Fecal Coliform TMDL

for the

Runnins River, Rhode Island

Prepared by:

Office of Water Resources
Rhode Island Department of Environmental Management (RIDEM)
235 Promenade Street
Providence, RI 02908
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EXECUTIVE SUMMARY

1. Description of water body

The Runnins River lies in a 10.2 square mile (6,545 acre) watershed within the Warren River basin. The watershed contains the City of East Providence, Rhode Island and the Towns of Rehoboth and Seekonk, Massachusetts. The river rises in Rehoboth and flows in a southerly direction a distance of approximately 7.5 miles to its mouth. The lower river forms the boundary between East Providence, Rhode Island and Seekonk, Massachusetts. At its mouth, the Runnins River flows over the Mobil dam to form the Barrington River, a tributary estuary to Narragansett Bay. This TMDL addresses the Class B waters of the Runnins River, water body RI0007021R - 01, from the County Street Bridge at the Rhode Island – Massachusetts border where the river enters the state, to the Mobil Dam, where the river forms the head of the Barrington River.

Based on the most recent land use study (NEIWPCC, 1994), land use in the 10.2 square mile watershed is 44.4% vacant land, 20.6% residential, 10% industrial (dominated by the 1.25 square mile Mobil Oil facility), 8.3% commercial (90% attributed to Seekonk), 7.1% public parks, 3.7% open space, and 5.9% agriculture. It is apparent that the rapid and unplanned growth in this watershed has led to water quality impairment. Studies conducted within the past decade raise concerns such as buffer encroachment along the river and its tributaries; destruction and filling of wetlands within the watershed; development occurring within the floodplain; potential failure of septic systems, particularly in Seekonk, development in areas of poorly drained soils, and an increase in impervious surfaces due to development (Feather et al, 1989, BRW, 1992, USACOE, 1994, NEIWPCC, 1994).

Water quality in the Runnins River is impaired primarily by nonpoint sources. No permitted point sources discharge to the Runnins River. Designated uses for the Runnins River are fish and wildlife habitat, and primary and secondary recreational activities. Frequent violations of Rhode Island's Water Quality Standards for fecal coliform have prompted the State to list this water body in its 1998 303(d) list.

The downstream waters of the Barrington River have historically been valuable as wildlife habitat and recreational waters. Portions of the Barrington River were historically managed for shellfish harvesting on a conditional basis, in which the area was open to shellfish harvesting during dry weather. The entire Barrington River is presently closed on a permanent basis because of the continued bacterial impairment.

2. Applicable water quality standards and numeric water quality target

State Water Quality Standard

The Rhode Island portion of the Runnins River is designated as a Class B water by RIDEM's Water Quality Regulations. The State water quality standard for fecal coliform for Class B waters requires that the geometric mean concentration may not exceed 200 MPN/100 ml and not more than 20% of the samples shall exceed 500 MPN/100 ml.

Designated Uses
Designated uses for the Runnins River include primary and secondary contact recreation and fish/wildlife habitat.

Numeric Water Quality Target
The maximum allowable concentration in the Runnins River was based on attaining Class SA water quality standards (i.e. shellfishing) in the Barrington River, immediately downstream of the mouth of the Runnins River both during dry and wet weather conditions. The point of compliance is at the School Street Bridge, 500m upstream of the Mobil dam. The numeric water quality target during dry and wet weather is a geometric mean value of 14 fc/100 ml at School Street. Historic data indicate that if a geometric mean concentration of 14 fc/100ml is met at School Street, upstream stations will meet the Class B standard of 200 fc/100 ml. No more than 10% of samples at the School Street bridge may exceed a value of 49 fc/100 ml to ensure that the Class SA variability standard is met downstream in the Barrington River.

Antidegradation Policy
Rhode Island's antidegradation policy requires that at a minimum the water quality necessary to support existing uses must be maintained. The Runnins River is designated for fish and wildlife habitat and primary and secondary recreational activities. The goal of this TMDL is to restore designated and existing uses to the Runnins River and to downstream reaches of the Barrington River. These areas are considered impaired due to fecal coliform concentrations higher than the Class B and SA water quality standards, respectively.

