEP, USGS_NJWSC	Spot measurements only
4	100%	NA	DRBC, PADEP, USGS_NJWSC	Spot measurements only
5	100%	NA	DNREC, DNREC, DRBC, USGS_NJWSC	Spot measurements only
6	98.6%	NA	DNREC, DRBC, NJDEP	Spot measurements only

Figure 5 below shows turbidity compared to the instantaneous maximum at the USGS monitor at Trenton, NJ in Zone 1E.

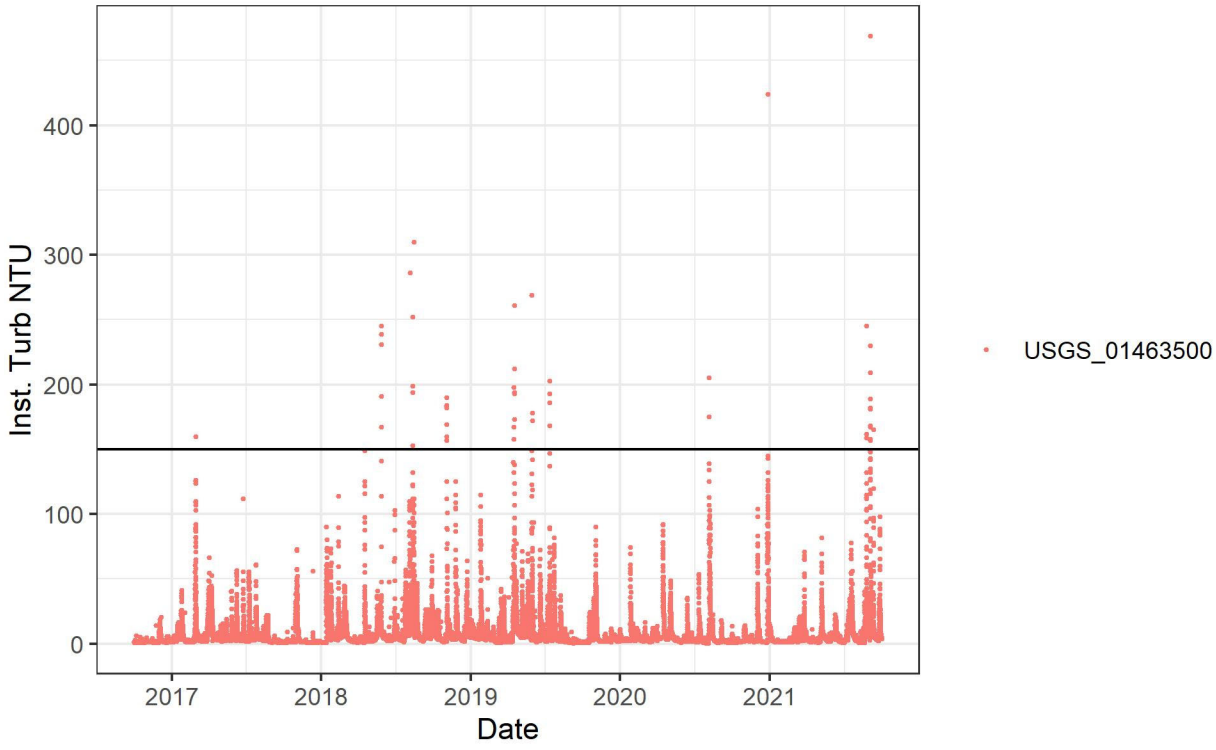

Figure 5: Turbidity Compared to Criteria in Zone 1E.

2.3.1.4 TEMPERATURE

Water temperature is an important factor for the health and survival of native fish and aquatic communities. Temperature can affect embryonic development; juvenile growth; adult migration; competition with non-native species; and the relative risk and severity of disease. Estuary Temperature Criteria are expressed in DRBC regulations by day of year in Zones 2, 3, and 4. In Zones 5 and 6, a single maximum water temperature is specified. Table 15 below shows that water temperature criteria were mostly met, with the greatest number of exceedances occurring in Zones 2,3, and 4.

Table 14: DRBC Temperature Assessment Results

Zone	% Observation Days Meeting Day-of-Year Criteria	% Observation Days Meeting Criteria Instantaneous Maximum	Source	Notes
1	DRBC Criteria applicable to Heat Dissipation Areas only for Zone 1 AU's *			
2	97.1%	100%	NOAA_8539094, NOAA_8548989, USGS_014670261	

Zone	% Observation Days Meeting Day-of-Year Criteria	% Observation Days Meeting Criteria Instantaneous Maximum	Source	Notes
3	97.3%	100%	NOAA_8545240, NOAA_8546252, USGS_01467200	
4	97.2%	100%	NOAA_8540433, USGS_01474703, USGS_01477050	
5	NA	98.9%	NOAA_8551762, NOAA_8551910, USGS_01482800	
6	NA	100%	NOAA_8536110, NOAA_8537121, NOAA_8555889, NOAA_8557380	

* See table 15 for additional assessment of Zone 1

Figure 6 below shows the comparison of water temperature observations in Zone 2 to the day-of-year temperature criteria. Note that observations in Zone 2 include continuous monitor data from NOAA PORTS monitors at Burlington and Newbold and USGS at Pennypack Woods.

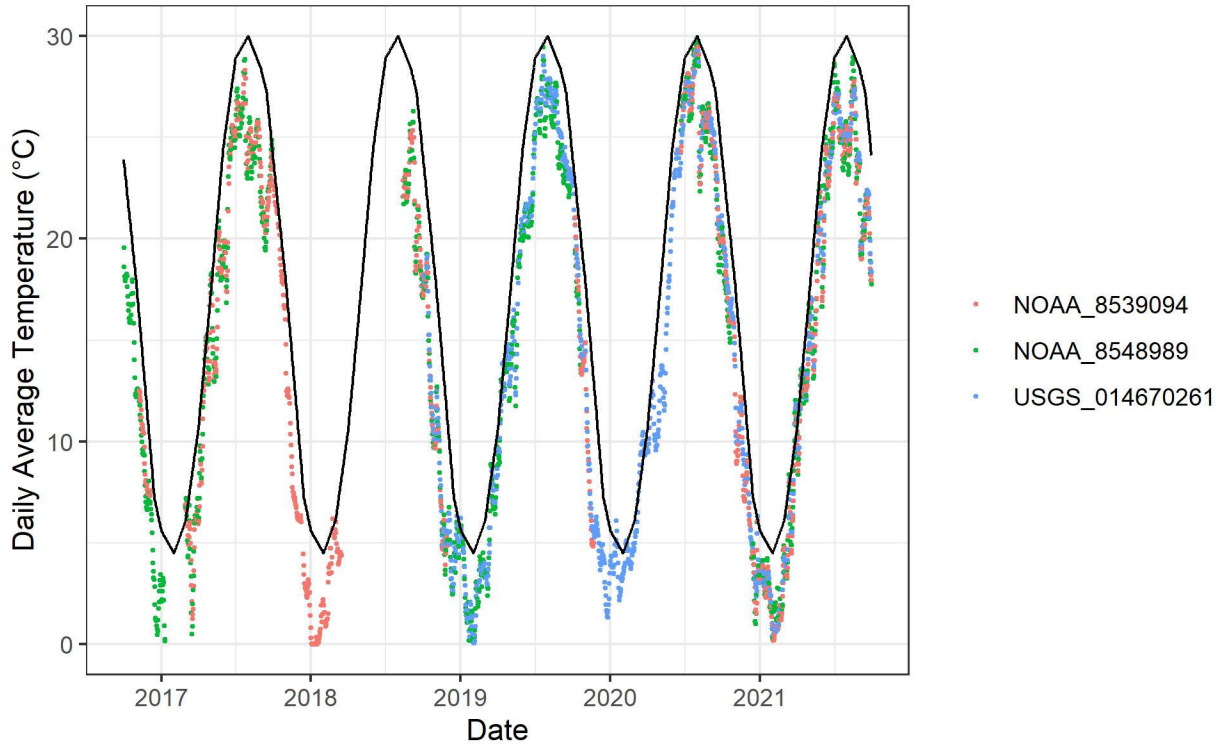

Figure 6: Water Temperature Observations Compared to Criteria in Zone 2

As noted in previous assessments, atmospheric temperatures and meteorological conditions are strong drivers of water temperature. DRBC previously demonstrated that water temperatures are strongly linked to air temperatures, and that a notable increase in air temperatures is observable between the temperature gradient period (1961-1966) and the current period. At present, we lack the tools to determine which portion of the exceedance is attributable to potentially controllable anthropogenic thermal inputs, and which portion is due to meteorological drivers beyond our control.

Criteria in Zones 1A through 1E are clearly oriented toward determining compliance of thermal mixing zones for point discharges. Currently, DRBC has no ambient surface water temperature standards in Zones 1A through 1E. In previous assessments, we investigated approaches for assessing surface waters in the non-tidal river against the thermal mixing zone criteria. None of these approaches was feasible. For this report, we assessed temperature in Zones 1B - 1E against PADEPs warmwater fisheries criteria and New Jersey's freshwater non-trout criteria. Zone 1A was not assessed as this is a transitional zone shifting from coldwater at Hancock, NY (upstream) to warmwater at Narrowsburg, NY (downstream). Water temperature in this zone is dependent on upstream reservoir releases. Water temperature data consistently met New Jerseys freshwater non-trout criteria throughout Zone 1. When assessed using Pennsylvania's warmwater fishery criteria, water temperature data met criteria between 91-97% of the time depending on the assessment zone. Excursion frequency increased in downstream zones.

