Quaker Creek

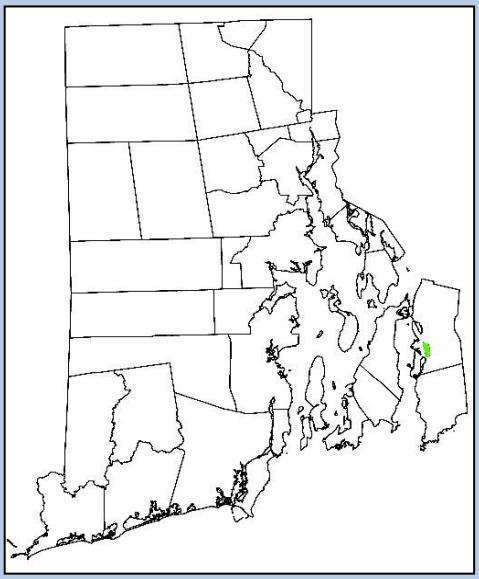
Watershed Description

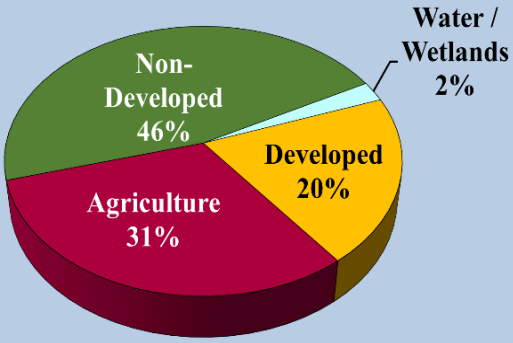
This TMDL applies to the Quaker Creek (also known as Quaket Creek) watershed (RI0010031R-04) that ultimately discharges into Nonquit Pond (RI0007035L-08). The pond is one of nine source reservoirs for the Newport Water System. The Newport Water System is comprised of a complex network that provides public water to all of Aquidneck Island with customers in Newport, Middletown, and a portion of Portsmouth, RI. It also provides water to the Portsmouth Water and Fire District and to Naval Station Newport.

Quaker Creek is a stream system that totals 2.4 miles, of which 2.3 miles are mapped and tracked for assessment purposes (Figure 1). It originates in a deciduous forest area southeast of the intersection of Main and Lafayette Roads in Tiverton. It proceeds south, parallel to Main Road, and passes west of the Tiverton Landfill. It continues south through some cropland and pasture areas before it enters an area designated as a brushland and reforestation area and eventually passes under East Road and merges with Borden Brook approximately 100 feet past the road crossing. There are several unnamed tributaries that merge with the mainstem of Quaker Creek. A drainage swale originates south of the Tiverton Landfill and merges with the brook south of the landfill access road. Approximately 0.45 miles south of the landfill access road, two streams merge with the mainstem in a deciduous forested area. The western tributary originates at a small pond at the edge of a pasture area. The eastern tributary originates in a deciduous forested area near the eastern edge if the watershed and joins the mainstem within feet of the confluence with the western tributary.

Assessment Unit Facts (RI0010031R-04)

- **Town:** Tiverton
- **Impaired Segment Length:** 2.31 miles
- **Classification:** Class AA
- **Direct Watershed:** 0.57 mi^2 (364 acres)
- **Impervious Cover:** 3%