3. Pollutant of concern, priority ranking, present condition of the water body, and pollutant sources

Pollutant of Concern
The pollutant of concern is fecal coliform, used by Rhode Island as an indicator of pathogen contamination.

Priority Ranking
The Runnins River is listed as a Group 1 water body (highest priority) for pathogens in Rhode Island 's 1998 303(d) list.

Present condition of the water body
The condition of the Runnins River at School Street, its most impacted location, is presented in Table 1. Fecal coliform concentrations have historically been highest during the warmer months between July and October. Water quality standards are typically not violated during the remainder of the year. The dry weather geometric mean fecal coliform concentration at School Street, based on RIDEM data, is 1576 fc/100 ml. The mean wet weather concentration of the river is 3211 fc/100 ml based on sampling by RIDEM during a storm event in October 1998. Sampling by Mr. Doug Rayner under a range of wet and dry weather conditions during this period shows that instream fecal coliform concentrations in the river at School Street exceed 500 fc/100 approximately 79% of the time. These values represent the current water quality conditions in the Runnins River in Table 1.

Pollutant Sources

RIDEM conducted a dry weather monitoring program in 1995 to identify fecal coliform sources to the Runnins River. The study found one significant dry weather source, the Route 195 stream

Table 1: Seasonal (July - October) fecal coliform water quality characterization for School Street

Dry weather		Wet weather		Combined wet and dry weather
Geometric mean concentration fc/100ml) [1]	Daily fecal coliform load (fc/day) [1]	Geometric mean concentration fc/100ml) [2]	Daily fecal coliform load (fc/day) [2]	Percent of samples exceeding 500 fc/100 ml [3]
1576	3.3×10^{11}	3211	1.5×10^{12}	79

[1] 1995-1997 RIDEM Dry weather data
[2] 1998 RIDEM Wet weather data
[3] 1990-1998 Rayner data

(Figure 1). Its elevated fecal coliform concentrations were attributed to pigeons roosting under the Route 195 Bridge overpass. The study found that this stream was the only tributary having fecal coliform concentrations that exceeded those in the adjacent waters of the river. Concentrations in the river rose sharply in an area of the lower Runnins River between the mouth of the Route 6 Stream #2 and School Street. No significant dry weather sources could be found in this reach. Fecal coliform concentrations in the four tributaries entering this reach were less than instream concentrations.

RIDEM examined the septic system design and water use records for commercial properties located near the lower river in Seekonk and East Providence to attempt to discover causes of the dry weather impairment of the river. The investigation indicated that a number of systems were either operating beyond their design capacity, were designed using assumptions that did not conform to current (Title V) standards, or were very old. The analysis indicated that given their proximity to the river and the high likelihood for failure, that these systems could potentially contribute to the impairment of the river between Route 6 stream #2 and School Street.

RIDEM followed this analysis with intensive monitoring of the lower Runnins River during the summer of 1999. Stations in this reach were sampled at closely spaced intervals in an attempt to bracket possible sources. The intensive sampling again found no sources in this reach. The data instead suggested that fecal coliform growth may occur during the summer as a result of low flows and elevated temperatures, combined with other factors such as the excessive growth of Phragmites. The dense growth of Phragmites was observed to block sunlight, thereby preventing ultraviolet radiation from killing off bacteria. Phragmites detritus was also observed to have accumulated in the river, forming floating mats over a foot thick. The mats appeared to harbor bacteria. In all cases, samples collected without disturbing the mats had significantly lower fecal coliform concentrations than samples collected at the same location after the mats had been

