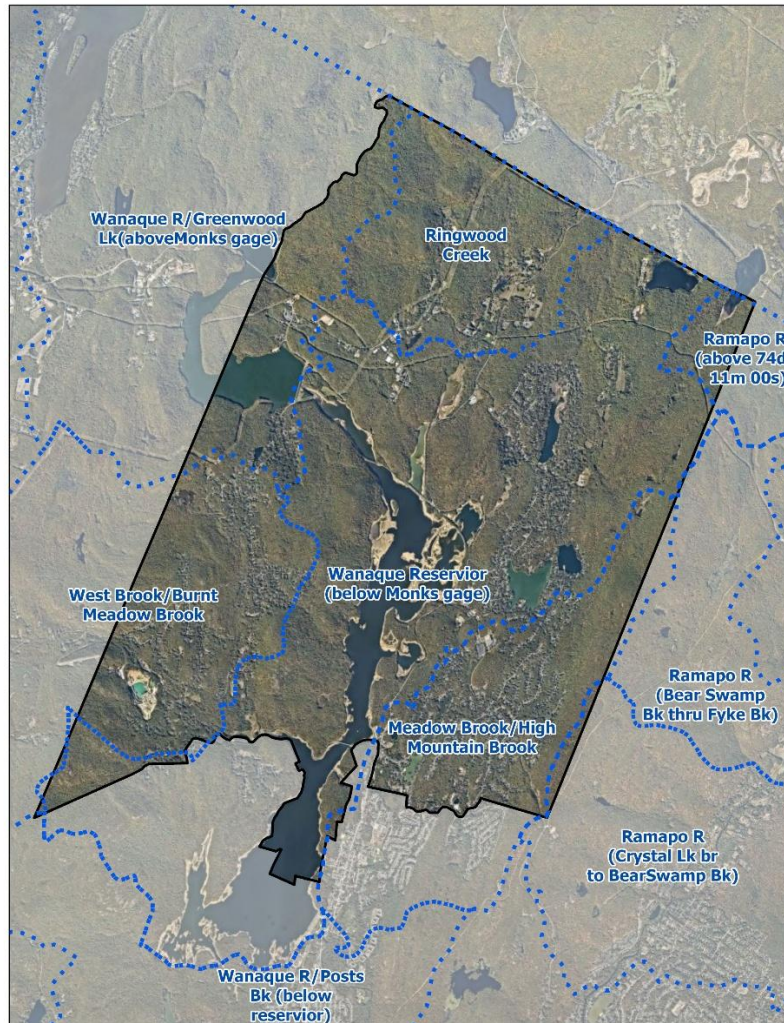


DRAFT

Watershed Assessment Report

BOROUGH OF RINGWOOD
PASSAIC COUNTY, NEW JERSEY



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October 2026

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Acronyms & Definitions

1. Acronyms

2.
 - i. “BMP” – Best Management Practice
 - ii. “CDO” – Climate Data Online
 - iii. “CRSSA” – Center for Remote Sensing and Spatial Analysis
 - iv. “EPA” – United States Environmental Protection Agency
 - v. “GIS” – Geographic Information System
 - vi. “HUC” – Hydrologic Unit Code
 - vii. “ICA” – Impervious Cover Assessment
 - viii. “MRLC” – Multi-Resolution Land Characteristics Consortium
 - ix. “MS4” – Municipal Separate Storm Sewer System
 - x. “NCDC” – National Climatic Data Center
 - xi. “NCEI” – National Centers for Environmental Information
 - xii. “NJDEP” – New Jersey Department of Environmental Protection
 - xiii. “NJGIS” – New Jersey Geographic Information Network
 - xiv. “NJPDES” – New Jersey Pollutant Discharge Elimination System
 - xv. “NJTPA” – North Jersey Transportation Planning Authority
 - xvi. “NJ-WET” – New Jersey Watershed Evaluation Tool
 - xvii. “NLCD” – National Land Cover Database
 - xviii. “NOAA” – National Oceanic and Atmospheric Administration
 - xix. “NPS” – Non-point Source Pollution
 - xx. “NRCS” – Natural Resources Conservation Service
 - xxi. “NWIS” – National Water Information System
 - xxii. “OQA” – Office of Quality Assurance
 - xxiii. “QAPP” – Quality Assurance Project Plan
 - xxiv. “RAP” – Restoration Action Plan
 - xxv. “SSA” – Sewer Service Area
 - xxvi. “TMDL” – Total Maximum Daily Load
 - xxvii. “TN” – Total Nitrogen
 - xxviii. “TP” – Total Phosphorus
 - xxix. “TPHC” – Total Petroleum Hydrocarbons
 - xxx. “TSS” – Total Suspended Solids
 - xxxi. “USGS” – United States Geological Survey
 - xxxii. “WAR” – Watershed Assessment Report
 - xxxiii. “WBP” – Watershed-Based Plan
 - xxxiv. “WIP” – Watershed Improvement Plan

Acknowledgements

The Borough of Ringwood's Watershed Inventory Report has been prepared by H2M Associates, Inc.

Funding for this project was provided by the Borough of Ringwood.

Regional Collaboration

The Borough of Ringwood did not participate in a regional collaboration for the development of this Watershed Assessment Report. The municipality independently completed the assessment and associated analyses in accordance with NJPDES MS4 permit requirements.

Executive Summary

The purpose of this Watershed Assessment Report is to evaluate existing water quality conditions within the Borough of Ringwood and to identify practical watershed management strategies to improve watershed health, reduce pollutant loading and support the long-term health of watershed resources. The assessment was completed to better understand existing watershed conditions, identify areas of concern and develop projects and management strategies to improve watershed health.

The watershed assessment evaluated surface water quality, drainage characteristics, hydrologic conditions and land use patterns, including changes in land use over time. Existing stream gauge monitoring data, regulatory requirements, community input and environmental conditions were reviewed to identify opportunities for watershed improvement. The assessment also evaluated potential sources of pollution and other factors influencing water quality throughout the Borough. Attention was given to subwatersheds containing impaired waterbodies and established TMDLs. Using the assessment criteria outlined in this report, subwatersheds were ranked and prioritized to have a meaningful environmental improvement.

Several priority areas and potential improvement projects were identified throughout the watershed. These projects vary in scope and cost but collectively support the goals of reducing pollutant loads, improving stormwater management, protecting aquatic resources and increasing watershed resiliency. Recommended projects include stormwater retrofits, green infrastructure practices, drainage improvements, stream corridor restoration, enhanced maintenance activities and public education initiatives. Projects were prioritized based on factors such as anticipated water quality benefits, regulatory significance, feasibility, anticipated pollutant reduction and overall community benefit.

Within each subwatershed, specific recommendations have been developed to address localized concerns while supporting broader watershed objectives. High-priority projects focus on locations where improvements are expected to provide the greatest reductions in pollutant loading and the most significant water quality benefits. Moderate-priority projects address infrastructure improvements, drainage concerns, or opportunities to improve system performance and resilience. Lower-priority projects generally consist of long-term planning initiatives, maintenance activities, or projects requiring additional study before implementation.

Implementation of the recommended projects is expected to contribute to reductions in pollutant loads and support compliance with applicable water quality goals and Total Maximum Daily Load (TMDL)

requirements. Anticipated benefits include reductions in nutrients, bacteria and other stormwater pollutants, as well as improvements in water quality, aquatic habitat and overall ecosystem health.

Public participation and stakeholder engagement are important components of successful watershed management. Community involvement during the assessment process helps identify local concerns and improve project acceptance. Continued public outreach, education, and coordination with local agencies and community stakeholders will help support the successful implementation of the recommended improvements.

Potential funding sources for the recommended projects include municipal capital improvement programs, state and federal grants, stormwater funding programs, and environmental restoration grants. As funding availability is uncertain, project implementation will likely occur in phases as funding and resources become available.

Overall, the findings of this Watershed Assessment Report provide a framework for improving water quality, enhancing ecosystem health and supporting long-term watershed management objectives. By implementing the recommended projects and continuing to evaluate watershed conditions over time, the Borough can make progress toward watershed protection and improvement. Continued monitoring, public and stakeholder engagement and ongoing evaluation will help influence future watershed management decisions and support the long-term watershed protection.

General Permittee Information

Permittee Location:

- The Borough of Ringwood is located within nine (9) Hydrologic Unit Code 14 (HUC-14) subwatersheds. These subwatersheds encompass portions of the Borough and surrounding municipalities and serve as the watershed units used for stormwater management planning and regional coordination. The HUC-14s associated with the Borough include 02030103070030, 02030103070040, 02030103070050, 02030103070060, 02030103070070, 02030103070080, 02030103100010, 02030103100040 and 02030103100050.
- Several of these subwatersheds are shared with neighboring municipalities, including the Boroughs of Bloomingdale, Franklin Lakes, Oakland, Pompton Lakes and Wanaque, as well as the Townships of Mahwah and West Milford. Ringwood comprises a substantial portion of several subwatersheds, including HUC 02030103070050 (78.4%), HUC 02030103070060 (61.9%) and HUC 02030103070080 (100%). Other subwatersheds are shared more extensively with neighboring municipalities, particularly West Milford Township, which contains the majority of HUCs 02030103070030 and 02030103070040. Figure 1 illustrates the Borough of Ringwood municipal boundary, the HUC-14 subwatershed boundaries and the boundaries of surrounding municipalities. Table 1 shows the percentage of each HUC-14 in the Borough of Ringwood and the surrounding municipalities.

Table 1: Distribution of HUC-14 Subwatershed Area by Municipality

HUC 14	Ringwood Borough	Bloomingdale Borough	Franklin Lakes Borough	Mahwah Township	Oakland Borough	Pompton Lakes Borough	Wanaque Borough	West Milford Township
02030103070030	16.90%	0.0%	0.0%	0.0%	0.0%	0.0%	0.00%	83.10%
02030103070040	34.10%	0.00%	0.0%	0.0%	0.0%	0.0%	0.20%	65.70%
02030103070050	78.40%	7.10%	0.00%	0.20%	0.00%	0.00%	14.10%	0.20%
02030103070060	61.90%	0.00%	0.0%	3.40%	0.00%	0.0%	34.70%	0.00%
02030103070070	0.02%	35.90%	0.00%	0.00%	0.00%	9.70%	32.90%	21.50%
02030103070080	100.00%	0.00%	0.0%	0.00%	0.00%	0.0%	0.00%	0.00%
02030103100010	8.60%	0.00%	0.0%	91.40%	0.00%	0.00%	0.00%	0.00%
02030103100040	0.10%	0.00%	0.0%	99.90%	0.00%	0.00%	0.00%	0.00%
02030103100050	2.00%	0.00%	2.40%	47.70%	47.10%	0.0%	0.80%	0.00%

Location

- The Borough of Ringwood is located in northern Passaic County, New Jersey with a land area of 25.6 square miles.
- To the West the Borough is bordered by West Milford Township. The southern border is bounded by Bloomingdale Borough and Wanaque Borough and the eastern border by Mahwah Township of Bergen County. The north of the Borough shares a boundary with New York State. The center of the Borough contains the Wanaque Reservoir which extends into Wanaque Borough.
- The Municipal Building is located at 60 Margaret King Avenue, Ringwood, NJ 07456

Subwatersheds within or bordering the Borough of Ringwood (NJ-WET 2025)

- The Borough of Ringwood encompasses portions of nine (9) HUC-14 subwatersheds, each contributing to the area's hydrologic and environmental profile. These subwatersheds collectively define the Borough's watershed boundaries and are essential for evaluating water quality conditions and TMDL impacts. Below are the subwatersheds listed in order of size. Figure 1: depicts each HUC 14 subwatersheds within the Borough of Ringwood.
-
1. **HUC 02030103070050** – Wanaque Reservoir (below Monk's gage), 13.90 square miles (sq mi)
 2. **HUC 02030103070040** – West Brook/Burnt Meadow Brook (4.01 sq mi)
 3. **HUC 02030103070080** – Ringwood Creek (3.75 sq mi)
 4. **HUC 02030103070060** – Meadow Brook/High Mountain Brook (3.71 sq mi)
 5. **HUC 02030103070030** – Wanaque River/Greenwood Lake (above Monk's gage) 2.47 sq mi
 6. **HUC 02030103100010** – Ramapo River (above 74 11'00") 0.50 sq mi
 7. **HUC 02030103100050** – Ramapo River (Crystal Lake branch to Bear Swamp Brook) (0.13 sq mi),
 8. **HUC 02030103100040** – Ramapo River (Bear Swamp Brook through Fyke Brook) (0.003 sq mi)
 9. **HUC 02030103070070** – Wanaque River/Posts Brook (below reservoir) (0.002 sq mi)

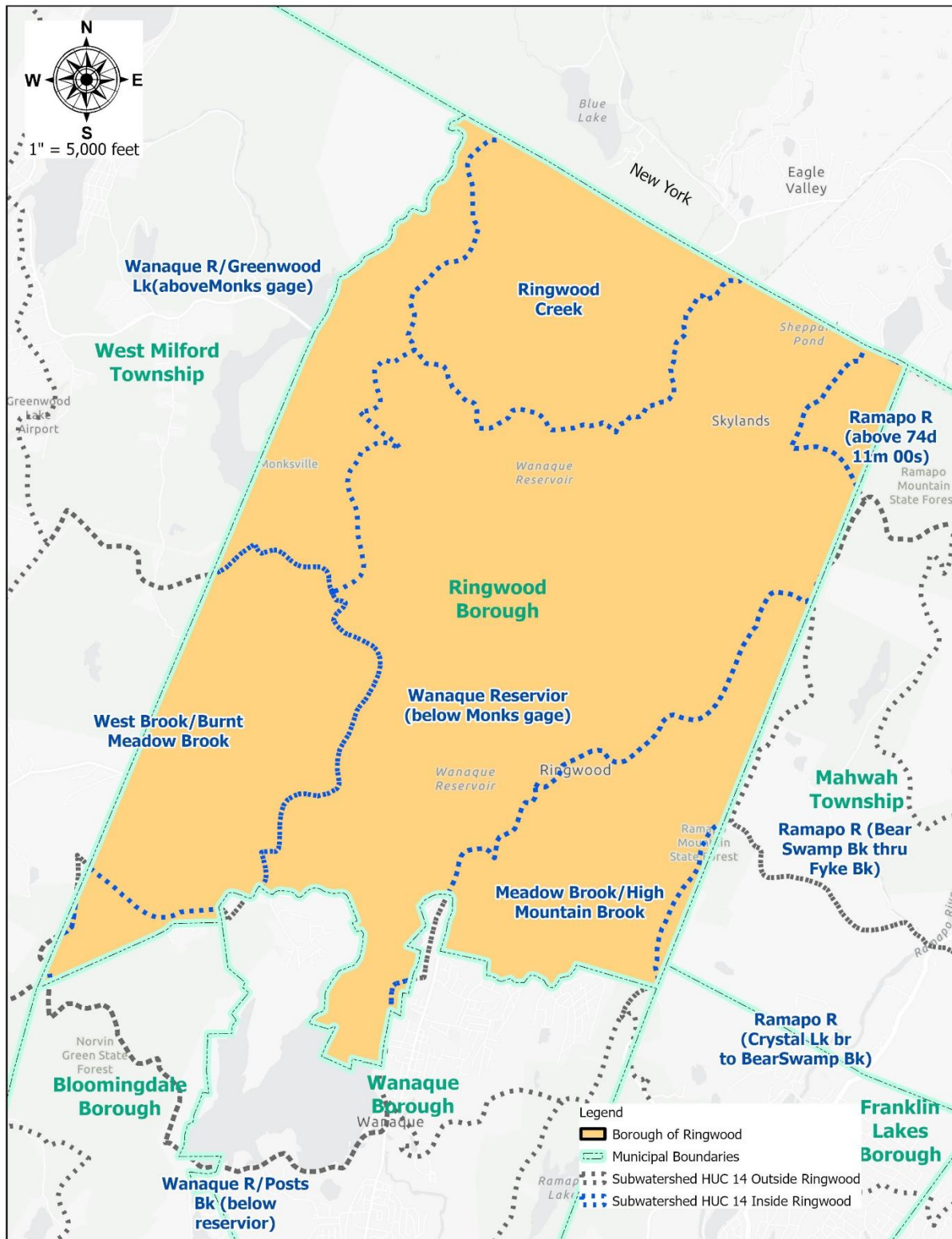


Figure 1: Borough of Ringwood Subwatersheds and surrounding Municipalities

Overview of Watershed Inventory Report Findings (Phase 1): Subwatershed Overview

The Borough of Ringwood includes portions of nine (9) HUC-14 subwatersheds. Table 2 summarizes the HUC-14 subwatersheds and the acreage of each watershed located within the Borough.

Table 2: Borough of Ringwood Subwatershed Areas

HUC-14	Subwatershed Name	Ringwood Area (Acres)	Total Area	Percent in Ringwood
2030103070030	Wanaque R/Greenwood Lk (above Monks gage)	1584.0	9360.2	16.9%
2030103070040	West Brook/Burnt Meadow Brook	2564.8	7523.5	34.1%
2030103070050	Wanaque Reservoir (below Monks gage)	8895.1	11342.7	78.4%
2030103070060	Meadow Brook/High Mountain Brook	2376.7	3837.8	61.9%
2030103070070	Wanaque R/Posts Bk (below reservoir)	1.3	6962.3	0.0%
2030103070080	Ringwood Creek	2402.4	2406.7	99.8%
2030103100010	Ramapo R (above 74d 11m 00s)	319.1	3720.9	8.6%
2030103100040	Ramapo R (Bear Swamp Bk thru Fyke Bk)	2.1	3018.1	0.1%
2030103100050	Ramapo R (Crystal Lk br to Bear Swamp Bk)	82.5	4041.2	2.0%

Existing Water Quality Problems

Overview

Existing water quality impairments and Total Maximum Daily Loads (TMDLs) were evaluated to characterize known water quality issues within the study area. Water quality impairments represent documented exceedances of state water quality standards, whereas TMDLs establish the maximum pollutant loading a waterbody can receive while continuing to meet those standards. Reviewing these resources provides insight into the nature, extent and severity of existing water quality concerns and helps identify watershed areas where management actions and pollutant-reduction measures may be most beneficial.

Impairments

NJDEP conducts routine water quality assessments to evaluate whether surface waters support their designated uses and meet applicable water quality standards. Waterbodies that fail to meet these standards are identified as impaired and included on the State's Clean Water Act Section 303(d) List of Water Quality-Limited Waters.

To support the water quality impairment analysis, the 2020 Water Quality Impairments Related to Stormwater dataset was obtained from the New Jersey Department of Environmental Protection (NJDEP) Open Data Portal in July 2026. The dataset was filtered to include only impairments occurring within the nine (9) HUC-14 subwatershed areas that intersect the Borough of Ringwood. Four impairment

parameters were identified within the Borough: pH, temperature, dissolved oxygen and Escherichia coli (E. coli).

As shown in Table 3 and Figure 2, the NJDEP 2020 303(d) List identifies no high-priority water quality impairments within the study area. However, four medium-priority impairments were identified across six of the nine HUC-14 subwatersheds. No low-priority water quality impairments were identified in the study area.

Temperature and dissolved oxygen represent the most prevalent impairment parameters within the study area. The remaining impairments are associated with pH and *E. coli*. Table 3 also identifies the year in which each impairment was first listed by NJDEP.

Table 3: Impairments within each HUC-14 Subwatershed

Medium Priority Water Quality Impairments According To 2020 303(d) List By Year First Listed					
HUC-14	Dissolved Oxygen	Temperature	Escherichia Coli (E. Coli)	pH	Total Impairments by HUC
02030103070040: West Brook/Burnt Meadow Brook	2008	2004			2
02030103070060: Meadow Brook / High Mountain Brook		2010	2020		2
02030103070070: Wanaque R/Posts Bk (below reservoir)		2012			1
02030103100010: Ramapo R (above 74d 11m 00s)	2010				1
02030103100040: Ramapo R (Bear Swamp Bk thru Fyke Bk)	2016			2010	2
02030103100050: Ramapo R (Crystal Lk br to Bear Swamp Bk)		2014		2016	2
Total Impairments by Parameter					10

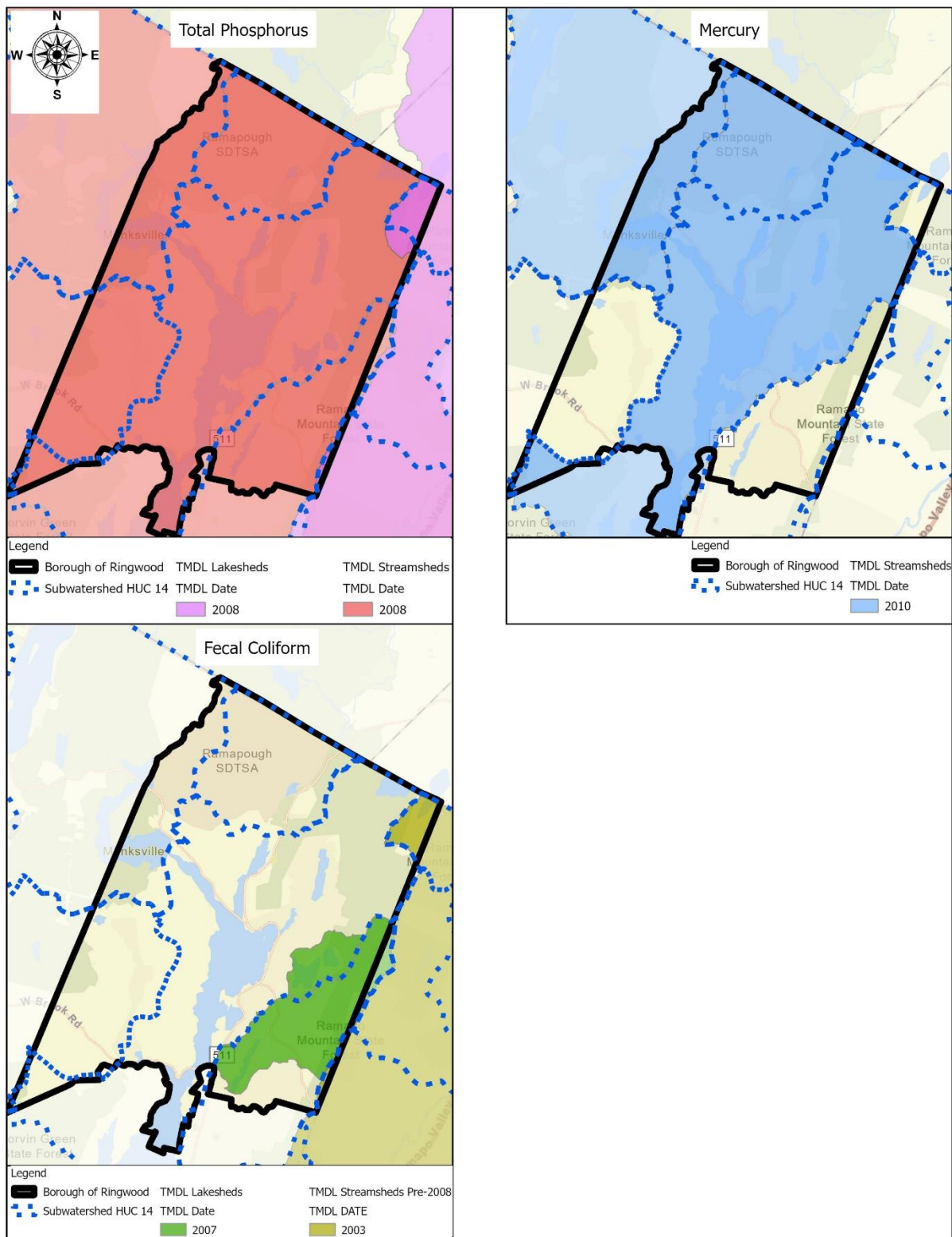


Figure 2: Borough of Ringwood Impairments

TMDLs

In accordance with Sections 303(d) and 305(b) of the Federal Clean Water Act, the New Jersey Department of Environmental Protection (NJDEP) identifies surface waters that do not attain applicable water quality standards and develops Total Maximum Daily Loads (TMDLs) for pollutants responsible for those impairments. A TMDL establishes the maximum pollutant load that a waterbody can receive while continuing to support its designated uses and meet water quality standards. TMDLs are developed to address both point and non-point sources of pollution and provide a framework for future water quality restoration efforts.

To identify TMDLs applicable to the Borough of Ringwood, the NJDEP TMDL Streamsheds, TMDL Streamsheds (Pre-2008), TMDL Lakesheds and TMDL Shellfish GIS datasets were obtained from the NJDEP Open Data Portal in July 2026. These datasets were spatially analyzed in GIS and compared with municipal boundaries and HUC-14 subwatershed boundaries to identify TMDL management areas that intersect the Borough.

The analysis identified TMDLs for three pollutants within the Borough and its contributing subwatersheds: Fecal Coliform, Total Phosphorus and Mercury. Total Phosphorus is the most widespread pollutant of concern, occurring within multiple stream and lake watersheds throughout the Borough. Mercury-related TMDLs occur within portions of the Wanaque River, Wanaque Reservoir and Meadow Brook/High Mountain Brook subwatersheds, while Fecal Coliform TMDLs are associated with portions of the Ramapo River watershed and several lake drainage areas.

A total of nine (9) HUC-14 subwatersheds within or adjacent to the Borough were found to intersect one or more TMDL management areas. Several HUC-14 subwatersheds intersect multiple TMDL management areas, particularly within the Wanaque Reservoir, Meadow Brook/High Mountain Brook and Ramapo River watersheds. Table 6 summarizes the applicable TMDLs and year of adoption for each affected waterbody, while Table 4 identifies the TMDLs present within each HUC-14 subwatershed. The spatial extent of these TMDL management areas is shown in Figure 3.

During preparation of the current Watershed Assessment Report, applicable Total Maximum Daily Load (TMDL) documentation was reviewed in greater detail to verify impairments and assessment units associated with each HUC-14 subwatershed. As part of this review, several HUC-14 subwatersheds previously identified as impaired based primarily on their proximity to mapped TMDL watershed boundaries were re-evaluated against the specific assessment units and impairment listings documented in the approved TMDL reports.

For the Mercury TMDL, HUC-14 subwatersheds were evaluated using the assessment units specifically identified within the report. For the Fecal Coliform TMDL, which is organized by monitoring stations and stream segments rather than HUC-14 subwatersheds, TMDL applicability was evaluated by comparing the associated subwatershed areas described in the report with the corresponding HUC-14 subwatersheds. GIS mapping was then used to confirm which HUC-14 subwatersheds within the Borough of Ringwood were located within the documented TMDL study area, rather than merely adjacent to the mapped boundary. This review determined that several subwatersheds were located within the broader geographic extent of certain TMDL mapping layers but were not specifically identified as impaired assessment units or otherwise addressed within the corresponding TMDL reports. As a result, these HUC-14 subwatersheds have been removed from the list of impaired waters in this update. A summary of these revisions is provided in Table 5.

Table 4: TMDL Parameters within each HUC-14 Subwatershed

HUC-14	Subwatershed Name	TMDL(s)
02030103070030	Wanaque R/Greenwood Lk (above Monks gage)	<u>Streamsheds</u> Mercury Total Phosphorus
02030103070040	West Brook/Burnt Meadow Brook	<u>Streamsheds</u> Total Phosphorus
02030103070050	Wanaque Reservoir (below Monks gage)	<u>Streamsheds</u> Mercury Total Phosphorus <u>Lakeshed</u> Fecal Coliform
02030103070060	Meadow Brook/High Mountain Brook	<u>Streamsheds</u> Total Phosphorus <u>Lakeshed</u> Fecal Coliform
02030103070070	Wanaque R/Posts Bk (below reservoir)	<u>Streamsheds</u> Total Phosphorus
02030103070080	Ringwood Creek	<u>Streamsheds</u> Total Phosphorus
02030103100010	Ramapo R (above 74d 11m 00s)	<u>Streamsheds</u> Total Phosphorus <u>Streamsheds (Pre-2008)</u> Fecal Coliform <u>Lakeshed</u> Total Phosphorus
02030103100040	Ramapo R (Bear Swamp Bk thru Fyke Bk)	<u>Streamsheds</u> Total Phosphorus <u>Streamsheds (Pre-2008)</u> Fecal Coliform <u>Lakeshed</u> Total Phosphorus
02030103100050	Ramapo R (Crystal Lk br to Bear Swamp Bk)	<u>Streamsheds</u> Total Phosphorus <u>Streamsheds (Pre-2008)</u> Fecal Coliform <u>Lakeshed</u> Total Phosphorus

Table 5: TMDL Revisions by HUC-14 Subwatershed

HUC-14	Subwatershed Name	TMDL Changes
02030103070030	Wanaque R/Greenwood Lk(above Monks gage)	No Change
02030103070040	West Brook/Burnt Meadow Brook	Mercury Removed
02030103070050	Wanaque Reservoir (below Monks gage)	Streamshed Fecal Coliform Removed Lakeshed Total Phosphorus Removed
02030103070060	Meadow Brook/High Mountain Brook	Mercury Removed Streamshed Fecal Coliform Removed Lakeshed Total Phosphorus Removed
02030103070070	Wanaque R/Posts Bk (below reservoir)	No Change
02030103070080	Ringwood Creek	Mercury Removed
02030103100010	Ramapo R (above 74d 11m 00s)	Mercury Removed
02030103100040	Ramapo R (Bear Swamp Bk thru Fyke Bk)	Mercury Removed
02030103100050	Ramapo R (Crystal Lk br to Bear Swamp Bk)	Lakeshed Fecal Coliform Removed

Table 6: TMDLs for Waterbodies Within or Bordering the Borough of Ringwood

Date	Pollutant	Waterbody
Lake Sheds TMDLs		
2007	Fecal Coliform	Skyline Lakes
2007	Fecal Coliform	Erskine Lake
2008	Total Phosphorus	Pompton Lake
Stream Sheds Pre-2008		
2003	Fecal Coliform	Ramapo River near Mahwah between Pompton Lake and NY
Stream Sheds		
2008	Total Phosphorus	Meadow Brook/High Mountain Brook
2008	Total Phosphorus	Ramapo R (above 74d 11m 00s)
2008	Total Phosphorus	Ramapo R (Bear Swamp Bk thru Fyke Bk)
2008	Total Phosphorus	Wanaque Reservoir (below Monks gage)
2008	Total Phosphorus	Ramapo R (Crystal Lk br to Bear Swamp Bk)
2008	Total Phosphorus	West Brook/Burnt Meadow Brook
2008	Total Phosphorus	Wanaque R/Greenwood Lk (above Monks gage)
2008	Total Phosphorus	Wanaque R/Posts Bk (below reservoir)
2010	Mercury	Wanaque R/Greenwood Lk(above Monks gage)
2010	Mercury	Wanaque Reservoir (below Monks gage)

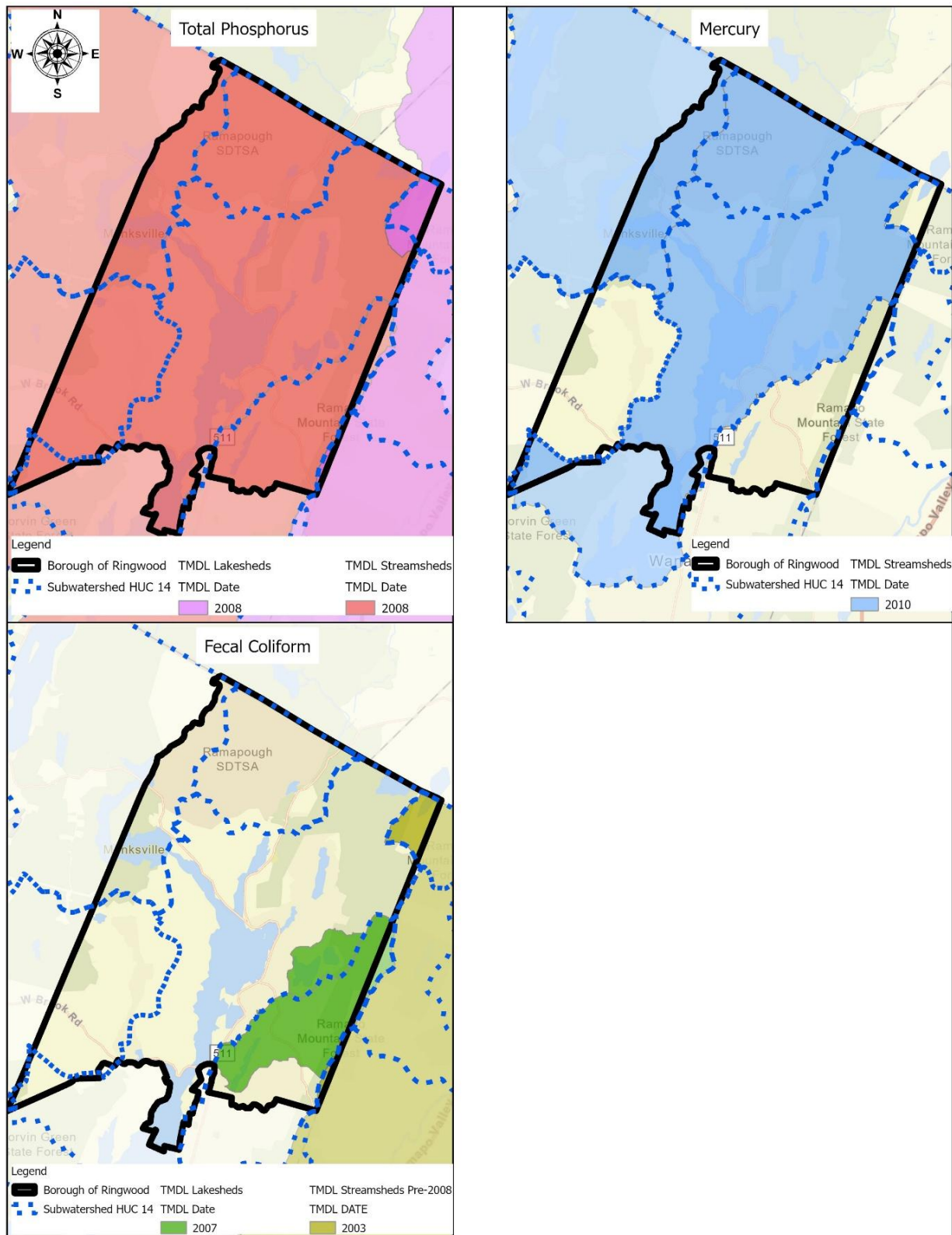


Figure 3: Borough of Ringwood TMDLs

Flooding Prone Areas

Due to the Borough's location at higher elevations, which are predominantly forested, areas prone to flooding have not been identified and none were identified by the public and stakeholders when they were asked for input. Subsequent phases of the Watershed Improvement Plan will seek public and stakeholders input to identify areas not immediately evident to the municipality.

