Paradise Brook

Watershed Description

This **TMDL** applies to the Paradise Brook assessment unit (RI0007035R-03), a 2.5-mile long stream located in Middletown, RI (Figure 1). The Town of Middletown is located on Aquidneck Island and Paradise Brook is located in the southern portion of the Island. The Paradise Brook watershed is presented in Figure 2 with land use types indicated.

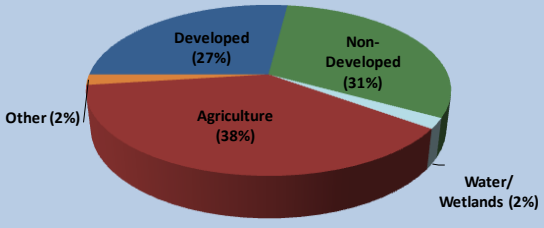
The headwaters of Paradise Brook consist of a marshy, agricultural area north and east of Mitchell's Lane, and south of Fayal Lane in the northeastern section of the Town of Middletown. The brook flows south along Third Beach Road, before turning westerly into land occupied by the Norman Bird Sanctuary. The brook flows into Nelson Pond, which is connected via pipeline to Gardiner Pond. The ponds are operated by Newport Water as a single reservoir. These ponds are two of the four surface water drinking reservoirs on Aquidneck Island (Berger, 2006a).

Historically, Paradise Brook was a tributary to the Maidford River. Currently, the brook is not directly connected to the Maidford River, but does contribute flow to the Maidford during periods of high flows and flooding (Berger, 2006a).

The Paradise Brook watershed covers 0.55 square miles. As shown in the aerial image of Figure 3, agricultural uses occupy a large portion (38%) of the watershed. Non-developed areas such as forests occupy 31%, including the Norman Bird Sanctuary. Developed uses (including residential and commercial) occupy approximately 27% of the land area. Impervious surfaces cover a total of 6.5%. Wetland and surface waters occupy 2%, and other land uses combine to occupy 2%.

Assessment Unit Facts (RI0007035R-03)

- **Town:** Middletown
- **Impaired Segment Length:** 2.5 miles
- **Classification:** Class AA
- **Direct Watershed:** 0.55 mi² (354 acres)
- **Impervious Cover:** 6.5%
- **Watershed Planning Area:** Aquidneck Island (#1)