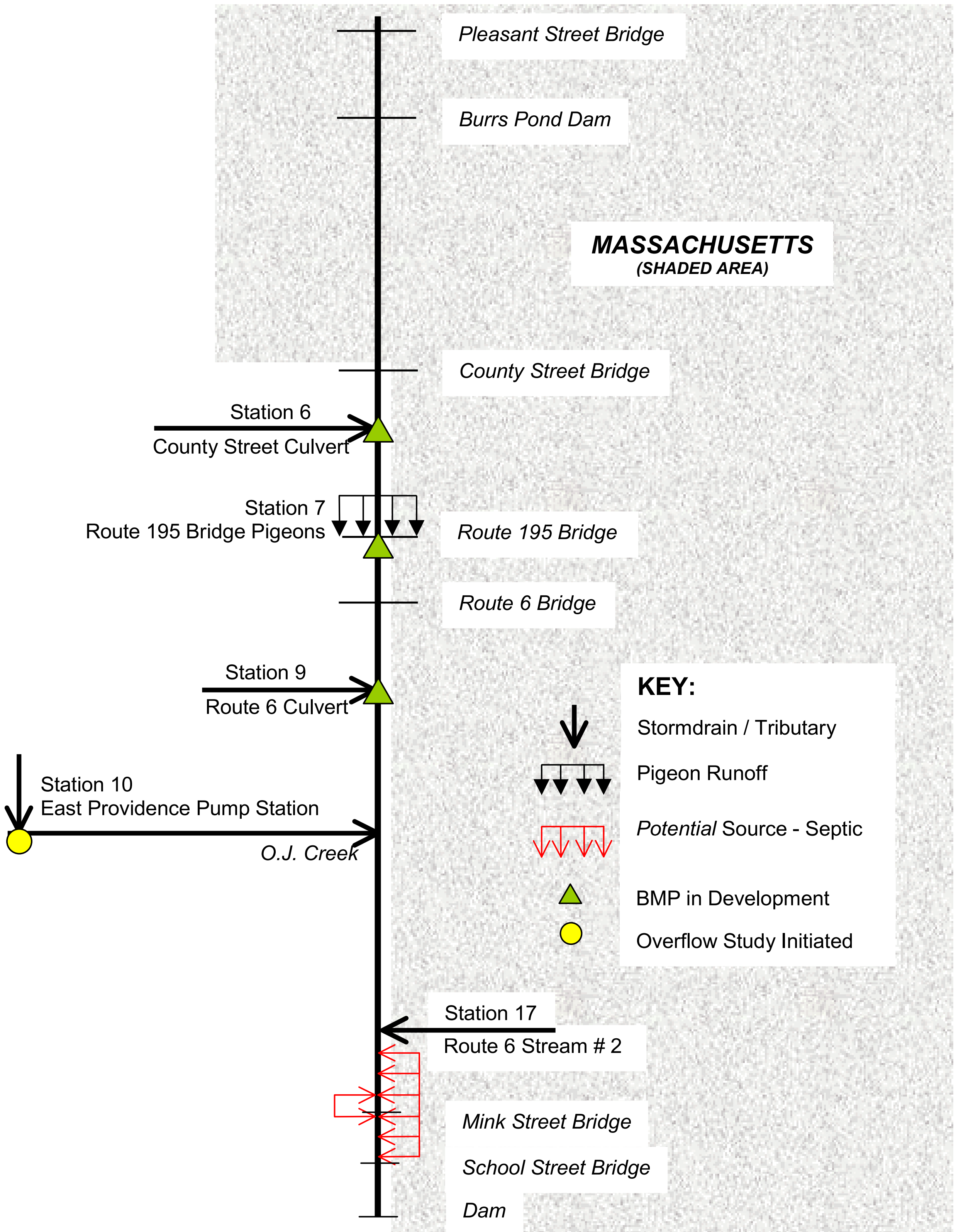

Figure 1: Diagram of pollution sources and implementation actions initiated in the Runnins River watershed.

disturbed. This study calls for further investigation into the causes of bacterial impairment of the river in dry weather.

The existing load attributed to known and potential sources to the Runnins River in dry weather is listed in Table 2 below. The existing loading is attributed to the five factors because the relative contributions of each factor could not be determined. Further investigation will be needed to determine the magnitudes of individual sources listed as sources in the table.