Overburdened Communities

According to the New Jersey Environmental Justice Law, an Overburdened Community is a Census block group in which at least 35 percent of households are classified as low-income, at least 40 percent of residents identify as minority or members of a State-recognized tribal community, or at least 40 percent of households have limited English proficiency (30).

Clean surface water plays an important role in supporting watershed health and community well-being. To evaluate the presence of overburdened communities within the Borough of Ringwood, NJDEP Overburdened Communities and HUC-14 subwatershed datasets were analyzed. A list of overburdened communities in each HUC-14 is shown in Table 7; three of the nine (9) HUC-14 subwatersheds that intersect the Borough contain areas designated as minority overburdened communities.

Table 7: Overburdened Communities within the Borough of Ringwood

HUC-14	Subwatershed Name	Overburdened Communities
02030103070030	Wanaque R/Greenwood Lk (above Monk's gage)	Minority
02030103070040	West Brook/Burnt Meadow Brook	None
02030103070050	Wanaque Reservoir (below Monk's gage)	Minority
02030103070060	Meadow Brook/High Mountain Brook	None
02030103070070	Wanaque R/Posts Bk (below reservoir)	None
02030103070080	Ringwood Creek	Minority
02030103100010	Ramapo R (above 74d 11m 00s)	None
02030103100040	Ramapo R (Bear Swamp Bk thru Fyke Bk)	None
02030103100050	Ramapo R (Crystal Lk br to Bear Swamp Bk)	None

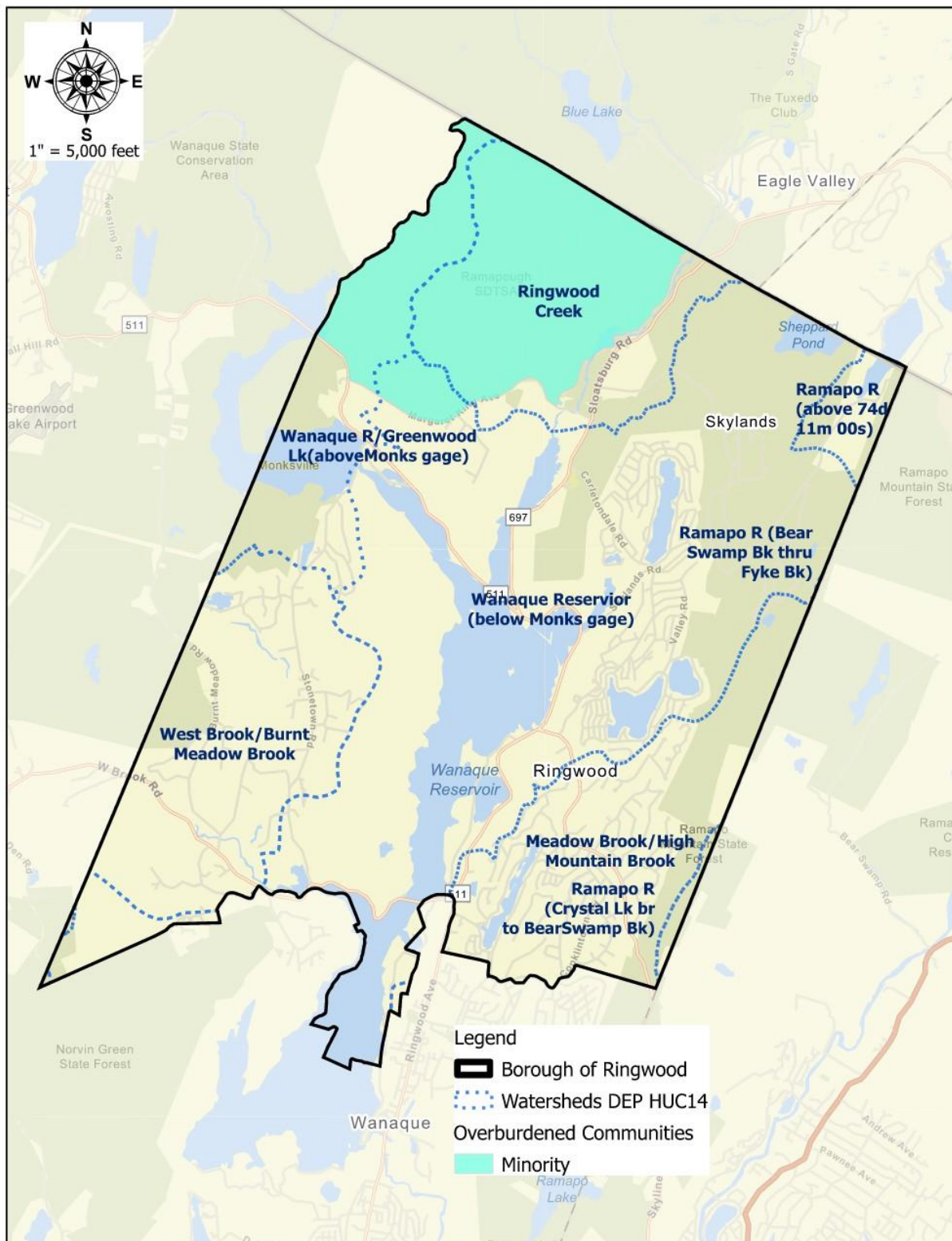


Figure 4: Overburdened Communities within the Borough of Ringwood

Impervious Coverage

Impervious surfaces, including roads, buildings, parking lots and driveways, can alter natural hydrology by reducing stormwater infiltration and increasing runoff volumes. As shown in Table 8, approximately 28.5 square miles of the Borough of Ringwood fall within the nine (9) HUC-14 subwatersheds evaluated. Impervious cover varies considerably among these watersheds, ranging from no mapped impervious surface in portions of the Ramapo River and Wanaque River subwatersheds to 14.2 percent impervious cover within the Meadow Brook/High Mountain Brook watershed, which is the highest percentage identified in the study area. Other subwatersheds with notable levels of impervious cover include West Brook/Burnt Meadow Brook (7.1 percent) and Wanaque Reservoir (below Monk's gage) (5.2 percent). These developed areas have the greatest potential to generate stormwater runoff and associated pollutant loading, which can negatively affect downstream water quality and aquatic habitat conditions. A list of percent impervious cover per HUC-14 is shown in Table 8 and in Figure 5.

Table 8: Impervious Surfaces within the Borough of Ringwood

HUC-14	Subwatershed Name	Square Miles	Percent Impervious Cover
02030103070030	Wanaque R/Greenwood Lk (above Monk's gage)	2.5	3.50%
02030103070040	West Brook/Burnt Meadow Brook	4	0.071
02030103070050	Wanaque Reservoir (below Monk's gage)	13.9	5.20%
02030103070060	Meadow Brook/High Mountain Brook	3.7	0.142
02030103070070	Wanaque R/Posts Bk (below reservoir)	0.002	No impervious Surface
02030103070080	Ringwood Creek	3.8	0.034
02030103100010	Ramapo R (above 74d 11m 00s)	0.5	0.10%
02030103100040	Ramapo R (Bear Swamp Bk thru Fyke Bk)	0.003	No impervious Surface
02030103100050	Ramapo R (Crystal Lk br to Bear Swamp Bk)	0.1	0.00%
Total		28.5	

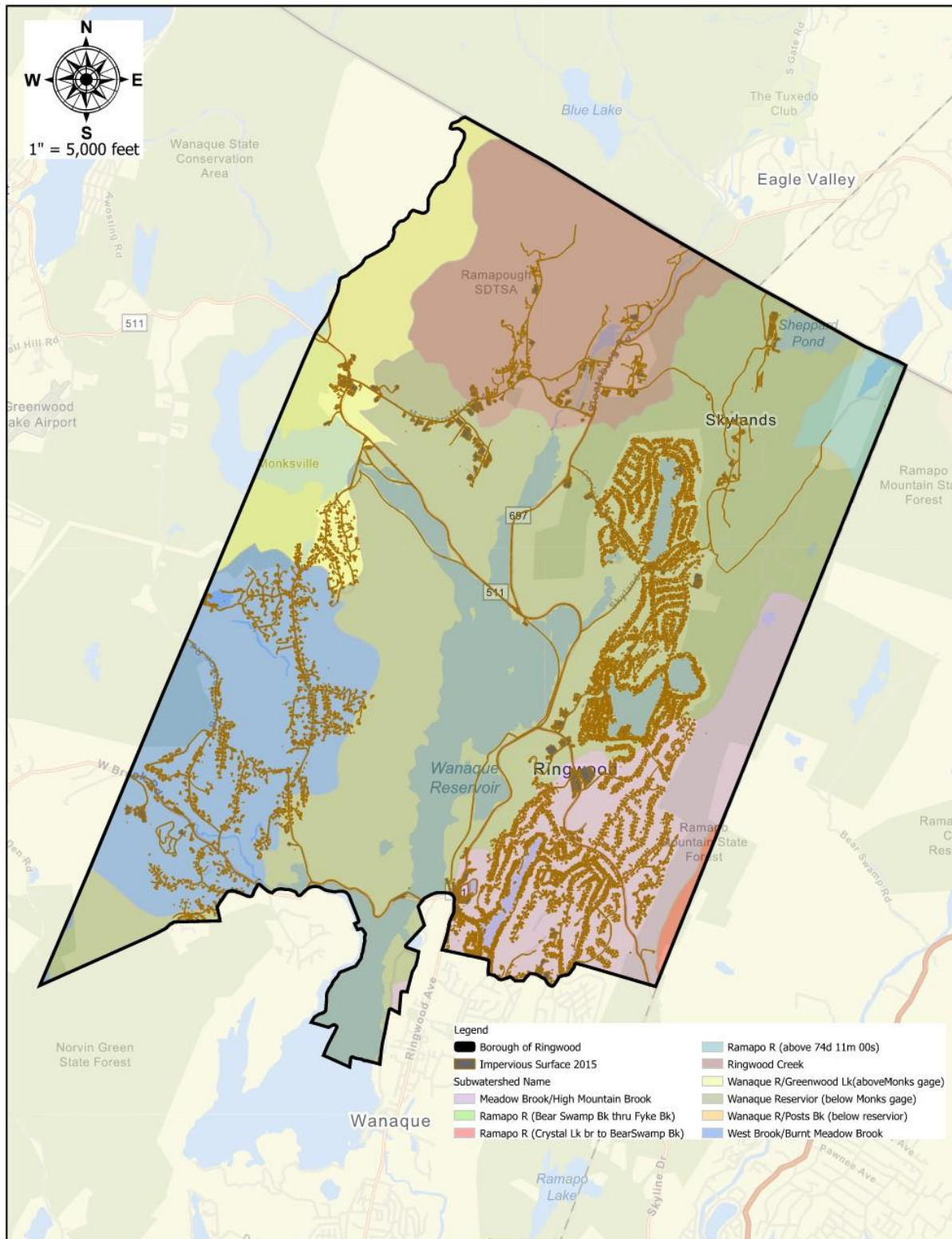


Figure 5: Impervious Cover within the Borough of Ringwood

Rank Subwatersheds

Based on the acreage of HUC-14 subwatersheds located within the Borough of Ringwood, the Wanaque Reservoir (below Monks gage) subwatershed contains the greatest land area within the Borough, whereas the Wanaque River/Posts Brook (below reservoir) subwatershed contains the least. Table 9 provides a comparison of the total acreage of each HUC-14 subwatershed and the acreage located within the Borough of Ringwood. This information was used in part for the subwatershed ranking.

The subwatersheds in the Borough of Ringwood were prioritized based on the number of water quality impairments, TMDLs, stormwater outfalls, impervious cover and the extent of the HUC-14 area located within Ringwood. Greater weight was given to subwatersheds where the Borough has a larger geographic presence and greater opportunity to implement watershed improvement measures. Table 10 and Figure 6 shows each HUC-14 and its priority rating.

Table 9: HUC-14 Subwatershed Areas within the Borough of Ringwood

HUC-14	Subwatershed Name	Ringwood Area (Acres)	Total Area	Percent in Ringwood
02030103070030	Wanaque R/Greenwood Lk(above Monks gage)	1,584.0	9,360.2	16.9%
02030103070040	West Brook/Burnt Meadow Brook	2,564.8	7,523.5	34.1%
02030103070050	Wanaque Reservoir (below Monks gage)	8,895.1	11,342.7	78.4%
02030103070060	Meadow Brook/High Mountain Brook	2,376.7	3,837.8	61.9%
02030103070070	Wanaque R/Posts Bk (below reservoir)	1.3	6,962.3	0.0%
02030103070080	Ringwood Creek	2,402.4	2,406.7	99.8%
02030103100010	Ramapo R (above 74d 11m 00s)	319.1	3,720.9	8.6%
02030103100040	Ramapo R (Bear Swamp Bk thru Fyke Bk)	2.1	3,018.1	0.1%
02030103100050	Ramapo R (Crystal Lk br to Bear Swamp Bk)	82.5	4,041.2	2.0%

Table 10: Subwatershed Ranking

HUC-14	Subwatershed Name	Square Miles in Ringwood	Percent Impervious Cover	Outfalls	Impairment / TMDL	Ranking
High Priority						
2030103070060	Meadow Brook/High Mountain Brook	3.7	14.2%	74	4	1
2030103070050	Wanaque Reservoir (below Monk's gage)	13.9	5.2%	115	3	2
2030103070040	West Brook/Burnt Meadow Brook	4	7.1%	65	3	3
Medium Priority						
2030103070030	Wanaque R/Greenwood Lk (above Monk's gage)	2.5	3.5%	5	2	4
2030103070080	Ringwood Creek	3.8	3.4%	10	2	5
2030103100010	Ramapo R (above 74d 11m 00s)	0.5	0.10%	0	4	6
Low Priority						
2030103100050	Ramapo R (Crystal Lk br to Bear Swamp Bk)	0.1	0%	0	5	7
2030103100040	Ramapo R (Bear Swamp Bk thru Fyke Bk)	0.003	No impervious Surface	0	5	8
2030103070070	Wanaque R/Posts Bk (below reservoir)	0.002	No impervious Surface	0	2	9

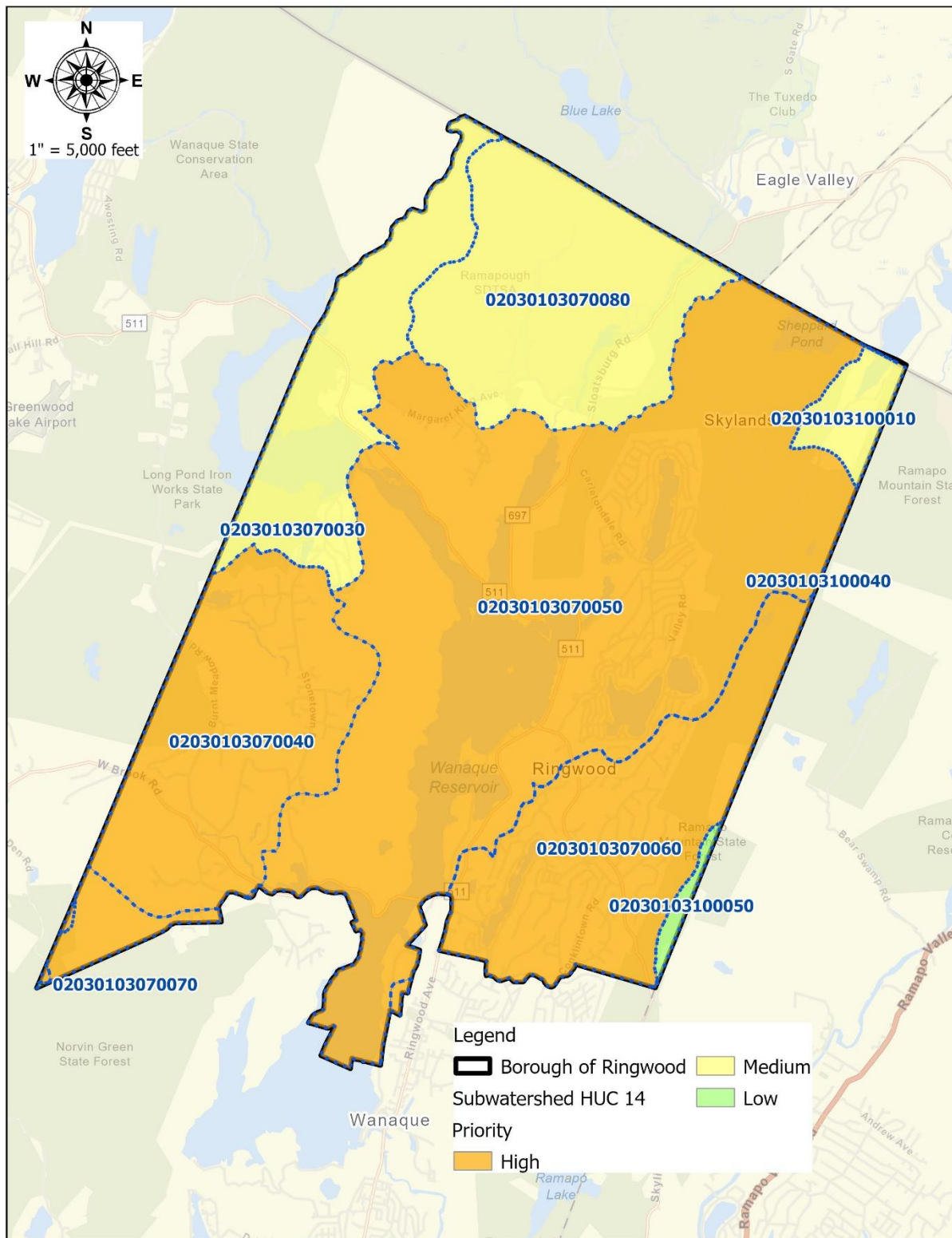


Figure 6: Subwatershed Ranking within the Borough of Ringwood

Community Engagement:

- Identified stakeholders within the Borough include the community lake environmental committees. These stakeholders are actively working to improve surface runoff in the Borough to improve the Borough's lakes.
- A public information session was held on September 22, 2026, with approximately 6 members of the public attending and is summarized below:

The Ringwood Watershed Assessment Report (Phase 2) Public Information Session focused on reviewing watershed conditions in Ringwood, discussing ongoing Phase 2 assessment work and gathering community input on water quality concerns and potential improvement projects. The H2M team and Borough representatives explained the three-phase NJDEP watershed improvement process, summarized Phase 1 findings and outlined plans to complete the Phase 2 report and move into Phase 3 project development.

A major focus of the discussion was phosphorus pollution, algae blooms, stormwater runoff, localized flooding and their impacts on Ringwood's lakes and the broader watershed. Lake association representatives identified several areas of concern, including runoff entering Cupsaw Lake, Erskine Lake, Mohawk, High Mountain Brook, Park Road and other drainage locations. Participants emphasized the need for targeted projects, monitoring and community involvement to improve water quality.

Overall, the meeting highlighted strong community interest in protecting Ringwood's lakes, reducing phosphorus loading and developing practical projects that improve water quality while supporting long-term watershed health.

Key outcomes included:

- The draft Phase 2 report will be posted on the Borough website for public review.
- A 60-day public comment period will follow publication of the draft report.
- H2M will reevaluate the 18 projects identified in the 2021 Lakes Report for potential inclusion in future watershed improvement plans.
- Water-quality monitoring and pollutant sampling may be considered as future projects to better identify contaminant sources and prioritize improvements.
- Funding for future projects remains uncertain and was identified as a significant concern.
- The Borough plans to notify all members of the public who were at the public information session and seek their input once the Phase 2 report is posted for the 60-day comment period. The Borough will also inform the Borough's Environmental Committee and lakes associations regarding the report to gather feedback.

General Assessment of Subwatersheds within the Permittee's Jurisdiction

Geology and Geomorphology

The Borough of Ringwood is located within the New Jersey Highlands Physiographic Province, a region characterized by rugged terrain, prominent ridges, narrow valleys and an extensive network of streams and reservoirs (1). Topography is a key factor influencing watershed hydrology throughout the Borough. Surface drainage generally flows toward the Ramapo River, Ringwood Creek and Wanaque Reservoir watershed systems, with drainage patterns and terrain influencing runoff generation (1). Steeper slopes tend to produce higher runoff velocities and reduced infiltration, while flatter valley areas provide greater opportunities for groundwater recharge and temporary stormwater storage (1). Figure 7 depicts slope within the Borough of Ringwood.

Elevations within the Borough's HUC-14 subwatersheds range from approximately 208 feet to 1,210 feet above mean sea level, demonstrating the substantial topographic variation characteristic of the New Jersey Highlands. Topographic relief ranges from 49 feet to 1,002 feet among the HUC-14 subwatersheds. The greatest relief occurs within the West Brook/Burnt Meadow Brook, Wanaque Reservoir (below Monk's gage) and Meadow Brook/High Mountain Brook watersheds, while portions of the Wanaque River/Posts Brook and Ramapo River (Bear Swamp Brook through Fyke Brook) watersheds exhibit comparatively little elevation change. These differences in elevation and relief influence drainage characteristics throughout the Borough. Table 11 depicts Elevation Characteristics in each subwatershed.

Slope analysis shows that the Borough is characterized by mostly moderate to steep terrain, with slopes exceeding 20 percent comprising a large portion of several HUC-14 subwatersheds. The highest concentrations of steep slopes occur within the West Brook/Burnt Meadow Brook, Wanaque Reservoir (below Monk's gage) and Meadow Brook/High Mountain Brook watersheds, where more than 40 percent of the land area consists of slopes greater than 20 percent. These conditions, combined with steep slopes characteristic of the Highlands physiographic region, can increase overland flow and contribute to erosion and sediment transport during precipitation events (1). Table 12 lists slope classification within each HUC-14 subwatershed.

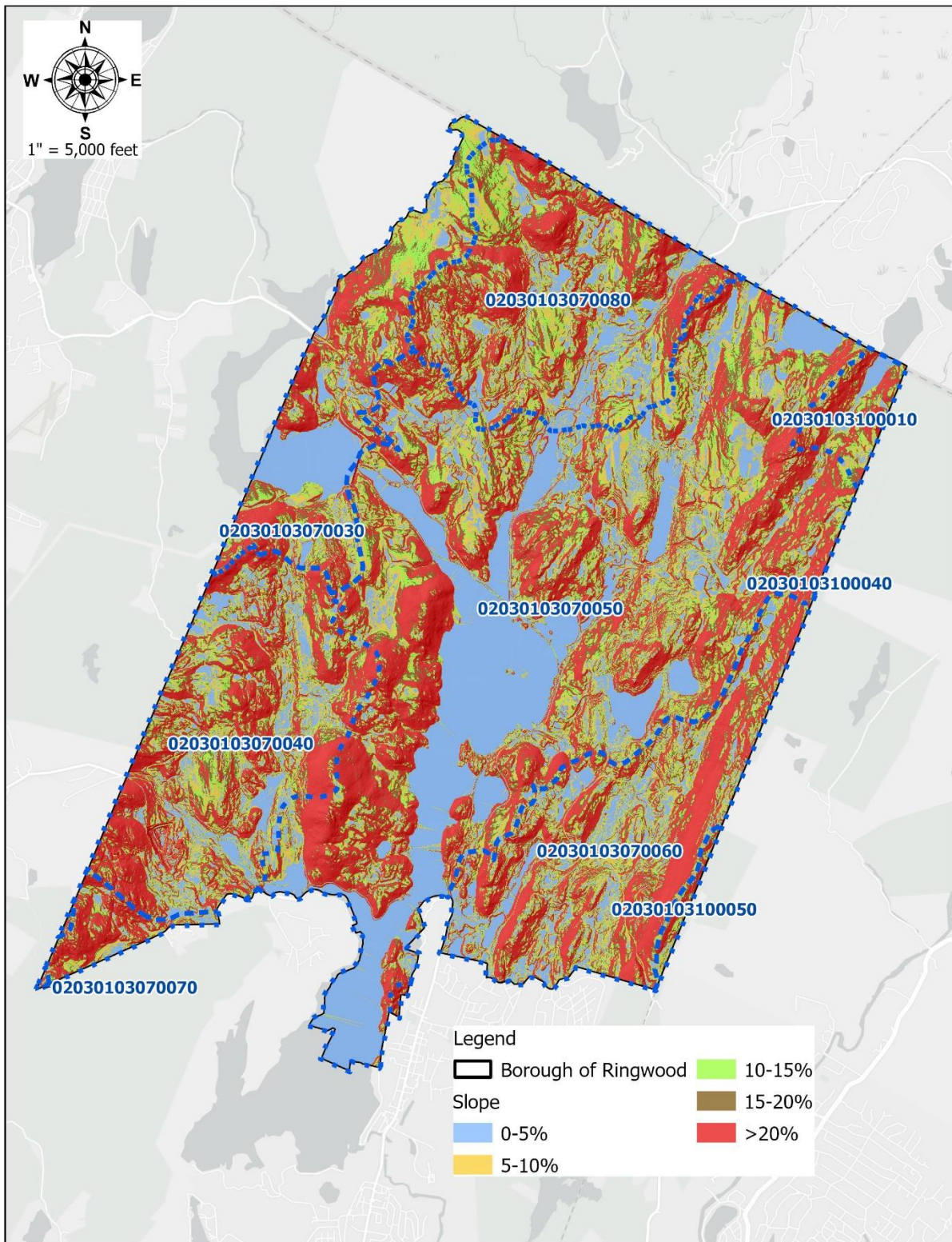


Figure 7: Slope within the Borough of Ringwood

Table 111: Elevation Characteristics by HUC-14 Subwatershed within the Borough of Ringwood

HUC-14	Elevation Characteristics by HUC-14 Subwatershed within the Borough of Ringwood	Min	Max	Relief
02030103070030	Wanaque R/Greenwood Lk (above Monk's gage)	375	978	603
02030103070040	West Brook/Burnt Meadow Brook	208	1,210	1,002
02030103070050	Wanaque Reservoir (below Monk's gage)	300	1,206	905
02030103070060	Meadow Brook/High Mountain Brook	254	1,101	847
02030103070070	Wanaque R/Posts Bk (below reservoir)	1,060	1,114	54
02030103070080	Ringwood Creek	301	1,058	758
02030103100010	Ramapo R (above 74d 11m 00s)	615	1,034	419
02030103100040	Ramapo R (Bear Swamp Bk thru Fyke Bk)	1,047	1,096	49
02030103100050	Ramapo R (Crystal Lk br to Bear Swamp Bk)	886	1,094	208

Table 12: Slope Classification by HUC-14 Subwatershed within the Borough of Ringwood

Slope Percent					
HUC-14	0-5%	5-10%	10-15%	15-20%	>20%
02030103070030	23%	16%	17%	13%	31%
02030103100010	15%	13%	15%	15%	43%
02030103100050	7%	19%	21%	16%	37%
02030103100040	11%	39%	33%	13%	4%
02030103070040	16%	16%	14%	12%	42%
02030103070060	18%	17%	14%	11%	40%
02030103070070	36%	13%	14%	14%	24%
02030103070050	31%	14%	12%	10%	33%
02030103070080	16%	18%	17%	14%	34%

Climate

Temperature

The Borough of Ringwood experiences climate characterized by cold winters and warm summers. Based on long-term climate records (1895–present), the average annual temperature is approximately 51.2°F, with average monthly temperatures ranging from 28.4°F in January to 73.5°F in July. Historical records indicate that annual average temperatures have ranged from a minimum of 45.3°F to a maximum of 53.8°F, reflecting both natural year-to-year variability and long-term climate change influences (10, 12).

The historical temperature record shows a gradual warming trend over the past century. While annual temperatures fluctuated considerably from year to year, the trend line indicates that average temperatures have generally increased since the late 1800s. The warmest years on record have occurred predominantly during the last three decades and annual average temperatures have frequently exceeded 52°F since the 1990s (10, 12).

In reviewing recent temperature trends over the last five years, temperatures have remained consistently above the long-term average annual temperature of 51.2°F. The warmest year in the five-year period was 2024 (53.8°F). All years from 2021 through 2025 were at or above the long-term average, suggesting that temperatures above average are becoming increasingly common (10, 12). Tables 13 and 14 and Figure 8 show the Temperature trends and statistics in the Borough of Ringwood.

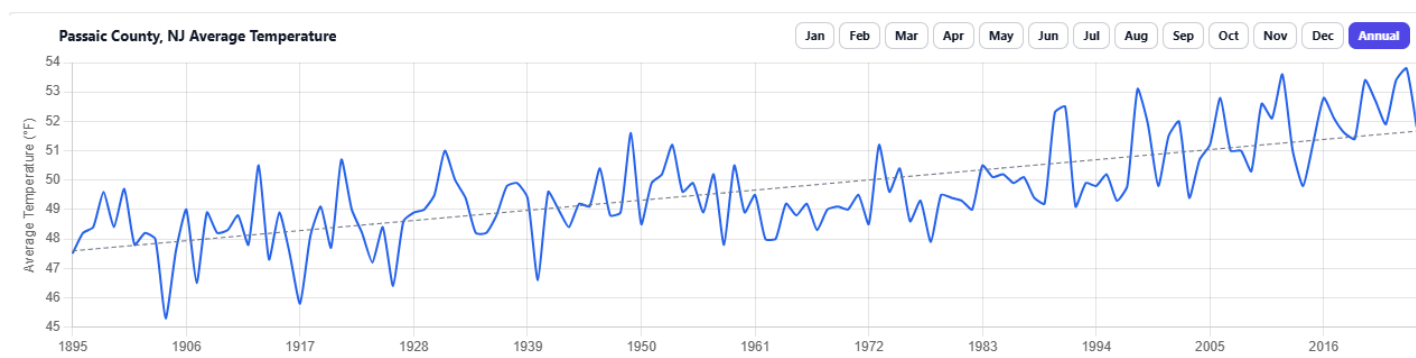


Figure 8: The Passaic County Historical Temperatures Statistics (1895–Present) (10)

Table 13: Passaic County Historical Temperatures Statistics 1895–Present (10)

The Borough of Ringwood Historical Temperatures Statistics (1895–Present)													
Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
30 yr Normal	28.4	30.7	38.3	49.6	59.7	68.3	73.5	71.8	64.7	53.2	42.8	33.7	51.2
Period of Rain Mean	26.8	28.1	37	48.2	58.7	67.1	72	70.1	63.2	52.3	41.3	30.9	49.6
Median	26.7	28.3	36.8	48.1	58.8	67.3	71.7	70	63.3	52.1	41	31.3	49.4
Min	15.8	14.8	27.6	42.3	50.7	61	67.1	64.2	58.2	45.1	34.2	19.6	45.3
Max	38.6	37	47.8	54.1	64.7	72.1	77.4	75.7	69.4	59.8	47.6	44.4	53.8

Table 14: Passaic County Recent Monthly and Annual Temperatures, 2021–2025 (10)

Recent Monthly and Annual Temperatures, 2021–2025													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2021	30.3	28.6	41	50.9	59.2	70.2	73.7	74.2	66.5	58.6	41.3	38.2	52.7
2022	25	31.7	40.7	49.3	62.1	67.4	75.4	75.7	65.4	51.9	44.9	32.9	51.9
2023	38.6	35.6	39.6	53.3	58	66.2	75.3	71.1	65.8	56.8	40.9	39.5	53.4
2024	32.4	35	43.8	50.9	63.1	71.9	76.7	72.4	64.8	55.9	46.9	31.8	53.8
2025	26.1	30.3	43.1	51.7	60.3	70.2	77.2	70.3	66.8	54.4	42.2	29	51.8

Precipitation

The Borough of Ringwood receives approximately 48.6 inches of precipitation annually based on long-term climate normals. Precipitation is relatively well distributed throughout the year, with monthly averages ranging from approximately 2.7 inches in February to 4.6 inches during June and October (10,12).

