

Buckeye Brook Watershed Plan

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Buckeye Brook at West Shore Road

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Buckeye Brook Watershed Plan

The Buckeye Brook watershed is a small watershed in eastern Warwick, RI, the waters of which drain to Narragansett Bay just south of Conimicut Point. This is a heavily urbanized watershed with almost all of its surface waters designated by the Rhode Island Department of Environmental Management (RIDEM) as impaired. The purpose of this plan is to:

- 1) Identify actions that need to be taken to protect and restore water quality and aquatic habitat in the watershed; and
- 2) Fulfill requirements of the federal Nonpoint Source Program and thereby qualify the watershed as eligible for financial assistance for implementation activities via Clean Water Act Section 319 funds as administered by RI.

This Plan assumes a basic understanding of water pollution and water resources management. Other resources are available to provide educational and supporting information on pollution sources and aquatic habitat issues and management.

Three water quality restoration plans (aka “TMDLs”) that are referred to in Section II Water Quality should be referred to for much more detailed information on water quality, sources of pollution, and implementation actions.

I. Watershed Description

Buckeye Brook proper originates at the south end of Warwick Pond and flows southeast into Old Mill Creek and into Narragansett Bay. North of Warwick Pond are tributaries to Spring Green Pond which has a tributary that flows into Warwick Pond. The named tributaries of Buckeye Brook are Lockwood Brook, Warner Brook and Parsonage (Knowles) Brook. Old Mill Creek begins at the confluence of Lockwood Brook and Buckeye. Tidal influence extends up Buckeye Brook to approximately West Shore Rd. (See Figure 1.)

Watershed Info:

- The Buckeye Brook watershed covers 4,169 acres (6.5 square miles).
- Warwick Pond is an 85-acre pond with an average depth of 14 feet and a maximum depth of 26 feet. It is a popular boating and fishing area, with a public boat ramp located on the western shore opposite Wells Avenue.
- Buckeye Brook supports a population of river herring that return every spring to spawn in Warwick and Spring Green Ponds. The river herring (alewives and blueback herring) are locally known as buckeyes. Buckeye Brook is unique in RI in that it has no man-made structures to obstruct the migration of herring from the sea to their spawning grounds.

- Several ponds in the watershed, including Little Pond, are not hydraulically connected to surface water and are considered surface expressions of the groundwater table.
- Land cover in the Buckeye Brook watershed is 72% developed. See the table below and also Figure 2.
- The watershed includes most of the area owned by the Rhode Island T.F. Green International Airport. The Airport property covers 21% of the watershed.
- Public drinking water is provided to all structures in the watershed by the City of Warwick Water Division from sources outside the watershed.
- Most of the watershed is sewered.
- There are no cold-water fisheries in the watershed.
- 6.8% of the watershed is in conserved land (including agricultural easements) (see Figure 3).

Land Cover	Area (Acres)	% of Watershed
Developed- Residential	1759.4	42.2%
Developed- Non-residential	1260.6	30.2%
Agriculture	101.9	2.4%
Forest & Wetlands	680.5	16.3%
Open (cemeteries, developed recreation areas, mixed barren areas, etc.)	237.3	5.7%
Water	129.8	3.1%