Table 2: Known and potential dry weather sources in the Runnins River

Known (K) & Potential (P) Sources/Problems	Existing Load (fc/100 ml)
Instream bacterial growth (K)	3.30×10^{11}
Route 195 stream (K)	
Suspect septic systems - Seekonk (P)	
Suspect septic system - East Providence (P)	
Wildlife[1] (P)	

[1] Wildlife other than the pigeons impacting the Route 195 stream.

A wet weather study conducted by RIDEM in 1995 identified four significant sources below County Street. The sources were sampled over the course of the event and evaluated in load (fc/day) units. The principal findings are summarized in Table 3. The Route 6 stream #2, the largest source (3.84×10^{11} fc/day), drains an area of Seekonk adjacent to the Route 6/Mink Street intersection. The County Street Culvert was the second largest source (2.73×10^{11} fc/day), and drains a portion of County Street in Seekonk and parts of Waterman Avenue in East Providence. The third largest source (1.92×10^{11} fc/day) was attributed to the Route 195 stream that empties into the river approximately 100 meters below County Street. Subsequent investigation linked the fecal coliform load to a large population of pigeons roosting under the Route 195 overpass. The fourth source, (1.77×10^{11} fc/day) was Orange Juice Creek, which drains a large area of East Providence. Follow-up investigation revealed that the Wannimoisett Road Pump Station in East Providence periodically overflows when the pump is unable to keep up with peak system flows. In that case, backpressure causes the overflow of a relief line that discharges to the Creek. It is not known if this condition occurred at the time of the 1995 wet weather survey. Other potential wet weather sources to the Creek include runoff from residential areas at the headwaters to the creek , Route 114, and commercial developments along Amaral Street on the lower creek.

The wet weather study revealed a number of potential problems in the waters of Massachusetts upstream of the study area. Wet weather loadings from the area upstream of Pleasant Street (Massachusetts) were considered high because fecal coliform concentrations observed during the initial stages of the storm, 360,000 fc/100 ml, were the highest observed in the system. The loading from Pleasant Street was sufficiently attenuated by the Grist Mill Pond and Burrs Pond during the course of the study, and the net instream fecal coliform flux at County Street remained low. The extent to which wet weather concentrations were attenuated by detention in the two ponds was not resolved. A large resident population of domestic and wild waterfowl congregates in the Grist Mill Pond and in the adjacent parking lot. Loadings from waterfowl may be attenuated by detention in Grist Mill Pond and downstream by Burrs Pond, but would be expected to contribute to levels downstream.

Table 3: Wet weather sources in the Runnins River (RIDEM 1995 study)

<table>
<tr><th>Source</th><th>Existing Load
(fc/day)</th><th>Existing Load[2]
(fc/day)</th></tr>
<tr><td>Route 6 Stream #2</td><td>3.84×10^{11}</td><td rowspan="7">1.16×10^{12}</td></tr>
<tr><td>County Street Culvert</td><td>2.73×10^{11}</td></tr>
<tr><td>Route 195 Stream</td><td>1.92×10^{11}</td></tr>
<tr><td>OJ Creek</td><td>1.77×10^{11}</td></tr>
<tr><td>Route 6 Culvert</td><td>6.00×10^{9}</td></tr>
<tr><td>Above County Street</td><td>4.00×10^{10}</td></tr>
<tr><td>Other nonpoint sources</td><td>7.10×10^{10}</td></tr>
</table>

Natural Background

The geometric mean fecal coliform concentration is 72 fc/100ml at County Street, the upper limit of the study area, is considered to be representative of the background condition of the river to this point. Below County Street, land use changes to a high intensity commercial use. Fecal coliform concentrations show a distinct seasonal elevation during the summer months particularly in the reach below Route 6 Stream #1. The cause of the seasonal elevation is not clearly understood, and may be related to bacterial survival or growth during the summer months. At present, the natural background loads or concentrations therefore could not be quantified and separated from nonpoint loads.

Critical/Seasonal Conditions

Critical conditions in the Runnins River occur during the months of July through October when violations of fecal coliform water quality criteria occur most often. The TMDL endpoint was set to achieve water quality criteria during this critical period and will therefore be protective throughout the year.