Watershed Land Uses

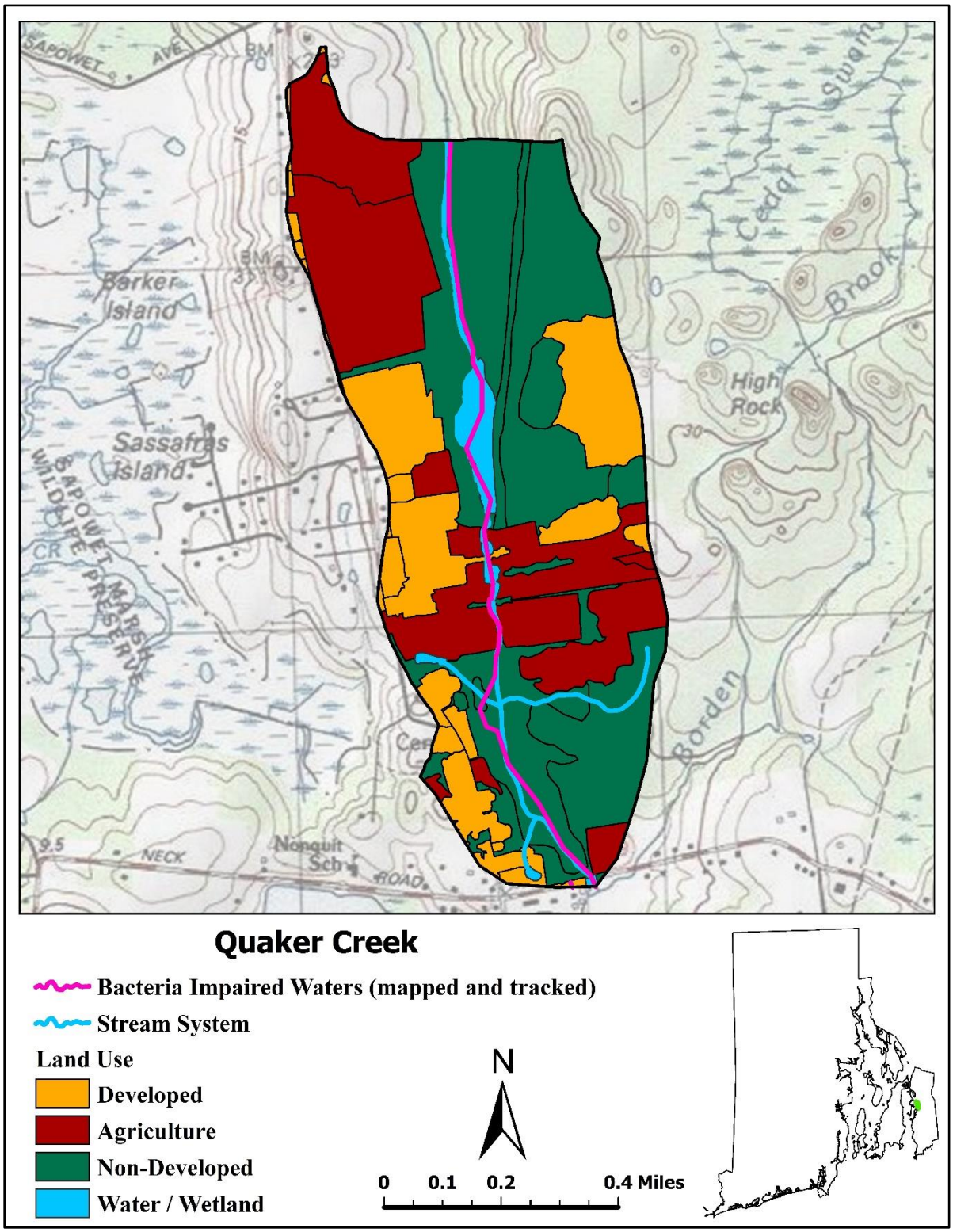


Figure 1. Quaker Creek Watershed with Land Cover and Impaired Waters

Why is a TMDL Needed?

Under Section 303(d) of the federal Clean Water Act, states, territories, and authorized tribes, are required to develop lists of impaired waters. The law also requires states, territories, and authorized tribes to develop total maximum daily loads (TMDLs), a calculation of the maximum amount of a pollutant that can be present in a waterbody and still meet water quality standards for those impaired waters. Based on data collected as described below, Quaker Creek is not meeting Water Quality Standards and must receive a TMDL.

During 2017, water samples were collected on selected tributaries to Nonquit Pond, including Quaker Creek (RI0010031R-04), as part of the National Water Quality Initiative (NWQI)[1]. The NWQI is collaborative effort between the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), US Environmental Protection Agency (EPA), and the Rhode Island Department of Environmental Management (RIDEM) to work in partnership to retore water quality in watersheds affected by agricultural pollution sources.

There were four sampling stations located on the stream system for Quaker Creek that were sampled for the NWQI study in 2017 (Figure 2). The first station (Q1) was located at the landfill access road. The second station (Q2) was located downstream of the landfill swale at the border of a cropland and deciduous forested area. The third sampling station (Q3) was located downstream of the livestock area just before a road crossing at the edge of a brushland and reforestation area. The final station (Q4) was located immediately upstream of Quaker Creek's confluence with Borden Brook. Sampling station locations are described in Table 5 and shown in Figure 2 below.

The RIDEM's Ambient River Monitoring (ARM) station for Quaker Creek, TLC04, is co-located at or near the NWQI Station Q4. Samples were collected in 2014 and 2021 by RIDEM at the East Road crossing of Quaker Creek as part of the ARM surveys. Due to space limitations on this figure, Station TLC04 at Q4 is not shown.

Additional sites were sampled during the NWQI field work. There is a swale that runs parallel to the Tiverton Landfill access road that is a stormwater-leachate conveyance for a portion of the landfill. Samples were collected from this discharge at Station LDF just upstream of the confluence with Quaker Creek. The flows in the swale are not considered a Water of the State and any exceedances of criteria do not represent a violation of the State's water quality criteria. Comparing pathogen levels for these discharges to the established criteria or guidance allows an evaluation of this discharge as a pollutant source, and whether there is potential degradation of water quality downstream in Quaker Creek. However, these values were not used in assessing the required pathogen reduction for the creek.

[1] Nonquit Pond Tributaries: Water Quality Study and Pollutant Source Identification National Water Quality Initiative http://www.dem.ri.gov/programs/benviron/water/quality/rest/pdfs/tdml-nonquit.pdf

Table 3 shows the results of the sampling conducted at this station as well as the geometric mean for the landfill discharge and Figure 3 shows the location.

A draft RIPDES permit is being developed to address the discharges from the Tiverton Landfill. The Town of Tiverton will be required to sample quarterly those outfalls with discharges to Quaker Creek and report the geometric mean for enterococci to the Department of Environmental Management RIPDES division.