Buckeye Brook at Old Warwick Avenue

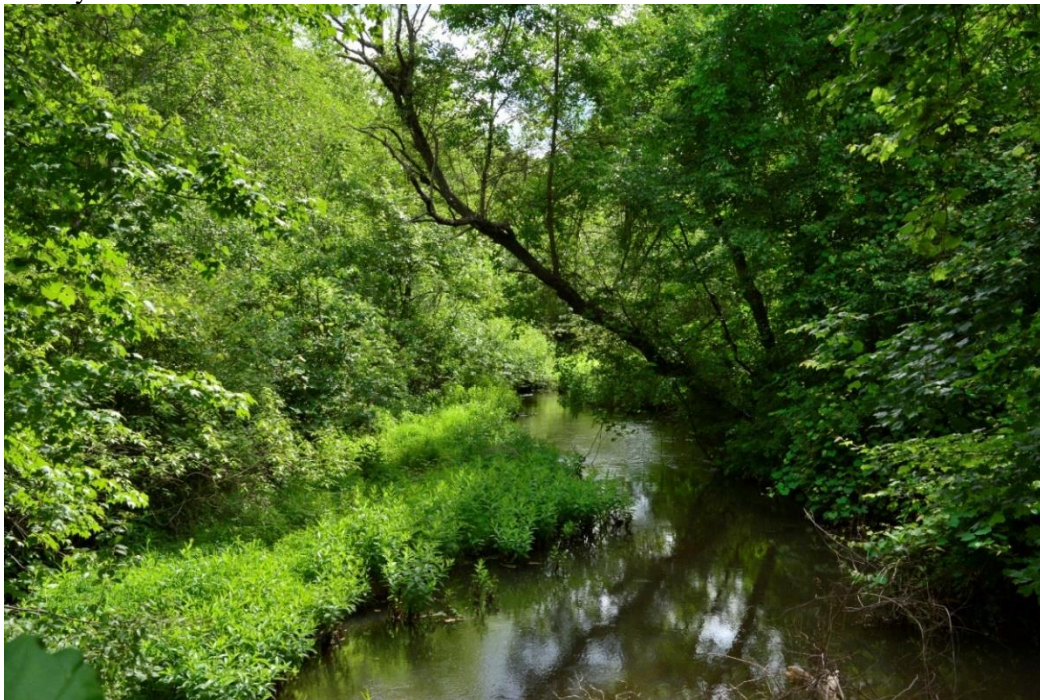


Figure 1. Surface Water Resources

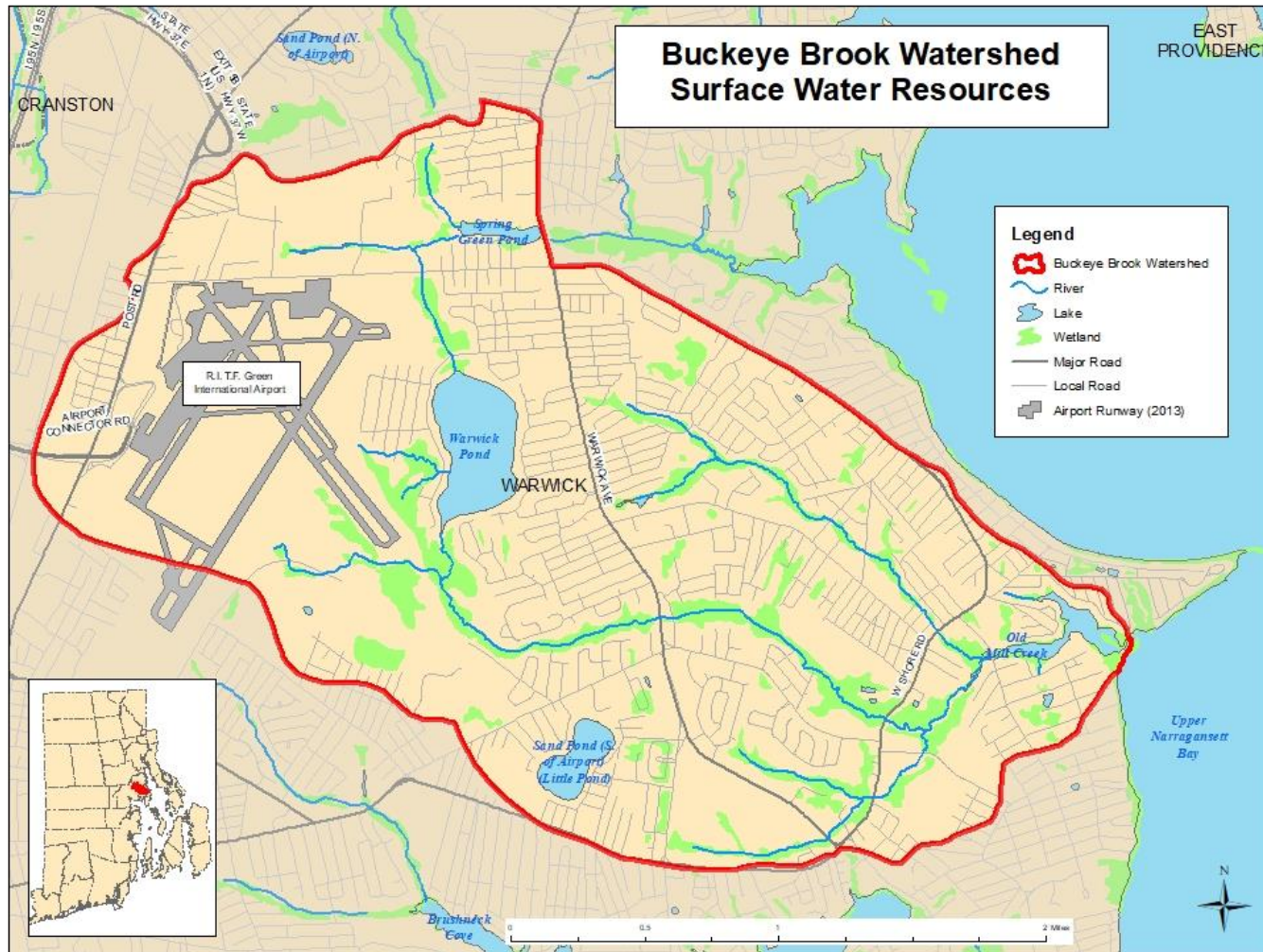


Figure 2. Land Cover

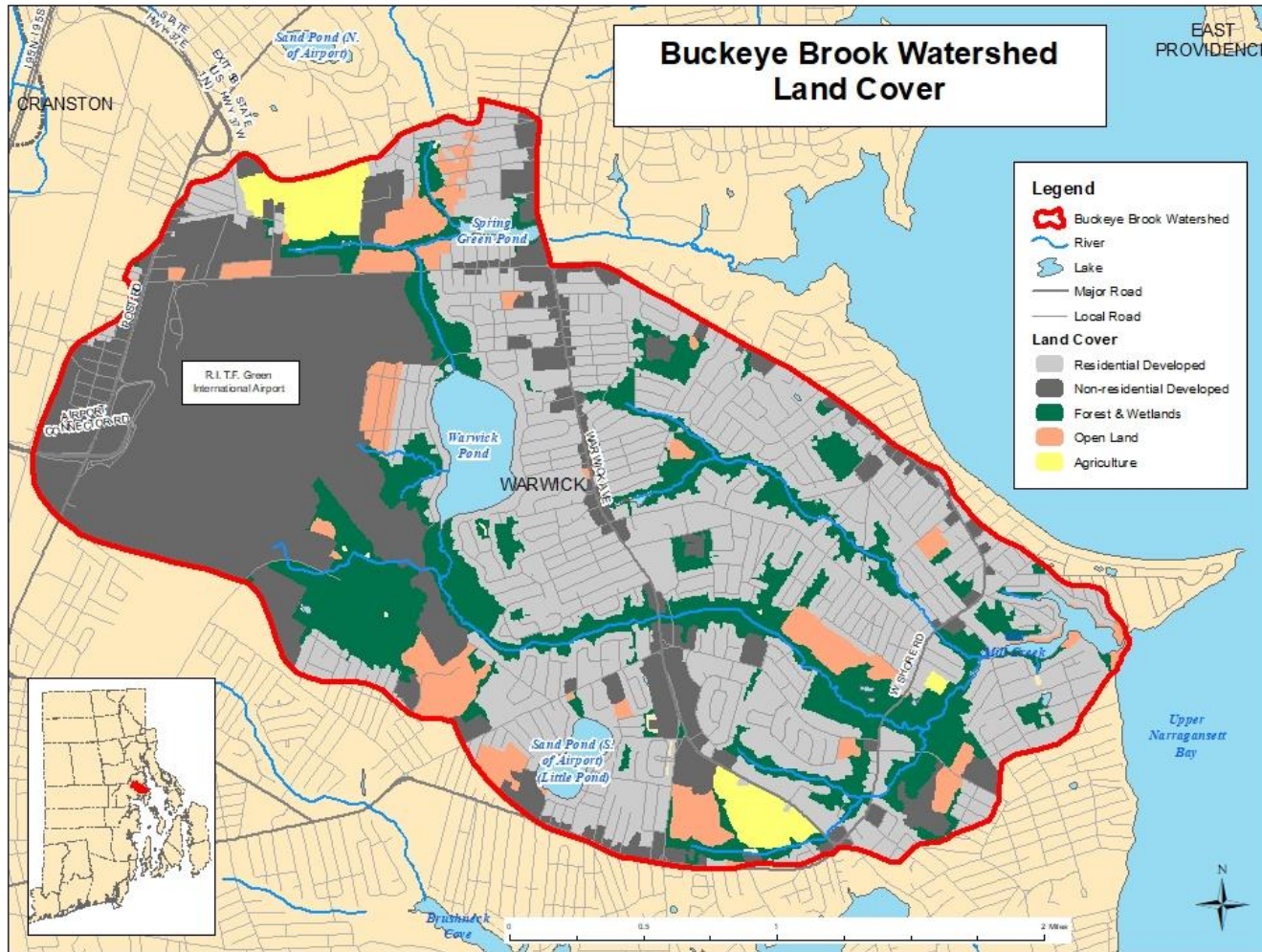
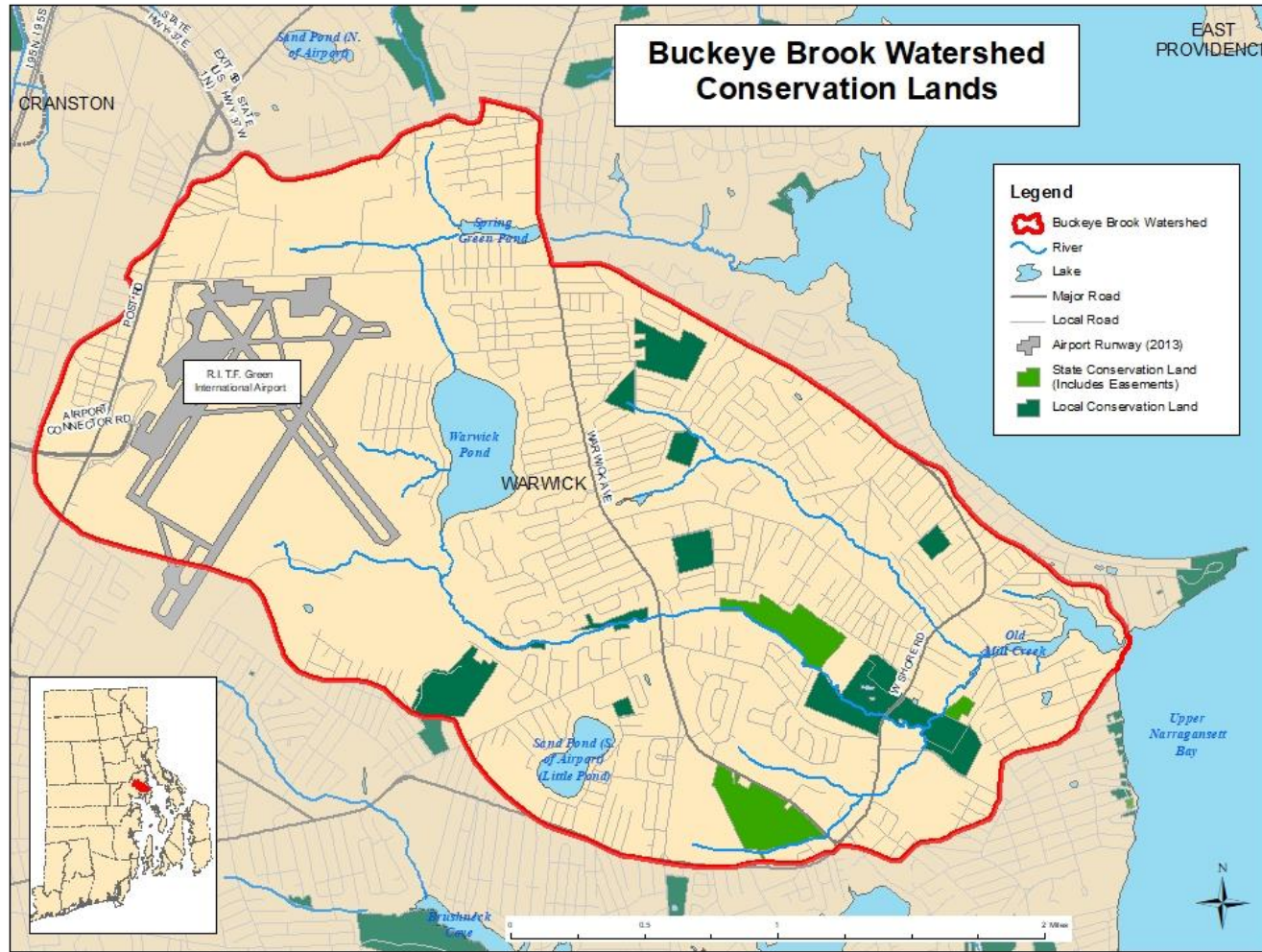


Figure 3. Conservation Lands



II. Water Quality

A. Surface Water

The RI Water Quality Rules specify the criteria each waterbody in the State shall meet based on its designated uses. When a waterbody does not support one (or more) of its designated uses (does not meet water quality criteria for that use), it is considered “impaired” for that use and the cause of the impairment is identified. Each waterbody segment, as defined by RIDEM, in the Buckeye Brook watershed is shown in Table 1 below with its use classification, assessment status including causes of impairment when applicable. Waters not assessed are the result of gaps in available data. Note that most of the surface waters in the watershed are considered impaired.

Table 1. Buckeye Brook Watershed Use Assessment Status (Source: RIDEM Draft Integrated Water Quality Monitoring and Assessment Reporting (January 2022))

Old Mill Creek RI0007024E-02 Class SA			
Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife Habitat	Not Assessed		
Fish Consumption	Insufficient Information		
Primary Contact Recreation	Not Supporting	Enterococcus	Approved TMDL
Secondary Contact Recreation	Not Supporting	Enterococcus	Approved TMDL
Shellfish Consumption	Not Supporting	Fecal Coliform	Approved TMDL
Buckeye Brook and Tributaries RI0007024R-01 Class B			
Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife Habitat	Not Supporting	Benthic Macroinvertebrate Bioassessments, Cadmium, Copper, Dissolved Oxygen, Iron, Lead	Approved TMDL
Fish Consumption	Not Assessed		
Primary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Secondary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Warwick Pond RI0007024L-02 Class B			

Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife Habitat	Not Supporting	Dissolved Oxygen, Total Phosphorus	Approved TMDL
Fish Consumption	Fully Supporting		
Primary Contact Recreation	Insufficient Information		
Secondary Contact Recreation	Insufficient Information		
Tributaries to Warwick Pond RI0007024R-05 Class B			
Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife Habitat	Not Supporting	Benthic Macroinvertebrate Bioassessments, Cadmium, Iron	Approved TMDL
Fish Consumption	Not Assessed		
Primary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Secondary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Spring Green Pond RI0007024L-03 Class B			
Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife Habitat	Insufficient Information		
Fish Consumption	Not Assessed		
Primary Contact Recreation	Not Assessed		
Secondary Contact Recreation	Not Assessed		
Unnamed Tributary to Spring Green Pond RI0007024R-10 Class B			
Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife Habitat	Not Assessed		
Fish Consumption	Not Assessed		
Primary Contact Recreation	Not Assessed		
Secondary Contact Recreation	Not Assessed		
Parsonage (Knowles) Brook RI0007024R-02 Class B			
Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife	Not Assessed		

Habitat			
Fish Consumption	Not Assessed		
Primary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Secondary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Warner Brook RI0007024R-04 Class B			
Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife Habitat	Not Assessed		
Fish Consumption	Not Assessed		
Primary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Secondary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Lockwood Brook and Tributaries RI0007024R-03 Class B			
Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife Habitat	Not Assessed		
Fish Consumption	Not Assessed		
Primary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Secondary Contact Recreation	Not Supporting	Enterococcus, Fecal Coliform	Approved TMDL
Sand Pond (South of Airport) aka Little Pond RI0007024L-01 Class B			
Use Description	Use Attainment Status	Cause of Impairment	TMDL Status
Fish and Wildlife Habitat	Fully Supporting		
Fish Consumption	Not Assessed		
Primary Contact Recreation	Fully Supporting		
Secondary Contact Recreation	Fully Supporting		

Once a waterbody is designated impaired it is then targeted for a water quality restoration plan, referred to as a TMDL (total maximum day load) report. Three TMDLs have been completed for the impaired waters targeting different parameters. The TMDLs and the load reductions required to meet water quality criteria are listed below.