4. TMDL - Linking water quality and pollutant sources

TMDL Loading Capacity

The TMDL loading capacity for fecal coliforms is expressed as a loading in mass per unit time units (numbers of coliform bacteria/day) following EPA guidance (Section 130.33 of the Clean Water Act). The Runnins River loading capacity is limited by the need to meet the numeric endpoints for the downstream waters of the Barrington River. These targets are established for the School Street Bridge, which is the most impaired location in the river.

Linking pollutant loading to a numeric target

The allowable dry weather load was calculated as the product of the concentration target of 14 fc/100 ml and the observed mean July - October dry weather discharge of 0.242 m^3/s. The allowable dry weather load is 2.93×10^9 fc/day. The allowable wet weather load was calculated in a similar manner using the RIDEM 1998 wet weather event mean discharge of 0.54 m^3/s. The corresponding allowable wet weather load is 6.5 x 10^9 fc/day.

Supporting documentation for the TMDL analysis
The supporting documentation pertaining to the Runnins River includes historical studies and the Barrington River TMDL listed in Section 10 of this document.

Strengths/Weakness in the overall analytical process
Principal strengths of the information and approach used in this allocation are:

1) Dry and wet weather loadings from the Runnins River were determined through direct measurements during dry and wet weather;
2) Storm related loadings from tributaries and storm drains entering the Runnins River were determined through wet weather studies;
3) Supplemental monitoring data collected independently by other parties was used to confirm data collected in RIDEM studies;
4) Historical trends in water quality dating back to 1990 were used;
5) Seasonal trends in water quality were investigated to identify the critical condition period.

The principal weakness of this analysis was that the determination of dry weather sources was inconclusive. Even after a determined sampling effort, no discrete dry weather sources were found within the hot spot, which extends from Route 6 Stream #2 to School Street.

5. Load allocations

Dry Weather
With the exception of the Route 195 stream, no dry weather sources could be identified in the watershed. The increased summer season fecal coliform concentrations in the lower reach of the river were attributed to natural conditions such as low flow or stagnant waters, elevated temperatures, and the dense growth of Phragmites. The study concluded that Phragmites blocked penetration sunlight and provided a medium for coliform accumulation and proliferation.

Table 4 presents the dry weather allocations for the Runnins River. The geometric mean allocations were based on the maximum loading from the Runnins River that would allow water quality standards to be met at the head of the Barrington River.

Table 4: Runnins River dry weather load allocation

Criterion	Existing Load (fc/day)	Discharge[1] (m^3/s)	Existing Concentration[2] (fc/100 ml)	Allocated Load (fc/day)	Target Concentration (fc/100 ml)	Percent Reduction
Geometric Mean	3.30 x 10^{11}	0.242	1576	2.93 x 10^9	14	99.1

[1] Discharge is the summer mean value obtained from RIDEM measurements during 1996 and 1997.
[2] The existing concentration was derived from the RIDEM studies conducted between 1995 and 1999.

Wet Weather
Wet weather sources to the river are summarized in Table 3. Four significant sources were found in the reach below County Street. RIDEM has additionally proposed a BMP for a fifth source in

this reach, the Route 6 Culvert, which routes storm water runoff to the river from Route 6 in East Providence. The five largest sources accounted for approximately 89% of the observed wet weather load to the River. Contributions from all other measured nonpoint sources below County Street account for approximately 7% of the total wet weather loading. Sources in the watershed upstream above County Street accounted for approximately 4% of the wet weather load.

The wet weather reduction target for the Runnins River is presented in Table 5. The geometric mean allocation is controlled by the need to meet the SA standard at the head of the Barrington River. Existing discharge and geometric mean concentrations were obtained from the RIDEM 1998 wet weather study. The resulting load reduction is 99.6%.

Table 5: Runnins River wet weather load allocation

Criterion	Allocated Load (fc/day)	Discharge (m^3/s)	Target Concentration (fc/100 ml)	Existing Load (fc/day)	Existing Concentration (fc/100 ml)	Percent Reduction
Geometric Mean	6.5×10^9	0.54	14	1.50×10^{12}	3211	99.6

Table 6 presents the load allocations for the Runnins River based on meeting the variability criterion of the water quality standard. The limiting condition was determined to be that for the downstream waters of the Barrington River, which requires that less than 10% of samples in the Runnins River at School Street may exceed a concentration of 49 fc/100 ml.