Watershed Land Uses

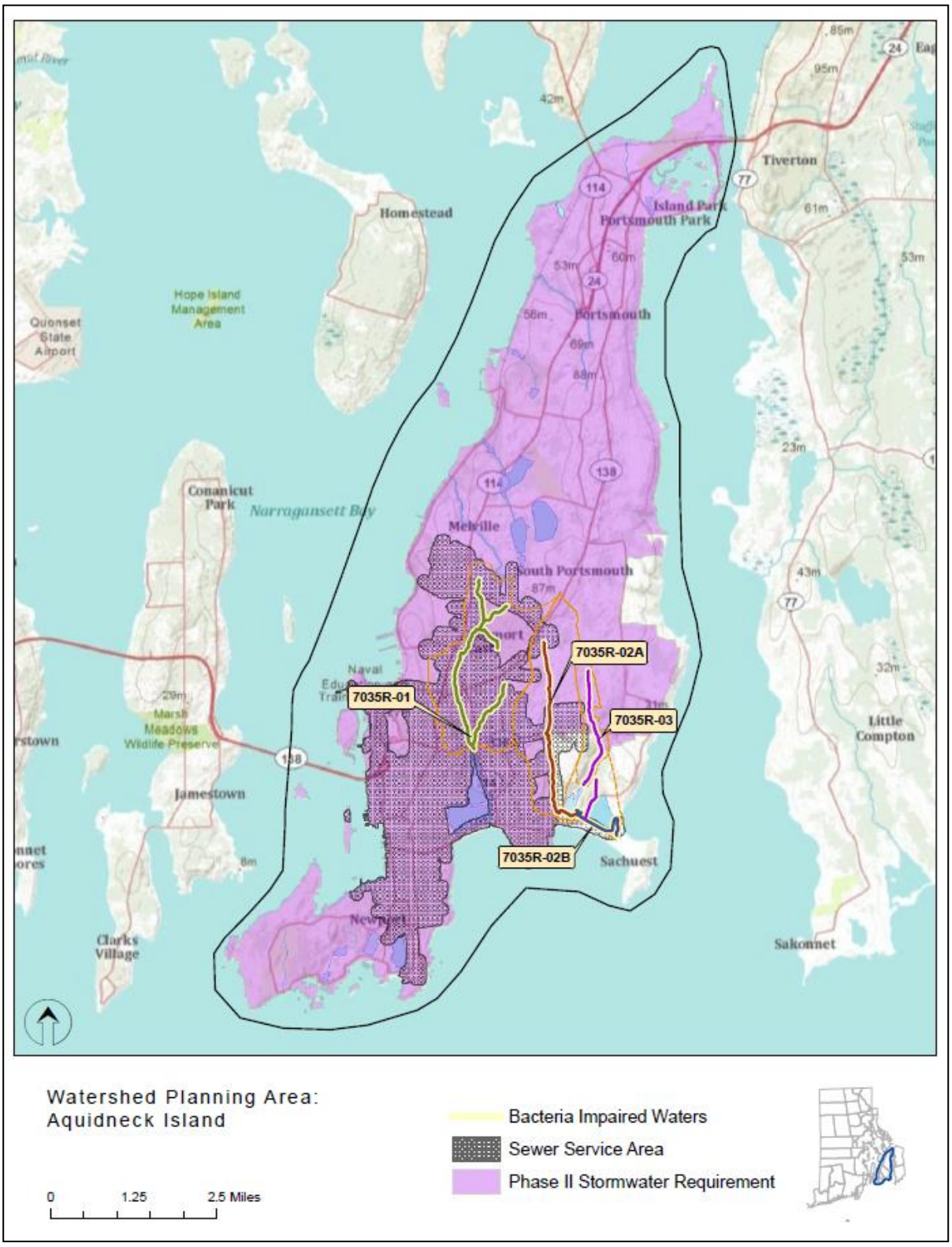


Figure 1: ***Map of Aquidneck Island with impaired segments addressed by the Statewide Bacteria TMDL, sewered areas, and stormwater regulated zones.***