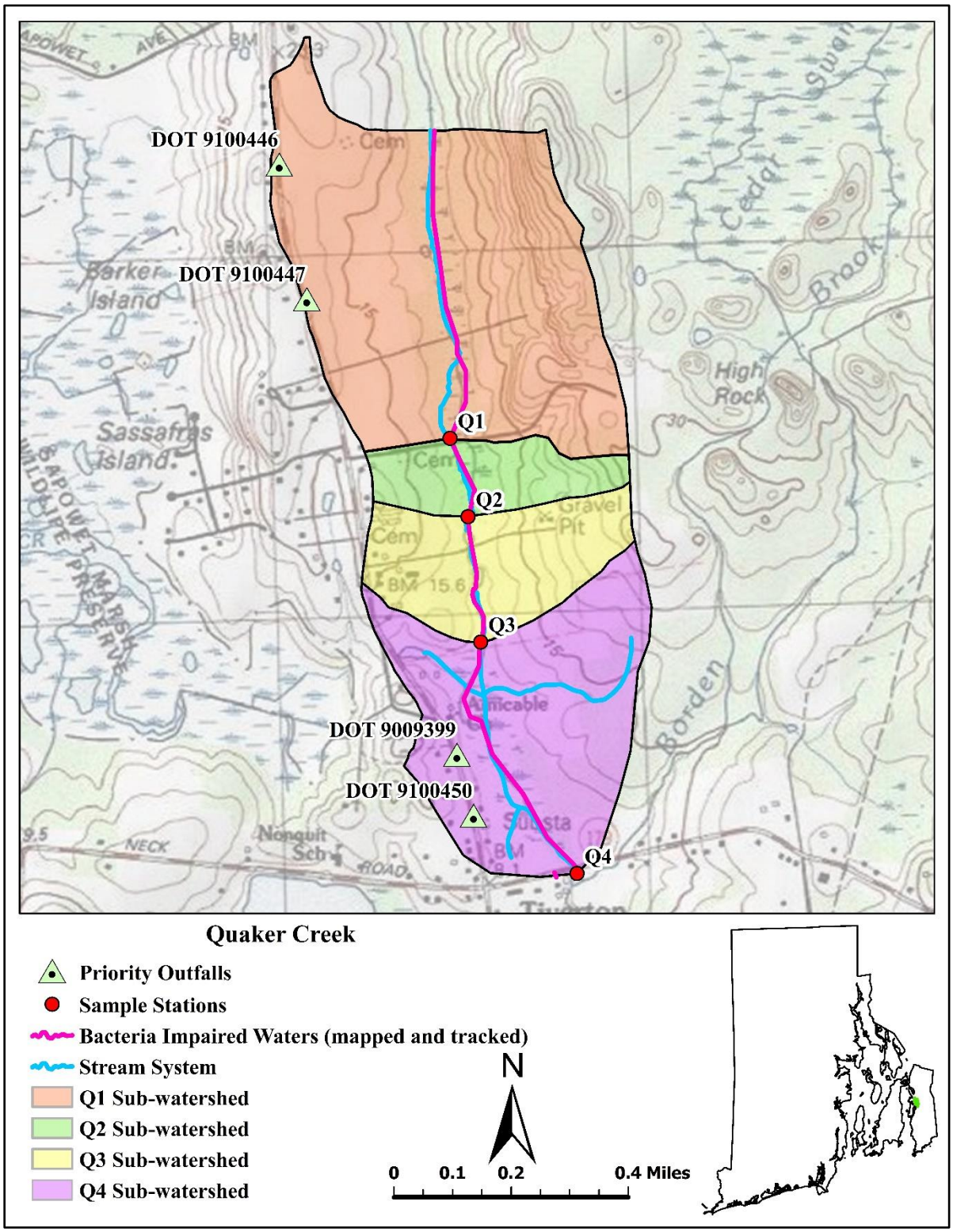


Figure 2. Quaker Creek Sampling Station Locations and Sub-watersheds.