- Buckeye Brook and Tributaries to Warwick Pond, November 2021
 - Buckeye Brook and Unnamed Tributaries for Benthic-Macroinvertebrate Bioassessments, Dissolved Oxygen, Total Iron, Dissolved Cadmium, Copper, and Lead
 - Tributaries to Warwick Pond for Benthic-Macroinvertebrate Bioassessments, Total Iron, and Dissolved Cadmium

Percent Load Reductions

- This TMDL is based on concentrations, not mass loadings.

Waterbody	Dissolved Cd		Dissolved Cu		Dissolved Pb		Total Fe	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Tribs to Warwick	42.9	41.2	N/A	N/A	N/A	N/A	39.4	44.5
Buckeye Brook	62.1	30.2	No Reduction	20.0	12.4	32.4	58.8	51.4

- Buckeye Brook Watershed Fecal Coliform and Enterococci Bacteria Impairments, December 2008;

Fecal Coliform Load Reductions

- The station on the waterbody with the largest violation of the standard was used to determine the percent reduction.
- The required reduction is the higher of two reductions – “geometric mean” versus the “90th percentile” necessary to meet the water quality standard

Waterbody	Fecal Coliform Value (CFU/100ml)	Target Value (CFU/100ml)	Fecal Coliform % Reduction
Tributaries to Warwick Pond	614 (90 th percentile)	400 (90 th percentile)	34.9
Buckeye Brook	509 (geometric mean)	14 (geometric mean)	97.2
Old Mill Creek	8,520 (90 th percentile)	49 (90 th percentile)	99.4
Knowles Brook	44,200 (90 th percentile)	400 (90 th percentile)	99.1
Lockwood Brook	5,340 (90 th percentile)	49 (90 th percentile)	99.1
Warner	4,904 (90 th percentile)	49 (90 th percentile)	99.0

Enterococci Load Reductions

- The station on the waterbody with the largest violation of the standard was used to determine the percent reduction.

Waterbody	Enterococci Geometric Mean (MPN/100ml)	Target Value (MPN/100ml)	Enterococci % Reduction
Tributaries to Warwick Pond	199	54	72.9
Buckeye Brook	129	35	72.9
Old Mill Creek	293	35	88.1
Knowles Brook	286	54	88.1
Lockwood Brook	292	35	88.0
Warner	138	35	74.6

- Warwick Pond as part of TMDL for Phosphorus to Address 9 Eutrophic Ponds in RI, September 2007
 33% Required Load Reductions – this equates to 62 kg/yr

Harmful algal blooms caused by cyanobacteria are a management concern in the watershed. Also known as blue-green algae, cyanobacteria occur naturally in many freshwater ecosystems. A combination of excess nutrients, sunlight, and high temperatures can lead to a rapid increase in cyanobacteria, called a “bloom.” Blooms of cyanobacteria generally occur in late summer into the early fall when water temperatures are warmest and an abundance of sunlight and nutrients are available. Some species of cyanobacteria can also produce toxins. These toxins are harmful to people and pets. Harmful algal blooms caused by cyanobacteria have been periodically reported in Warwick Pond (2015, 2016, 2017 and 2021) and Little Pond (2018 and 2019) resulting in RIDEM and the Rhode Island Department of Health (DOH) issuing health advisories to notify the public.

Buckeye Brook empties into Old Mill Creek which in turn flows into Upper Narragansett Bay. Old Mill Creek, which is estuarine, is included in the area covered in this watershed plan. As noted in Table 1., shellfishing is prohibited in Old Mill Creek due to bacteria pollution. Due to this pollution in the Buckeye Brook Watershed, shellfishing is also prohibited in the Bay just outside Old Mill Creek in an area defined as the Old Mill Cove Closure Extension.

B. Groundwater

As shown on Figure 4, the groundwater in the watershed is partly classified GB and partly GA. The western side of the watershed, including the Airport, is classified GB whereas the eastern sector is classified GA. Groundwater classified GA is to be protected in order to be suitable for drinking water without treatment, even in those areas where it is not consumed. Groundwater classified GB is known or presumed to be not suitable for drinking water use without treatment.

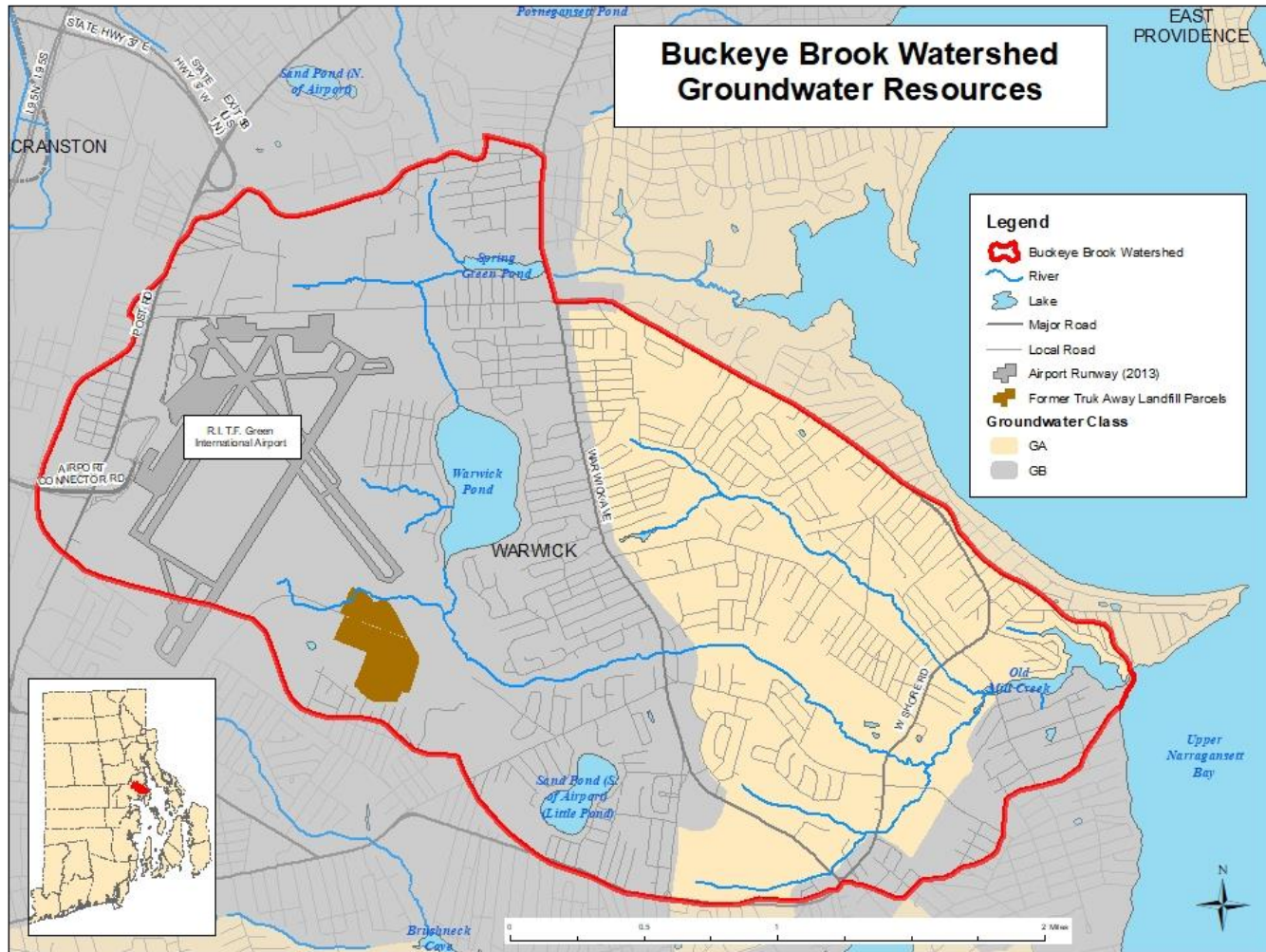
Because groundwater contamination is usually localized in nature, no ambient groundwater monitoring network has been established in RI. Groundwater is monitored at either known or

suspected sources of contamination or at public wells. Because there are no known public or private wells in the watershed, one of the primary reasons to be concerned about groundwater quality is the transport of pollutants from groundwater to surface waters as part of the stream baseflow.

Little Pond



Figure 4. Groundwater Resources



III. Pollution Sources

A. Stormwater

Stormwater is the major source of water quality degradation in the watershed. The pollutants typically washed off the ground and carried by stormwater come from all around us:

- Bacteria and other pathogens that may limit recreational use of waters from:
 - Pet waste left on the ground
 - Surface backup from failing septic systems and cesspools
 - Farm animals and wildlife (in particular, resident Canada geese)
- Nutrients (nitrogen and phosphorus) that can result in algal blooms (including toxic cyanobacteria) from:
 - Farm and lawn fertilization
 - Waste from pets, farm animals and wildlife
 - Surface backup from failing septic systems and cesspools
- Salt and sand from winter road safety maintenance;
- Soil and sediment from construction sites, plowed farmland, and eroding areas can result in changes in aquatic habitat conditions, and other pollutants (such as metals) can be attached to and transported with the sediments;
- Petroleum products and metals from automobiles;
- Combustion of fossil fuels also contributes nitrogen, phosphorus, mercury, and other contaminants that are deposited from the atmosphere directly into waterbodies or on the ground where they are transported in stormwater.

The degree to which stormwater impacts water quality in any particular watershed is a function of the amount of impervious cover and how that stormwater generated from the impervious cover is managed. Buckeye Brook watershed is 41% impervious, which is generally considered a high degree of landscape alteration. (See Figure 5). Typically, watersheds begin showing signs of degraded water quality and habitat with impervious cover as low as 10%.

The negative impacts of this impervious cover result from both the pollutant loadings transported by stormwater runoff and the physical changes that occur with increased volumes and velocities of runoff, e.g., eroded stream channels and reduced biodiversity of existing streams. Because water runs more rapidly off an impervious area, flooding also becomes both more common and more intense downstream. Meanwhile, because less water is soaking into the ground, water tables may be altered which may result in impacts to wetlands and streams. In brief, impervious surfaces may significantly change both the *quality* and *quantity* of runoff.

Proper design, siting and installation of stormwater best management practices (BMPs) as property is developed or redeveloped are not enough to achieve water quality goals. Two additional challenges associated with stormwater management include:

- Proper maintenance of BMPs: Ensuring maintenance of the existing stormwater infrastructure is a critical and often-overlooked task; and

- Improving treatment of stormwater from existing developed lands. New development is required to meet certain stormwater management controls, but these typically do not apply to existing development. The responsibility for upgrading stormwater infrastructure in the watershed rests largely with the City and the RIDOT.

