NWQI Assessment Report for the Barden Reservoir-Ponaganset River Watershed, Rhode Island

NRCS Rhode Island
RHODE ISLAND

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Barden Reservoir-Ponaganset River Watershed Assessment Report Involved Stakeholders:

Northern Rhode Island Conservation District

Providence Water Supply Board

Rhode Island Department of Environmental Management

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Consultant – Tetra Tech, Inc.
10306 Eaton Place, Suite 340
Fairfax, VA 22030-2201

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I. Background and Purpose of the Assessment

The National Water Quality Initiative (NWQI) provides a way to accelerate voluntary, on-farm conservation investments and focused water quality monitoring and assessment resources where they can deliver the greatest benefits for clean water. NWQI is designed to help individual agricultural producers take actions to reduce the runoff of sediment, nutrients, and pathogens into waterways where water quality is a critical concern. The initiative is a partnership among the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), state water quality agencies, and the U.S. Environmental Protection Agency to identify and address impaired waterbodies through voluntary conservation.

While high-priority watersheds have been identified around the country, typically watershed-scale evaluations identifying specific pollution sources and the conservation practices needed to improve water quality are not available to field office staff responsible for working with landowners. The Barden Reservoir-Ponaganset River watershed in Rhode Island was identified by NRCS and the Northern Rhode Island Conservation District (NRICD) as not having a watershed assessment in place that addresses agriculture. NRICD supports the needs of local land users in the conservation of soil, water, and other related natural resources within the watershed. The objective of this report is to assess how water quality conditions (nutrients, sediments, or livestock-related pathogens) relate to agriculture and determine voluntary conservation efforts that could be implemented on agricultural lands in the watershed. This will provide NRCS field staff with the necessary information to identify locations within the watershed where soil, slope, and land use practices have the highest pollution potential and to describe conservation practices that can be the most beneficial to improve water quality. The assessment aims to fulfill requirements needed to enter the implementation phase of NWQI.

The first section of the report provides an overview of the assessment area, identifies the primary water quality resource concerns, and outlines the associated water quality objectives. It also summarizes how the problems can be addressed through NRCS technical and financial assistance.

General Overview of Assessment Area

This NWQI assessment focuses on the Barden Reservoir-Ponaganset River watershed in Providence County, northeastern Rhode Island. The drainage area covers one 12-digit hydrologic unit code (HUC) watershed (12-digit HUC ID: 010900040605). The watershed drains approximately 33 square miles and lies within the broader Narraganset Bay Basin (NRCS 2014). The Ponaganset River flows southeasterly from the Ponaganset Reservoir (located northeast of the Town of Foster) for approximately 5 miles to the Barden Reservoir (located at the outlet of the watershed)—the Barden Reservoir subsequently discharges to the Scituate Reservoir.

The Scituate Reservoir is the largest freshwater body in Rhode Island and is the public drinking water source for the Providence metropolitan area. Providence Water works to conserve the entire Scituate Reservoir watershed, including the Barden Reservoir-Ponaganset River HUC-12 watershed area. The Scituate Reservoir drainage area is located primarily within the rural towns of Scituate, Foster, and Glocester, and also includes parts of western Cranston and Johnston. The total drainage area covers 93 square miles (Providence Water 2024).

Providence Water owns some of the land in the watershed and relies on local municipalities and private landowners as stewardship partners. The watershed area is approximately 87% forested. Agricultural land makes up about 2% of land use and is distributed throughout the drainage area. Most agricultural operations are small backyard farms with land predominantly dedicated to forage (e.g., other hay/non-alfalfa, pasture). Developed land makes up just over 8% of the area.

Water Quality Degradation Resource Concerns and Impairments

Occasional high levels of phosphorus and bacteria are the main water quality concerns for the Barden Reservoir-Ponaganset River watershed. Stream segments in Shippee Brook and Winsor Brook exceed recreational water quality standards for *Enterococcus* (indicating the potential presence of pathogenic organisms) (RIDEM 2021). Only Winsor Brook has an approved Total Maximum Daily Load (TMDL). Recent U.S. Geological Survey (USGS) and Providence Water Supply Board (PWSB) water quality monitoring data also indicates elevated levels of phosphorus occurring episodically at stream sites throughout the watershed.

Constituents of Concern

Water quality concerns are primarily caused by periodically high levels of nutrients, sediment, and bacteria in the waterbodies of the Barden Reservoir-Ponaganset River watershed.

Opportunities and Objectives for Meeting Water Quality Goals

The NWQI assessment provided an opportunity for NRCS and partners to take a focused look at water quality concerns within the Barden Reservoir-Ponaganset River watershed. The Agricultural Conservation Planning Framework (ACPF) was applied to identify critical source areas (runoff risk) in agricultural fields. Existing and potential future water quality loads in the watersheds were estimated using the Pollutant Load Estimation Tool (PLET). Load reductions were modeled using established conservation practice efficiencies. The efficiencies of combined practices were calculated using PLET's Best Management Practice (BMP) Calculator. Although PLET does not model bacteria, it is assumed that simulated nutrient and sediment load reductions would result in comparable decreases in bacteria loads from agricultural sources in each drainage area.

The ultimate goal is to reduce pollutant loading from agricultural sources and meet designated criteria for Class AA surface waters in the watershed (RIDEM 2020). In order to meet this goal, NRCS' focus will be to increase the participation rate and to increase the level of conservation towards water quality within the watershed.

In the first phase of this effort (2025–2030) NRCS expects to increase participation by 15%. Acreage with conservation treatment (or the level of conservation treatment) is expected to increase by 10%, while the number of conservation practices applied is expected to increase by 15% during the first phase of this effort. Each year of the first phase will include a programmatic review of the data to allow for adjustments for outreach and treatments.

Assessment of NRCS' Ability to Help Partners Reach the Watershed Goals

NRCS in Rhode Island has many partners in the watershed starting with the farmers and landowners. Participation in NRCS' programs has been fairly consistent throughout the years. NRCS also has a number of partners with the local land trusts, local associations, and town, state, and other federal partners.

The Northern District staff and NRCS staff have the capacity and resources to provide effective and timely technical assistance to landowners and operators within the NWQI watersheds. The NRCS staff include the following: a District Conservationist, two (2) Soil Conservationist, and access to a Civil Engineer and Civil Engineering Technician. The Northern District staff includes four (4) Soil Conservationist. In addition, the field office staff can request assistance from state office technical specialists. Technical assistance will include outreach, conservation planning, design, layout, construction check of practices, and practice evaluation.

The NRICD staff will assist with outreach and promotion of NWQI efforts in addition to providing planning support through agreements with NRCS.

II. Watershed Characterization

This section provides an overview of the Barden Reservoir-Ponaganset River watershed and identifies associated water resource concerns. The background information is useful context for water quality assessment and watershed planning.

Location of Watershed within the Drainage Network

The Barden Reservoir-Ponaganset River watershed (HUC-12 ID: 010900040605), in Providence County, Rhode Island, is the focus of this NWQI assessment. Figure 1 displays the location of the watershed within the State of Rhode Island. The Ponaganset River flows southeasterly for approximately 7 miles into Barden Reservoir, which subsequently drains to the Scituate Reservoir (less than a half mile downstream). The watershed drains approximately 33 square miles and lies within the broader Narragansett Bay system along the northwestern part of the basin. It covers a large proportion of Providence County and includes the towns of Foster, North Foster, South Foster, Simmons Corner, Hopkins Mills, and Foster Center. Ponaganset Reservoir is located in the northern part of the HUC-12 drainage area near the headwaters.

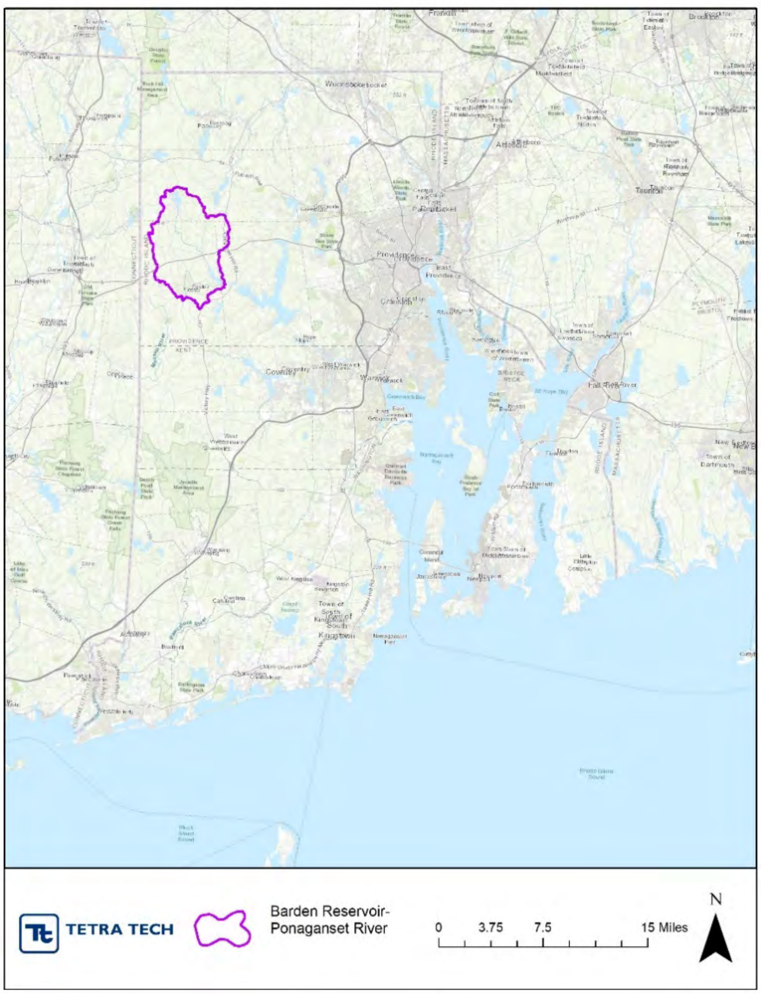

Figure 1. Location of the Barden Reservoir-Ponaganset River watershed within the state of Rhode Island.

Landscape Characteristics

A description of landscape characteristics, such as major land resource areas (MLRAs) and ecoregions, provides understanding about the watershed setting and can inform the management of water resources.

Major Land Resource Area

MLRAs are geographic areas characterized by similar soils, climate, water resources, and land uses (NRCS 2006). Rhode Island forms part of MLRA 144A New England and Eastern New York Upland, Southern Part, which covers areas of Connecticut, Rhode Island, and Massachusetts, and makes up about 6% of the total MLRA area (Figure 2). The full area covers about 18,590 square miles and consists of an eastern and western section. The Barden Reservoir-Ponaganset River area is located within the eastern section (NRCS 2006). The MLRA 144A is characterized primarily by forested areas, numerous wetlands, small areas of cropland and pasture, and abundant cranberry bogs. The forested areas include Oak-Hickory and Oak-Pine forests, which have coastal influences and are used for wood products, hunting, and other kinds of recreation. Agriculture in the area is dominated by dairy, nursery, and greenhouse stock. Forage crops for dairy cattle, truck crops, small fruits, and apples are grown on some farms, mainly near the larger towns and cities (Griffith et al. 2009).

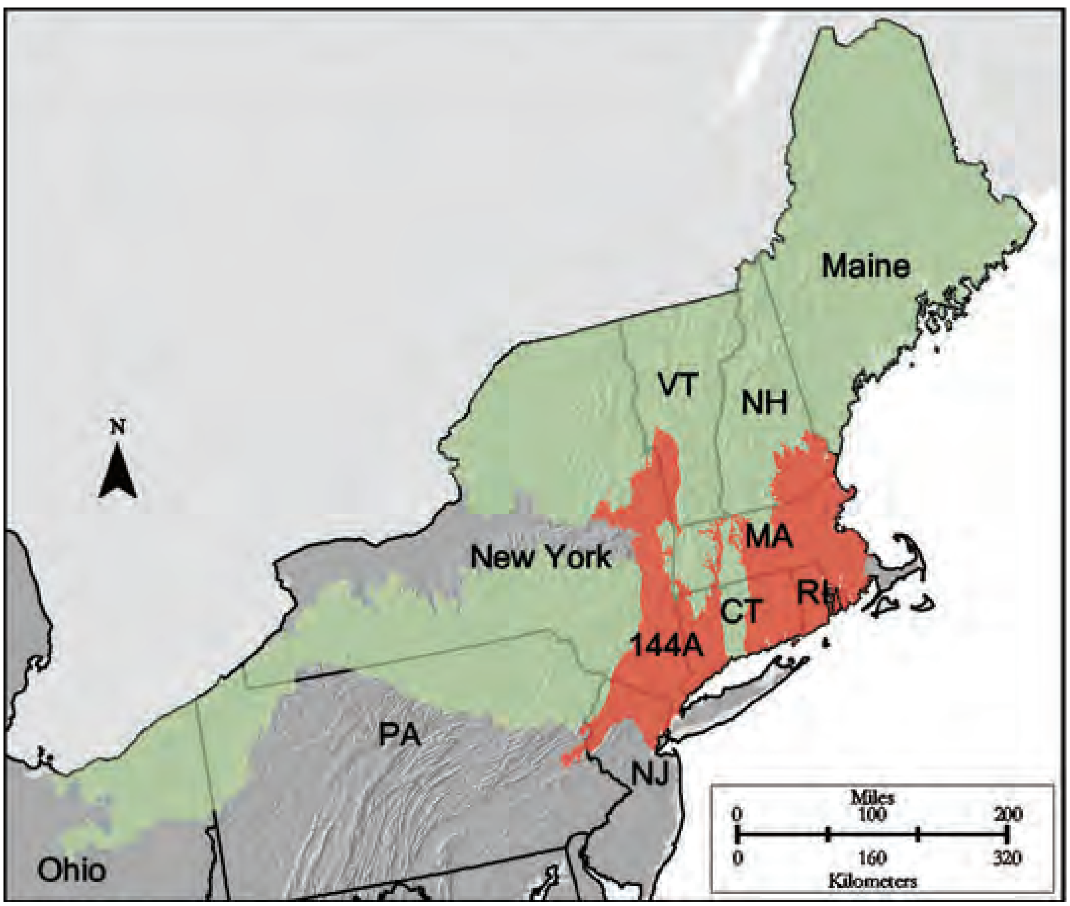

Figure 2. Location of MLRA 144A, with orange shading showing the extent of the MLRA. Green shading indicates North Lakes States Land Resource Region (NRCS 2006).

Ecoregion

Ecoregions are based on abiotic and biotic factors such as climate, geology, vegetation, wildlife, and hydrology. The mapping of ecoregions is therefore beneficial in the management of ecosystems. The Barden Reservoir-Ponaganset River watershed falls within the Southern New England Coastal Plains and Hills level IV ecoregion (Griffith et al. 2009). A map of the level IV ecoregions found within the state of Rhode Island, together with the Barden Reservoir-Ponaganset River watershed location, is shown in Figure 3. The Southern New England Coastal Plains and Hills ecoregion stretches through Connecticut, Rhode Island, and southeastern Massachusetts. The ecoregion consists of irregular plains with low hills and some open high hills and topography ranging from 100 to 400 feet. Historically, forests were dominated by a mix of oaks, hickories, American chestnut, other hardwoods, and some white pine and hemlock. These forests were cleared for agriculture and grazing or to produce charcoal. Today, a variety of dry to mesic successional oak and oak-pine forests cover the region, along with some ash, elm, and red maple (Griffith et al. 2009).

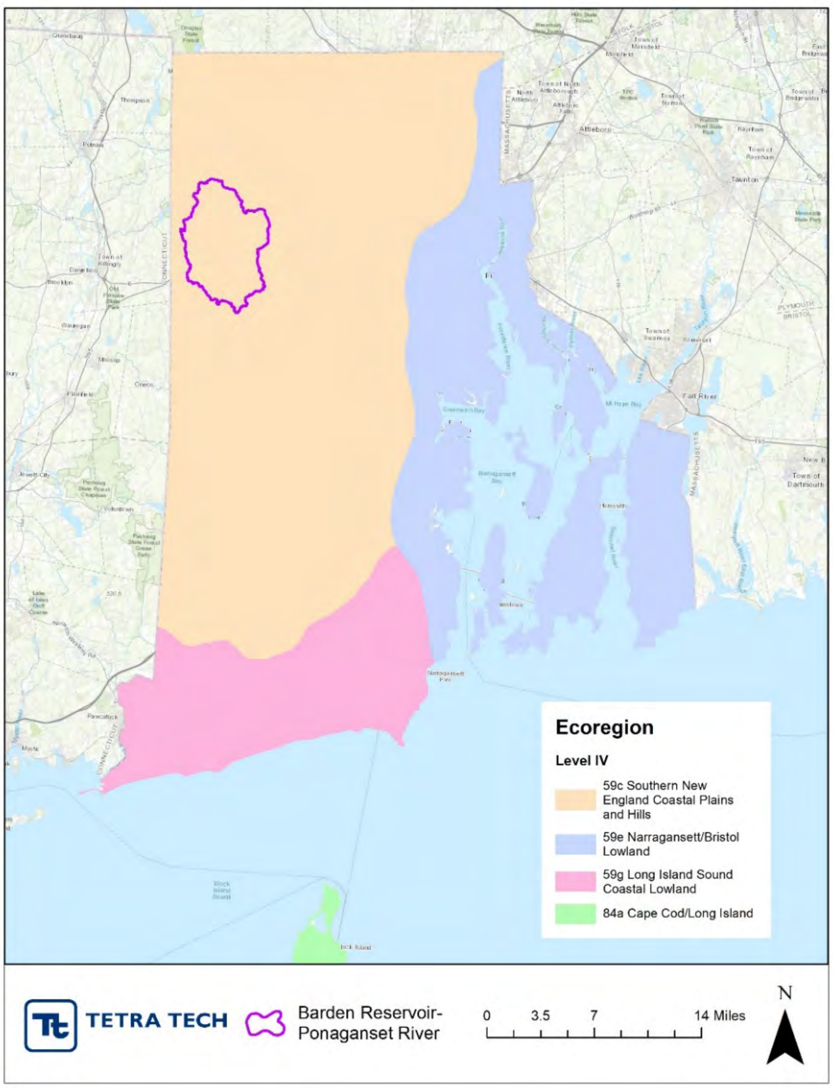

Figure 3. Location of Barden Reservoir-Ponaganset River watershed and Level IV Ecoregions of Rhode Island.

Regional Climate Overview

The climate in the region is considered humid continental with hot summers and year-round precipitation (Köppen climate classification Dfa). Precipitation near the coasts is slightly lower in the summer and slightly higher in spring and fall in inland areas. Additionally, rainfall occurs as high-intensity, convective thunderstorms during the summer. During the winter, most of the precipitation occurs as moderate-intensity storms (northeasters) that produce large amounts of rain or snow (Griffith et al. 2009; NRCS 2006). Long-term average annual precipitation ranges from about 29 to 66 inches for Providence County, Rhode Island (Figure 4), with long-term mean annual snowfall of 53.5 inches between the years of 1975 and 2019 (Spaetzel and Smith 2022). Annual precipitation has increased 0.64 inches per decade since 1900 (Figure 4).

The climate is considered temperate with a mean annual temperature of 48.8 °F between 1975 and 2019 (Spaetzel and Smith 2022). Long-term average annual temperature for Providence County, Rhode Island ranges from about 45 °F to 52 °F (Figure 5). Temperatures in the region vary widely on an annual basis, with the coldest month being January (average minimum temperature of ~17 °F and average maximum temperature of ~35 °F) and the warmest month generally being July (average minimum temperature of ~60 °F and average maximum temperature of ~81 °F). The average annual temperature has increased 0.3 °F per decade over the past 100 years. The annual frost-free period for this region ranges between 145 and 240 days and averages 190 days (Griffith et al. 2009).

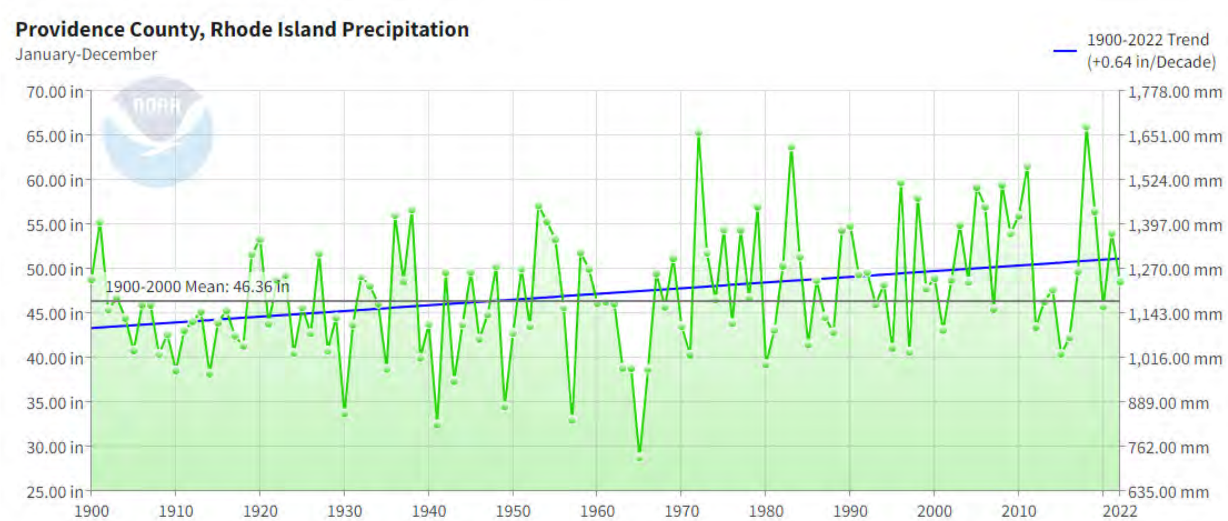

Figure 4. Average annual precipitation in Providence County, Rhode Island, 1900–2022 (NOAA 2023).

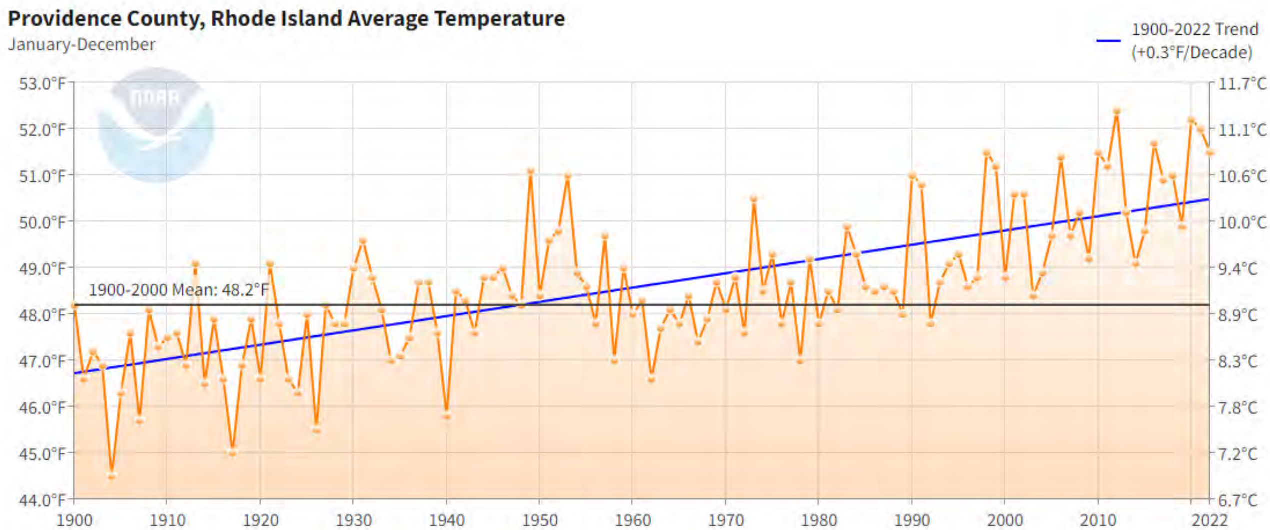

Figure 5. Average annual temperature in Providence County, Rhode Island, 1900–2022 (NOAA 2023).

Topography

The topography for the Southern New England Coastal Plains and Hills ecoregion, which comprises the northern portion of the watershed, ranges from irregular plains with low hills to elevations up to about 1,000 feet in western Connecticut. The watershed is relatively flat with an average slope of 4.4% (range is 0%–30.6%). Within the watershed, elevation ranges from about 346 feet (area around Barden Reservoir) to 810 feet at the highest elevation (northwestern portion of the watershed). Figure 6 shows the elevation changes throughout the Barden Reservoir-Ponaganset River watershed.

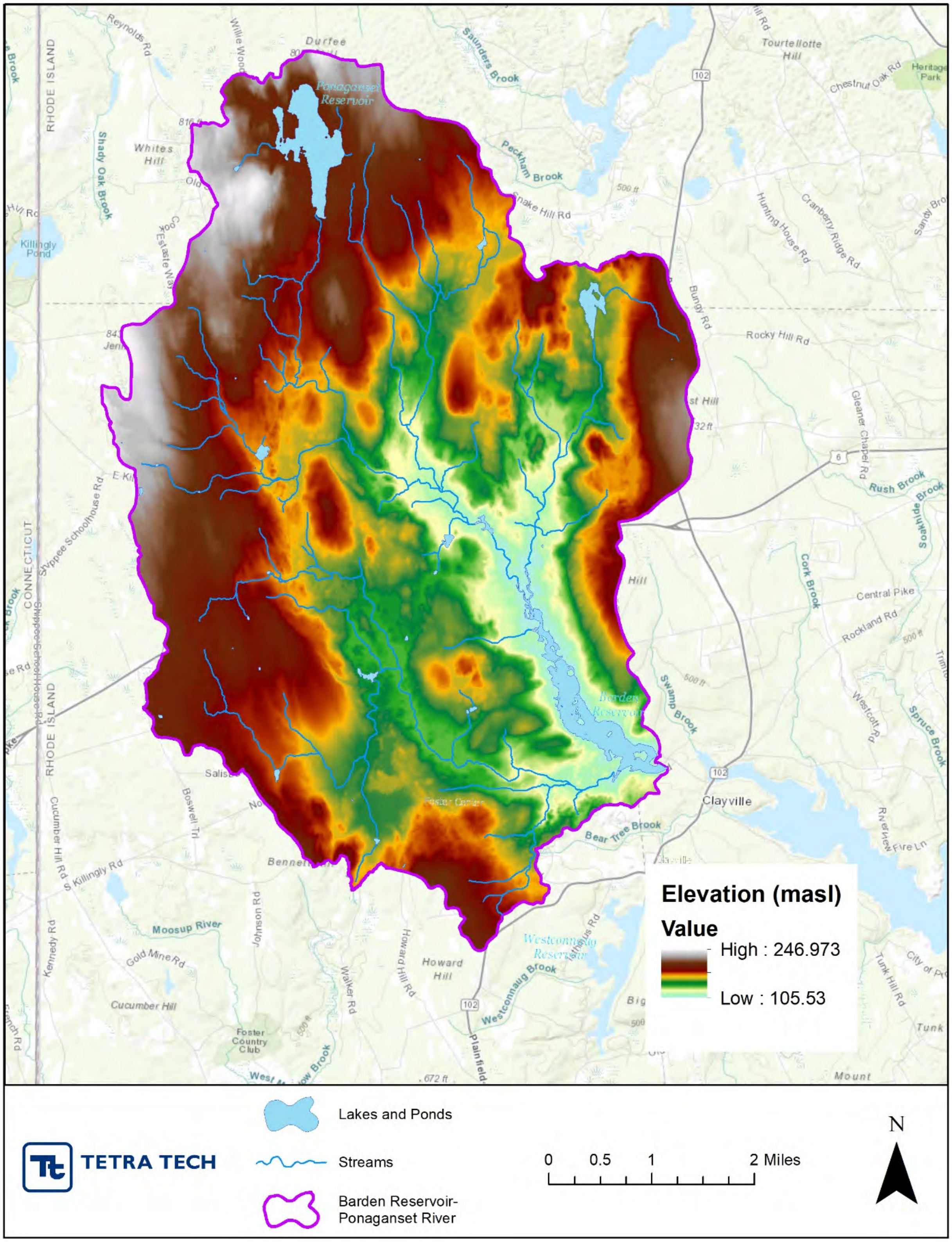

Figure 6. Elevation levels (meters above sea level [masl]) within Barden Reservoir-Ponaganset River watershed (note: 105.53–246.97 masl = 346.23 to 810.28 feet above sea level).