Table 15. Assessment of temperature data against PA and NJ criteria

Zone	% Observations meeting PA Warmwater Fisheries Day of Year Criteria	% Observations meeting NJ FW-NT Instantaneous Criteria (31˚C)	% Observations meeting NJ FW-NT 7-day Average Criteria (28˚C)	Gages
1A	Not assessed due to transitional nature of this zone.			
1B	97.7%	100%	100%	USGS 01428500, 01432805, 01434000
1C	95.7%	100%	100%	USGS 01438500
1D	93.0%	100%	100%	USGS 01446500
1E	91.1%	99.9%	99.5%	USGS 01457500, 01458500, 01462000, 01463500

2.3.1.5 TOTAL DISSOLVED SOLIDS (TDS)

Total Dissolved Solids (TDS) reflect the concentration of solids in a water sample capable of passing through a filter (typically 2 um) and dried. As an analytical parameter, TDS represents the collective mass of individual constituents, including cations, anions, and dissolved organic material. Studies have shown that high TDS concentrations negatively impact aquatic life and cause shifts in biological communities. In freshwater, TDS is frequently used as an indicator of the anthropogenic burden.

Table 16 below shows the TDS 500 mg/l criteria were met in all Zones. The 133% of background criteria were met in Zones 1C, 1D, 1E, 2, and 3. The TDS criteria in Zone 4 is expressed only as a percentage above background, and background in Zone 4 has not been defined. DRBC has no TDS criteria in Zones 5 and 6, presumably because TDS in marine waters is naturally high.

Table 16: TDS Assessment Results

Zone	% Observations Meeting 133% of Background Criteria	% Observations Meeting 500 mg/l criteria	Source	Notes
1a	97.4%	100%	DRBC,PADEP	
1b	97.4%	100%	DRBC,PADEP	
1c	100%	100%	DRBC,USGS_NJWSC	
1d	100%	100%	DRBC,PADEP,USGS_PAWSC	
1e	100%	100%	DRBC,PADEP	
2	100%	100%	DRBC	
3	100%	100%	DRBC,USGS_NJWSC	
4	Does not apply			
5	No Criteria			
6				

2.3.1.6 ALKALINITY

According to Standard Methods (2005), “alkalinity of a water is its acid-neutralizing capacity. It is the sum of all the titratable bases.” As shown in Table 17 below, alkalinity criteria were met in Zones 2, 4, 5, and 6.

Table 17: Alkalinity Assessment Results

Zone	% Observations Meeting Criteria	Source	Notes
1a	No Criteria		
1b			
1c			
1d			
1e	98.3%	DRBC,PADEP	
2	99.4%	DRBC	
3	97.7%	DRBC	
4	100%	DRBC,PADEP	
5	100%	DNREC,DRBC	
6	99.4%	DNREC,DRBC,NJDEP	

2.3.1.7 TOXIC POLLUTANTS

The DRBC stream quality objectives for human health and aquatic life apply in the tidal portion of Delaware Basin from the head of tide at Trenton, NJ to the mouth of the Delaware Bay (Zones 2 through 6). DRBC has adopted numeric toxics criteria in Zones 2 through 6. DRBC assesses data from Zones 2 through 6 against its numeric criteria. DRBC criteria are used in the 2022 assessment for Zones 2 through 6, as described in Methodology for the 2022 Delaware River and Bay Water Quality Assessment Report. In addition, DRBC has a narrative standard applicable to waters of the Basin requiring that: “the waters shall be substantially free from … substances in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life”.

The DRBC toxics criteria subcommittee recommended, at the November 19, 2014 meeting, a review of DRBC water quality assessment methodology for toxics in Zone 1. To ensure attainment and maintenance of downstream water quality standards and to facilitate consistent and efficient implementation and coordination of water quality-related management actions in shared interstate waters, an assessment methodology based on the most stringent of basin state standards in Zones 1A though 1E is used in this assessment. Criteria and standards to be used in the assessment of Zone 1 are New Jersey Surface Water Quality Standards; Pennsylvania Title 25, Chapter 93 Water Quality Standards; NYDEC Part 703: Surface Water and Groundwater Quality Standards and Groundwater Limitations and USEPA National Recommended Water Quality Criteria.

In waters protected for public water supply, the most stringent ambient water quality criteria for human health for New York or Pennsylvania are compared to surface water data in Zones 1A and 1B. The most stringent ambient water quality criteria for human health for Pennsylvania or New Jersey is compared to surface water data in Zones 1C, 1D, and 1E.

For waters protected for use by fish and other aquatic life, the most stringent ambient water quality criteria of basin state standards in Zones 1A though 1E apply. Water quality criteria for the protection of aquatic life for cadmium, chromium, copper, lead, nickel, silver and zinc are expressed as the dissolved form of the metal. Water quality criteria for other metals are expressed as the concentration of the total recoverable form of the metal. For those water quality criteria

whose numerical value is related to hardness (cadmium, chromium III, copper, nickel silver and zinc), the actual criteria numeric value is computed with site-specific paired hardness measured concurrently with the toxic analytical parameter. When concurrent data is not available, median site-specific hardness measured at other times or at the nearest interstate control point (ICP) may be used. Where multiple sources of hardness data are available, the assessment considers the weight of evidence for multiple derivations of the criteria.

For those water quality criteria whose numerical value is related to pH (such as pentachlorophenol), site- specific paired pH measured concurrently with the toxic analytical parameter or median site-specific pH measured at other times or at the nearest interstate control point (ICP) or boundary control point (BCP) may be used.

Water quality monitoring data from multiple organizations (DRBC, DNREC, NYSDEC, NJDEP, PADEP and USGS) are included in the 2022 toxics assessment. Toxic pollutants data are collected using EPA approved or equivalent methods with the level of monitoring varying by Zone and toxic pollutant. DRBC toxic pollutants monitored during the timeframe of the assessment are listed in Appendix C and D.

DRBC water quality regulations include aquatic life toxics criteria for fresh and marine waters. As a policy, freshwater criteria apply in all areas of the estuary upstream of the Delaware Memorial Bridges. In the main stem Delaware River below the Delaware Memorial Bridges and above Liston Point (RM 48.2, the downstream limit of Zone 5) and in tributaries up to the 5ppt isopleth at 7Q10, the more stringent of the freshwater or marine criteria will apply. Downstream from Liston Pt., the marine criteria are used. In addition, site-specific paired salinity measured between RM 68.7 and 48.2 concurrently with toxic analytical parameters confirm that, when exceedances of freshwater objectives occur, ambient conditions are < 5 ppt salinity and when exceedances of marine objectives occur, ambient conditions are ≥ 5 ppt salinity.

2.3.1.7.1 Dissolved Metals

For criteria expressed as the dissolved form of the metal, assessment of monitoring data is as follows:

- In assessment Zones with dissolved metals data collected, direct comparison to DRBC dissolved criteria is the preferred assessment.
- In assessment Zones with only total metals data collected (as noted in Appendix C2), the comparison is total metals data to estimated total metals criteria using conversion factors listed in “Revised Procedure for Converting Total Recoverable Water Quality Criteria for Metals to Dissolved Criteria” https://www.nj.gov/drbc/library/documents/criteria-metals1995.pdf.

2.3.1.7.2 Hardness Dependent Stream Quality Objectives

For criteria requiring hardness values to compute the actual criteria numeric value, toxics data from ambient water are compared to stream quality objectives using hardness values listed in DRBC Water Quality Regulations for Zones 2 through 5 (i.e., 74 mg/L as CaCO3).

- An additional comparison is conducted as part of this assessment with site-specific paired hardness measured concurrently with toxic analytical parameters.

- For Zone 1 assessments, the actual criteria numeric value is computed with site-specific paired hardness measured concurrently with the toxic analytical parameter. If site-specific paired data is not available, the measured ambient water concentrations of copper are compared to criteria numeric values calculated with median, minimum and maximum hardness values measured at the nearest interstate control point (ICP).
- Site-specific ambient hardness outside of a 25 to 400 mg/L range is noted in the assessment (Table C2).

2.3.1.7.3 Polycyclic Aromatic Hydrocarbons (PAHs)

Coordination among basin states and agencies should continue to ensure the use of the most appropriate analytical and assessment methodologies for PAHs.

2.3.1.7.4 Whole Effluent Toxicity

Most effluent discharges to the Delaware River are currently monitored for chronic whole effluent toxicity. Limiting chronic toxicity in effluents decreases the impact of point source discharges on water quality in the Delaware River. WET monitoring in the Delaware River should be coordinated among the basin states, DRBC and USEPA to generate consistent WET testing and reporting with full compliance by dischargers. Receiving waters of the Delaware River were not monitored using WET test methods during the period of this assessment (October 1, 2016, through September 30, 2021).

2.3.1.7.5 Exceedances in Zones 2 through 6

Data showed numerous exceedances of aluminum acute and chronic freshwater objectives for the support of aquatic life over multiple years. With enhanced monitoring in 2017, the chronic criterion was exceeded in Zones 2, 3 4, and 5 and acute criterion was exceeded in Zones 4 and 5. Coordination among basin states and agencies should continue to ensure the use of the most appropriate methods and procedures for the conduct of monitoring studies in the Basin, and the harmonization of water quality criteria and assessment methodologies for aluminum.

2.3.1.7.6 Exceedances in Zone 1

Data showed exceedances for the following recommended water quality criteria for the support of aquatic life:

Exceedances of freshwater chronic objectives for the support of aquatic life for dissolved copper were confirmed with site specific hardness more than once in three years in Zones 1A. No dissolved copper data was available for Zones 1B, 1C, 1D and 1E. For total copper measurements compared to total copper criteria (using conversion factors) exceedances were found in 1B, 1D and 1E. Assessment is complicated by factors such as field sampling and analytical issues with contamination, a need to assess revisions to current criteria, and the influence of other water quality attributes that influence the partitioning and toxicity of copper. Coordination among basin states and agencies should continue to ensure the use of the most appropriate methods and procedures for the conduct of monitoring studies for copper in the Basin, and the harmonization of water quality criteria and assessment methodologies in all Zones.