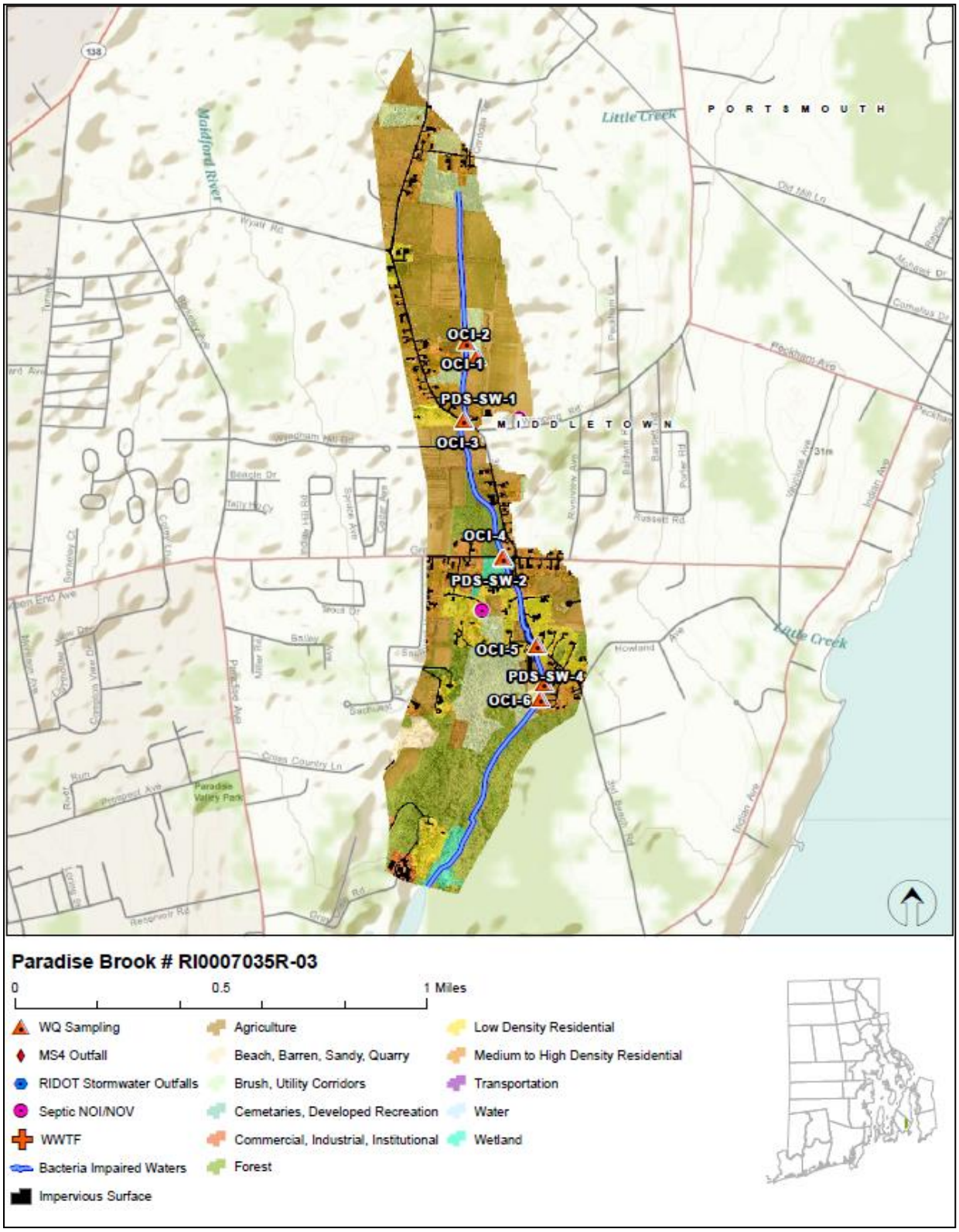


Figure 2: ***Map of Paradise Brook watershed with impaired segment, sampling locations, and land cover indicated.***

Why is a TMDL Needed?

Paradise Brook is a Class AA fresh water stream and is a tributary within Newport's public drinking water supply. However, as it is not a terminal reservoir, its applicable designated uses are primary and secondary contact recreation (RIDEM, 2009). Due to its location within a drinking water supply, Paradise Brook has been designated by RIDEM as a Special Resource Protection Water (SRPW), providing it with special protections under RIDEM's Antidegradation Provisions. SRPWs are high quality surface waters that have been identified as having significant ecological or recreational uses and/or are public water supplies.

Figure 3: Partial aerial view of the Paradise Brook watershed (Source: Google Maps)

From 2000-2005, water samples were collected from eight sampling locations and analyzed for the indicator bacteria, fecal coliform. The water quality criteria for fecal coliform, along with bacteria sampling results from 2000-2005 and associated statistics are presented in Table 1. The geometric mean and 90th percentile maximum exceeded the water quality criteria for fecal coliform at six of the eight stations, with the highest values found at Station OCI-5.

To aid in identifying possible bacteria sources, the geometric mean and 90th percentile were also calculated for wet and dry-weather sample days, where appropriate. The wet-weather geometric mean and 90th percentile value could only be calculated for Station OCI-5. It exceeded both of the water quality criteria for fecal coliform. The dry-weather geometric mean and 90th percentile values were calculated for seven of the eight stations, and exceeded the water quality criteria for over half of the stations.

Due to the elevated bacteria measurements presented in Table 1, Paradise Brook did not meet Rhode Island's bacteria water quality standards, was identified as impaired and was placed on the 303(d) list (RIDEM, 2008). The Clean Water Act requires that all 303(d) listed waters undergo a TMDL assessment that describes the impairments and identifies the measures needed to restore water quality. The goal is for all waterbodies to comply with state water quality standards.