Geology, Geomorphology, and Soils

Geology and Geomorphology

Although bedrock outcrops are not common here, there is an extensive covering of glacial till in the area, which consists almost entirely of till plains and drumlins dissected by narrow valleys with a thin mantle of till (NRCS 2006). The bedrock in the MLRA area consists primarily of igneous and metamorphic rocks of early Paleozoic age (NRCS 2006). The different rock types that underlay the watershed are shown in Figure 7. Gneiss is the main bedrock type in the watershed, with granite, migmatite, and tonalite making up a smaller percentage.

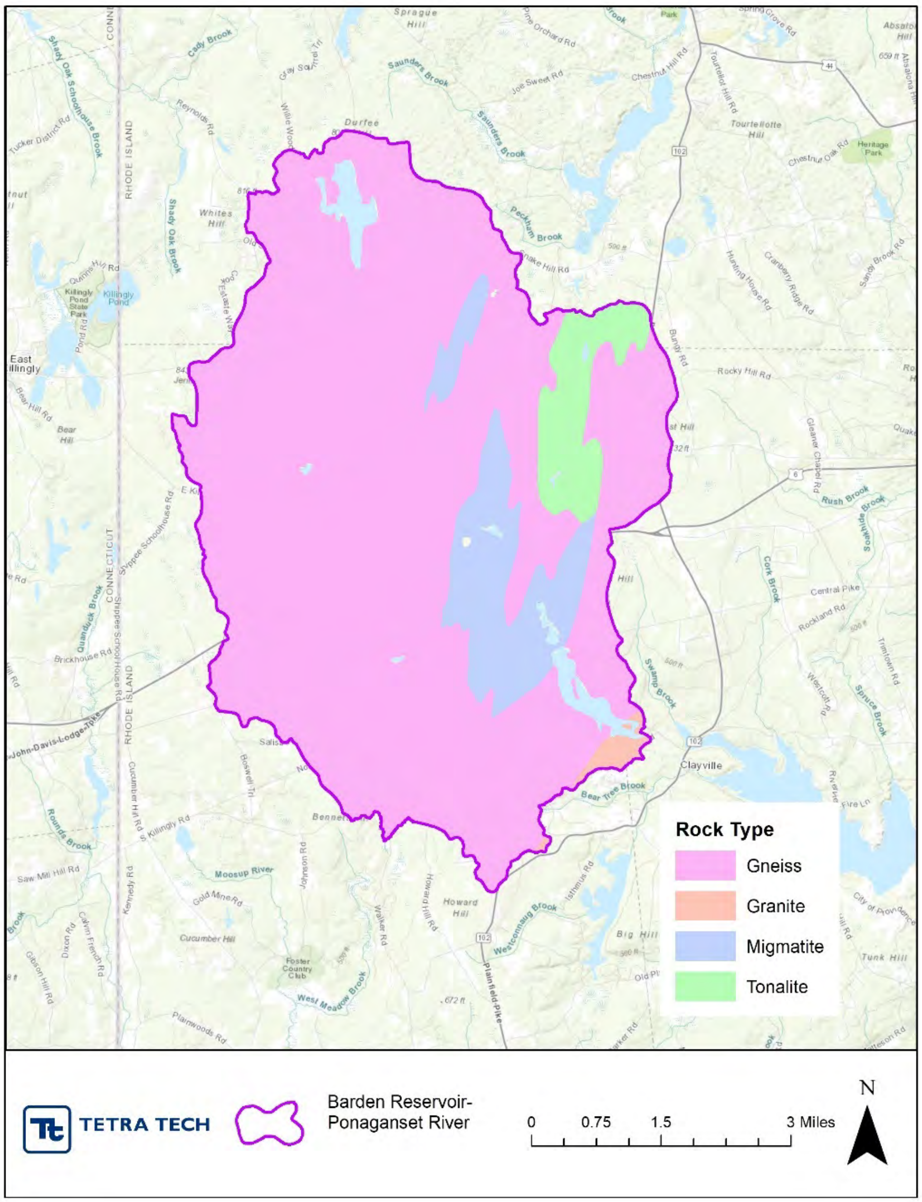

Figure 7. Location of different rock types that underlay the Barden Reservoir-Ponaganset River watershed.

Soils

Information about soil types and characteristics is important when planning management practices in a watershed. The dominant soil orders in the MLRA are Entisols, Histosols, and Inceptisols (NRCS 2006), and the dominant soils in the ecoregion where the watershed is located are coarse-loamy and sandy, mesic Histisols and Entisols (Griffith et al. 2009).

NRCS has mapped the soils in the area and classified them on the basis of slope and type. The main soil types in the watershed are Woodbridge, Ridgebury, Leicester, Whitman, and Canton and Charlton. Numerous other minor soil types are also present within the assessment area (NRCS 2023). A summary of the main soil types is provided in Table 1 (NRCS 2023).

Table 1. Summary of main soil types in the Barden Reservoir-Ponaganset River watershed (NRCS 2023)

Soil Name	Soil Type	Parent Material
Woodbridge	Fine sandy loams	Coarse-loamy lodgment till derived from gneiss, granite, and/or schist
Ridgebury	Extremely stony	Coarse-loamy lodgment till derived from gneiss, granite, and/or schist
Leicester	Extremely stony	Coarse-loamy melt-out till derived from gneiss, granite, and/or schist
Whitman	Extremely stony	Coarse-loamy lodgment till derived from gneiss, granite, and/or schist
Canton and Charlton	Fine sandy loams	Coarse-loamy over sandy melt-out till derived from gneiss, granite, and/or schist

The soil erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value the more susceptible the soil is to sheet and rill erosion by water. Within the Barden Reservoir-Ponaganset River watershed, K ranges from 0.02 to 0.64. Areas with K values between 0.3 and 0.6 make up approximately 86% of the watershed area, indicating potential for erosion. Figure 8 shows the spatial distribution of soil erodibility values within the watershed.

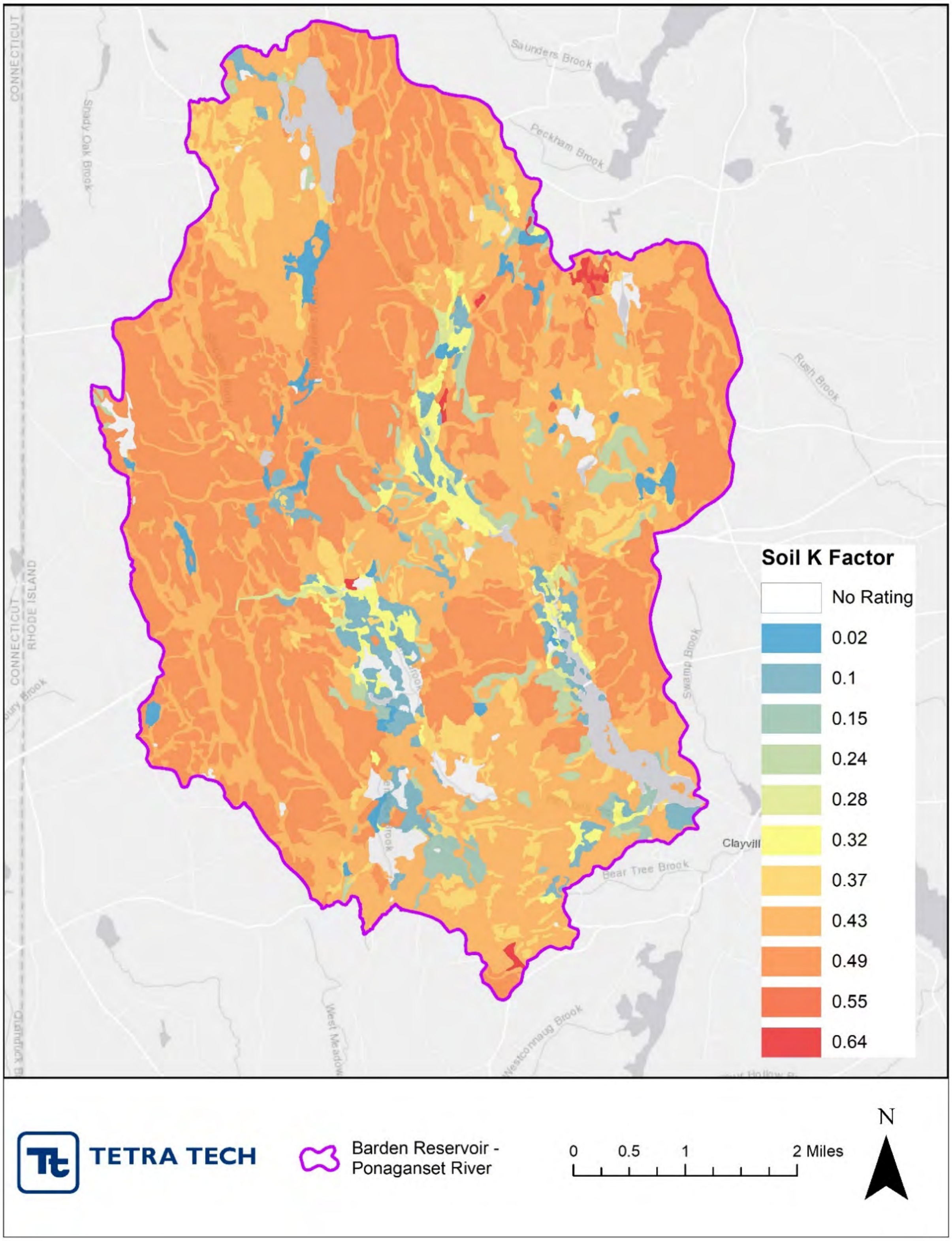

Figure 8. Soil erodibility (K-factor for whole soil) within the Barden Reservoir-Ponaganset River watershed.

Hydrologic soil groups (HSGs) are groups of soils that have similar runoff potential under similar storm and cover conditions. Groupings indicate the amount of runoff to be expected from the soil when saturated. Soils in Group A yield very little runoff because they are rapidly or very rapidly permeable and take in water at equal or faster rates than most rains fall in the area. Soils in Hydrologic Group D take water very slowly and yield large amounts of runoff. Soils in Group B and C yield less than Group D and more than Group A. Poorly drained soils are generally in Group D because the high water table prevents movement of water in the soil (USDA 2024). Figure 9 shows the spatial extent of HSGs in the Barden Reservoir-Ponaganset River watershed, while Table 2 summarizes the breakdown of HSGs. Group B (moderate infiltration) covers the largest amount of the watershed area, followed by group D (very slow infiltration) (NRCS 2023). Areas covered by dual HSGs (A/D, B/D, and C/D) are also present in the watershed, with group C/D covering approximately 30% of the watershed.

Table 2. Area and coverage of each HSG in the Barden Reservoir-Ponaganset River watershed (NRCS 2023)

Hydrologic Soil Group Type	**Coverage (%)[a]**
A - High Infiltration	6
A/D - High/Very Slow Infiltration	< 1
B - Moderate Infiltration	24
B/D - Medium/Very Slow Infiltration	11
C - Slow Infiltration	10
C/D - Medium/Very Slow Infiltration	30
D - Very Slow Infiltration	19
Total	100

Note:
[a] Numbers were rounded to the nearest whole number

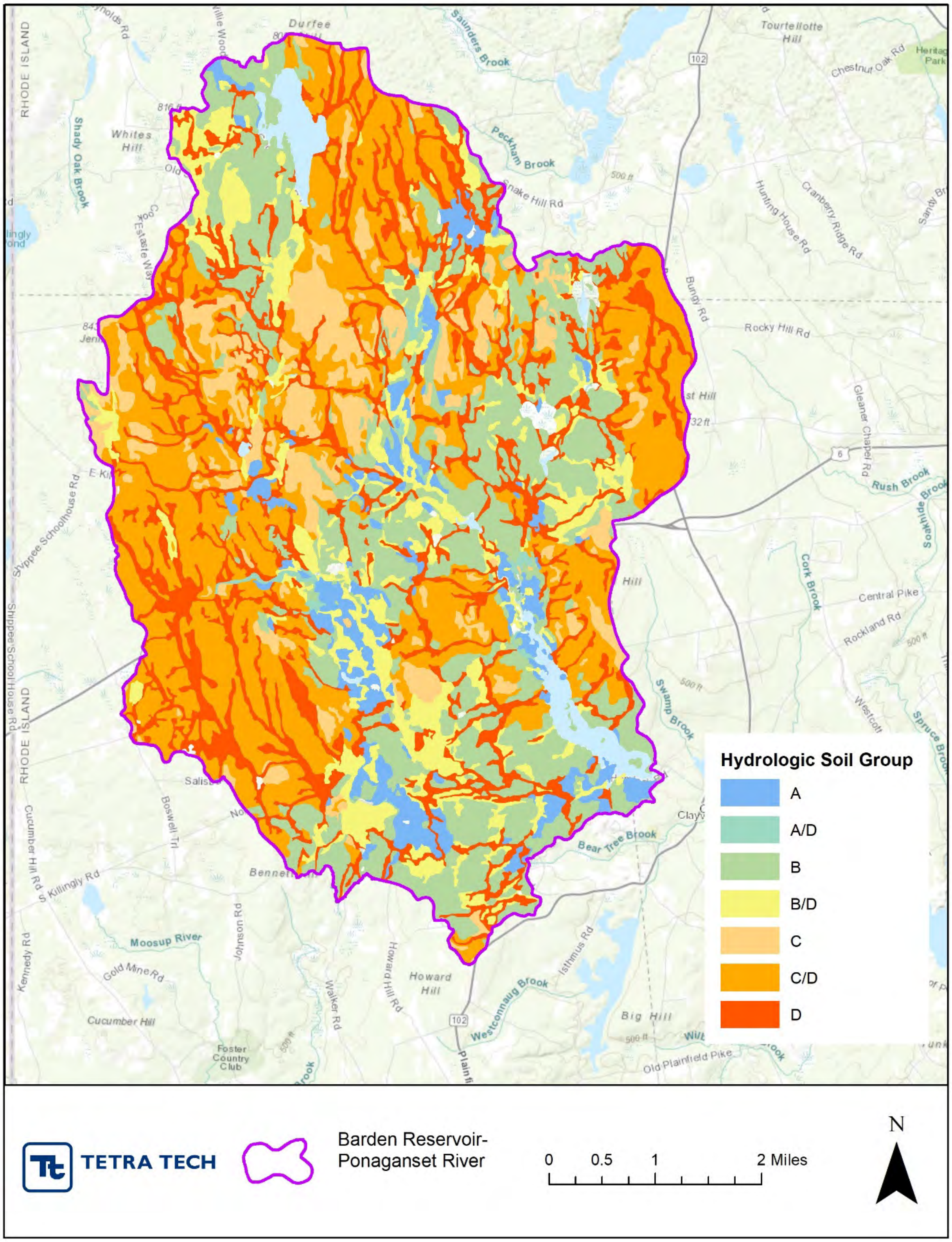

Figure 9. Map of HSGs in the Barden Reservoir-Ponaganset River watershed.

Drainage classes represent the moisture condition of the soil and how frequently the soil is saturated or not throughout the year. The majority of the watershed is considered to be “moderately well drained” based on SSURGO drainage classifications. The locations of various soil drainage classes within the watershed are shown in Figure 10.

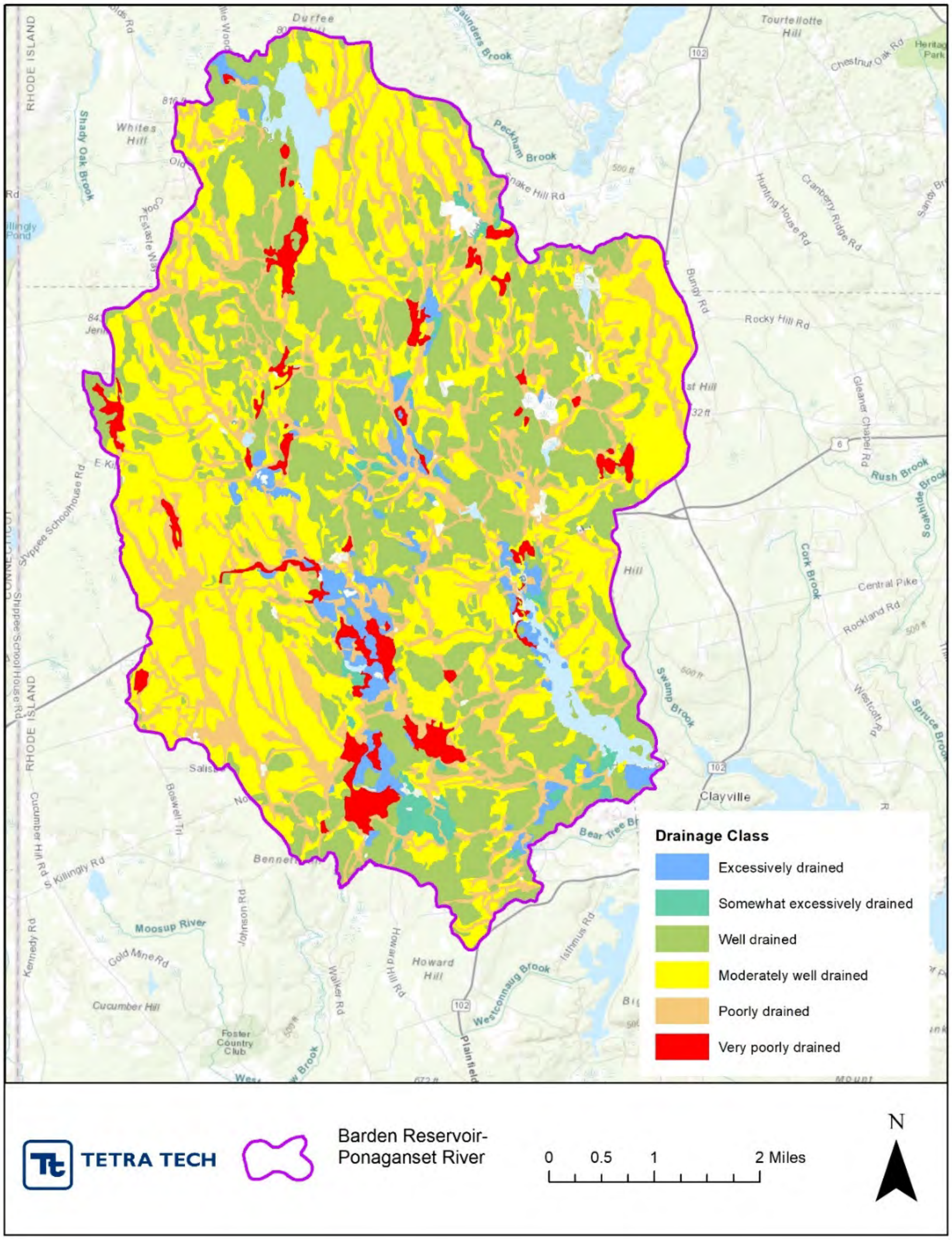

Figure 10. Spatial distribution of soil drainage classes within the Barden Reservoir-Ponaganset River watershed.

Drainage Network

The full watershed area is designated as a surface water protection area, which are drainage areas contributing to drinking water supply reservoirs serving public water systems in Rhode Island. The stream network and locations of impoundments within the Barden Reservoir-Ponaganset River watershed are displayed in Figure 11. The watershed consists of a complex network of tributaries, wetlands, and smaller ponds with associated rivers and brooks, all of which drain to Barden Reservoir. Shippee Brook and Winsor Brook drain to Ponaganset River (which flows into Barden Reservoir). Hemlock Brook and Dolly Cole Brook discharge directly to Barden Reservoir. The stream network consists of approximately 51 stream miles—about 0.1 miles are estimated to intersect agricultural areas. Streams are mainly first and second order ([NHDPlus Version 2](#)). Reservoirs and ponds in the watershed include Ponaganset Reservoir, Brush Meadow Pond, Shippee Saw Mill Pond, Spear Pond, Hopkins Mill Pond, and Barden Reservoir.

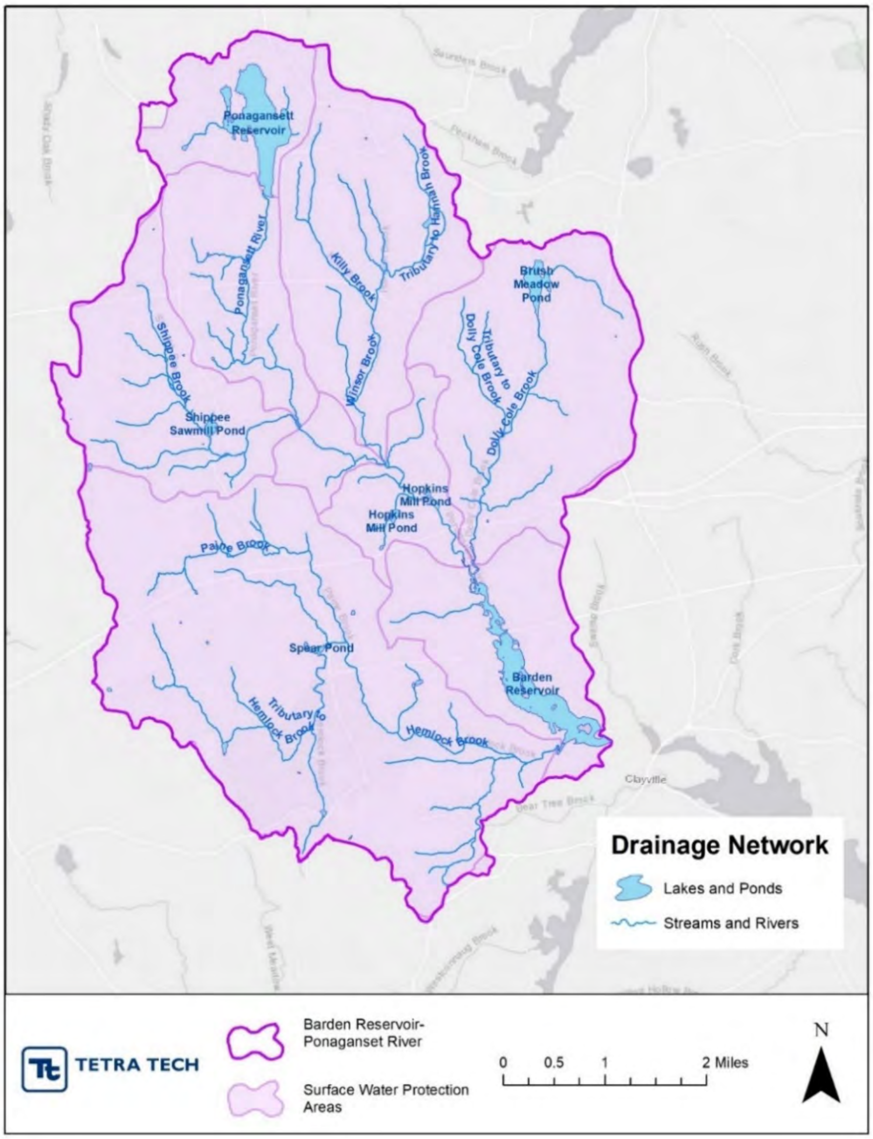

Figure 11. Rivers, streams, and other waterbodies within the Barden Reservoir-Ponaganset River watershed.

About 13% of the Barden Reservoir-Ponaganset River watershed contains wetland areas. Wetland areas are mainly freshwater forested/shrub wetlands with some areas of freshwater emergent wetlands present (USFWS 2018). The locations of wetland areas with the watershed extent are displayed in Figure 12.

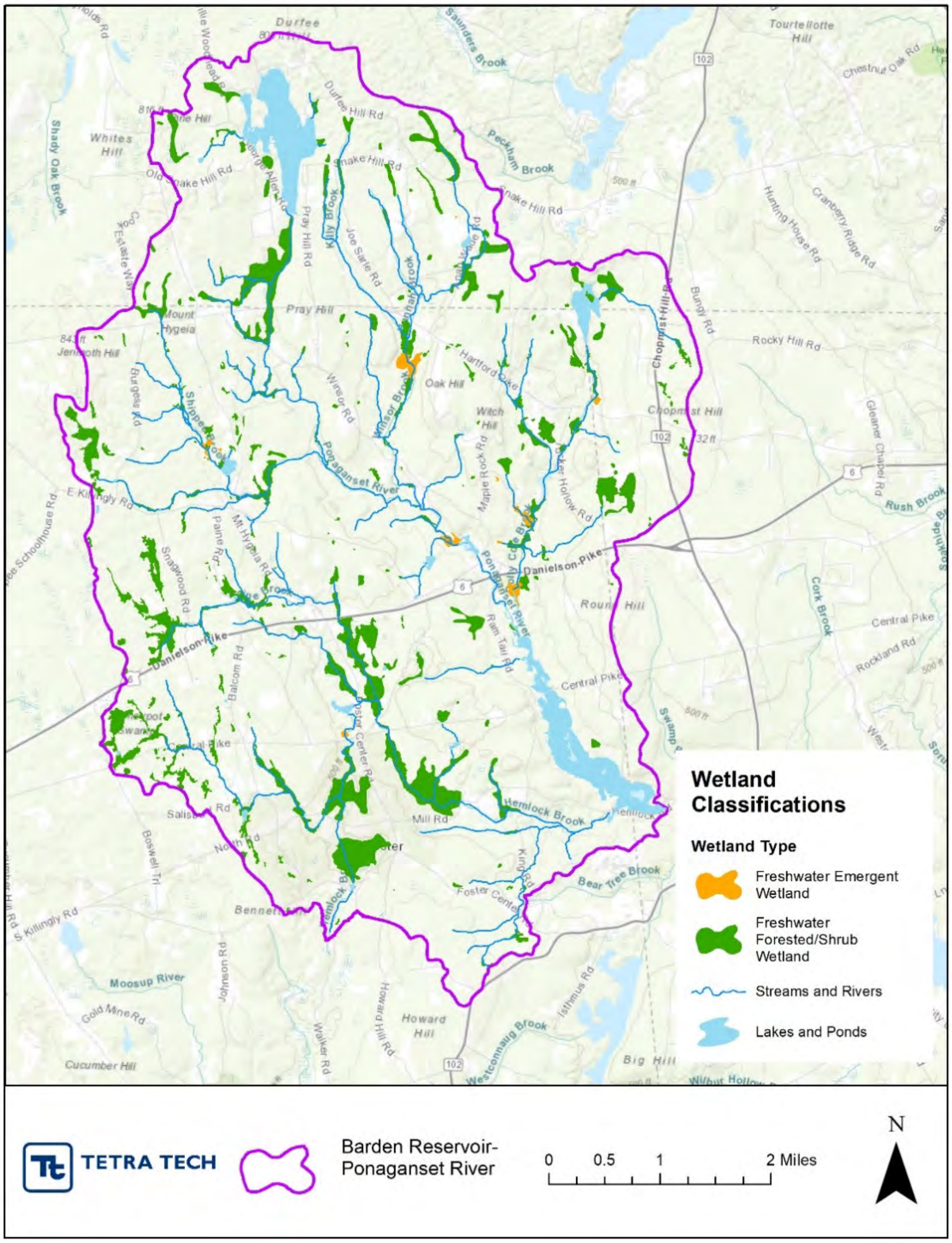

Figure 12. Locations of wetland within the drainage area (USFWS 2018).