Historical precipitation records indicate year-to-year variability. Annual precipitation totals have generally fluctuated between approximately 35 and 60 inches, with several exceptionally wet years exceeding 65 inches. While the long-term record does not show a pronounced increasing or decreasing trend in total annual precipitation (10, 12). Refer to Figure 9 and Tables 15 and 16 below for precipitation , summaries.

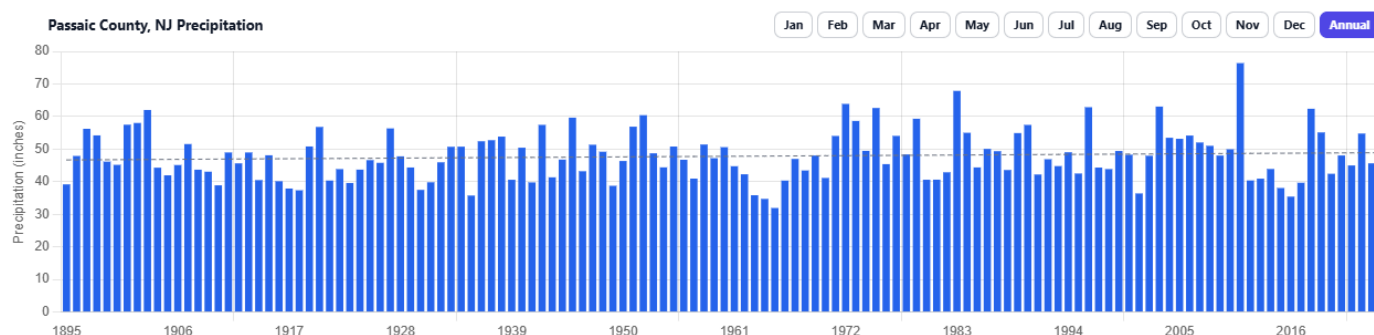


Figure 9: Passaic County Historical Precipitation (inches) Statistics (1895–Present) (10)

Table 15: Passaic County Historical Precipitation (inches) Statistics 1985–Present (10)

Passaic County Historical Precipitation (inches) Statistics (1895–Present)													
Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
30 yr Normal	3.51	2.74	4.04	3.96	3.9	4.63	4.41	4.5	4.45	4.56	3.64	4.26	48.6
Period of Rain Mean	3.47	3.11	3.93	4	4.15	4.17	4.56	4.58	4.13	3.93	3.79	3.92	47.79
Median	3.13	2.83	3.65	3.8	3.94	3.67	4.19	4.16	3.48	3.71	3.66	3.8	46.89
Min	0.53	0.74	0.79	1.13	0.65	0.39	0.86	0.9	0.35	0.01	0.65	0.43	31.93
Max	10.8	7.55	9.96	11.04	10.81	11.61	11.97	15.72	11.96	15.28	10.37	9.25	76.39

Table 16: Recent Precipitation Monthly and Annual Precipitation Totals, 2021–2025 (10)

Recent Precipitation Monthly and Annual Precipitation Totals, 2021–2025													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2021	1.24	3.62	2.41	1.96	4.94	2.32	7.51	6.4	8.47	6.5	1.33	1.35	48.05
2022	2.93	2.85	2.34	6.87	5.74	3.72	1.84	1.71	3.05	5.64	2.52	5.78	44.99
2023	4.69	1.18	2.13	4.95	1.65	4.83	7.61	5.04	7.44	3.89	2.93	8.44	54.78
2024	6.48	1.78	8.39	4.78	4.16	1.75	2.3	8.91	0.62	0.01	2.49	3.97	45.64
2025	0.53	2.7	3.42	2.87	7.81	3.01	3.26	1.67	1.84	4.34	1.73	2.77	35.95

Anticipated Impacts of Climate Change

Climate change is projected to increase the intensity and frequency of heavy rainfall events while also contributing to warmer temperatures and longer periods of drought. These changes may increase surface runoff, erosion and localized flooding, while reducing groundwater recharge during extended dry periods (5). As a result, the region may experience greater hydrologic variability, including more intense storm events that could lead to increased flooding, sediment transport, pollutant loading and stress on stormwater infrastructure. Conversely, prolonged dry conditions may reduce stream baseflow, limit groundwater availability and adversely affect aquatic habitat health (6).

Hydrologic Conditions

There are two gauging stations located within the Borough of Ringwood, USGS-01384500 – Ringwood Creek Near Wanaque and USGS 01386000 – West Brook near Wanaque. Figure 10 depicts both stations within the Borough. NOAA Precipitation data from July 2023 through June 2026 indicates substantial seasonal and rain event variability. Several months experienced precipitation exceeding 7 inches, including July 2023, November 2023, March 2024, August 2024 and May 2025 (10, 12). Figure 11 shows precipitation over the last two years (10).

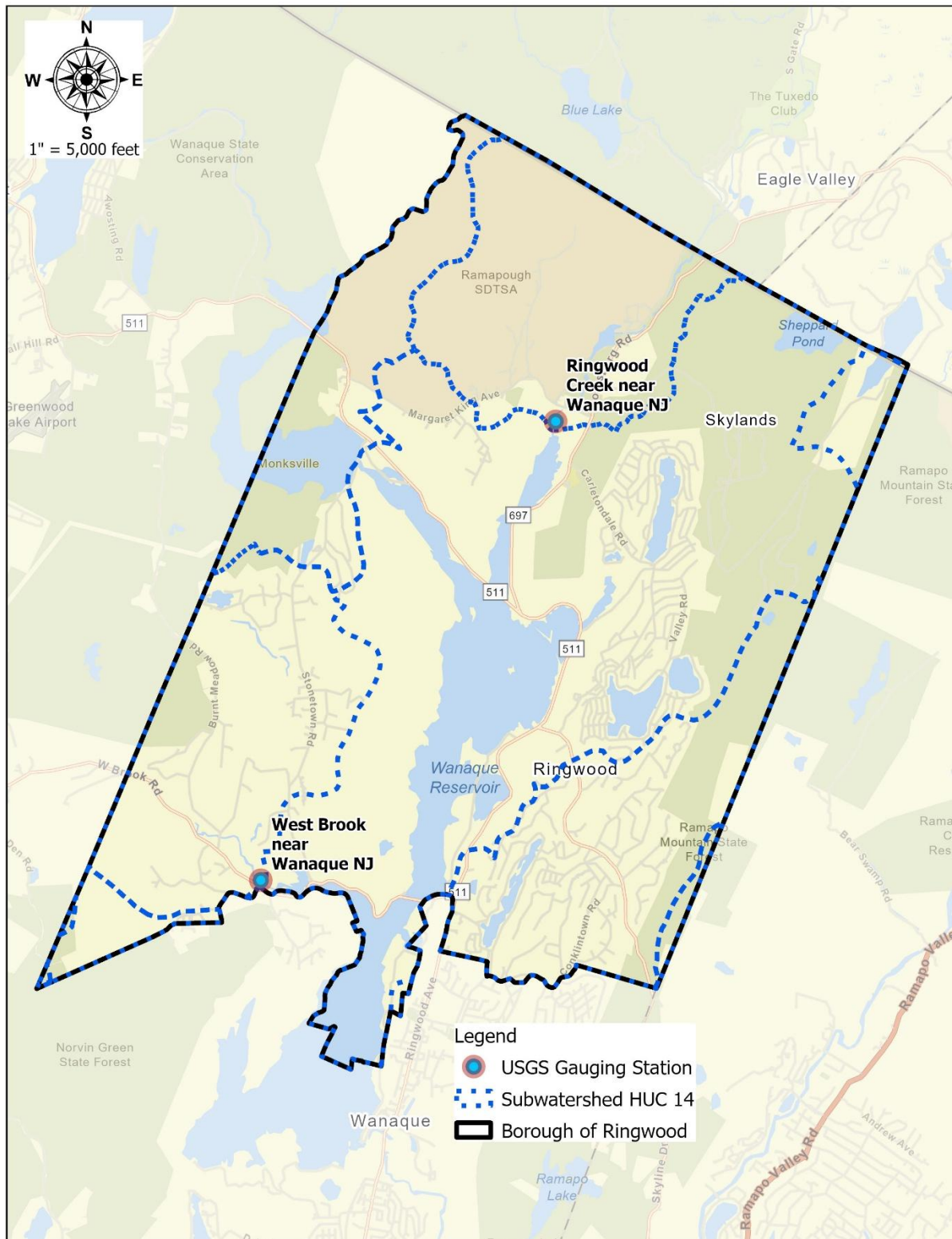


Figure 10: USGS Gauging Stations

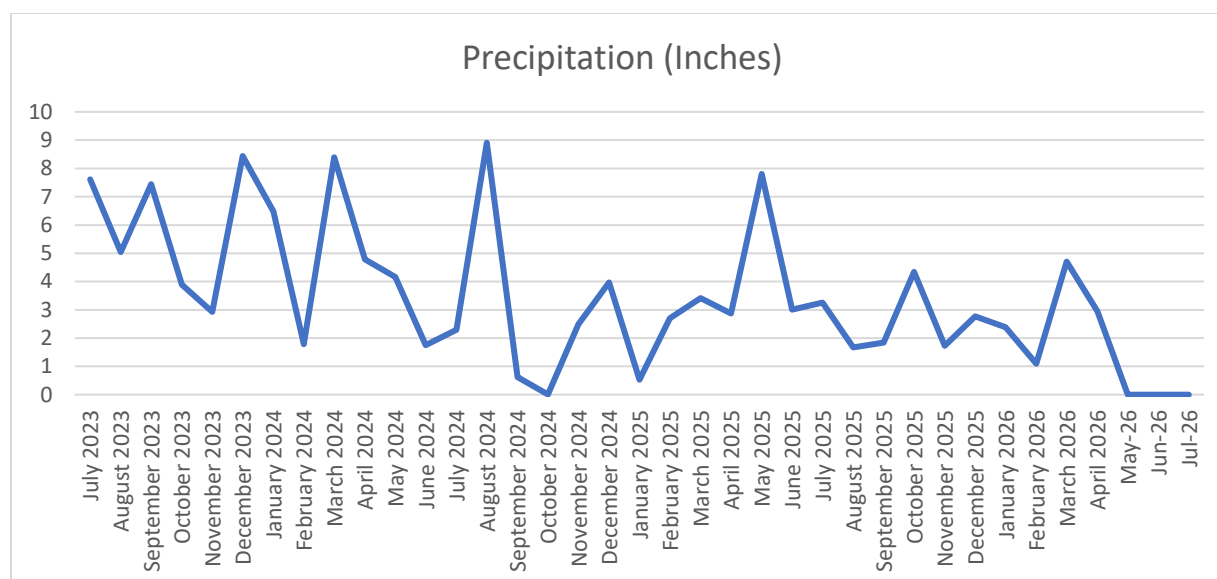


Figure 11: NOAA Precipitation (2023 to 2026) (12)

USGS-01384500 – Ringwood Creek Near Wanaque Gauging Station

Analysis of precipitation records and streamflow data from USGS Station 01384500 (Ringwood Creek near Wanaque) indicates a strong relationship between precipitation and streamflow conditions. Major precipitation events corresponded with increases in both gage height and discharge, including peak discharges exceeding 1,000 cubic feet per second during late 2023. Streamflow was maintained throughout the monitoring period, even during relatively dry conditions, suggesting that groundwater contributions and watershed storage provide sustained baseflow to the creek. In contrast, periods of increased precipitation were associated with rapid rises in stream stage and discharge, reflecting the watershed's response to storm runoff (2). Figure 12 illustrates the relationship between discharge and gage height at the Ringwood Creek gauging station from 2023 through 2026.

USGS 01384500 Ringwood Creek near Wanaque NJ

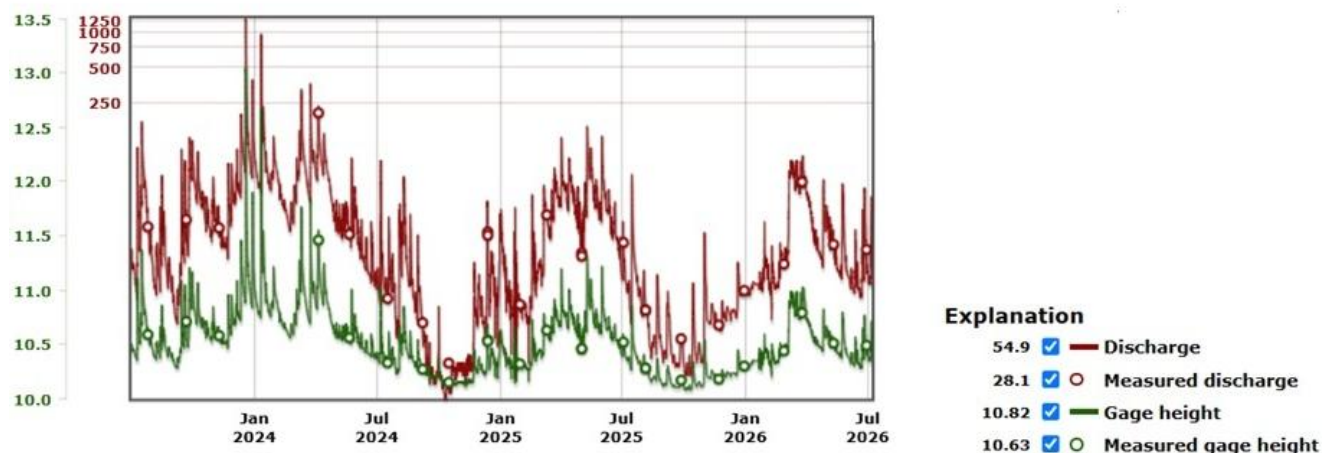


Figure 12: USGS Ringwood Creek Gauging Station Gage Height in feet and Discharge cubic feet per second (2023-2026) (11)

USGS 01386000 – West Brook near Wanaque

Analysis of discharge and gage height records from USGS Station 01386000 (West Brook near Wanaque) indicates a rapid hydrologic response to precipitation events, characterized by sharp increases in discharge followed by relatively short recession periods. This behavior is characteristic of watersheds where direct runoff is a significant component of streamflow response (2). Although discharge decreased during periods of reduced precipitation, continuous streamflow was maintained throughout the monitoring period, suggesting that groundwater contributions help sustain baseflow conditions. The observed flow patterns indicate that West Brook is responsive to rainfall events while also benefiting from groundwater inputs that maintain flow during drier periods (2). Figure 13 illustrates the relationship between discharge and gage height at the West Brook gauging station from 2023 through 2026.

USGS 01386000 West Brook near Wanaque NJ

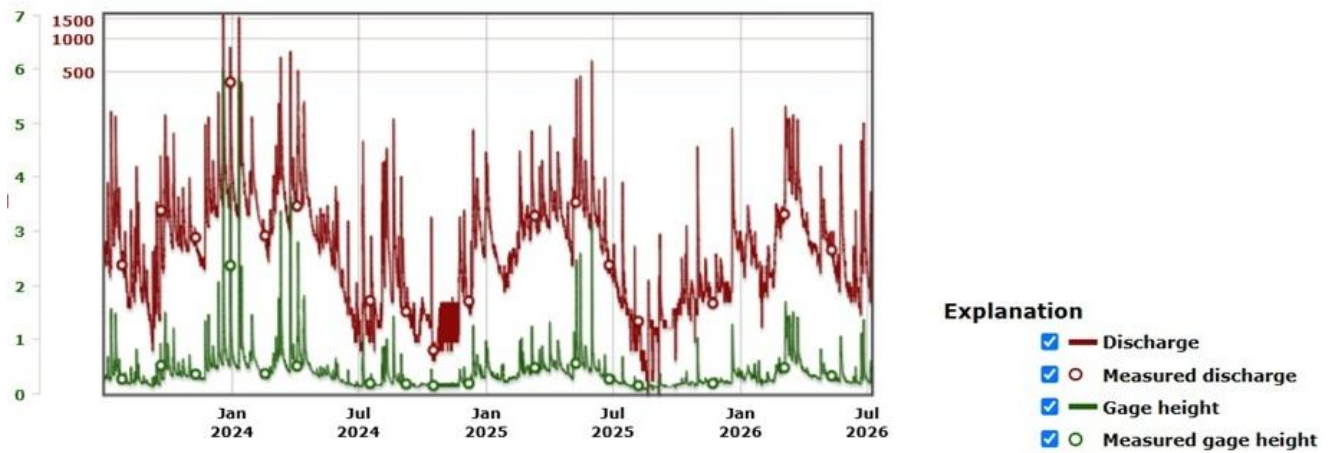


Figure 13: USGS West Brook Gauging Station Gage Height in feet and Discharge cubic feet per second (2023-2026) (11)

Existing Stormwater Improvement Project(s)

CURRENT IMPROVEMENT PROJECT #1 TO ADDRESS TSS, TOTAL PHOSPHORUS, TOTAL NITROGEN AND METALS (MERCURY) FOR SUBWATERSHED(S): ALL

· Description:

- Storm Drain Inventory and Maintenance
- Location: Entire Borough
- Description: The Borough records and maintains an inventory of all of its stormwater infrastructure and cleans them on an annual basis. The Borough also requires the owners of private stormwater facilities within the Borough but not under its ownership/operation to inspect and, if needed, clean the stormwater facilities. The Borough itself inspects all properties every 5 years.
- Roadways, parking areas and open land drains towards the storm system (inlets) which is collected in catch basins and channeled through pipes and manholes.
- Scope: The Scope of the work encompasses the entire municipality: 2,359 total catch basins (100% inspected and cleaned annually).
- Inspection will be done manually by DPW crews by opening grates, manholes, etc. and using CCTV cameras to inspect piping where necessary. The catch basins and manholes are cleaned out with vacuum trucks and jetters. The material that is removed is then disposed of via landfill.

· Impairment and/or TMDL Parameters addressed:

- TSS, Total Nitrogen, Total Phosphorus and Heavy Metals (Mercury) are all removed by this process. For Fecal Coliform, it is assumed that animal waste exists on pavement and land upstream of storm infrastructure and leach bacteria into the runoff afterwards.

· Estimated Load Reduction:

- A reduction of 221.6 CY of material is removed from the storm system each year. Based on removal rates reported in professional guidance, it is expected that this operation achieves a 12% reduction in TSS and 5% reduction of Total Nitrogen, Total Phosphorus and Mercury in the watershed. By physically removing debris from the storm system, contaminants are stopped from migrating into the natural watercourses and streams of the area. This estimation is based on a study reported in Milwaukee Metropolitan Sewer District's (MMSD) 2020 State of the Art Report: 35% of TSS and 15% of TN, TP and Metals can be removed on a monthly cleaning schedule. When adjusted to match the Borough's maintenance schedule, only 12% is removed.

CURRENT IMPROVEMENT PROJECT #2 TO ADDRESS TSS, TOTAL PHOSPHORUS, TOTAL NITROGEN, METALS (MERCURY) AND FECAL COLIFORM FOR SUBWATERSHED(S): ALL

· Description:

- Storm Drain Labeling and Retrofitting Program
- Location: Entire Borough
- Description: The Borough labels all of its stormwater inlets (i.e., catch basin curb pieces) informing the public that dumping is not permitted. Storm drain inlets are retrofitted to newer eco-type curb pieces stating similar messaging as the labels. This operation is best categorized under public education.
- Scope: The Scope of work encompasses the entire municipality. Wherever drain labels need to be replaced, they are replaced by the DPW.
- The retrofit process is done by placing new sticky labels with “No Dumping” or similar information on storm inlets and also replacing inlets to include castings with “No dumping” text on them.

· Impairment and/or TMDL Parameters addressed:

- It is estimated that TSS, Total Nitrogen, Total Phosphorus, Heavy Metals (Mercury) and Fecal Coliform are all removed by this process.

· Estimated Load Reduction:

- The total reduction for the Borough Storm Drain Labeling and Retrofitting Program totals 2%. This estimate is based on multiple sources, indicating that storm drain labeling and retrofitting to a newer Eco-Type curb piece has an impact on stormwater quality (32). Unfortunately, it did not provide a definitive percent removal; therefore, a de minimis removal rate of 2% was chosen.

CURRENT IMPROVEMENT PROJECT #3 TO ADDRESS TSS, TOTAL PHOSPHORUS, TOTAL NITROGEN, METALS (MERCURY) AND FECAL COLIFORM FOR SUBWATERSHED(S): ALL

· Description:

- Street Sweeping Program
- Location: Entire Borough
- Description: The Borough cleans all streets under its jurisdiction using street 4 times per year. This is conducted over 75 miles of roadway by Borough DPW staff. This action is categorized as an Improved Source Control technique by NJDEP.
- All major roads are swept.
- Scope: All 75 miles of roadway (100%) approximately once every two (2) months (i.e., one out of every 8 weeks, done frequently during the warmer months and none during the winter). The latest total amount of debris collected is 1,315.29 CY of material recorded by the Borough.

· Impairment and/or TMDL Parameters addressed:

- TSS, Total Nitrogen, Total Phosphorus and Heavy Metals (Mercury) are all removed by this process.

· **Estimated Load Reduction:**

- It is estimated that reductions of 2% for Fecal Coliform, 5% for heavy metals (Mercury), 4.5% for TSS and 5% for nutrients (TN, TP) can be achieved by removal of debris by street sweeping. Based on the Borough's sweeping frequency (4 times a year), the removal rates are estimated to be reduced due to the monthly sweeping presented in the literature (31).

Potential Sources of Pollution

Potential sources of contamination include both point and non-point sources. The potential sources associated with each category are discussed below.

Non-Point Sources

Septic Systems

Septic systems can act as non-point sources of pollution (primarily fecal coliform, phosphorus and nitrogen) and have the potential to contribute to the pollution of surface waters when the systems are not functioning adequately (4). The estimated number of residential parcels were determined using NJGIS parcel layer downloaded in August 2026 and then this layer was refined to only display the residential land use parcels that did not fall within the majority of the Sewer Service Area boundary. The Sewer Service Area boundary was downloaded from NJDEP Open Data downloaded in August 2026. Factors contributing to septic system pollution may include inadequate maintenance, aging infrastructure, excessive wastewater loading, improper siting, poor soil conditions and elevated groundwater levels (13). These conditions can reduce treatment effectiveness and increase the potential for nutrients, pathogens and other contaminants to reach groundwater and nearby surface waters (13). The approximate count of residential parcels with septic systems in The Borough of Ringwood are shown in Table 17 and mapped in Figure 14.

Table 17: Estimated number of residential parcels with suspected septic systems

HUC-14	Subwatershed Name	Parcels Outside of the Sewer Service Area
2030103070030	Wanaque R/Greenwood Lk (above Monk's gage)	93
2030103070040	West Brook / Burnt Meadow Brook	535
2030103070050	Wanaque Reservoir (below Monk's gage)	1,957
2030103070060	Meadow Brook / High Mountain Brook	1,537
2030103070070	Wanaque R/Posts Bk (below reservoir)	0
2030103070080	Ringwood Creek	39
2030103100010	Ramapo R (above 74d 11m 00s)	0
2030103100040	Ramapo R (Bear Swamp Bk thru Fyke Bk)	0
2030103100050	Ramapo R (Crystal Lk br to Bear Swamp Bk)	0
Total		4,161

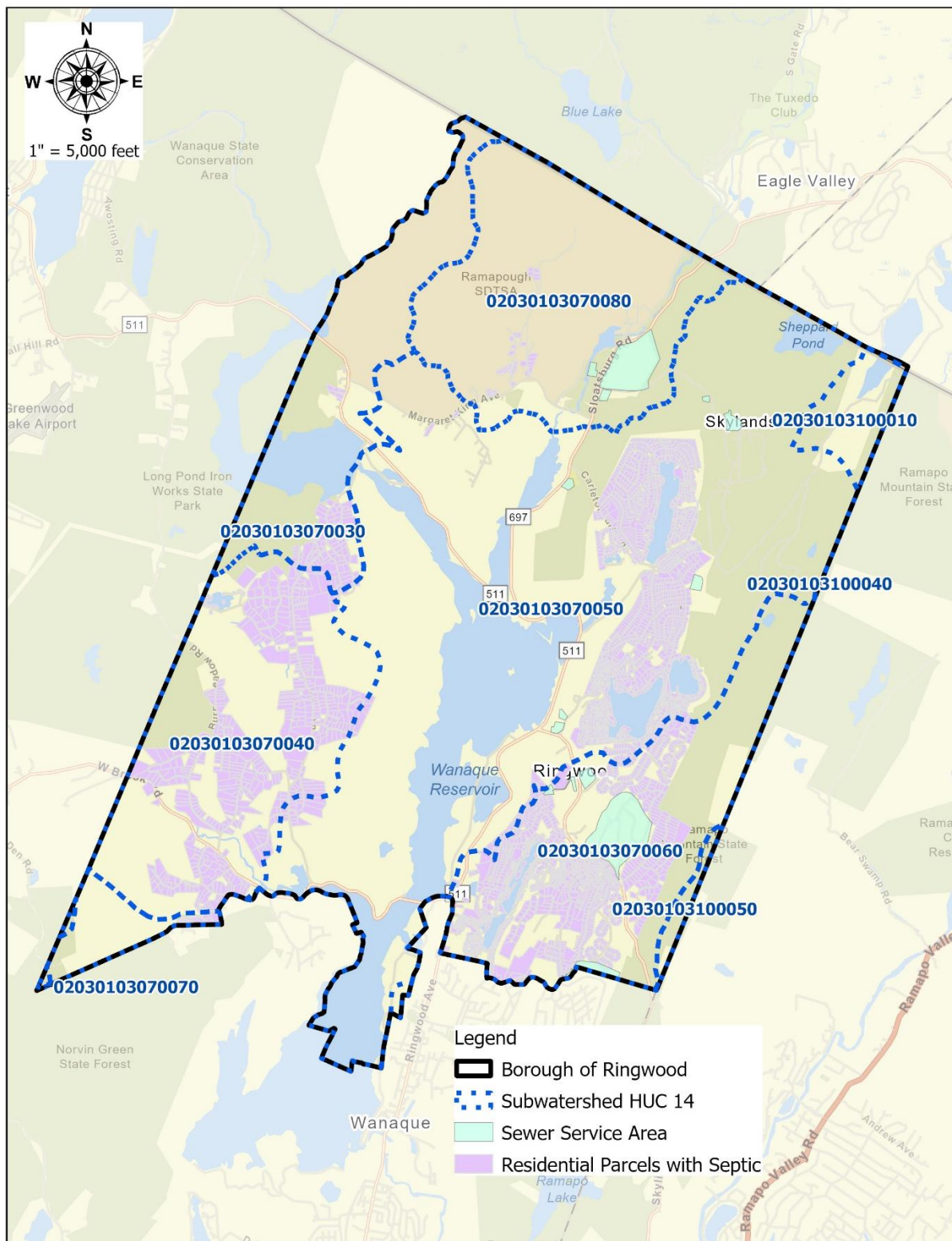


Figure 14: Sewer service area and residential parcels with suspected septic systems in The Borough of Ringwood

Stormwater Runoff from Developed Areas

Stormwater runoff from developed areas is a significant source of non-point source pollution. Dirt, oil, chemicals, litter and other debris that accumulate on roads, parking lots, rooftops and other impervious surfaces can be washed away during precipitation events and conveyed through storm sewer systems to nearby waterbodies (8,9). Pollutants commonly associated with stormwater runoff include petroleum products, heavy metals, road salt, sediment, nutrients, trash and debris, as well as oil, grease and other substances generated by vehicles and developed areas (8,9). Once mobilized, these pollutants may be transported to streams, wetlands, reservoirs and groundwater recharge areas, where they may adversely affect water quality and aquatic resources (8,9).

Lawn Fertilizers and Pesticides

Residential lawn care practices may contribute to non-point source pollution through the application of excess fertilizers, herbicides and pesticides. During rainfall events, these materials can be transported by stormwater runoff into nearby streams, lakes, wetlands and groundwater recharge areas. Excess nutrients, particularly nitrogen and phosphorus, may degrade water quality and contribute to nuisance algal growth and other ecological impacts (8,9).

Pet Waste and Wildlife Contributions

Pet waste and wildlife can contribute bacteria, nutrients and pathogens to water resources. When pet waste is not properly collected and disposed of, stormwater runoff can transport these contaminants into storm drains and nearby waterbodies. The introduction of bacteria, pathogens and excess nutrients may degrade water quality and affect aquatic habitats. Runoff from developed and open space areas can further facilitate the movement of these pollutants throughout the watershed (9).

Point Sources

The New Jersey Pollutant Discharge Elimination System (NJPDES) is a regulatory program that oversees wastewater and stormwater discharges to New Jersey's surface waters and groundwater resources. Through the issuance of permits for industrial, sanitary and stormwater discharge sources, the program helps protect water quality by establishing treatment requirements and discharge limitations that reduce pollutant inputs to rivers, streams, lakes, coastal waters and aquifers. NJDEP DataMiner was reviewed in August 2026 to identify active NJPDES permits within the Borough of Ringwood. A total of 33 active permits were identified and are summarized in Table 18 and displayed in Figure 15.