2.3.1.8 BIOLOGICAL ASSESSMENT

Biological assessment results indicate reference-quality invertebrate communities in all zones. This includes "attaining" scores in the thermally altered upper mainstem Delaware River between Hancock and Callicoon (i.e., the upper portion of Zone 1A). It is important to note that the "background" rate of scores below 75.6 in reference reaches of the Delaware River is 10%.

Zone 1E (below the Lehigh River) showed improved conditions when compared to previous assessments with only 29% of the invertebrate samples falling below the impairment threshold (Table 18). For the interim methodology, DRBC has defined "impairment" as greater than 30% of sampling falling below the threshold, so this zone fell just below the "impairment" threshold. The biological community in this stretch of river should continue to be monitored to see if improvement continues.

Table 18: Biological Assessment Results

Zone	Years of Data	Stations per Assessment Unit	% of samples in time window w/ 6-metric IBI < 75.6
1a	1 (2017)	5	0%
1b		3	0%
1c		6	17%
1d		5	20%
1e		7	29%

2.3.2 Public Water Supply

The public water supply designated use is assessed through evaluation of TDS, hardness, chlorides, odor, phenols, sodium, turbidity, systemic toxicants, carcinogens, and administrative drinking water closures. Table 19 below shows the Public Water Supply assessment results for the 2022 assessment. Additional detail on each evaluation is provided in the subsequent sections.

Table 19: Public Water Supply Designated Use Assessment Results

Zone (AU)	TDS	Hardness	Chlorides	Odor	Phenols	Sodium	Turbidity	Systemic Toxicants	Carcinogens	Drinking water closures	2022 Assessment	2020 Assessment
1A	-[AB]	NC	NC	ID	ID	NC	+	+	+	+	NS[A]	NS[A]
1B	-[AB]	NC	NC	ID	ID	NC	+	+	+	+	NS[A]	NS[A]
1C	+	NC	NC	ID	ID	NC	+	+	+	+	S	S
1D	+	NC	NC	ID	ID	NC	+	+	+	+	S	NS[A]
1E	+	NC	NC	ID	ID	NC	+	+	+	+	S	S

2	+	-[AC]	+	ID	ID	NC	+	+	+	+	NS[A]	NS[A]
3	+	+	+	ID	ID	+	+	+	+	+	S	S

Notes:

+	The Assessment unit meets WQC
-	The Assessment unit does not meet WQC
A	Rate of criteria exceedance is below the historical threshold of 10%.
B	Exceedance of criteria based on 133% of background, not 500 mg/L MCL
C	Exceedance of criteria based on limited spot measurement data
ID	Insufficient Data
N/A	Not applicable (no criteria in this assessment unit)
S	The use is supported in this Assessment Unit
NS	The use is not supported in this Assessment Unit
NC	No criteria developed.

2.3.2.1 TDS

A description of TDS and assessment against the TDS criteria are presented under the Aquatic Life designated use in the previous section.

2.3.2.2 HARDNESS

Hardness is an integrated measure of divalent metallic cations. Measuring hardness in source water provides an indication of whether water softening will be desirable either in drinking water processing or in the finished drinking water at the point of use. Table 20 below shows that hardness criteria were met in all samples in Zone 3, but not in Zone 2. Limited data was available for hardness in Zone 2 and the exceedance was caused by a small number of data points collected over two months in 2019. Observations before and after this event always met criteria.

Table 20: Hardness Assessment Results

Zone	% Observations Meeting Criteria	Source	Notes
1a	No Criteria		
1b			
1c			
1d			
1e			
2	95.9%	DRBC	Spot measurements only, insufficient data to calculate 30-day mean criteria
3	100%	DRBC,USGS_NJWSC	No individual observation exceeded criteria, therefore, attainment of 30- day mean criteria is presumed
4	Use not applicable in these zones		
5			
6			

2.3.2.3 CHLORIDES

Chloride is one of the major inorganic ions in water and wastewater and can impart a salty taste to drinking water at elevated concentrations. Chloride criteria are expressed as a 15-day mean in Zone 2 and a 30-day mean in Zone 3. Although sequential daily measurements are not made as part of routine surface water monitoring programs, a single observation exceeded the numerical criteria (as shown in Table 21 below), therefore 100% attainment of the criteria is presumed.

Table 21: Chloride Assessment Results

Zone	% Observations Meeting Criteria	Source	Notes
1a	No Criteria		
1b			
1c			
1d			
1e			
2	99.4%	DRBC	Only a single observation exceeded criteria, therefore, attainment of 30- day mean criteria is presumed
3	100%	DRBC,USGS_NJWSC	No individual observation exceeded criteria, therefore, attainment of 30- day mean criteria is presumed
4	Use not applicable in these zones		
5			
6			

2.3.2.4 ODOR

No odor data was indicated in any of the data sets reviewed. Therefore, no assessment against odor criteria was made.

2.3.2.5 PHENOLS

No data were found for Zones 1, 2, or 3. The public water supply use does not apply to Zones 4, 5, or 6.

2.3.2.6 SODIUM

A criterion for sodium exists only in Zone 3. A review of all available data shows 72 observations of sodium in Zone 3 with all values were below the 30-day mean criterion of 100 mg/L. Although the spacing of the data did not support computing a 30-day mean, attainment of this criterion is presume since all values were below 100 mg/L.

2.3.2.7 TURBIDITY

A detailed discussion of the turbidity assessment is provided in the Aquatic Life section of this report.

2.3.2.8 SYSTEMIC TOXICANTS

Systemic toxicants affect the entire body or many organs rather than a specific site. For example, cyanide is a systemic toxicant that can affect every cell and organ in the body by interrupting oxygen exchange by cells. Stream quality objectives for systemic toxicants are established if a reference dose (RfD) exists in EPA's Integrated Risk Information System (IRIS). Public water supply use is supported in Zones 1, 2, and 3 (Table 18, with additional detail in Appendix C4).

2.3.2.9 CARCINOGENS

Carcinogens are substances that act directly in causing cancer. This may be due to the ability of the substance such as dioxins/furans to damage the genome or to disrupt cellular metabolic processes. Stream quality objectives for carcinogenic toxicants are established if a cancer potency factor (CPF) is available and the substance is classified as a carcinogen in EPA's Integrated Risk Information System (IRIS). Based on limited data on certain parameters, public water supply use is supported in Zone 1, 2 and 3 (Table 18, with additional detail in Appendix C3).

2.3.2.10 MAXIMUM CONTAMINANT LEVELS

Maximum contaminant levels to be applied as human health stream quality objectives in Zones 2 and 3 were not exceeded.

2.3.2.11 CONTAMINANT S OF EMERGING CONCERN

Contaminants of emerging concern (CEC) are unregulated substances that have entered the environment through human activities. Current regulatory approaches are inadequate to address these contaminants and the increasing public concern over their environmental and human health implications. CEC have historically not been routinely monitored. The DRBC has monitored CEC such as per- and polyfluoroalkyl substances (PFAS) in the Delaware River, including in the water column, in fish tissue and in sediments, and has confirmed that PFAS are present in the main stem Delaware River

https://www.nj.gov/drbc/library/documents/macgillivray_PFAS_NJWEAmay2019.pdf.

Pharmaceuticals, monitored in a 2017 survey, have also been confirmed to be present in the Delaware River https://www.state.nj.us/drbc/library/documents/contaminants-of-emerging-concern_07-09rpt_appendixE.pdf. Assessment priorities include further characterization of persistent and bioaccumulative PFAS and a more comprehensive evaluation of potential ecological effects from pharmaceuticals. Benchmark values for environmental safety are needed and in some cases water quality criteria may need to be derived for some CEC to facilitate future water quality assessment.

2.3.2.12 DRINKING WATER CLOSURES

For the Assessment Period, there were no administrative closures to drinking water intakes as a result of water quality issues or violations.

2.3.3 Contact Recreation

The DRBC water quality regulations sub-divide Zone 4 for bacteria criteria. The upper portion of Zone 4, above River Mile 81.8, is designated as secondary contact recreation only, while the lower portion of Zone 4, below River Mile 81.8, is designated for both primary and secondary contact recreation. Where bacterial counts were present above the quantification limit, we assumed counts equal to the quantification limit (if reported) or assumed a count of 600 colonies per 100 mL if the quantification limit was not reported. Where the bacterial count was not detected, we assumed a count equal to the detection limit.

Primary contact recreation is supported in all applicable Zones, except Zone 2 where assessment results slightly exceeded criteria. Secondary contact recreation is supported in Zones 3 and 4 (Table 22). A disproportionate number of samples were collected in the extreme downstream portion of Zone 2 (i.e., more urbanized portion) as part of an enhanced bacteria monitoring effort (see below). This additional sample collection drove assessment results to slightly exceed primary contact recreational use criteria.

In the summers of 2019, 2020, and 2021, DRBC instituted a focused bacterial monitoring effort in Water Quality Zone 3 and upper Zone 4, the portion of the Delaware River around Philadelphia and Camden. This project developed more parameters and analyses than included in the Water Quality Assessment Report. For more information on this study see https://www.state.nj.us/drbc/quality/conventional/bacteria-monitoring.html. Applicable parameters from this monitoring effort were included in the 2022 assessment.