Stormwater discharges are regulated under RIDEM Pollutant Discharge Elimination System Program (RIPDES) General Permit for Stormwater Discharge from Small Municipal Separate Storm Sewer Systems (MS4s). The City of Warwick and the Rhode Island Department of Transportation are MS4 operators in the Buckeye Brook watershed, and as such are responsible for preparing and implementing required Stormwater Management Program Plans (SWMPP). The Stormwater Management Program Plan describes the Best Management Practices (BMPs) for each of the following required six minimum measures, including goals and implementation schedules. The six minimum measures are:

1. Public Education and Outreach
2. Public Involvement/Participation
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post Construction Runoff Control
6. Pollution Prevention/Good Housekeeping

Consent decrees have been entered into by US EPA and RIDEM with both the Rhode Island Department of Transportation (RIDOT) and the City of Warwick to compel compliance with the RIPDES MS4 Program. As part of this, RIDOT and the City are required to target a goal of treating sufficient impervious cover to eventually achieve a functional equivalent of 10% or less impervious cover and reduce stormwater impacts to impaired waters. The concept behind the approach is that it is desirable for a watershed to be similar, in terms of water quality effects, to a watershed with 10% or less impervious cover overall. Accordingly, RIDOT and the City must prepare and implement plans to work towards achieving this 10% goal in the Buckeye Brook watershed.

The stormwater impacts from T.F. Green International Airport are discussed in more detail in section III.2.

Low Impact Development

Low impact development (LID) is a comprehensive approach to project design that minimizes the impacts of development or re-development on water quality and aquatic habitats by improving stormwater management. The goal of LID is to design a site so that water moves over and through the site similarly to how it would move under natural, pre-developed conditions. Stormwater treatment practices are placed throughout the site to decrease, infiltrate, manage and treat runoff as close to the point where it is generated as possible.

To assist in incorporating LID into community planning processes, RIDEM, University of RI (URI), and RIDOT have developed “LID Site Planning and Design Techniques: A Municipal Self-Assessment.” (See RIDEM webpage at

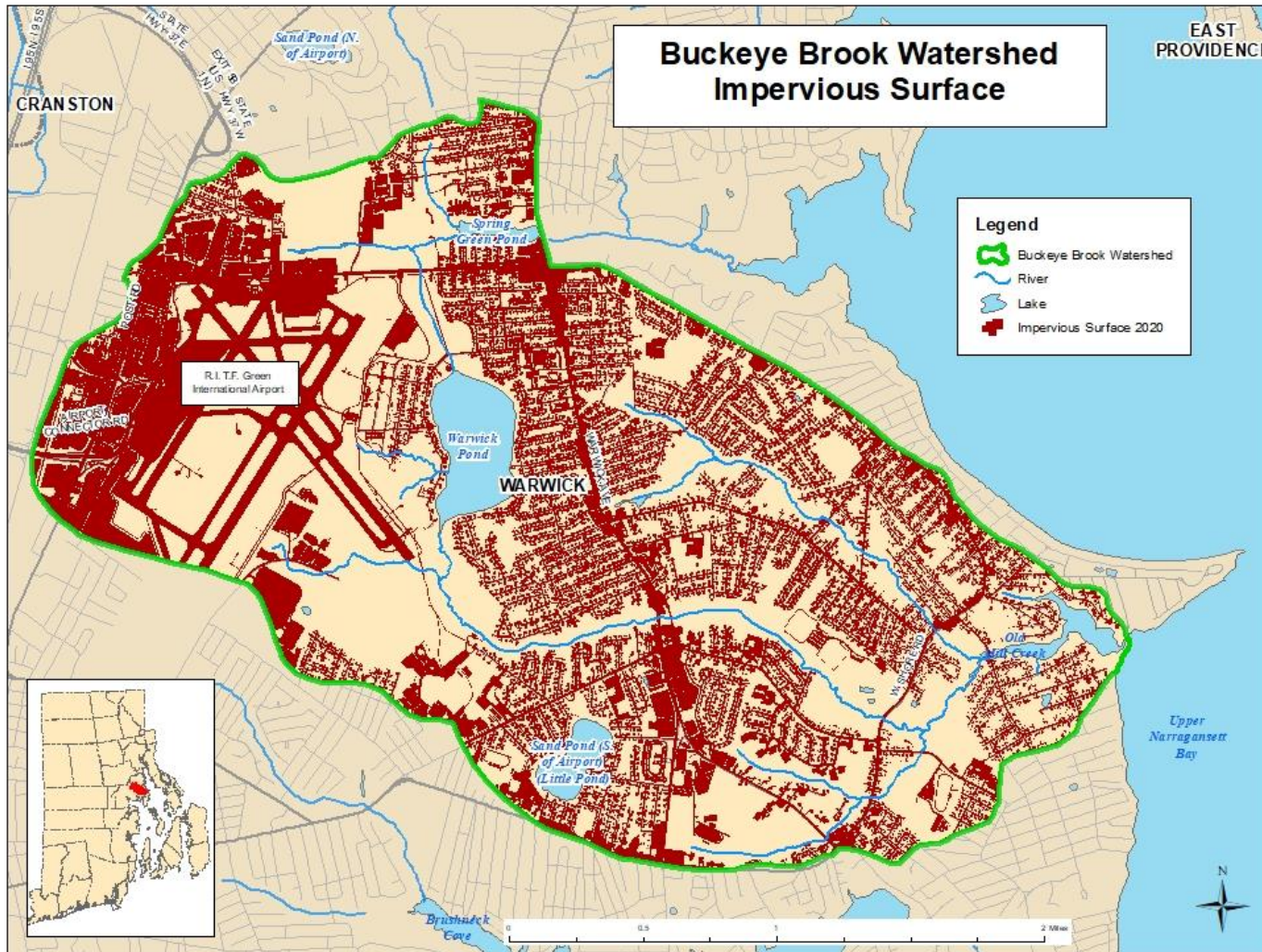
<http://www.dem.ri.gov/programs/benviron/water/permits/ripdes/stwater/t4guide/lid-checklist-primer.pdf>) The self-assessment contains questions covering a variety of topics related to low impact development (LID). These topics range from conserving open space and minimizing land disturbance to reducing impervious surfaces and controlling soil erosion. Working through the assessment tool allows an in-depth review of the local regulations that shape development in the community and a comparison to LID benchmark techniques and practices. The intent is to identify which LID techniques are in place and which techniques could be improved or employed.

Stormwater Utility

One way for a community to address local funding shortfalls for stormwater management is to explore the feasibility of establishing a sustainable local funding source such as a stormwater enterprise or utility fund that will assess property owners a stormwater fee. A stormwater fee is based on the demand placed on the municipal stormwater system by each user, not on property's assessed value. It is therefore considered more equitable than other funding methods since users with a large burden on the stormwater system will pay their fair share. As with a water or sewer utility, a stormwater utility fee generates revenue based upon the amount of stormwater generated on a property and conveyed to a public stormwater system. These fees are assessed by measuring the amount of impervious cover within a parcel and are determined by the stormwater management financing needs of the municipality. They can be adjusted over time to continually meet those needs. A stormwater utility provides a means for:

- Consolidating or coordinating responsibilities that were previously dispersed among several departments and divisions;
- Generating funding that is adequate, stable, equitable and dedicated solely to managing stormwater;
- Creating incentives for property owners to reduce the stormwater generated on their properties; and
- Developing stormwater management programs that are comprehensive, cohesive and consistent year-to-year.

Figure 5. Impervious Surfaces



B. Specific Pollution Sources

RI T.F. Green International Airport

The RI Airport Corporation (RIAC) has a stormwater collection system to convey stormwater runoff from runways, terminal, parking lots, and other impervious surfaces that is permitted under an individual RI Pollutant Discharge Elimination System (RIPDES) Permit (Number RI0021598). RIDEM is currently working on reissuing this RIPDES permit in order to be consistent with the requirements in the 2021 TMDL.

Historically, stormwater contaminated with de-icing and anti-icing chemicals discharging from the property contained varying amounts of propylene glycol, the major constituent in aircraft deicing fluid. The concern was the effects on the biological oxygen demand in Buckeye Brook and tributaries to Warwick Pond caused by the breakdown of the deicing and anti-icing compounds. RIAC has recently implemented contamination prevention measures (including construction of propylene glycol treatment and diversion structures) that will prevent violations of in-stream dissolved oxygen criteria associated with propylene glycol discharges.

In response to concerns about the proliferation of bacteria in the areas downstream of the airport's stormwater outfalls, studies showed high levels of iron and that iron bacteria growth was prevalent in the stormwater systems for those outfalls, which discharge directly to the tributaries to Warwick Pond and Buckeye Brook. The outfalls were flowing during dry weather conditions and had iron levels high enough which provided a food source for the bacteria. Iron rich groundwater that is seeping into the storm water piping system needs to be addressed.

Waste Sources

As described in the 2021 TMDL, there are two waste sources within the watershed boundaries:

Truk-Away Landfill

Truk-Away landfill is located at the end of Warwick Industrial Drive and was open from 1970 until 1977. The landfill has an area of 52 acres. Approximately 32 acres was used for waste disposal with the remaining area consisting of open land and freshwater wetlands. A small tributary stream to Buckeye Brook flows in a northeasterly direction along the southern edge of the landfill property where it merges with another unnamed tributary that receives discharges from the airport. The confluence of these tributaries with Buckeye Brook is approximately 430 yards (400 meters) from the exit of Warwick Pond.

When the landfill was closed in 1977, it was not properly capped. As a result, precipitation infiltrates through the buried waste leaching out pollutants. This leachate moves through groundwater to the tributary stream contributing elevated levels of pollutants to Buckeye Brook. Surface flow over the landfill can also end up discharging into the Buckeye Brook through an adjacent wetland area. The landfill must be properly closed to prevent pollution from leachate and stormwater runoff. Since 2003, the Rhode Island Department of Administration has been the responsible agency for the Truk-Away Landfill. The landfill is also listed on the Comprehensive Environmental Response,

Compensation and Liability Information System (CERCLIS) and is listed on RIDEM's Management Landfill Closure Program. Closure of the landfill is an ongoing process. Remediation and closure plans are currently in the process of being developed.