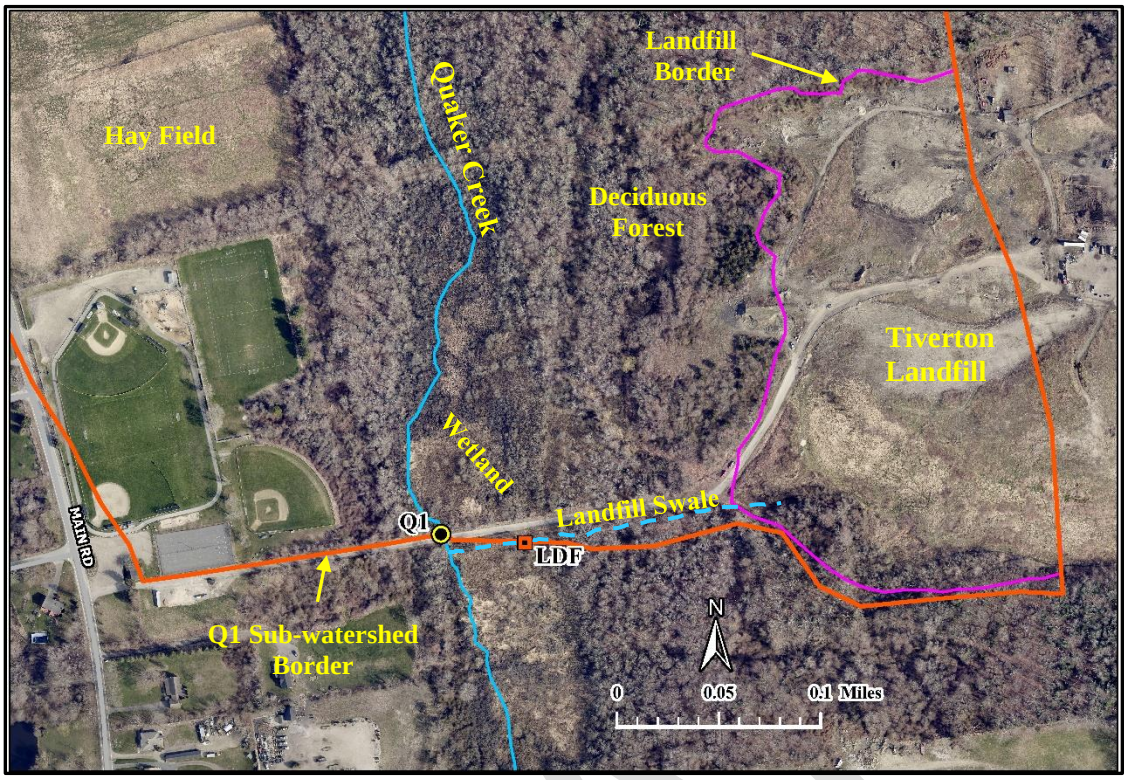


Figure 3. Quaker Creek Station Q1 and Landfill Station LDF

Table 1. Tiverton Landfill Swale - Station LDF Results

Date	Enterococci (MPN/100ml)	Geomean (MPN/100ml)	Rainfall 48 Hrs Prior (in)	Rainfall on sampling day (in)	Total Rainfall (in)
4/26/2017	**14,100**	**5,841**	0.06	2.00	2.06
5/4/2017	20		0.55	0	0.55
6/1/2017	**2,420**		0.47	0.62	1.09
10/25/2017	**504**		0.03	0.23	0.26

Station Q1. Landfill Access Road

Despite its depiction as an uninterrupted channel in Figure 1, an inspection of aerial photographs shows no discernable channel north of the Tiverton landfill access road. Instead, the area central to the sub-watershed is a wetland. Much of the central portion of the wetland is a marsh, characterized by organic soil, with standing water, most of the year. Forested swamp borders both sides of the marsh area. There are two 12-18-inch culverts that conduct flow under the access road. Station Q1 was located at the easternmost culvert under the landfill access road, just downstream of the roadway, and upstream any influence from the landfill swale.

The western portion of the landfill lies within the southeastern portion of the sub-watershed of Station Q1. The toe-of-slope of the landfill lies within proximity to the edge of the wetland corridor. The

remaining land to the east of the stream/wetland corridor, consists of upland forest. The Tiverton Landfill is in the process of final closure and capping. The RIDEM Office of Land Revitalization and Sustainable Materials Management (LRSMM) License Conditions contain requirements including meeting all Solid Waste Regulations, a final date of solid waste delivery of November 30, 2022 or earlier, and the facility shall meet and comply with stormwater permitting requirements of the DEM Office of Water Resources. The facility is designing stormwater best management practices (BMPs) in accordance with Stormwater Regulations[2]. Therefore, the final closure and capping will effectively manage stormwater and other discharges that could contribute bacteria to Quaker Creek.

Town recreational fields are located on the western side of the sub-watershed. There is a 100-foot vegetative buffer separating the lower baseball field from the wetland corridor associated with Quaker Creek. However, the soccer fields, located in the northeast portion of the park, directly abut the wetland corridor. A large hay field (part of Pardon Gray Preserve) is also present in the western portion of the sub-watershed. The hay field also directly abuts the stream/wetland corridor. Part of the southern portion of the pasture area has been tilled. Inspection of aerial photographs reveals flow paths from the hayfield towards the wetland corridor.

Station Q2. Downstream of Tiverton Landfill Swale

The stream corridor, between Stations Q1 and Q2, consists of wetland. Much of the central portion of the wetland is marsh, which is characterized by an organic soil and standing water for much of the year. Despite its depiction as an uninterrupted channel in the base map in Figure 1, an inspection of aerial photographs reveals no discernable channel in this area (except for the immediate area at Stations Q1 and Q2). The landfill swale discharges to the Quaker Creek system downstream of Station Q1, and upstream of Station Q2. The remaining area, to the east of the stream-wetland corridor, consists of upland forest.

There is a 75-100 foot buffer of upland forest adjacent to the western edge of the stream/wetland corridor. A hayfield (fallow field) and commercial area (artist cooperative; formerly a greenhouse area) are located to the west (upslope of the forested buffer). Residential houses are located along Main St., upslope of the hayfield and commercial property.

Station Q3. Downstream of Equestrian Centers and Cattle Farm

Stations Q2 and Q3 bracket a livestock area and there are two equestrian centers located immediately downstream of Station Q2, with a cattle farm located immediately downstream of the equestrian centers. There are two farm ponds, adjacent to each of the equestrian centers. The remainder of the stream

[2] Stormwater Management, Design, and Installation Rules https://rules.sos.ri.gov/regulations/part/250-150-10-8

corridor consists of a well-defined single channel. There is no significant vegetated buffer along the stream or farm ponds. There are several fenced enclosures associated with the equestrian centers. Those fenced enclosures closest to the stream are characterized by saturated muddy soils and are devoid of vegetation for much of the year.

Although there appears to be no direct livestock access to the stream adjacent to the upstream farm pond, the fenced enclosure to the west of the farm pond is a source of runoff from this area and sheet flow was observed during rain events in 2018. The fenced enclosure on the western side of the stream between the two farm ponds is also saturated or partially flooded during wet weather. Turbid stormwater runoff from the corrals and the dirt parking lot of the bus depot was observed to discolor flow in the stream in this area. A pile of manure was observed adjacent to the barn and up-gradient of the corrals that are associated with the downstream equestrian center. Flooded conditions were also observed in corrals located to the east of the upper farm pond. A significant area to the east of the stream between the two farm ponds floods periodically. Horses have direct access to this periodically flooded area and a significant amount of manure was observed in this location.