Table 22: Primary and Secondary Contact Recreation Results

AU	Fecal Coliform		Enterococcus		2022 Assessment	2020 Assessment
	Primary	Secondary	Primary	Secondary		
1A	+	NC	NC	NC	S	ID
1B	+	NC	NC	NC	S	ID
1C	ID	NC	NC	NC	ID	ID
1D	ID	NC	NC	NC	ID	ID
1E	+	NC	NC	NC	S	ID
2	+	NC	-	NC	NS	S
3	NC	+	NC	+	S	S
4 (> RM 81.8)	NC	+	NC	+	S	S
4 (< RM 81.8)	+	NC	+	NC	S	ID
5	+	NC	+	NC	S	S
6	+	NC	+	NC	S	S

Notes:
+ The Assessment Unit meets WQC
- TheAssessment Unit does not meet WQC
ID Insufficient Data
NC No criteria developed
S The use is supported in this Assessment Unit
NS The use is not supported in this Assessment Unit

2.3.4 Fish Consumption

The fish consumption designated use applies to all DRBC WQM Zones. The assessment criterion is based primarily on the presence of the Basin states' fish consumption advisories in the mainstem Delaware River and Bay for the assessment period. The presence of fish consumption advisories results in an assessment of "not supporting the designated use".

The following fish advisories reports were used:

State	Fish Consumption Advisory Link
Delaware	https://dnrec.alpha.delaware.gov/fish-wildlife/fishing/consumption-advisories/
New Jersey	https://www.nj.gov/dep/dsr/njmainfish.htm
Pennsylvania	https://www.dep.pa.gov/Business/Water/CleanWater/WaterQuality/FishConsumptionAdvisory/Pages/default.aspx
New York	https://www.health.ny.gov/environmental/outdoors/fish/health_advisories//regional/catskill.htm

Table 22 below provides a summary of the representative consumption advisories issued by the states as of February 2022. For each assessment unit, advisories were issued. There is no assessment unit without an advisory, so the use is not supported in any zone.

It is important to note that the table below provides a summary of consumption advisories only to determine the presence or absence of advisories. In most cases, the actual advisories issued by the respective states are much more detailed. Users should consult the advisories directly for health information regarding consumption of caught fish. Actual state-issued advisories may differ from Table 22 in several ways, including:

1. Different advisories may be issued for specific subpopulations;
2. Different advisories may be issued for subsections of the water quality management zones;
3. Specific recommendations may be provided for preparation of fish to reduce exposure to contaminants;
4. Species with no restrictions may not be listed in Table 22, as these do not contribute to the total count of advisories for assessing achievement of criteria. However, anglers should be aware of species with no recommended restrictions on consumption.

The exceedances of criteria indicated by the presence of fish consumption advisories is further supported by the presence of measurable PCB concentrations in the water column in excess of the applicable surface water quality PCB criterion. Twenty-two main stem channel sites in the tidal Estuary were sampled in 2015 for PCBs and analyzed using EPA method 1668 Rev A. Sampling stations were located from Biles Channel near Trenton NJ to the ocean boundary between Cape May and Lewis. Whole water samples were analyzed for all 209 PCB congeners. Results indicated that whole water concentrations ranged from approximately 400 pg/L near the ocean to a maximum of 17,700 pg/L in Zone 5 and decreasing to an average concentration of 2,000 pg/L in Zone 2. All PCB concentrations exceed the current PCB water quality criterion for the protection of human health from carcinogenic effects at 16 pg/L.

DRBC developed and EPA established total maximum daily loads (TMDLs) for PCBs for Zones 2 through 5 in December 2003 (http://www.nj.gov/drbc/library/documents/TMDL/FinalRptDec2003.pdf), and a PCB TMDL for Zone 6 in December 2006 (https://www.nj.gov/drbc/library/documents/TMDL/Zone6final-rpt_Dec2006.pdf).

Table 23. Fish Consumption Advisory Summary

Fish Species	Contaminant	Fish Consumption Advisory – General Population									
		1A	1B	1C	1D	1E	2	3	4	5	6
DELAWARE											
All Finfish	PCBs, Dioxins and furans, Dieldrin									3/year State line to C&D Canal	
Striped Bass, Channel Catfish, White Catfish, American Eel	PCBs										3/year C&D Canal to mouth of Bay
White Perch	PCBs										6/year C&D Canal to mouth of Bay

Fish Species	Contaminant	Fish Consumption Advisory – General Population									
		1A	1B	1C	1D	1E	2	3	4	5	6
Bluefish 20 inches or less	PCBs										12/year C&D Canal to mouth of Bay
Bluefish greater than 20 inches	PCBs, Mercury										3/year C&D Canal to mouth of Bay
NEW JERSEY											
Largemouth Bass							1/month	1/month	1/month		
Striped Bass					1/month	4/year	4/year	4/year	4/year		3/year
White Perch							4/year	4/year	4/year		6/year

Fish Species	Contaminant	Fish Consumption Advisory – General Population									
		1A	1B	1C	1D	1E	2	3	4	5	6
White Catfish					1/week	1/month	1/month	1/month	1/month		3/year
Channel Catfish					1/month	4/year	1/year	1/year	1/year		3/year
American Eel				1/week	1/month	1/month	1/year	1/year	1/year		3/year
Common Carp							1/week	1/week	1/week		
Flathead Catfish							1/month	1/month	1/month		
All Finfish										3/year	
Bluefish 20 inches or less											1/month
Bluefish greater than 20 inches											3/year

Fish Species	Contaminant	Fish Consumption Advisory – General Population									
		1A	1B	1C	1D	1E	2	3	4	5	6
Rock Bass				2/month	2/month	2/month					
Smallmouth Bass				1/week	1/month	1/week					
White Sucker				1/month	1/week	1/month					
Walleye				1/week		2/month					
Weakfish											1/week
NEW YORK (All waters NOT listed, Catskill Region)											
Yellow Perch	Mercury	4/month	4/month								
Largemouth Bass	Mercury	4/month	4/month								
Northern Pike	Mercury	4/month	4/month								

Fish Species	Contaminant	Fish Consumption Advisory – General Population									
		1A	1B	1C	1D	1E	2	3	4	5	6
Smallmouth Bass	Mercury	4/month	4/month								
Walleye	Mercury	4/month	4/month								
Pickerel	Mercury	4/month	4/month								
Brook Trout	Mercury	4/month	4/month								
Brown Trout	Mercury	4/month	4/month								
Rainbow Trout	Mercury	4/month	4/month								
Rock Bass	Mercury	4/month	4/month								
Sunfish	Mercury	4/month	4/month								
Bullhead	Mercury	4/month	4/month								
All other fish	Mercury	4/month	4/month								
PENNYSYLVANIA											

Fish Species	Contaminant	Fish Consumption Advisory – General Population									
		1A	1B	1C	1D	1E	2	3	4	5	6
Rock Bass	Mercury	2/month	2/month	2/month	2/month	2/month					
Smallmouth Bass	Mercury	1/month	1/month	1/month	1/month	1/month					
Walleye (>17 inches)	Mercury	2/month	2/month	2/month	2/month	2/month					
White Perch	PCBs						1/month	1/month	1/month		
Channel Catfish	PCBs						1/month	1/month	1/month		
Flathead Catfish	PCBs						1/month	1/month	1/month		
Striped Bass (>28 inches)	PCBs						1/month	1/month	1/month		
Carp	PCBs						6/year	6/year	6/year		
American Eel	PCBs						Do not eat	Do not eat	Do not eat		

Fish Species	Contaminant	Fish Consumption Advisory – General Population									
		1A	1B	1C	1D	1E	2	3	4	5	6
Advisories in place?		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

2.3.5 Shellfish Consumption

Shellfish consumption, as a DRBC designated use, only applies to DRBC WQM Zone 6. In the latest shellfish spatial data from the states, the state of Delaware classifies its designated shellfish waters within Delaware Bay as falling into the following two categories:

- Approved (assumed)
- Prohibited

New Jersey classifies shellfish waters as falling into the following categories:

- Approved
- Conditionally Approved
- Prohibited
- Special Restricted
- Suspended Harvesting

Figure 7 indicates the current DE and NJ classifications for shellfish in Zone 6. Table 24 lists a summary of current DE and NJ classifications areas. Since sub-area shapes and dimensions have changed, direct comparison with the 2020 assessment is not possible.

For the current 2022 assessment, approved and conditionally approved harvesting areas were considered to be supporting (S) the use. Prohibited waters were considered to be not supporting (NS) the use. AUs classified as special restricted are considered to be supported, but with special conditions (SS). Note, however, that the states of DE and NJ 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 (see the respective state Integrated Assessment reports for further information).

In total for the 2022 assessment, 617 mi^2 are in full support 11 mi^2 are supporting with special conditions and 34 mi^2 are not supporting the shellfish consumption use.