The City of Warwick's Municipal Recycling Facility

The Recycling Facility is located adjacent to the Mickey Stevens Sports Complex off Sandy Lane. This facility processes yard waste for compost on a concrete pad that is adjacent to a large wetland area. This area was investigated, and it was determined that based upon the operating procedures followed and the layout of the site that this facility was not a source of concern relative to pollutants or nutrients discharged to Buckeye Brook.

C. Wastewater

Pollutants in wastewater from domestic, commercial and industrial use include: excess nutrients (nitrogen and phosphorus), pathogens (bacteria and viruses), pharmaceuticals, personal care products, chemical pollutants (including household hazardous materials), metals, and other contaminants of emerging concern.

Buckeye Brook is an almost completely sewer watershed with the wastewater system operated in accordance with a RIDEM RIPDES permit issued to the City of Warwick. The areas not currently sewer are:

- The area on both sides of Tidewater Creek Road south of Buckeye Brook. Sewer installation in this area is targeted for completion by the end of 2023.
- A low area on Warwick Avenue in the vicinity of Revere Street.

In these areas without sewer connections, homes are served by onsite wastewater treatment systems (OWTS) that are regulated by RIDEM.

Some means by which wastewater may not be properly treated include the following:

- Overflow of wastewater sewer facilities (pump station, manholes, etc.) due to extraneous water inputs from stormwater or groundwater.
- Cracks in wastewater sewer pipes (wastewater seeps into groundwater, and may subsequently enter surface waterbodies or stormwater drainage pipes)
- Illicit connections of wastewater to the stormwater pipe system. This may be through direct connections or through cracks.
- Failing OWTS or cesspools (cesspools do not provide any treatment)

D. Road Salt and Sand

Road salt washes into surface waters changing the salinity and impacting aquatic life. The sand is either washed into the waters impacting streambed habitat dramatically, or it becomes a major contributor to stormwater BMP failure by clogging the systems. Generally, only a small percent of the sand applied to the road is recovered as street sweepings.

The salt and sand should also be stored in a manner to reduce impacts to water quality. RIDEM regulations for salt storage require salt and salt/sand mixtures to be covered if the groundwater at the site is classified GAA or GA. The City of Warwick stores salt in the watershed at its Facility at 925 Sandy Way where groundwater is classified GB. The Facility was inspected by RIDEM in March 2022. The site does not have a structure to store salt. Two significant salt piles were not covered, and no tarp or means to secure a tarp were present onsite. Review of aerial photographs from the past several years showed that the salt at this site is not covered. The site potentially discharges to the Sandy Lane storm drain system, which discharges to either nearby Tuscatucket Brook, Little Pond (Sand Pond South of Airport) or Buckeye Brook.

E. Pet Waste and Waterfowl

Pet waste can be a significant contributor of bacteria and other pathogens and nutrients (nitrogen and phosphorus) to surface waters. The primary issue is dog waste, although other backyard pets (horses, goats, etc.) and wildlife can cause localized problems. Pet waste in urban and suburban areas that is left on the sidewalk or on grass near the street is often washed into stormwater drainage systems. Dog waste can harbor a host of different bacteria, parasites, and viruses that can cause human illness and disease.

Concentrations of geese, gulls, and ducks are of particular concern because they often deposit their waste directly into surface waters. Therefore, they can be major sources of pathogens, particularly near lakes and ponds where large resident populations have become established in the area. Waterfowl have been observed in many of the areas in the lower part of the watershed where high concentrations of pathogens were found.

F. Lawn and Grounds Management

The care and maintenance of landscaped areas can contribute to water quality degradation. Excessive amounts of fertilizer (nutrients) and pesticides, inappropriate formulations of fertilizer, and poor timing of fertilizer and pesticide applications can result in losses to the environment via stormwater runoff and/or leaching to groundwater. Lawn areas adjacent to waterbodies also attract geese and other waterfowl.

Most homeowners are not aware of the appropriate best management practices to reduce the impacts to water quality in managing their lawns. Landscape contracting businesses can also overapply fertilizers. Aside from professional pesticide application (which requires a license), no certification or educational requirements exist for lawn care management. Education of homeowners and landscape contractors on proper turf management continues to be the primary strategy to minimize water quality impacts from lawn and grounds management.

G. Agriculture

Only 2.4% of the land within the Buckeye Brook is used for agriculture. This farmed land consists primarily of Morris Farm. The state has secured development rights to most of the farm's property. The potential surface water and groundwater pollutants from agricultural operations include nutrients (nitrogen and phosphorus) from fertilizers and animal wastes; pathogens and organic materials primarily from animal wastes; sediment from field erosion; pesticides; and petroleum products.

Well-managed farms that address the following can operate with minimal negative effect on water resources:

- Provide sufficient stream/wetland buffers,
- Manage fertilizer and pesticides properly,
- Provide fencing to restrict access of livestock to streams and wetlands,
- Properly manage animal waste (handling and disposal).

Farm field off Warwick Avenue



H. Other Pollution Threats from Residential Land Use

Threats to water quality from residential land use include several of the topics that are further discussed elsewhere in this section (i.e., stormwater runoff, lawn management, and pet waste). Other potential sources of groundwater and surface water contamination from residential uses include:

- Household cleaning chemicals, automotive fluids (oil and gasoline), and paints and solvents disposed of down the drain or onto the land surface (aka, Household Hazardous Waste). Most citizens are unaware of the effects of numerous potential contaminants stored, used, and disposed of around the home;
- Heating oil storage (above and below ground tanks) and spills -- Although most heating oil tanks sized to hold less than 1,100 gallons that are located at residences are likely above ground (outside or in a basement), an unknown, but potentially significant number of heating oil tanks are buried and will eventually leak.

If taken on an individual basis, the threat from a single residence is normally less than the threat from other land uses, but when factoring in all residences, they form a significant source of potential contamination.

Old Mill Creek at Tidewater Drive



IV. Aquatic Habitat Management

A. Wetlands

Wetlands (freshwater and saltwater) are one of our most valuable natural resources. They are transition zones between land and water where the flow of water and the cycling of nutrients meet to produce a unique ecosystem -- making these areas very important features of a watershed. Wetlands are the most biologically fertile and diverse landscapes in RI. All wetlands in RI are protected by law, as are the bordering lands adjacent to certain wetlands, which serve as buffers for water quality and important habitat. (Note: in RI, under RIDEM and the Coastal Resources Management Council (CRMC) Freshwater Wetland Rules, surface waters, i.e., lakes, ponds, rivers and streams, are also considered “wetlands” for regulation purposes.) See Figure 1. for general locations of wetlands in the Buckeye Brook watershed.

Wetlands have many important functions. They:

- Help control floodwaters by storing excess water during heavy periods of rain and snowmelt,
- Provide key links in the water cycle by helping to maintain streamflow and water resources through much of the year by releasing water from both surface and groundwater storage,
- Naturally filter polluted runoff,
- Serve as important habitat for many plants, animals, and fish,
- Support recreational activities including fishing, hunting, hiking, photography, bird watching, education, and nature studies.

When wetlands are altered, these services are diminished or lost. Direct disturbance to wetlands includes activities such as cutting of vegetation, filling, illegal dumping, excavating, water diversion, or roads and crossings (section IV.D below). Indirect impacts include the loss of vegetated upland buffers (see section IV.B. below).

B. Vegetated Upland Buffers

A vegetated upland buffer bordering a pond or lake, a stream or wetland will act to:

- Filter out sediments, nutrients, pesticides and other pollutants coming off the landscape;
- Provide valuable habitat for plants and animals;
- Absorb stormwater and therefore mitigate potential streambank erosion and flooding; and
- Moderate water temperature by providing shade.

In this very heavily developed watershed, much of the greenspace evident as one looks at the aerial photos is actually along the stream corridors. It is important that these vegetated buffers

are maintained to maximize the benefits they provide. However, there are areas where a minimal to no buffer exists, and in these areas, buffer restoration should be promoted wherever possible.

C. Invasives

Aquatic invasive species (AIS), also called ‘non-native aquatic species,’ can out-compete native plants and disrupt ecosystems. Once established, AIS are difficult and expensive to control. Management of AIS is often necessary to improve habitat and public use of a waterbody. However, the best strategy is to prevent AIS from spreading to uncolonized areas. It is much easier to intervene and contain a small population than attempt to abate and control a widespread, well-established population of aquatic invasive species. Impacts from aquatic invasive species generally include:

- Reduced diversity of native plants and animals,
- Impairment of recreational uses such as swimming, boating, and fishing,
- Degradation of water quality,
- Degradation of wildlife habitat,
- Increased threats to public health and safety,
- Diminished property values,
- Declines in finfish and shellfish populations,
- Local extinction of rare and endangered species, and
- Increased expenditures for prevention, eradication or control.

Phragmites australis is an invasive reed that has been observed in many areas in the watershed. In particular, a large stand of *Phragmites* along Buckeye Brook from Warwick Avenue to Warwick Pond has been noted to be constricting flow on Buckeye Brook resulting in:

- Impediments to fish passage upstream (river herring), and
- Raised water levels in Warwick Pond causing flooding along Lake Shore Drive.

The City of Warwick has an approved DEM Freshwater Wetlands Permit to chemically treat and remove that portion of this stand of phragmites (approximately 1.52 acres) that is currently blocking the normal flow regime in the Buckeye Brook channel.

RIDEM has been assessing publicly accessible waterbodies in RI for aquatic invasives other than *Phragmites*. The aquatic invasives that have been identified in the watershed are:

- Warwick Pond
 - Last surveyed for invasive plants in June 2010, none found.
 - Asian clam found in 2014. This clam prefers sandy lake bottoms and can multiply very rapidly. The exterior of the shell ranges from yellow-green to light brown to nearly black with thick concentric rings, while the interior is white to light blue or light purple.
- Little Pond
 - Last surveyed for invasive plants in August 2018. Mudmat was observed. It is characterized by tiny leaves rising from stems that grow horizontally below the soil surface. It appears as bright green, turf-like patches developing on the muddy substrates of littoral zones. Mudmat spreads rapidly to cover prime littoral habitat.

D. Stream Connectivity

Stream connectivity is about ensuring the free movement of fish and other wildlife up and down a stream corridor. Barriers to this movement can be caused by dams and sub-standard road/driveway culverts preventing wildlife from using certain portions of the river system resulting in fragmented aquatic habitat. In some cases, undersized culverts can also cause localized flooding. As noted above, *Phragmites* has been reported to be reducing stream connectivity south of Warwick Pond.