Potential Bacteria Sources

There are several potential sources of bacteria in the Paradise Brook watershed including agricultural activities, wildlife and domestic animal waste, stormwater runoff from developed areas, and illicit discharges.

Agricultural Activities

As indicated in Figures 2 and 3, the Paradise River watershed is highly agricultural (38%), particularly in the northern portions of the watershed where there are extensive fields in cultivation. Agricultural operations are an important economic activity and landscape feature in many areas of the state. There are approximately 14 farms in the Town of Middletown, and multiple cattle farms are located within the watershed itself (Berger, 2006a). Agricultural practices such as allowing livestock to graze near streams, crossing livestock through waterbodies, and spreading manure as fertilizer may contribute to bacterial contamination.

Waterfowl, Wildlife, and Domestic Animal Waste

Domestic animals within the Paradise Brook watershed represent another potential source of bacteria. The Newport Equestrian Center, a private establishment situated off of Third Beach Road, stables numerous horses immediately adjacent to Paradise Brook, and has been cited by RIDEM for improper storage and handling of horse manure (Berger, 2006a).

A private duck pond is located behind a residence on Cordeiro Terrace, situated immediately north of the Norman Bird Sanctuary. This duck pond is located adjacent to Paradise Brook and contaminated surface water from around the pond could enter the stream. Also, waterfowl from the nearby Norman Bird Sanctuary may contribute bacteria to the brook (Berger, 2006a).

Wildlife, including waterfowl, may be a significant bacteria source to surface waters. With the construction of roads and drainage systems, these wastes may no longer be retained on the landscape, but instead may be conveyed via stormwater to the nearest surface water. As such these physical land alterations can exacerbate the impact of these natural sources on water quality.

Developed Area Stormwater Runoff

The Paradise Brook watershed has an impervious cover of 6.5%. Impervious cover is defined as land surface areas, such as roofs and roads that force water to run off land surfaces, rather than infiltrating into the soil. Impervious cover provides a useful metric for the potential for adverse stormwater impacts. While runoff from impervious areas in developed portions of the watershed may be

contributing bacteria to Paradise Brook, as discussed in Section 6.3 of the Core TMDL Document, as a general rule, impaired streams with watersheds having less than 10% impervious cover are assumed to be affected by sources other than urbanized stormwater runoff.

In 2008, all stormwater outfalls and catch basins throughout Middletown were mapped as part of Phase II requirements (Berger, 2008). Paradise Brook was shown to receive discharges from approximately six stormwater outfalls.

Onsite Wastewater Treatment Systems

The Paradise Brook watershed relies mostly on onsite wastewater treatment systems (OWTS), such as septic systems and cesspools, although the western portion of the watershed is partially sewered (Berger, 2006a). Failing OWTS can be significant sources of bacteria by allowing improperly treated waste to reach surface waters (RI HEALTH, 2003). As shown in Figure 2, one OWTS Notice of Violation/Notice of Intent to Violate has been issued by the RIDEM Office of Compliance and Inspection in the lower portion of the watershed adjacent to the stream.

Sewer Leaks

Leaks to the municipal sanitary sewer system may be another source of bacteria to Paradise Brook. Sewer system leaks and other illicit discharges have historically been reported in Middletown (Berger, 2008).

Existing Local Management and Recommended Next Steps

Additional bacteria data collection may be beneficial to support identification of sources of potentially harmful bacteria in the Paradise Brook watershed. These activities could include sampling at several different locations and under different weather conditions (e.g., wet and dry). Field reconnaissance surveys focusing on stream buffers, stormwater runoff, and other source identification may also be beneficial.

Based on existing ordinances and previous investigations, the following steps are recommended to support water quality goals.

Agricultural Activities

If not already in place, agricultural producers within the Paradise Brook watershed should work with the RIDEM Division of Agriculture and the U.S. Department of Agriculture Natural Resources and Conservation Service (NRCS) to develop conservation plans for their farming activities within the watershed. These plans should ensure that there are sufficient stream buffers, that fencing exists to

restrict access of livestock and horses to streams and wetlands, and that animal waste handling, disposal, and other appropriate BMPs are in place.