Land Use and Land Cover

The spatial distribution of different land cover within the Barden Reservoir-Ponaganset River watershed is displayed in Figure 13. Land cover types were determined using the USDA NASS 2023 Cropland Data Layer (CDL; USDA NASS 2023). Table 3 provides a breakdown of land uses in the watershed. Forested land (~87% of the overall area) covers the majority of the Barden Reservoir-Ponaganset River watershed. Developed land accounts for approximately 8% of the drainage area. Forest land is forecasted to continue to drop in future years to be converted to developed land such as commercial land and low-density residential development (Bellet et al. 2003).

Table 3. Area and coverage of land use types in the Barden Reservoir-Ponaganset River watershed (USDA NASS 2023)

Land Use Type	Acreage (Acres)	Coverage (%)
Cropland	48.6	0.23
Forest	18,378.4	87.27
Pastureland	388.3	1.84
Urban	1,714.5	8.14
Water	529.5	2.52
Total	21,059.3	100%

Agricultural land only accounts for approximately 2% of the watershed area (USDA NASS 2023). The main agricultural land cover categories are other hay/non alfalfa (1% of drainage area), grass/pasture (<1% of drainage area), and corn (<1% of drainage area) (see Figure 13). Around 3% of the drainage area is classified as "prime farmland" and approximately 5% is considered farmland of statewide importance—the remaining 92% is considered to be "not prime farmland" (see Figure 14). Note, Appendix A shows land cover types determined using the 2019 National Land Cover Database (NLCD).

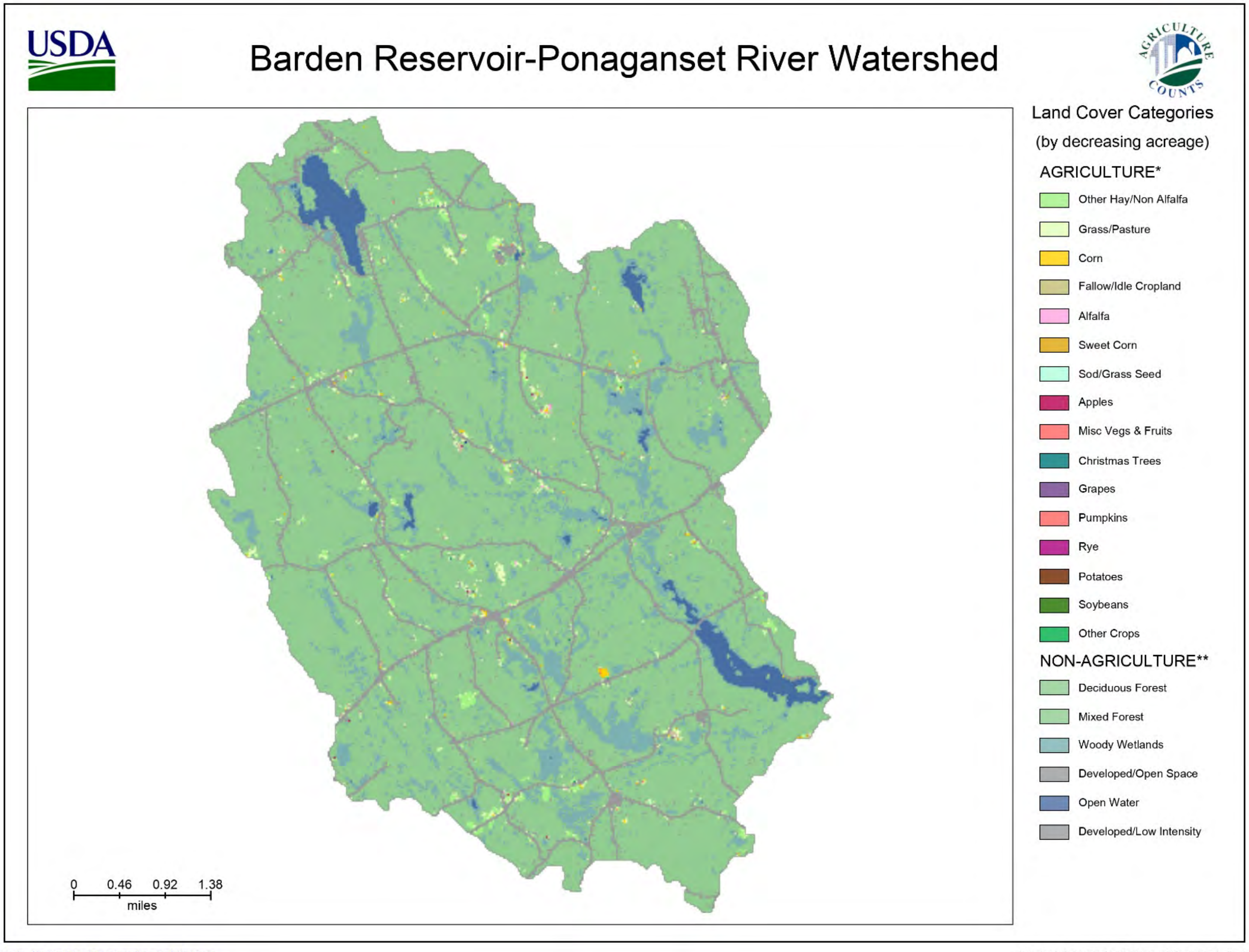

*Figure 13. Agricultural land cover distribution across the assessment area (USDA NASS 2023). Legend shows the top 13 agricultural categories; *Denotes the top 6 non-agriculture categories.*

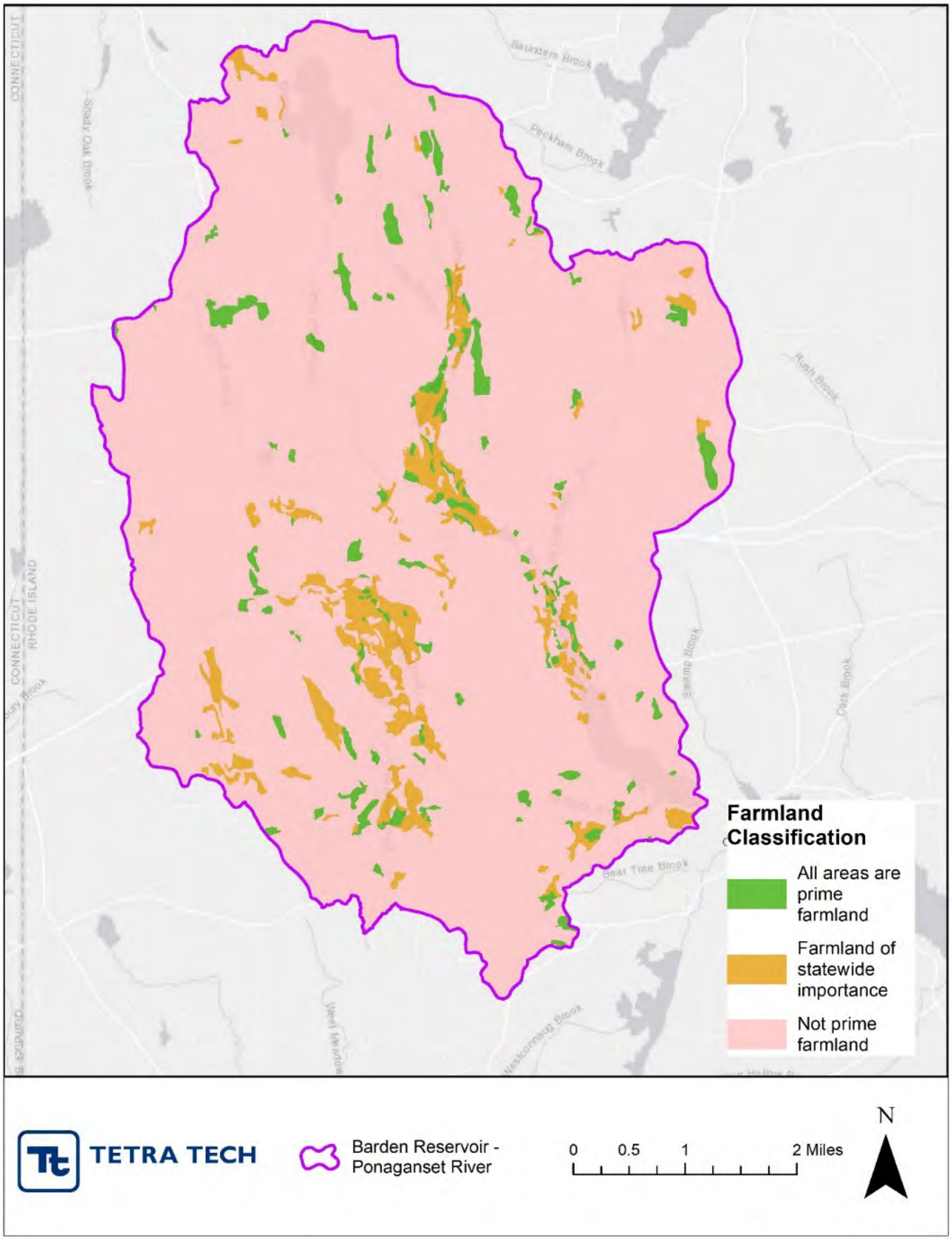

Figure 14. Location of various farmland classes within the Barden Reservoir-Ponaganset River watershed.

Socioeconomic Conditions

The Barden Reservoir-Ponaganset River is in Providence County, Rhode Island and the towns of Foster, North Foster, South Foster, Simmons Corner, Hopkins Mills, and Foster Center. County subdivisions and populated places are shown in Figure 15. A summary of population data for Providence County can be found in Table 4. Based on the 2020 U.S. Census, the population of Providence County is approximately 660,741. The population is expected to remain similar in upcoming years. The median household income in Providence County was $72,579 and 86.3% of the population attained a high school education or higher and 31.2% of the population attained a bachelor's degree or higher. The main industries in the county are health care and social assistance, retail trade, and manufacturing (Deloitte and Datawheel 2021; U.S. Census Bureau 2020).

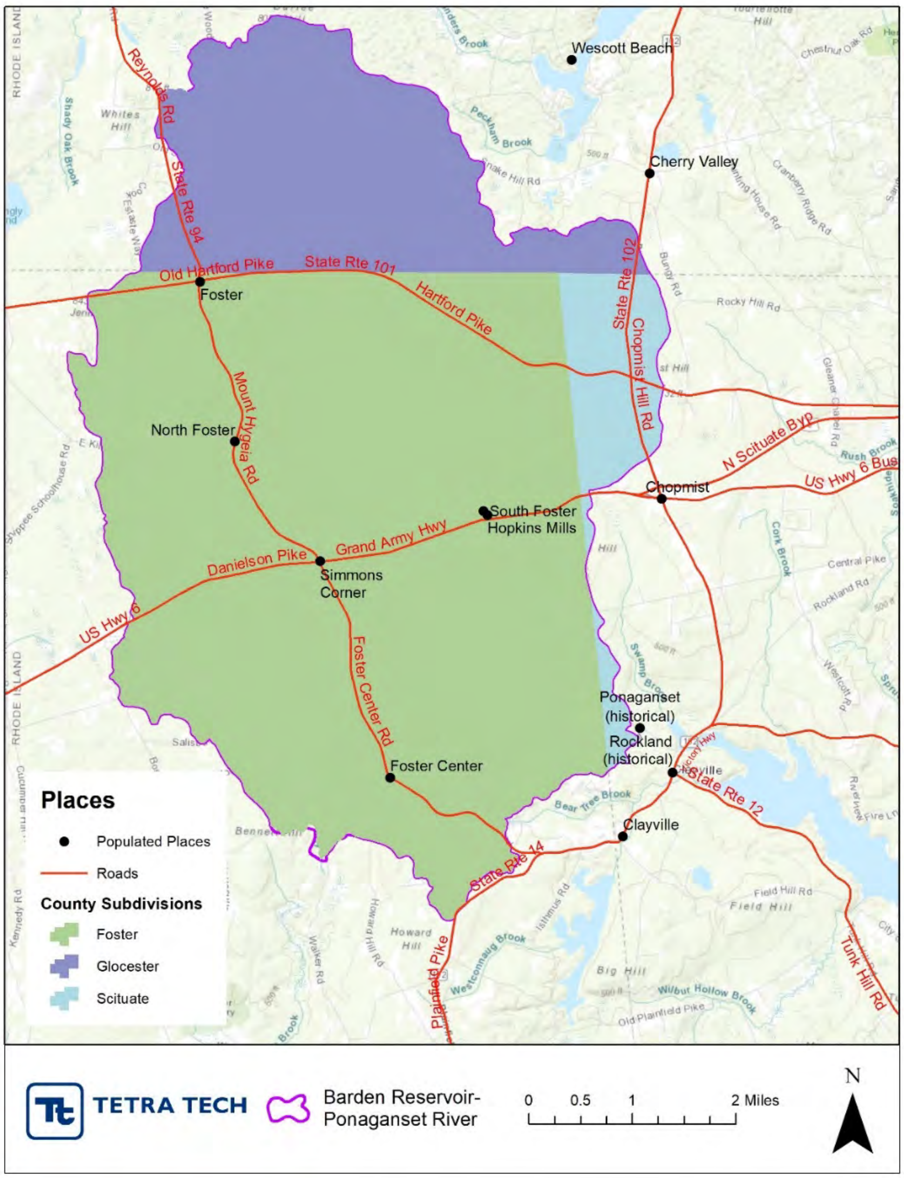

Figure 15. Town boundaries and populated places within the Barden Reservoir-Ponaganset River watershed (U.S. Census Bureau 2020).

Table 4. Population data for the Barden Reservoir-Ponaganset River watershed jurisdictions from the U.S. 2020 Census

	Rhode Island	Providence County
Total Population	1,097,379	660,741
Total Households	432,219	253,635
Median Household Income	$81,370	$72,579
Education Attainment: High School Graduate or Higher	89.4%	86.3%
Education Attainment: Bachelor's Degree or Higher	36.3%	31.2%

The 2017 USDA Agriculture Census indicates that there are 377 farms in Providence County that operate over approximately 16,328 acres. The average size of farm within the county is 43 acres, with the majority of farms ranging from 1–9 acres in size (USDA NASS 2017).

The total market value of products sold from these farms was $12,432,000 in 2017, with an average of $32,977 of market value of products sold per farm. Crops make up the majority of sales at 73% and livestock and poultry products account for the remaining 27% of sales. Providence County agricultural sales account for 21% of sales for the state of Rhode Island (USDA NASS 2017).

Out of the crops produced, forage occupies the most acreage, followed by vegetables, cultivated Christmas trees, and apples. The highest sales come from vegetable and nursery products. Cattle and calves, hogs and pigs, and horses and ponies are the main livestock raised (USDA NASS 2017).

III. Hydrologic and Water Quality Characterization

This section describes the hydrology and water quality conditions within the Barden Reservoir-Ponaganset River watershed. The objective is to demonstrate the transport mechanisms for pollutants of concern, and the spatial and temporal characteristics of transport. A summary of available information resources compiled for the watershed is also provided.

Available Data and Resources

TMDLs and Management Plans/Report

Table 5 summarizes available plans and reports within the Barden Reservoir-Ponaganset River watershed. A statewide bacteria TMDL was completed in 2011 for impaired waters and was updated in 2014. As part of the process, Rhode Island Department of Environmental Management (RIDEM) also created summary reports for bacteria impaired waterbody segments across the state and included separate summaries for the Winsor Brook assessment unit (RI0006015R-30), a 3.5-mile long stream in the watershed.

Numerous reports are available the Scituate Reservoir watershed which includes the Barden Reservoir-Ponaganset River. The reports have been developed by organizations such as USGS, PWSB, NRICD, the University of Rhode Island, and the Rhode Island Department of Health. Topics covered include watershed stewardship, water quality assessment, and source water assessment.

Data and Other Resources

Table 6 summarizes the available data and other resources within the watershed. A brief description of available data and resources is provided below.

Hydrological Data: Within the watershed, continuous daily streamflow discharge has been measured at three USGS sites (USGS 1115187, USGS 1115190, and USGS 1115265) in the Barden Reservoir-Ponaganset River. The gaged site on Ponaganset River at South Foster (USGS 1115187) provides long term historical observations of discharge from 1994 to present. Sites on Dolly Cole Brook (USGS 1115190) and Hemlock Brook (USGS 1115265) provide discharge measurements from 2009 to present.

Winsor Brook (USGS 0115185) also provides a partial discharge record (2020–current; not included in this report). Older flow measurements for a discontinued USGS sites are also available for Shippee Brook but were not included in the compilation for this report. USGS has also sampled groundwater depth intermittently at numerous wells in the watershed.

Water Quality Data: A comprehensive database of water quality data is available from USGS and PWSB for stream locations within the HUC-12 watershed area. Monthly water quality measurements for over 10 years are available at most monitoring locations. Parameters measured include nutrients (nitrogen species and phosphorus species), bacteria, turbidity, chloride, pH, and other conventional parameters. Seven sites (listed in Table 6) provide instantaneous water quality data. USGS has also intermittently sampled some sites for groundwater quality within the watershed.

Biological Assessment Data: No information was found about biological community assessments (e.g., fish, macroinvertebrates) within the watershed.

Other Data: Historical climate data are available for the National Oceanic and Atmospheric Administration (NOAA) North Foster 1 E, Rhode Island climate station, located in the center of the watershed.

Reports

Table 5. Compilation of available reports used to characterize hydrology and water quality conditions in the watershed

Title	Year Published	Author(s)	Type of Resource	Description
State of Rhode Island 2022 Impaired Waters Report	2021	RIDEM	Impaired Waters Report	This report includes a complete list of all impaired waterbodies in Rhode Island.
State of Rhode Island 2018-2020 Impaired Waters Report	2021	RIDEM	Impaired Waters Report	This report includes a complete list of all impaired waterbodies in Rhode Island.
Rhode Island Statewide Total Maximum Daily Load (TMDL) for Bacteria Impaired Waters	2011	RIDEM	TMDL Report	This statewide TMDL provides a framework to address bacterial pollution by establishing the allowable bacterial contributions for Rhode Island's surface waters, providing documentation of impairment, and specifying the pollutant reductions needed to meet water quality standards.
Updates to the Rhode Island Statewide Total Maximum Daily Load (TMDL) for Bacteria Impaired Waters	2014	RIDEM	TMDL Report	Provides TMDL updates for six bacteria impaired waterbodies on the 2012 303(d) list with the goal of providing guidance to attaining water quality standards in each waterbody.
Winsor Brook Bacteria TMDL	2011	RIDEM	TMDL Report	Waterbody summary TMDL report from the Rhode Island Statewide Bacteria TMDL.
Development of an Index of Biotic Integrity for Macroinvertebrates in Freshwater Low Gradient Wadeable Streams in Southeast New England Final Report	2021	Tetra Tech, New England Interstate Water Pollution Control Commission, and Restore America's Estuaries Southeast New England Program	Report	Report describing the development of a statewide low gradient multihabitat index of biotic integrity for Massachusetts. The index calibration dataset included data from 178 sites, some of which were located in Rhode Island.

Title	Year Published	Author(s)	Type of Resource	Description
Scituate Reservoir - Forest Stewardship Plan	2012	PWSB	Report	This forest management plan is intended to set forth management goals, objectives, and strategies and to guide Providence Water's Water Resources Division in managing approximately 12,500 acres of public watershed forestland surrounding the Scituate Reservoir and its smaller tributary reservoirs.
Scituate Reservoir Watershed Management Plan	1990	Rhode Island Division of Planning	Report	The plan establishes state policy to ensure the long-term water quality protection of the Scituate Reservoir and its tributaries, in addition to groundwater.
The Scituate Reservoir	NA	Jane Bamberg	Presentation	Background information on the Reservoir.
The Healthy Farm, Healthy Watershed Program	NA	NRCID	Fact Sheet	Outlines issues for water resources from agriculture in the Scituate Reservoir drainage area.
Providence Water Annual Water Quality Reports	2010–2022	PWSB	Reports	Annual Water Quality Report which includes some basic information on source of supply, levels of any detected contaminants, and some general educational material.
The Scituate Reservoir Source Water Assessment	2003	Rhode Island Department of Health and PWSB	Report	The assessment provides a consistent framework for identifying and ranking threats to all Rhode Island public water supplies.
The Scituate Reservoir Drinking Water Assessment Results	2003	Rhode Island Department of Health and University of Rhode Island	Fact Sheet	Fact sheet summarizing results of a source water assessment conducted for the PWSB.
USGS Water Quality and Hydrology Reports	2002–2023	USGS: New England Water Science Center	Reports and Data	Long-term cooperative program to monitor streamflow and water quality within the Scituate Reservoir drainage area. USGS, in cooperation with the PWSB, collected streamflow and water-quality data at the Scituate Reservoir and tributaries.

Data

Table 6. Compilation of available data used to characterize hydrology and water quality conditions in the watershed

Title	Year(s) of Data	Description	Available Data Parameters	Monitoring Frequency
USGS 011151843: Ponaganset reservoir outlet, RI	2023	Water quality data collected by USGS and PWSB	Water quality: nutrients, sediment, and conventional parameters	Monthly (water quality)
USGS 011151843: Unnamed tr to Ponaganset R nr N Foster, RI	1994	Water quality data collected by USGS and PWSB.	Water quality: nutrients, sediment, and conventional parameters	Monthly (water quality)
USGS-01115200 Shippee Brook tributary at North Foster, RI	1966–1974 and 1994–2023	Streamflow (partial) and water quality data collected by USGS and PWSB.	Streamflow Water quality: nutrients, sediment, conventional parameters	Monthly (streamflow) Monthly (water quality)
USGS 01115185 Winsor Brook at Winsor rd near south foster, RI	2020–2024	Streamflow and water quality data collected by USGS and PWSB.	Streamflow Water quality: nutrients, metals, conventional parameters	Daily (streamflow) Monthly (water quality)
USGS 01115187 Ponaganset River at South Foster, RI	1994–2024	Streamflow and water quality data collected by USGS and PWSB.	Streamflow Water quality: nutrients, metals, conventional parameters	Daily (streamflow) Monthly (water quality)
USGS 01115190 Dolly Cole Bk at Old Danielson Pk at S Foster, RI	2008–2024	Streamflow and water quality data collected by USGS and PWSB.	Streamflow Water quality: nutrients, metals, conventional parameters	Daily (streamflow) Monthly (water quality)
USGS 01115265 Hemlock Brook at King road nr Foster, RI	2008–2024	Streamflow and water quality data collected by USGS and PWSB.	Streamflow Water quality: nutrients, metals, conventional parameters	Daily (streamflow) Monthly (water quality)
USGS StreamStats Tool	2024	USGS web-based geographic information systems application that provides access to additional flow statistics and estimates and previously published information for USGS.	Various stream flow statistics, groundwater recharge statistics	Daily, monthly

Title	Year(s) of Data	Description	Available Data Parameters	Monitoring Frequency
Base-flow index grid for the conterminous United States	2014	This 1-kilometer raster (grid) dataset for the conterminous United States was created by interpolating base-flow index (BFI) values estimated at USGS stream gages; base flow is the component of streamflow that can be attributed to groundwater discharge into streams.	Baseflow indices	N/A
Water Balance (estimated)	1960–1990	The Model My watershed model simulates 30 years of daily water fluxes using the Generalized watershed Loading Function Enhanced (GWLF-E) model that was developed for the MapShed desktop modeling application.	Average monthly water fluxes: stream flow, surface runoff, subsurface flow, evapotranspiration, precipitation	Daily
North Foster 1 E, RI climate station data	1981–2010	Climate data collected from the North Foster 1 E, RI climate station, located within the watershed.	Average precipitation, average minimum temperature, average mean temperature, average maximum temperature	Daily

Runoff and Streamflow Hydrology

Overview

Runoff and streamflow vary naturally in response to changes in the rate and timing of water inputs to a watershed (e.g., precipitation), water outputs from a watershed (e.g., evapotranspiration), and changes in watershed storage (e.g., groundwater, snow, ice). Other factors like soils, land use, and human activity also impact runoff and hydrology. Runoff and streamflow are the principal drivers of changes in water quality. The soils, geology, and hydrology of the watershed indicate that infiltration, upland recharge, and local discharge of shallow subsurface flow are important in the maintenance of stream baseflow. The section summarizes the climate and hydrologic regime in the watershed using available data and modeling tools.

Methods Used in the Analysis

Available data were used to characterize hydrology when measured data were not available—the following information was considered:

- The *Model My Watershed* application was applied to simulate the precipitation-runoff budget for the area.
- Flow observations from USGS sites 01115187, 01115190, and 01115265 were used to characterize streamflow in the watershed.
- USGS flow estimations were used to assess the baseflow contributions and calculate a variety of other flow metrics for the location.
- The USGS StreamStats tool was used to estimate low flow and peak flow statistics.
- NOAA National Weather Climate data from the North Foster 1 E, Rhode Island station was used to assess climate conditions within the watershed.

Climate Data

The NOAA station at North Foster 1 E, Rhode Island, located in the center of the watershed (GHCND:USC00375270; latitude/longitude: 41.8564°, -71.7333°; elevation: 630 ft), provides long-term data on climate. Table 7 summarizes temperature and precipitation data for the 1981–2010 climate period at the station (data from NOAA's Data Tools: 1981-2010 Normals). The mean monthly temperature for January was 25.5 °F and 70.1 °F for July. Monthly air temperatures range from about 17.2–33.8 °F (average minimum to average maximum) in January to 60.4–79.7 °F (average minimum to average maximum) in July (Table 7).

The average annual precipitation for this period was 48.4 inches. Average monthly precipitation ranges from 3.82–5.45 inches. Precipitation is evenly distributed throughout the year, with precipitation slightly higher in the spring and fall and occurring as high-intensity thunderstorms during the summer (NRCS 2006). Most precipitation during the winter occurs as moderate-intensity storms, or northeasters, that produce large amounts of rain or snow (NRCS 2006).

Table 7. Average temperature and precipitation measurements from North Foster 1 E, RI climate station, 1981–2010

Month	Average Precipitation (inches)	Average Minimum Temperature (°F)	Average Mean Temperature (°F)	Average Maximum Temperature (°F)
January	4.28	17.2	25.5	33.8
February	3.96	19.8	28.6	37.5
March	5.45	26.5	36.1	45.7
April	4.7	36.3	46.7	57.2

Month	Average Precipitation (inches)	Average Minimum Temperature (°F)	Average Mean Temperature (°F)	Average Maximum Temperature (°F)
May	3.92	45.6	56.5	67.3
June	4.58	55	65.1	75.2
July	3.82	60.4	70.1	79.7
August	4.33	59.3	68.8	78.2
September	4.09	51.7	61.3	71
October	4.77	40.7	50.5	60.2
November	4.96	32.4	41	49.5
December	4.84	22.7	30.6	38.5
Summary	53.7 (total)	39 (mean)	48.4 (mean)	57.8 (mean)

Precipitation-Runoff Budget

The water balance for the watershed was generated using the Model My Watershed application (30 years of daily water balance) and shows how much of the annual average precipitation that falls on the watershed leaves as streamflow and evapotranspiration. It also indicates the proportion of streamflow provided by surface runoff and subsurface flow. The model is informed by estimates of average daily precipitation and temperature data (source for initial data input is average daily from 1961–1990 provided from the U.S. Environmental Protection Agency (EPA)). The model utilizes the nearest two weather stations (Providence, RI and Worcester, MA) to calculate an average daily value prior to feeding into the model.