There are no dams in the watershed, which makes the watershed unique in comparison to other RI watersheds. A review of aerial photographs identified 16 stream crossings in the watershed. The condition of these crossings relative to connectivity for aquatic life has not been determined. The RI Department of Transportation has developed a “Road-Stream Crossing Assessment Handbook” to systematically assess road crossing conditions for flooding impact and aquatic organism passage (https://www.dot.ri.gov/documents/about/protecting/stormwater/RIDOT_Road-Stream_Crossing_Assessment_Handbook.pdf). Further work is needed to identify and prioritize the upgrades to stream crossings that may be needed.

The stream crossings identified in the watershed are as follows:

Buckeye Brook

- Warwick Avenue
- Old Warwick Avenue
- West Shore Road
- Tidewater Drive

Tributaries north of Warwick of Pond

- Commerce Drive
- Airport Road
- Lovelady Street – private drive extending north
- Lydick Avenue

Lockwood Brook and Tributaries

- Vernon Street
- Overbrook Avenue
- West Shore Road

Warner Brook

- West Shore Road
- Draper Avenue

Knowles Brook

- Warwick Avenue
- Edyth Street

V. Implementation – Protection and Restoration Actions

A. Public Action

Watershed protection and restoration can only be successful when those that live and work in the watershed realize that they are a crucial part of their watershed. Individual actions may not seem to have much of an effect by themselves, but the overall cumulative impact (positive or negative) on water quality in the watershed by individuals can be dramatic. Actions that can be taken include:

- Take steps identified in the DEM brochure “Simple Ways YOU Can Help Keep Rhode Island’s Waters Clean” in Appendix 1.
- Participate in local activities that benefit the environment.
- Attend public meetings on water related issues.
- Advocate for strong municipal government actions for water resources and open space protection.
- Volunteer and support the efforts of local/regional/statewide non-profit groups that can help make a difference in the Buckeye Brook watershed:

The Buckeye Brook watershed is fortunate to have two active local environmental groups that advocate for its protection and restoration:

- Buckeye Brook Coalition -- The Coalition has been designated by the RI Rivers Council as the state-designated Watershed Council for the watershed. As stated on the Coalition’s website: “The major goal of the Buckeye Brook Coalition is to protect and preserve this natural treasure and the future of blue back herring and alewives who annually spawn in these waters. It supports activities that work to clean-up debris in the brook and surrounding areas and promote good water quality. It advocates for protection of the brook and it’s wetlands from destruction and focuses attention on situations and policies that endanger it’s well being.”
- Friends of Warwick Ponds – Mission Statement from their website: “We will partner with our community to restore and preserve the health of Warwick’s water resources and wildlife to ensure their safe enjoyment by future generations.”

B. Implementation Table

This Implementation Table identifies actions for water quality and aquatic habitat protection and restoration in the Buckeye Brook watershed. The action items are derived from the development of the Plan and from review of the TMDLs cited earlier.

The Implementation Table is divided by management topic, and it includes the information below. Unless otherwise specified, all actions are the responsibility of the City.

- Action Item
- Timeframe: ongoing, 1-2 years, 3-5 years, 5-10 years.
- Cost Estimate: Relative indication of estimated cost as follows:
 - \$ = <\$25,000;
 - \$\$ = \$25,000 -- \$100,000;
 - \$\$\$ = >\$100,000
- Priority:
 - H – High
 - M – Medium
 - L – Low

NGO = non-governmental organizations

New stormwater BMP off of Warwick Avenue



Implementation Table

Action Items	Timeframe	Cost Estimate	Priority
<ul style="list-style-type: none"> - Listed by Management Topic - Unless otherwise specified, actions are the responsibility of the City - Refer to the TMDLs for more detailed information on implementation actions 			
Stormwater Management			
Implement the RIPDES Phase II MS4 Stormwater Water Management Program Plan; comply with Consent Decrees (City and RIDOT)	Ongoing	\$\$\$	H
Using the TMDLs, identify and prioritize locations for stormwater BMP retrofits throughout the watershed. (City and RIDOT)	Ongoing	\$\$\$	H
Increase frequency of stormwater BMP maintenance.	Ongoing	\$\$	H
Reduce stormwater runoff by encouraging construction of rain gardens and dry wells which facilitate groundwater infiltration on private and public properties.	1-2 years (then ongoing)	\$	M
Conduct an analysis of sustainable funding options to meet stormwater management needs, including the feasibility of establishing a stormwater utility district.	3-5 years	\$	M
Complete the LID Self-Assessment. Review existing planning and development ordinances to evaluate what LID techniques are included, decide what LID techniques would be appropriate for the community to incorporate, and adopt the use of the selected LID techniques into local development regulations for use in proposed development and redevelopment projects.	1-2 years	\$	M
Consider adopting local stormwater requirements, including soil erosion control, for development projects smaller than one acre (smaller than the state minimum requirement) for new and redevelopment applications.	3-5 years	\$	L

Action Items - Listed by Management Topic - Unless otherwise specified, actions are the responsibility of the City - Refer to the TMDLs for more detailed information on implementation actions	Timeframe	Cost Estimate	Priority
Specific Sources of Pollution			
RI T.F. Green Airport a. RIDEM reissue the Individual RIPDES stormwater permit (RIDEM) b. RI Airport Corporation come into compliance with the permit (RIAC)	1-3 years As soon as practical after permit issued	\$\$ \$\$\$	H H
Truk-Away Landfill – Continue investigation and then properly close the landfill (State)	Ongoing	\$\$\$	H
Wastewater Management			
Continue to operate and maintain the wastewater management infrastructure in the watershed.	Ongoing	\$\$\$	H
Complete sewer installation in the Tidewater Creek Area.	1-2 years	\$\$\$	H
Ensure property owners connect to the sewer system.	Ongoing	\$	M
Road Salt and Sand			
Conduct street sweeping at a frequency that minimizes water quality impacts. Consider increased sweeping on mild winter days. (City and RIDOT)	Ongoing	\$\$	M
Take action to cover salt at the Warwick Facility using tarps with secure tie-downs. Consider a more permanent solution by means of a salt storage structure.	1-2 years	\$	M
Identify strategies and technology innovations minimize the use of road salt and sand throughout the watershed. Implement such actions. (City and RIDOT)	5-10 years	\$-\$\$\$	L

Action Items - Listed by Management Topic - Unless otherwise specified, actions are the responsibility of the City - Refer to the TMDLs for more detailed information on implementation actions	Timeframe	Cost Estimate	Priority
Pet Waste and Waterfowl			
Inform the public about the impact of pet waste on water quality. Consider providing pet waste educational materials with dog licensing renewals. (NGO and City)	Ongoing	\$	M
Install pet waste signage at high intensity use locations in the watershed.	1-2 years	\$	L
Install signage instructing the public not to feed the waterfowl at public areas where feeding may occur.	1-2 years	\$	L
Install fencing or plantings along Pond edges where lawns extend down to the pond to reduce waterfowl feeding areas. (Residents)	3-5 years	\$	L
Lawn and Grounds Management			
Inform residents on proper amounts and application of fertilizers and pesticides to lawns and gardens to minimize water quality impacts. (NGO and City)	1-2 (then ongoing)	\$	M
City recreation areas and other turf managed to minimize water quality impacts.	1-2 (then ongoing)	\$	L
Agriculture			

Action Items - Listed by Management Topic - Unless otherwise specified, actions are the responsibility of the City - Refer to the TMDLs for more detailed information on implementation actions	Timeframe	Cost Estimate	Priority
Morris Farm works with the RIDEM Division of Agriculture and the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) to develop a conservation plan for their farming activities within the watershed. (Farmer with NRCS support)	3-5 years	\$	L
Farmer install BMPs determined necessary to prevent adverse impacts to water quality. Emphasis on manure management to minimize pathogen release to Knowles Brook. (Farmer)	3-5 years	\$\$-\$	L
Heating Oil Storage Tanks			
Inform homeowners of the threat to water quality from existing above-ground and underground home heating oil tanks and the steps to take to minimize risk. (NGO and City)	3-5 years	\$	L
Wetlands and Vegetated Upland Buffer Protection			
Maintain and restore wetlands and associated wetland/stream/pond upland buffers in the watershed. (City and NGO)	Ongoing as opportunities arise	\$	H
Invasive Species			
Remove and manage <i>Phragmites</i> where practical including implementation of the Buckeye Brook Restoration Project. (City, State, NGO)	1-2 (then ongoing)	\$ - \$\$\$	H
Install education signs at points of public access to the watershed ponds. (NGO and City)	1-2 years	\$	M
Consider developing a regular monitoring program for aquatic invasive species in the watershed. (City and NGO)	1-2 years	\$	L

Action Items - Listed by Management Topic - Unless otherwise specified, actions are the responsibility of the City - Refer to the TMDLs for more detailed information on implementation actions	Timeframe	Cost Estimate	Priority
Provide education and outreach material on how to prevent spread of aquatic invasives. (NGO and City)	3-5 years	\$	L
Stream Connectivity			
Address flow constrictions caused by <i>Phragmites</i> south of Warwick Pond. (City, State, NGO)	1-2 years	\$\$\$	H
Conduct an assessment of stream connectivity at road crossings in the watershed. (City and NGO)	3-5 years	\$\$	L
Open Space/Conservation			
Identify and prioritize open space parcels in the watershed as part of the City's overall open space management plan.	1-2 years	\$	M
Preserve open space in the watershed. (City and NGO)	Ongoing (as opportunities and funding arise)	\$\$\$	M
Water Quality Monitoring			
Continue Watershed Watch monitoring. (Private citizens, NGO)	Ongoing	\$	H
Add additional stations to Watershed Watch, e.g., Spring Green Lake. (Private Citizens, NGO)	3-5	\$	M
RIDEM continues to monitor water quality in accordance with statewide monitoring strategy. (RIDEM)	Every 4-5 years	\$	H

Action Items <ul style="list-style-type: none"> - Listed by Management Topic - Unless otherwise specified, actions are the responsibility of the City - Refer to the TMDLs for more detailed information on implementation actions 	Timeframe	Cost Estimate	Priority
Public Information and Outreach			
Inform residents about the watershed and promote actions that can be taken by homeowners and others to protect water resources and aquatic habitats. (City and NGO)	Ongoing	\$	M

Warwick Pond



VI. Financial Support/Implementation Tools

Funding assistance for water quality and aquatic habitat protection and restoration actions is available from various government and private sources. This section provides a brief program overview and contact agency for financial and technical assistance that may be used to implement some of the actions in this plan.