Waterfowl, Wildlife, and Domestic Animal Waste

Middletown's education and outreach programs should highlight the importance of picking up after horses, dogs, and other pets and not feeding waterfowl, particularly in the lower portion of the watershed. Animal wastes should be disposed of away from any waterway or stormwater system. Middletown should work with volunteers from the town to map locations where animal waste is a significant and chronic problem. This work should be incorporated into the municipalities' Phase II plans and should result in an evaluation of strategies to reduce the impact of animal waste on water quality. This may include installing signage, providing pet waste receptacles or pet waste digester systems in high-use areas, enacting ordinances requiring clean-up of pet waste, and targeting educational and outreach programs in problem areas.

Particular attention should be paid to the Newport Equestrian Center, as it has been cited for improper disposal of horse manure in the past, and is located adjacent to Paradise Brook (Berger, 2006a). The Town of Middletown and RIDEM should continue inspections of manure disposal practices and encourage the installation of BMPs on the property to reduce the amount of manure leaving the property.

Towns and residents can also take several measures to minimize waterfowl-related impacts. They can allow tall, coarse vegetation to grow in areas along the shores of Paradise Brook that are frequented by waterfowl. Waterfowl, especially grazers like geese, prefer easy access to the water. Maintaining an uncut vegetated buffer along the shore will make the habitat less desirable to geese and encourage migration. With few exceptions, Part XIV, Section 14.13 of Rhode Island's Hunting Regulations prohibits feeding wild waterfowl at any time in the state of Rhode Island. Educational programs should emphasize that feeding waterfowl, such as ducks, geese, and swans, may contribute to water quality impairments in Paradise Brook and can harm human health and the environment. Middletown should ensure that mention of this regulation is included in their SWMPPs.

Stormwater Management

The Town of Middletown (RIPDES permit RIR040032) and the Rhode Island Department of Transportation (RIDOT) (RIPDES permit RIR040036) are municipal separate storm sewer system (MS4) operators in the Paradise Brook watershed and both have prepared the required Phase II Stormwater Management Plans (SWMPP). The upper portion of the watershed is regulated under the Phase II program. Middletown's SWMPP (2008) outlines the goals for the reduction of stormwater runoff to Paradise Brook through the implementation of Best Management Practices (BMPs). Many of

these BMPs are now in place, including mapping all stormwater outfalls, instituting annual inspections and cleaning of the town's 1400 catch basins, implementing an annual street sweeping program, adopting construction erosion and sediment control and post-construction stormwater ordinances, and conducting public education activities (RIDEM, 2010a).

In 2006, the Town of Middletown adopted an illicit discharge detection and elimination ordinance, based on the model ordinance developed by the Center for Watershed Protection (Berger, 2008). This ordinance prohibits illicit discharges to the MS4 and provides an enforcement mechanism. The town should continue to locate priority areas to identify and eliminate illicit discharges in the Paradise Brook watershed (Berger, 2008). Illicit discharges can be identified through continued dry weather outfall sampling and microbial source tracking.

RIDOT has completed a SWMPP for state-owned roads in the watershed. RIDOT's SWMPP and its 2011 Compliance Update outline its goals for compliance with the General Permit statewide. It should be noted that RIDOT has chosen to enact the General Permit statewide, not just for the urbanized and densely populated areas that are required by the permit. RIDOT has finished mapping its outfalls throughout the state and is working to better document and expand its catch basin inspection and maintenance programs along with its BMP maintenance program. Storm Water Pollution Prevention Plans (SWMPP) are being utilized for RIDOT construction projects. RIDOT also funds the University of Rhode Island Cooperative Extension's Stormwater Phase II Public Outreach and Education Project, which provides participating MS4s with education and outreach programs that can be used to address TMDL public education recommendations.

Middletown and RIDOT will have no changes to their Phase II permit requirements and no TMDL Implementation Plan (TMDL IP) will be required at this time for the Paradise Brook watershed.