As of September 2022, field observations showed a stone wall had been constructed to prevent direct access to this area by farm animals. Until 2019, cattle had direct access to the entire length of stream that is downstream of the second farm pond. Recent field observations found that this portion of the stream is enclosed by a fence preventing cattle from entering the stream. However, the fields on either side where cattle do graze are upslope and there exists the possibility pollutant transport during storm events when there is significant runoff from these areas. There were approximately 40 head of cattle on the farm downstream of the second farm pond.

Other than livestock areas, there are several other land uses located along the periphery of the sub-watershed. There is a 4-acre area of excavated soil located in the northeast portion of the sub-watershed. Although it is located over 400 feet from the upper farm pond, turbid runoff from the excavated area was observed flowing along the northern tree line of the farm, discoloring the eastern side of the farm pond in 2018. This area was not accessible to evaluate for any changes in September 2022

There are two commercial areas to the west of the stream, including a small landscaping business to the west of the equestrian center barn as well as an artist's cooperative in the northwest corner of the sub-watershed. The parking lots and driveways associated with the artist's cooperative, landscaping business, and upper equestrian center have a gravel/seashell surface. In 2018, turbid stormwater runoff (milky brown in color) from these areas was observed flowing into a ditch parallel to the main drive accessing the equestrian center. Runoff from the ditch discharges to the stream south of the upper farm pond, discoloring the water in the stream.

A school bus depot is located between the two equestrian center barns to the west of the stream. Turbid runoff from the bus depot's saturated dirt parking area was observed flowing towards the stream in 2018.

As mentioned previously, there was additional sampling that was conducted during the NWQI field study. On January 23, 2018, a targeted wet weather sampling event was conducted downstream of the livestock area described above. Since this was an event where single grab samples were collected, the enterococci samples were not used in the geometric mean calculations for this TMDL.

During this sampling event, two additional stations were added between Station Q2 and Q3 to more help bracket potential pollutant sources. Station Q2a was located at the outlet of the upstream farm pond, and Station Q2b was located at the outlet of the downstream farm pond within the sub-watershed for Q3. The location of these stations is shown in Figure 4, and the results of the sampling event are shown in Table 2. As mentioned above, there was a potential for areas around the farm ponds to become flooded during wet weather events. The areas around the ponds and the stream segments between the ponds are slightly elevated in relation to the streambed. As mentioned earlier in the document, fences have been constructed to contain the farm animals and prevent them from having direct access to the stream area, but the potential still exists for stormwater to be a transport mechanism for pollutant runoff from the pasture areas near the ponds where livestock do have access.

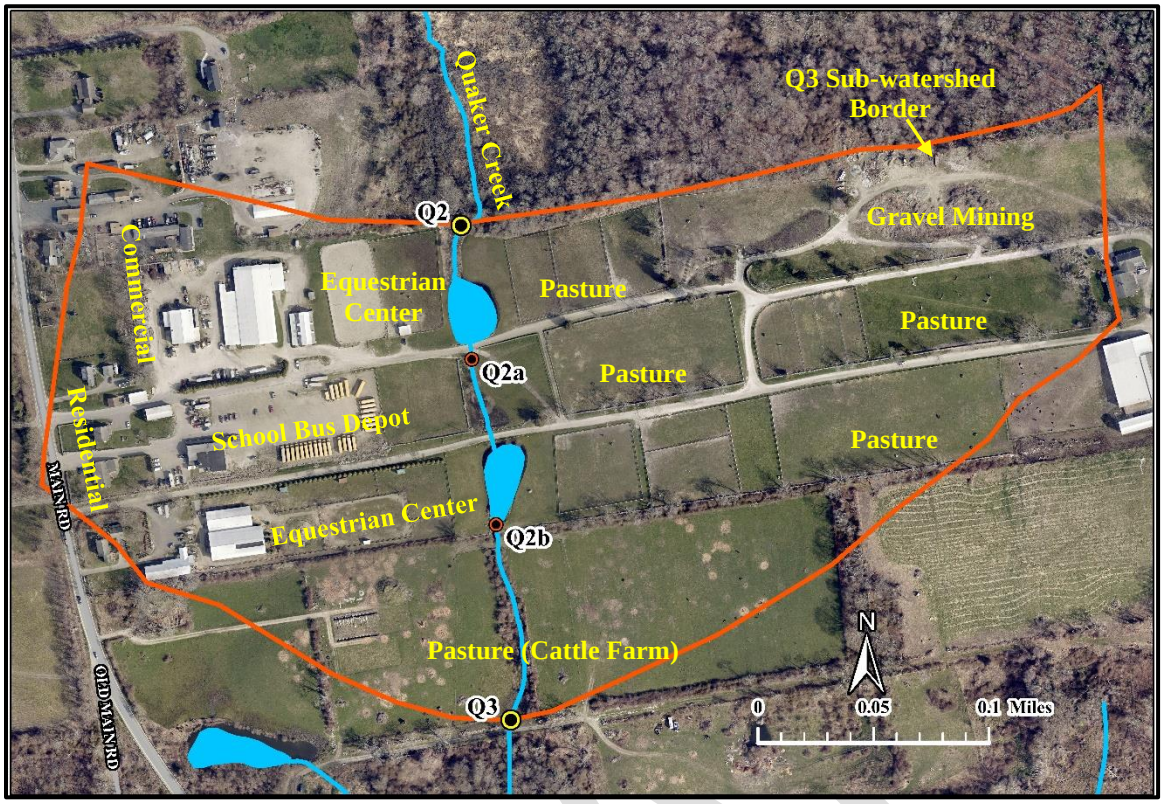


Figure 4. Quaker Creek Sub-watershed Q3 Station Locations for Targeted Wet Weather Sampling Event

Table 2 shows that there was a decrease in the enterococci concentrations from Station Q2 to Q2a, which may be attributed to settling within the upper farm pond. However, the enterococci values doubled between Stations Q2a and Q2b where livestock have direct access to the lower farm pond and the stream segment between the two ponds. Station Q3 was below the 10 MPN/100ml detection limit for enterococci during this targeted sampling event. Overall, the geometric means for this stream segment during this event was 191 MPN/100ml.