Table 8 summarizes the estimated average annual and average monthly water flux. Of the approximately 47 inches of average annual precipitation falling on the watershed, 21.8 inches (46.6%) leaves as streamflow (5.3 inches surface runoff, 16.5 inches groundwater discharge), and 24.8 inches (53.1%) leaves as evapotranspiration.

Table 8. Average monthly water fluxes (units in inches) from 30-years of daily water balance (simulated by GWLF-E MapShed Model) for the watershed

Month	Stream Flow (in.)	Surface Runoff (in.)	Subsurface Flow (in.)	Evapotranspiration (in.)	Precipitation (in.)
January	**2.9**	0.9	2.0	**0.2**	**3.8**
February	**3.0**	0.9	2.2	**0.2**	**3.5**
March	**3.8**	0.9	2.9	**0.8**	**4.0**
April	**3.2**	0.4	2.8	**1.9**	**4.0**
May	**2.0**	0.1	1.9	**3.8**	**4.1**
June	**1.3**	0.2	1.1	**5.1**	**3.6**
July	**0.6**	0.1	0.5	**4.0**	**3.5**
August	**0.4**	0.2	0.2	**3.3**	**3.7**
September	**0.3**	0.2	0.1	**2.7**	**3.8**
October	**0.7**	0.4	0.3	**1.8**	**4.0**
November	**1.3**	0.4	0.9	**0.9**	**4.5**
December	**2.4**	0.7	1.8	**0.3**	**4.2**
Annual	**21.8**	5.3	16.5	**24.8**	**46.7**

Note:
A database of national-scale daily weather data was previously compiled by the EPA for use in water balance simulations. These data were used to estimate daily weather data (i.e., precipitation and temperature; compiled for the time period 1960–1990) for use in driving runoff calculations.

USGS has conducted baseflow modeling in the region that relates annual precipitation and recharge rates to streamflow. Analysis for the Barden Reservoir-Ponaganset River watershed indicates that baseflow contributes approximately 52%–56% of streamflow. As a reference, modeling suggests that baseflow indices range from about 51% (northwestern parts of the state) to approximately 71% (southwest part of the state where the watershed is located) in Rhode Island.

Streamflow

Runoff within the watershed was estimated for hypothetical 1-inch and 2-inch storm events over 24 hours using Model My Watershed. The results are displayed in Table 9. For a 2-inch storm event, 14% of the precipitation forms runoff and approximately 76% infiltrates into the soils.

Table 9. Runoff generated by hypothetical 24-hour storm events in the Barden Reservoir-Ponaganset River watershed (simulated by SLAMM and TR-55 algorithms in Model My Watershed)

Storm Event Precipitation Fate	Water Depth (in.)		Water Volume (ft^3)	
	1-inch Storm Event	2-inch Storm Event	1-inch Storm Event	2-inch Storm Event
Runoff	0.05	0.28	3,900,705	21,644,631
Evapotranspiration	0.21	0.21	15,910,988	15,910,988
Infiltration	0.74	1.51	56,686,043	115,439,854

Three long-term USGS flow gages are currently maintained on Ponaganset River (USGS 01115187), Dolly Cole Brook (USGS 01115190), and Hemlock Brook (USGS 01115265) within the Barden Reservoir-Ponaganset River watershed. Partial low flow records also exist for Shippee Brook (USGS 01118055) and Winsor Brook (USGS 01115185). Available flow data (continuous records, partial records, low flow, and peak flow) and statistics for all USGS streamflow sites in the watershed can viewed using the StreamStats tool.

The site located on the Ponaganset River at South Foster (USGS 01115187) provides a flow record from 1995 to 2021—it has a contributing drainage area of 14.4 square miles. Long-term flow gages on Hemlock Brook (USGS 01115265) and Dolly Cole Brook (USGS 01115190) provide flow measurements from 2008 to 2024. For the three sites, annual mean daily discharges are shown in Figure 16, annual peak discharges are shown in Figure 17, and monthly mean discharges are shown in Figure 18.

At the Ponaganset River site, over the period of record 1994–2024, monthly mean streamflow ranged from 3.7 cubic feet per second in August to 53.1 cubic feet per second in March. According to the USGS StreamStats tool, the maximum daily flow recorded at the gage over the period of record was 946 cubic feet per second, while the minimum daily flow recorded was 0 cubic feet per second.

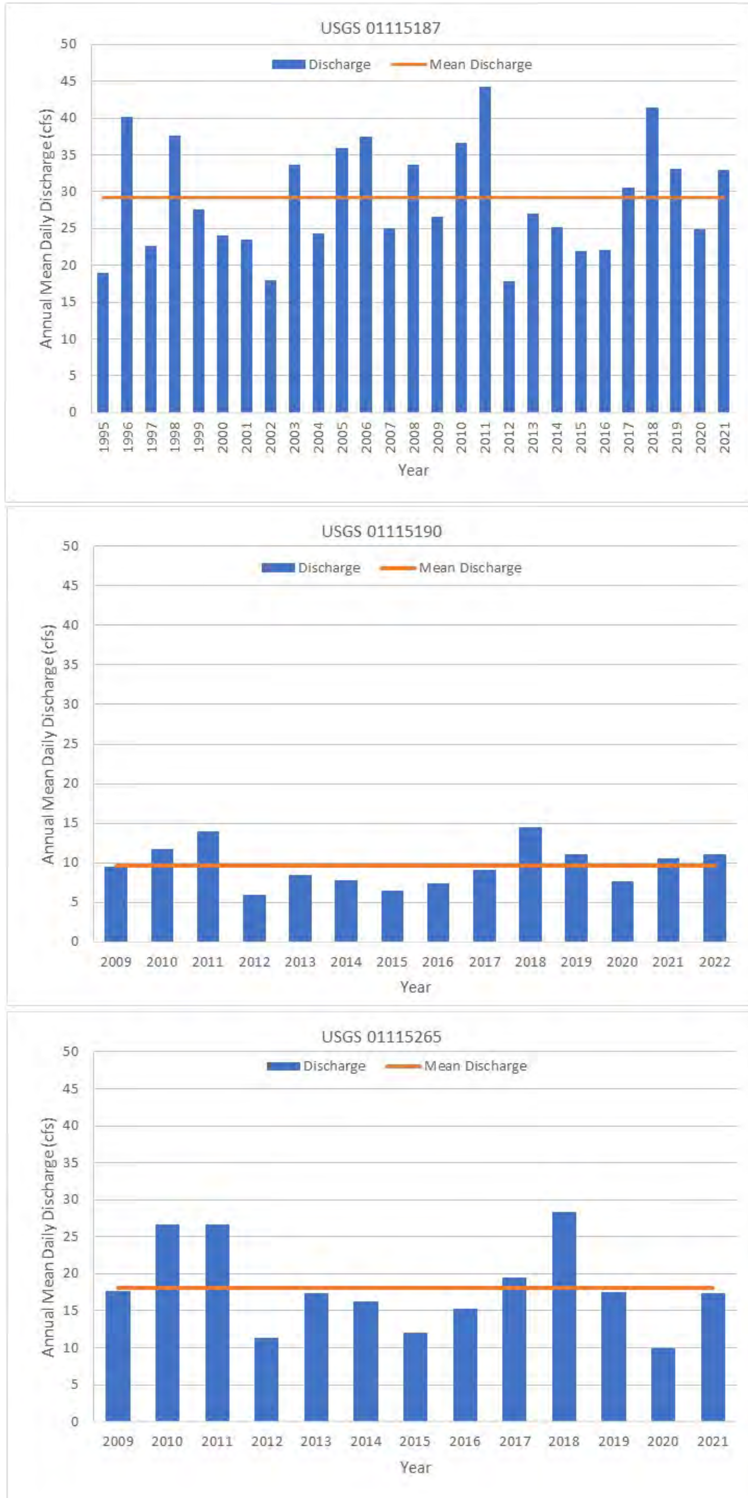

Figure 16. Annual mean daily discharge at Ponaganset River (USGS 01115187), Dolly Cole Brook (USGS 01115190), and Hemlock Brook (USGS 01115265).

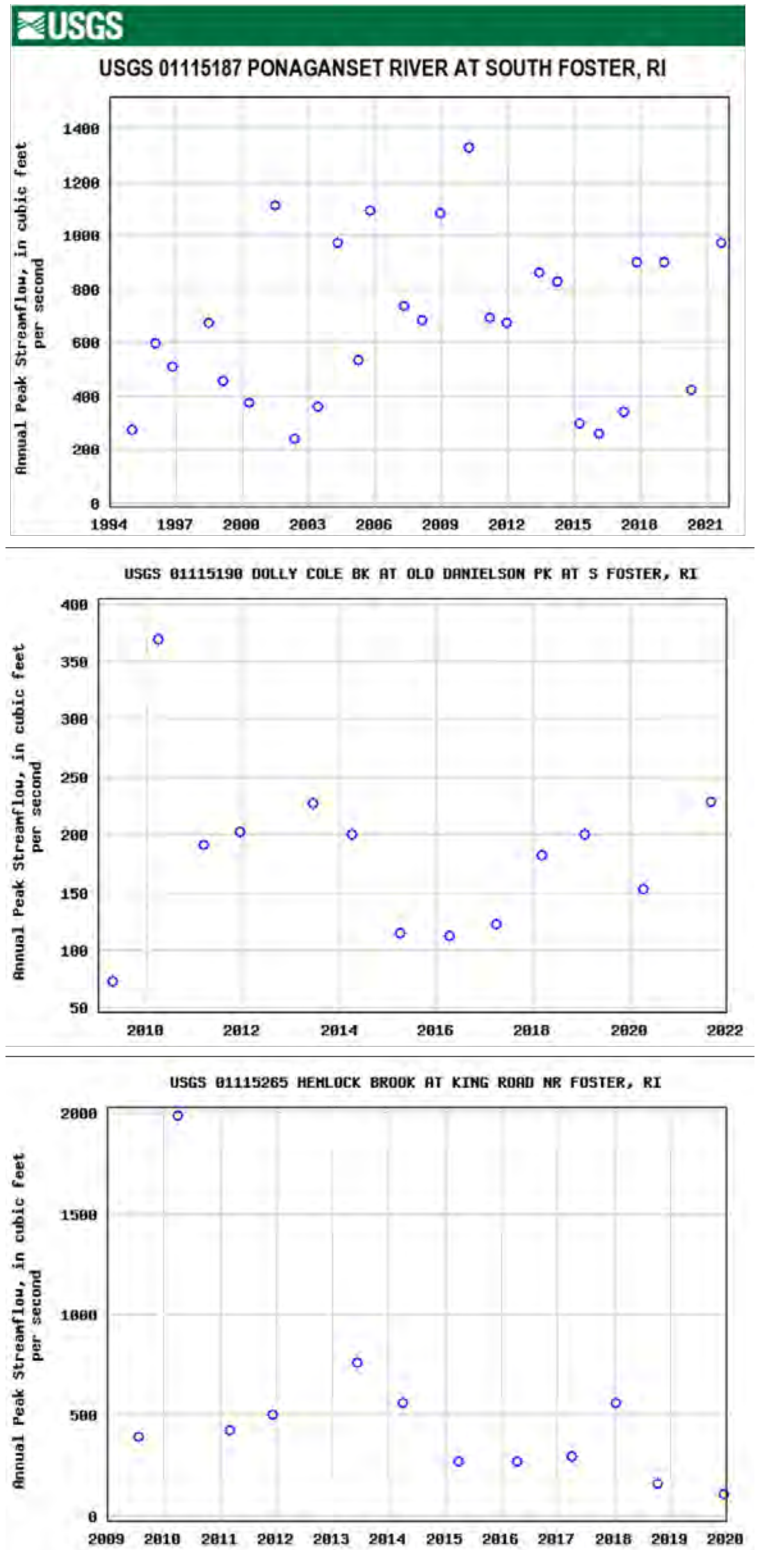

Figure 17. Annual peak discharge at Ponaganset River (USGS 01115187), Dolly Cole Brook (USGS 01115190), and Hemlock Brook (USGS 01115265).

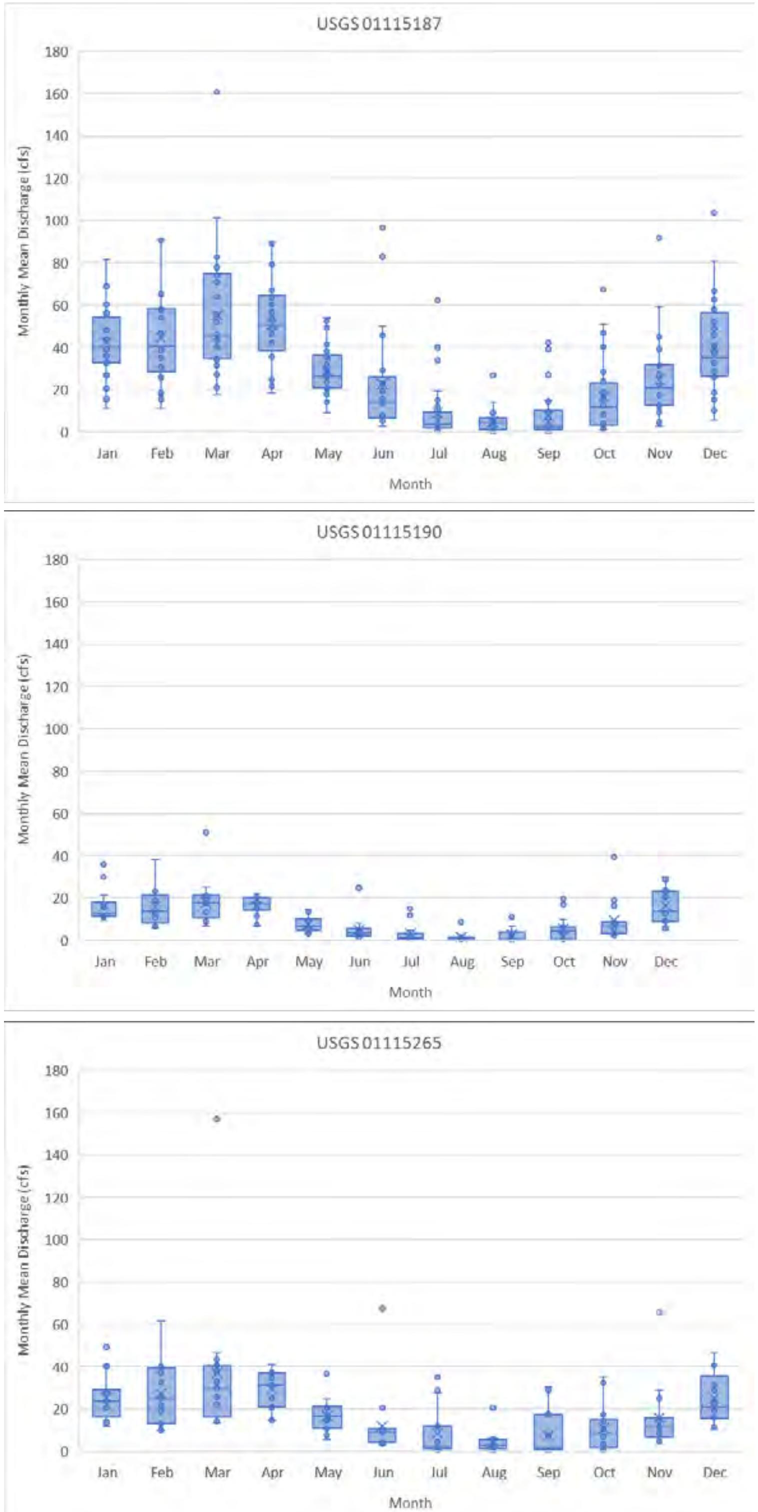

Figure 18. Monthly mean discharge at Ponaganset River (USGS 01115187), Dolly Cole Brook (USGS 01115190), and Hemlock Brook (USGS 01115265); box and whisker plots show max/min (whiskers); 25th, 50th, and 75th percentiles (box); and individual values for each record (circles).

Water Quality Conditions

Overview

This section reviews applicable standards, details current impairments, and assesses available water quality monitoring data for the Barden Reservoir-Ponaganset River watershed. Stream segments in Shippee Brook and Winsor Brook exceed recreational water quality standards for *Enterococcus* (indicating the potential presence of pathogenic organisms) (RIDEM 2021). Only Winsor Brook has an approved TMDL. Shippee Sawmill Pond is also considered to have an impairment due to non-native aquatic plants.

Applicable Water Quality Standards

Water quality standards serve as the basis for the state's water quality management program. They define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to maintain and protect water quality from pollutants. The standards are composed of three parts: designated uses, water quality criteria, and antidegradation. Each of these components is briefly discussed below.

Surface Water Classes and Designated Uses

As described in the state's water quality standards (RIDEM 2020), all surface waters are assigned to one of four freshwater classes (AA, A, B, B1) or one of three saltwater classes (SA, SB, SB1) (see RIDEM 2020). Freshwaters in the Barden Reservoir-Ponaganset River watershed have been assigned to Class AA, (see Figure 19). Table 10 provides more details about Class AA waters.

Table 10. Designated uses for the Barden Reservoir-Ponaganset River watershed (source: RIDEM 2020)

Classification	**Designated Uses from Regulation *250-RICR-150-05-1***
Class AA	These waters are designated as a source of public drinking water supply (PDWS) or as tributary waters within a PDWS watershed, for primary and secondary contact recreational activities and for fish and wildlife habitat. These waters shall have excellent aesthetic value.

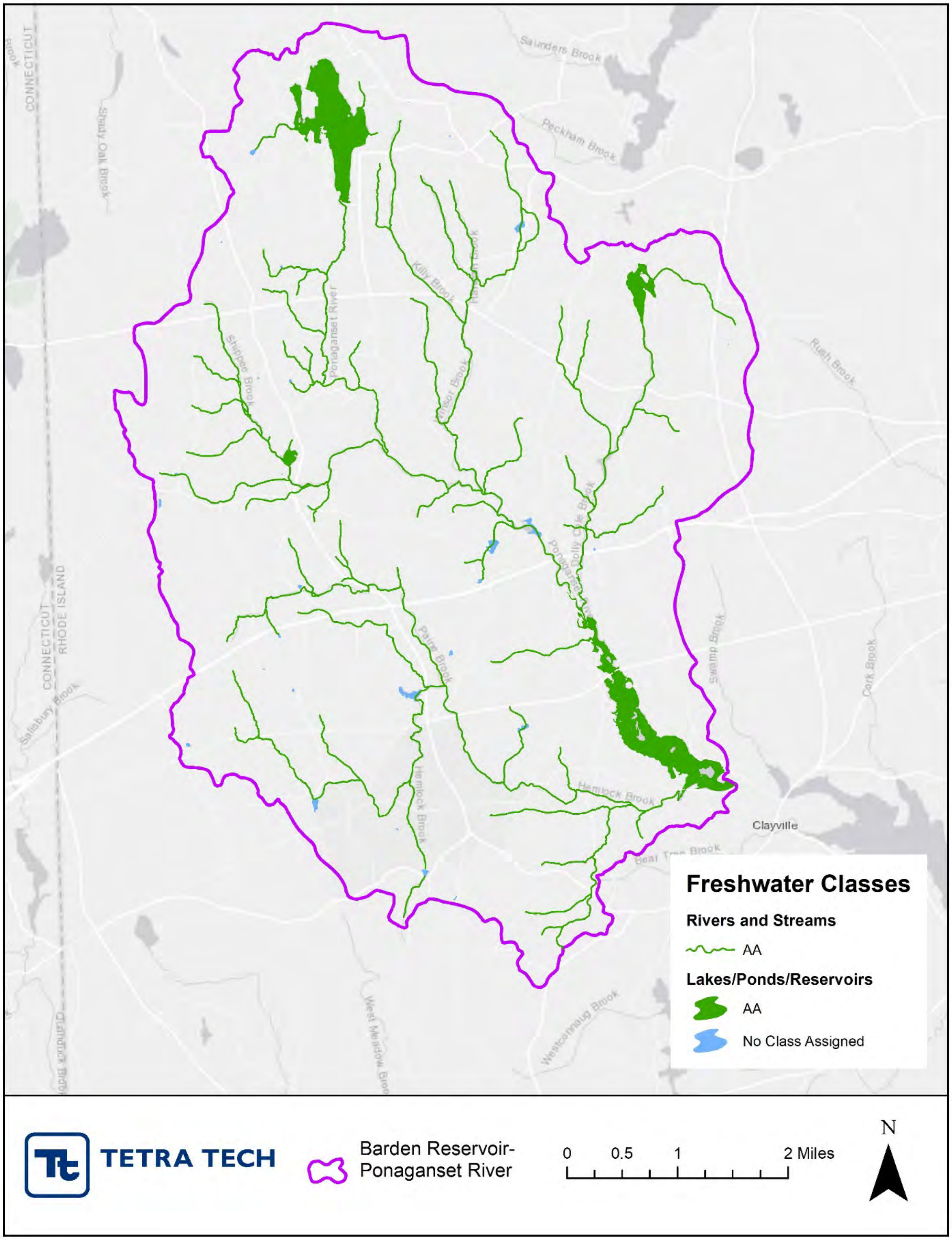

Figure 19. Surface water classifications for the Barden Reservoir-Ponaganset River watershed.

Water classes are in turn defined by the designated uses. Designated uses are the desirable uses that surface waters should support such as swimming (i.e., primary contact recreation) and fishing (i.e., aquatic life). Table 11 summarizes the designated uses and associated water classes that are applicable to the watershed (all uses are outlined in Rhode Island's state surface water quality regulations *250-RICR-150-05-1*). Freshwaters in the Barden Reservoir-Ponaganset River watershed are assigned to class AA and therefore should support PDWS, fish and wildlife habitat, and primary and secondary contact recreational activities.

Table 11. Designated uses in the Barden Reservoir-Ponaganset River watershed for class AA surface waters (source: RIDEM 2020)

Designated Use	Description
Public drinking water supply	The waterbody can supply safe drinking water with conventional treatment.
Primary contact recreation	Swimming, water skiing, surfing, and similar water contact activities where a high degree of bodily contact with the water, immersion, and ingestion are likely.
Secondary contact recreation	Boating, canoeing, fishing, kayaking, or other recreational activities in which there is minimal contact by the human body with the water and the probability of immersion and/or ingestion of the water is minimal.
Fish and wildlife habitat	Waters suitable for the protection, maintenance, and propagation of a viable community of aquatic life and wildlife.
No specific analogous use, but implicit in "fish and wildlife habitat"	The waterbody supports fish free from contamination that could pose a human health risk to consumers.

Relevant Water Quality Criteria (Nutrients, Sediment, Bacteria)

The second major component of the Rhode Island water quality standards is the criteria intended to protect the designated uses of all surface waters. Criteria can be expressed in either numeric or narrative form. A waterbody that meets the criteria for its assigned classification is considered to meet its intended use.

A summary of applicable water quality standards found for key water quality parameters in the NWQI assessment area are given in Table 12. More details can be found in Rhode Island's Water Quality Regulations (*250-RICR-150-05-1*) and in Rhode Island's *2022 Consolidated Assessment and Listing Methodology (CALM) for Section 305(B) and 303(D) Integrated Water Quality Monitoring and Assessment Reporting*.

The regulations do not contain numeric criteria for nutrients and sediment in rivers or estuarine waters. However, numeric water quality criteria for total phosphorus (TP) have been adopted in lakes and tributaries at the point they enter lakes. TP may be listed as the suspected cause of impairment in freshwater rivers with persistent eutrophication and/or low dissolved oxygen (RIDEM 2020). The state's regulations also contain narrative nutrient criteria for nutrient concentrations associated with cultural eutrophication that cause undesirable or nuisance aquatic vegetation or render waters unsuitable for the designated uses.

For bacteria, Rhode Island primarily uses enterococci to determine risk associated with primary and secondary contact recreation activities in freshwater. Sections 1.10(D)(1) and 1.10(E)(1) of Rhode Island's *Water Quality Regulations* (RIDEM 2020) identify two types of recreational uses:

1. Primary Contact Recreation defined as "those water-related recreational activities that involve significant ingestion risks and includes, but is not limited to, swimming, diving, surfing, and water skiing."
2. Secondary Contact Recreation defined as "those water-related recreational activities where the probability of water ingestion is minimal and includes, but is not limited to, boating and fishing."

The water quality standards use fecal coliform criteria when adequate enterococci data are not available. In some freshwaters where *Escherichia coli* (*E. coli*) data are available, the EPA criteria for this indicator is used to evaluate exceedances.

Table 12. Applicable water quality standards in the Barden Reservoir-Ponaganset River watershed (source: RIDEM 2020)

Water Quality Parameter	**Water Quality Criteria**	**Comment**
Total Phosphorus (TP)	Numeric: Average TP < 0.025 mg/L in any lake, pond, kettle hole or reservoir, and tributaries at the point where they enter such bodies of water. Narrative: None in such concentration that would impair any usages specifically assigned to said class, or cause undesirable or nuisance aquatic species associated with cultural eutrophication, nor cause exceedance of the criterion above in a downstream lake, pond, or reservoir.	Exception if as naturally occurs
Total Nitrogen (TN)	Narrative: None in such concentration that would impair any usages specifically assigned to said class, or cause undesirable or nuisance aquatic species associated with cultural eutrophication, nor cause exceedance of the criterion above in a downstream lake, pond, or reservoir.	EPA Guidance for Northeastern Coastal Zone: 610 µg/L
Turbidity	Narrative: None in such concentrations that would impair any usages specifically assigned to this class. Turbidity not to exceed 5 NTU over background.	
Bacteria–Fecal Coliform	Primary Contact Recreation: • Geometric mean < 200 MPN/100 mL • No more than 10% of the total samples taken > 400 MPN/100 mL	Applied only when adequate enterococci data are not available
Bacteria–Enterococci	Primary Contact Recreation: • Non-designated bathing beach waters geometric mean density: 54 colonies/100 mL	Only applies May through October

Water Quality Parameter	Water Quality Criteria	Comment
Dissolved Oxygen	Cold Water Fish Habitat: • Daily average ≥ 75% saturation • Instantaneous minimum 5 mg/L Cold water fish spawning areas; early life stages not directly exposed to the water column: • 7-day mean ≥ 9.5 mg/L • Instantaneous minimum ≥ 8 mg/L Cold water fish spawning areas; early life stages exposed to the water column: • 7-day mean ≥ 6.5 mg/L • Instantaneous minimum ≥ 5.0 mg/L	Exception if naturally occurs October 1 to May 14 October 1 to May 14
	Warm Water Fish Habitat: • Daily average ≥ 60% saturation • Instantaneous minimum 5.0 mg/L • 7-day mean ≥ 6 mg/L	Exception if naturally occurs
pH	6.5–9.0 pH units or as naturally occurs	

Antidegradation

The third component of water quality standards is antidegradation, which is a provision designed to preserve and protect the existing beneficial uses and to minimize degradation of the state's surface waters (Part 250-RICR-150-05-1.20 of Rhode Island's Surface Water Quality Regulations). Antidegradation applies to "to all projects or activities subject to these regulations which will likely lower water quality or affect existing or designated water uses, including but not limited to all Water Quality Certification reviews and any new or modified RIPDES permits." The antidegradation regulations consist of four tiers of water quality protection:

- Tier 1: Protection of Existing Uses
- Tier 2: Protection of Water Quality in High Quality Waters
- Tier 2½: Protection of Water Quality for Special Resource Protection Waters (SRPWs)
- Tier 3: Protection of Water Quality for Outstanding National Resource Waters (ONRWs)

Impairments

The recent *State of Rhode Island 2022 Impaired Waters Report* provides information about impaired waterbodies in the Barden Reservoir-Ponaganset River watershed. Table 13 summarizes impaired waterbodies within the watershed and lists the causes of impairments based on the 2018–2020 report (RIDEM 2021). Parts of Winsor Brook and Shippee Brook are impaired due to excessive levels of bacteria (*Enterococcus*). TMDLs have been approved for most of the sections on Winsor Brook. An impairment due to non-native aquatic plants is also apparent in Shippee Sawmill Pond (see Table 13). Figure 20 shows the location of impaired assessment units within the waters based on information from the 2022 impaired waters report.