Table 6: Runnins River load allocations and reductions based on the variability criterion.

Criterion	Discharge (m^3/s)	Target Concentration (fc/100 ml)	Existing Concentration (fc/100 ml)	Percent Reduction
90^{th} Percentile	0.54	49	12100	99.6

The Pokanoket Watershed Alliance (Rayner) wet and dry weather data were used to determine the 90^{th} percentile concentration at School Street because a considerably larger number of samples were available from this data set. RIDEM decided to restrict the use of the Rayner data to providing estimates of the variability of the data. The 90^{th} percentile value from the Rayner data was determined to be 12,100 fc/100 ml. The 99.6% reduction needed to the existing 90^{th} percentile concentration to 49 fc/100 ml, is equivalent to that needed to meet the wet weather reduction target in Table 5.

6. Point sources – waste load allocation

The Wannimoisett Road Pump Station in East Providence is considered a point source due to periodic overflows of partially treated sewage. However, since the overflows are considered a violation, a waste load allocation of zero is assigned to the Wannimoisett station. The waste load allocation for any future point sources in this watershed is 0 fc/day. In this TMDL report, all storm water discharges are considered nonpoint sources. Where appropriate, RIDEM specifies the investigation and/or implementation of stormwater BMPs to reduce pollutant loads through detention and infiltration. The City of East Providence, the Town of Barrington, and RIDOT should evaluate opportunities for stormwater attenuation in the watershed. Actions to achieve the required reductions can be taken voluntarily prior to the issuance of Phase II Stormwater Permits, or will be required by the Phase II permits.

7. Margin of safety (MOS)

The MOS for this TMDL is incorporated implicitly into estimates of current pollutant loads, the targeted water quality goal (i.e., the instream numeric endpoint), and the load allocations. This is done by making conservative assumptions throughout the TMDL development process. Key assumptions are described below.

1) The geometric mean numeric target value for the Runnins River at its point of discharge to the Barrington River of 14 fc/100 ml is considerably lower than the standard of 200 fc/100 ml for Class B waters.

2) The 90th percentile concentration target of 49 fc/100 ml is also significantly lower than the 80th percentile criterion of 500 fc/100 ml for Class B waters.

3) Reduction targets are based on conditions at School Street, which is the most impaired location in the river. If the targets are met at this location, they will also be met in the rest of the river.

4) Wet weather conditions were based on storm flow data from a rainfall event of 0.93 inches. Based on the frequency of rainfall events recorded at T.F. Green Airport (Warwick), 81% of rainfall events are equal to or less than 0.93 inches.

5) The TMDL was developed for the July - October period, a period in which fecal coliform concentrations are significantly elevated relative to other seasons.

8. Implementation plans

Plans are in place to reduce a significant portion of the current load. Key areas in which progress is already underway are described below.

BMP's / Initiatives Under Development

1. County Street Culvert - The County Street Culvert was identified as the second largest wet weather source of fecal coliform to the Runnins River (RIDEM, 1996). RIDOT has preliminary plans for a storm water BMP to remove sediments. Plans have been made with RIDOT and RIDEM for RIDOT to further sample the storm drain system once the pigeon deterrent structure is in place. The City of East Providence will also be mapping the County Street storm drain system and inspecting for illicit connections as part of an SEP.

2. Route 195 Stream - Under a RIDOT contract, a pigeon deterrent BMP is currently being designed to prevent pigeons from nesting under the Route 195 Bridge. The Route 195 Stream was the sole identified dry weather source and the third largest wet weather contributor of fecal coliform to the Runnins River (RIDEM, 1996). This BMP may also reduce loadings at County Street because runoff from the bridge does flow to the County street drain.