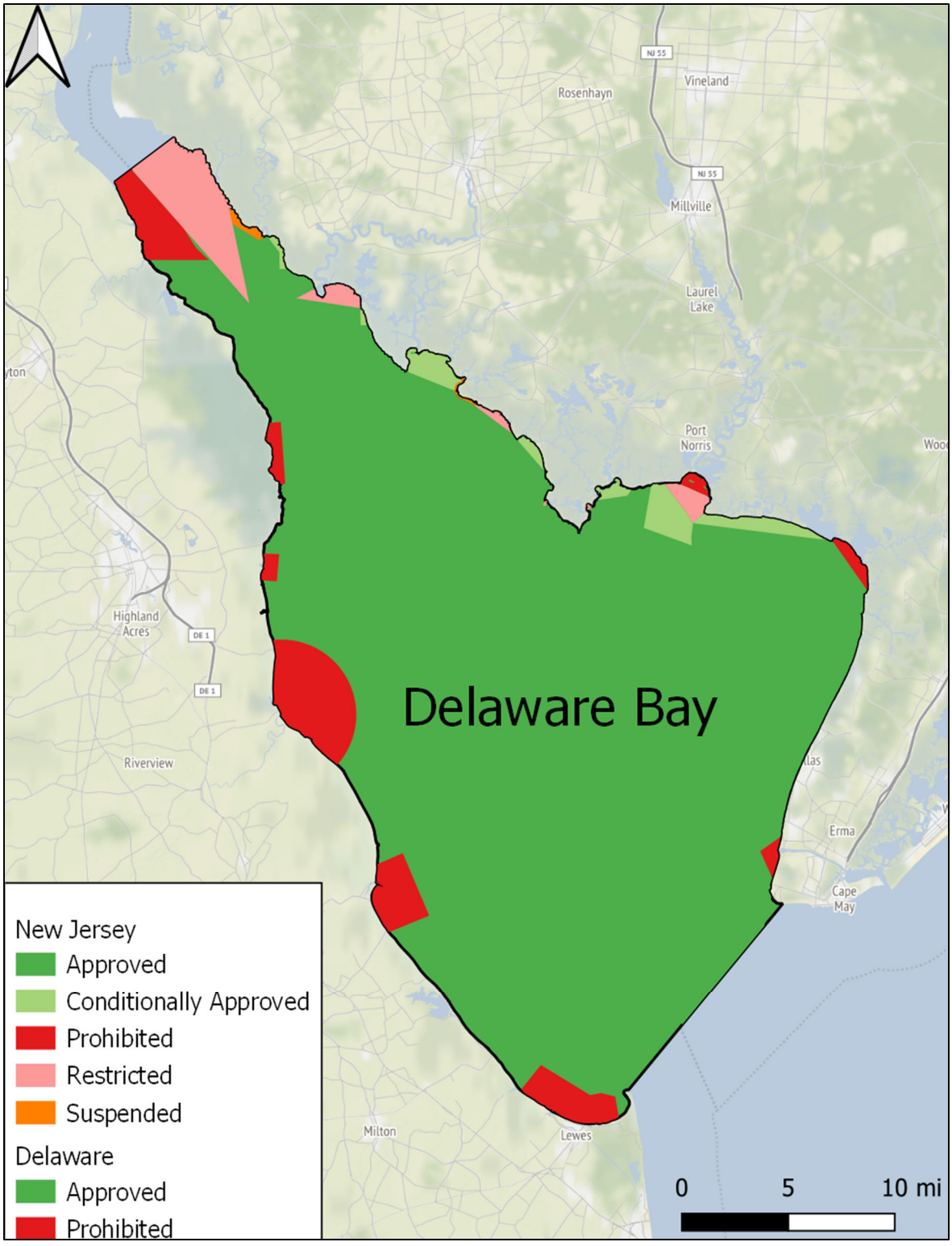

Figure 7: Shellfish Consumption Classifications designated by New Jersey and Delaware for the Delaware Bay

Table 24: Shellfish Consumption Designated Use Assessment Results

State	Approved (S)		Seasonal or Special Restricted (SS)		Prohibited (NS)	
	mi^2	%	mi^2	%	mi^2	%
Delaware	288	88	0	0	12	23
New Jersey	329	91	11	3	22	6

2.4 ASSESSMENT SUMMARY

Table 25 below shows the summary of assessments for Aquatic Life, Public Water Supply, Recreation, and Fish Consumption.

Assessment of Shellfish applies only to Zone 6 and utilizes shellfish-specific sub areas. The Shellfish assessment summary is provided in Table 24 in the previous section.

Table 25: Summary of the 2022 Assessment

Zone (AU)	Aquatic Life		Drinking Water		Recreation		Fish Consumption	
	2022	2020	2022	2020	2022	2020	2022	2020
1A	NS[A]	NS[A]	NS[AB]	NS[AB]	S	ID	NS	NS
1B	NS	NS	NS[AB]	NS[AB]	S	ID	NS	NS
1C	NS[A]	NS[A]	S	S	ID	ID	NS	NS
1D	NS[A]	NS[A]	S	NS[AB]	ID	ID	NS	NS
1E	NS[A]	NS[A]	S	S	S	ID	NS	NS
2	NS[A]	NS[A]	NS[AC]	NS[AC]	NS	S	NS	NS
3	NS[A]	NS[A]	S	S	S	S	NS	NS
4	NS[A]	NS[A]	N/A	N/A	S	S	NS	NS
5	NS[A]	NS[A]	N/A	N/A	S	S	NS	NS
6	NS[A]	NS[A]	N/A	N/A	S	S	NS	NS

Notes:

A	Based primarily on fewer than 10% exceedances of criteria
B	Based on exceedance of 133% of background TDS, not 500 mg/L MCL
C	Based on limited spot measurement data
ID	Insufficient Data
N/A	Not applicable (not an applicable designated use)
S	The use is supported in this Assessment Unit
NS	The use is not supported in this Assessment Unit

3. RECOMMENDATIONS FOR FUTURE ACTIONS

Based on the results of this assessment cycle, we recommend additional effort prior to the next cycle to help address the following issues:

- DRBC and its partner organizations must craft a specific plan to better define the linkage between atmospheric and meteorological drivers of temperature to estimate the proportion of temperature exceedances attributable to potentially controllable anthropogenic activities.
- The pH criteria allow exceedances if due to natural conditions, however the Commission has not defined what would constitute demonstration of natural conditions. Natural conditions, for the application of pH criteria, should be defined before the next assessment. In recent years, additional continuous pH monitors have come online in Zone 1, which may help in defining "natural conditions".
- Work is needed to clarify the evaluation of the TDS for drinking water use. Observed TDS values always fall well within the secondary standard of 500 mg/L, but occasionally exceed the 133% of background standard. Whether or not this situation should denote a drinking water standard exceedance is difficult to interpret from the DRBC regulations and needs clarification. The basin states and EPA utilize 500 mg/L as a drinking water standard; however, a similar designation is not distinctly defined in DRBC's water quality regulations.
- DRBC and its Toxics Advisory Committee should review the list of parameters used in the public water supply evaluation.

REFERENCES

Fikslin, TJ, GJ Cavallo, AR MacGillivray, N Suk, D Haltmeier. 2013. An Assessment of Metals in Estuarine Water using Clean Hand Techniques, PDE Science Symposium. January 2013.

Cavallo, GJ, TJ Fikslin, N Suk. 2013. Clean Hands Metals Sampling Techniques, PDE Science Symposium. January 2013.

APPENDIX A: DESCRIPTIONS OF DRBC MONITORING PROGRAMS

The surface water quality monitoring program utilized by the DRBC consists of the following programs:

- The upper, middle and lower non-tidal portions of the River (RM 330.7 to 133.4) are monitored through the Special Protection Waters Monitoring Program, a joint NPS and DRBC effort. Details about this monitoring program are available at:

  http://www.nj.gov/drbc/programs/quality/spw.html

- 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, a joint effort between the DNREC and DRBC. Details about the Boat Run monitoring program are available at:

  https://www.nj.gov/drbc/programs/quality/boat-run.html

- Periodic monitoring of Chronic Toxicity in the estuary is described at:

  https://www.nj.gov/drbc/quality/toxics/ambient-tox.html

- The Biological Monitoring Program collects macroinvertebrate samples throughout the non-tidal River (RM 300.7 to 133.4) for assessment of Aquatic Life Use. More information about the Biological Monitoring Program is available at:

  https://www.nj.gov/drbc/programs/quality/biomonitoring.html

In addition, data obtained from other agencies' monitoring efforts are used to supplement data obtained through the DRBC sampling efforts. The other data sources include:

- DNREC Dioxins and Furans in Fish from the Delaware River Study,
- Pennsylvania Department of Environmental Protection (PADEP) Water Quality Network (WQN),
- New Jersey Department of Environmental Protection (NJDEP) Ambient Surface Water Monitoring Network (from STORET),
- New York State Department of Environmental Conservation (NYSDEC) Ambient Water Quality Monitoring Program (from STORET),
- United States Geological Survey (USGS) National Water Information System (NWIS),
- DRBC/USGS Cooperative Monitoring Program (continuous monitors),
- National Oceanic Atmospheric Administration (NOAA) Physical Oceanographic Real-Time System (PORTS) data, and
- EPA National Coastal Assessment Programs.

APPENDIX B: LINKS TO DRBC WATER RESOURCES MANAGEMENT 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 criteria (WQC) 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 WQC 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 total maximum daily loads (TMDLs), issuing of permits and other mechanisms to reduce loading of pollutants in order to improve water quality to levels that meet the criteria. In addition, DRBC has other layers of protection (i.e., Special Protection Waters) that aim to maintain existing water quality where it is better than the water quality criteria. The links below provide access to much more detailed information on several of the key DRBC water resources management programs.

- Special Protection Waters

  http://www.state.nj.us/drbc/programs/quality/spw.html

- Pollutant Minimization Plan

  http://www.nj.gov/drbc/programs/quality/pmp.html

- Project Review / Docketing

  http://www.nj.gov/drbc/programs/project/

- Southeastern Pennsylvania Ground Water Protected Area

  https://www.state.nj.us/drbc/programs/project/gwpa-instructions.html

- Integrated Water Resource Management and Basin Planning

  http://www.nj.gov/drbc/programs/basinwide/

- Estuary CBOD Allocations

  The Commission determined that the 1964 carbonaceous biochemical oxygen demand (CBOD20) of the effluent load to Zones 2, 3, 4, and 5 exceeded the waste assimilative capacity of those Zones to meet the stream quality objectives based upon numerical modeling study conducted in the late 1960s. In accordance with the regulations, the assimilative capacity of each Delaware Estuary Zone minus a reserve was originally allocated in 1968 among the individual dischargers based upon the concept of uniform reduction of raw waste in a Zone (Zones 2, 3, 4, and 5). Since 1968, the wasteload allocations for individual dischargers have been updated and documented by the Commission.