Table 13. List of impaired waterbodies within the Barden Reservoir-Ponaganset River watershed

Waterbody ID (WBID)	Waterbody Name	Impairments (Category)[1]
RI0006015R-30	Winsor Brook	*Enterococcus* (4A)
RI0006015R-23	Shippee Brook	*Enterococcus* (5)
RI0006015L-05	Shippee Sawmill Pond	Non-native aquatic plants (4C)

Note:
[1] Impairment categories include 4A: Impaired waterbody with approved TMDL; 4C: Impairment is not caused by a pollutant; and 5: Impaired waterbody requiring a TMDL.

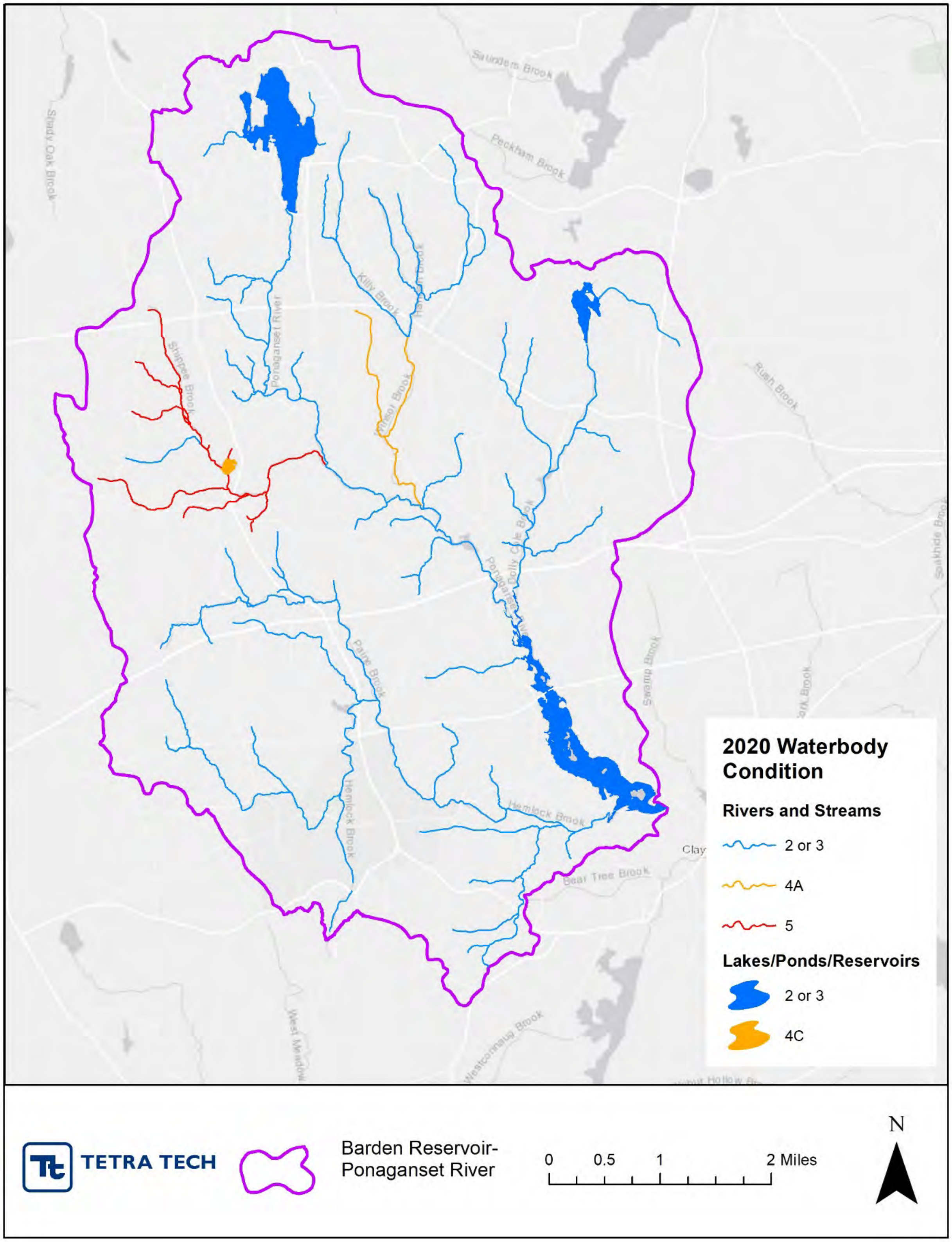

Figure 20. Impaired waterbodies in the Barden Reservoir-Ponaganset River watershed. Impairment categories include 4A: Impaired waterbody with approved TMDL, 4C: Impairment is not caused by a pollutant and 5: Impaired waterbody requiring a TMDL.

Water Quality Monitoring

Available Data and Site Locations

A selection of recent water quality data (2018–2022) is used to characterize current conditions in the Barden Reservoir-Ponaganset River watershed. Nutrients, bacteria, and other water quality parameters have been monitored for more than 10 years at the following USGS and PWSB sites:

- USGS 01115185: Winsor Brook at Winsor RD Near South Foster
- USGS 01115187: Ponaganset River at South Foster
- USGS 01115190: Dolly Cole BK at Old Danielson PK at S Foster
- USGS 01115200: Shippee Brook
- USGS 01115265: Hemlock Brook at King Road NR Foster
- USGS 011151843: Ponaganset Reservoir
- USGS 011151845: Unnamed tributary to Ponaganset River (unnamed brook B, unnamed brook west of Winsor Brook)

Additionally, bacteria monitoring has been conducted by RIDEM at some stream locations during 2007 and 2008. Figure 21 displays the locations of the water quality monitoring sites used to assess current conditions in the watershed. The stations at Ponaganset Reservoir (USGS 011151843), Shippee Brook (USGS 01115200), Winsor Brook (USGS 01115185), and Ponaganset River at South Foster are used to characterize current water quality conditions in the watershed.

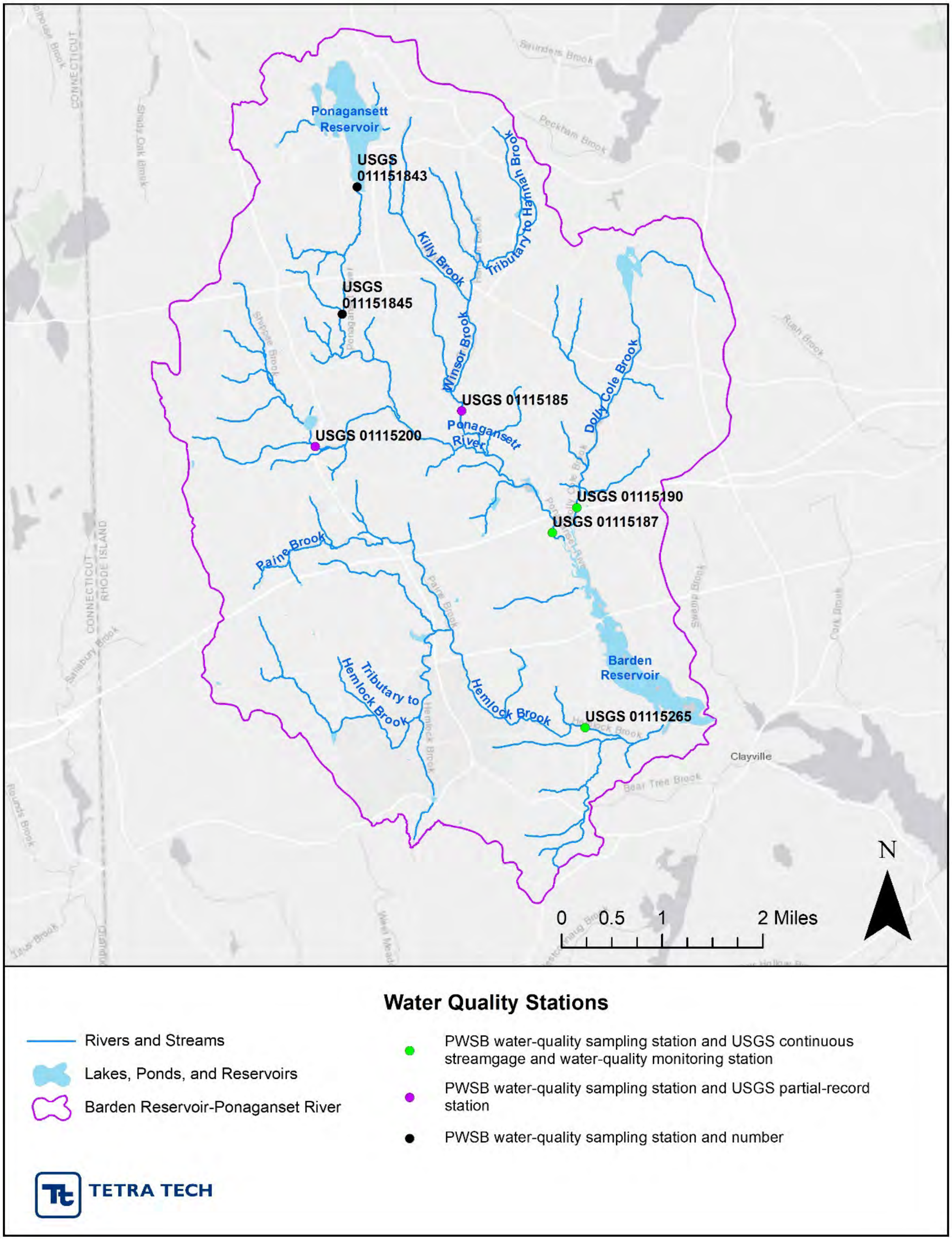

Figure 21. Location of USGS and PWSB monitoring sites within the Barden Reservoir-Ponaganset River watershed.

Rivers and Streams

Orthophosphate (PO_4) as P: observed orthophosphate as P concentrations between 2018 and 2022 at six monitoring sites are displayed in Figure 22. Along Ponaganset River and tributaries, PO_4 concentrations ranged from 0.003 mg/L to 0.056 mg/L at Ponaganset Reservoir (USGS 011151843), 0.007 mg/L to 0.049 mg/L at Shippee Brook (USGS 01115200), 0.006 mg/L to 0.036 mg/L at Winsor Brook (USGS 01115185), 0.003 mg/L to 0.065 mg/L at Ponaganset River (USGS 01115187; prior to discharging Barden Reservoir), 0.003 mg/L to 0.042 mg/L at Dolly Cole Brook (USGS 01115190), and 0.003 mg/L to 0.056 mg/L at Hemlock Brook (USGS 01115265).

The level III ecoregion derived guidance for orthophosphate as P was often exceeded at all sites in the watershed. Median PO_4 concentrations between 2018 and 2022 were above the EPA derived level III ecoregion guidance (reference condition for level III ecoregion 59 streams) of 0.01 mg/L (based on 25th percentile value). The guidance value for TP (0.024 mg/L) in the ecoregion is also displayed in Figure 22.

Nitrite and Nitrate (NO_2 + NO_3): observed nitrite and nitrate concentrations monitoring sites between 2018 and 2022 are displayed in Figure 23. Nitrite and nitrate concentrations ranged from 0.05 to 0.16 mg/L at Ponaganset Reservoir (USGS 011151843), 0.05 mg/L to 0.19 mg/L at Shippee Brook (USGS 01115200), 0.05 mg/L to 0.43 mg/L at Winsor Brook (USGS 01115185), 0.05 mg/L to 0.21 mg/L at Dolly Cole Brook (USGS 01115190), 0.05 mg/L to 0.29 mg/L at Hemlock Brook (USGS 01115265), and 0.05 mg/L to 0.2 mg/L at Ponaganset River (USGS 01115187; prior to discharging Barden Reservoir). The EPA level III ecoregion guidance of 0.31 mg/L (reference condition for level III ecoregion 59 streams) was not exceeded at any monitoring sites between 2018 and 2022.

Turbidity: turbidity is often used as a surrogate for suspended sediment in waterbodies. Observed turbidity measurements at monitoring sites between 2018 and 2022 are displayed in Figure 24. Turbidity values ranged from 0.36 NTU to 1.05 NTU at Ponaganset Reservoir (USGS 011151843), 0.28 NTU to 1.18 NTU at Shippee Brook (USGS 01115200), 0.19 NTU to 2.48 NTU at Winsor Brook (USGS 01115185), 0.25 NTU to 2.26 NTU at Dolly Cole Brook (USGS 01115190), 0.29 NTU to 2.88 NTU at Hemlock Brook (USGS 01115265), and 0.33 NTU to 2.02 NTU at Ponaganset River (USGS 01115187; prior to discharging Barden Reservoir). The EPA level III ecoregion guidance of 1.68 NTU (reference condition for level III ecoregion 59 streams) was exceeded occasionally at Winsor Brook, Dolly Cole Brook, Hemlock Brook, and Ponaganset River during the period. Median turbidity values at all monitoring sites were below the ecoregion guidance value.

***Escherichia coli (E. coli)*:** observed *E. coli* concentrations at selected monitoring sites between 2018 and 2022 are displayed in Figure 25. *E. coli* concentrations ranged from 2 MPN/100mL to 520 MPN/100mL at Ponaganset Reservoir (USGS 011151843), 6 MPN/100mL to 1,722 MPN/100mL at Shippee Brook (USGS 01115200), 2 MPN/100mL to 7,701 MPN/100mL at Winsor Brook (USGS 01115185), 2 MPN/100mL to 1,153 MPN/100mL at Dolly Cole Brook (USGS 01115190), 5 MPN/100mL to 1,780 MPN/100mL at Hemlock Brook (USGS 01115265), and 2 MPN/100mL to 1,789 MPN/100mL at Ponaganset River (USGS 01115187; prior to discharging Barden Reservoir). EPA recommended thresholds for *E. coli* in recreational waters indicate that the geometric mean should not exceed 126 CFU/100mL. A statistical threshold value (90th percentile) of 410 CFU/100mL is also suggested (should not exceed). At all sites, both thresholds were occasionally exceeded between 2018 and 2022.

At Ponaganset River, Hemlock Brook, and Dolly Cole Brook there were more than 10 exceedances of the geometric mean recommendation—most of these exceedances occurred during the growing season (May through October). Annual geometric mean concentrations at all stations were, however, below both recommended EPA criteria. It should be noted that Winsor Brook and Shippee Brook are currently listed as impaired due to exceedances of RIDEM primary contact recreation criteria for *Enterococcus* (see Table 13).

Other Water Quality Parameters: PWSB and USGS also measure pH, color, alkalinity, total coliform, and chloride at the same monitoring stations in the Barden Reservoir-Ponaganset River watershed. A summary of observations (median values and ranges) for these parameters at the seven monitoring sites is provided in Table 14.

Table 14. Median observed measurements for other water quality parameters at monitoring sites in the Barden Reservoir-Ponaganset River watershed between 2018 and 2022

Parameter	USGS 01115185	USGS 01115187	USGS 01115190	USGS 01115200	USGS 01115265	USGS 011151843	USGS 011151845
***pH**	6.38 (5.92–6.72)	6.38 (5.95–6.92)	6.40 (5.78–6.87)	6.17 (5.73–6.49)	6.12 (5.47–6.53)	6.24 (5.52–6.67)	5.98 (5.52–6.44)
Color (PCU)	43 (10–90)	43 (17–160)	46 (25–200)	60 (5–100)	88 (35–250)	18 (8–30)	20 (15–30)
Alkalinity (mg/L CaCO3)	5.35 (3–8.4)	5.40 (2.7–14.4)	5.70 (3.2–12.7)	5.10 (2.8–7.9)	5.10 (2.7–11.1)	3.50 (2.1–6.8)	4.25 (2.5–12.1)
Total Coliform (CFU/100mL)	1170 (240–24196)	1790 (200–17329)	1427 (171–24196)	1658 (262–19863)	961 (140–7270)	465 (10–17330)	631 (86–19860)
Chloride (mg/L)	28.00 (20.7–52.1)	22.80 (16–31.3)	25.70 (18.9–42.1)	12.70 (9.3–17.7)	27.25 (1.6–45.1)	19.45 (16.9–28.9)	13.25 (9.9–20.3)

Note:

*Rhode Island criteria range is 6.5–9.0 pH units or as naturally occurs.

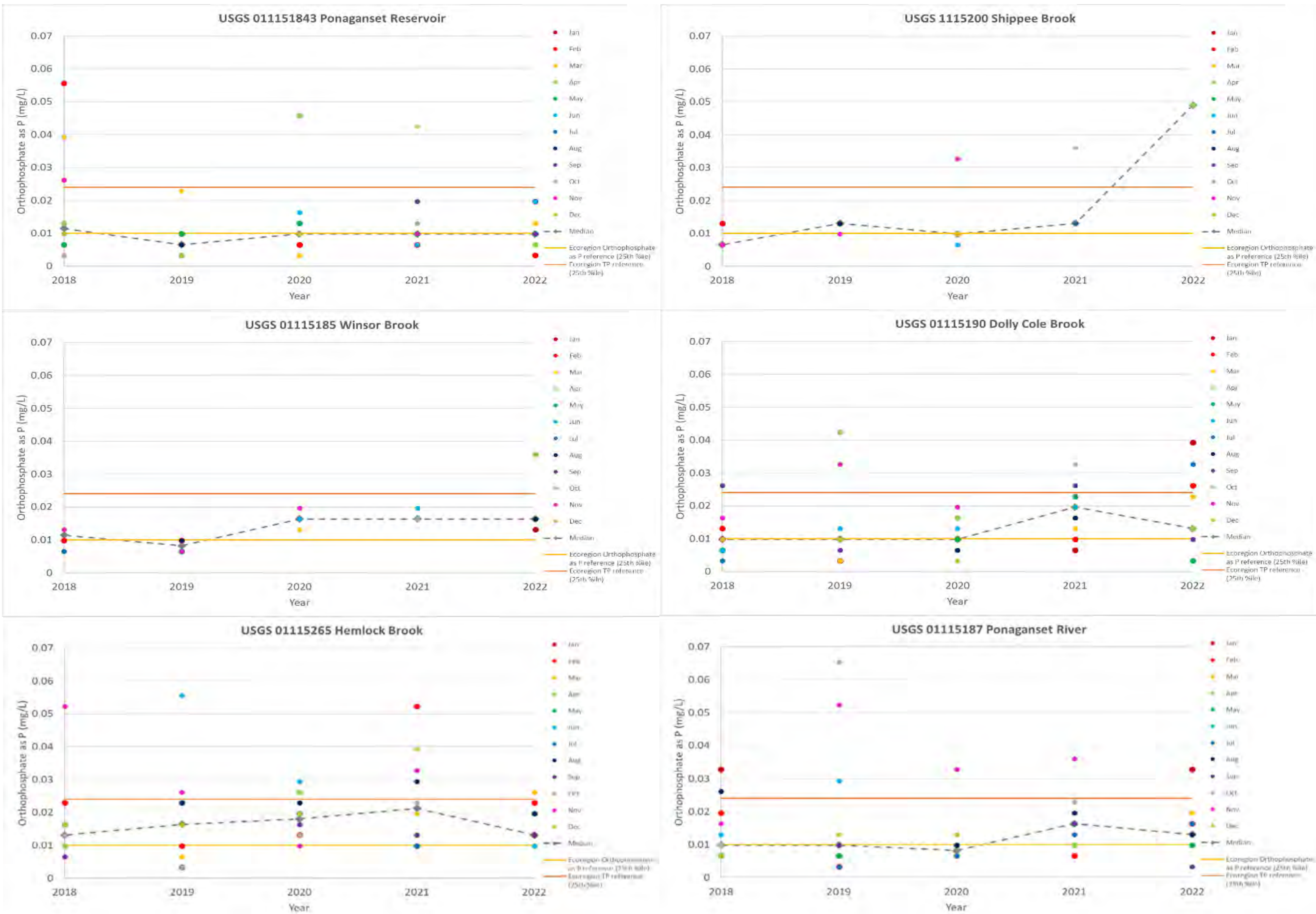

Figure 22. Observed orthophosphate concentrations from 2018 to 2022 at selected monitoring locations in the Barden Reservoir-Ponaganset River watershed.

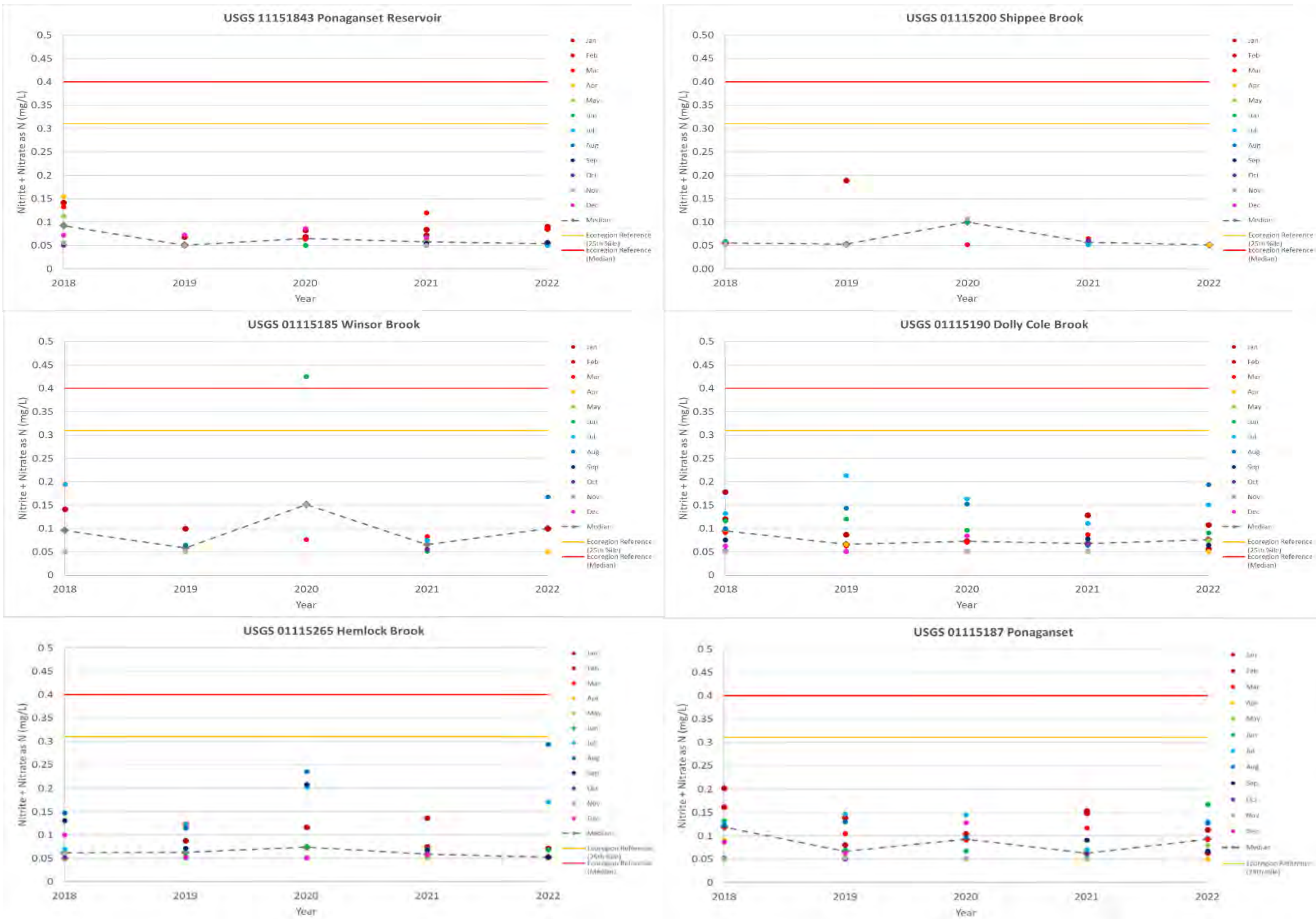

Figure 23. Observed nitrite plus nitrate concentrations from 2018 to 2022 at selected monitoring locations in the Barden Reservoir-Ponaganset River watershed.

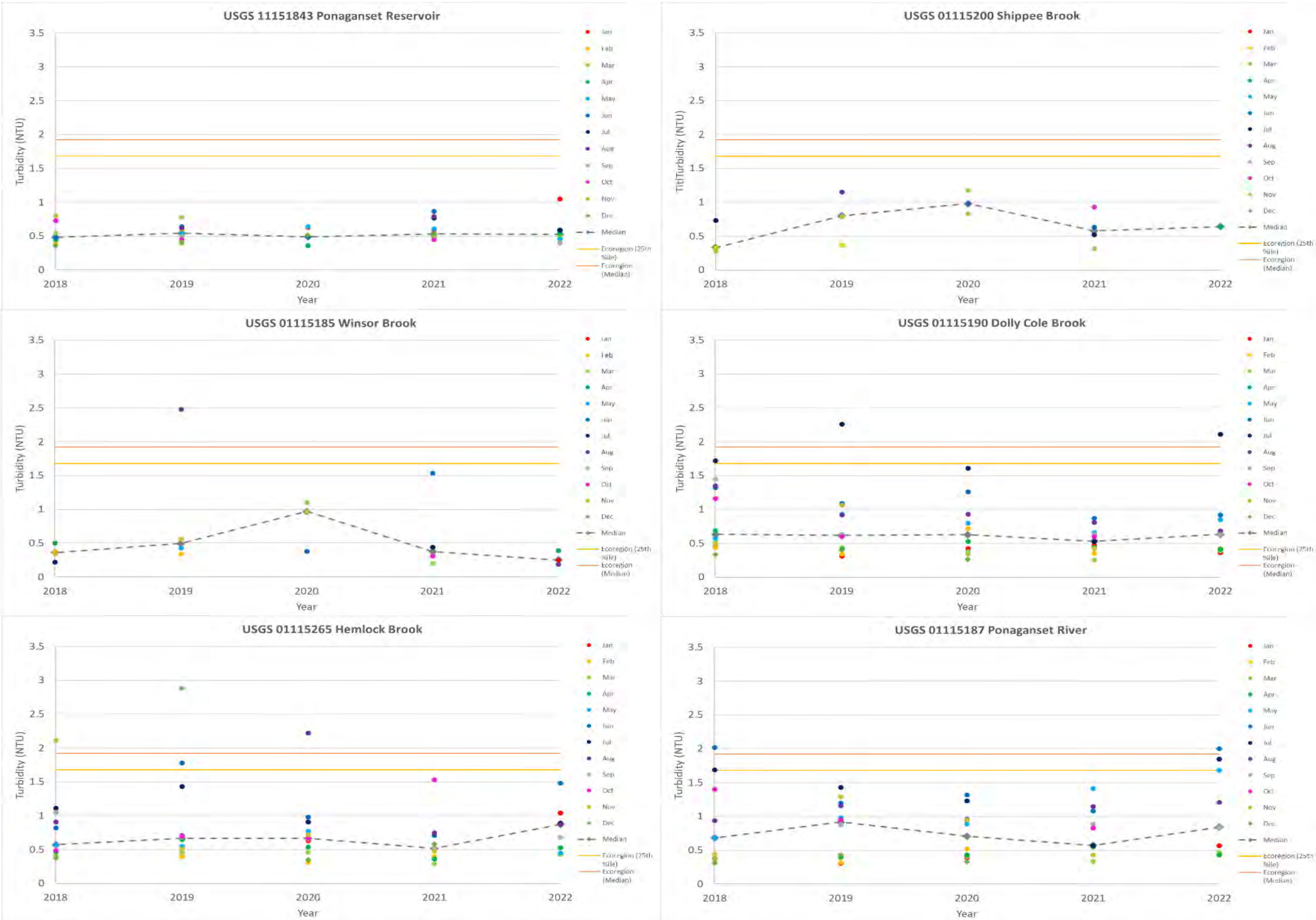

Figure 24. Observed turbidity measurements from 2018 to 2022 at selected monitoring locations in the Barden Reservoir-Ponaganset River watershed.