Table 18: Active NJPDES Permits

NJPDES Permit Number	Program Interest Number	Facility Information			
		Name	Street Address	Permit Expiration Date	Discharge Category Description
NJ0027006	46846	Ringwood Acres Treatment Plant	James Dr Ringwood, NJ 07456	12/31/2024	Sanitary Wastewater (IP) (A)
NJ0032395	46848	Ringwood Plaza STP	Alta Vista Dr Ringwood, NJ 07456	3/31/2027	Sanitary Wastewater (IP) (A)
NJ0069213	46360	Avatar Residential Detox Center Inc	2 Morris Rd Ringwood, NJ 074560000	9/30/2022	Discharge to Groundwater (IP) (GW)
NJ0091278	46692	Ringwood State Park	1304 Sloatsburge Rd Ringwood, NJ 07456	12/31/2024	Discharge to Groundwater (IP) (GW)
NJG0029432	46845	Robert Erskine School STP	121 Erskine Rd Ringwood, NJ 07456	12/31/2027	Consolidated School Sanitary Treatment Plants (GP) (ASC)
NJG0062316	46847	Fieldstone Shopping Plaza	130 Skyline Dr Ringwood, NJ 074560000	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)
NJG0085073	47288	St Catherine's School	112 Erskine Rd Ringwood, NJ 074560000	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)
NJG0100102	47416	Martin Ryerson Middle School WTP	Valley Rd Ringwood, NJ 074560000	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)
NJG0100111	47417	EG Hewitt School WTP	Sloatsburg Rd Ringwood, NJ 074560000	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)

NJPDES Permit Number	Program Interest Number	Facility Information			
		Name	Street Address	Permit Expiration Date	Discharge Category Description
NJG0133329	46692	Ringwood State Park	1304 Sloatsburg Rd Ringwood, NJ 07456	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)
NJG0145599	156607	Van Orden Sand & Gravel Of Ringwood	589 Westbrook Rd Ringwood, NJ 07456	8/31/2022	Mining and Quarrying Activity Stormwater (GP) (R13)
NJG0152749	213907	Ringwood Boro	60 Margaret King Ave Ringwood, NJ 074561796	12/31/2027	MS4 - Tier A Municipal Stormwater (GP) (R9)
NJG0159361	252735	Green Residential Community Home	1311 Sloatsburg Rd Ringwood, NJ 07456	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)
NJG0161683	270350	201 Margaret King Property LLC	201 Margaret King Ave Ringwood, NJ 07456	1/31/2028	Basic Industrial Stormwater (GP) (5G2)
NJG0161829	271064	Haskell Paving Inc	30 Greenwood Lake Tpke Ringwood, NJ 07420	1/31/2028	Basic Industrial Stormwater (GP) (5G2)
NJG0170453	462271	Ringwood Commons	55 Skyline Dr Ringwood, NJ 07456	8/31/1930	Dental Facilities Onsite WW Treatment Systems (GP) (K2)
NJG0171981	476946	Dentists @10 Greenwood Lake Tpke LLC	10 Greenwood Lake Tpke Ringwood, NJ 07456	8/31/1930	Dental Facilities Onsite WW Treatment Systems (GP) (K2)
NJG0189057	90570	Coppola Services Inc	28 Executive Pkwy Ringwood Boro, NJ 07456	12/31/1930	Residuals Transfer Facilities (GP) (ZG)

NJPDES Permit Number	Program Interest Number	Facility Information			
		Name	Street Address	Permit Expiration Date	Discharge Category Description
NJG0200093	569464	Monksville Plaza	1131 1141 1159 GREENWOOD LK TPKE Ringwood, NJ 07456	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)
NJG0211397	595065	EMSF/Proposed American Addiction Ctr	474 Sloatsburg Rd Ringwood, NJ 07456	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)
NJG0213659	601475	Transmission line 89	manor road, ringwood manro state park Ringwood Manor State Park, NJ 07456	2/28/2027	Construction Activity Stormwater (GP) (5G3)
NJG0223824	46846	Ringwood Acres Treatment Plant	James Dr Ringwood, NJ 07456	12/31/2029	Sludge Quality Category 1 (GP) (S1G)
NJG0223867	46692	Ringwood State Park	1304 Sloatsburg Rd Ringwood, NJ 07456	12/31/2029	Sludge Quality Category 1 (GP) (S1G)
NJG0236519	46360	Avatar Residential Detox Center Inc	2 Morris Rd Ringwood, NJ 074560000	12/31/1930	Sludge Quality Exempt (GP) (SXG)
NJG0236543	46845	Robert Erskine School STP	121 Erksine Rd Ringwood, NJ 07456	12/31/1930	Sludge Quality Exempt (GP) (SXG)
NJG0236551	46848	Ringwood Plaza STP	Alta Vista Dr Ringwood, NJ 07456	12/31/1930	Sludge Quality Exempt (GP) (SXG)
NJG0238384	595065	EMSF/Proposed American Addiction Ctr	474 Sloatsburg Rd Ringwood, NJ 07456	2/28/2027	Construction Activity Stormwater (GP) (5G3)

NJPDES Permit Number	Program Interest Number	Facility Information			
		Name	Street Address	Permit Expiration Date	Discharge Category Description
NJG0257222	732730	Skyline Lakes Plaza	16 Skyline Links Dr Ringwood, NJ 07456	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)
NJG0260592	726703	Spring Lake Day Camp	234 Conklintown Rd Ringwood, NJ 07456	6/30/1930	Sanitary Subsurface Disposal (GP) (T1)
NJG0264237	747233	Van Orden Settlement Ponds	589 Westbrook Road Ringwood, NJ 07508	2/28/2027	Construction Activity Stormwater (GP) (5G3)
NJG0356344	1053165	Avatar Residential Detox Center	474 Sloatsburg Road Ringwood, NJ 07436	2/28/2027	Construction Activity Stormwater (GP) (5G3)
NJG0366994	1088102	Ringwood Recycling Center	Peters Mine Road Ringwood Boro, NJ 07456	2/28/2027	Construction Activity Stormwater (GP) (5G3)
NJG0372579	1105111	Next Gen Motor Vehicle Storage Facility	400 Margaret King Avenue Ringwood, NJ 07456	2/28/2027	Construction Activity Stormwater (GP) (5G3)

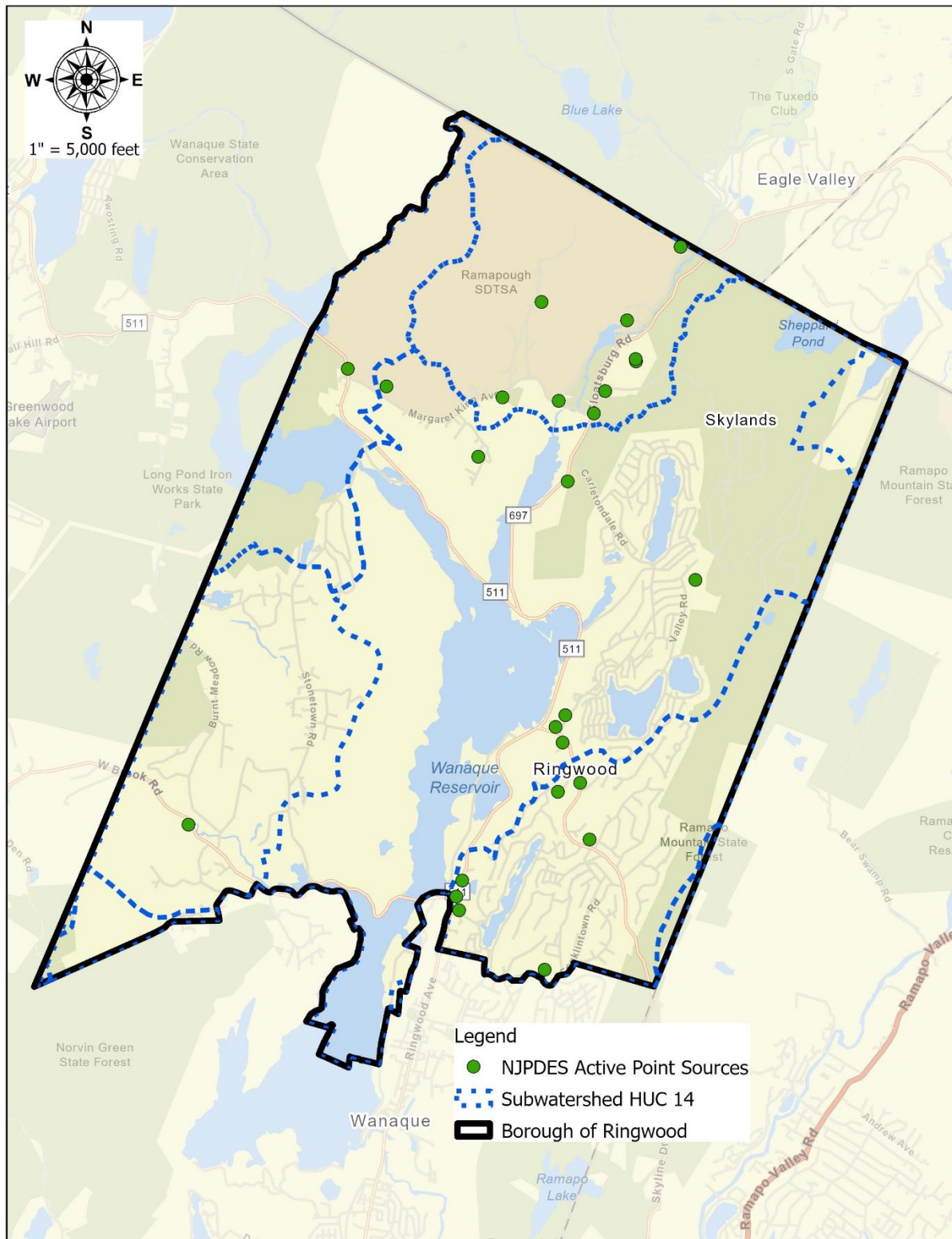


Figure 15: Map of NJPDES Active permitted facilities in The Borough of Ringwood

Summary of Existing Watershed-Based Plan(s)

The Borough reviewed available records to determine whether any Watershed Restoration and Protection Plans (WBPs) has been developed within the Borough's jurisdiction. Based on this review, the Borough is not aware of any existing WBPs that apply to areas within its municipal boundaries.

Should a watershed-based plan be developed or identified in the future, the Borough will review the plan and evaluate opportunities to support applicable watershed protection and restoration objectives.

Subwatershed Specific Assessment

HUC-14 - 02030103070030 (Wanaque R/Greenwood Lake, above Monks Gage)

TMDL and Impairment Parameter Review

- **Streamshed TMDL– Mercury**

- TMDL Report: Total Maximum Daily Load for Mercury Impairments Based on Concentration in Fish Tissue Caused Mainly by Air Deposition to Address 122 HUC-14s Statewide
- TMDL Report Approval Date: Approved: September 25, 2009
- The Wanaque River/Greenwood Lake (Above Monks Gage) subwatershed was identified in NJDEP's 2010 Mercury Total Maximum Daily Load (TMDL) as impaired for mercury based on elevated fish tissue concentrations. The TMDL concluded that atmospheric deposition is the dominant source of mercury contamination within the watershed. Source analyses indicated that approximately 52 percent of the mercury load originates from background atmospheric sources, 26 percent from surrounding states and 12.5 percent from New Jersey sources. (14).

To address the impairment, NJDEP established a target fish tissue concentration of 0.18 µg/g and determined that an overall 84.3 percent reduction in mercury loading would be required to achieve this goal. Because a substantial portion of mercury loading originates from background conditions and atmospheric sources outside New Jersey, the report concluded that mercury reduction efforts are largely dependent on statewide, regional and national emission control programs rather than local watershed management measures (14).

- **Streamshed TMDL – Total Phosphorus**

- TMDL Report: Total Maximum Daily Load Report For the Non-Tidal Passaic River Basin Addressing Phosphorus Impairments
- TMDL Report adopted: April 24, 2008
- The Wanaque River/Greenwood Lake (Above Monks Gage) subwatershed was included within NJDEP's 2008 Phosphorus TMDL study area for the Non-Tidal Passaic River Basin. In the 2006 Integrated Water Quality Monitoring and Assessment Report, the assessment unit was classified as Sublist 3, indicating that additional information was needed to fully assess phosphorus conditions. The TMDL report indicates that waste load allocations and load allocations for this subwatershed were addressed through the previously established Greenwood Lake TMDL rather than through the Passaic River Basin phosphorus TMDL. As a result, no watershed-specific phosphorus restoration measures were established for this HUC under the 2008 Passaic Basin TMDL (15).
- The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent, to be achieved through implementation of stormwater management measures and other best management practices throughout the contributing watershed rather than at the individual subwatershed level (15).
- Potential phosphorus sources identified in the report include stormwater runoff from residential, commercial, industrial and transportation land uses, wastewater treatment facility discharges, septic systems, agricultural activities and wildlife-related sources (15).

Area(s) prone to flooding

The Phase 1 Watershed inventory report did not outline any areas prone to flooding in this subwatershed.

Land Cover and Land Use

Development by regulatory era was estimated using historic and current land use/land cover datasets. Pre-1983 development was derived from the Rutgers CRSSA 1984 Land Cover dataset, 1983-2004 development was identified using the NJDEP 1986 Land Use/Land Cover dataset and post-2004 development was evaluated using the NJDEP 2020 Land Use/Land Cover dataset. All datasets were analyzed within a GIS environment to quantify acreage by land use category and regulatory era.

Wanaque R/Greenwood Lake, above Monks Gage subwatershed contains approximately 1,584 acres and is characterized by a largely natural landscape, with forest, wetland and open water cover comprising 88% of the watershed. Developed land uses represent approximately 11% of the total area, consisting primarily of low-density residential (6.2%), urban/mixed urban (3.6%) and commercial land uses (1.3%). Development analysis indicates that 78% of developed acreage predates 1983, with only 7.1% occurring after 2004, suggesting limited recent growth and a relatively low contribution from newer regulated development. Refer to Tables 19, 20 and 21 and Figure 16 land use details.

Table 19: Land Use Distribution for HUC 02030103070030

HUC-14 - 02030103070030 (Wanaque R/Greenwood Lake, above Monks Gage)		
Land Use 2020	Area (Acres)	Percentage of Total Area
Agricultural	9.6	0.6%
Barren Land/Transitional Area	0.0	0.0%
Commercial	21.3	1.3%
Forest, Water, Wetlands	1,394.3	88.0%
High, Medium Density Residential	0.0	0.0%
Industrial	3.1	0.2%
Low Density, Rural Residential	97.9	6.2%
Urban, Mixed Urban, Other Urban	57.8	3.6%

Table 20: Area of New Development During Regulatory Eras (Acres) for HUC 02030103070030

HUC-14	Pre-1983	1983-2004	Post-2004	Total
02030103070030	140.4	26.9	12.8	180.1

Table 21: Area of New Development During Regulatory Eras (%) for HUC 02030103070030

HUC-14	Pre-1983	1983-2004	Post-2004
02030103070030	78.0%	14.9%	7.1%

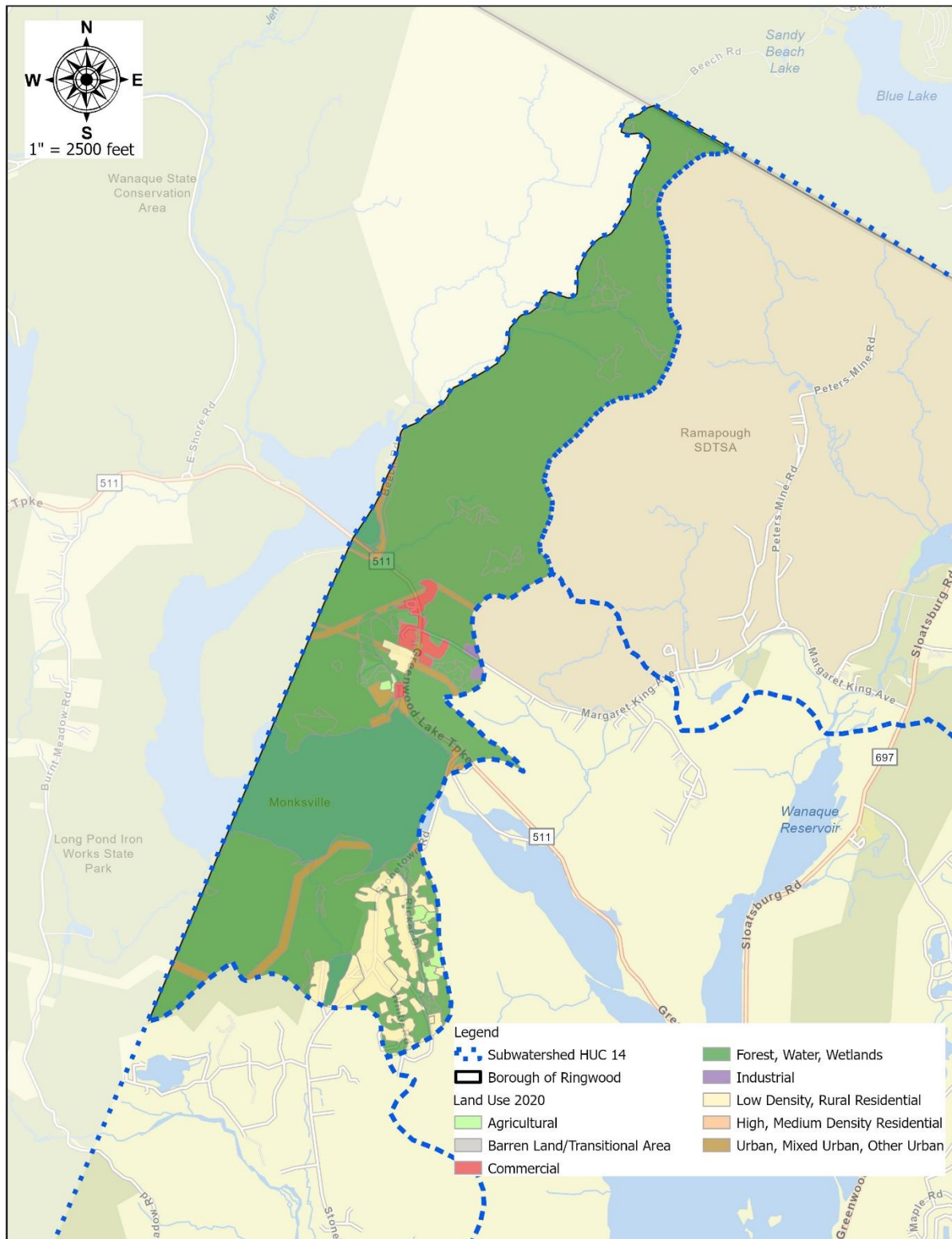


Figure 16: Land Use Cover Map HUC 02030103070030

HUC-14 - 02030103070040 (West Brook/Burnt Meadow Brook)

TMDL and Impairment Parameter Review

- **Streamshed TMDL—Mercury**
 - During preparation of the current Watershed Assessment Report, the NJDEP Mercury TMDL documentation was reviewed in greater detail to verify impairments and assessment units associated with each HUC-14 subwatershed. This HUC was previously identified by the NJDEP as mercury-impaired based on their proximity to mapped TMDL watershed boundaries. The NJDEP re-evaluated against the assessment units specifically addressed in the Mercury TMDL report. This review determined that this subwatershed was located within the broader TMDL study area but were not identified as mercury-impaired assessment units and were not assigned mercury-related restoration measures. As a result, these HUC-14s have been removed from the list of mercury-impaired waters in this updated NJDEP evaluation. The revised assessment reflects the specific impairment designations documented in the NJDEP Mercury TMDL report rather than the geographic extent of the associated GIS streamshed layer (14).
- **Streamshed TMDL— Total Phosphorus**
 - TMDL Report: Total Maximum Daily Load Report For the Non-Tidal Passaic River Basin Addressing Phosphorus Impairments
 - TMDL Report adopted: April 24, 2008
 - The West Brook/Burnt Meadow Brook watershed was included within the study area of NJDEP's 2008 Total Maximum Daily Load (TMDL) for phosphorus in the Non-Tidal Passaic River Basin. The assessment unit was not identified as impaired for phosphorus in the 2006 Integrated Water Quality Monitoring and Assessment Report and was not designated as a critical phosphorus-response location within the TMDL analysis. Although included in the watershed modeling effort, the report did not establish watershed-specific phosphorus restoration measures for this HUC. Instead, the subwatershed was evaluated as part of the broader Passaic River Basin analysis developed to support attainment of water quality objectives in downstream receiving waters, including the Wanaque Reservoir (15).
 - The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent, to be achieved through implementation of stormwater management measures and other best management practices throughout the contributing watershed rather than at the individual subwatershed level (15).
 - Potential phosphorus sources identified in the report include stormwater runoff from residential, commercial, industrial and transportation land uses, wastewater treatment facility discharges, septic systems, agricultural activities and wildlife-related sources (15).
- **Impairment— Temperature**
 - Elevated water temperatures can adversely affect aquatic life, particularly cold-water and trout-supporting species. Increased stream temperatures may result from loss of riparian vegetation and stream shading, increased stormwater runoff from impervious surfaces, reduced groundwater inputs and alterations to natural stream hydrology (19, 20, 21). Elevated temperatures can also reduce dissolved oxygen concentrations and negatively affect aquatic habitat quality (19, 20, 21). Potential management measures include preservation and restoration of riparian buffers, protection of groundwater recharge areas and implementation of stormwater management practices designed to reduce thermal impacts (19, 20, 21).

- **Impairment– Dissolved Oxygen**

- Dissolved oxygen is necessary to support healthy aquatic ecosystems. Low dissolved oxygen concentrations may result from elevated water temperatures, excessive nutrient loading, organic matter decomposition, reduced streamflow, or stagnant water conditions. Insufficient dissolved oxygen can stress aquatic organisms and impair fish (19, 22, 23). Preventative measure to reduce dissolved oxygen impairment include reduced nutrient inputs, improve stormwater management and protecting riparian corridors (19, 22, 23).

Area(s) prone to flooding

The Phase 1 Watershed inventory report did not outline any areas prone to flooding in this subwatershed.

Land Cover and Land Use

Development by regulatory era was estimated using historic and current land use/land cover datasets. Pre-1983 development was derived from the Rutgers CRSSA 1984 Land Cover dataset, 1983-2004 development was identified using the NJDEP 1986 Land Use/Land Cover dataset and post-2004 development was evaluated using the NJDEP 2020 Land Use/Land Cover dataset. All datasets were analyzed within a GIS environment to quantify acreage by land use category and regulatory era.

West Brook/Burnt Meadow Brook is predominantly characterized by natural land cover, with forest, water and wetlands comprising approximately 73.9% of the watershed. Developed land uses are primarily low-density residential, which account for 20.9% of the watershed area. Other developed land uses, including urban, industrial, commercial and high-density residential areas, collectively comprise less than 3% of the watershed. Agricultural land uses are minimal, representing less than 1% of the total watershed area. Refer to Table 22 and Figure 17 for land use details.

A total of approximately 590.3 acres of developed land were identified within this subwatershed. Most development occurred prior to 1983, accounting for 513.0 acres (86.9%) of the total developed area. Development between 1983 and 2004 accounted for 20.9 acres (3.5%), while 56.4 acres (9.5%) were developed after 2004. The predominance of pre-1983 development indicates that much of the watershed's developed area was established prior to the implementation of modern stormwater management regulations. Refer to Tables 23 and 24 for historical land use details.

Table 22: Land Use Distribution for HUC 02030103070040

HUC-14 - 02030103070040 (West Brook/Burnt Meadow Brook)		
Land Use 2020	Area (Acres)	Percentage of Total Area
Agricultural	20.6	0.8%
Barren Land/Transitional Area	57.2	2.2%
Commercial	1.3	0.1%
Forest, Water, Wetlands	1,896.7	73.9%
High, Medium Density Residential	8.7	0.3%
Industrial	11.6	0.5%
Low Density, Rural Residential	536.5	20.9%
Urban, Mixed Urban, Other Urban	32.1	1.2%

Table 23: Area of New Development During Regulatory Eras (Acres) for HUC 02030103070040

HUC-14	Pre-1983	1983-2004	Post-2004	Total
02030103070040	513.0	20.9	56.4	590.3

Table 24: Area of New Development During Regulatory Eras (%)for HUC 02030103070040

HUC-14	Pre-1983	1983-2004	Post-2004
02030103070040	86.9%	3.5%	9.5%

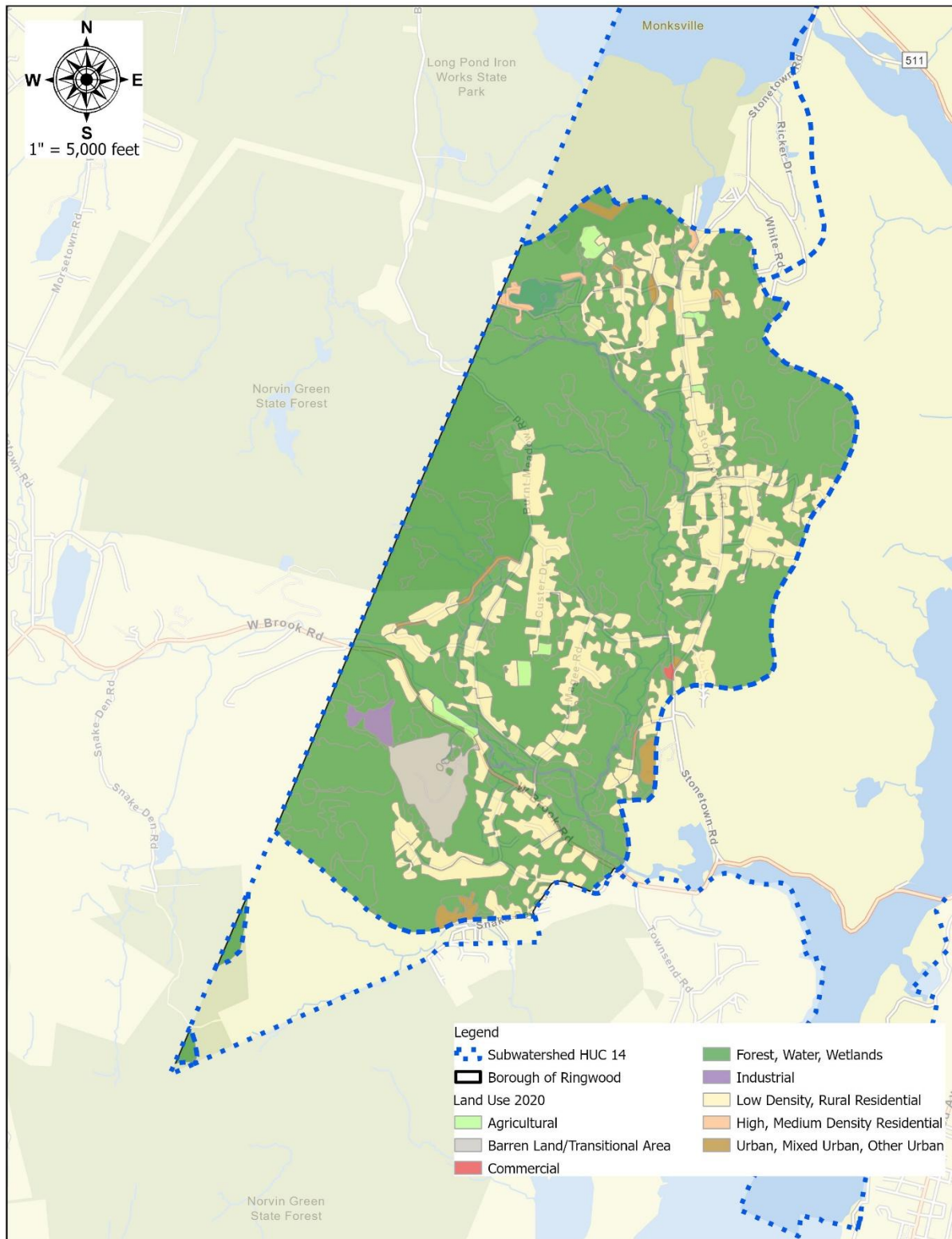


Figure 17: Land Use Cover Map HUC 02030103070030

HUC-14 - 02030103070050 (Wanaque Reservoir, below Monks Gage)

TMDL and Impairment Parameter Review

- **Streamshed TMDL – Mercury**

- TMDL Report: Concentration in Fish Tissue Caused Mainly by Air Deposition to Address 122 HUC-14s Statewide
- TMDL Report Approval Date: Approved: September 25, 2009
- The Wanaque Reservoir (below Monks Gage) subwatershed was identified in NJDEP's 2010 Mercury Total Maximum Daily Load (TMDL) as impaired for mercury based on elevated fish tissue concentrations. The TMDL concluded that atmospheric deposition is the dominant source of mercury contamination within the watershed. Source analyses indicated that approximately 52 percent of the mercury load originates from background atmospheric sources, 26 percent from surrounding states and 12.5 percent from New Jersey sources. (14).

To address the impairment, NJDEP established a target fish tissue concentration of 0.18 µg/g and determined that an overall 84.3 percent reduction in mercury loading would be required to achieve this goal. Because a substantial portion of mercury loading originates from background conditions and atmospheric sources outside New Jersey, the report concluded that mercury reduction efforts are largely dependent on statewide, regional and national emission control programs rather than local watershed management measures (14).

- **Streamshed TMDL – Total Phosphorus**

- TMDL Report: Total Maximum Daily Load Report For the Non-Tidal Passaic River Basin Addressing Phosphorus Impairments
- TMDL Report adopted: April 24, 2008
- The Wanaque Reservoir (Below Monks Gage) subwatershed was identified by NJDEP as one of the two critical locations evaluated in the 2008 Total Maximum Daily Load (TMDL) for phosphorus in the Non-Tidal Passaic River Basin. Water quality monitoring and modeling indicated that phosphorus loading contributed to excessive primary productivity within the reservoir, resulting in elevated algal growth. To protect drinking water supply, aquatic life and recreational uses, NJDEP established a watershed-specific criterion of 10 µg/L seasonal average chlorophyll-a for the Wanaque Reservoir. The TMDL determined that phosphorus reductions from wastewater treatment facilities, urban stormwater runoff and other watershed sources throughout the contributing drainage area were necessary to achieve this water quality target (15).
- The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent, to be achieved through implementation of stormwater management measures and other best management practices throughout the contributing watershed rather than at the individual subwatershed level (15).
- Potential phosphorus sources identified in the report include stormwater runoff from residential, commercial, industrial and transportation land uses, wastewater treatment facility discharges, septic systems, agricultural activities and wildlife-related sources (15).

- **Streamshed TMDL – Fecal Coliform**

- TMDL Report: Total Maximum Daily Loads for Fecal Coliform to Address 32 Streams in the Northeast Water Region
- TMDL Report approved: July 29, 2003

- The 2003 Fecal Coliform TMDL identifies impaired stream segments and monitoring stations rather than HUC-14 subwatersheds. As part of this update, the Fecal Coliform TMDL was reviewed to compare the impaired stream reaches and watershed areas described in the report with the corresponding HUC-14 subwatersheds. This review determined that several HUC-14s previously included based on their proximity to the mapped TMDL boundary were not directly associated with the impaired stream segments or implementation areas identified in the report. Accordingly, these HUC-14 subwatersheds have been removed from the fecal coliform impairment inventory presented in this report (16).
- **Lakeshed TMDL – Fecal Coliform**
 - TMDL Report: Total Maximum Daily Loads for Pathogens to Address 25 Lakes in the Northeast Water Region
 - TMDL Report approved: September 28, 2007
 - Portions of this subwatershed is located within lakesheds evaluated under the NJDEP 2007 Fecal Coliform TMDL for pathogen-impaired lakes in the Northeast Water Region. The TMDL identifies pathogen impairments for specific lakes and evaluates the contributing drainage areas associated with those waterbodies. Potential sources of fecal coliform identified by NJDEP include stormwater runoff, failing septic systems, sanitary sewer infrastructure deficiencies, pets, wildlife and waterfowl. Recommended implementation measures include stormwater management improvements, septic system maintenance and replacement, elimination of illicit discharges, public education, pet waste management and wildlife control measures. Because portions of these HUC-14 subwatersheds occur within the mapped lakesheds evaluated under the TMDL, they are considered to be within the TMDL study and implementation area; however, the TMDL does not identify impairments on a HUC-14 basis (17).
 - The report indicates that Lake Erskine requires a 96.48% reduction in fecal coliform.
- **Lakeshed TMDL – Total Phosphorus**
 - TMDL Report: Total Maximum Daily Load Report to Address Phosphorus Impairment in Pompton Lake and Ramapo River in the Northeast Water Region
 - TMDL Report adopted: April 24, 2008
 - Although GIS mapping shows a portion of this subwatershed within the mapped Pompton Lake/Ramapo River Total Phosphorus TMDL boundary, a review of the approved TMDL report determined that this HUC-14 as not included among the assessment units evaluated or addressed by the TMDL. Because the report does not identify this subwatershed as part of the TMDL study area or assign phosphorus-related allocations or implementation actions to them, they are being removed from further TMDL consideration (18).

Area(s) prone to flooding

The Phase 1 Watershed inventory report did not outline any areas prone to flooding in this subwatershed.

Land Cover and Land Use

Development by regulatory era was estimated using historic and current land use/land cover datasets. Pre-1983 development was derived from the Rutgers CRSSA 1984 Land Cover dataset, 1983-2004 development was identified using the NJDEP 1986 Land Use/Land Cover dataset and post-2004

development was evaluated using the NJDEP 2020 Land Use/Land Cover dataset. All datasets were analyzed within a GIS environment to quantify acreage by land use category and regulatory era.

Wanaque Reservoir, below Monks Gage subwatershed is predominantly characterized by natural land cover, with forest, water and wetlands comprising approximately 86.5% of the watershed area. Developed land uses account for a relatively small portion of the watershed and are primarily composed of high- and medium-density residential areas (8.3%), urban/mixed urban land uses (2.8%) and low-density residential development (1.1%). Commercial, industrial, agricultural and barren land uses collectively represent less than 2% of the watershed. Refer to Table 25 and Figure 18 for land use details.

A total of approximately 1,198.3 acres of developed land were identified within the HUC-14. The majority of development occurred prior to 1983, accounting for 1,106.1 acres (92.3%) of the total developed area. Development between 1983 and 2004 accounted for 33.5 acres (2.8%), while 58.7 acres (4.9%) were developed after 2004. This development pattern indicates that most developed land within the watershed predates the implementation of modern stormwater management regulations. Refer to Tables 26 and 27 for historical land use details.