APPENDIX C: TOXIC POLLUTANT WATER QUALITY ASSESSMENT DETAILS

Table C1:Human Health Objectives (Toxics MCLs) Assessment Results

Parameter	Maximum Contaminant Level (µg/l)	2022 Assessment/Zones monitored
Metals		
Arsenic	10	NM Zone 2 NE Zone 3
Barium	2000	NM Zone 2 NE Zone 3
Beryllium	4	NM
Chromium (trivalent)	100	NM
Copper	1300	NE Zones 2, 3
Lead	15	NE Zones 2 ,3
Selenium	50	NM
Pesticides		
alpha-BHC	0.2	NM
beta-BHC	0.2	NM
gamma - BHC (Lindane)	2	NM
2,4-Dichloro-phenoxyacetic acid (2,4-D)	70	NM
Methoxychlor	40	NM
Toxaphene	3	NM
Dioxin (2,3,7,8-TCDD)	0.00003	NM
2,4,5 Trichloro-phenoxypropionic acid (2,4,5-TP-Silvex)	50	NM
Volatile Organic Compounds (VOCs)		
Benzene	5	NE Zones 2, 3
Carbon Tetrachloride	5	NE Zones 2, 3
1,2-Dichloroethane	5	NE Zones 2, 3
1,1-Dichloroethylene	7	NE Zones 2, 3
1,2 - trans – Dichloroethene	100	NM

Parameter	Maximum Contaminant Level (µg/l)	2022 Assessment/Zones monitored
Dichloromethane (methylene chloride)	5	NE Zones 2, 3
Tetrachloroethylene (PCE)	5	NE Zones 2, 3
Toluene	1000	NE Zones 2, 3
Total Trihalomethanes	80	NM
1,1,1-Trichloroethane	200	NE Zones 2, 3
1,1,2-Trichloroethane	5	NE Zones 2, 3
Trichloroethylene	5	NE Zones 2, 3
Vinyl Chloride	2	NE Zones 2, 3
Polycyclic Aromatic Hydrocarbons (PAHs)		
Benzo(a)Pyrene	0.2	NM
Other Compounds		
Asbestos	7 million fibers/L	NM
Bis(2-Ethylhexyl) Phthalate	6	NM
Fluoride	4,000	NM Zone 2 NE Zone 3
Nitrate	10,000	NE Zones 2, 3
Pentachlorophenol	1	NM

NE No exceedance
NM Not monitored

Table C2:Aquatic Life Objectives Assessment Results

Parameter	Freshwater Objectives (µg/l)		2022	Marine Objectives (µg/l)		2022
	Acute	Chronic		Acute	Chronic	
Metals						
Aluminum [a,b]	750	87	EA 1D, 1E, 4, 5 EC Zones 1A, 1B, 2, 3, 4, 5 NE Zone 1C	NA	NA	NA
Arsenic (trivalent) [c]	340	150	NE Zones 3, 4,5 NM Zones 1, 2	69	36	NE Zones 5, 6
Cadmium [c]	0.651*EXP(1.0166* LN(hardness)-3.924)	0.651*EXP(0.7409* LN(hardness)-4.719)	NE Zone 1A, 1B, 1C NM other Zones	40	8.8	NM
Chromium (trivalent) [c]	0.277*EXP(0.819* LN(hardness)+3.7256)	0.277*EXP(0.819* LN(hardness)+0.6848)	NM	NA	NA	
Chromium (hexavalent) [c]	16	11	NE Zones 2-5 NM Zone 1	1,100	50	NE
Copper [c,g]	0.908*EXP(0.9422* LN(hardness)-1.7)	0.908*EXP(0.8545* LN(hardness)-1.702)	E Zone 1A NE Zones 2-5 NM 1B, 1C, 1D, 1E	4.8	3.1	E
Lead [c]	38	5.4	EC Zones 1E, 4 NE Other Zones	210	8.1	NE
Mercury [c]	1.4	0.77	NE Zones 1D, 1E, 2-5 NM 1A, 1B, 1C	1.8	0.94	NE
Nickel [c]	0.846*EXP(0.846* LN(hardness)+2.255)	0.846*EXP(0.846* LN(hardness)+0.0584)	NE Zones 2-5 NM Zone 1	64	22	NE
Selenium [a]	20	5.0	NE Zone 1 NM Other Zones	290	71	NM
Silver [c]	0.85*EXP(1.72* LN(hardness)-6.59)	NA	NE Zone 1B, NM other Zones	1.9	NA	NM
Zinc [c]	0.95*EXP(0.8473* LN(hardness)+0.884)	0.95*EXP(0.8473* LN(hardness)+0.884)	SE Zone 1D NE Zones 1A, 2-5 NM Zone 1B,1C,1E	90	81	NE

Parameter	Freshwater Objectives (µg/l)		2022	Marine Objectives (µg/l)		2022
	Acute	Chronic		Acute	Chronic	
Pesticides/PCBs						
Aldrin	3	NA	NE Zones 1C, 1D, 1E NM Other Zones	1.3	NA	NM
gamma - BHC (Lindane)	0.95	NA	NE Zones 1C, 1D, 1E NM Other Zones	0.16	NA	NM
Chlordane	2.4	0.0043	NM	0.09	0.004	NM
Chlorpyrifos (Dursban)	0.083	0.041	NE Zones 1C, 1E NM Other Zones	0.011	0.0056	NM
DDT and metabolites (DDE & DDD) [d]	1.1	0.001	NM	0.13	0.001	NM
Dieldrin	0.24	0.056	NE Zones 1C, 1D, 1E NM Other Zones	0.71	0.0019	NM
Endosulfan [e]	0.22	0.056	NM	0.034	0.0087	NM
Endrin	0.086	0.036	NE Zones 1C, 1D, 1E NM Other Zones	0.037	0.0023	NM
Heptachlor	0.52	0.0038	NE Zones 2-5 NM Zone 1	0.053	0.0036	NE
Heptachlor Epoxide	0.52	0.0038	NM	0.053	0.0036	NM
Parathion	0.065	0.013	NE Zones 1C, 1E NM Other Zones	NA	NA	NM
PCBs (Total)	1.0	0.014	Ongoing TMDL	5.0	0.03	
Toxaphene	0.73	0.0002	NM	0.21	0.0002	NM
Other Compounds						
Cyanide (free)	22	5.2	NM	1	1	NM
Pentachlorophenol	$e^{(1.005*pH-4.83)}$	e(1.005*pH-5.29)	NM	13	7.9	NM
Indicator Parameters						
Whole Effluent Toxicity	0.3 Toxic Units $_{acute}$	1.0 Toxic Units $_{chronic}$	NM	0.3 TU_a	1.0 TU_c	NM

a Total recoverable criterion

b Aluminum criteria listed should be restricted to waters with pH between 6.5 and 9.0. Coordination among basin states and agencies should continue to ensure the use of the most appropriate methods and procedures for the conduct of monitoring studies in the Basin, and the harmonization of water quality criteria and assessment methodologies.

c Dissolved criterion

d This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value.

e This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

f Criteria for cadmium, chromium(trivalent), copper, nickel, silver and zinc are hardness dependent and are expressed as the dissolved form (see Section 3.10.3.C.2. for form of metal).

g Copper concentrations continue to be near water quality criteria in the Delaware Estuary with apparent exceedances of the marine criteria in Zones 5 and 6. Exceedances of chronic freshwater criteria using DRBC regulatory hardness but not with site specific hardness in Zone 5. Exceedances of acute and chronic freshwater criteria in Zones 1A, 1B, and 1D but not with site specific hardness within EPA recommended hardness range of 25 to 400 mg/L. Exceedances of chronic criteria in Zone 1E if total copper is converted to dissolved in the absence of dissolved copper data. The apparent exceedances are low in both frequency and magnitude. Coordination among basin states and agencies should continue to ensure the use of the most appropriate methods and procedures for the conduct of monitoring studies in the Basin, and the harmonization of water quality criteria and assessment methodologies.

NA Not available

NE No chronic or acute exceedances

NEA No acute exceedance

NEC No chronic exceedance

SE Single exceedance

E Exceedances both acute and chronic

EA Acute exceedance

EC Chronic exceedance

NM Not monitored

DL Detection limit

Table C3:Human Health Objectives (Carcinogens) Assessment Results

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2022 assessment	MARINE OBJECTIVES (µg/l)	2022 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Metals					
Arsenic	*	NA		NA	
Pesticides/PCBs					
Aldrin	0.000049	0.000050	NM	0.000050	NM
alpha – BHC	0.0026	0.0049	NM	0.0049	NM
beta – BHC	0.0091	0.017	NM	0.017	NM
Chlordane	0.00080	0.00081	NM	0.00081	NM
DDD	0.00031	0.00031	NM	0.00031	NM
DDE	0.00022	0.00022	NM	0.00022	NM
DDT	0.00022	0.00022	NM	0.00022	NM
Dieldrin	0.000052	0.000054	NM	0.000054	NM
Heptachlor	0.000079	0.000079	NM	0.000079	NM
Heptachlor Epoxide	0.000039	0.000039	NM	0.000039	NM
PCBs (Total)	0.000016	0.000016	Ongoing TMDL NM Zone 1	0.000016	Ongoing TMDL
Toxaphene	0.00028	0.00028	NM	0.00028	NM
Volatile Organic Compounds (VOCs)					
Acrylonitrile	0.051	0.25	NM	0.25	NM
Benzene	0.61	14	NE Zones 2-5 NM Zone 1	14	NE
Benzidine	0.000086	0.00020	NM	0.00020	NM
Bromoform(tribromomethane)	4.3	140	NE Zones 2-5 NM Zone 1	140	NE
Bromodichloromethane	0.55	17	NM	17	NM
Carbon Tetrachloride	0.23	1.6	NE Zones 2-5 NM Zone 1	1.6	NE
Chlorodibromomethane	0.40	13	NE Zones 2-5 NM Zone 1	13	NE