Table 2. Targeted Wet Weather Sampling Event on January 23, 2018.

Station	Enterococci (MPN/100ml)	Rainfall 48 Hrs Prior (in)	Rainfall 48 Hrs Prior (in)	Total Rainfall (in)
Q2	960	0.02	1.24	1.26
Q2a	256			
Q2b	546			
Q3	<10			

Station Q4. East Road Upstream of Confluence with Borden Brook

The stream reach of Quaker Brook upstream of its confluence with Borden Brook flows through a broad wetland corridor. Much of the interior of the wetland consists of marsh, with organic soil and standing

water in places for much of the year. There are at least two distinct channels in this reach; one in the interior of the marsh and one at its western edge.

There are pastures and a hayfield located in the northeastern portion of the watershed. Another pasture is located in the southeast corner of the sub-watershed. However, there was no evidence of concentrated surface water runoff from the hayfields or pastures to the wetland/stream corridor in this sub-watershed. In addition, there was at least a 50-100 ft. buffer between the hay fields and wetland corridor. The remaining land to the east of the stream/wetland corridor consists of upland forest.

Much of the land, to the west of the stream/wetland corridor, directly abuts the wetland, with minimal or no buffer of upland forest. A pasture is located in the northwestern portion of the sub-watershed. Cattle in this area have direct access to a small farm pond that is hydrologically connected to Quaker Creek. Most of the sub-watershed west of the stream corridor consists of residential land use along Main Road. There is a church in the west-central portion of the sub-watershed and areas of commercial land use, including a sculpture garden in its southwestern corner.

Sampling Conditions

Instream sampling surveys were collected under dry and wet weather conditions at Stations Q1, Q2, Q3, and Q4 in 2017. Dry weather was defined as less than 0.25 inches of rainfall during the 48-hour period preceding a sampling event. Wet weather was defined as greater than 0.25 inches of rainfall during the preceding 48-hour period prior to sampling. Daily rainfall data reported from the Newport State Airport Weather Underground Station KUUU was used to determine if a survey was conducted under wet or dry conditions. Enterococci samples were collected over the survey dates as shown in Table 3 along with the rainfall data reported for those days and the previous 48-hour period.

Exceedances and Potential Sources

As described in the Consolidated Assessment and Listing Methodology[3], the assessment of recreational use is based on data for enterococci, fecal coliform, and/or *Escherichia coli (E. coli)*. Enterococci is the primary bacteria indicator for assessing recreational use attainment. For non-designated beach waters, the geometric mean should be less than 54 MPN/100mL. Typically, the geometric mean is calculated using samples collected over the recreational bathing period of May through October; however, with the limited dataset, all samples collected were used to assess recreational use for this assessment and TMDL development.

[3] 2022 Consolidated Assessment and Listing Methodology http://www.dem.ri.gov/programs/benviron/water/quality/pdf/calm22.pdf

Table 3. Sampling Dates and Rainfall Amounts for All Surveys

Newport State Airport (KUUU)				
Date	**Organization**	**Rain 48-hrs Prior (In)**	**Rain on Sampling Date (In)**	**Total Rain**
5/28/14	RIDEM-ARM	0.01	0.05	0.06
7/8/14	RIDEM-ARM	0	0	
7/30/14	RIDEM-ARM	0.33	0	0.33
3/22/17	NWQI	0	0	
4/26/17	NWQI	0.06	2.00	2.06
5/4/17	NWQI	0.55	0	0.55
6/1/17	NWQI	0.47	0.62	1.09
10/25/17	NWQI	0.03	0.23	0.26
1/23/18	NWQI	0.02	1.24	1.26
5/18/21	RIDEM-ARM	0.04	0	0.04
6/16/21	RIDEM-ARM	0.35	0	0.35
7/28/21	RIDEM-ARM	0	0.01	0.01
9/8/21	RIDEM-ARM	0.05	0	0.05
9/21/21	RIDEM-ARM	0	0	

Geometric mean values were calculated for all stations, and for each organization for both dry and wet weather days as well as the geomean for each station using all survey data (Table 5). The combined geomeans for all four NWQI stations exceeded the geomean of 54 MPN/100mL criteria as well as the combined geomean for the RIDEM Ambient River Monitoring station TLC04 2014 and 2021.

There are limitations when comparing wet and dry weather geomeans due to the small sample size at particular stations, which is inherently due to the targeted weather condition of the RIDEM ARM and NWQI programs. However, in general, the geomeans and individual samples of wet weather are higher than dry weather suggesting that stormwater is significant component of bacteria impairment.

Sources in the Station Q1 sub-watershed include the extensive forested areas as well as a wetland segment where it was hard to find a defined streambed in the aerial photos. While the NWQI 2017 dry weather geomean for this station was below criteria, the wet weather geomean for this station was 214 MPN/100ml. The overall geomean for Station Q1 was 116 MPN/100ml. It should be noted that only a single grab sample was collected under the defined dry weather conditions which measures below the detection limit of 10 MPN/100ml. The last two wet weather grab samples at Station Q1 measured 1,500 and 1,560 MPN/100ml respectively.