A. Federal Clean Water Act, Section 319 Nonpoint Source Implementation Grants

Section 319 Grants are available for projects to protect and restore water quality through reducing and managing nonpoint source pollution and for projects restoring aquatic habitat. Projects must be consistent with the goals and actions in the USEPA-approved RI Nonpoint Source Management Program Plan. These grants are made possible by federal funds provided to RIDEM by the USEPA under Section 319 of the Clean Water Act.

Eligible applicants: Projects must be in watershed with an approved watershed plan; municipal, state, or regional governments, quasi-state agencies, public schools and universities, and non-profit watershed, environmental, or conservation organizations.

Contact: RIDEM's Office of Water Resources

B. R.I. Infrastructure Bank, Clean Water State Revolving Fund Loans

The Clean Water State Revolving Fund is a federal/state partnership designed to finance the cost of infrastructure needed to achieve compliance with the Clean Water Act. The program is available to fund a wide variety of water quality projects including 1) Traditional municipal wastewater treatment projects; 2) contaminated runoff from urban and agricultural areas; 3) wetlands restoration; 4) groundwater protection; 5) brownfields remediation, and 6) estuary management. Through this program, Rhode Island maintains revolving loan funds to provide low-cost financing for a wide range of water quality infrastructure projects. Funds to establish or capitalize these programs are provided through federal government grants and state matching funds. The interest rate charged to the Clean Water State Revolving Fund is one-third off the borrower's market rate.

In addition to the overall program described above, the Infrastructure Bank has a Sewer Tie-In Loan Fund for homeowners to access funds to connect to the local sewer system. Individual loans are funded from a Clean Water State Revolving Fund loan to a sewer system owner and are administered locally by Rhode Island Housing. Loans to homeowners up to \$10,000 are offered at a 2% interest rate for up to a five-year term.

Eligible applicants: Statewide, including municipal, state, or regional governments, and quasi-state agencies. Funds are awarded to projects based on ranking of environmental benefits of the project, readiness to proceed, and availability of funds.

Contact: RIDEM Office of Water Resources; Rhode Island Infrastructure Bank

C. Narragansett Bay and Watershed Restoration Bond Fund

State funds approved by RI voters are periodically available from this bond fund to restore and protect the water quality, and enhance the economic viability, environmental sustainability and resiliency of Narragansett Bay and its watersheds. The fund is meant to provide funding assistance for the feasibility analysis, design, and construction of means to control nonpoint sources of pollution, stormwater pollution control projects, riparian buffer and aquatic habitat restoration projects.

Eligible applicants: Statewide; municipal, state, or regional governments; quasi-state agencies, public schools and universities, and non-profit watershed, environmental, or conservation organizations; and non-governmental for-profit businesses, private schools.

Contact: RIDEM Office of Water Resources

D. U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Grants

Environmental Quality Incentives Program (EQIP)

This is a voluntary conservation grant program designed to promote and stimulate innovative approaches to environmental enhancement and protection, while improving agricultural production. Through EQIP, farmers and forestland managers may receive financial and technical help to install or implement structural and management conservation practices on eligible agricultural and forest land. Examples of eligible EQIP activities include practices for farm waste storage, nutrient management, riparian buffers and stream bank improvements, wetland restrictions, and groundwater and surface water conservation activities. EQIP payment rates may cover up to 75 percent of the costs of installing certain conservation practices.

Eligible applicants: Any person engaged in livestock, agricultural production, aquaculture, shellfishing, or forestry on eligible land.

Contact: USDA NRCS – RI State Office/Service Center

Wildlife Habitat Incentives Program (WHIP)

This program is a voluntary program for landowners who want to develop and improve fish and wildlife habitat on private agricultural land, non-industrial private forest land, and tribal land. Through WHIP, farmers and forestland managers may receive financial and technical help to develop upland, wetland, aquatic, and other types of wildlife habitat on their property. The current focus of WHIP in RI is on coastal habitats, freshwater wetlands, vernal pools, riparian habitats, upland habitats of State significance (early successional habitats), and the restoration of native habitats impacted by invasive species.

Eligible applicants: Any person owning private agricultural land, non-industrial private forest land, or tribal land.

Contact: USDA NRCS – RI State Office/Service Center

Easement Programs

NRCS offers various easement programs to landowners who want to maintain or enhance their land in a way beneficial to agriculture and/or the environment. NRCS provides technical help and financial assistance to protect private lands through a variety of programs. These programs include the Farm and Ranch Land Protection Program, the Grasslands Reserve Program, the Healthy Forests Reserve Program, and the Wetlands Reserve Program.

Eligible applicants: Private landowners.

Contact: USDA NRCS – RI State Office/Service Center

E. EPA Southeast New England Program (SNEP)

The US EPA Southeast New England Program for Coastal Watershed Restoration brings together partnerships to protect and restore coastal watersheds of southeast New England from Westerly to Cape Cod. The Program seeks projects and partnerships that leverage multiple resources to generate collaboration to implement innovations and efficiencies in ecosystem management.

Eligible applicants: Municipalities, non-profit organizations, and research/educational institutions.

Contact: US EPA, Southeast New England Program

F. State Open Space Grants

RIDEM administers a grant program to facilitate land conservation relying on State bond funding and Federal program funds. Local Open Space Grants provide up to 50% matching funds to preserve valuable open space through ownership or easements.

Eligible Applicants: Municipalities, land trusts, watershed councils, and non-profit organizations.

Contact: RIDEM Office of Planning and Development

G. Narragansett Bay Estuary Program

The Narragansett Bay Estuary Program is a stakeholder-led organization pursuing place-based conservation across the three-state Narragansett Bay region. Program work spans boundaries to provide independent convening, scientific data analysis, and watershed project funding. The Program supports often under-funded pre-project steps, including studies, assessments, and engineering design.

Eligible Applicants: Typically municipalities, land trusts, watershed councils, and non-profit organizations.

Contact: Narragansett Bay Estuary Program

H. Community Development Block Grants

Title 1 of the Housing and Community Development Act of 1974 authorized the Community Development Block Grant program. The program is sponsored by the US Department of Housing and Urban Development, and the Rhode Island program is administered through the State of Rhode Island Office of Housing and Community Development. These grants include water and sewer system improvements.

Eligible applicants: Municipalities

Contact: R.I. Department of Administration, Division of Planning, Office of Housing and Community Development

I. Technical Assistance Organizations

University of Rhode Island (URI) Cooperative Extension

As a function of URI's Land Grant mission, URI's Cooperative Extension Water Quality Programs include the following four areas of activity:

- New England Onsite Wastewater Training Program
- RI Nonpoint Education for Municipal Officials (NEMO)- provides information, education, and assistance to local land-use officials regarding how they can accommodate growth while protecting their water resources
- URI Home*A*Syst – provides information and training on pollution prevention for homeowners
- Watershed Watch Program– coordination of volunteer water quality monitoring

Southern Rhode Island Conservation District (SRICD)

The mission of the Southern RI Conservation District is to promote and achieve a healthy environment and sustainable use of natural resources for the people of Kent and Washington Counties and the State of Rhode Island, now and for the future, by coordinating partners to provide technical, educational and financial resources.

VII. Evaluation- Monitoring and Measuring Progress

A. Monitoring

RIDEM Ambient River Monitoring (ARM) Program

RIDEM's strategy for monitoring wadeable rivers and streams includes a sampling design to visit freshwater streams around the state over a 4-5 year rotating basin cycle. RIDEM's Ambient River Monitoring (ARM) Program conducts monitoring during late spring to early fall. Water quality samples are collected for chemical and pathogen lab analysis. Additional physical data is measured during field visits. All samples are taken in accordance with a USEPA-approved Quality Assurance Project Plan. The data RIDEM collects is used to characterize general river and stream conditions, identify pollution problems and their causes, support development of water quality restoration plans (TMDLs), and contribute to environmental management and decision-making.

Buckeye Brook was last sampled under the ARM program in 2021 and the next expected rotation to Buckeye Brook would be 2025.

URI Watershed Watch Volunteer Water Quality Monitoring Program

The URI Watershed Watch volunteer water quality testing program (URI WW) works with local communities to assess water quality, identify sources of pollution in water, and provide information about water leading to more effective management of critical water resources. Led by trained scientists, URI Watershed Watch helps local governments, watershed, tribal and other organizations recruit and train volunteers to become citizen scientists who gather detailed, quality-assured monitoring data.

As of April 2022, two sites are monitored in the Buckeye Brook Watershed by the URI WW Program:

- Buckeye Brook at Novelty Road
- Warwick Pond

This comprehensive watershed-based program focuses on long-term environmental monitoring of RI's fresh- and saltwater resources including lakes, ponds, streams, and coastal waters. The program provides training, equipment, supplies, and analytical services tailored to organizational needs, while meeting strict quality assurance and quality control guidelines in the field and in a state-certified water testing laboratory. The monitoring season runs from May through October. Parameters tested for are as follows:

Biweekly

- Temperature
- Dissolved Oxygen
- Chlorophyll (algal biomass)

Monthly

- pH
- Salinity
- Total Phosphorus
- Total Dissolved Phosphorus
- Total Nitrogen
- Nitrate and Nitrite
- Ammonium Nitrogen
- Bacteria- Fecal Coliform
- Bacteria- Enterococci

Harmful Algal Blooms/ Cyanobacteria Monitoring

The RI Department of Health and RIDEM work cooperatively to detect and respond to the presence of cyanobacteria blooms, evaluate the potential risks to the public, and when necessary, issue health advisories notifying the public of health concerns. RIDEM Office of Water Resources receives reports about nuisance algal conditions and cyanobacteria blooms from municipal staff, lake and watershed associations, and the broader public. RIDEM screens lakes with reported blooms and lakes that have historically had high nutrient and/or chlorophyll-a levels (factors that lead to cyanobacteria blooms) and responds to citizen complaints, as funding and manpower allow.

When health advisories are issued, individuals are instructed to avoid all contact with the affected waterbody, including recreational activities such as swimming, boating, or fishing. People are also advised to not eat fish from the affected waterbody or to allow pets to wade or swim in, or drink untreated water from the affected waters. Health advisories remain in effect for the remainder of what is considered to be the recreation season (until November 1st), unless follow-up sampling by a city, town, or third party indicates that the advisory can be lifted. Health advisories may be lifted after two successive and representative sampling rounds, two weeks apart, demonstrate no evidence of a cyanobacterial scum or mat and demonstrate cyanobacteria cell counts and toxin levels below threshold concentrations.

As noted in Section II., Harmful algal blooms caused by cyanobacteria have been periodically reported in Warwick Pond (2015, 2016, 2017 and 2021) and Little Pond (2018 and 2019) resulting in RIDEM and DOH issuing health advisories to notify the public.