Table 25: Land Use Distribution for HUC 02030103070050

HUC-14 - 02030103070050 (Wanaque Reservoir, below Monks Gage)		
Land Use 2020	Area (Acres)	Percentage of Total Area
Agricultural	4.2	0.0%
Barren Land/Transitional Area	1.6	0.0%
Commercial	66.6	0.7%
Forest, Water, Wetlands	7,690.9	86.5%
High, Medium Density Residential	741.2	8.3%
Industrial	37.6	0.4%
Low Density, Rural Residential	99.9	1.1%
Urban, Mixed Urban, Other Urban	253.0	2.8%

Table 26: Area of New Development During Regulatory Eras (Acres) for HUC 02030103070050

HUC-14	Pre-1983	1983-2004	Post-2004	Total
02030103070050	1,106.1	33.5	58.7	1,198.3

Table 27: Area of New Development During Regulatory Eras (%) for HUC 02030103070050

HUC-14	Pre-1983	1983-2004	Post-2004
02030103070050	92.3%	2.8%	4.9%

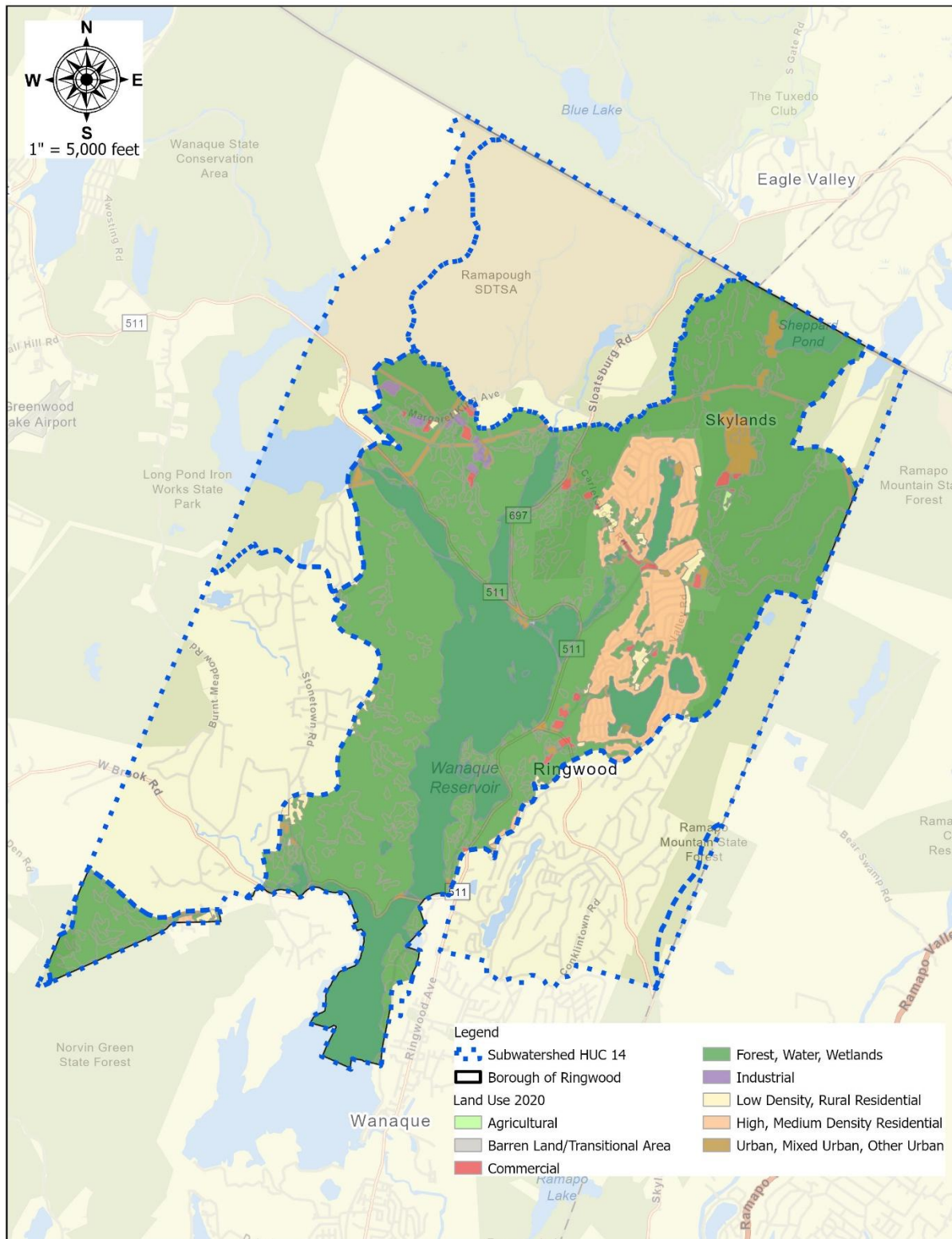


Figure 18: Land Use Cover Map HUC 02030103070050

HUC-14 - 02030103070060 (Meadow Brook/High Mountain Brook)

TMDL and Impairment Parameter Review

- **Streamshed TMDL—Mercury**
 - During preparation of the current Watershed Assessment Report, the NJDEP Mercury TMDL documentation was reviewed in greater detail to verify impairments and assessment units associated with each HUC-14 subwatershed. This HUC was previously identified as mercury-impaired based on their proximity to mapped TMDL watershed boundaries. The NJDEP re-evaluated against the assessment units specifically addressed in the Mercury TMDL report. This review determined that this subwatershed was located within the broader TMDL study area but were not identified as mercury-impaired assessment units and were not assigned mercury-related restoration measures. As a result, these HUC-14s have been removed from the list of mercury-impaired waters in this update. The revised assessment reflects the specific impairment designations documented in the NJDEP Mercury TMDL report rather than the geographic extent of the associated GIS streamshed layer (14).
- **Streamshed TMDL – Total Phosphorus**
 - TMDL Report: Total Maximum Daily Load Report For the Non-Tidal Passaic River Basin Addressing Phosphorus Impairments
 - TMDL Report adopted: April 24, 2008
 - The Meadow Brook/High Mountain Brook was included within the study area of NJDEP's 2008 Total Maximum Daily Load (TMDL) for phosphorus in the Non-Tidal Passaic River Basin. The subwatershed was not identified as impaired for phosphorus and was classified as having no phosphorus impairment designation in the 2006 Integrated Water Quality Monitoring and Assessment Report. However, the HUC was included within the broader watershed model and assigned load allocations as part of the basin-wide phosphorus reduction strategy developed to protect downstream critical waterbodies, including the Wanaque Reservoir (15).
 - The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent, to be achieved through implementation of stormwater management measures and other best management practices throughout the contributing watershed rather than at the individual subwatershed level (15).
 - Potential phosphorus sources identified in the report include stormwater runoff from residential, commercial, industrial and transportation land uses, wastewater treatment facility discharges, septic systems, agricultural activities and wildlife-related sources (15).
- **Streamshed TMDL – Fecal Coliform**
 - TMDL Report: Total Maximum Daily Loads for Fecal Coliform to Address 32 Streams in the Northeast Water Region
 - The 2003 Fecal Coliform TMDL identifies impaired stream segments and monitoring stations rather than HUC-14 subwatersheds. As part of this update, the Fecal Coliform TMDL was reviewed to compare the impaired stream reaches and watershed areas described in the report with the corresponding HUC-14 subwatersheds. This review determined that several

HUC-14s previously included based on their proximity to the mapped TMDL boundary were not directly associated with the impaired stream segments or implementation areas identified in the report. Accordingly, these HUC-14 subwatersheds have been removed from the fecal coliform impairment inventory presented in this report (16).

- **Lakeshed TMDL – Fecal Coliform**

- TMDL Report: Total Maximum Daily Loads for Pathogens to Address 25 Lakes in the Northeast Water Region
- TMDL Report approved: September 28, 2007
- Portions of this subwatershed are located within lakesheds evaluated under the NJDEP 2007 Fecal Coliform TMDL for pathogen-impaired lakes in the Northeast Water Region. The TMDL identifies pathogen impairments for specific lakes and evaluates the contributing drainage areas associated with those waterbodies. Potential sources of fecal coliform identified by NJDEP include stormwater runoff, failing septic systems, sanitary sewer infrastructure deficiencies, pets, wildlife and waterfowl. Recommended implementation measures include stormwater management improvements, septic system maintenance and replacement, elimination of illicit discharges, public education, pet waste management and wildlife control measures. Because portions of these HUC-14 subwatersheds occur within the mapped lakesheds evaluated under the TMDL, they are considered to be within the TMDL study and implementation area; however, the TMDL does not identify impairments on a HUC-14 basis (17).
- The report indicates that Skyline Lakes requires a 95.96% reduction in fecal coliform.

- **Lakeshed TMDL – Total Phosphorus**

- Pompton Lake and Ramapo River in the Northeast Water Region
- TMDL Report adopted: April 24, 2008
- Although GIS mapping shows a portion of this subwatershed within the mapped Pompton Lake/Ramapo River Total Phosphorus TMDL boundary, a review of the approved TMDL report determined that this HUC-14 is not included among the assessment units evaluated or addressed by the TMDL. Because the report does not identify this subwatershed as part of the TMDL study area or assign phosphorus-related allocations or implementation actions to them, they are being removed from further TMDL consideration (18).

- **Impairment – Escherichia Coli**

- Elevated concentrations of Escherichia coli (E. coli) indicate the presence of fecal contamination and may pose risks to recreational users and aquatic resources. Potential sources include failing septic systems, sanitary sewer overflows, stormwater runoff, pet waste and wildlife waste (19, 26, 27). Elevated bacteria concentrations are commonly associated with precipitation events and runoff from developed areas. Implementation measures such as stormwater management improvements, septic system maintenance, illicit discharge elimination, pet waste controls and public education programs may help reduce bacterial loading to surface waters (19, 26, 27).

- **Impairment– Temperature**

- Elevated water temperatures can adversely affect aquatic life, particularly cold-water and trout-supporting species. Increased stream temperatures may result from loss of riparian vegetation and stream shading, increased stormwater runoff from impervious surfaces, reduced groundwater inputs and alterations to natural stream hydrology (19, 20, 21).

Elevated temperatures can also reduce dissolved oxygen concentrations and negatively affect aquatic habitat quality (19, 20, 21). Potential management measures include preservation and restoration of riparian buffers, protection of groundwater recharge areas and implementation of stormwater management practices designed to reduce thermal impacts (19, 20, 21).

Area(s) prone to flooding

The Phase 1 Watershed inventory report did not outline any areas prone to flooding in this subwatershed.

Land Cover and Land Use

Development by regulatory era was estimated using historic and current land use/land cover datasets. Pre-1983 development was derived from the Rutgers CRSSA 1984 Land Cover dataset, 1983-2004 development was identified using the NJDEP 1986 Land Use/Land Cover dataset and post-2004 development was evaluated using the NJDEP 2020 Land Use/Land Cover dataset. All datasets were analyzed within a GIS environment to quantify acreage by land use category and regulatory era.

Meadow Brook/High Mountain Brook subwatershed is characterized by a mixture of natural and residential land uses. Forest, water and wetlands represent the dominant land cover, accounting for approximately 63.3% of the watershed area. Residential development is the primary developed land use, with high- and medium-density residential areas comprising 19.4% of the watershed and low-density residential areas accounting for an additional 13.1%. Commercial and urban/mixed urban land uses comprise relatively small portions of the watershed at 2.3% and 1.6%, respectively, while agricultural and industrial uses are negligible. Refer to Table 28 and Figure 19 for land use details.

A total of approximately 867.5 acres of developed land were identified within this subwatershed. Development is overwhelmingly composed of pre-1983 development, which accounts for 820.3 acres (94.6%) of the total developed area. Development occurring between 1983 and 2004 accounts for 7.7 acres (0.9%), while 39.5 acres (4.6%) were developed after 2004. Tables 29 and 30 provide historical land use details.

Table 28: Land Use Distribution for HUC 02030103070060

HUC-14 - 02030103070060 (Meadow Brook/High Mountain Brook)		
Land Use 2020	Area (Acres)	Percentage of Total Area
Agricultural	3.7	0.2%
Barren Land/Transitional Area	0.0	0.0%
Commercial	55.1	2.3%
Forest, Water, Wetlands	1,505.6	63.3%
High, Medium Density Residential	462.1	19.4%
Industrial	0.0	0.0%
Low Density, Rural Residential	312.0	13.1%
Urban, Mixed Urban, Other Urban	38.2	1.6%

Table 29: Area of New Development During Regulatory Eras (Acres) for HUC 02030103070060

HUC-14	Pre-1983	1983-2004	Post-2004	Total
02030103070060	820.3	7.7	39.5	867.5

Table 30: Area of New Development During Regulatory Eras (%) for HUC 02030103070060

HUC-14	Pre-1983	1983-2004	Post-2004
02030103070060	94.6%	0.9%	4.6%

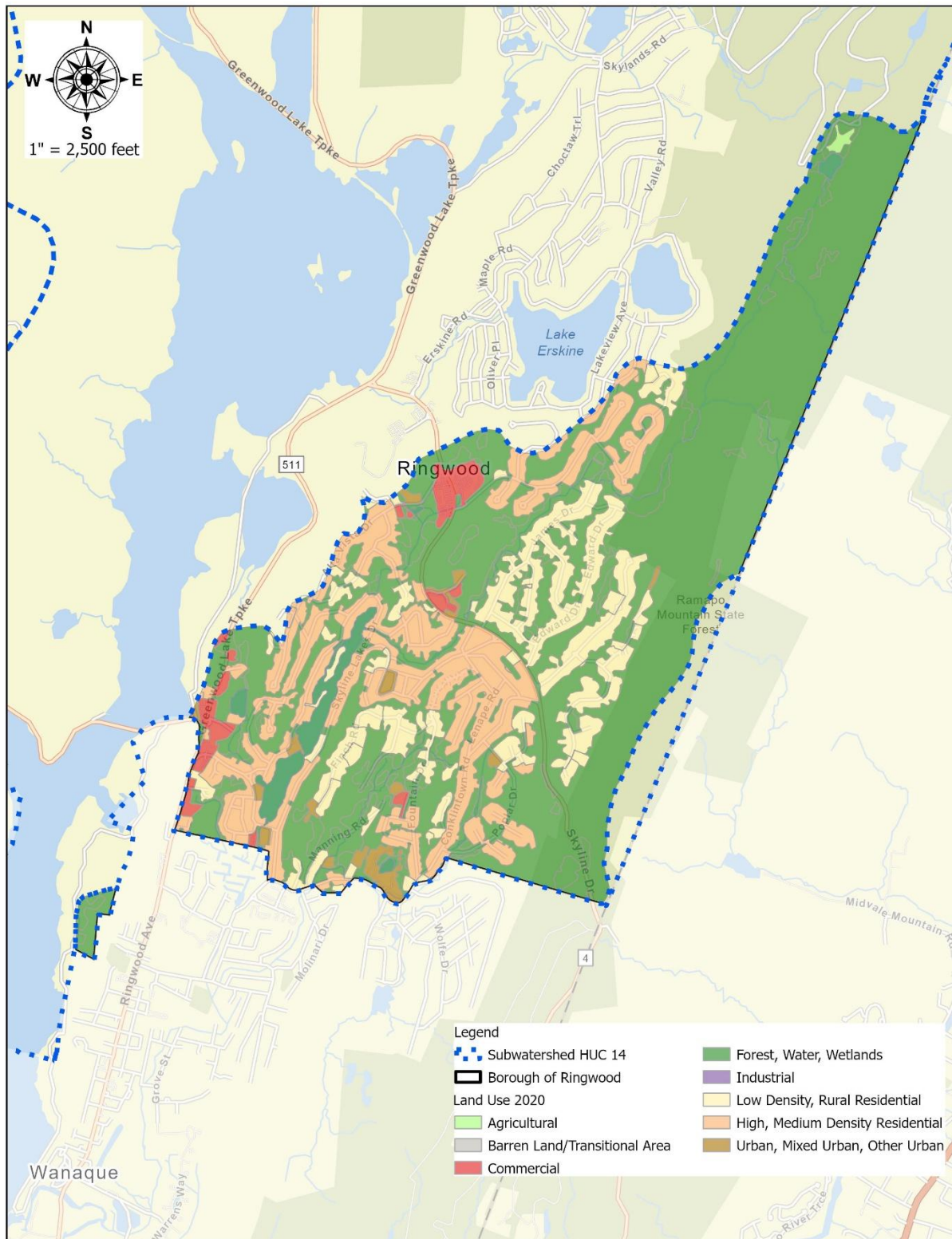


Figure 19: Land Use Cover Map HUC 02030103070060

HUC-14 - 02030103070070 (Wanaque R/Posts Bk, below reservoir)

TMDL and Impairment Parameter Review

- **Streamshed TMDL – Total Phosphorus**
 - TMDL Report: Total Maximum Daily Load Report For the Non-Tidal Passaic River Basin Addressing Phosphorus Impairments
 - TMDL Report adopted: April 24, 2008
 - The Wanaque River/Posts Brook (Below Reservoir) subwatershed was identified as an impaired assessment unit and was directly addressed by NJDEP's 2008 Phosphorus TMDL for the Non-Tidal Passaic River Basin. The subwatershed received phosphorus-related load allocations as part of the watershed-wide restoration strategy developed to achieve water quality objectives in downstream critical locations, including the Wanaque Reservoir and Dundee Lake (15).
 - The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent, to be achieved through implementation of stormwater management measures and other best management practices throughout the contributing watershed rather than at the individual subwatershed level (15).
 - Potential phosphorus sources identified in the report include stormwater runoff from residential, commercial, industrial and transportation land uses, wastewater treatment facility discharges, septic systems, agricultural activities and wildlife-related sources (15).
- **Impairment– Temperature**
 - Elevated water temperatures can adversely affect aquatic life, particularly cold-water and trout-supporting species. Increased stream temperatures may result from loss of riparian vegetation and stream shading, increased stormwater runoff from impervious surfaces, reduced groundwater inputs and alterations to natural stream hydrology (19, 20, 21). Elevated temperatures can also reduce dissolved oxygen concentrations and negatively affect aquatic habitat quality (19, 20, 21). Potential management measures include preservation and restoration of riparian buffers, protection of groundwater recharge areas and implementation of stormwater management practices designed to reduce thermal impacts (19, 20, 21).

Area(s) prone to flooding

The Phase 1 Watershed inventory report did not outline any areas prone to flooding in this subwatershed.

Land Cover and Land Use

Development by regulatory era was estimated using historic and current land use/land cover datasets. Pre-1983 development was derived from the Rutgers CRSSA 1984 Land Cover dataset, 1983-2004 development was identified using the NJDEP 1986 Land Use/Land Cover dataset and post-2004 development was evaluated using the NJDEP 2020 Land Use/Land Cover dataset. All datasets were analyzed within a GIS environment to quantify acreage by land use category and regulatory era.

Wanaque River/Posts Brook, below Reservoir subwatershed is entirely composed of forest, water and wetland land cover, which accounts for 100% of the approximately 1.3-acre assessment area. No residential, commercial, industrial, agricultural, barren, or urban land uses were identified within this subwatershed. Refer to Table 31 and Figure 20 for land use details.

No developed land was identified within the watershed. Consequently, no development was attributed to any regulatory era and no pre-1983, 1983-2004, or post-2004 development acreage was calculated. Tables 32 and 33 provide historical land use details.

Table 31: Land Use Distribution for HUC 02030103070070

HUC-14 - 02030103070070 (Wanaque R/Posts Bk, below reservoir)		
Land Use 2020	Area (Acres)	Percentage of Total Area
Agricultural	0.0	0.0%
Barren Land/Transitional Area	0.0	0.0%
Commercial	0.0	0.0%
Forest, Water, Wetlands	1.3	100.0%
High, Medium Density Residential	0.0	0.0%
Industrial	0.0	0.0%
Low Density, Rural Residential	0.0	0.0%
Urban, Mixed Urban, Other Urban	0.0	0.0%

Table 32: Area of New Development During Regulatory Eras (Acres) for HUC 02030103070070

HUC-14	Pre-1983	1983-2004	Post-2004	Total
02030103070070	0.0	0.0	0.0	0.0

Table 33: Area of New Development During Regulatory Eras (%) for HUC 02030103070070

HUC-14	Pre-1983	1983-2004	Post-2004
02030103070070	0.0%	0.0%	0.0%

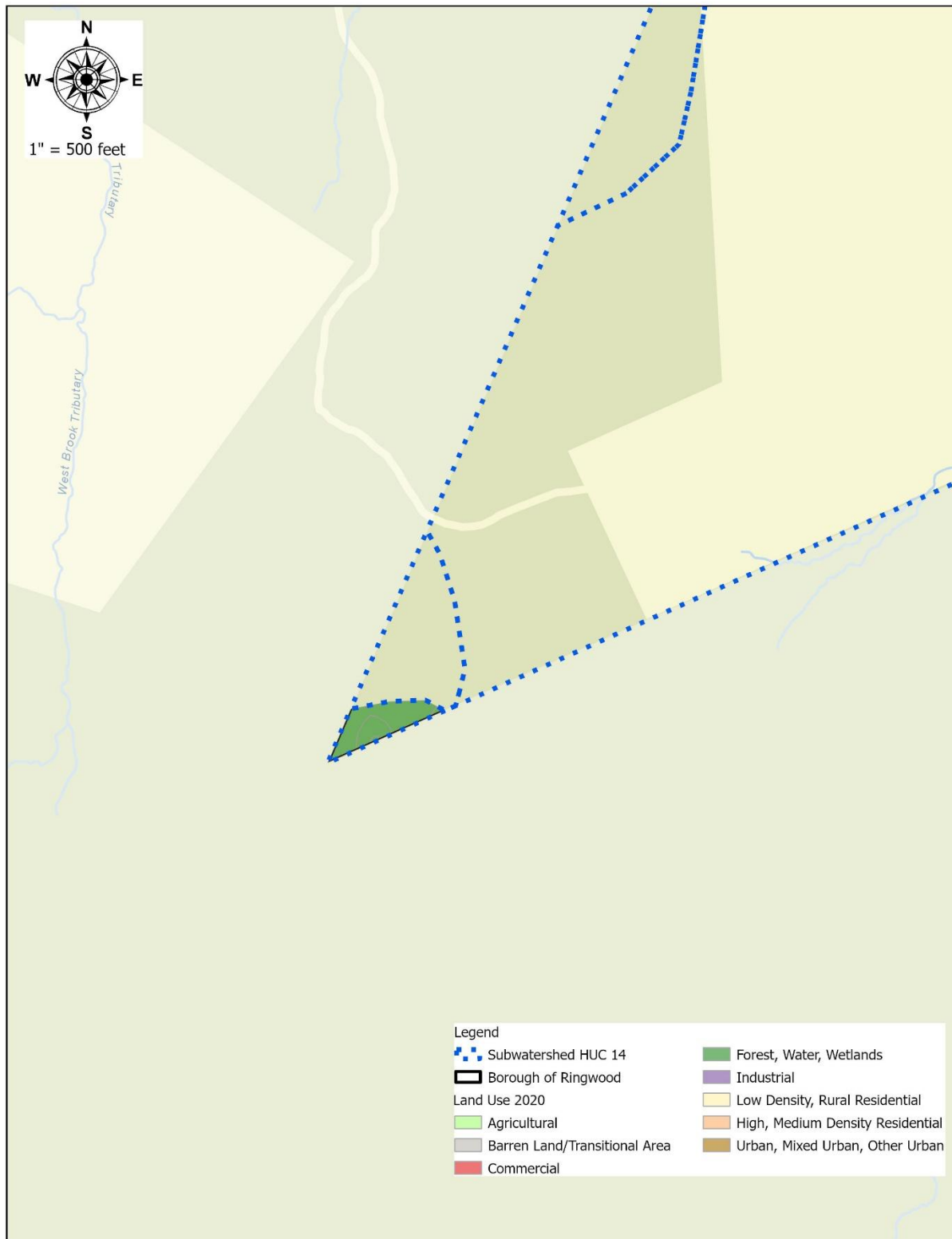


Figure 20: Land Use Cover Map HUC 02030103070070

HUC-14 - 02030103070080 (Ringwood Creek)

TMDL and Impairment Parameter Review

- **Streamshed TMDL—Mercury**
 - During preparation of the current Watershed Assessment Report, the NJDEP Mercury TMDL documentation was reviewed in greater detail to verify impairments and assessment units associated with each HUC-14 subwatershed. This HUC was previously identified as mercury-impaired based on its proximity to mapped TMDL watershed boundaries. NJDEP re-evaluated against the assessment units specifically addressed in the Mercury TMDL report. This review determined that this subwatershed was located within the broader TMDL study area but was not identified as a mercury-impaired assessment unit and was not assigned mercury-related restoration measures. As a result, this HUC-14 has been removed from the list of mercury-impaired waters in this update. The revised assessment reflects the specific impairment designations documented in the NJDEP Mercury TMDL report rather than the geographic extent of the associated GIS streamshed layer (14).
- **Streamshed TMDL – Total Phosphorus**
 - TMDL Report: Total Maximum Daily Load Report For the Non-Tidal Passaic River Basin Addressing Phosphorus Impairments
 - TMDL Report adopted: April 24, 2008
 - Ringwood Creek (HUC 02030103070080) lies within the geographic area covered by NJDEP's phosphorus TMDL for the Non-Tidal Passaic River Basin. However, the subwatershed was not specifically identified as a phosphorus-impaired assessment unit nor was it individually addressed within the TMDL allocation tables. The watershed is located within the broader drainage area associated with the basin-wide phosphorus restoration strategy developed to protect downstream receiving waters, including the Wanaque Reservoir (15).
 - The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent, to be achieved through implementation of stormwater management measures and other best management practices throughout the contributing watershed rather than at the individual subwatershed level (15).
 - Potential phosphorus sources identified in the report include stormwater runoff from residential, commercial, industrial and transportation land uses, wastewater treatment facility discharges, septic systems, agricultural activities and wildlife-related sources (15).

Area(s) prone to flooding

The Phase 1 Watershed inventory report did not outline any areas prone to flooding in this subwatershed.

Land Cover and Land Use

Development by regulatory era was estimated using historic and current land use/land cover datasets. Pre-1983 development was derived from the Rutgers CRSSA 1984 Land Cover dataset, 1983-2004 development was identified using the NJDEP 1986 Land Use/Land Cover dataset and post-2004 development was evaluated using the NJDEP 2020 Land Use/Land Cover dataset. All datasets were analyzed within a GIS environment to quantify acreage by land use category and regulatory era.

Ringwood Creek subwatershed is predominantly characterized by natural land cover, with forest, water and wetlands comprising approximately 86.1% of the watershed area. Developed land uses are limited and are primarily associated with urban/mixed urban land uses, which account for 9.9% of the watershed. Low-density residential, commercial, industrial and high-/medium-density residential land uses collectively represent less than 4% of the watershed, while agricultural land uses are absent. Refer to Table 34 and Figure 21 for land use details.

A total of approximately 325.2 acres of developed land were identified within this subwatershed. The majority of development occurred prior to 1983, accounting for 207.5 acres (63.8%) of the total developed area. Development occurring between 1983 and 2004 accounted for 94.7 acres (29.1%), while 23.0 acres (7.1%) were developed after 2004. Tables 35 and 36 provide historical land use details.

Table 34: Land Use Distribution for HUC 02030103070080

HUC-14 - 02030103070080 (Ringwood Creek)		
Land Use 2020	Area (Acres)	Percentage of Total Area
Agricultural	0.0	0.0%
Barren Land/Transitional Area	7.8	0.3%
Commercial	30.5	1.3%
Forest, Water, Wetlands	2,069.4	86.1%
High, Medium Density Residential	5.1	0.2%
Industrial	15.7	0.7%
Low Density, Rural Residential	35.7	1.5%
Urban, Mixed Urban, Other Urban	238.3	9.9%

Table 35: Area of New Development During Regulatory Eras (Acres) for HUC 02030103070080

HUC-14	Pre-1983	1983-2004	Post-2004	Total
02030103070080	207.5	94.7	23.0	325.2

Table 36: Area of New Development During Regulatory Eras (%) for HUC 02030103070080

HUC-14	Pre-1983	1983-2004	Post-2004
02030103070080	63.8%	29.1%	7.1%

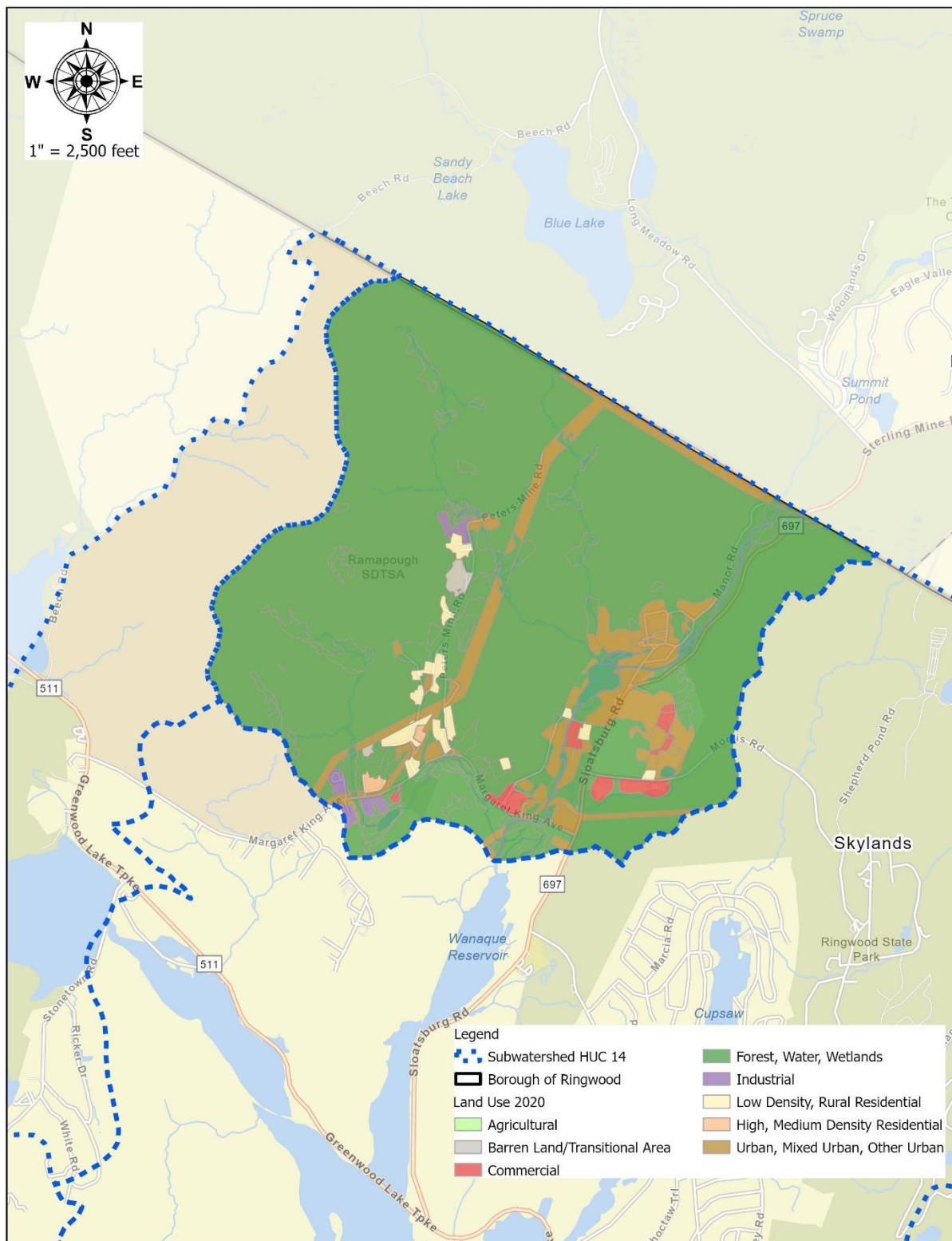


Figure 21: Land Use Cover Map HUC 02030103070080

HUC-14 - 02030103100010 (Ramapo R, above 74d 11m 00s)

TMDL and Impairment Parameter Review

- **Streamshed TMDL—Mercury**
 - During preparation of the current Watershed Assessment Report, the NJDEP Mercury TMDL documentation was reviewed in greater detail to verify impairments and assessment units associated with each HUC-14 subwatershed. This HUC was previously identified as mercury-impaired based on its proximity to mapped TMDL watershed boundaries. NJDEP re-evaluated against the assessment units specifically addressed in the Mercury TMDL report. This review determined that this subwatershed was located within the broader TMDL study area but was not identified as a mercury-impaired assessment unit and was not assigned mercury-related restoration measures. As a result, this HUC-14 has been removed from the list of mercury-impaired waters in this update. The revised assessment reflects the specific impairment designations documented in the NJDEP Mercury TMDL report rather than the geographic extent of the associated GIS streamshed layer (14).
- **Streamshed TMDL – Total Phosphorus**
 - TMDL Report: Total Maximum Daily Load Report For the Non-Tidal Passaic River Basin Addressing Phosphorus Impairments
 - TMDL Report adopted: April 24, 2008
 - The Ramapo R, above 74d 11m 00s subwatershed was listed as phosphorus-impaired (Sublist 5) and was addressed through NJDEP's companion Pompton Lake/Ramapo River Phosphorus TMDL rather than the 2008 Non-Tidal Passaic River Basin Phosphorus TMDL (15).
 - The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent, to be achieved through implementation of stormwater management measures and other best management practices throughout the contributing watershed rather than at the individual subwatershed level (15).
 - Potential phosphorus sources identified in the report include stormwater runoff from residential, commercial, industrial and transportation land uses, wastewater treatment facility discharges, septic systems, agricultural activities and wildlife-related sources (15).
- **Streamshed TMDL – Fecal Coliform**
 - TMDL Report: Total Maximum Daily Loads for Fecal Coliform to Address 32 Streams in the Northeast Water Region
 - The subwatershed contains a portion of the Ramapo River corridor addressed under NJDEP's 2003 Fecal Coliform TMDL for the Northeast Water Region. The TMDL identified elevated fecal coliform concentrations at monitoring Station 01387500 (Ramapo River Near Mahwah) and established a watershed-wide reduction target of 91 percent rather than at the individual subwatershed level.
 - Potential sources identified by NJDEP included failing septic systems, stormwater runoff, Canada geese, agricultural activities and other non-point sources. The TMDL implementation plan applies throughout the broader watershed draining to the impaired Ramapo River segment (16).
- **Lakeshed TMDL – Total Phosphorus**
 - TMDL Report: Total Maximum Daily Load Report to Address Phosphorus Impairment in Pompton Lake and Ramapo River in the Northeast Water Region

- TMDL Report adopted: April 24, 2008
 - The Ramapo R, above 74d 11m 00s subwatershed was specifically identified in the NJDEP 2008 Total Phosphorus TMDL as an assessment unit addressed by the phosphorus TMDL. The TMDL establishes watershed-wide phosphorus reduction measures to support attainment of water quality objectives within the Pompton Lake watershed. Potential phosphorus sources identified in the TMDL include wastewater treatment facility discharges, stormwater runoff from residential, commercial, industrial and transportation land uses, septic systems and wildlife-related sources. Accordingly, this HUC-14 remains associated with the approved Total Phosphorus TMDL and its implementation area (18).
 - The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent.
- **Impairment– Dissolved Oxygen**
 - Dissolved oxygen is necessary to support healthy aquatic ecosystems. Low dissolved oxygen concentrations may result from elevated water temperatures, excessive nutrient loading, organic matter decomposition, reduced streamflow, or stagnant water conditions. Insufficient dissolved oxygen can stress aquatic organisms and impair fish (19, 22, 23). Preventative measure to reduce dissolved oxygen impairment include reduced nutrient inputs, improve stormwater management and protecting riparian corridors (19, 22, 23).