In the Q2 sub-watershed, the data indicates that the landfill swale may contribute significantly to the increases in the enterococci concentrations. Like Q1, the dry weather results were below the 54 MPN/100ml freshwater criteria. The single dry grab sample measure below the 10 MPN/100ml detection limit. The wet weather geomean for this station was 531 MPN/100ml, more than double what

it was at Station Q1. The overall geomean for the station was also double the value at Station Q1, measuring 240 MPN/100ml. The highest single grab sample at Q2 measured 6,490 MPN/100ml during the October 25, 2017, sampling event.

The dry weather grab sample collected at Station Q3 was below the 10 MPN/100ml detection limit. During wet weather, the enterococci geomean values at Station Q3 showed an increase in the enterococci results measuring 703 MPN/100ml, a 32% increase over the wet weather geomean results from Q2. The overall geomean value for Station Q3 was 300 MPN/100ml, a 25% increase from Station Q2. This station also had the highest single grab sample for wet weather among all the NWQI station, measuring 7,700 MPN/100ml for the last survey in October 2017.

The likely source is manure associated with the livestock areas, including both equestrian centers and the cattle farm to the south. The enterococci increase was likely caused by manure in close proximity to the stream. As of 2018, horses have direct access to the eastern side of the stream, along this entire reach. This short reach of stream channel between the two farm ponds on the eastern side of the stream, was often flooded during wet weather. A significant amount of manure was observed in the flooded area in 2018. In addition, the fenced enclosure to the west of the stream is located in very close proximity to the channel.

As with the previous stations, the dry weather grab sample value for Station Q4 was also below the 10 MPN/100ml detection limit. The geomean values for this station during wet weather were the lowest of the four Quaker Creek stations with a geomean of 135 MPN/100ml for the site. This was a significant decrease in wet weather enterococci from Station Q3. The overall geomean for Station Q4 was 80 MPN/100ml, a 73% decrease from the overall geomean value observed at Station Q3.

Co-located at Station Q4 was RIDEM's Ambient River Monitoring (ARM) station that was sampled in 2014 and 2021. Over the two survey years, eight samples were collected, three in 2014 and five in 2021. This station is sampled during dry weather; however, two of the surveys met the statewide bacteria TMDL wet weather conditions, one each in 2014 and 2021. The overall geomean values for this station were 769 and 158 MPN/100ml in 2014 and 2021 respectively. The value geomean value for 2014 was the highest of all stations and is the determining value used for the percent reduction in this TMDL.

Stormwater Runoff

Studies have shown that the first flush of stormwater runoff from urban and rural areas can contain significant levels of pollution. Stormwater has been determined to be a source of the pollutant of concern, bacteria. The Rhode Island Department of Transportation wwas issued coverage under the

Rhode Island Phase II Stormwater General Permit (issued in 2003) and have prepared the required Phase II Stormwater Management Plans (SWMPP).

As part of the Phase II MS4 requirements, municipalities and RIDOT are required to confirm ownership, map outfalls and catch basins, among other information required by the general permit, and submit this information to RIDEM. However, there is little information, other than pipe diameter, that would allow for evaluation of accurate water quality impacts from specific outfalls. It should be noted that information related to these outfalls has not been independently confirmed by RIDEM staff. Priority outfalls should be subject to Illicit Discharge Detection and Elimination (IDDE) protocols. All illicit discharges will be eliminated.

Table 4. Priority Outfall in Quaker Creek Watershed

Outfall ID	Direct Discharge to	LAT	LONG	Pipe Diameter (inches)	Interpreted Responsibility
NARR273 (aka 9009399)	Quaker Creek	41.574396	-71.188144	12	RIDOT
9100450	Quaker Creek	41.572855	-71.188102	12	RIDOT
9100447	Quaker Creek	41.585633	-71.193470	12	RIDOT
9100446	Quaker Creek	41.588966	-71.194396	12	RIDOT

Agricultural Activities

Animal manure is the primary source of bacterial pollution from agricultural land uses. Agricultural runoff is generally defined as water leaving agricultural operations because of rain, melted snow, or irrigation and may be associated with soil erosion. Agricultural runoff in the Quaker Creek watershed includes that originating from soil erosion, feeding operations, grazing, plowing, animal waste, irrigation water, and fertilizer. The NWQI investigation showed that polluted runoff from agricultural activities was flowing into the stream system during storm events. Field observations in 2018 found cattle and horses could access flooded areas and to areas adjacent to the stream system itself, and one of the residential areas along the stream had no vegetated buffer zone.

Onsite Wastewater Treatment Systems

Most of Tiverton is unsewered, so reliance for wastewater disposal is on onsite wastewater treatment systems (OWTS), such as septic systems and potentially cesspools. Failing OWTS can be a significant

source of bacteria by allowing improperly treated waste to reach surface waters. Additionally, cesspools are not considered treatment systems and were the subject of the Rhode Island Cesspool Act of 2007 (RIGL § 23-19.15), as amended in 2015, which mandates that all cesspools within the State of Rhode Island must, over time, be removed from services. Cesspools contribute directly to groundwater and surface water contamination and environmental impacts. No OWTS Notices of Violation/Notices of Intent to Violate have been issued by the RIDEM Office of Compliance and Inspection in the Quaker Creek watershed; however, maintaining OWTS that are properly sited and sized is important in this watershed, as well as elimination of cesspools and upgrade of improperly sited and/or sized septic systems.