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2022 assessment	MARINE OBJECTIVES (µg/l)	2022 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Chloroform	5.7	470	NE Zones 2-5 NM Zone 1	470	NE
3,3 - Dichlorobenzidine	0.021	0.028	NM	0.028	NM
1,2 - Dichloroethane	0.38	37	NE Zones 2-5 NM Zone 1	37	NE
1,2 - Dichloropropane	0.50	15	NE Zones 2-5 NM Zone 1	15	NE
1,3 - Dichloropropene	0.34	21	NM	21	NM
Dichloromethane (Methylene chloride)	*	590	NE Zones 2-5 NM Zone 1	590	NE
Tetrachloroethylene	0.69	3.3	NE Zones 2-5 NM Zone 1	3.3	NE
1,1,2,2 - Tetrachloroethane	0.17	4.0	NM	4.0	NM
1,1,2 - Trichloroethane	0.59	16	NE Zones 2-5 NM Zone 1	16	NE
Trichloroethylene	2.5	30	NE Zones 2-5 NM Zone 1	30	NE
Vinyl Chloride	0.025	2.4	NE Zones 2-5 NM Zone 1	2.4	NE
Polycyclic Aromatic Hydrocarbons (PAHs)					
Benz[a]anthracene	0.0038	0.18	NM	0.18	NM
Benzo[b]fluoranthene	0.038	0.18	NM	0.18	NM
Benzo[k]fluoranthene	0.38	1.8	NM	1.8	NM
Benzo[a]pyrene	0.0038	0.018	NM	0.018	NM
Chrysene	3.8	18	NM	18	NM
Dibenz[a,h]anthracene	0.0038	0.018	NM	0.018	NM
Indeno[1,2,3-cd]pyrene	0.038	0.18	NM	0.18	NM
Other Compounds					
Bis (2-chloroethyl) ether	0.03	0.53	NM	0.53	NM
Bis (2-ethylhexyl) phthalate	1.2	2.2	NM	2.2	NM
2,4 - Dinitrotoluene	0.11	3.4	NM	3.4	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2022 assessment	MARINE OBJECTIVES (µg/l)	2022 assessment
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
1,2 - Diphenylhydrazine	0.036	0.2	NM	0.2	NM
Hexachlorobenzene	0.00028	0.00029	NM	0.00029	NM
Hexachlorobutadiene	0.44	18	NM	18	NM
Hexachloroethane	1.4	3.3	NM	3.3	NM
Isophorone	35	960	NM	960	NM
N-Nitrosodi-N-butylamine	0.0063	14	NM	14	NM
N-Nitrosodi-N-methylamine	0.00069	3.0	NM	3.0	NM
N-Nitrosodiethylamine	0.0008	1.24	NM	1.24	NM
N-Nitrosodi-N-phenylamine	3.3	6	NM	6	NE
N-Nitrosodi-N-propylamine	0.0050	0.51	NM	0.51	NM
N-Nitrosopyrrolidine	0.016	34	NM	34	NM
Pentachlorophenol	0.27	3.0	NM	3.0	NM
Dioxin (2,3,7,8 – TCDD)	0.000000005	0.0000000051	NM	0.0000000051	NM
2,4,6 - Trichlorophenol	1.4	2.4	NM	2.4	NM

* The MCL for this compound applies in Zones 2 and 3 and is listed in Table 3.

NA Not Available

SE Single Exceedance

E Exceedance

NE No Exceedance

NM Not Monitored

Table C4:Human Health Objectives (Systemic Toxicants) Assessment Results

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2022	MARINE OBJECTIVES (µg/l)	2022
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Metals					
Antimony	5.6	640	NE Zones 2-5 NM Zone 1	640	NE
Arsenic	*	NA		NA	
Beryllium	*	420	NM	420	NM
Cadmium	3.4	16	NE Zones 1B NM Zones 1A, 1C, 1D, 1E, 2-5	16	NM
Chromium (trivalent)	*	380,000	NM	380,000	NM
Chromium (hexavalent)	92	NA	NE Zones 2-5 NM Zone 1	NA	
Chromium (total)	NA	750	NM	750	NM
Mercury	0.050	0.051	NE Zones 1D, 1E, 2-5 NM Zones 1A, 1B, 1C	0.051	NE Zone 5 E Zone 6
Methylmercury [a]	0.3 mg/kg fish tissue	0.3 mg/kg fish tissue	NE Zones 2-5 Exceedances Zone 1	0.3 mg/kg fish tissue	NE Zone 5 NM Zone 6
Nickel	500	1,700	NE	1,700	NE
Selenium	170	4,200	NE Zone 1 NM 2-5	4,200	NM
Silver	170	40,000	NM	40,000	NM
Thallium	0.24	0.47	NM	0.47	NM
Zinc	7,400	26,000	NE	26,000	NE
Pesticides/PCBs					
Aldrin	0.025	0.025	NE Zone 1C, 1E NM Zones 1A, 1B, 1D, 2-5	0.025	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2022	MARINE OBJECTIVES (µg/l)	2022
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
gamma - BHC (Lindane)	0.98	1.8	NE Zone 1C, 1E NM Zones 1A, 1B, 1D, 2-5	1.8	NM
Chlordane	0.14	0.14	NM	0.14	NM
DDT and Metabolites (DDD and DDE)	0.037	0.037	NM	0.037	NM
Dieldrin	0.041	0.043	NE Zone 1C, 1E NM Zones 1A, 1B, 1D, 2-5	0.043	NM
alpha -Endosulfan	62	89	NM	89	NM
beta- Endosulfan	62	89	NM	89	NM
Endosulfan Sulfate	62	89	NM	89	NM
Endrin	0.059	0.060	NE Zone 1C, 1E NM Zones 1A, 1B, 1D, 2-5	0.060	NM
Endrin Aldehyde	0.29	0.30	NM	0.30	NM
Heptachlor	0.18	0.18	NM	0.18	NM
Heptachlor Epoxide	0.0046	0.0046	NM	0.0046	NM
Total PCBs	0.00839	0.00849	Ongoing TMDL NM Zone 1	0.00149	Ongoing TMDL
Volatile Organic Compounds (VOCs)					
Acrolein	6.1	9.3	NM	9.3	NM
Benzene	*	3,100	NE Zones 2-5 NM Zone 1	3,100	NE
Bromoform (tribromomethane)	650	9,600	NE Zones 2-5 NM Zone 1	9,600	NE
Bromodichloromethane	680	NA	NM	NA	NM
Dibromochloromethane	680	21,000	NM	21,000	NM
Carbon Tetrachloride	*	150	NE Zones 2-5 NM Zone 1	150	NE

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2022	MARINE OBJECTIVES (µg/l)	2022
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
Chloroform	68	2,100	NE Zones 2-5 NM Zone 1	2,100	NE
Chlorobenzene	130	1,600	NE Zones 2-5 NM Zone 1	1,600	NE
1,1 - Dichloroethylene	*	7,100	NE Zones 2-5 NM Zone 1	7,100	NE
1,2 - trans - Dichloroethylene	140	10,000	NM	10,000	NM
1,3 - Dichloropropene	1,000	63,000	NM	63,000	NM
Ethylbenzene	530	2,100	NE Zones 2-5 NM Zone 1	2,100	NE
Methyl Bromide	47	1,500	NE Zones 2-5 NM Zone 1	1,500	NE
Methylene Chloride	*	260,000	NE Zones 2 -5 NM Zone 1	260,000	NE
1,1,2 – Trichloroethane	*	3,600	NE Zones 2-5 NM Zone 1	3,600	NE
Tetrachloroethylene	*	1,300	NE Zones 2-5 NM Zone 1	1,300	NE
Toluene	1,300	15,000	NE Zones 2-5 NM Zone 1	15,000	NE
Polycyclic Aromatic Hydrocarbons (PAHs)					
Anthracene	8,300	NM	NE Zones 2-5 NM Zone 1	40,000	NM
Fluoranthene	130	140	NM	140	NM
Fluorene	1,100	5,300	NM	5,300	NM
Pyrene	830	4,000	NM	4,000	NM
Other Compounds					
Acenaphthene	670	990	NM	990	NM
Benzidine	59	140	NM	140	NM
Bis (2-chloroisopropyl) ether	1,400	65,000	NM	65,000	NM
Bis (2-ethylhexyl) phthalate	*	620	NM	620	NM
Butylbenzyl phthalate	1,500	1,900	NM	1,900	NM