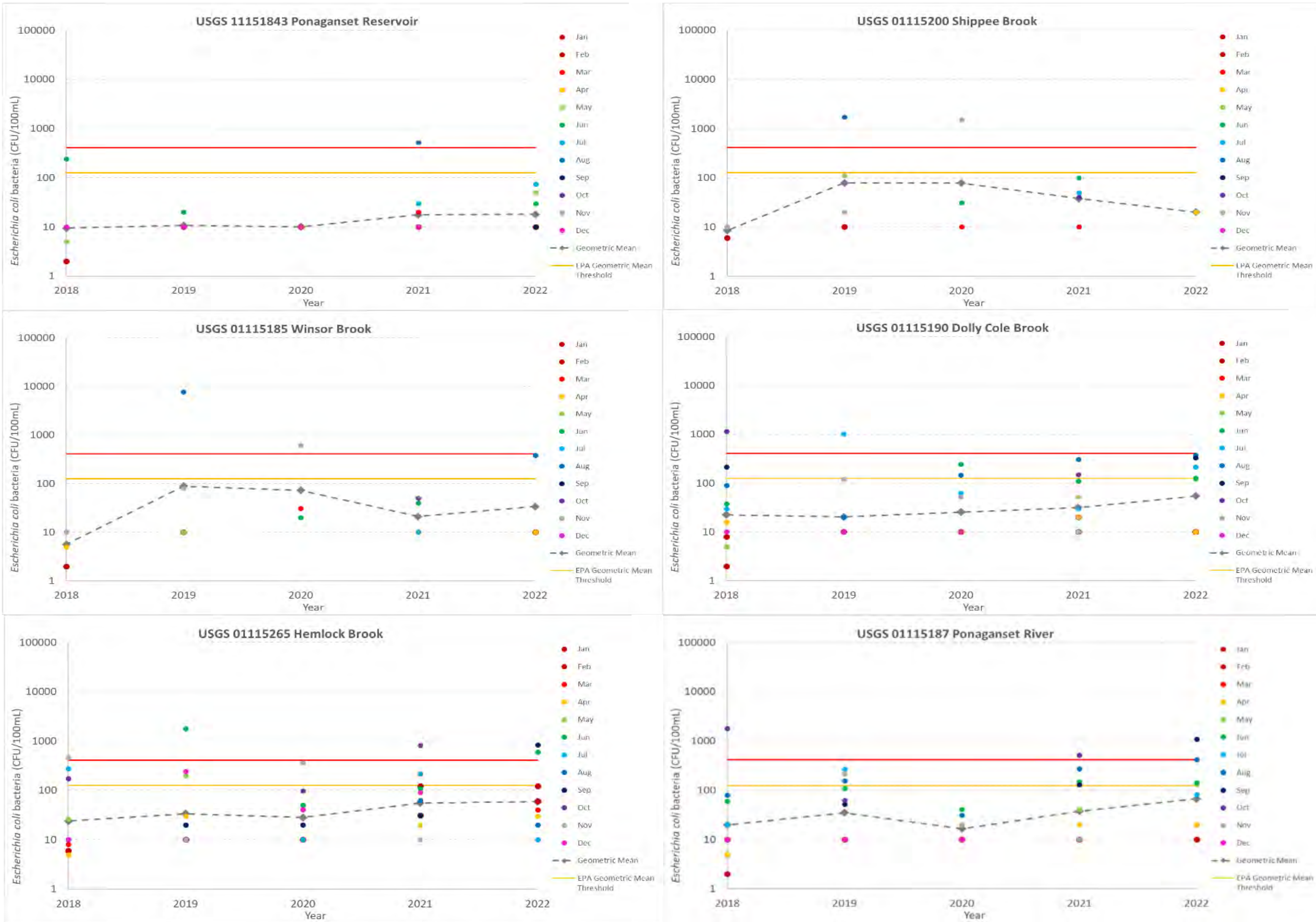

Figure 25. Observed E. coli concentrations from 2018 to 2022 at selected monitpring locations in the Barden Reservoir-Ponaganset River watershed.

IV. Resource Analysis and Source Assessment

The resource analysis of the watershed includes a source assessment, comparisons between existing and potential conditions, and the types/extent of conservation practices needed to assist in meeting the water quality goals. These results will help identify which land uses are producing the most pollution and what practices would effectively reduce nutrient and sediment loads within the watershed. Although bacteria loads are not explicitly considered in the analysis, it is expected that results will target the main sources of these loads and lead to reductions.

Causes and Sources of the Resource Problem

Bacteria, nutrients, and sediment are the main surface water resource stressors related to agriculture in the Barden Reservoir-Ponaganset River watershed. Water quality monitoring data for several stream sections indicates that orthophosphate, turbidity, and bacteria concentrations occasionally exceed guidance values. Shippee Brook and Winsor Brook are currently impaired due to exceedances related to *Enterococcus,* a bacterial indicator (see Table 13).

Information from the watershed characterization, hydrologic characterization, and water quality characterization suggests that areas of agricultural operations are likely contributing to pollutant loading to waterbodies in the watershed. A TMDL was approved for impaired sections on Winsor Brook. Agricultural runoff—together with onsite wastewater treatment systems, wildlife, and stormwater runoff—were considered the main sources of bacteria. Additionally, animal waste runoff was suggested to be a potential bacteria source to surface waters in the town of Foster (Town of Foster 2003). Agricultural operations are distributed throughout the watershed. Activities that include animals grazing near streams, application of manure as fertilizer, and improper use of manure can potentially lead to bacterial, nutrient, and sediment contamination (RIDEM 2011). Numerous waterbodies in the watershed are adjacent to or intersect areas of agricultural land.

The Winsor Brook bacteria TMDL suggests that agricultural operations develop conservation plans for farming activities. These plans should consider that there are sufficient stream buffers, that fencing exists to restrict access of livestock to streams and wetlands, and that animal waste handling, disposal, and other appropriate practices are in place.

Potential Assessment Tools

Existing and potential future water quality loads in the watersheds were estimated using EPA's PLET. PLET uses simple algorithms to calculate nutrient and sediment loads from different land uses and load reductions from implementation of conservation practices (Tetra Tech, Inc. 2022). Annual nutrient loading was calculated based on the annual runoff volume and established land use specific pollutant concentrations. The annual sediment load from sheet and rill erosion was calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. Accuracy is limited by the wide spatial variability in pollutant runoff concentrations across watersheds—general or common concentration values are used to calculate annual pollutant loadings.

Load reductions for the watersheds were modeled with PLET using established conservation practice efficiencies provided in PLET version 1.0. The efficiencies of combined practices were calculated using PLET's BMP Calculator. Although PLET does not model bacteria, it is assumed that simulated nutrient and sediment load reductions would also help to reduce bacteria loads from agricultural sources in each drainage area.

The ACPF was applied to identify critical source areas (runoff risk) in agricultural fields and determine priority areas for structural BMPs. The Framework identifies locations where specific landscape attributes are favorable for implementing certain conservation practices and includes methods to help prioritize these locations according to their susceptibility to runoff and erosion. The ACPF was developed by the USDA's Agricultural Research Service in partnership with USDA NRCS to support agricultural watershed management using high-resolution elevation data. It uses an ArcGIS toolbox to identify site-specific opportunities for installing conservation practices across small watersheds. The tool is used in conjunction with local knowledge of water and soil resource concerns, landscape features, and producer conservation preferences. Together, these provide a better understanding of the options available in developing a watershed conservation plan.

Analysis and Assessment of Watershed Conditions

PLET Model Inputs

Models were developed for the Barden Reservoir-Ponaganset River watershed following methods and input requirements outlined in the PLET user's guide. Model inputs include drainage area, soil hydrologic group, land use, animal numbers, and estimates for septic systems. Land use was derived from the 2023 USDA CDL (USDA NASS 2023). Animal numbers were based on PLET Input Data Server values with modifications from local NRCS staff, and cropland irrigation amounts were based on input from local NRCS staff. The number of septic systems within the watershed was based on an area-weighted ratio of the number of septic systems by county in the PLET Input Data Server. Septic failure rates and the average population per household were also based on the default values in the PLET Input Data Server.

Feedlots were assumed to be 1,200 square feet each, and the number of feedlots in the watershed was estimated by local NRCS staff. Local NRCS staff estimated that 1% of feedlots are zero discharge facilities.

USLE parameters were based on local soil erodibility (K factor) and slopes (LS factor). Soil nutrient concentrations were applied at the default values for the region (Haith et al. 1992). The number of gullies and their dimensions were estimated by NRCS staff based on local knowledge. Additionally, NRCS staff estimated the current level of BMP treatment in the Barden Reservoir-Ponaganset River watershed using available data and best professional judgement. Details on currently implemented practices are outlined in upcoming sections.

Current Conditions

The current level of BMP treatment in the Barden Reservoir-Ponaganset River watershed was estimated by NRCS field staff using available data and best professional judgement. About 59% of cropland and 63% of pastureland currently have some level of treatment in place (current conditions). Average annual pollutant loads, yields, and concentrations simulated by PLET under current conditions in each drainage area are summarized in Table 15. Figure 26–Figure 28 summarize pollutant loads from various sources within the Barden Reservoir-Ponaganset River watershed.

Currently, agricultural sources are estimated to account for about 20,882 lbs TN/year (~48% of watershed TN loads), 6,302 lbs TP/year (~48% of watershed TP load), and 1,250 tons sediment/year (68% of overall TN load). Estimates indicate that feedlots and gullies are the main source of nutrient and sediment pollution from agriculture in the watershed. Cropland and pastureland are the other key agricultural sources (see Figure 26–Figure 28), with potentially reducible pollutant loads in the watershed, which will be addressed in this plan. Urban land (35% of watershed TN load, 19% of watershed TP load, 21% of watershed sediment load) and forest land (16% of watershed TN load, 33% of watershed TP load, 11% of watershed sediment load) account for the remaining nutrient and sediment loads (see Figure 26–Figure 28 for estimates). The majority of the watershed is forested (~87%) and accounts for a large proportion of the TN load and TP load – these contributions are considered background or natural. Urban land uses cover about 8% of the watershed (mainly residential and low intensity developed land) and also contribute a large proportion of the overall pollutant load.

Table 15. PLET results for existing pollutant loads, yields, and concentrations in the Barden Reservoir-Ponaganset River Watershed

Runoff (ac-ft)	Runoff Yield (ac-ft/ac)	% Rainfall as runoff	Annual Load			Annual Yield			Mean Concentration		
			TN (lb/yr)	TP (lb/yr)	Sed (t/yr)	TN (lb/ac/yr)	TP (lb/ac/yr)	Sed (t/ac/yr)	TN (mg/L)	TP (mg/L)	Sed (mg/L)
15,136	0.74	17%	43,844	13,221	1,828	2.14	0.64	0.09	1.07	0.3	89

Notes:
TN = total nitrogen; TP = total phosphorus; Sed = sediment; ac-ft = acre-feet; ac-ft/ac = acre-feet per acre; lb/yr = pounds per year; t/yr = tons per year; lb/ac/yr = pounds per acre per year; t/ac/yr = tons per acre per year; mg/L = milligrams per liter

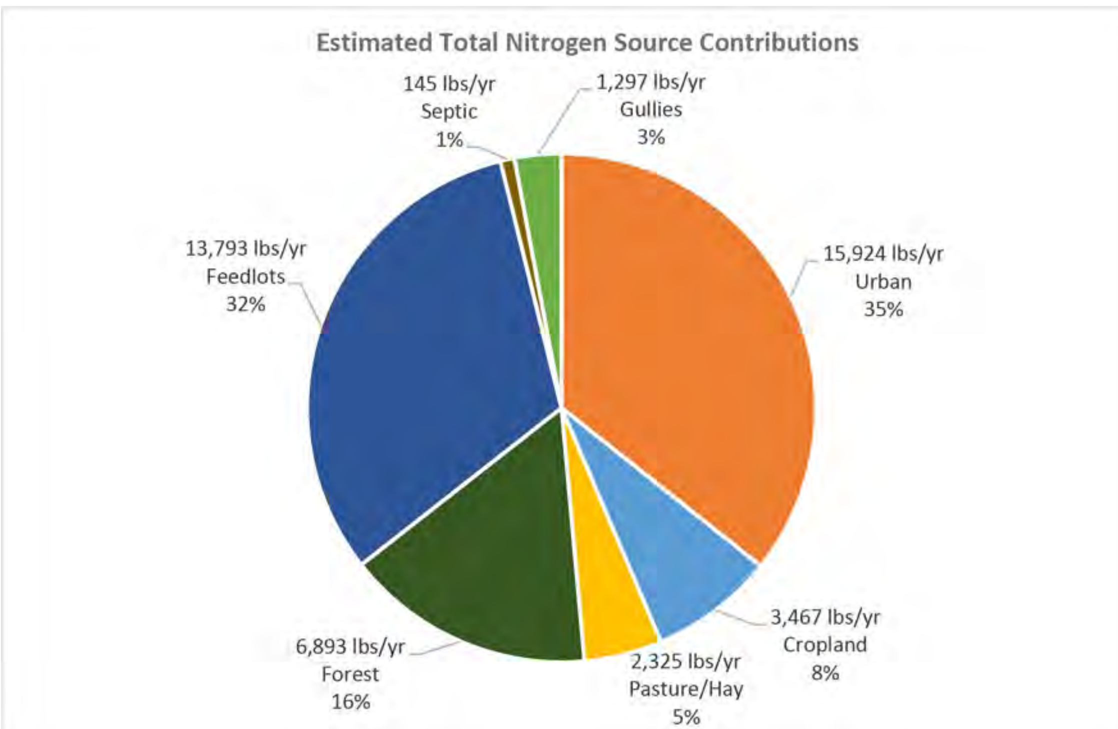

Figure 26. Estimated source contributions for TN within the Barden Reservoir-Ponaganset River Watershed.

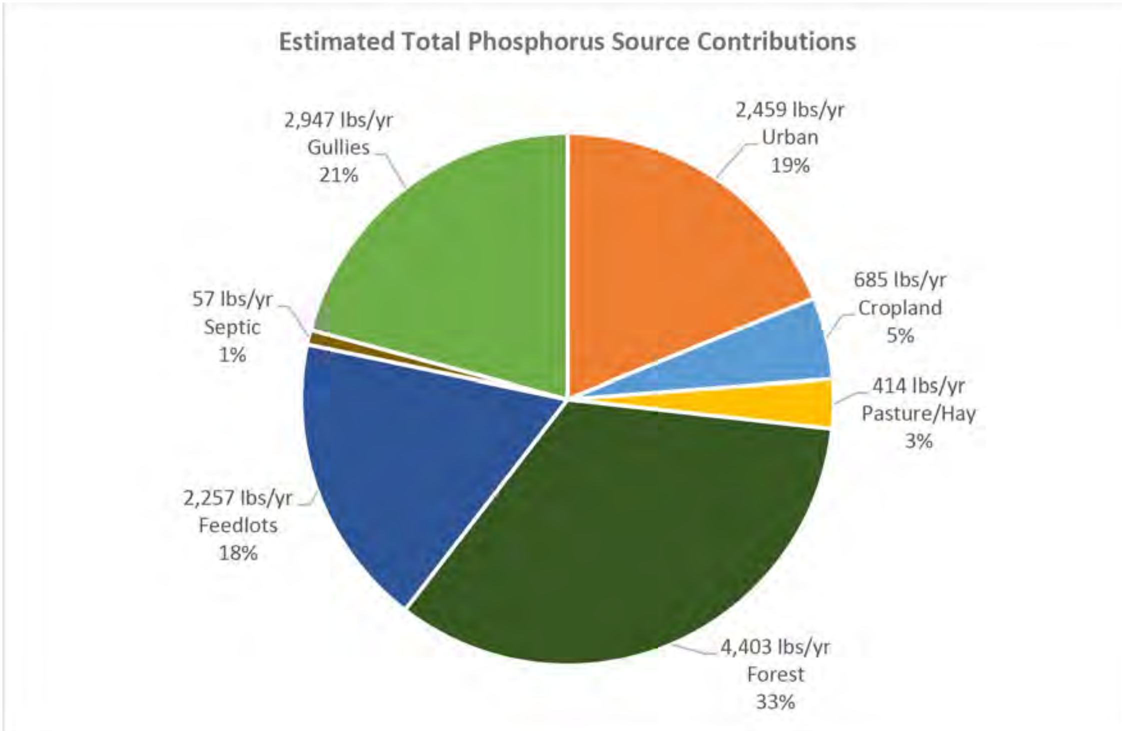

Figure 27. Estimated source contributions for TP within the Barden Reservoir-Ponaganset River Watershed.

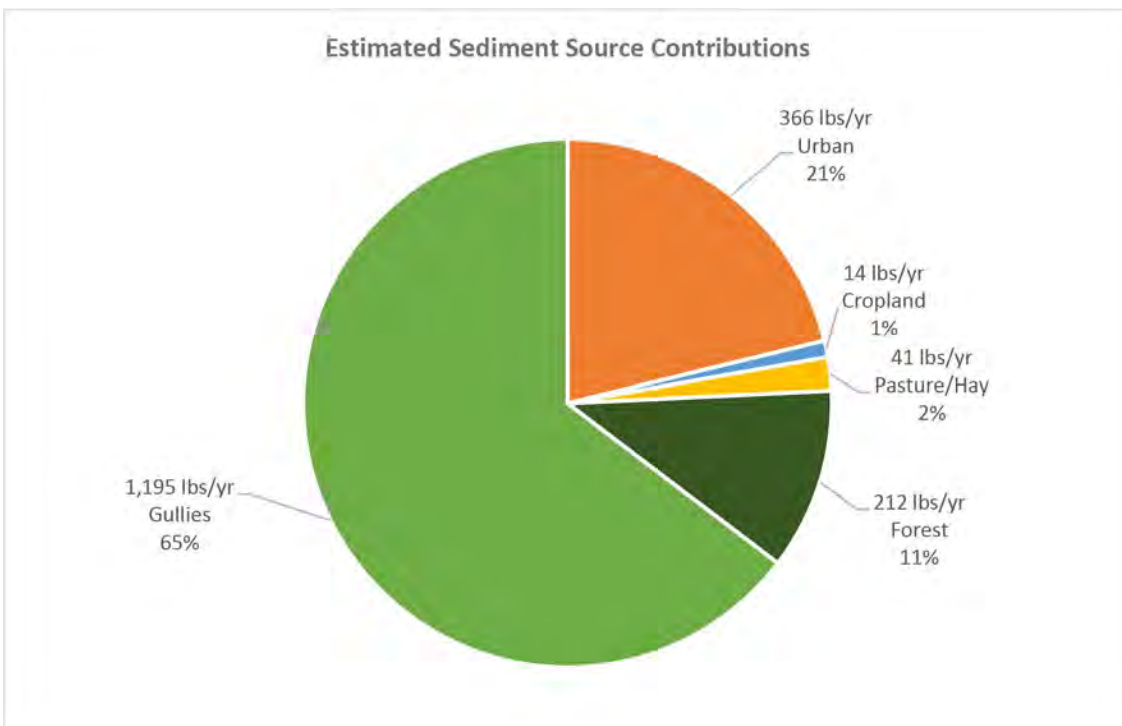

Figure 28. Estimated source contributions for sediment within the Barden Reservoir-Ponaganset River Watershed.

Potential Conditions

Load Reduction Analysis

The pollutant loads associated with current conditions were initially estimated using PLET (see previous tables) and used as a baseline to assess the potential reductions associated with further implementation of BMPs across each watershed. As no water quality target (e.g., a TMDL) has been proposed for nutrients or sediment in the watershed at this time, a load reduction analysis was subsequently conducted. The analysis applied incremental increases in BMP implementation (implementation phases) from current conditions to meet the following targets:

- **Phase 1:** 10% reduction in TP loads from agricultural sources across the watershed.
- **Phase 2:** 20% reduction in TP loads from agricultural sources across the watershed.
- **Phase 3:** 30% reduction in TP loads from agricultural sources across the watershed.

The analysis provides information about the extent of practices that could be deployed on agricultural land to achieve realistic goals and get the most water quality benefit across the Barden Reservoir-Ponaganset River watershed. The associated load reductions provide a suite of targets that could be achieved through phased implementation. A summary of the phases modeled and the associated BMPs is provided in Table 16.

Table 16. Summary of implementation phases and load reductions simulated in the Barden Reservoir-Ponaganset River Watershed

Implementation Phase	Level of Implementation (% of Land Treated)			
	***Current**	**Phase 1**	**Phase 2**	**Phase 3**
Cropland				
Buffer - Forest (100ft wide)	10%	10%	10%	10%
Buffer - Grass (35ft wide)	2%	5%	8%	11%
Conservation Tillage1, Cover Crop 2, Nutrient Management 1, Forest Buffer	2%	2%	2%	2%
Conservation Tillage1, Cover Crop 2, Nutrient Management 1, Grass Buffer	1%	2%	3%	4%
Conservation Tillage1, Cover Crop 2, Nutrient Management 1	5%	6%	7%	8%
Conservation Tillage1, Nutrient Management 1, Grass Buffer	7%	9%	11%	13%
Conservation Tillage1, Nutrient Management 1	5%	6%	7%	8%
Cover Crop2, Nutrient Management 1, Grass Buffer	5%	5%	5%	5%
Cover Crop2, Nutrient Management 1	5%	7%	9%	11%
Conservation Tillage 1	5%	5%	5%	5%
Controlled Drainage	2%	2%	2%	2%
Cover Crop 2	5%	7%	4%	-
Cover Crop 3	-	-	5%	9%
Nutrient Management 1	5%	6%	3%	0%
Nutrient Management 2	-	-	4%	8%
Total	**59%**	**72%**	**85%**	**96%**

Implementation Phase	Level of Implementation (% of Land Treated)			
	*Current	Phase 1	Phase 2	Phase 3
Pasture/Hay				
30m Buffer with Optimal Grazing	2%	2%	2%	2%
Prescribed Grazing, Alternative Water Supply, Pasture and Hyland Planting, Heavy Use Area Protection, Forest Buffer	2%	2%	2%	2%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Heavy Use Area Protection, Grass Buffer	2%	3%	4%	5%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Heavy Use Area Protection	1%	2%	3%	4%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Forest Buffer	5%	5%	5%	5%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Grass Buffer	5%	7%	9%	11%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting	1%	2%	3%	4%
Prescribed Grazing, Pasture and Hayland Planting, Forest Buffer	5%	6%	7%	8%
Prescribed Grazing, Pasture and Hayland Planting, Grass Buffer	5%	6%	7%	8%
Prescribed Grazing, Pasture and Hayland Planting	2%	3%	4%	5%
Forest Buffer (minimum 35 feet wide)	5%	5%	5%	5%
Grass Buffer (minimum 35 feet wide)	5%	6%	7%	8%
Grazing Land Management (rotational grazing with fenced areas) • Prescribed Grazing (528) • Fence (382) • Pasture and Hay Planting (512) • Watering Facility (614)	5%	5%	5%	5%
Heavy Use Area Protection • Heavy Use Area Protection (561) • Roofs and Covers (367) • Fence (382) • Watering Facility (614)	2%	3%	4%	5%
Litter Storage and Management • Waste Storage Facility (313) • Composting Facility (317) • Roofs and Covers (367) • Roof Runoff Structure (558)	2%	2%	2%	2%
Livestock Exclusion Fencing • Fence (382)	2%	3%	4%	5%
Pasture and Hayland Planting (Forage Planting) • Pasture and Hay Planting (512)	5%	5%	5%	5%

Implementation Phase	Level of Implementation (% of Land Treated)			
	*Current	Phase 1	Phase 2	Phase 3
Prescribed Grazing • Prescribed Grazing (528) • Fence (382) • Pasture and Hay Planting (512) • Watering Facility (614)	5%	5%	5%	5%
Winter Feeding Facility • Heavy Use Area Protection (561) • Roofs and Covers (367) • Fence (382) • Watering Facility (614)	2%	2%	2%	2%
Total	**63%**	**74%**	**85%**	**96%**
Gully Restoration	**0%**	**25%**	**50%**	**75%**
Feedlots				
Diversion • Diversion (362) • Critical Area Planting (342) • Grassed Waterway (412) • Lined Waterway or Outlet (468)	5%	5%	5%	5%
Filter strip • Filter Strip (393)	10%	20%	30%	40%
Runoff Management System • Roof Runoff Structure (558) • Vegetated Treatment Area (635) • Conservation Cover (327)	5%	20%	30%	40%
Waste Management System • Waste Storage Facility (313) • Composting Facility (317) • Roofs and Covers (367) • Roof Runoff Structure (558)	2%	5%	8%	12%
Waste Storage Facility • Waste Storage Facility (313) • Composting Facility (317) • Roofs and Covers (367) • Roof Runoff Structure (558)	2%	2%	2%	2%
Zero Discharge	1%	1%	1%	1%
Total	**25%**	**53%**	**76%**	**100%**

Conservation Practice Effectiveness

In addition to individual crop and pastureland conservation practices, several combinations of practices were assumed to occur throughout the watershed under the existing conditions phase and future pollutant reduction phases of implementation. These combination practices have higher pollutant removal efficiencies than the individual practices.

Table 17 shows the modeled reduction efficiencies (%) associated with combinations of conservation practices in the Barden Reservoir-Ponaganset River watershed. This is useful to help identify the most effective combination of conservation practices to reduce pollutant loads. Full details on efficiencies associated with all individual practices can be found in Appendix B.

For cropland, simulations for the combination of conservation tillage (>60% residue), cover crops, nutrient management, and forest buffers (100 ft) was most effective at reducing nutrient and sediment loads. Substituting a grass buffer or removing the buffer component also resulted in high phosphorus removal efficiencies. For pasture/hay, the combination of prescribed grazing, alternative water supply, pasture and hayland planting, heavy use area protection, and a grass buffer was the most effective management option, followed by prescribed grazing, alternative water supply, pasture and hayland planting, and a grass buffer.