Waterfowl, Wildlife, and Domestic Animal Waste

Waterfowl, wildlife, and domestic animals within the Quaker Creek watershed represent another potential source of bacteria. Over ninety percent of the watershed is undeveloped land that consists of upland forest and wetlands which provide a habitat for wildlife and waterfowl, both of which can contribute to the pathogen pollution observed in the stream system. Areas within the watershed that are impervious or constructed may not retain the waste on the land but instead convey it via stormwater to the nearest surface water. Food sources encouraging proliferation of waterfowl and wildlife where stormwater is likely to uptake waste and its associated bacterial source should be removed or secured. Domestic animal waste should be properly disposed.

Reasonable Assurance

RIDEM acknowledges that it will take significant effort to reduce bacteria loading to the maximum extent practicable from as many sources as possible, given the variable nature of bacteria sourcing and tracking. In some cases, reductions from individual sources (e.g. manure piles, direct animal access to waterbody) can and should be given greater priority. Reasonable assurance that non-point loads will be reduced include enforcement of Rhode Island's existing water quality regulations (RIDEM 2018[4]) and the recently enacted Wetlands Regulations (RIDEM 2022[5]) includes expanded jurisdiction, with exception to certain agricultural activities, and strengthened buffer protection for future changes. Because the streams included in this update are tributaries to water supply reservoir, they received the maximum buffer of 200' in the 2022 Wetlands Regulations for new activities. There are also requirements for creating new buffer for new activities.

Additionally, the collaborative efforts of RIDEM, NRCS, ERICD, municipalities, and many agricultural producers in the Newport Water Supply watersheds, as evidenced in Section 6.0 Implementation in the

[4] State of Rhode Island Water Quality Regulations https://rules.sos.ri.gov/regulations/part/250-150-05-1
[5] State of Rhode Island Rules and Regulations Governing the Administration and Enforcement of the Fresh Water Wetlands Act https://rules.sos.ri.gov/regulations/part/250-150-15-1

TMDL update cover document, which contains a table of non-point source watershed activities being undertaken. Furthermore, recent inspections of accessible locations in September 2022 documented in this appendix confirm changes in agricultural practices that support reduction of likely large bacteria sources, such as manure pilings and direct animal access to waterbody.

Table 5: Quaker Creek Bacteria Data

***Waterbody ID*:** RI0010031R-04

Watershed Planning Area: 16 – Sakonnet-East

Characteristics: Freshwater, Class AA, Primary and Secondary Contact Recreation, Fish and Wildlife Habitat

Impairment: Enterococci (MPN/100mL)

Water Quality Criteria for Enterococci: Geometric Mean: 54 MPN/100mL

***Percent Reduction to meet TMDL: 98%* (Includes 5% Margin of Safety)**

Data: from RIDEM ARM Program (2014, 2021), NWQI Sampling Survey (2017)

Single Sample Enterococci (MPN/100mL) Results for the Quaker Creek with Geometric Mean Statistics

Station Name	Station Location	Date	Result	Wet/Dry	Geometric Mean
Q1	Downstream side of landfill access road crossing	3/22/17	10	Dry	**116**
		5/4/17	10	Wet	
		6/1/17	89	Wet	
		4/26/17	1,500	Wet	
		10/25/17	1,560	Wet	
Q2	Downstream boundary of landfill property and northern boundary of livestock area.	3/22/17	<10	Dry	**240**
		5/4/17	10	Wet	
		6/1/17	756	Wet	
		4/26/17	1,620	Wet	
		10/25/17	6,490	Wet	
Q3	Downstream of livestock area adjacent to wetland area	3/22/17	NS	Dry	**703**
		5/4/17	10	Wet	
		6/1/17	1,990	Wet	
		4/26/17	1,590	Wet	
		10/25/17	7,700	Wet	
Q4	East Road crossing above confluence with Borden Brook	3/22/17	<10	Dry	**80**
		5/4/17	<10	Wet	
		6/1/17	44	Wet	
		4/26/17	243	Wet	
		10/25/17	3,080	Wet	
TLC04	East Road crossing above confluence with Borden Brook	5/28/14	121	Dry	**769**^ (98%)
		7/8/14	1,550	Dry	
		7/30/14	2,420	Wet	

Station Name	Station Location	Date	Result	Wet/Dry	Geometric Mean
TLC04	East Road crossing above confluence with Borden Brook	5/18/21	20	Dry	**158**
		7/28/21	266	Dry	
		9/8/21	649	Dry	
		9/21/21	178	Dry	
		6/16/21	162	Wet	

^- Geometric Mean Used to determine percent Reduction

* - Includes 5% Margin of Safety NS=No Sample

Shaded indicates the sample was below DL of 10 MPN/100ml. Following the National Shellfish Sanitation Program (NSSP) Protocol, a value of 10 was used for values <10 for geomean calculations.

Wet and Dry Weather Geometric Mean Enterococci Values for all Stations

Station Name	Station Location	Years Sampled	Number of Samples		Geometric Mean (MPN/100ml)		
			Wet	Dry	All	Wet	Dry
Q1	Landfill access road crossing	2017	4	1	**116**	**214**	10*
Q2	Northern boundary of livestock area	2017	4	1	**240**	**531**	<10*
Q3	Southern boundary of livestock area	2017	4	-	**300**	**703**	-
Q4	East Road crossing before Borden Bk	2017	4	1	**80**	**135**	<10*
TLC04	East Road crossing before Borden Bk	2014	1	2	**769**	2,420*	**433**
		2021	1	4	**158**	162*	**157**

*These are single grab samples, not a geomean.