PARAMETER	FRESHWATER OBJECTIVES (µg/l)		2022	MARINE OBJECTIVES (µg/l)	2022
	FISH & WATER INGESTION	FISH INGESTION ONLY		FISH INGESTION ONLY	
2 - Chloronaphthalene	1,000	1,600	NM	1,600	NM
2 - Chlorophenol	81	150	NM	150	NM
Cyanide	140	140	NM	140	NM
Dibutyl Phthalate	2,000	4,500	NM	4,500	NM
1,2 - Dichlorobenzene	420	1,300	NM	1,300	NM
1,3 - Dichlorobenzene	420	1,300	NM	1,300	NM
1,4 - Dichlorobenzene	63	190	NM	190	NM
2,4 - Dichlorophenol	77	290	NM	290	NM
Diethyl Phthalate	17,000	44,000	NM	44,000	NM
Dimethyl Phthalate	270,000	1,100,000	NM	1,100,000	NM
2,4 - Dimethylphenol	380	850	NM	850	NM
2,4 - Dinitrophenol	69	5,300	NM	5,300	NM
2,4 - Dinitrotoluene	68	2,100	NM	2,100	NM
Hexachlorobenzene	0.35	0.36	NM	0.36	NM
Hexachlorocyclopentadiene	40	1,100	NM	1,100	NM
Hexachloroethane	20	46	NM	46	NM
Isophorone	6,700	180,000	NM	180,000	NM
2-Methyl-4,6-dinitrophenol	13	280	NM	280	NM
Nitrobenzene	17	690	NM	690	NM
Pentachlorobenzene	1.4	1.5	NM	1.5	NM
Pentachlorophenol	*	11,000	NM	11,000	NM
Phenol	10,000	860,000	NM	860,000	NM
1,2,4,5-Tetrachlorobenzene	0.97	1.1	NM	1.1	NM
1,2,4 - Trichlorobenzene	35	70	NM	70	NM
2,4,5-Trichlorophenol	1,800	3,600	NM	3,600	NM
Vinyl Chloride	*	10,000	NE Zones 2-5 NM Zone 1	10,000	NE

* The MCL for this compound applies in Zones 2 and 3 and is listed in Table 3.
NA Not Available
SE Single Exceedance
E Exceedance
NE No Exceedance
NM Not Monitored

For this assessment cycle, where DRBC has not adopted numeric toxics criteria (Zones 1A through 1E), to ensure attainment and maintenance of downstream water quality standards and to facilitate consistent and efficient implementation and coordination of water quality-related management actions in shared interstate waters, an assessment methodology based on the most stringent of basin state standards in Zones 1A though 1E is used in the assessment.

Some criteria require hardness values to compute the actual criteria numeric value. In these cases, toxics data from ambient water are compared to stream quality objectives using hardness values listed in DRBC Water Quality Regulations for Zones 2 through 5 (i.e., 74 mg/L as CaCO3).

• An additional comparison is conducted as part of this assessment with site-specific paired hardness measured concurrently with toxic analytical parameters.

For Zone 1 assessments, the actual criteria numeric value is computed with site-specific paired hardness measured concurrently with the toxic analytical parameter.

For criteria expressed as the dissolved form of the metal, assessment of monitoring data is as follows:

• In assessment Zones with dissolved metals data collected, direct comparison to DRBC dissolved criteria;

• In assessment Zones with only total metals data collected (as noted in Table 5), comparison of total metals data to estimated total metals criteria using conversion factors listed in “Revised Procedure for Converting Total Recoverable Water Quality Criteria for Metals to Dissolved Criteria” http://www.state.nj.us/drbc/library/documents/criteria-metals1995.pdf.

[a] The DRBC methyl mercury criterion is fish tissue residue based as recommended by USEPA. No exceedances were observed in the fish species monitored by the DRBC in tidal waters (channel catfish, white perch). Concentrations of mercury as wet weight in fish species sampled do not exceed a residue-based water quality criteria of 300 ppb methylmercury. To include data for other aquatic biota in the water quality assessment, DRBC staff is soliciting data on methyl mercury in biota sampled from the Delaware River especially large fish that have a high potential for bioaccumulation of methyl mercury.

APPENDIX D: TASTE AND ODOR WATER QUALITY ASSESSMENT 2022

Table D1:Taste and Odor as Human Health Objectives Assessment Results

PARAMETER	STREAM QUALITY OBJECTIVE (µg/l)	2016 assessment
Phenol	300	NM
2 - Chlorophenol	0.1	NM
2,4 - Dichlorophenol	0.3	NM
2,4 - Dimethylphenol	400	NM
4 - Chloro - 3 - methylphenol	3.0 mg/l	NM
Pentachlorophenol	30	NM
Acenaphthene	20	NM
Chlorobenzene	20	NE Zones 2-6 NM Zone 1
Hexachlorocyclopentadiene	1.0	NM
Nitrobenzene	30	NM

NE No Exceedance
SE Single Exceedance
NM Not Monitored

APPENDIX E: PUBLIC PARTICIPATION AND COORDINATION PROCESS

Action	Date
Draft Assessment Methodology posted on the DRBC web site	November 11, 2021
Notice of Proposed Methodology for the 2022 Delaware River and Bay Water Quality Assessment Report and call for data published in the Federal Register	November 22, 2021

In addition to the above, the assessment schedule was discussed at DRBC advisory committee meetings during the latter half of 2021 and early 2022.

Initial assessment results were shared with State cooperating agencies as they became available during 2022.

APPENDIX F: BARTRAM'S GARDEN DATA SUBMISSION

In 2021, DRBC received water quality data from the tidal Schuylkill River at Bartram's Garden. This dataset included several parameters including dissolved oxygen, temperature, pH, turbidity, and bacteria (*E. coli)*. The data submission noted that sensor data may be unreliable, so dissolved oxygen, temperature, pH, and turbidity were not assessed. DRBC does not have criteria for *E. coli* , however this parameter was assessed here using EPA criteria.

EPA criteria can be seen below in Table F1. DRBC assessed this data set using the criteria found under recommendation 1 for *E. coli* (geometric mean = 126 cfu/mL, STV = 410 cfu/mL). The geometric mean for the samples collected should not be greater than 126 cfu/100 ml in any 30-day interval. There should not be greater than a 10% excursion frequency of 410 cfu/100ml for the samples collected in the same 30–day duration interval. A minimum of 5 samples was needed in any 30-day period.

Table F1. EPA Contact Recreation Criteria

CRITERIA ELEMENTS	**Recommendation 1** Estimated Illness Rate 36/1,000		**Recommendation 2** Estimated Illness Rate 32/1,000	
Indicator	GM (cfu/100 mL)	STV (cfu/100 mL)	GM (cfu/100 mL)	STV (cfu/100 mL)
Enterococci (marine & fresh)	35	130	30	110
E. coli (fresh)	126	410	100	320

Any *E. coli* sample result value that was reported as below detection (< 1 cfu/100ml) was treated as 1 cfu/100ml. Likewise, any *E. coli* sample result value reported as above the maximum detection treated as 2419.6 cfu/100ml for the calculation of the geometric mean (Flemer et al., 2014).

Results of sample collection can be seen in Figure F1 below. *E. coli* samples routinely exceed recommended criteria limits. 95% of 30-day windows in which at least 5 samples were collected exceeded either the geometric mean or STV criteria suggesting that this section of the tidal Schuylkill River did not meet primary contact recreational use.

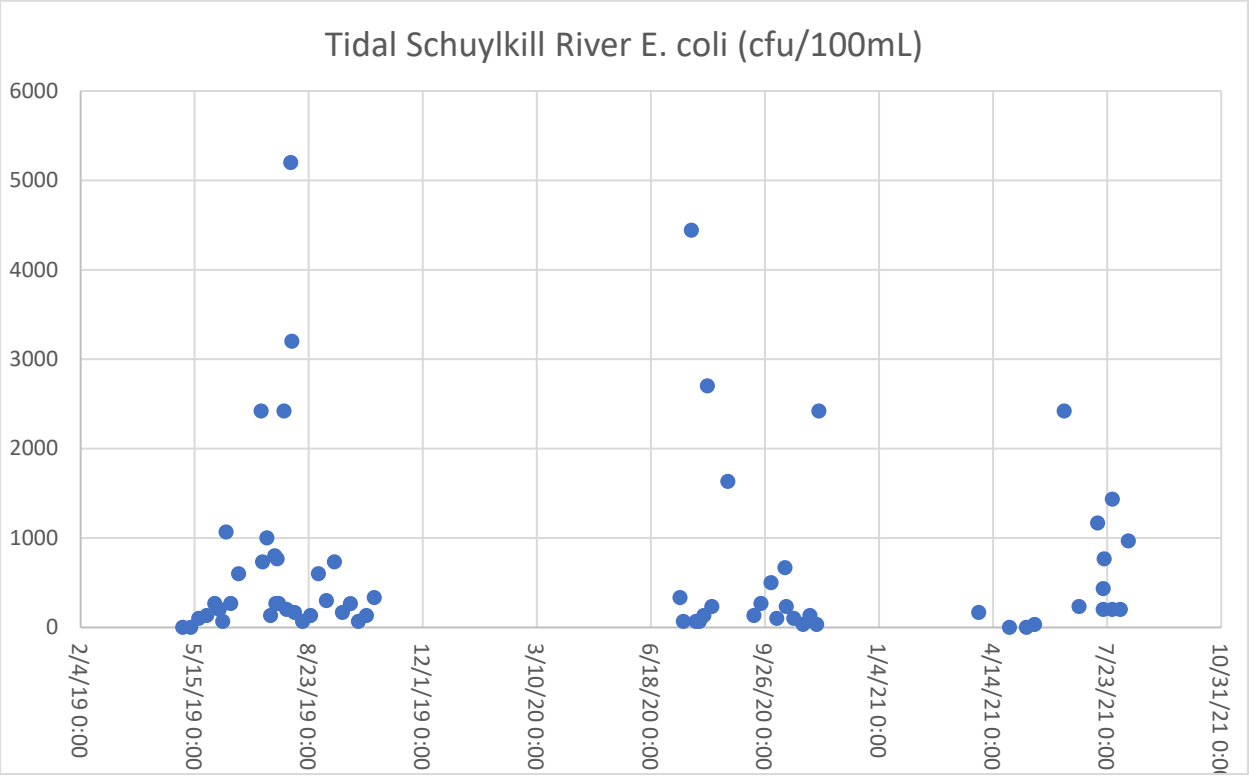

Figure F1. Results of *E. coli* sample collection in the tidal Schuylkill River at Bartram's Garden