Onsite Wastewater Management

The majority of the Paradise Brook watershed relies on OWTS. Currently, the Town of Middletown does not have an Onsite Wastewater Management Plan. As part of an onsite wastewater planning process, Middletown should adopt ordinances to establish enforceable mechanisms to ensure that existing OWTS are properly operated and maintained. RIDEM recommends that communities create an inventory of OWTS through mandatory inspections. Inspections encourage proper maintenance and identify failed and sub-standards systems. Policies that govern the eventual replacement of sub-standard OWTS and cesspools within a reasonable time frame should be adopted. The Rhode Island Wastewater Information Systems (RIWIS) can help develop an initial inventory of OWTS and can track voluntary inspection and pumping programs (RIDEM, 2010b).

The Town of Middletown is not eligible for the Community Septic System Loan Program (CSSLP). The CSSLP program provides low-interest loans to residents to help with maintenance and replacement

of OWTS. It is recommended that the town develop a program to assist citizens with the replacement of older and failing systems.

Land Use Protection

Currently, the Paradise Brook watershed is approximately 73% undeveloped, a large portion of which is in agricultural production. A portion of the undeveloped lands are protected as open space. As source waters to the Newport water supply system, preserving these natural areas is particularly important. Woodland and wetland areas within the Paradise Brook watershed absorb and filter pollutants from stormwater and agricultural runoff, and help protect both water quality in the stream and stream channel stability. Woodland and wetland areas represent a large amount of the Paradise Brook watershed, approximately 33% of the land including portions of the Norman Bird Sanctuary. It is important to preserve these undeveloped areas, and institute controls on development in the Paradise Brook watershed (RI HEALTH, 2003).

The steps outlined above will support the goal of mitigating bacteria sources and meeting water quality standards in Paradise Brook.

Table 1: Paradise Brook Bacteria Data

***Waterbody ID*:** RI0007035R-03

Watershed Planning Area: 1 – Aquidneck Island

Characteristics: Freshwater, Class AA, Tributary within a Public Drinking Supply, Primary and Secondary Contact Recreation, Special Resource Protection Water (SRPW)

Impairment: Fecal Coliform (MPN/100mL)

Water Quality Criteria for Fecal Coliform:

Geometric Mean: 200 MPN/100 mL

90th Percentile Maximum: 400 MPN/100 mL

Percent Reduction to meet TMDL: **100% (Includes Margin of Safety)**

Data: 2000-2005 from RIDEM

Single Sample Fecal Coliform (MPN/100 mL) Results for Paradise Brook (2000-2005) with Geometric Mean and 90th Percentile Statistics

Station Name	Station Location	Date	Result	Wet/Dry	Geometric Mean	90th Percentile
OCI-1	RI Nurseries, 200 ft W Composting Pile	5/1/2003	430	Wet	827	8390
OCI-1	RI Nurseries, 200 ft W Composting Pile	12/2/2001	43	Dry		
OCI-1	RI Nurseries, 200 ft W Composting Pile	9/11/2000	2300	Dry		
OCI-1	RI Nurseries, 200 ft W Composting Pile	8/21/2000	11000	Dry		
OCI-2	RI Nurseries, 50 ft SW Composting Pile	5/1/2003	1500	Wet	38	1202
OCI-2	RI Nurseries, 50 ft SW Composting Pile	5/23/2002	4	Dry		
OCI-2	RI Nurseries, 50 ft SW Composting Pile	8/21/2000	9	Dry		
PDS-SW-1	Mitchell's Lane	8/31/2005	1601	Wet	1004	1561
PDS-SW-1	Mitchell's Lane	6/24/2005	900	Dry		
OCI-3	Mitchell's Lane	5/1/2003	1500	Wet		
OCI-3	Mitchell's Lane	9/11/2000	430	Dry		
OCI-3	Mitchell's Lane	8/21/2000	1100	Dry		
PDS-SW-2	Green End Avenue	8/31/2005	1601	Wet	252	1161
PDS-SW-2	Green End Avenue	6/24/2005	500	Dry		
OCI-4	Green End Avenue	12/5/2000	230	Dry		
OCI-4	Green End Avenue	9/11/2000	23	Dry		
OCI-4	Green End Avenue	8/21/2000	240	Dry		