Table 17. Summary of combination conservation practice efficiencies in the Barden Reservoir-Ponaganset River Watershed

Conservation Practices	TN Efficiency	TP Efficiency	TSS Efficiency
Cropland			
Conservation Tillage1, Cover Crop 2, Nutrient Management 1, Forest Buffer	68%	83%	81%
Conservation Tillage1, Cover Crop 2, Nutrient Management 1, Grass Buffer	58%	82%	77%
Conservation Tillage1, Cover Crop 2, Nutrient Management 1	37%	67%	51%
Conservation Tillage1, Nutrient Management 1, Grass Buffer	48%	80%	75%
Conservation Tillage1, Nutrient Management 1	21%	65%	46%
Cover Crop2, Nutrient Management 1, Grass Buffer	55%	71%	58%
Cover Crop2, Nutrient Management 1	32%	49%	10%
Pastureland			
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Heavy Use Area Protection, Forest Buffer	82%	72%	83%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Heavy Use Area Protection, Grass Buffer	96%	95%	87%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Heavy Use Area Protection	68%	54%	64%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Forest Buffer	78%	66%	75%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Grass Buffer	95%	94%	81%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting	60%	43%	46%
Prescribed Grazing, Pasture and Hayland Planting, Forest Buffer	73%	61%	69%
Prescribed Grazing, Pasture and Hayland Planting, Grass Buffer	94%	93%	77%
Prescribed Grazing, Pasture and Hayland Planting	52%	35%	33%

Notes:

Conservation Tillage 1 = 30-59% residue; Conservation Tillage 2 = 60% or more residue
Cover Crop 2 = (Group A traditional normal planting time)
Nutrient Management 1 = Determined rate
Nutrient Management 2 = Determined rate plus additional considerations

Results

Load reductions associated with different management phases modeled in each watershed are provided in Table 18. The analysis suggests that further adoption of management practices on agricultural land would significantly reduce nutrient and sediment loads within the Barden Reservoir-Ponaganset River watershed. Simulations indicate that load reductions of 3%–9% for TN, 12%–33% for TP, and 17%–50% for total suspended solids (TSS) could be achieved depending on the implementation phase. The phases assume agricultural operations that currently implement one or two conservation practices will adopt additional practices to achieve further reductions, and those operations currently without conservation practices will adopt several new practices.

Table 18. Summary of management phases and load reductions simulated in the Barden Reservoir-Ponaganset River Watershed

	Load Reduction Analysis			
Implementation Phase	***Current**	**Phase 1**	**Phase 2**	**Phase 3**
TN Load (lbs) Total	***43,844***	**42,457**	**41,127**	**39,896**
Total Load Reduction	**-**	**3%**	**6%**	**9%**
Reductions by Source				
Cropland	-	12%	23%	28%
Pastureland	-	12%	24%	36%
Feedlots	-	3%	5%	9%
Gully	-	25%	50%	75%
TP Load (lbs) Total	***13,221***	**11,689**	**10,271**	**8,849**
Total Load Reduction	**-**	**12%**	**22%**	**33%**
Reductions by Source				
Cropland	-	13%	25%	35%
Pastureland	-	10%	21%	31%
Feedlots	-	30%	54%	80%
Gully	-	25%	50%	75%
TSS Load (tons) Total	***1,828***	**1,524**	**1,220**	**916**
Total Load Reduction	**-**	**17%**	**33%**	**50%**
Reductions by Source				
Cropland	-	7%	15%	22%
Pastureland	-	10%	20%	30%
Gully	-	25%	50%	75%

Note:
* Current: existing BMP implementation estimated by NRCS

Feedlots and gully restoration, coupled with other practices on crop and pastureland, are indicated to be integral to achieving reduction targets (see Table 16). Feedlot areas were currently considered to be treated by some pollutant reducing practices—existing practices are very efficient and broader implementation was suitable to gain additional reductions. In addition, the number of gullies treated/repaired each year increased through the implementation phases. Gullies are caused by erosive forces triggered by a number of factors, including excess rainfall, poor infiltration, concentrated runoff from upslope or excessive erosion within wheel tracks and furrows. Gully prevention strategies vary based on the cause of erosion, but generally focus on vegetation as mitigation. Measures could include cover crops, contouring, no-till, strip cropping, residue cover, and grassed waterways. Irrigation treatment (e.g., irrigation water management) was assumed to reduce the amount of irrigation water used and associated contribution to cropland runoff. For current conditions, water depth per irrigation was 2 inches (information from NRCS). Water depth per irrigation was reduced to 1.5 inches for Phase 1, and 1 inch for Phase 2 and Phase 3.

Summary of Agricultural Risk Areas

To target areas with the most pollution potential, a map of runoff risk was developed using ACPF to help field staff isolate areas of concern and prioritize projects. Four vulnerability classes were used to rank the agricultural risk based on runoff potential. Risk classification includes A (very high risk), B (high), C (moderate), and D (low) designations (Porter et al. 2018). Figure 29 shows the process applied in ACPF for assigning runoff risk classifications to fields.

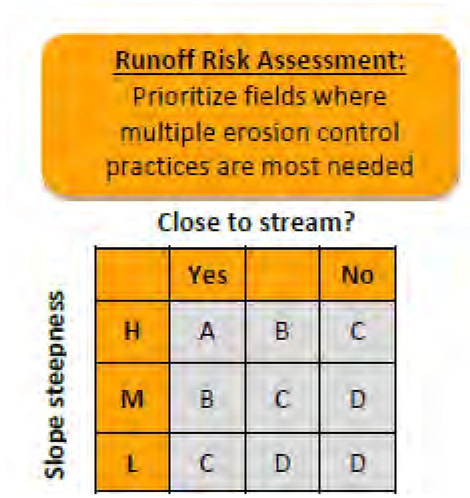

Figure 29. Runoff risk assessment matrix applied in the ACPF.

Fields with "very high" or "high" runoff risk represent the most critical areas for pollution potential from agricultural land and should be prioritized for planning. Land areas indicated to have a "moderate" runoff risk are also a key pollution source. "Low" risk fields are considered a lesser priority for treatment. A "low" classification does not mean that a runoff-control conservation practice would not benefit a given field, but rather indicates that other fields have a greater potential to deliver sediment and nutrients to the streams via surface runoff (Porter et al. 2018). Figure 30 shows the spatial distribution of vulnerable fields in the watersheds and helps to locate agricultural land areas where conservation measures could be focused to meet water quality goals. The breakdown of classifications by drainage area is provided in Table 19.

Table 19. Summary of runoff risk acres for fields within the Barden Reservoir-Ponaganset River watershed.

Drainage Class	Area (acres)	No. of Fields
A-Very High	18	3
B-High	70	18
C-Moderate	64	18
D-Low	146	42
Null	991	75

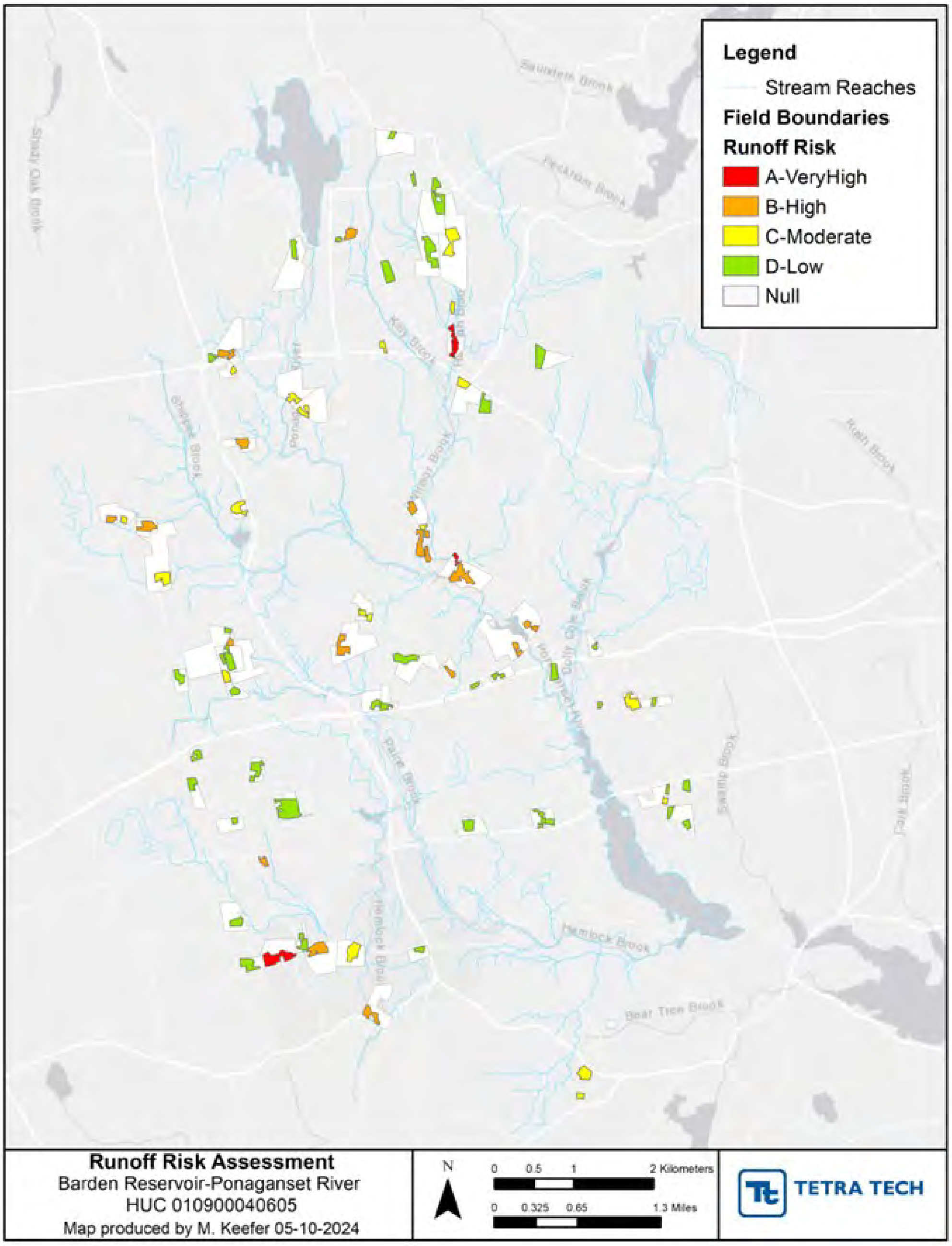

Figure 30. Spatial distribution of run off risk classifications for fields within the Barden Reservoir-Ponaganset River watershed.

The tile drainage classification tool estimates which fields are likely to be tile drained based on a combination of by-field slope and soils information. Figure 31 shows potential agricultural fields with tile drains in the watershed. The following conditions are indicated as being met for fields:

- Condition 1 = fields with both "slope OR soils condition A" and "slope OR soils condition B".
- Condition 2 = fields with slope "OR" soils condition A.
- Condition 3 = fields with slope "OR" soils condition B.

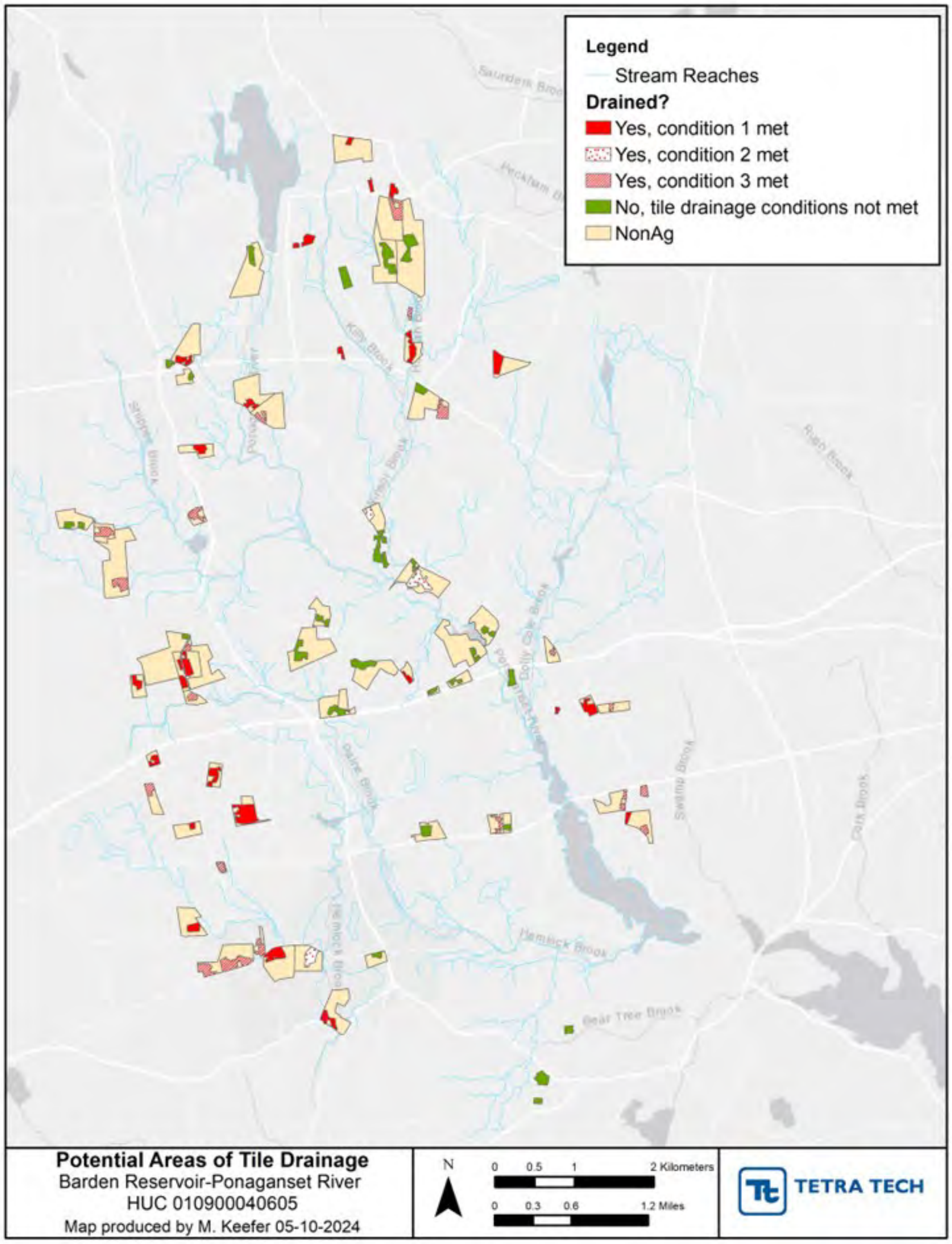

Figure 31. Potential areas of tile drainage for Barden Reservoir-Ponaganset River (HUC 010900040605) [Condition 1 = fields with both "slope OR soils condition A" and "slope OR soils condition B" met; Condition 2 = fields with slope "OR" soils condition A met only; Condition 3 = fields with slope "OR" soils condition B met only].

Soils condition A indicates that ≥10% of the field has a mean hydric soil percentage ≥10%. Soil condition B indicates that ≥40% of the field is poorly drained soils (HSG D or dual-class). The slope condition highlights where ≥90% of the field has a slope <5%.

The spatial maps on runoff risk and tile drain conditions by agricultural field can help prioritize locations to focus implementation efforts. To further help with implementation planning, the number of fields characterized as having moderate to very high runoff risk within 300 feet of a waterbody are indicated in

Table 20. Table 21 shows the number of fields meeting drainage condition 1 to 3 within 300 feet of a waterbody. Appendix C provides additional information about the number of fields meeting runoff risk classes and drainage conditions at distances more than 300 feet from a waterbody.

Note that agricultural land areas only make up a small proportion (< 10%) of the watershed. Most of the watershed is forest land, which is also eligible for treatment within the NWQI program; however, pollutant loadings from agricultural sources are considered to be key controllable contributing factors.

Table 20. Number of fields within 300 feet of the nearest waterbody classified to have Very High, High, and Moderate runoff risk.

Waterbody Name	Waterbody Type	A - Very High	B - High	C- Moderate
Hannah Brook	Stream/Brook	1		2
Huntington Brook	Stream/Brook		1	1
Ponaganset River	Stream/Brook		1	1
Tributary to Hemlock Brook	Stream/Brook		3	2
Tributary to Killy Brook	Stream/Brook		1	
Tributary to Paine Brook	Stream/Brook		1	
Tributary to Ponaganset River	Stream/Brook		2	
Tributary to Shippee Brook	Stream/Brook			2
Tributary to Winsor Brook	Stream/Brook		1	1
Winsor Brook	Stream/Brook	1	4	1
Hopkins Mill Pond	Lake/Pond		2	
Unnamed Waterbody	Lake/Pond	1	2	1
Grand total		**3**	**18**	**11**

Note:
Field proximities to streams/brooks and lakes/ponds were determined separately.

Table 21. Number of fields within 300 feet of the nearest waterbody meeting drainage condition 1, 2, and 3.

Waterbody Name	Waterbody Type	Condition 1	Condition 2	Condition 3
Hannah Brook	Stream/Brook	1		1
Huntington Brook	Stream/Brook			2
Paine Brook	Stream/Brook			2
Ponagansett River	Stream/Brook	1		
Tributary to Dolly Cole Brook	Stream/Brook			2
Tributary to Hemlock Brook	Stream/Brook	3	1	2
Tributary to Killy Brook	Stream/Brook	1		
Tributary to Paine Brook	Stream/Brook			1
Tributary to Ponagansett River	Stream/Brook	2		1
Tributary to Shippee Brook	Stream/Brook			2
Tributary to Winsor Brook	Stream/Brook	1	1	
Winsor Brook	Stream/Brook	1	1	
Unnamed Waterbody	Lake/Pond	5		8
Grand Total		**15**	**3**	**21**

Notes:
Field proximities to streams/brooks and lakes/ponds were determined separately.
[Condition 1 = fields with both “slope OR soils condition A” and “slope OR soils condition B” met; Condition 2 = fields with slope “OR” soils condition A met only; Condition 3 = fields with slope “OR” soils condition B met only].

Analysis of Treatment and Opportunities

Current Level of Treatment in the Watershed

Because Rhode Island is not a traditional agricultural state, it can be challenging to follow normal agricultural characterizations within watersheds using conventional inventories such as land use/cover. Such inventories represent the best data publicly available and can be used as a guideline for characterization. Rhode Island's farms are typically small and diverse and often contribute to water quality issues from lands that are not explicitly characterized as agricultural. Acres contributing to agriculture can therefore seem under-reported when compared to available land use/cover data. To capture all potential agricultural lands, NRCS in Rhode Island endeavors to reach agricultural producers by assessing conventional land cover data and also accounting for "backyard farms", which are common in the state.

In 2012, NRCS in Rhode Island collaborated with the RIDEM and with the Rhode Island Association of Conservation Districts to develop a statewide agricultural inventory. This inventory provided NRCS and RIDEM with a snapshot of "backyard farming" and general information about conservation needs across the state. Informed by this information and good outreach, Rhode Island's conservation acres have extended beyond normal land cover acres.

The Barden Reservoir-Ponaganset River watershed is typical of state agriculture and includes a number of backyard farms. Since 2015, 80 conservation practices have been applied across 2,105 planning land unit acres (PLUs - distinct acres of land equivalent of a field that have similar management) in the Barden Reservoir-Ponaganset River watershed. NRCS NWQI approved conservation practices benefit water quality by avoiding, controlling, or trapping pollutants and account for 80% of the applied conservation practices. Of the NWQI approved conservation practices, 17 were "Core" conservation practices as identified by the NWQI. NWQI "Core" conservation practices are conservation practices that have the most benefit for addressing water quality issues. The 17 "Core" conservation practices were applied on 89 PLU acres across the Barden Reservoir-Ponaganset River watershed. This would equate to approximately 21% of the land use acres for cropland and pastureland as having some level of treatment. During the last 10 years, "Core" conservation practices have accounted for 4% of the total applied conservation practices PLU acreage. NWQI "supporting" conservation practices are applied in support of the "Core" conservation practices. Over the last 10 years, there have been 47 "Supporting" conservation practices applied across 1,254 PLU acres. Core and supporting conservation practice currently implemented are shown in Table 22.

Table 22. Number (no.) of core and supporting conservation practices applied (2015–2024)

Conservation Practices	Core (no.)	Supporting (no.)	Grand Total
Prescribed Grazing	13		13
Cover Crop	1		1
Critical Area Planting	2		2
Filter Strip	1		1
Brush Management		13	13
Fence		19	19
Pasture and Hay Planting		8	8
Herbaceous Weed Treatment		1	1
Watering Facility		3	3
Livestock Pipeline		2	2
Mulching		1	1
Grand Total	17	47	64

Analysis of Producers Available in the Watershed to Participate in the Initiative and Their Likely Willingness to Participate

Farm Service Agency (FSA) data indicates 144 distinct tracts within the Barden Reservoir-Ponaganset River watershed. NRCS data indicates that there are 18 distinct tracts that have utilized NRCS programs over the last 10 years and implemented 80 conservation practices. Of those tracts, 9 distinct tracts have applied 17 "Core" conservation practices.

One goal will be to increase participation from the 18 distinct tracts for water quality purposes. Some producers may be ineligible to participate, but the local field office will offer technical assistance to encourage treatment in critical source areas. Eligible producers throughout the watershed will be able to apply for programs to receive financial assistance for implementing conservation practices to promote water quality. As part of NRCS' financial assistance programs, applicants go through a process to rank the assessment and planned practices so that assistance can be prioritized in areas that are the most vulnerable. Additional ranking points will be given to producers located in areas that are rated "very high", "high", or "moderate" within high priority critical source areas. Ranking points will be greatest for locations rated "very high "and lowest for locations rated "moderate" or "low".

NRCS data indicates that while there is a considerable willingness for producers to participate in NRCS programs within the Barden Reservoir-Ponaganset River, varying levels of conservation currently exist throughout the watershed. A key goal will be to increase the level of conservation using a systematic approach where suites of conservation practices will be applied in combination to achieve pollutant load reduction targets. To promote conservation practice implementation, additional ranking points will be given to producers willing to increase their level of conservation using recommended practices. When an applicant receives extra points for high priority critical source areas and/or increasing their level of conservation using recommended practices, the applicant will achieve a higher overall score ranking and have a better opportunity to receive funding. This ranking process is critical if a limited amount of funding is available. By providing priority rankings, funding is directed to areas where it will provide the most water quality benefit.

NRCS in Rhode Island will continue using an Outreach Agreement with the Districts to support implementation in the broader Scituate Reservoir drainage area. Outreach events will be tracked to provide information such as type of event and number of participants attending. NRCS will monitor the implementation progress based on number of contracts/practices, and accordingly adjust the number of outreach events that occur each year.

Assessment of Balancing Critical Area Treatment with Participation to Achieve the Most Effective Prioritization of Implementation

To effectively prioritize implementation of conservation practices, runoff risk areas identified by the ACPF will be used to provide "Critical Areas of Treatment" (see Summary of Risk Areas section, above). Projects located in these critical areas ("Moderate", "High", and "Very High" areas) will receive increasing points towards overall ranking score. Additional ranking points will also be provided to participants that increase the level of conservation implementation through use of practice bundles to achieve a better level of pollutant load reduction. By adding points for these priority criteria, participants will be provided with a greater opportunity for NRCS program funding and conservation efforts will proceed where they are most needed. Additionally, participants will have opportunities for selection within the EQIP fund pool as well as the NWQI fund pool.

Set of Preferred Practices, Locations, Responsible Parties, Costs, and Timelines

NRCS Rhode Island will seek to provide assistance in the Barden Reservoir-Ponaganset River watershed utilizing multiple approaches to planning. This is needed to achieve the different levels of load reductions that are suggested for the watershed. NRCS Rhode Island will continue to work within the NWQI conservation practice concepts for "Avoiding, Controlling, and Trapping" nutrients to benefit water quality while also increasing the level of conservation by promoting load reduction conservation practices as a systematic approach in which a suite of conservation practices will be applied together to achieve the desired level of load reduction.

As mentioned previously, NRCS' NWQI program has a set of approved conservation practices that benefit water quality by avoiding, controlling, or trapping pollutants. The list of practices is broken down into "Core" or "Supporting" conservation practices. For NWQI purposes a "Core" practice is required and may be accompanied by "Supporting" practices but "Supporting" practices cannot be planned alone. These practices may be planned in the watershed—a full list of approved "Core" and "Supporting" conservation practices is provided in Table 23 and Table 24.

Table 23. Approved list of "core" conservation practices

Core Practices	Code	Avoiding	Controlling	Trapping
Waste Storage Facility	313	X	X	
Animal Mortality Facility	316		X	
Composting Facility	317	X	X	
Conservation Cover	327	X		X
Conservation Crop Rotation	328	X		
Residue and Tillage Management, No Till/Strip Till/Direct Seed	329		X	X
Contour Farming	330		X	X
Contour Orchard and Other Perennial Crops	331		X	X
Contour Buffer Strips	332			X
Cover Crop	340	X		X
Critical Area Planting	342		X	X
Residue and Tillage Management, Reduced Till	345		X	X
Well Water Testing	355	X		
Waste Treatment Lagoon	359		X	
Waste Facility Closure	360	X		
Anaerobic Digester	366		X	
Field Border	386		X	X
Riparian Herbaceous Cover	390			X
Riparian Forest Buffer	391			X
Filter Strip	393		X	X
Stream Habitat Improvement and Management	395	X		
Grade Stabilization Structure	410		X	X
Grassed Waterway	412		X	
Irrigation Reservoir	436		X	
Irrigation Water Management	449		X	

Core Practices	Code	Avoiding	Controlling	Trapping
Access Control	472	X		
Prescribed Grazing	528	X		
Drainage Water Management	554		X	
Heavy Use Area Protection	561	X		
Trails and Walkways	575		X	
Streambank and Shoreline Protection	580	X		
Nutrient Management	590	X		
Terrace	600		X	
Vegetative Barrier	601			X
Tree/Shrub Establishment	612	X		X
Waste Treatment	629		X	
Waste Recycling	633		X	
Waste Transfer	634	X		
Vegetated Treatment Area	635			X
Water and Sediment Control Basin	638		X	X
Constructed Wetland	656			X

Table 24. Approved list of “supporting” conservation practices

Supporting Practices	Code	Avoiding	Controlling	Trapping
Agrichemical Handling Facility	309	X		
Alley Cropping	311		X	X
Brush Management	314	X	X	
Herbaceous Weed Control	315	X		
Prescribed Burning	338	X		
Sediment Basin	350		X	
Water Well Decommissioning	351	X		
Dike	356		X	X
Diversion	362		X	
Roofs and Covers	367	X	X	
Pond	378			X
Windbreak/Shelterbelt Establishment	380		X	X
Silvopasture Establishment	381	X		
Fence	382	X		
Dam	402		X	X
Hedgerow Planting	422	X		X
Hillside Ditch	423		X	
Irrigation Ditch Lining	428	X	X	
Irrigation Pipeline	430		X	
Irrigation System, Micro irrigation	441	X		
Sprinkler System	442	X		

Supporting Practices	Code	Avoiding	Controlling	Trapping
Irrigation System, Surface & Subsurface	443	X		
Precision Land Forming	462			X
Irrigation Land Leveling	464	X	X	
Lined Waterway or Outlet	468		X	
Mulching	484		X	X
Forage Harvest Management	511	X	X	
Forage and Biomass Planting	512	X		X
Livestock Pipeline	516	X	X	
Range Planting	550			X
Row Arrangement	557	X		
Roof Runoff Structure	558	X		
Access Road	560	X		
Spring Development	574	X		
Stream Crossing	578	X		
Open Channel	582		X	
Stripcropping	585		X	
Structure for Water Control	587		X	X
Cross Wind Ridges	588		X	
Cross Wind Trap Strips	589C		X	X
Amendments for the Treatment of Agricultural Waste	591	X	X	
Integrated Pest Management	595	X		
Herbaceous Wind Barriers	603		X	
Surface Drain, Field Ditch	607		X	
Surface Drain, Main or Lateral	608		X	
Surface Roughening	609	X		
Watering Facility	614	X		
Underground Outlet	620		X	
Solid/Liquid Waste Separation Facility	632		X	
Waterspreading	640		X	
Water Well	642	X		
Restoration and Management of Declining Habitats	643	X		
Wetland Wildlife Habitat Management	644		X	
Windbreak/Shelterbelt Renovation	650		X	X
Wetland Restoration	657		X	
Wetland Creation	658		X	
Wetland Enhancement	659		X	

Costs and Timeline

Cropland

It is estimated that over the next 10 years NRCS can increase the level of participation and the level of conservation by implementing conservation practices on the estimated acreage for 35 acres of cropland (see Table 25). Using a systems approach, a higher level of conservation can be accomplished focusing on the practices that are commonly used in Rhode Island to provide benefits to water quality. Other conservation practices may be used from the NWQI Conservation Practice list for "Core" and "Supporting" conservation practices.