Area(s) prone to flooding

The Phase 1 Watershed inventory report did not outline any areas prone to flooding in this subwatershed.

Land Cover and Land Use

Development by regulatory era was estimated using historic and current land use/land cover datasets. Pre-1983 development was derived from the Rutgers CRSSA 1984 Land Cover dataset, 1983-2004 development was identified using the NJDEP 1986 Land Use/Land Cover dataset and post-2004 development was evaluated using the NJDEP 2020 Land Use/Land Cover dataset. All datasets were analyzed within a GIS environment to quantify acreage by land use category and regulatory era.

Ramapo R, above 74d 11m 00s subwatershed is almost entirely comprised of natural land cover, with forest, water and wetlands accounting for approximately 97.9% of the watershed area. The remaining 2.1% consists of urban/mixed urban land uses. No agricultural, commercial, industrial, residential, or barren land uses were identified within the HUC. Refer to Table 37 and Figure 22 for land use details.

A total of approximately 6.9 acres of developed land were identified within this subwatershed. All development occurred during the post-2004 regulatory era, accounting for 100% of the developed acreage. No pre-1983 or 1983-2004 development was identified within the watershed. Tables 38 and 39 provide historical land use details.

Table 37: Land Use Distribution for HUC 02030103100010

HUC-14 - 02030103100010 (Ramapo R, above 74d 11m 00s)		
Land Use 2020	Area (Acres)	Percentage of Total Area

Agricultural	0	0.0%
Barren Land/Transitional Area	0	0.0%
Commercial	0	0.0%
Forest, Water, Wetlands	312.22	97.9%
High, Medium Density Residential	0	0.0%
Industrial	0	0.0%
Low Density, Rural Residential	0	0.0%
Urban, Mixed Urban, Other Urban	6.85	2.1%

Table 38: Area of New Development During Regulatory Eras (Acres) for HUC 02030103100010

HUC-14	Pre-1983	1983-2004	Post-2004	Total
02030103100010	0.0	0.0	6.9	6.9

Table 39: Area of New Development During Regulatory Eras (%) for HUC 02030103100010

HUC-14	Pre-1983	1983-2004	Post-2004
02030103100010	0.0%	0.0%	100.0%

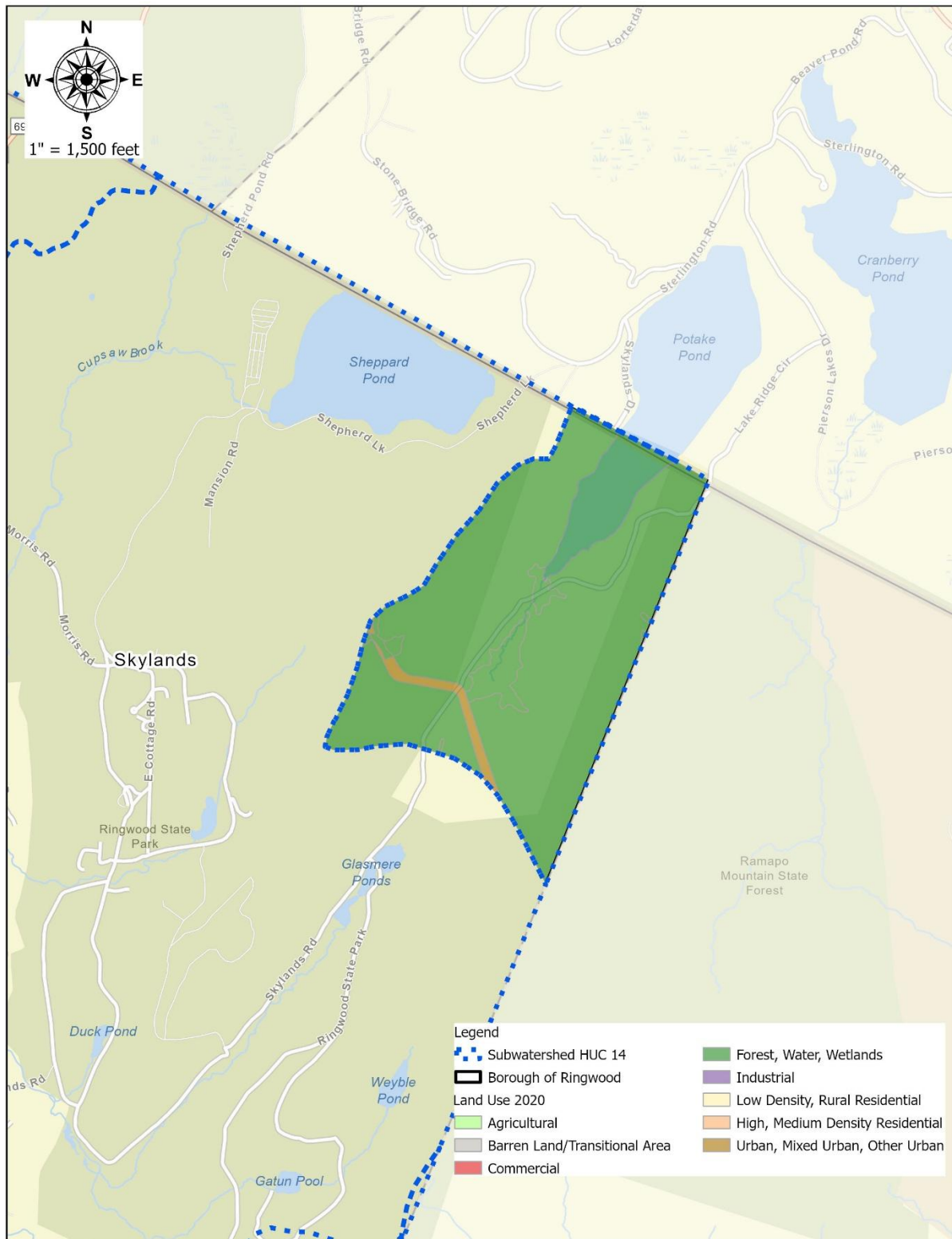


Figure 22: Land Use Cover Map HUC 02030103100010

HUC-14 - 02030103100040 (Ramapo R, Bear Swamp Bk thru Fyke Bk)

TMDL and Impairment Parameter Review

- **Streamshed TMDL—Mercury**
 - During preparation of the current Watershed Assessment Report, the NJDEP Mercury TMDL documentation was reviewed in greater detail to verify impairments and assessment units associated with each HUC-14 subwatershed. This HUC was previously identified as mercury-impaired based on its proximity to mapped TMDL watershed boundaries. NJDEP re-evaluated against the assessment units specifically addressed in the Mercury TMDL report. This review determined that this subwatershed was located within the broader TMDL study area but was not identified as a mercury-impaired assessment unit and was not assigned mercury-related restoration measures. As a result, this HUC-14 has been removed from the list of mercury-impaired waters in this update. The revised assessment reflects the specific impairment designations documented in the NJDEP Mercury TMDL report rather than the geographic extent of the associated GIS streamshed layer (14).
- **Streamshed TMDL – Total Phosphorus**
 - TMDL Report: Total Maximum Daily Load Report For the Non-Tidal Passaic River Basin Addressing Phosphorus Impairments
 - TMDL Report adopted: April 24, 2008
 - The Ramapo River (Bear Swamp Brook through Fyke Brook) subwatershed was included in NJDEP's phosphorus TMDL evaluation process but was addressed through the companion Pompton Lake/Ramapo River Phosphorus TMDL rather than the 2008 Non-Tidal Passaic River Basin Phosphorus TMDL. The assessment unit was listed as Sublist 3, indicating insufficient information for a complete phosphorus impairment determination at the time of assessment (15).
 - The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent, to be achieved through implementation of stormwater management measures and other best management practices throughout the contributing watershed rather than at the individual subwatershed level (15).
 - Potential phosphorus sources identified in the report include stormwater runoff from residential, commercial, industrial and transportation land uses, wastewater treatment facility discharges, septic systems, agricultural activities and wildlife-related sources (15).
- **Streamshed TMDL – Fecal Coliform**
 - TMDL Report: Total Maximum Daily Loads for Fecal Coliform to Address 32 Streams in the Northeast Water Region
 - The subwatershed contains a portion of the Ramapo River corridor addressed under NJDEP's 2003 Fecal Coliform TMDL for the Northeast Water Region. The TMDL identified elevated fecal coliform concentrations at monitoring Station 01387500 (Ramapo River Near Mahwah) and established a watershed-wide reduction target of 91 percent rather than at the individual subwatershed level. Potential sources identified by NJDEP included failing septic systems, stormwater runoff, Canada geese, agricultural activities and other non-point sources. The TMDL implementation plan applies throughout the broader watershed draining to the impaired Ramapo River segment (16).

- **Lakeshed TMDL – Total Phosphorus**

- TMDL Report: Total Maximum Daily Load Report to Address Phosphorus Impairment in Pompton Lake and Ramapo River in the Northeast Water Region
- TMDL Report adopted: April 24, 2008
- The Ramapo R (Bear Swamp Brook through Fyke Brook) subwatershed was specifically identified in the NJDEP 2008 Total Phosphorus TMDL as an assessment unit addressed by the phosphorus TMDL. The TMDL establishes watershed-wide phosphorus reduction measures to support attainment of water quality objectives within the Pompton Lake watershed. Potential phosphorus sources identified in the TMDL include wastewater treatment facility discharges, stormwater runoff from residential, commercial, industrial and transportation land uses, septic systems and wildlife-related sources. Accordingly, this HUC-14 remains associated with the approved Total Phosphorus TMDL and its implementation area (18).
- The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent.

- **Impairment – pH**

- A pH impairment indicates that water quality conditions are outside the range established to support designated uses and maintain healthy aquatic ecosystems. Variations in pH may result from natural geologic conditions, stormwater runoff, wastewater discharges, industrial activities, or other watershed influences (19, 24, 25). Significant changes in pH can affect aquatic life and influence the toxicity, mobility and availability of other pollutants (19, 24, 25). Stormwater management practices and reduction of non-point source pollutants may contribute to improved water quality conditions (19, 24, 25).

- **Impairment– Temperature**

- Elevated water temperatures can adversely affect aquatic life, particularly cold-water and trout-supporting species. Increased stream temperatures may result from loss of riparian vegetation and stream shading, increased stormwater runoff from impervious surfaces, reduced groundwater inputs and alterations to natural stream hydrology (19, 20, 21). Elevated temperatures can also reduce dissolved oxygen concentrations and negatively affect aquatic habitat quality (19, 20, 21). Potential management measures include preservation and restoration of riparian buffers, protection of groundwater recharge areas and implementation of stormwater management practices designed to reduce thermal impacts (19, 20, 21).

Area(s) prone to flooding

The Phase 1 Watershed inventory report did not outline any areas prone to flooding in this subwatershed.

Land Cover and Land Use

Development by regulatory era was estimated using historic and current land use/land cover datasets. Pre-1983 development was derived from the Rutgers CRSSA 1984 Land Cover dataset, 1983-2004 development was identified using the NJDEP 1986 Land Use/Land Cover dataset and post-2004 development was evaluated using the NJDEP 2020 Land Use/Land Cover dataset. All datasets were analyzed within a GIS environment to quantify acreage by land use category and regulatory era.

Ramapo River, Bear Swamp Brook through Fyke Brook subwatershed is entirely comprised of natural land cover, with forest, water and wetlands accounting for 100% of the watershed area. No agricultural, commercial, industrial, residential, urban, or barren land uses were identified within this subwatershed. Refer to Table 40 and Figure 23 for land use details.

No developed land was identified within the watershed. As a result, no development was attributed to the pre-1983, 1983-2004, or post-2004 regulatory eras and no developed acreage was calculated for this subwatershed. Tables 41 and 42 provide historical land use details.

Table 40: Land Use Distribution for HUC 02030103100040

HUC-14 - 02030103100040 (Ramapo R, Bear Swamp Bk thru Fyke Bk)		
Land Use 2020	Area (Acres)	Percentage of Total Area
Agricultural	0.0	0%
Barren Land/Transitional Area	0.0	0%
Commercial	0.0	0%
Forest, Water, Wetlands	2.1	100%
High, Medium Density Residential	0.0	0%
Industrial	0.0	0%
Low Density, Rural Residential	0.0	0%
Urban, Mixed Urban, Other Urban	0.0	0%

Table 41: Area of New Development During Regulatory Eras (Acres) for HUC 02030103100040

HUC-14	Pre-1983	1983-2004	Post-2004	Total
02030103100040	0.0	0.0	0.0	0.0

Table 42: Area of New Development During Regulatory Eras (%) for HUC 02030103100040

HUC-14	Pre-1983	1983-2004	Post-2004
02030103100040	0.0000%	0.0000%	0.0%

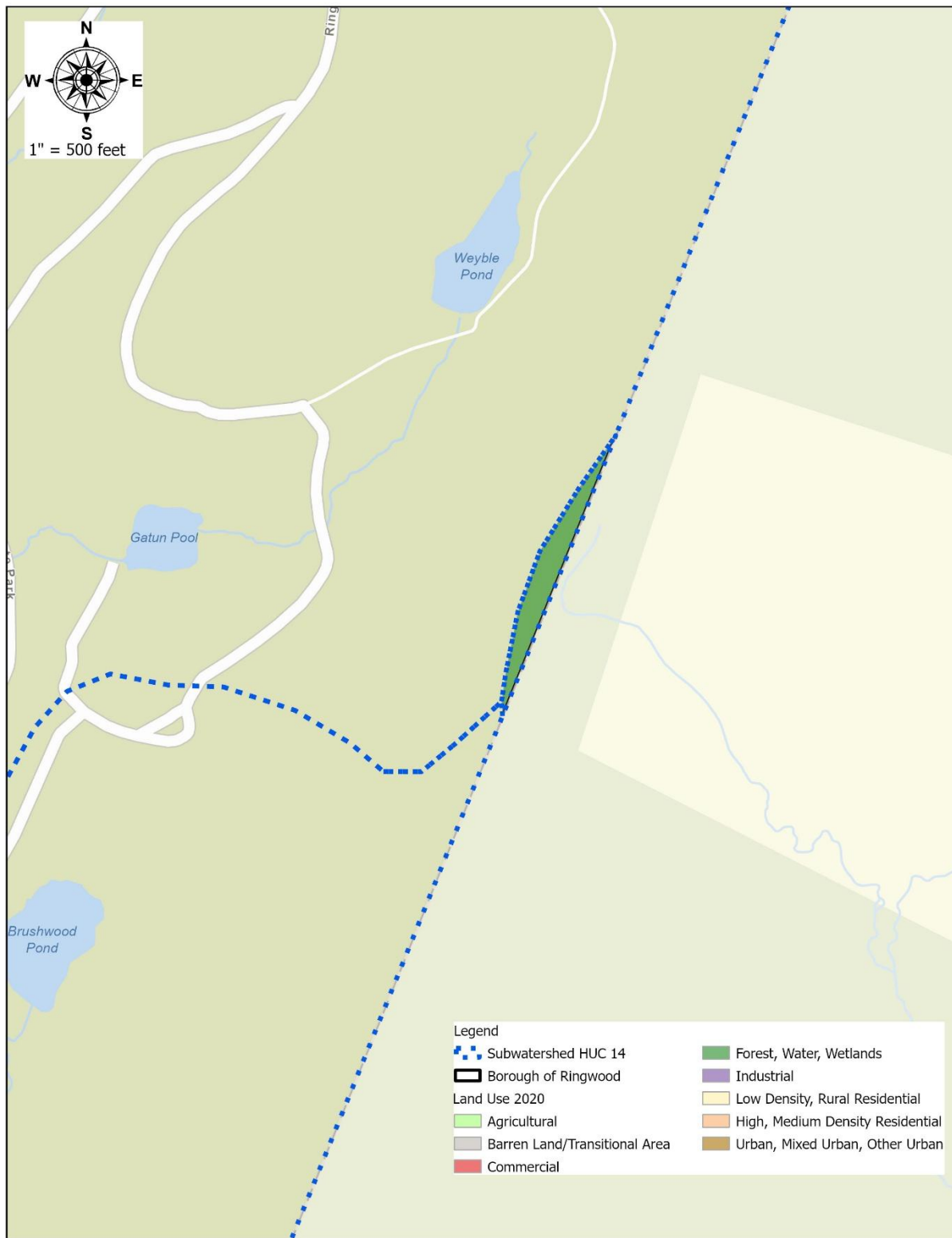


Figure 23: Land Use Cover Map HUC 02030103100040

HUC-14 - 02030103100050 (Ramapo R, Crystal Lk br to BearSwamp Bk)

TMDL and Impairment Parameter Review

- **Streamshed TMDL – Total Phosphorus**
 - TMDL Report: Total Maximum Daily Load Report For the Non-Tidal Passaic River Basin Addressing Phosphorus Impairments
 - TMDL Report adopted: April 24, 2008
 - The Ramapo River (Crystal Lake Branch to Bear Swamp Brook) subwatershed was included in NJDEP's phosphorus TMDL evaluation process but was addressed through the companion Pompton Lake/Ramapo River Phosphorus TMDL rather than the 2008 Non-Tidal Passaic River Basin Phosphorus TMDL. The assessment unit was classified as Sublist 4A indicating that restoration activities were being addressed through an approved TMDL or other pollution control strategy and was therefore considered to be addressed through an existing restoration strategy (15).
 - The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent, to be achieved through implementation of stormwater management measures and other best management practices throughout the contributing watershed rather than at the individual subwatershed level (15).
 - Potential phosphorus sources identified in the report include stormwater runoff from residential, commercial, industrial and transportation land uses, wastewater treatment facility discharges, septic systems, agricultural activities and wildlife-related sources (15).
- **Streamshed TMDL – Fecal Coliform**
 - TMDL Report: Total Maximum Daily Loads for Fecal Coliform to Address 32 Streams in the Northeast Water Region
 - TMDL Report approved: July 29, 2003
 - The subwatershed contains a portion of the Ramapo River corridor addressed under NJDEP's 2003 Fecal Coliform TMDL for the Northeast Water Region. The TMDL identified elevated fecal coliform concentrations at monitoring Station 01387500 (Ramapo River Near Mahwah) and established a watershed-wide reduction target of 91 percent rather than at the individual subwatershed level. Potential sources identified by NJDEP included failing septic systems, stormwater runoff, Canada geese, agricultural activities and other non-point sources. The TMDL implementation plan applies throughout the broader watershed draining to the impaired Ramapo River segment (16).
- **Lakeshed TMDL – Fecal Coliform**
 - TMDL Report: Total Maximum Daily Loads for Pathogens to Address 25 Lakes in the Northeast Water Region
 - TMDL Report approved: September 28, 2007
 - The 2007 Fecal Coliform TMDL identifies impaired lakes and associated lakesheds rather than HUC-14 subwatersheds. As part of this update, the TMDL report and supporting mapping were reviewed to compare the impaired lakesheds described in the document with the corresponding HUC-14 subwatersheds within the Borough of Ringwood. This review determined that several HUC-14 subwatersheds previously included based on their proximity to the mapped TMDL boundary were not substantially located within the impaired lakesheds

identified in the report. Accordingly, these HUC-14 subwatersheds have been removed from the fecal coliform impairment inventory presented in this report (17).

- **Lakeshed TMDL – Total Phosphorus**

- TMDL Report: Total Maximum Daily Load Report to Address Phosphorus Impairment in Pompton Lake and Ramapo River in the Northeast Water Region
- TMDL Report adopted: April 24, 2008
- The Ramapo R (Crystal Lake Branch to Bear Swamp Brook) subwatershed was specifically identified in the NJDEP 2008 Total Phosphorus TMDL as an assessment unit addressed by the phosphorus TMDL. The TMDL establishes watershed-wide phosphorus reduction measures to support attainment of water quality objectives within the Pompton Lake watershed. Potential phosphorus sources identified in the TMDL include wastewater treatment facility discharges, stormwater runoff from residential, commercial, industrial and transportation land uses, septic systems and wildlife-related sources. Accordingly, this HUC-14 remains associated with the approved Total Phosphorus TMDL and its implementation area (18).
- The TMDL report established a watershed-wide phosphorus load reduction target of approximately 57 percent.

- **Impairment – pH**

- A pH impairment indicates that water quality conditions are outside the range established to support designated uses and maintain healthy aquatic ecosystems. Variations in pH may result from natural geologic conditions, stormwater runoff, wastewater discharges, industrial activities, or other watershed influences (19, 24, 25). Significant changes in pH can affect aquatic life and influence the toxicity, mobility and availability of other pollutants (19, 24, 25). Stormwater management practices and reduction of non-point source pollutants may contribute to improved water quality conditions (19, 24, 25).

- **Impairment– Temperature**

- Elevated water temperatures can adversely affect aquatic life, particularly cold-water and trout-supporting species. Increased stream temperatures may result from loss of riparian vegetation and stream shading, increased stormwater runoff from impervious surfaces, reduced groundwater inputs and alterations to natural stream hydrology (19, 20, 21). Elevated temperatures can also reduce dissolved oxygen concentrations and negatively affect aquatic habitat quality (19, 20, 21). Potential management measures include preservation and restoration of riparian buffers, protection of groundwater recharge areas and implementation of stormwater management practices designed to reduce thermal impacts (19, 20, 21).

Area(s) prone to flooding

The Phase 1 Watershed inventory report did not outline any areas prone to flooding in this subwatershed.

Land Cover and Land Use

Development by regulatory era was estimated using historic and current land use/land cover datasets. Pre-1983 development was derived from the Rutgers CRSSA 1984 Land Cover dataset, 1983-2004 development was identified using the NJDEP 1986 Land Use/Land Cover dataset and post-2004

development was evaluated using the NJDEP 2020 Land Use/Land Cover dataset. All datasets were analyzed within a GIS environment to quantify acreage by land use category and regulatory era.

Ramapo River, Crystal Lake Bridge to Bear Swamp Brook subwatershed is almost entirely comprised of natural land cover, with forest, water and wetlands accounting for approximately 99.7% of the watershed area. Urban/mixed urban land uses represent only 0.3% of the watershed, while no agricultural, commercial, industrial, residential, or barren land uses were identified. Refer to Table 43 and Figure 24 for land use details.

A total of approximately 0.2 acres of developed land were identified within this subwatershed. All development occurred during the post-2004 regulatory era, accounting for 100% of the developed acreage. No pre-1983 or 1983-2004 development was identified within the watershed. Tables 44 and 45 provide historical land use details.

Table 43: Land Use Distribution for HUC 02030103100050

HUC-14 - 02030103100050 (Ramapo R, Crystal Lk br to BearSwamp Bk)		
Land Use 2020	Area (Acres)	Percentage of Total Area
Agricultural	0.0	0.0%
Barren Land/Transitional Area	0.0	0.0%
Commercial	0.0	0.0%
Forest, Water, Wetlands	82.3	99.7%
High, Medium Density Residential	0.0	0.0%
Industrial	0.0	0.0%
Low Density, Rural Residential	0.0	0.0%
Urban, Mixed Urban, Other Urban	0.2	0.3%

Table 44: Area of New Development During Regulatory Eras (Acres) for HUC 02030103100050

HUC-14	Pre-1983	1983-2004	Post-2004	Total
02030103100050	0.0	0.0	0.2	0.2
Grand Total	2,787.4	183.7	197.4	3,168.5

Table 45: Area of New Development During Regulatory Eras (%) for HUC 02030103100050

HUC-14	Pre-1983	1983-2004	Post-2004
02030103100050	0.0%	0.0%	100.0%

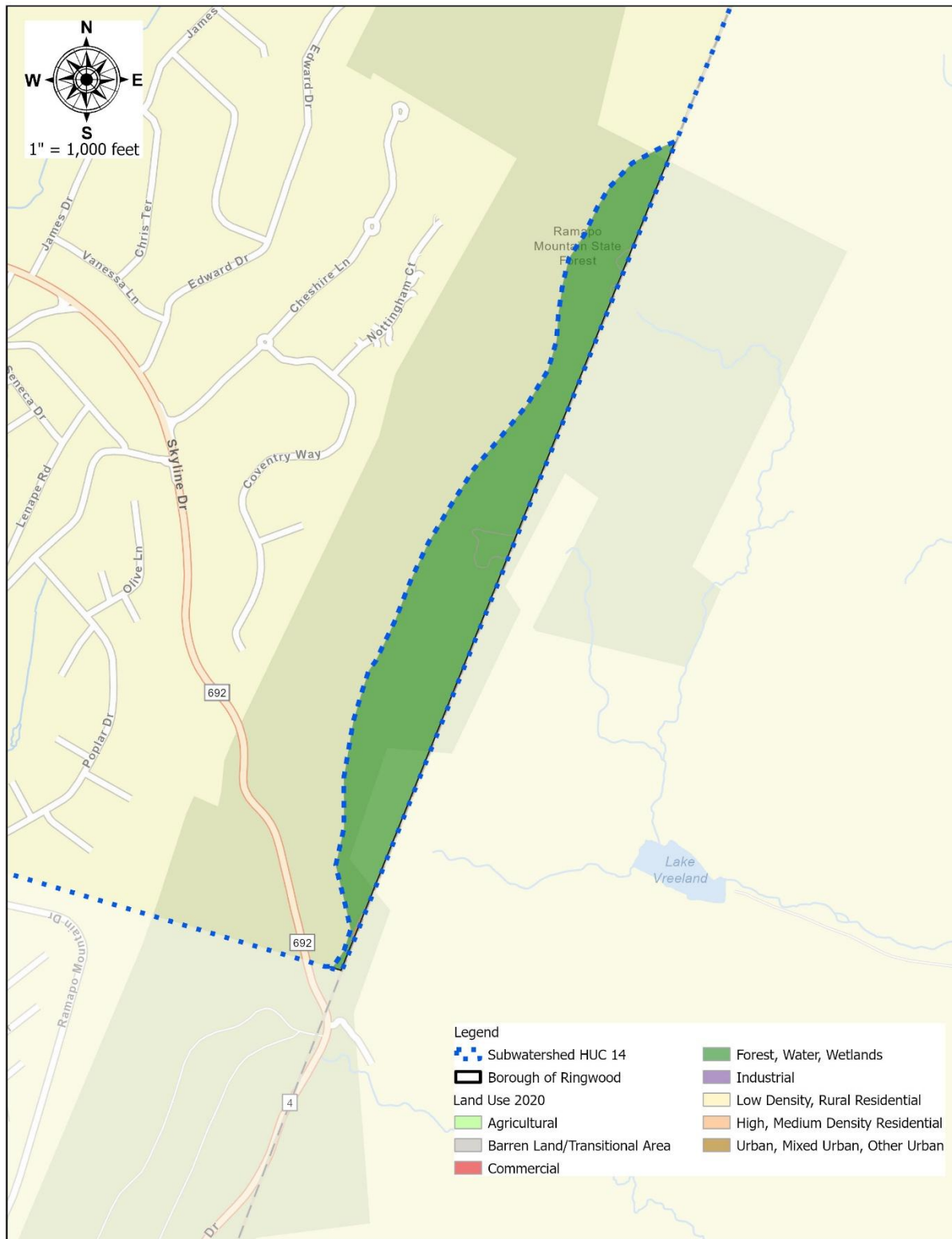


Figure 24: Land Use Cover Map HUC 02030103100050

Potential Improvement Projects

Potential Stream Study Project #1S to address All Subwatershed(s):

- **Description:**
 - Stream Monitoring Study
 - Location: The study shall be conducted throughout the Borough's watershed at multiple outfalls.
 - A monitoring study at outfall locations and/or lakes could be used to determine actual TMDL loading rates within the Borough. The project will require multiple water quality stations set up throughout the Borough to measure water quality at key locations. This will allow the Borough to focus its efforts on projects that will make the largest difference.
 - The monitoring will focus on the high-priority HUC-14 locations in the Borough. The monitors will be located at outfall and pond locations in HUC's 2030103070060, 2030103070050 and 2030103070040.
 - Monitors will be set up to record contaminants to refine the yearly TMDLs. This will allow the Borough to determine what project will provide the highest impact to reduce TMSL's.
- **Impairment and/or TMDL Parameters addressed:**
 - This project may not directly address a TMDL; however, it will allow the Borough to better determine which project will have the largest impact on reducing the TMDL's.
- **Estimated Load Reduction:**
 - The study will allow the Borough to refine the yearly TMDL loading to better understand how the Borough's current projects affect TMDL's and the best way to achieve the required TMDL reduction.
- **Other Benefits:**
 - This project will allow the community to understand sources of the contamination and target projects that will effectively reduce TMDL loading.
- **Funding Needs:**
 - The estimated financial cost of a stream monitoring program is \$300,000 to \$600,000; however, it is very dependent on the number of locations monitored and the length of the study.
 - The major costs for this project are the number of sampling locations and how long the sampling takes place.

Potential Improvement Project #1 to address TSS, Total Phosphorus, Total Nitrogen and Metals (Mercury) for Subwatershed(s): All

- **Description:**
 - Improved Storm Drain Inventory and Maintenance
 - The project location is the entire Borough.
 - Overview: The Borough will increase its efforts in cleaning frequency of the storm system. The objective is to gather more accurate information on the existing system and to remove more debris from catch basins and storm manholes. Implementation will be done through mobilizing a contractor or DPW crews in-house with improved data collection devices (i.e., GPS antennas and hi-res cameras) and cleaning technology (i.e., vacuum trucks and jetters).

- The project site is the entire Borough, likely including roadways and parking lot areas. However, the project limits may extend to vegetated easements and off-road areas as well.
- The Scope of the work encompasses 2,359 total catch basins (100% are inspected and cleaned annually).
- Catch basin cleaning will occur twice a year (currently performed annually).
- **Impairment and/or TMDL Parameters addressed:**
 - All of the HUC 14 areas have TMDLs for TSS, Total Nitrogen, Total Phosphorus and Heavy Metals (Mercury), which are all targeted for removal.
 - Fecal Coliform also affects all of the HUC 14 areas. It is assumed that animal waste exists on pavement and upstream of storm infrastructure and leach bacteria into the runoff afterwards. Catch basin and manhole cleaning will likely not remove this waste.
- **Estimated Load Reduction:**
 - Considering current estimates, reduction can be increased to 24% for TSS and 10% for Total Nitrogen, Total Phosphorus and Mercury. By increasing the frequency of cleaning, the amount of removed material will increase, but with decreasing returns. This is estimated to yield up to an additional 20,000 lb per year of contaminant removal.
 - This project will contribute to meeting the TMDL by removing the listed pollutants on the TMDL that are contained in the removed waste before they reach receiving bodies.
- **Other Benefits:**
 - Anticipated benefits of this project include cleaner and healthier waterways that will become more appropriate to primary and secondary contact (for example, swimming, fishing and boating).
 - Additional benefits of more frequent inspection and cleaning of the storm system include helping the Borough monitor and track the condition of specific infrastructure they own and can reduce clogs or damage to the system on a more proactive basis. Improvements to the methods of inspection include GPS tagging and photographing of infrastructure each year for accurate and up-to-date records.
- **Funding Needs:**
 - The estimated cost of this project is \$470,000 annually¹, assuming one additional cleaning per year (which would bring the total cleanings to 2 per year).
 - The cost of doing this project with Borough staff may be less. However, for comparison, we assumed this project would be subcontracted to a sewer-cleaning company that cleans each unit on a regular schedule (non-emergency work). The cost of the additional cleaning, including cleaning and daily mobilization, is estimated at approximately \$5,600 per day for the 80 days it takes to clean all the catch basins. Waste disposal costs are approximately \$22,000 per year, based on a disposal cost of

¹ A significant portion of the annual cost is for disposal and is calculated considering that this is the only project performed. This cost will be reduced if Project 3 is also performed.