B. Measuring Progress

There are several indicators of progress that can be used to measure and document improvements in water quality and aquatic habitat protection and restoration in the watershed. The most direct and straightforward indicators are water quality measurements. Water quality monitoring data can be compared with the water quality criteria for the waterbody classification. Monitoring can extend to biological indicators, such as aquatic macroinvertebrates. Biological monitoring can look at species population levels, species composition, and/or contaminant levels in tissues.

An additional way to measure progress is to systematically track the implementation of the actions in the Implementation Table in Section V. Taking this a step further, the programmatic performance indicators below may be used to measure plan implementation. Although these actions are not a measure of direct environmental improvements, they are assumed to contribute to water quality and aquatic habitat improvements. Some potential performance indicators for water quality and aquatic habitat improvements include:

- Number of stormwater BMPs installed.
- Increase in impervious area that is connected to stormwater treatment (area that is disconnected).
- Number of illicit discharges discovered.
- Reduced number of algae blooms observed in watershed ponds.
- Number of waterbodies without invasive species.
- Acreage of open space/percent of watershed in conservation.
- Acreage of wetlands protected, and acreage of restored wetlands.
- Number of watershed projects implemented to improve and protect wetlands.
- Acreage of buffers protected, and acreage of restored buffers.
- Number of watershed projects implemented to improve and protect riparian buffers.
- Number of stream connectivity projects implemented to improve connectivity.
- Number of contact hours of educational outreach attained for board members, elected officials, and municipal staff.
- Awareness among residents and other targeted audiences as measured by surveys.

VIII. Next Steps

This plan is provided to the City of Warwick as a tool to use in the long-term protection and restoration of water quality and aquatic habitat in the Buckeye Brook watershed.

The Plan will satisfy the requirements for eligibility for USEPA Section 319 funds that are administered by RIDEM. Projects requesting Section 319 funds must be either identified in the Plan's implementation section or at minimum consistent with the intent of the Plan, in addition to

meeting the criteria of the RIDEM Section 319 funding program. The Plan will also be useful in showing support for applications to other sources of funding for implementation.

This Plan should be continually evaluated and updated in order to guide appropriate actions to protect and restore water quality and aquatic habitat in the Buckeye Brook watershed.



Outlet of Old Mill Creek at Narragansett Bay

Appendix 1. RIDEM Water Quality Brochure

REDUCE YOUR LAWN by creating “no-mow zones” of native wildflowers, grasses, shrubs, and trees, especially as buffers near ponds and streams. This reduces water, fertilizer, and pesticide use and provides a welcoming habitat for wildlife.



FERTILIZE SMART Have your soil tested before applying fertilizer to your lawn to see if it even needs it. Don't over-fertilize - more is not better. During rainstorms, nutrients from fertilizers can wash off lawns into local waters where the excess nutrients promote algae blooms, including some algae that are harmful to people and pets. Algae blooms cause a decrease in oxygen in the water which endangers aquatic life and can cause fish kills. Use phosphorus fertilizer for new lawns only, unless the soil test shows a need for phosphorus on an established lawn. Sweep up fertilizer that spills on hard surfaces. Leaving grass clippings on your lawn can reduce your fertilizer needs by up to 25%. For more information on soil testing see www.URIMasterGardeners.org



REDUCE USE OF LAWN AND GARDEN PESTICIDES Investigate use of biological controls and products with natural ingredients. Read the labels—apply the right amount at the right time and be aware of the toxicity warnings.



REDUCE RUNOFF Increase the amount of stormwater absorbed into the ground by directing downspouts onto your lawn, not onto paved surfaces where the runoff could pick up oil, yard waste, and other debris. Install a rain barrel— use the water for plantings. Install a rain garden to increase the amount of stormwater absorbed into the ground. For more information, see www.RIStormwaterSolutions.org



DON'T DRAIN YOUR SWIMMING POOL into storm drains, wetlands, rivers, or ponds. Instead drain it onto the ground away from your drinking water well. Drain your pool only when your test kit does not detect chlorine levels so that it won't harm vegetation.



PUMP IT, DON'T DUMP IT! If you own a boat, have your holding tank emptied at one of the local pumpout stations around Rhode Island. For a list of pumpout locations contact DEM.



VOLUNTEER with clean-up efforts or water quality monitoring. Participate in local activities that benefit the environment. Find out if there is a watershed council for your area. YOUR opinion counts! Attend public meetings. Your participation makes the statement that your community is concerned about local waterways. If you see a problem or want something done, say something! If you don't have time to attend meetings, call or contact a city or town official, a state representative, or DEM.



NOW...GET OUT AND ENJOY THE WATER !

Swim, sail, surf, kayak, fish, boat, shellfish, go birding or walk along the shore. Explore Rhode Island's waters.

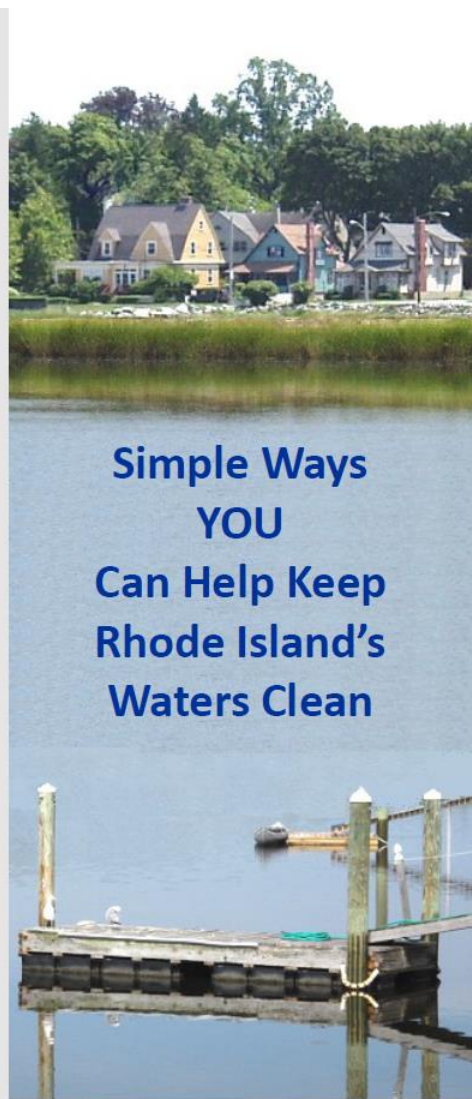


If you need more information on any of these topics contact DEM Water Resources

RI Department of Environmental Management
Office of Water Resources
235 Promenade Street
Providence, RI 02908-5767
401-222-4700
www.dem.ri.gov



Rev 3/2015



Simple Ways
YOU
Can Help Keep
Rhode Island's
Waters Clean

YOU Can Make A Difference!

- **DO YOU EVER STOP AND WONDER** what you can do to make a difference in keeping our waters safe enough to swim in, fish from, or use for drinking? What you can do to protect the groundwater that supplies your drinking water well?
- **WHEN IT RAINS** water travels across our properties collecting pollutants such as animal feces, fertilizers, soil, oil, and chemicals. This runoff then flows untreated into local rivers, lakes, and streams; polluting water for human use as well as plant and animal life.

LEARN ABOUT YOUR LOCAL WATERS Everyone lives in a watershed, which is the area that drains to a nearby river, stream, lake, or pond. Think about washing everything in a sink then letting it go down the drain. The sink is your watershed and the drain is your local river or stream. Find out what waters are closest to you and where they flow.



TAKE CARE OF YOUR SEPTIC SYSTEM Faulty septic systems can pollute local waters. Systems should be inspected every three to five years and tanks pumped as recommended. Don't drive or park anywhere on your septic system. Plant only grass over and near the system. If you have a cesspool, consider replacing it with a septic system.



DON'T FEED THE DUCKS! Feeding geese, ducks, gulls, and other waterfowl can cause large populations of birds to become concentrated in areas that are incapable of supporting them. The waste they produce contributes bacteria to our waterways and results in beach closures and pollution of shellfishing areas.



SCOOP THE POOP Pet waste left on sidewalks, streets or yards can be washed away by rainwater and carried into storm drains and drainage ditches which flow untreated to nearby rivers, ponds and beaches. Pet waste contains bacteria that can cause human illness and contribute to the closing of beaches and shellfish beds. Always carry a baggie - scoop up waste, bag it, and put it in the trash.



DON'T FLUSH MEDICATIONS Old or unwanted prescription drugs and over the counter medications flushed down the toilet or drain can end up in our waters and harm organisms living there. Check to see if you can drop off medications at your police station. If not, properly dispose of them in the trash. Crush pills and tablets. Put the medicine into a sealable plastic bag. Place the sealed bag in the trash.



MINIMIZE THE USE OF HAZARDOUS PRODUCTS as much as possible. Cleaning and other household products contain many hazardous chemicals. Read labels and try to use the least harmful products available. Don't dispose of products down the toilet or drain. Dispose of household hazardous chemicals (e.g., oil based paint, pesticides, drain cleaner, oven cleaner, pool chemicals) using the RI Eco-Depot Program. See www.rirrc.org



DRIVEWAY CARE Driveway sealant can be either an asphalt or a coal tar mixture. Coal tar has much higher levels of chemicals harmful to human health and aquatic life. As sealants wear down, particles wash off in stormwater. If you must seal your driveway, use an asphalt sealant.



WASH VEHICLES ON YOUR LAWN (away from your drinking water well) or use a commercial car wash. Washing on your lawn minimizes the amount of dirty, soapy water flowing into the storm drains that run directly into our waterbodies. If you are unable to wash your car on your lawn, use only biodegradable, phosphate-free cleaners. If washing near a storm drain, temporarily divert the water towards grassy areas. Commercial car washes typically use far less water, recycle their wash water, and treat their water prior to releasing it into the sewer system.



RECYCLE USED MOTOR OIL AND ANTIFREEZE Don't dump automotive fluids down the storm drain or dispose of them in your trash. Contact your local Department of Public Works or see the RI Eco-Depot Program at www.rirrc.org



CONSERVE WATER Don't overwater your lawn. Lawns need only one inch of water per week (from either watering or rain). Excessive water use, especially in summer, can dramatically reduce flow in rivers and streams, harming aquatic life.



If your house is connected to a public sewer, conserving water will help reduce the discharge from your wastewater treatment facility into local waters AND save you money! If you use a septic system, water conservation helps prevent system failures.