Table 25. Conservation investment information for cropland

CONSERVATION SYSTEMS BY TREATMENT LEVELS	FUTURE	USDA INVESTMENT		
	New Treatment Units	Installation Cost 75%	Technical Assistance 20%	Total Present Value Cost
Progressive System Acres Treated	**33**			
Cover Crop (ac.) 340	24	$51,346	$10,269	$61,616
Filter Strip (ac.) 393	1	$319	$64	$383
Mulching (ac.) 484	16	$5,915	$1,183	$7,098
Nutrient Management (ac.) 590	20	$24,646	$4,929	$29,576
Residue and Tillage Management, Mulch Till (ac.) 345	20	$647	$129	$776
Riparian Forest Buffer (ac.) 391	4	$10,317	$2,063	$12,380
Riparian Herbaceous Cover (ac.) 390	7	$8,730	$1,746	$10,476
Soil and Source Testing for nutrient management - #7 Soil Test (no	33	$23,294	$4,659	$27,953
	Subtotal	**$125,215**	**$25,043**	**$150,258**
Resource Management System (RMS) Acres Treated	**2**			
Cover Crop (ac.) 340	1.1	$2,285	$457	$2,742
Filter Strip (ac.) 393	0.02	$8	$2	$10
Mulching (ac.) 484	0.9	$321	$64	$385
Nutrient Management (ac.) 590	1.0	$1,217	$243	$1,460
Residue and Tillage Management, Mulch Till (ac.) 345	1.0	$32	$6	$38
Riparian Forest Buffer (ac.) 391	0.1	$258	$52	$310
Riparian Herbaceous Cover (ac.) 390	0.2	$218	$44	$262
Soil and Source Testing for nutrient management - #7 Soil Test (no	0.8	$582	$116	$699
	Subtotal	**$4,921**	**$984**	**$5,905**
TOTAL ACRES TREATED / ESTIMATED TREATMENT COSTS	**35**	**$130,136**	**$26,027**	**$156,163**

Pastureland

It is estimated that over the next 10 years NRCS can increase the level of participation and the level of conservation by implementing conservation practices on the estimated acreage for 276 acres of pastureland (see Table 26). Using a systems approach, a higher level of conservation can be accomplished focusing on the practices that are commonly used in Rhode Island to provide benefits to water quality. Other conservation practices may be used from the NWQI Conservation Practice list for "Core" and "Supporting" conservation practices.

Table 26. Conservation investment information for pasture

CONSERVATION SYSTEMS BY TREATMENT LEVELS	FUTURE	USDA INVESTMENT		
	New Treatment Units	Installation Cost 75%	Technical Assistance 20%	Total Present Value Cost
Progressive System Acres Treated	**261**			
Animal Trails and Walkways (ft.) 575	5,997	$42,413	$8,483	$50,896
Composting Facility (sf.) 317	2,868	$68,361	$13,672	$82,033
Fence (ft.) 382	26,074	$74,701	$14,940	$89,641
Heavy Use Area Protection (sf.) 561	28,681	$346,323	$69,265	$415,587
Pasture & Hayland Planting (ac.) 512	117	$49,121	$9,824	$58,945
Pipeline (ft.) 516	15,644	$45,642	$9,128	$54,770
Prescribed Grazing (ac.) 528	156	$18,040	$3,608	$21,648
Roofs and Covers (sf.) 367	3,129	$46,017	$9,203	$55,221
Waste Storage Facility (sf.) 313	574	$4,487	$897	$5,385
Watering Facility (no.) 614	52	$19,555	$3,911	$23,466
	Subtotal	**$714,660**	**$142,932**	**$857,592**
Resource Management System (RMS) Acres Treated	**15**			
Animal Trails and Walkways (ft.) 575	149.9	$1,060	$212	$1,272
Composting Facility (sf.) 317	71.7	$1,709	$342	$2,051
Critical Area Planting (ac.) 342	0.1	$179	$36	$215
Diversion (ft.) 362	305.0	$826	$165	$991
Fence (ft.) 382	651.8	$1,868	$374	$2,241
Filter Strip (ac.) 393	0.3	$149	$30	$179
Grassed Waterway (ac.) 412	0.1	$339	$68	$406
Heavy Use Area Protection (sf.) 561	717.0	$8,658	$1,732	$10,390
Lined Waterway or Outlet (ft.) 468	305.0	$35,736	$7,147	$42,883
Pasture & Hayland Planting (ac.) 512	7.5	$3,143	$629	$3,772
Prescribed Grazing (ac.) 528	7.7	$891	$178	$1,069
Riparian Forest Buffer (ac.) 391	1.8	$4,817	$963	$5,780
Riparian Herbaceous Cover (ac.) 390	3.0	$4,076	$815	$4,891
Roof Runoff Structure (no.) 558	38.1	$653	$131	$784
Roofs and Covers (sf.) 367	78.2	$1,150	$230	$1,381
Soil and Source Testing for nutrient management - #7 Soil Test (no	1.5	$1,088	$218	$1,305
Waste Storage Facility (sf.) 313	14.3	$112	$22	$135
	Subtotal	**$66,453**	**$13,291**	**$79,744**
TOTAL ACRES TREATED / ESTIMATED TREATMENT COSTS	**276**	**$781,113**	**$156,223**	**$937,335**

V. Summary and Recommendations

This section summarizes water quality resource concerns, the water quality goals, and the extent that the problem can be addressed through NRCS technical and financial assistance.

Description of Water Quality Impairments

While there are no streams within the watershed currently deemed impaired for nutrients or sediment, recent water quality monitoring data (from PWSB and USGS) suggests that elevated levels of phosphorus occur episodically at stream sites throughout the watershed.

Additionally, the most recent *State of Rhode Island 2022 Impaired Waters Report* states that parts of the Winsor Brook (RI0006015R-30) and Shippee Brook (RI0006015R-23) are impaired due to excessive levels of bacteria (*Enterococcus*). A TMDL has been approved for Winsor Brook.

Description of the Water Quality Reduction Goals

The main goal is to meet designated criteria for surface water classes in the Barden Reservoir-Ponaganset River watershed based on the state's water quality standards (RIDEM 2020). Freshwaters in the Barden Reservoir-Ponaganset River watershed have been assigned to Class AA (see Figure 19 for details).

- Class AA waters: are designated as a source of PDWS or as tributary waters within a PDWS watershed, for primary and secondary contact recreational activities and for fish and wildlife habitat. They shall have excellent aesthetic value.

The NWQI is focused on agricultural sources of nonpoint sources of pollution; therefore the main objective is to reduce nutrient, sediment, and bacterial loadings from agricultural sources and ensure waters are suitable for fish, wildlife, and recreation (based on state or recommended criteria). Conservation practices for agricultural operations should reduce the potential of nutrient, sediment, and bacterial laden runoff from reaching waterbodies.

Establish Interim Metrics to Track Progress

For the periods of 2025–2035, goals will be focused on increasing participation and increasing level of conservation for water quality. The increased level of conservation will prioritize the modelled conservation practices outlined in Table 16 for addressing water quality issues. However, given the voluntary nature of NRCS' Programs, planners will utilize the NWQI approved "Core and Supporting" conservation practice list in Table 23 and Table 24 in cases where the modelled approach is not chosen by the landowner. The NRCS based metrics for tracking progress would utilize:

1. Integrated Data for Enterprise Analysis (IDEA) which provides reports for internal analysis of National Planning and Agreements Database (NPAD).
2. Protracts which provides contracting information.

Metrics will include the number of clients, acres treated, and practices planned and installed. The percent of pollutant load reduced will also be tracked throughout the watershed based on modeled efficiencies for conservation practices. Annual review of these metrics will allow progress to be analyzed and discussed to better determine if goals for implementation and effectiveness are on track. Water quality monitoring will continue to be done by PWSB and USGS, which can inform progress towards implementation goals.

Locations of Critical Source Areas or Vulnerable Acres Needing Treatment

Fields with "very high" or "high" runoff risk represent the most critical areas for pollution potential from agricultural land and should be prioritized for planning. Land areas indicated to have a "moderate" runoff risk are also a key pollution source. "Low" risk fields are considered a lesser priority for treatment. A "low" classification does not mean that a runoff-control conservation practice would not benefit a given field, but rather indicates that other fields have a greater potential to deliver sediment and nutrients to the streams via surface runoff (Porter et al. 2018). Locations of these critical source areas are shown in Figure 30, with a summary of runoff risk acres for fields within the Barden Reservoir-Ponaganset River watershed detailed in Table 19.

Description and Evaluation of Planned Practice Phases and Alternatives that Meet the Water Quality Goals, Including Estimation of Treatment Costs

To increase the level of conservation, NRCS Rhode Island will promote conservation systems to improve nutrient reducing efficiencies. Conservation systems that will be included are listed in Table 17. Conservation practices included on the NWQI list of core and supporting conservation practices will also be utilized as needed.

Documentation of NEPA Concerns

The National Environmental Policy Act (NEPA) of 1964 requires all federal agencies to conduct an environmental review of all federal actions. This requirement also applies to area wide or watershed planning activities. As part of these plans the responsible federal agency is required to evaluate the individual and cumulative effects of the actions being proposed. Any project that has significant environmental impacts must be evaluated with an Environmental Assessment (EA) or Environmental Impact Statement (EIS), unless the activities are eligible under a categorical exclusion or are covered by an existing EA or EIS.

NRCS utilizes a planning process that incorporates an evaluation of potential environmental impacts using an Environmental Evaluation checklist. NRCS also has categorical exemptions for a number of different activities that include many NRCS conservation practices. These categorical exemptions include conservation practices that reduce soil erosion, involve the planting of vegetation and/or restore areas to natural ecological systems.

As mentioned above, as part of the planning process, each planned practice will be evaluated individually and in combination with other planned practices to ensure it meets the criteria of the categorical exclusions and any existing EAs. Any significant negative practice impacts, either individually or cumulatively, will first try to be avoided, then minimized and/or mitigated to the extent possible or eliminated from the individual farm plan if necessary.

Documentation of NHPA Concerns

Section 106 of the National Historic Preservation Act (NHPA), as amended (1966) (54 U.S.C. § 306108) (P.L. 89-665) and its implementing regulations found at 36 CFR 800, mandates federal agencies to "take into account" the effect a project (federally funded or permitted) may have on historic properties (e.g. sites listed in, or eligible for listing in, the National Register of Historic Places). Historic properties include any "prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places, including artifacts, records, and material remains related to such a property or resource" (54 U.S.C. § 300308).

Similar to environmental impacts, NRCS utilized a planning process that incorporates the evaluation of cultural resources. Each planned practice is evaluated individually and in combination to determine the potential to affect historic properties and if the practices. When practices have the potential to affect historic properties both the State Historic Preservation Office (SHPO) and the Tribal Historic Preservation Offices (THPOs) takes place. Any significant negative practice impacts, either individually or cumulatively, will first try to be avoided, then minimized and/or mitigated to the extent possible or eliminated from the individual farm plan if necessary.

Outreach Strategy and Plan

NRCS Rhode Island has a Public Affairs Specialist on staff and utilizes partnership agreements with the Soil and Water Districts of Rhode Island to provide assistance with outreach. This partnership allows NRCS to increase outreach efforts, as well as reach more of the public than NRCS could alone. The SWCDs coordinate outreach events with NRCS staffing to place the right people in the right place at the right time. This model has demonstrated benefits and value in our efforts to reach the public with NRCS programs over the years.

The overall objective of community outreach in the Barden Reservoir-Ponaganset River watershed is to develop an atmosphere that promotes the understanding and desire for sustained, long-term protection and improvement of the aquatic resources in the watershed. Specific goals of education efforts in the watershed include the following:

- Increase public awareness of the value of clean water.
- Increase public awareness of agricultural runoff and encourage behaviors that will help reduce levels of nutrients and sediment in the watershed, better understand watershed dynamics, and foster stewardship opportunities.
- Increase public awareness of how BMPs can help improve water quality and habitat restoration.
- Increase public awareness of the long term environmental and economic advantages of protecting and improving water quality and habitat in the Barden Reservoir-Ponaganset River watershed.

The outreach strategy also seeks to leverage other outreach efforts active in the broader Scituate Reservoir drainage area, namely the Scituate Reservoir Watershed Education Program (funded by Providence Water) and the Conservation District/USDA NRCS Outreach Program (funded by USDA NRCS) to share the findings of the watershed-level assessments with community stakeholders and empower them to take steps to conserve water quality in their communities. Conservation District staff will maintain close contact with relevant USDA NRCS staff throughout the process of completing these deliverables. Table 27 outlines objectives, indicators, and an implementation schedule identified to meet the education and outreach goals defined above.

Table 27. Identified deliverables, schedule, and other details to meet education and outreach goals

Deliverable	Approximate Date	Description	Projected Reach
Press release created in partnership with USDA NRCS public affairs specialist	Within one month of completion of plans	Press release will be published in the Foster Home Journal and also sent to EcoRI, the Valley Breeze Observer, Boston Globe, and Providence Journal	Approximately 14,000 homes for Foster Home Journal; reach will increase if picked up by other outlets
“Healthy Farm, Healthy Watershed” workshop at Scituate Community House	February/March 2025	Indoor educational workshop focused on practical opportunities for livestock farmers in the Scituate Reservoir watershed to protect their community’s water resources. Existing resources from the concluded Healthy Farm, Healthy Watershed project will be utilized	Approximately 20 livestock owners who are candidates for Farm Bill/IRA program participation
“Healthy Farm, Healthy Watershed” tour in Foster, Glocester, or Scituate	April/May 2025	Outdoor tour of a farm utilizing good conservation practices with livestock that will share practical suggestions for conservation with other livestock owners	Approximately 20 livestock owners who are candidates for Farm Bill/IRA program participation
“Your Farms, Your Watershed” factsheet/infographic	May 2025	Handout to be distributed and posted publicly that summarizes key findings from the plans in an attractive and easily-readable format	400 recipients of Neighbor to Neighbor packets, 100 attendees of public events in 2025
“Watershed Wednesdays” social media series	April/May 2025	Series of ten social media posts will emphasize water quality findings found in the watershed plans in a fun and engaging way	200–2000 post viewers, depending on algorithm reach
“Manure Mondays” video post series	May/June 2025	Series of social media posts directing viewers to existing NRICD manure management videos as well as USDA NRCS manure management resources	200–2000 post viewers, depending on algorithm reach
Final Review of Phase 1 outreach plan; submission of Phase 2 plan	August 2025	Document summarizing reach of the Phase 1 deliverables and submitting a plan for Phase 2	Submitted to project team

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Appendix A

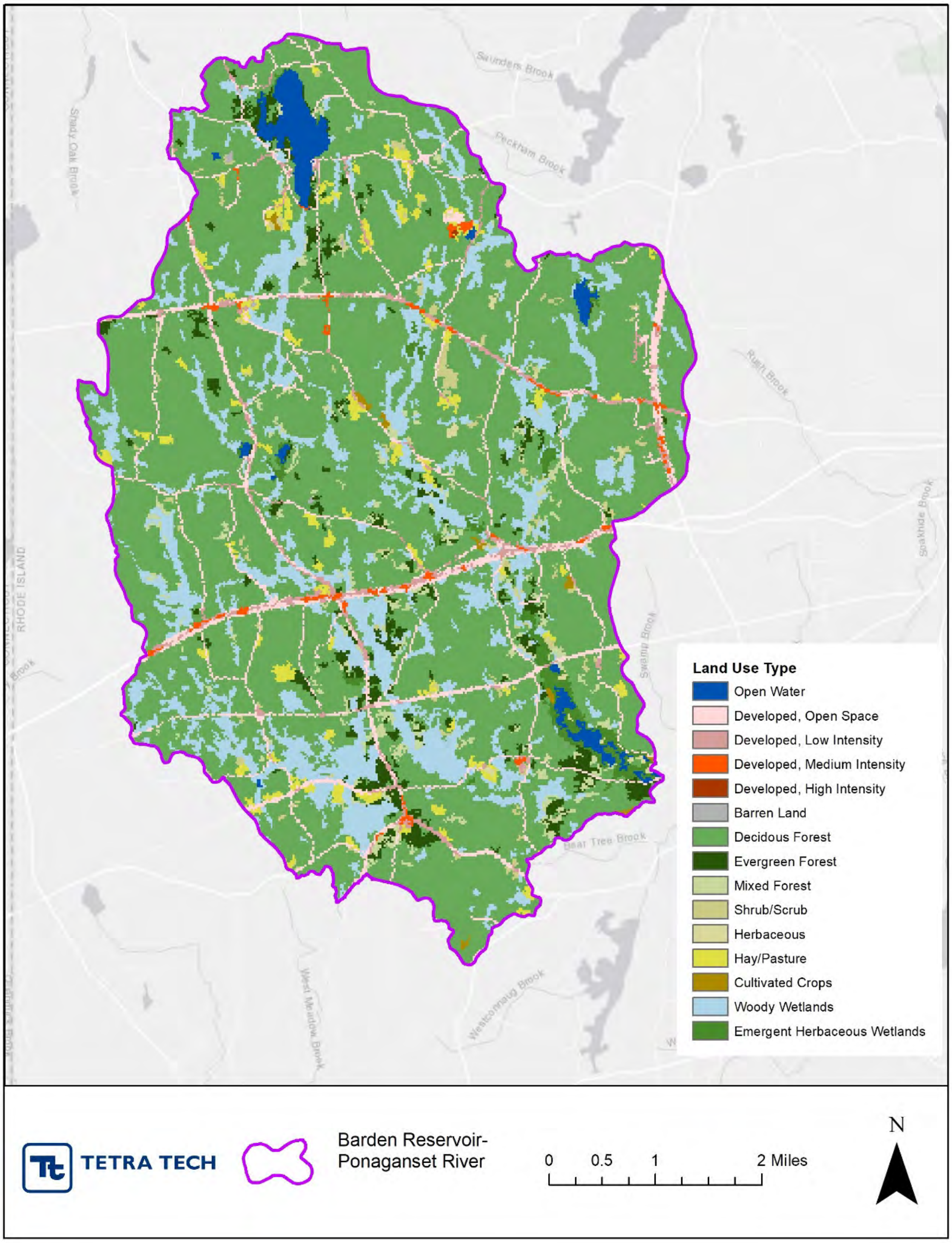

Figure A-1. Spatial distribution of land cover within the Barden Reservoir-Ponaganset River watershed (Dewitz and USGS 2021).

Appendix B

Table B-1. Reduction efficiencies (%) associated with individual and combinations of conservation practices in the Barden Reservoir-Ponaganset River watershed

Conservation Practices	TN Efficiency	TP Efficiency	TSS Efficiency
Cropland			
Combination Practices			
Conservation Tillage1, Cover Crop 2, Nutrient Management 1, Forest Buffer	70%	82%	78%
Conservation Tillage1, Cover Crop 2, Nutrient Management 1, Grass Buffer	62%	81%	75%
Conservation Tillage1, Cover Crop 2, Nutrient Management 1	42%	67%	46%
Conservation Tillage1, Nutrient Management 1, Forest Buffer	63%	81%	75%
Conservation Tillage1, Nutrient Management 1, Grass Buffer	52%	80%	72%
Conservation Tillage1, Nutrient Management 1	28%	65%	40%
Cover Crop2, Nutrient Management 1, Forest Buffer	65%	73%	63%
Cover Crop2, Nutrient Management 1, Grass Buffer	55%	71%	58%
Cover Crop2, Nutrient Management 1	32%	49%	10%
Conservation Tillage 2, Cover Crop 2, Nutrient Management 2, Forest Buffer	76%	93%	91%
Conservation Tillage 2, Cover Crop 2, Nutrient Management 2, Grass Buffer	70%	93%	90%
Conservation Tillage 2, Cover Crop 2, Nutrient Management 2	55%	87%	79%
Individual Practices			
Bioreactor	45%	ND	ND
Buffer - Forest (100ft wide)	48%	47%	59%
Buffer - Grass (35ft wide)	34%	44%	53%
Combined BMPs-Calculated	0%	0%	0%
Conservation Tillage 1 (30-59% Residue)	15%	36%	40%
Conservation Tillage 2 (equal or more than 60% Residue)	25%	69%	77%
Contour Farming	28%	40%	34%
Controlled Drainage	39%	35%	ND
Cover Crop 1 (Group A Commodity) (High Till only for Sediment)	1%	ND	ND
Cover Crop 2 (Group A Traditional Normal Planting Time) (High Till only for TP and Sediment)	20%	7%	10%
Cover Crop 3 (Group A Traditional Early Planting Time) (High Till only for TP and Sediment)	20%	15%	20%
Land Retirement	90%	81%	95%
Nutrient Management 1 (Determined Rate)	15%	45%	ND
Nutrient Management 2 (Determined Rate Plus Additional Considerations)	25%	56%	ND
Streambank Stabilization and Fencing	75%	75%	75%
Terrace	25%	31%	40%
Two-Stage Ditch	12%	28%	ND

Conservation Practices	TN Efficiency	TP Efficiency	TSS Efficiency
Pastureland			
Combination Practices			
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Heavy Use Area Protection, Forest Buffer	81%	72%	83%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Heavy Use Area Protection, Grass Buffer	96%	89%	87%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Heavy Use Area Protection	66%	53%	64%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Forest Buffer	77%	65%	75%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting, Grass Buffer	95%	86%	81%
Prescribed Grazing, Alternative Water Supply, Pasture and Hayland Planting	58%	42%	46%
Prescribed Grazing, Pasture and Hayland Planting, Forest Buffer	73%	61%	69%
Prescribed Grazing, Pasture and Hayland Planting, Grass Buffer	94%	85%	77%
Prescribed Grazing, Pasture and Hayland Planting	52%	34%	33%
Individual Practices			
30m Buffer with Optimal Grazing	36%	65%	ND
Alternative Water Supply	13%	12%	19%
Combined BMPs-Calculated	0%	0%	0%
Critical Area Planting	18%	20%	42%
Forest Buffer (minimum 35 feet wide)	45%	40%	53%
Grass Buffer (minimum 35 feet wide)	87%	77%	65%
Grazing Land Management (rotational grazing with fenced areas)	43%	26%	ND
Heavy Use Area Protection	18%	19%	33%
Litter Storage and Management	14%	14%	0%
Livestock Exclusion Fencing	20%	30%	62%
Multiple Practices	25%	21%	22%
Pasture and Hayland Planting (also called Forage Planting)	18%	15%	ND
Prescribed Grazing	41%	23%	33%
Streambank Protection w/o Fencing	15%	22%	58%
Streambank Stabilization and Fencing	75%	75%	75%
Use Exclusion	39%	4%	59%
Winter Feeding Facility	35%	40%	40%
Feedlots			
Diversion	45%	70%	ND
Filter strip	ND	85%	ND
Runoff Mgmt System	ND	83%	ND
Solids Separation Basin	35%	31%	ND

Conservation Practices	**TN Efficiency**	**TP Efficiency**	**TSS Efficiency**
Solids Separation Basin w/Infilt Bed	ND	80%	ND
Terrace	55%	85%	ND
Waste Mgmt System	80%	90%	ND
Waste Storage Facility	65%	60%	ND

Appendix C

Table C-1. Number of fields within 300 to 1,000 feet of the nearest waterbody classified to have Very High, High, and Moderate runoff risk

Waterbody	Waterbody Type	A-Very High	B-High	C-Moderate
Hannah Brook	Stream/Brook			1
Huntington Brook	Stream/Brook		1	
Paine Brook	Stream/Brook			1
Ponaganset River	Stream/Brook		1	
Tributary to Hemlock Brook	Stream/Brook	1		1
Tributary to Paine Brook	Stream/Brook		1	
Tributary to Ponaganset River	Stream/Brook			2
Winsor Brook	Stream/Brook		1	1
Shippee Sawmill Pond	Lake/Pond			1
Unnamed Waterbody	Lake/Pond		1	2
Grand Total		1	5	9

Note:
Field proximities to streams/brooks and lakes/ponds were determined separately.

Table C-2. Number of fields within 1,000 to 2,000 feet of the nearest waterbody classified to have Very High, High, and Moderate runoff risk

Waterbody	Waterbody Type	A-Very High	B-High	C-Moderate
Barden Reservoir	Lake/Pond			2
Ponaganset Reservoir	Lake/Pond		1	
Unnamed Waterbody	Lake/Pond		5	2
Grand Total		0	18	11

Note:
Field proximities to streams/brooks and lakes/ponds were determined separately.

Table C-3. Number of fields over 2,000 feet from the nearest waterbody classified to have Very High, High, and Moderate runoff risk

Waterbody	Waterbody Type	A-Very High	B-High	C-Moderate
Dolly Cole Brook	Stream/Brook			1
Tributary to Barden Reservoir	Stream/Brook			1
Barden Reservoir	Lake/Pond			1
Hopkins Mill Pond	Lake/Pond	1	5	2
Ponaganset Reservoir	Lake/Pond			1
Unnamed Waterbody	Lake/Pond	1	2	6
Grand Total		2	7	12

Note:
Field proximities to streams/brooks and lakes/ponds were determined separately.

Table C-4. Number of fields within 300 to 1000 feet of the nearest waterbody meeting drainage condition 1, 2, and 3

Waterbody	Waterbody Type	Condition 1	Condition 2	Condition 3
Hannah Brook	Stream/Brook			1
Killy Brook	Stream/Brook	1		
Paine Brook	Stream/Brook	1		1
Tributary to Dolly Cole Brook	Stream/Brook	1		
Tributary to Hemlock Brook	Stream/Brook	1		5
Tributary to Killy Brook	Stream/Brook	1		
Tributary to Paine Brook	Stream/Brook	2	1	2
Tributary to Ponaganset River	Stream/Brook			1
Barden Reservoir	Lake/Pond	1		
Ponaganset Reservoir	Lake/Pond			1
Shippee Sawmill Pond	Lake/Pond	5	2	4
Unnamed Waterbody	Lake/Pond	1		
Grand Total		14	3	15

Note:
Field proximities to streams/brooks and lakes/ponds were determined separately.

Table C-5. Number of fields within 1000 to 2000 feet of the nearest waterbody meeting drainage condition 1, 2, and 3

Waterbody	Waterbody Type	Condition 1	Condition 2	Condition 3
Allen Richard Brook	Stream/Brook	1		
Dolly Cole Brook	Stream/Brook	1		
Hannah Brook	Stream/Brook	1		
Paine Brook	Stream/Brook	1		
Tributary to Hemlock Brook	Stream/Brook	1		1
Tributary to Paine Brook	Stream/Brook	1		1
Winsor Brook	Stream/Brook	1		1
Barden Reservoir	Lake/Pond	2		4
Ponaganset Reservoir	Lake/Pond	1		
Unnamed Waterbody	Lake/Pond	5		7
Grand Total		10	2	7

Note:
Field proximities to streams/brooks and lakes/ponds were determined separately.

Table C-6. Number of fields over 2000 feet from the nearest waterbody meeting drainage condition 1, 2, and 3

Waterbody	Waterbody Type	Condition 1	Condition 2	Condition 3
Dolly Cole Brook	Stream/Brook	1		1
Hemlock Brook	Stream/Brook			1
Tributary to Barden Reservoir	Stream/Brook	1		3
Tributary to Dolly Cole Brook	Stream/Brook			1
Barden Reservoir	Lake/Pond			2
Hopkins Mill Pond	Lake/Pond		2	
Ponaganset Reservoir	Lake/Pond	1		
Unnamed Waterbody	Lake/Pond	4		6
Grand Total		7	7	14

Note:
Field proximities to streams/brooks and lakes/ponds were determined separately.