\$100 per ton and the removal of 230 tons² (their current removal amount for their once-a-year cleaning).

- Heavy or multi-pass pipe cleaning is assumed negligible because more frequent cleaning should eliminate the need for heavy cleaning.
- Project 1 will have an impact on the benefits seen from Project 3.

Potential Improvement Project #2 to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): All

- **Description:**

- Public Education and Storm Drain Labeling Program
- The project location is the entire Borough.
- The Public Education and Storm Drain labeling program includes both public outreach and storm drain labeling. The public education would include the distribution of flyers and pamphlets noting the importance of environmental stewardship and personal responsibility at fairs, schools and municipal offices. Programs like this may be interspersed or coordinated with the County and the State as well. The Storm drain labeling program would label inlets with messages encouraging the public not to dump into them.
- In many cases, the public does not have detailed knowledge of how storm drains or the stormwater system works. By informing the public concerning how to handle litter and waste, the environment can be kept cleaner.
- The scope of work encompasses the entire municipality. This project will include developing the content of the stormwater literature and replacing drain labels where it has faded or illegible. Examples of good environmental and stormwater stewardship would include disposing of litter in the trash, recycling in the recycling bin, collecting pet waste from the ground, not dumping waste oil, pesticides, or fertilizer down the storm drains, selecting particular lawn fertilizers that are more environmentally friendly and clearing property areas of yard waste before it reaches the drain during wet weather.
- Once per year, DPW or consultant experts could do a presentation to the school informing students regarding the importance of stormwater and environmental stewardship. During County or Town fairs, it is quite common to have a Soil and Water Conservation District or Watershed Protection Committee table to feature this kind of literature. Mailing of the flyers to the residents is also part of this program.

- **Impairment and/or TMDL Parameters addressed:**

- It is estimated that TSS, Total Nitrogen, Total Phosphorus, Heavy Metals (Mercury) and Fecal Coliform are all removed by this process. It is assumed “No Dumping” signage would discourage the public from doing so.
- No other water quality parameters or quantity issues have been identified affecting this HUC 14.

² This is conservative due to the amount of waste removed from the catch basin cleaning being unlikely to double with 1 additional cleaning.

- **Estimated Load Reduction**
 - The creation of flyers, literature and public outreach may give the Borough a reduction credit of 2% across all target parameters. This adds up to 9,000 lb per year of contaminant removal.
 - Public education programs using literature and multimedia have proven effective in the reduction of all targeted pollutants in a watershed. Given the relative affluence of the residents in the Borough of Ringwood (median income is greater than \$110,000 for both households and families for 2010 Census), low population density (485.0 per square mile), key attractions being the lake communities, and previous educational materials made available by the Borough, there is likely an already high level of storm pollution awareness. This would limit the impact of additional public education efforts, so it is assumed that it may only be an additional 2% reduction in pollution.
 - This project contributes to meeting the TMDL by removing the listed pollutants on the TMDL by informing the public concerning good stormwater stewardship and that they should dispose of litter and garbage away from the storm system.
- **Other Benefits**
 - Drain labeling programs may be conducted by youth-core programs, which allow young students at the direction of municipal officials to learn water conservation, water quality, environmental and stormwater management.
- **Funding Needs:**
 - The total cost for this project is estimated to be \$9,000 up front and around \$4,000 per year for upkeep (maintain and distribute printings).
 - The cost assumes that booklets or flyers will be printed for regular use in public buildings plus an additional 4,200 households via mailing. The cost for re-writing or updating the literature may only be incurred once every several years to decade, depending on how frequently and vastly regulations and guidance change. If the work for creating and distributing literature is done in-house, by the County (a Soil and Water Conservation District) or by summer interns hired by the DPW, the cost may be substantially lower. There will be a minor cost to send employees to cover tabling efforts or needs if at a fair.

Potential Improvement Project #3 to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): All

- **Description:**
 - Improved Source Control Projects
 - The project location is the entire Borough.
 - There are three separate projects the Borough can engage in that fall under the NJDEP category of Improved Source Control. Street sweeping is already performed by the Borough. The Borough cleans all streets under its jurisdiction using street sweepers 4 times per year. This is conducted for over 75 miles of roadway by Borough DPW staff. The Borough may increase street-sweeping frequency. The Borough may also pursue a

pet waste station installation program, such as in parks and trails. A Canada Geese deterrent program can also provide further source reduction.

- All major and minor roads are swept. All parks would have at least three pet waste stations in them. All major municipal fields would be equipped with geese deterrent devices or programs.
 - In terms of scope, the Borough shall consider modifying its street sweeping program to sweep once a month, an increase from the 4 times a year that they currently do. Consider upgrading the sweeping system to newer technology (i.e., vacuum-assisted sweeping). This could be done with new equipment that can operate during cold weather. The Borough can install at least three (3) new pet waste stations in each of its four (4) municipal parks near the walking trails and refill them with new bags as needed. The Borough shall also investigate and implement a geese deterrent program to deter geese from public lands.
 - Both Project 1 and 3 focus on removing contaminants before they enter the storm system. The costs and removal amount will be reduced if Project 1 is performed in conjunction with project 1.
- **Impairment and/or TMDL Parameters addressed:**
 - TSS, Total Nitrogen, Total Phosphorus and Heavy Metals (Mercury) can be removed by Street Sweeping.
 - Total Nitrogen, Total Phosphorus and Fecal Coliform can be removed by Pet Waste Stations and by Geese Control.
- **Estimated Load Reduction:**
 - Street Sweeping: From the current estimated load reduction, increasing the frequency of sweeping will at least double the reduction credit. TSS removal will be 14%. The nutrient removal will be approximately 15%. Metals will be approximately 15%. Fecal Coliform will be approximately 62%.
 - Pet Waste Management: may reduce the loading to the watershed by around 2% for all except Mercury.
 - Geese Deterrent Program: Removing Geese from public grounds may reduce the TMDL pollutant rate by around 50% for Fecal Coliform and 5% for nutrients. It is estimated that similar to Pet Waste management, removal of geese will provide a credit of around 2% of TSS.
 - By removing contamination before it reaches the storm system the TMDL are reduced. This adds up to an additional 56,000 lb per year of contaminant removal.
 - **Other Benefits:**
 - Additional benefits to street sweeping include improved aesthetics of the public right-of-way and catching sharp debris.
 - Additional benefits to pet waste removal include a cleaner, more aesthetically pleasing park and community area as well as maintaining public health.

- Additional benefits to Goose Control include cleaner recreational fields (improved public health) and reduced risk of human-animal interactions.
- **Funding Needs:**
 - The total cost for this project is approximately \$650,000 to \$950,000 up front and \$350,000 in annual cost (assuming monthly cleaning). This cost is significantly lower if the Borough decides to increase street-sweeping frequency in the spring and summer months.
 - The major upfront costs are the two new sweeping equipment units, which will be \$600,000 (\$300,000 each). The upfront costs can be reduced by purchasing only one new sweeping unit. The costs of paying for a crew to perform the labor and run the equipment is estimated to be \$70,000 annually, based on 8 additional cleanings per year. The disposal of debris collected will cost \$240,000³ per year. The assumption is that by increasing the cleaning frequency year-round, the amount of material collected will increase to 2,630 tons per year.
 - The cost to implement the pet waste solutions into the parks is approximately \$4,000 up front and \$360 per year for maintenance. The cost of a single pet waste station is estimated to be around \$300. It is assumed that there will be at least three (3) waste stations in each of the four (4) municipal parks. It is estimated that one of the stations will need a bag replacement per month, which totals approximately \$360 per year.
 - The cost to implement the Geese Control is approximately \$27,000 and approximately the same amount to implement annually. This would include costs associated with a private company visiting municipal fields and school sites to use trained dogs to scare away populations of the migratory birds from open fields and other forms of geese deterrents.
 - Project 3 will have an impact on the benefits seen from Project 1.

Potential Improvement Project # 4: Cupsaw Lake – Parking Lot for the Sheppard Pond Recreation Area (Pavement Conversion) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk’s gage)

- **Description:**
 - Shepard Pond Recreation Area, Ringwood State Park, Ringwood, NJ.
 - Geographical Coordinates: 565837.642, 839568.408
 - The project will reduce stormwater pollutant loads entering Cupsaw Brook and Cupsaw Lake by converting a portion of the existing parking lot into a stormwater treatment BMP. The proposed improvements will capture and treat runoff before it leaves the site, reducing sediment and nutrient discharges to downstream waterbodies.
 - Cupsaw Brook discharges to the northeastern portion of Cupsaw Lake, with Shepherd Pond functioning as a forebay that directs attention to the downstream area of the lake. The drainage area contains connected impervious surfaces that are used primarily during the summer months and includes paved roadways, turf lawns, commercial buildings,

³ A significant portion of the annual cost is for disposal and is calculated considering that this is the only project performed. This cost will be reduced if Project 1 is also performed.

parking lots and forested areas. Runoff from the Shepherd Pond recreation area parking lot is collected by catch basins and discharged directly to Cupsaw Brook.

- The project will disconnect impervious surfaces and retrofit portions of the existing parking lot with rain gardens and porous pavement systems. Existing vegetated islands will be modified to capture and treat runoff and supporting stormwater infrastructure such as underdrains and outlet structures may be installed as needed.
- Stormwater will be managed using rain gardens planted with native vegetation, porous pavement and infiltration based BMPs. These practices will reduce runoff volume and nutrient loads through infiltration, filtration, evapotranspiration and biological uptake while also enhancing habitat and site resilience.
- **Impairment and/or TMDL Parameters Addressed:**
 - The project aims to reduce Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorus (TP) loads associated with untreated stormwater runoff entering Cupsaw Brook and Cupsaw Lake.
 - Other water quality and quantity issues affecting the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage), include increased runoff volumes, streambank erosion, reduced groundwater recharge and localized flooding resulting from impervious cover and direct stormwater discharges.
- **Estimated Load Reduction:**
 - Pollutant load reductions were estimated using NJDEP BMP removal rates and methodologies consistent with NJDEP guidance and supporting technical references.
 - The proposed pervious pavement and rain gardens are estimated to provide up to 100% reduction in TN, TP and TSS loads from the treated drainage area, assuming runoff is fully captured and treated by the system. This adds up to 10.9 lb per year of contaminant removal.
 - By reducing sediment and nutrient loads entering Cupsaw Brook and Cupsaw Lake, the project will support water quality improvement goals and applicable TMDL objectives within the watershed.
- **Other Benefits:**
 - The project will improve water quality, reduce runoff volumes, increase infiltration and enhance groundwater recharge.
 - Additional benefits include improved wildlife and pollinator habitat, increased biodiversity, enhanced site resilience and aesthetic improvements through naturalized landscaping.
- **Funding Needs:**
 - The total cost for this project is approximately \$630,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #5: Cupsaw Lake – Thunder Mountain Trap and Skeet (Pavement Conversion) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk's gage)

- **Description:**
 - Mountain Trap and Skeet, Mansion Road, Ringwood State Park, Ringwood, NJ.
 - Geographical Coordinates: 565308.514, 837524.006
 - The project will reduce stormwater pollutant loads entering Cupsaw Brook and Cupsaw Lake by converting a portion of the existing parking lot into a stormwater treatment

BMP. The proposed improvements will capture and treat runoff before it leaves the site, reducing sediment and nutrient discharges to downstream waterbodies.

- The project site consists of an asphalt parking lot, an existing building and a large field area with minimal vegetation. Stormwater runoff from the site generally flows north toward Cupsaw Brook and ultimately discharges to Cupsaw Lake. The site does not contain a formal stormwater collection system and runoff from the parking lot is conveyed via a roadside ditch to Cupsaw Brook, contributing untreated stormwater flows and associated pollutants to the downstream waterbody.
- The project will convert the western portion of the existing parking lot into a stormwater treatment area. The BMP will extend from the parking lot entrance to the southern end of the paved area and will be designed to capture, filter and treat runoff before it leaves the site.
- Stormwater will be managed using a vegetated treatment strip and/or porous pavement system along the western edge of the parking lot. These practices will promote filtration and infiltration while reducing sediment and nutrient loads discharged from the site.
- **Impairment and/or TMDL Parameters Addressed**
 - The project will address Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) by treating runoff before it reaches Cupsaw Brook and Cupsaw Lake.
 - Other water quality and quantity issues affecting the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage), include increased runoff volumes, streambank erosion, reduced groundwater recharge and impacts to aquatic habitat.
- **Estimated Load Reduction**
 - Pollutant load reductions were estimated using NJDEP BMP removal rates and methodologies consistent with NJDEP guidance and supporting technical references.
 - The proposed pervious pavement and rain gardens are estimated to provide up to 100% reduction in TN, TP and TSS loads from the treated drainage area, assuming runoff is fully captured and treated by the system. This adds up to 6.6 lb per year of contaminant removal.
 -
 - By reducing sediment and nutrient loads entering Cupsaw Brook and Cupsaw Lake, the project will support water quality improvement goals and applicable TMDL objectives within the watershed.
- **Other Benefits**
 - The project will improve water quality, reduce runoff volumes, increase infiltration and decrease erosion associated with untreated stormwater discharges.
 - Additional benefits include enhanced groundwater recharge, improved downstream habitat conditions, increased site resilience and aesthetic improvements through the incorporation of vegetated stormwater treatment practices.
- **Funding Needs:**
 - The total cost for this project is approximately is \$90,000.00 based costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #6: Cupsaw Lake – Cupsaw Lake House (Vegetated Filter Strip, Rain Garden) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk's gage)

- **Description:**

- Cupsaw Lake House Parking lot Area, Cupsaw Drive, Ringwood, NJ
- Geographical Coordinates: 561766.688, 833533.19

- The project will replace sparse vegetation along the eastern shoulder of Cupsaw Drive with a vegetated filter strip and convert the existing grassed parking lot island into a rain garden to reduce stormwater runoff, sediment and nutrient loading to Cupsaw Lake through filtration, infiltration, evapotranspiration and vegetative uptake. Implementation will include site preparation, native plant installation and rain garden construction, with an underdrain and outlet structure provided if necessary.
- The project site is located along Cupsaw Drive and the Cupsaw Lake House parking lot, where runoff from roadway and parking lot surfaces drains toward Cupsaw Lake. Existing site features include roadway shoulders, parking areas, drainage infrastructure and a grassed island that contribute stormwater runoff containing sediment, nutrients and roadway-related pollutants. The proposed vegetated filter strip and rain garden will intercept, filter and treat runoff before it reaches the lake.
- The project will replace sparse vegetation along the eastern shoulder of Cupsaw Drive with a vegetated filter strip and convert the existing grassed island within the Cupsaw Lake House parking lot into a rain garden. Work will include site preparation, minor grading, installation of native vegetation, construction of the bioretention area and installation of any necessary underdrain and outlet structures to ensure proper stormwater management and long-term functionality.
- The project will utilize a vegetated filter strip and rain garden to treat stormwater runoff before it reaches Cupsaw Lake. Native vegetation will promote filtration, infiltration, evapotranspiration and nutrient uptake while reducing runoff volumes and pollutant transport. The rain garden will capture and infiltrate runoff from adjacent impervious surfaces and supporting drainage infrastructure may be incorporated to convey excess runoff during larger storm events.
- **Impairment and/or TMDL Parameters Addressed**
 - The project will reduce Fecal Coliform (FC), Total Phosphorus (TP), Total Nitrogen (TN) and Total Suspended Solids (TSS) by treating stormwater runoff before it enters Cupsaw Lake. The proposed BMPs will also reduce runoff volumes and help improve overall water quality within the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage).
- **Estimated Load Reduction**
 - Pollutant load reductions were estimated using NJDEP BMP removal rates and methodologies consistent with NJDEP guidance and supporting technical references.
 - The proposed vegetated filter strip and rain garden as a combination are expected to reduce Fecal Coliform by 40% and TP, TN and TSS by 100%, through filtration, infiltration and vegetative uptake, supporting water quality improvement goals within the HUC-14 watershed affected. This adds up to 4.4 lb per year of contaminant removal.
 - The vegetated filter strip and rain garden will reduce sediment and nutrient loads by filtering, infiltrating and treating stormwater runoff before it reaches Cupsaw Lake. These BMPs will decrease runoff volumes from impervious surfaces, helping to reduce pollutant loading and support watershed water quality goals.
- **Other Benefits**
 - The project will improve water quality, increase groundwater recharge and enhance the appearance of the site using native vegetation. Additional benefits include providing habitat for pollinators and wildlife, increasing biodiversity and improving the overall resilience of the watershed.

- **Funding Needs:**

- The total cost for this project is approximately is \$892,500.00 based costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #7: Cupsaw Lake – Martin J. Ryerson Middle School (Vegetated Buffer, Pavement Conversion) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk's gage)

- **Description:**

- Martin J. Ryerson Middle School, Valley Road, Ringwood, NJ
- Geographical Coordinates: 562735.805, 828758.829
- The project will reduce stormwater pollutant loads entering nearby streams and then eventually Cupsaw Lake. Converting a portion of the existing parking lot into a stormwater treatment BMP. The proposed improvements will capture and treat runoff before it leaves the site, reducing sediment and nutrient discharges to downstream waterbodies.
- The project site includes the impervious entrance roadway from Valley Road, multiple school parking lots and adjacent recreational fields within the Cupsaw Lake watershed. Parking lots are the primary contributors of impervious runoff generated at the site and represent a significant source of stormwater pollutants, including sediment, nutrients and hydrocarbons.
- Stormwater runoff from the school parking areas is collected by an existing drainage system that conveys flow to a nearby stream, which ultimately discharges to Cupsaw Lake, creating a direct connection between site-generated runoff and downstream water quality impacts.
- Construct a vegetated meadow buffer near the school entrance to treat runoff from the northern parking lot and entrance roadway and convert portions of the southern parking lot to porous or vegetated pavement to promote infiltration and reduce runoff volumes.
- Install a rain garden to capture and treat remaining runoff prior to discharge to the existing drainage system and regrade drainage areas with native vegetation to maximize stormwater treatment, pollutant removal and groundwater recharge.
- The project will utilize vegetated filtration through native meadow plantings, rain gardens and engineered soil media, along with infiltration, groundwater recharge, impervious surface disconnection and runoff volume reduction techniques to capture, treat and reduce stormwater runoff and associated pollutant loads before discharge to downstream waters.

- **Impairment and/or TMDL Parameters addressed:**

- The project will reduce Total Phosphorus (TP), Total Nitrogen (TN) and Total Suspended Solids (TSS) by treating stormwater runoff from impervious surfaces before it reaches downstream waters. In addition to addressing these water quality parameters, the project will reduce stormwater runoff volume and peak flows within the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage), helping to minimize downstream erosion, pollutant transport and impacts to Cupsaw Lake and its tributaries.

- **Estimated Load Reduction:**

- Pollutant load reductions were estimated using NJDEP BMP removal rates and methodologies consistent with NJDEP guidance and supporting technical references.
- The proposed meadow buffer, porous pavement and rain garden system is expected to provide up to 100% TSS, TP and TN removal through filtration, infiltration, groundwater recharge and vegetative uptake, supporting water quality improvement goals within the HUC-14 watershed. This adds up to 7.2 lb per year of contaminant removal.
- These BMPs will reduce sediment and nutrient loads by capturing and treating stormwater runoff before it enters the downstream drainage system and ultimately reaches Cupsaw Lake, helping to reduce pollutant loading and support applicable TMDL and watershed management objectives.
- **Other Benefits:**
 - The project will improve water quality by reducing stormwater runoff and pollutant loads to Cupsaw Lake, enhance groundwater recharge, reduce localized flooding and erosion, restore habitat and increase biodiversity through native meadow and rain garden plantings, improve site aesthetics, provide environmental education opportunities for students and increase the overall resilience of the site to stormwater impacts.
- **Funding Needs:**
 - The total cost for this project is approximately is \$260,000.00 based costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #8: Cupsaw Lake – Outlet at West Circle (Manufactured Treatment Device) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk's gage)

- **Description:**
 - West Circle (Street)
 - Geographical Coordinates: 561169.162, 832979.147
 - The project will reduce stormwater pollutant loads entering the western side of Cupsaw Lake. Installing a Manufactured Treatment Device (MTDs) along the stormwater pipe on the stormwater site of Circle West.
 - The project site consists of a paved roadway and parking access area to Cupsaw Lake, with runoff from portions of West Circle, Cupsaw Drive, Kendall Drive, Winbeam Loop, Kraft Place and adjacent residential properties collected through a series of inlets and conveyed by an existing outfall pipe directly to the lake, transporting untreated sediment, nutrients and other stormwater pollutants that contribute to downstream water quality impacts.
 - Due to the piped Conveyance system, limited shoulder and minimal open space, a MTD would be best along the West Circle discharge pipe.
 - The project will utilize a MTD to capture and treat stormwater runoff from surrounding roadway drainage areas before discharge to Cupsaw Lake. An MTD was selected as the most suitable Best Management Practice due to the existing pipe conveyance system, limited roadway shoulder width and constrained site conditions that restrict the use of larger stormwater management practices.
- **Impairment and/or TMDL Parameters addressed:**

- The project will reduce Fecal Coliform (FC), Total Phosphorus (TP), Total Nitrogen (TN) and Total Suspended Solids (TSS) by treating stormwater runoff before it reaches Cupsaw Lake.
- In addition to these water quality parameters, the project will address stormwater runoff volume, peak flow rates and the transport of sediment, debris and other pollutants from impervious surfaces within the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage) watershed, helping to reduce downstream erosion and water quality impacts.
- **Estimated Load Reduction:**
 - Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
 - The project is expected to reduce stormwater runoff and associated pollutant loads by treating runoff prior to discharge, with estimated removals of 75% FC, 30% TN, 40% TP and 80% TSS. This adds up to 28.5 lb per year of contaminant removal.
 - By reducing the transport of sediment, nutrients and other contaminants, the project will support applicable TMDL objectives, improve water quality within the HUC-14 watershed and advance state stormwater management, water quality and watershed restoration goals.
- **Other Benefits:**
 - The project will provide multiple environmental and community benefits, including reduced flood risk, nutrient and pollutant load reductions, improved water quality in Cupsaw Lake and downstream waters, enhanced aquatic habitat and ecosystem resilience, reduced erosion, restoration of natural habitat, increased biodiversity and overall improvements to watershed health and environmental conditions.
- **Funding Needs:**
 - The total cost for this project is approximately is \$360,000.00 based costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #9: Upper Erskine Lake – Upper Erskine Lake Beach (Pavement Conversion) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk's gage)

- **Description:**
 - Upper Erskine Lake Beach is located at the Center of the Southern shore of Upper Erskine Lake.
 - Geographical Coordinates: 561853.16, 824177.811
 - The project will reduce stormwater pollutant loads entering Upper Erskine Lake by converting a portion of impervious pavement areas, parking lot and recreational areas into a stormwater treatment BMP. The proposed improvements will capture and treat runoff before it leaves the site, reducing sediment and nutrient discharges to downstream waterbodies.
 - The project site consists of stormwater drainage areas that receive runoff from surrounding residential neighborhoods, roadways and on-site impervious surfaces. Existing asphalt roadways and other impervious areas facilitate the transport of sediment, nutrients and other pollutants through the drainage system, contributing to stormwater discharges to Upper Erskine Lake

- The project will convert the western portion of the portion of impervious pavement areas, parking lot and recreational areas into a vegetated pavement system or porous pavement system.
- The project site consists of stormwater drainage areas that receive runoff from surrounding residential neighborhoods, roadways and on-site impervious surfaces. Existing asphalt roadways and other impervious areas facilitate the transport of sediment, nutrients and other pollutants through the drainage system, contributing to stormwater discharges to Upper Erskine Lake.
- **Impairment and/or TMDL Parameters Addressed**
 - The project will address Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) by treating stormwater runoff before it reaches Upper Erskine Lake. In addition to reducing pollutant loads, the project will help address broader watershed concerns by reducing runoff volumes, minimizing streambank erosion, promoting groundwater recharge and supporting improved aquatic habitat conditions
- **Estimated Load Reduction**
 - Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
 - The proposed pervious pavement and rain gardens are estimated to provide up to 100% reduction in TN, TP and TSS loads by capturing, infiltrating and treating runoff from the contributing drainage area, thereby supporting applicable TMDL objectives and water quality goals for Upper Erskine Lake and the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage). This adds up to 15.2 lb per year of contaminant removal.
- **Other Benefits**
 - The project will improve water quality, reduce runoff volumes, increase infiltration and decrease erosion associated with untreated stormwater discharges.
 - Additional benefits include enhanced groundwater recharge, improved downstream habitat conditions, increased site resilience and aesthetic improvements through the incorporation of vegetated stormwater treatment practices.
- **Funding Needs:**
 - The total cost for this project is approximately is \$570,000.00 based costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #10: Lower Erskine Lake – Upper Lakeview Avenue Boat Launch at Lower Erskine Lake (Manufactured Treatment Device) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk's gage)

- **Description:**
 - Lower Erskine Lake where Upper Erskine Discharges.
 - Geographical Coordinates: 561060.021, 824766.667
 - The project will reduce stormwater pollutant loads entering Lower Erskine Lake. Installing a Manufactured Treatment Device (MTDs) along the stormwater discharge pipe.
 - The project site is located at the Lower Erskine Lake boat launch area along Lakeview Avenue, where stormwater runoff from adjacent roadways, the asphalt boat ramp and the gravel launch area is collected by existing inlets and conveyed through a stormwater outfall that discharges directly to the lake. To reduce pollutant loads entering Lower

Erskine Lake, the project will install a Manufactured Treatment Device (MTD) within the existing stormwater conveyance system to capture and treat runoff prior to discharge.

- Due to limited space in this area and accessibility to connect into the pipe conveyance system a MTDs is the recommendation to intercept flow along the stormwater discharge pipe.
- The project will utilize a Manufactured Treatment Device (MTD) installed within the existing stormwater conveyance system near the Lower Erskine Lake boat launch to capture and treat runoff prior to discharge to the lake. The MTD will remove sediment and associated pollutants from stormwater conveyed through the underground piping network and may also capture additional runoff from the boat ramp area. The selected location within the gravel parking area provides convenient access for inspection, maintenance and removal of accumulated material.
- **Impairment and/or TMDL Parameters addressed:**
 - The project will reduce Total Phosphorus (TP), Total Nitrogen (TN) and Total Suspended Solids (TSS) by treating stormwater runoff before it reaches Lower Erskine Lake.
 - In addition to these water quality parameters, the project will address stormwater runoff volume, peak flow rates and the transport of sediment, debris and other pollutants from impervious surfaces within the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage), helping to reduce downstream erosion and water quality impacts.
- **Estimated Load Reduction:**
 - Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
 - The project is expected to reduce stormwater runoff and associated pollutant loads by treating runoff prior to discharge, with estimated removals of 75% FC, 30% TN, 40% TP and 80% TSS. This adds up to 2.5 lb per year of contaminant removal.
 - By reducing the transport of sediment, nutrients and other contaminants, the project will support applicable TMDL objectives, improve water quality within the HUC-14 watershed and advance state stormwater management, water quality and watershed restoration goals.
- **Other Benefits:**
 - Improves water quality in Lower Erskine Lake by reducing sediment, nutrients and other contaminant loads conveyed by stormwater runoff, while also helping to reduce localized flooding and erosion associated with unmanaged runoff.
 - Supports aquatic habitat restoration, enhances conditions for fish and wildlife, promotes biodiversity and improves the overall environmental quality and recreational value of Lower Erskine Lake for the surrounding community.
- **Funding Needs:**
 - The total cost for this project is approximately is \$360,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #11: Lower Erskine Lake – Lakeview Avenue Boat Launch at Lower Erskine Lake (Manufactured Treatment Device) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk's gage)

- **Description:**

- Northeastern side of the lower Erskine lake, where Lakeview Avenue intersects with the end of Upper Lakeview Avenue.
- Geographical Coordinates: 561086.366, 823920.946
- Install a vegetated paver system at the end of the boat ramp and a manufactured treatment device (MTD) on the existing stormwater discharge pipe to reduce pollutant loads entering Lower Erskine Lake.
- The drainage area includes portions of Lakeview Avenue, Upper Lakeview Avenue, adjacent residential areas and impervious surfaces within the boat launch site. Existing stormwater runoff is conveyed through inlets and piping that discharge directly to Lower Erskine Lake. Due to the site's proximity to the lake shoreline, stormwater runoff has limited opportunity for treatment, allowing sediment, nutrients and other pollutants from surrounding developed areas to enter the lake.
- Includes installation of vegetated pavers at the transition between the existing asphalt boat ramp and adjacent dirt and grass areas to promote infiltration, filtration and sediment capture before runoff reaches Lower Erskine Lake. Work also includes installation of a Manufactured Treatment Device (MTD) on the existing stormwater outfall to treat runoff from roadway and residential drainage areas, as well as associated grading, site restoration and stabilization of disturbed areas.
- Utilizes vegetated permeable pavers to promote infiltration, filtration and sediment capture before runoff reaches Lower Erskine Lake, while a Manufactured Treatment Device (MTD) will capture sediment, debris and associated pollutants from stormwater runoff. Disturbed areas will be graded, stabilized and revegetated to provide erosion control and long-term site stability.
- **Impairment and/or TMDL Parameters addressed:**
 - The project will reduce Fecal Coliform, Total Phosphorus (TP), Total Nitrogen (TN) and Total Suspended Solids (TSS) by treating stormwater runoff before it reaches Lower Erskine Lake
 - In addition to these water quality parameters, the project will address stormwater runoff volume, peak flow rates and the transport of sediment, debris and other pollutants from impervious surfaces within the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage), helping to reduce downstream erosion and water quality impacts.
- **Estimated Load Reduction:**
 - Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
 - The project is expected to reduce stormwater runoff and associated pollutant loads by treating runoff prior to discharge, with estimated removals 75% FC, 30% TN, 40% TP and 80% TSS. This adds up to 1671 lb per year of contaminant removal.
 - Vegetated pavers will reduce sediment and nutrient transport through infiltration and filtration, while the Manufactured Treatment Device (MTD) will remove sediment, debris, bacteria and associated pollutants from stormwater conveyed through the drainage system. Together, these BMPs are expected to reduce pollutant loads entering Lower Erskine Lake, support applicable TMDL objectives, improve water quality within the HUC-14 watershed and advance watershed restoration and stormwater management goals.
- **Other Benefits**
 - Improves water quality by reducing pollutant loads, stormwater runoff volumes and erosion associated with untreated discharges, while increasing infiltration and enhancing overall stormwater management.