Single Sample Fecal Coliform (MPN/100 mL) Results for Paradise Brook (2000-2005) with Geometric Mean and 90th Percentile Statistics (continued)

Station Name	Station Location	Date	Result	Wet/Dry	Geometric Mean	90th Percentile
OCI-5	3rd Beach Road before Equestrian Center	10/16/2004	160,000	Wet	982	**112,330† (100%)***
OCI-5	3rd Beach Road before Equestrian Center	12/5/2000	23	Dry		
OCI-5	3rd Beach Road before Equestrian Center	9/11/2000	230	Dry		
OCI-5	3rd Beach Road before Equestrian Center	8/21/2000	1,100	Dry		
OCI-6	Downstream Equestrian Center	5/23/2002	2300	Dry	995	2026
OCI-6	Downstream Equestrian Center	9/11/2000	930	Dry		
OCI-6	Downstream Equestrian Center	8/21/2000	460	Dry		
PDS-SW-4	Downstream Newport Equestrian Center	8/31/2005	1601	Wet	1200	1531
PDS-SW-4	Downstream Newport Equestrian Center	6/24/2005	900	Dry		
OCI-6A	Duck Pond, Below Stonewall (OCI file)	5/23/2002	930	Dry	556	3626
OCI-6A	Duck Pond, Below Stonewall (OCI file)	12/5/2000	43	Dry		
OCI-6A	Duck Pond, Below Stonewall (OCI file)	9/11/2000	4300	Dry		

Shaded cells indicate an exceedance of water quality criteria
*Includes Margin of Safety
†Geometric mean used to determine percent reduction

Wet and Dry-Weather Fecal Coliform Geometric Mean Values for all Stations

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean		
			Wet	Dry	All	Wet	Dry
OCI-1	RI Nurseries, 200 ft W Composting Pile	2001-2003	1	3	827	NA	1028
OCI-2	RI Nurseries, 50 ft SW Composting Pile	2000-2003	1	2	38	NA	6
PDS-SW-1 OCI-3	Mitchell's Lane	2000-2003 2005	2	3	1004	1550	752
PDS-SW-2 OCI-4	Green End Avenue	2000, 2005	1	4	252	NA	159
OCI-5	3rd Beach Road before Equestrian Ctr	2000-2004	1	3	982	NA	180
OCI-6	Downstream Equestrian Center	2000-2002	0	3	995	NA	995
PDS-SW-4	Downstream Newport Equestrian Ctr	2005	1	1	1200	NA	NA
OCI-6A	Duck Pond, Below Stonewall (OCI file)	2000-2002	0	3	556	NA	556

Shaded cells indicate an exceedance of water quality criteria
Weather condition determined from rain gage at Newport County Airport in Middletown, RI or at Kingston, RI if Newport data was not available.

Wet and Dry-Weather Fecal Coliform 90th Percentile Values for all Stations

Station Name	Station Location	Years Sampled	Number of Samples		90th Percentile Value		
			Wet	Dry	All	Wet	Dry
OCI-1	RI Nurseries, 200 ft W Composting Pile	2001-2003	1	3	8390	NA	9260
OCI-2	RI Nurseries, 50 ft SW Composting Pile	2000-2003	1	2	1202	NA	9
PDS-SW-1 OCI-3	Mitchell's Lane	2000-2003 2005	2	3	1561	1591	1060
PDS-SW-2 OCI-4	Green End Avenue	2000, 2005	1	4	1161	NA	422
OCI-5	3rd Beach Road before Equestrian Ctr	2000-2004	1	3	112330	NA	926
OCI-6	Downstream Equestrian Center	2000-2002	0	3	2026	NA	2026
PDS-SW-4	Downstream Newport Equestrian Ctr	2005	1	1	1531	NA	NA
OCI-6A	Duck Pond, Below Stonewall (OCI file)	2000-2002	0	3	3626	NA	3626

Shaded cells indicate an exceedance of water quality criteria

Weather condition determined from rain gage at Newport County Airport in Middletown, RI or at Kingston, RI if Newport data was not available.

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