- Increases vegetative cover, reduces exposed soil areas, minimizes shoreline erosion and sediment discharge to Lower Erskine Lake, improves site aesthetics and enhances long-term site resilience and protection of lake water quality.
- **Funding Needs:**
 - The total cost for this project is approximately is \$540,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #12: Lower Erskine Lake – Laurel Drive (Manufactured Treatment Device) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk's gage)

- **Description:**
 - Bordering Shore of Lower Erskine Lake, along Lakeview Avenue.
 - Geographical Coordinates: 560511.413, 822692.063
 - Install a vegetated paver system at the end of the boat ramp and a manufactured treatment device (MTD) on the existing stormwater discharge pipe to reduce pollutant loads entering Lower Erskine Lake
 - The site consists of an existing stormwater conveyance system, including multiple storm sewer pipes, inlets and a metal discharge pipe that conveys runoff through a grassed area located between two residential properties before discharging to Lower Erskine Lake. Runoff from Laurel Place and Lakeview Avenue is collected and routed through the drainage network to the lake. The contributing drainage area is primarily associated with Laurel Place, an uncurbed roadway that slopes steeply toward Lower Erskine Lake, resulting in the transport of sediment and other pollutants. The lower portion of the drainage area includes residential development with a mix of impervious surfaces and vegetated areas that contribute stormwater runoff to the existing system.
 - Includes installation of a Manufactured Treatment Device (MTD) near the existing inlet at the intersection of Lakeview Avenue and Laurel Place to capture and treat stormwater runoff from contributing roadway and drainage areas before discharge to Lower Erskine Lake. The existing stormwater conveyance system will be utilized to route runoff through the treatment device and convey treated flows to the lake.
 - Includes installation of a Manufactured Treatment Device (MTD) within the existing stormwater drainage network to remove sediment, nutrients, debris and associated pollutants from stormwater runoff. The MTD will be connected to the existing storm sewer infrastructure to provide treatment prior to discharge to Lower Erskine Lake, reducing pollutant loads and improving water quality
- **Impairment and/or TMDL Parameters addressed:**
 - The project will reduce Fecal Coliform, Total Phosphorus (TP), Total Nitrogen (TN) and Total Suspended Solids (TSS) by treating stormwater runoff before it reaches Lower Erskine Lake.
 - In addition to these water quality parameters, the project will address stormwater runoff volume, peak flow rates and the transport of sediment, debris and other pollutants from impervious surfaces within the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage), helping to reduce downstream erosion and water quality impacts.
- **Estimated Load Reduction:**

- Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
- The project is expected to reduce stormwater runoff and associated pollutant loads by treating runoff prior to discharge, with estimated removals 75% FC, 30% TN, 40% TP and 80% TSS. This adds up to 164.9 lb per year of contaminant removal. This project also removes 75% of fecal coliform, which most projects do not (removal of 0.3 lb per year of fecal coliform).
- The Manufactured Treatment Device (MTD) will remove sediment, nutrients, debris and associated pollutants from stormwater conveyed through the drainage system prior to discharge to Lower Erskine Lake. These reductions will decrease pollutant loads entering the lake, support applicable TMDL objectives, improve water quality within the HUC-14 watershed and advance watershed restoration and stormwater management goals.
- **Other Benefits**
 - Improves water quality by reducing sediment, nutrient and other pollutant loads entering Lower Erskine Lake, while helping to reduce localized flooding, runoff impacts and erosion associated with untreated stormwater discharges.
 - Enhances aquatic habitat conditions, supports biodiversity and habitat restoration, improves water quality for aquatic life and provides long-term environmental benefits through improved watershed health and shoreline protection.
- **Funding Needs:**
 - The total cost for this project is approximately is \$360,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #13: Lower Erskine Lake – Lower Erskine Lake Beach (Pavement Conversion) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk’s gage)

- **Description:**
 - On the Peninsula at the south end of lower Erskine Lake, on Main Beach Road.
 - Geographical Coordinates: 559838.277, 822633.528
 - The project will reduce stormwater pollutant loads entering Lower Erskine Lake by converting a portion of the existing parking lot into a stormwater treatment BMP. The proposed improvements will capture and treat runoff before it leaves the site, reducing sediment and nutrient discharges to downstream waterbodies.
 - The site consists of an existing asphalt parking lot, adjacent roadways and surrounding residential development. The northeastern and northwestern portions of the peninsula contain steep slopes with a high potential for erosion and sediment transport. The site lacks a formal stormwater collection system, with runoff from the parking lot draining to a roadside ditch that conveys flow to Lower Erskine Lake. Known pollutants associated with runoff from the site include sediment, Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN), which can adversely affect downstream water quality.
 - Includes replacing portions of the existing parking lot and roadway surfaces with porous pavement and/or vegetated pavers to reduce runoff, promote infiltration and improve stormwater treatment. Work also includes retrofitting existing storm drain inlets to function as overflow structures, providing controlled drainage while reducing sediment and nutrient transport to Lower Erskine Lake.

- Utilizes permeable pavement systems to promote stormwater infiltration, reduce runoff volume and enhance pollutant removal through filtration. Existing storm drain inlets will be retrofitted and incorporated as overflow structures to safely convey excess runoff during larger storm events while maintaining treatment benefits and reducing sediment and nutrient transport to Lower Erskine Lake.
- **Impairment and/or TMDL Parameters Addressed**
 - Addresses Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) by reducing stormwater runoff and associated pollutant loads from impervious surfaces before discharge to Lower Erskine Lake.
 - In addition to reducing sediment and nutrient loading, the proposed improvements will help decrease runoff volume, improve infiltration and reduce the transport of pollutants that contribute to water quality impairments within the HUC 02030103070050 – Wanaque Reservoir (below Monk’s gage).
- **Estimated Load Reduction**
 - Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
 - The proposed pervious pavement and rain gardens are estimated to provide up to 100% reduction in TN, TP and TSS loads by capturing, infiltrating and treating runoff from the contributing drainage area, thereby supporting applicable TMDL objectives and water quality goals for Upper Erskine Lake and the HUC-14 watershed. This adds up to 26.4 lb per year of contaminant removal.
- **Other Benefits**
 - Improves groundwater recharge, reduces stormwater runoff volumes and enhances the resilience of the lake shoreline to erosion and stormwater-related impacts.
 - Provides long-term water quality benefits by reducing sediment transport, improving infiltration, supporting aquatic habitat and enhancing the overall health and sustainability of the watershed.
- **Funding Needs:**
 - The total cost for this project is approximately is \$600,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #14: Lower Erskine Lake – Ramapo Boat Launch (Manufactured Treatment Device) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk’s gage)

- **Description:**
 - Southwestern shore of Lower Erskine Lake, next to the intersection of Ramapo Place and Lakeview
 - Geographical Coordinates: 558864.82, 822802.917
 - Install a manufactured treatment device (MTD) on the existing stormwater discharge pipe to reduce pollutant loads entering Lower Erskine Lake.
 - The site consists of a boat launch and boat storage area that receives stormwater runoff through an existing network of pipes and inlets conveying flow from surrounding developed areas to a discharge point at Lower Erskine Lake. Due to the size of the contributing drainage area and the direct connection of the stormwater conveyance system to the lake, the site represents a significant source of sediment, nutrients and other contaminants entering Lower Erskine Lake.

- Includes installation of a Manufactured Treatment Device (MTD) near the existing inlet on the western side of Lakeview Avenue and Ramapo Place intersection to capture and treat stormwater runoff from the contributing drainage area. The MTD will provide treatment prior to runoff entering the existing stormwater conveyance system and discharging to Lower Erskine Lake. Installation will be coordinated to avoid conflicts with existing utilities, including the nearby fire hydrant water supply infrastructure.
- Utilizes vegetated permeable pavers to promote stormwater infiltration, enhance filtration and reduce sediment runoff before it reaches Lower Erskine Lake. A Manufactured Treatment Device (MTD) will be installed to capture sediment, debris and associated pollutants from stormwater runoff, while disturbed areas will be graded, stabilized and revegetated to provide erosion control and long-term site stability.
- **Impairment and/or TMDL Parameters Addressed**
 - Addresses Fecal Coliform, Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) by treating stormwater runoff before it reaches Lower Erskine Lake.
 - In addition to reducing pollutant loading, the proposed improvements will help address increased runoff volumes, streambank erosion, reduced groundwater recharge and impacts to aquatic habitat, supporting improved watershed conditions within the HUC-14 drainage area.
- **Estimated Load Reduction**
 - Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
 - Estimated removals of 75% FC, 30% TN, 40% TP and 80% TSS are based on the contributing drainage area treated, runoff captured and anticipated BMP performance. This adds up to 214 lb per year of contaminant removal. This project also removes 75% of fecal coliform, which most projects do not (0.3 lb per year).
 - Vegetated permeable pavers will reduce sediment and nutrient transport through infiltration and filtration, while the Manufactured Treatment Device (MTD) will remove sediment, debris and associated pollutants from stormwater conveyed through the drainage system. Together, these BMPs will decrease Contaminant loads entering Lower Erskine Lake, supporting applicable TMDL objectives, improving water quality within the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage) and advancing watershed restoration and stormwater management goals.
- **Other Benefits**
 - Improves water quality by reducing pollutant loads, stormwater runoff volumes and erosion associated with untreated stormwater discharges, while increasing infiltration and enhancing overall stormwater management.
 - Increases vegetative cover, reduces exposed soil areas, minimizes shoreline erosion and sediment discharge to Lower Erskine Lake, improves site aesthetics and enhances the long-term resilience of the site and protection of lake water quality.
- **Funding Needs:**
 - The total cost for this project is approximately is \$360,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #15: Lower Erskine Lake – Mohawk Trail Boat Launch (Manufactured Treatment Device) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque Reservoir (below Monk's gage)

- **Description:**
 - Mohawk Trail Boat Launch is located opposite of Mohawk Trail, at the intersections of Lakeview Avenue and Mohawk Trail.
 - Geographical Coordinates: 558983.858, 824764.499
 - Install a manufactured treatment device (MTD) on the existing stormwater discharge pipe to reduce pollutant loads entering Lower Erskine Lake.
 - The site consists of a gravel driveway and dirt boat launch area that receive runoff from adjacent residential neighborhoods and roadways; stormwater is collected through inlets along Lakeview Avenue, Mohawk Trail and surrounding streets, converges at the inlet system on Lakeview Avenue near the boat launch and is conveyed through a 12-inch concrete pipe that discharges east of the site into the receiving waterbody.
 - Install a Manufactured Treatment Device (MTD) within the existing stormwater conveyance system to capture and treat runoff from the contributing drainage area before discharge to Lower Erskine Lake, reducing sediment, nutrient and debris loading to the lake.
 - Install a Manufactured Treatment Device (MTD) within the existing stormwater system to capture sediment, debris and associated pollutants from runoff prior to discharge, improving the quality of stormwater entering Lower Erskine Lake
- **Impairment and/or TMDL Parameters Addressed**
 - Addresses Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) by treating stormwater runoff before discharge to Lower Erskine Lake, while also helping to reduce runoff volumes, erosion, diminished groundwater recharge and impacts to aquatic habitat within the watershed.
 - In addition to reducing pollutant loading, the proposed improvements will help address increased runoff volumes, streambank erosion, reduced groundwater recharge and impacts to aquatic habitat, supporting improved watershed conditions within the HUC 02030103070050 – Wanaque Reservoir (below Monk's gage) drainage area.
- **Estimated Load Reduction**
 - Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
 - Estimated removals of 75% FC, 30% TN, 40% TP and 80% TSS are based on the contributing drainage area treated, runoff captured and anticipated BMP performance. This adds up to 2630 lb per year of contaminant removal. This project also removes 75% of fecal coliform, which most projects do not (3.9 lb per year).
 - Vegetated permeable pavers will reduce sediment and nutrient transport through infiltration and filtration, while the Manufactured Treatment Device (MTD) will remove sediment, debris and associated pollutants from stormwater conveyed through the drainage system.
- **Other Benefits**
 - Improves water quality in Lower Erskine Lake by reducing pollutant loading, sedimentation and associated impacts to aquatic habitat; additional benefits include reduced stormwater impacts, enhanced recreational use of the lake and boat launch area, improved aesthetic conditions and protection of downstream aquatic resources.
- **Funding Needs:**
 - The total cost for this project is approximately \$360,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #16: Upper Skyline – Skyline Drive Shopping Center (Retention Basin, Manufactured Treatment Device, Vegetated Buffer) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Meadow Brook/High Mountain Brook

- **Description:**
 - Approximately half a mile to the northeast of Upper Skyline Lake.
 - Geographical Coordinates: 557466.724, 820157.778
 - The project will implement a retention basin, Manufactured Treatment Device (MTD) and vegetated buffer within a commercial shopping center drainage area northeast of Upper Skyline Lake. These BMPs will capture, detain and treat stormwater runoff from impervious surfaces to reduce sediment, phosphorus and nitrogen loading before discharge to the adjacent wetland, tributary stream and Upper Skyline Lake, resulting in improved water quality and stormwater management throughout the watershed.
 - The Skyline Drive Shopping Center site consists of an approximately 18-acre commercial shopping center and associated parking areas located on both sides of Skyline Drive. The drainage area includes the predominantly impervious shopping center, adjacent roadways and surrounding wooded areas. Stormwater runoff is collected through a network of inlets and storm sewer pipes that convey flow to a wetland southwest of the shopping center. Portions of the stormwater system also convey stream flow beneath the shopping center, with the stream briefly daylighting on the eastern side of the site before passing under Skyline Drive, flowing through the wetland and ultimately draining to Upper Skyline Lake.
 - Construct a stormwater retention basin within an existing vegetated area to capture, store and treat runoff from the shopping center drainage area; install a Manufactured Treatment Device (MTD) within the stormwater conveyance system downstream of the basin; convert a portion of the paved area behind the shopping center into a vegetated buffer; and improve stormwater treatment and pollutant removal prior to discharge to the adjacent wetland and ultimately Upper Skyline Lake.
 - Construct a stormwater retention basin within the existing vegetated area to capture and detain runoff, promoting sediment settling, nutrient uptake and flow attenuation before discharge downstream; install a Manufactured Treatment Device (MTD) within the stormwater conveyance system to intercept and treat piped stormwater flows, removing sediment, debris and associated pollutants prior to entering the adjacent wetland; and establish a vegetated buffer by converting a portion of the paved area behind the shopping center to provide additional filtration, infiltration, sediment capture and nutrient removal. These practices will function together as an integrated treatment system to improve stormwater quality before discharge to the wetland and Upper Skyline Lake.
- **Impairment and/or TMDL Parameters Addressed**
 - Addresses Fecal Coliform, Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) by capturing, detaining and treating stormwater runoff before discharge to the adjacent wetland, tributary stream and Upper Skyline Lake.
 - Additional watershed concerns within the HUC 02030103070060 - Meadow Brook/High Mountain Brook, include elevated stormwater runoff volumes, streambank erosion, sedimentation, reduced groundwater recharge, altered hydrology and degradation of aquatic habitat, all of which will be mitigated through the implementation of the proposed stormwater management practices
- **Estimated Load Reduction**

- Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
- The retention basin, Manufactured Treatment Device (MTD) and vegetated buffer are expected to reduce 100% FC, 100% TSS, 90% TP and 70% TN from the commercial drainage area before discharge to the adjacent wetland, tributary stream and Upper Skyline Lake. This adds up to 2.3 lb per year of contaminant removal.
- **Other Benefits**
 - Improves water quality in the adjacent wetland, tributary stream and Upper Skyline Lake by reducing sediment, nutrient and pollutant loads; enhances wetland and aquatic habitat function; promotes groundwater recharge through infiltration and vegetative treatment practices; reduces peak stormwater flows during storm events; minimizes erosion and downstream flooding potential; and provides aesthetic and environmental benefits to the surrounding commercial area and watershed.
- **Funding Needs:**
 - The total cost for this project is approximately \$335,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #17: Upper Skyline – Upper Skyline Dam (Pavement Conversion) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Meadow Brook/High Mountain Brook

- **Description:**
 - West to the Upper Skyline Lake Dam.
 - Geographical Coordinates: 554387.349, 814819.100
 - The project will reduce stormwater pollutant loads entering Upper Skyline Lake by converting a portion of the existing parking lot into a stormwater treatment BMP. The proposed improvements will capture and treat runoff before it leaves the site, reducing sediment and nutrient discharges to downstream waterbodies.
 - The site consists of the Skyline Lakes clubhouse building, parking lot, boat launch ramp and beach area. The drainage area includes adjacent residential neighborhoods, roadways and on-site impervious surfaces. Stormwater runoff is conveyed through an existing stormwater collection system that captures drainage from Skyline Lake Drive and surrounding areas and discharges to Upper Skyline Lake through a network of inlets and pipes that pass beneath the parking lot.
 - The project will replace portions of the existing asphalt parking lot with porous pavement or vegetated pavers to improve stormwater infiltration and treatment. Installation of a Manufactured Treatment Device (MTD), where feasible, to further reduce pollutant loading and improve water quality before runoff reaches Upper Skyline Lake.
 - The site consists of the Skyline Lakes clubhouse building, parking lot, boat launch ramp and beach area. The drainage area includes adjacent residential neighborhoods, roadways and on-site impervious surfaces. Stormwater runoff is conveyed through an existing stormwater collection system that captures drainage from Skyline Lake Drive and surrounding areas and discharges to Upper Skyline Lake through a network of inlets and pipes that pass beneath the parking lot.
- **Impairment and/or TMDL Parameters Addressed**
 - Addresses Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) by reducing stormwater pollutant loads before discharge to Upper Skyline Lake.

- Additional HUC 02030103070060 - Meadow Brook/High Mountain Brook concerns addressed include excessive runoff volumes, streambank erosion, reduced groundwater recharge, sedimentation and degradation of aquatic habitat associated with impervious surface runoff.
- **Estimated Load Reduction**
 - Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
 - There is up to 100% reductions in TSS, phosphorus and nitrogen loads are expected through infiltration, filtration and pollutant capture provided by porous pavement, vegetated pavers and any supplemental stormwater treatment measures. These BMPs will reduce pollutant discharges to Upper Skyline Lake and support compliance with applicable watershed restoration goals and water quality objectives. This adds up to 1.6 lb per year of contaminant removal
- **Other Benefits**
 - Improves water quality in Upper Skyline Lake by reducing direct stormwater discharges, promotes groundwater recharge through increased infiltration, reduces runoff volumes and peak stormwater flows, decreases erosion, enhances aquatic habitat and ecosystem health, improves the aesthetic appearance of the site and supports recreational use of the lake and surrounding community amenities.
- **Funding Needs:**
 - The total cost for this project is approximately is \$360,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #18: Lower Skyline Lake – Lower Skyline Beach (Pavement Conversion) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Meadow Brook/High Mountain Brook

- **Description:**
 - Western shore of Lower Skyline Lake, adjacent to Skyline Lake Drive.
 - Geographical Coordinates: 553461.680, 814182.798
 - The Lower Skyline Lake Beach project will install porous pavement, vegetated pavers and shoreline stabilization measures to reduce stormwater runoff, erosion, sediment and nutrient loading from the beach, parking lot and boat launch areas before discharge to Lower Skyline Lake, improving water quality and shoreline resilience.
 - The site includes a beach, parking lot, basketball court, playground, boat ramp and kayak storage area. Stormwater runoff from the site is conveyed both as overland flow directly toward the lake and through an existing stormwater collection system consisting of parking lot and roadside inlets along Skyline Lake Drive. Runoff is ultimately discharged through a 12-inch high-density polyethylene (HDPE) pipe connected to the on-site drainage network, which conveys stormwater to Lower Skyline Lake. The recreational facilities, parking areas and surrounding roadways represent potential sources of sediment, nutrients and other stormwater pollutants that can be transported to the lake during runoff events
 - The project will convert portions of the existing asphalt parking lot to porous pavement and install vegetated pavers at the boat launch area to promote stormwater infiltration and treatment.

- Install porous pavement within the parking lot to promote infiltration, filtration and treatment of stormwater runoff; install vegetated pavers at the boat launch area to reduce erosion and capture sediment; and utilize these green infrastructure practices to provide infiltration, filtration and sediment capture before runoff reaches Lower Skyline Lake, thereby reducing pollutant loading and improving water quality.
- **Impairment and/or TMDL Parameters Addressed**
 - Addresses Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) by reducing stormwater pollutant loads before discharge to Lower Skyline Lake.
 - Additional HUC 02030103070060 - Meadow Brook/High Mountain Brook concerns addressed include excessive runoff volumes, streambank erosion, reduced groundwater recharge, sedimentation and degradation of aquatic habitat associated with impervious surface runoff.
- **Estimated Load Reduction**
 - Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
 - There is up to 100% reductions in TSS, phosphorus and nitrogen loads are expected through infiltration, filtration and pollutant capture provided by porous pavement, vegetated pavers and any supplemental stormwater treatment measures. These BMPs will reduce pollutant discharges to Lower Skyline Lake and support compliance with applicable watershed restoration goals and water quality objectives. This adds up to 42.7 lb per year of contaminant removal
- **Other Benefits**
 - Improves water quality, reduces runoff volumes, increases infiltration, decreases erosion, increases vegetative cover, minimizes shoreline erosion and sediment discharge to Lower Skyline Lake, enhances site aesthetics and stormwater management and improves the long-term resilience of the site while protecting lake water quality.
- **Funding Needs:**
 - The total cost for this project is approximately is \$775,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Potential Improvement Project #19: Lake Rickonda – Lake Rickonda Beach (Vegetated Swale) to address TSS, Total Phosphorus, Total Nitrogen, Metals (Mercury) and Fecal Coliform for Subwatershed(s): Wanaque R/Greenwood Lk (above Monks gage)

- **Description:**
 - Lake Rickonda beach is located on the northwestern side of lake Rickonda, with access from lake Lake Rickonda drive.
 - Geographical Coordinates: 545809.757, 830141.836
 - The project will convert an existing rock-lined swale into a vegetated swale to improve stormwater treatment before discharge to Lake Rickonda. The vegetated swale will slow runoff, promote infiltration and filtration and reduce sediment, nutrient and pollutant loads, improving water quality and reducing stormwater impacts to the lake.
 - The site includes a swimming beach and small dock along Lake Rickonda. The drainage area consists of adjacent residential properties and Lake Rickonda Drive, which contribute stormwater runoff to the site. Runoff is collected by two curb inlets and conveyed to an existing rock-lined swale that discharges directly to Lake Rickonda,

creating a pathway for sediment, nutrients and other stormwater pollutants to enter the lake.

- Convert the existing rock-lined swale into a vegetated swale designed to improve stormwater treatment prior to discharge to Lake Rickonda and install sediment collection pools within the swale to capture accumulated sediment and facilitate routine maintenance while enhancing pollutant removal and runoff management.
- Convert the existing rock-lined swale to a vegetated swale to slow runoff velocities, promote filtration and infiltration and improve pollutant removal prior to discharge to Lake Rickonda.

- **Impairment and/or TMDL Parameters Addressed**

- Addresses Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) by treating stormwater runoff before discharge to Lake Rickonda
- Also addresses concerns identified with HUC 02030103070030 - Wanaque R/Greenwood Lk (above Monks gage), such as excessive runoff volumes, reduced groundwater recharge and degradation of aquatic habitat associated with untreated stormwater runoff.

- **Estimated Load Reduction**

- Pollutant load reductions were estimated using NJDEP removal rates and assumptions consistent with NJDEP reference guidance and supporting technical reports.
- The vegetated swale, sediment forebays and shoreline stabilization measures are expected to reduce 80% TN, 90% TP and 70% TSS by promoting filtration, infiltration, sediment capture and flow attenuation before runoff reaches Lake Rickonda, supporting watershed restoration and water quality improvement goals. This adds up to 2.1 lb per year of contaminant removal

- **Other Benefits**

- Improves water quality in Lake Rickonda, reduces sediment and nutrient loading, stabilizes shoreline areas and reduces erosion, enhances aquatic habitat conditions, promotes infiltration and groundwater recharge, improves the appearance of the beach and waterfront area and provides long-term environmental and recreational benefits to the surrounding community.

- **Funding Needs:**

- The total cost for this project is approximately is \$225,000.00 based on costs calculated in the report titled "An Assessment of Lake and Watersheds of Ringwood Borough" by Princeton Hydro.

Overview of Funding Needs and Potential Funding Sources

Successful implementation of the proposed watershed improvement projects will depend on the availability of funding and the Borough's ability to leverage multiple financing opportunities. Estimated costs and funding acquisition timelines listed in this report should be considered planning-level estimates and may be refined during project design and implementation. Table 46 presents the estimated project costs, potential funding sources and anticipated timelines for securing funding.

Table 46: Potential Funding for Proposed Projects

Project(s)	Project Name	HUC-14(s)	Estimated Cost	Potential Funding Sources	Estimate Timeline of Funding Acquisition
<i>Stream Study Project 1S</i>	<i>Stream Monitoring Study</i>	Developed Areas of Ringwood	<i>\$600,000.00</i>	<i>Federal, state, local, private, nonprofit grants and watershed ambassador programs.</i>	<i>6 to 12 Months</i>
<i>Project 1</i>	<i>Storm Drain Maintenance</i>	Developed Areas of Ringwood	<i>\$530,000.00</i>	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	<i>12 to 24 Months</i>
<i>Project 2</i>	<i>Public Education</i>	Developed Areas of Ringwood	<i>Annually: \$9,000.00</i>	<i>Federal, state, local, private, nonprofit grants and watershed ambassador programs.</i>	<i>6 Months</i>
<i>Project 3</i>	<i>Improved Source Control</i>	Developed Areas of Ringwood	<i>Initial: \$1,000,000.00 Annually: \$590,000.00</i>	<i>Federal, state, local, private, nonprofit grants and watershed ambassador programs.</i>	<i>12 to 24 Months</i>
<i>Project 4</i>	<i>Pavement Conversion</i>	02030103070050	<i>\$630,000.00</i>	<i>Federal, state, local, private, nonprofit grants and watershed ambassador programs.</i>	<i>12 to 24 Months</i>

Project(s)	Project Name	HUC-14(s)	Estimated Cost	Potential Funding Sources	Estimate Timeline of Funding Acquisition
Project 5	Pavement Conversion	02030103070050	\$90,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	6 to 12 Months
Project 6	Vegetated Filter Strip, Rain Garden	02030103070050	\$892,500.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	12 to 24 Months
Project 7	Vegetated Buffer, Pavement Conversion, Rain Garden	02030103070050	\$260,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	6 to 12 Months
Project 8	Manufactured Treatment Device	02030103070050	\$360,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	6 to 12 Months
Project 9	Pavement Conversion	02030103070050	\$570,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	12 to 24 Months
Project 10	Manufactured Treatment Device	02030103070050	\$360,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	6 to 12 Months

Project(s)	Project Name	HUC-14(s)	Estimated Cost	Potential Funding Sources	Estimate Timeline of Funding Acquisition
Project 11	Manufactured Treatment Device	02030103070050	\$540,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	12 to 24 Months
Project 12	Manufactured Treatment Device	02030103070050	\$360,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	6 to 12 Months
Project 13	Pavement Conversion	02030103070050	\$600,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	12 to 24 Months
Project 14	Manufactured Treatment Device	02030103070050	\$360,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	6 to 12 Months
Project 15	Manufactured Treatment Device	02030103070050	\$360,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	6 to 12 Months
Project 16	Retention Basin, Manufactured Treatment Device, Vegetated Buffer	02030103070060	\$335,000.00	Federal, state, local, private, nonprofit grants and watershed ambassador programs.	6 to 12 Months

Project(s)	Project Name	HUC-14(s)	Estimated Cost	Potential Funding Sources	Estimate Timeline of Funding Acquisition
Project 17	<i>Pavement Conversion, Manufactured Treatment Device</i>	02030103070060	\$360,000.00	<i>Federal, state, local, private, nonprofit grants and watershed ambassador programs.</i>	<i>6 to 12 Months</i>
Project 18	<i>Pavement Conversion</i>	02030103070060	\$775,000.00	<i>Federal, state, local, private, nonprofit grants and watershed ambassador programs.</i>	<i>12 to 24 Months</i>
Project 19	<i>Vegetated Swale</i>	02030103070030	\$225,000.00	<i>Federal, state, local, private, nonprofit grants and watershed ambassador programs.</i>	<i>6 to 12 Months</i>

Estimate Implementation Schedule

The proposed implementation schedule provides a phased approach for advancing watershed improvement projects. Projects were assigned to implementation phases based on factors including watershed priority, anticipated water quality benefits, regulatory significance, project complexity, funding availability and implementation readiness. Additionally, the projects were evaluated based on which contaminants were removed and the amounts they removed.

Table 47: Proposed Implementation Schedule

Phase	Project	Project Name	Key Steps	Pollutant Removed/Flood area mitigated	Timeline
Phase 1	Project 1S	Stream Monitoring Study		TSS, TN, TP, Fecal Coliform	Year 1-2
	Project 2	Public Education		TSS, TN, TP, Fecal Coliform	Year 1-2
Phase 2	Project 3	Improved Source Control		TSS, TN, TP, Fecal Coliform	Year 3-4
	Project 14	Manufactured Treatment Device	Install a manufactured treatment device (MTD) to capture and treat stormwater runoff before discharge to Lower Erskine Lake.	TSS, TN, TP, Fecal Coliform	Year 3-4
	Project 15	Manufactured Treatment Device	Install a manufactured treatment device (MTD) within the existing stormwater system to reduce pollutant loading to Lower Erskine Lake.	TSS, TN, TP, Fecal Coliform	Year 4-5
Phase 3	Project 8	Manufactured Treatment Device	Install a manufactured treatment device (MTD) to capture and treat stormwater runoff before discharge to Cupsaw Lake.	TSS, TN, TP, Fecal Coliform	Year 5-6
	Project 11	Manufactured Treatment Device	Install vegetated pavers and a manufactured treatment device (MTD) to capture and treat stormwater runoff before discharge to Lower Erskine Lake.	TSS, TN, TP	Year 5-6

	Project 12	Manufactured Treatment Device	Install a vegetated paver system and manufactured treatment device (MTD) to capture and treat stormwater runoff before discharge to Lower Erskine Lake.	TSS, TN, TP, Fecal Coliform	Year 5-6
	Project 18	Pavement Conversion	Convert parking lot areas to porous pavement and vegetated pavers to reduce stormwater runoff, erosion and pollutant loading to Lower Skyline Lake.	TSS, TN, TP	Year 5-6
Phase 4	Project 1	Storm Drain Maintenance		TSS, TN, TP, Fecal Coliform	Year 7
	Project 4	Pavement Conversion	Retrofit the parking lot with green infrastructure to reduce stormwater runoff, improve water quality and decrease sediment and nutrient pollution.	TSS, TN, TP	Year 7
	Project 7	Vegetated Buffer, Pavement Conversion, Rain Garden	Convert parking lot areas to green infrastructure BMPs, including meadow buffers, porous pavement and rain gardens, to reduce stormwater runoff and pollutant loading to Cupsaw Lake.	TSS, TN, TP	Year 7
	Project 9	Pavement Conversion	Convert impervious pavement, parking lot and recreational areas to vegetated or porous pavement systems to reduce stormwater runoff and pollutant loading to Upper Erskine Lake.	TSS, TN, TP	Year 7
	Project 13	Pavement Conversion	Replace parking lot surfaces with porous pavement and vegetated pavers to reduce stormwater runoff and pollutant loading to Lower Erskine Lake.	TSS, TN, TP	Year 7

Phase 5	Project 5	Pavement Conversion	Convert a portion of the parking lot into green infrastructure to capture and treat stormwater runoff, reducing sediment and nutrient pollution to Cupsaw Brook and Cupsaw Lake.	TSS, TN, TP	Year 8
	Project 6	Vegetated Filter Strip, Rain Garden	Replace roadside vegetation and a parking lot island with a vegetated filter strip and rain garden to reduce stormwater runoff and pollutant loading to Cupsaw Lake.	TSS, TN, TP, Fecal Coliform	Year 8
	Project 10	Manufactured Treatment Device	Install a manufactured treatment device (MTD) within the existing stormwater system to reduce sediment and pollutant loading to Lower Erskine Lake.	TSS, TN, TP, Fecal Coliform	Year 8
	Project 16	Retention Basin, Manufactured Treatment Device, Vegetated Buffer	Construct a retention basin, manufactured treatment device (MTD) and vegetated buffer to reduce stormwater runoff and pollutant loading to Upper Skyline Lake.	TSS, TN, TP, Fecal Coliform	Year 8
Phase 6	Project 17	Pavement Conversion, Manufactured Treatment Device	Replace parking lot surfaces with porous pavement or vegetated pavers and install a manufactured treatment device (MTD) to reduce stormwater runoff and pollutant loading to Upper Skyline Lake.	TSS, TN, TP, Fecal Coliform	Year 9
	Project 19	Vegetated Swale	Convert an existing rock-lined swale to a vegetated swale to improve stormwater treatment and reduce pollutant loading to Lake Rickonda.	TSS, TN, TP	Year 9

Public Involvement and Feedback

- **Meetings and Feedback:**
 - **List of Previously Held Meetings**
 - A public information session was held on September 22, 2026.
 - The report was posted for public comment on October 6, 2026.
 - **Summary of Feedback**
 - The Ringwood Watershed Assessment Report (Phase 2) Public Information Session focused on reviewing watershed conditions in Ringwood, discussing ongoing Phase 2 assessment work and gathering community input on water quality concerns and potential improvement projects. The H2M team and Borough representatives explained the three-phase NJDEP watershed improvement process, summarized findings from Phase 1 and outlined plans for completing the Phase 2 report and moving into Phase 3 project development.

A major focus of the discussion was phosphorus pollution, algae blooms, stormwater runoff, localized flooding and their impacts on Ringwood's lakes and the broader watershed. Lake association representatives identified several areas of concern, including runoff entering Cupsaw Lake, Erskine Lake, Mohawk, High Mountain Brook, Park Road and other drainage locations. Participants emphasized the need for targeted projects, monitoring and community involvement to improve water quality.

Overall, the meeting highlighted strong community interest in protecting Ringwood's lakes, reducing phosphorus loading and developing practical projects that improve water quality while supporting long-term watershed health.

- **Future Scheduled Meetings**
 - No future meetings are scheduled at this time.
 - The Borough of Ringwood's dedicated stormwater webpage link, where all WIP information, including upcoming meeting dates/times, can be found here: [Stormwater Management - Borough of Ringwood, New Jersey](#)

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