3. Orange Juice Creek - On December 29, 1998, a Notice of Violation (NOV) was issued to the City of East Providence (NOVCI1342) for periodic overflows of partially treated sewage and rain water from the Wannimoisett Road Pumping Station, as well from a manhole on the corner of Boyd Avenue and Howland Avenue. Past overflows entered a wetland and Orange Juice Creek, identified as the fourth largest wet weather fecal coliform source to the Runnins River (RIDEM, 1996). To resolve the NOV, the City of East Providence and RIDEM entered a Consent Agreement, which requires that the City implement short and long term measures to eliminate these discharges. The City of East Providence is currently adding hypochlorite to bypassed effluent and is monitoring all bypass events as a temporary measure until the bypass problems are resolved.

   The City of East Providence is currently investigating the cause of high infiltration and inflow (I/I) into the facility collection system. It is hypothesized that flow is entering the system by illegal connections to storm drains (discharging sump pump water) and/or infiltration of groundwater at high groundwater table levels. As part of the infiltration study, suspect locations in East Providence will be investigated to locate sources of illegal discharges to the system. Infiltration of groundwater into the system will also be investigated. The results of the investigation were due in August 2000. Additional work may be required pending results of the study.

   In addition to the I/I study, a pump efficiency study will be conducted to minimize bypass volumes. This study was scheduled for completion in November 2000. Also, a sewer capacity study will be conducted to determine the capacity of the sewer system, and to determine if any blockages or obstructions may be causing problems. The sewer capacity study was scheduled for completion in July 2000.

   The consent agreement also requires that the City of East Providence survey the stormwater drainage system and incorporate it into GIS as a Supplemental Environmental Project (SEP). As part of the SEP, the City will eliminate all illegal discharges to the storm drainage system that pose a threat to public health or the environment (that is, sewage discharges, floor drains, etc.).
4. Route 6 Culvert - A storm water BMP is currently being designed under a RIDOT contract, to remove sediments from a culvert draining the area along Route 6 in East Providence next to the river. The Route 6 Culvert was not identified as a significant source of fecal coliform, however, sedimentation of this area has been observed.

5. Failing septic system identified in East Providence - A gas station on the East Providence side of the river was cited in October 1999 for a septic system failure. A new system design

was evaluated by both the RIDEM ISDS section and TMDL section and was approved. The new system became operational in April 2000.

Planned BMPs / Initiatives

Additional work will be necessary in order to achieve the TMDL goal for the Runnins River. Further efforts will be required from the State of Rhode Island, the Commonwealth of Massachusetts, and by EPA Region I (New England). In addition to the above mentioned efforts currently underway in Rhode Island, the following actions to further improve water quality are identified for the remaining problems areas which are primarily located in Massachusetts:

1) Design and construct stormwater BMP for Route 6 Stream #2. Route 6 Stream # 2 was identified as the largest wet weather contributor of fecal coliform to the Runnins River (RIDEM, 1996).

   Currently, the surrounding wetland provides little storage for storm water runoff. The wetland also functions poorly as a pollutant buffer for the Runnins River. For example, the Route 6 Stream #1 which is also adjacent to the Seekonk commercial district drains a larger area, which extends past Route 195 to the north. This stream had similar flows during the 1995 storm because a significant amount of runoff was diverted into retention ponds. Fecal coliform concentrations were an order of magnitude lower than those in Route 6 Stream #2 (RIDEM, 1996). A BMP to collect storm water runoff would help reduce storm-related loadings to the River by reducing the volume of runoff entering the River during rain events. In addition to a BMP, it is recommended that an investigation into illegal connections to storm drains in this area be conducted. The Town of Seekonk, with assistance from other Massachusetts agencies, has obtained 604(b) funding to address stormwater loadings to this area.

2) Evaluate the sustainable transition from Phragmites to other wetland plant species in the area between Route 6 Stream #2 and School Street.

   The wetland is comprised almost entirely of Phragmites, which has little habitat or food value for wildlife and has been shown to create conditions that promote instream growth of bacteria. In addition to improving habitat value, transition to other wetland plant species would be intended to reduce the instream growth of bacteria by exposing the area to sunlight and improving water movement.

3) Characterize ground water quality in the Mink-School-Leavitt Street area on the Seekonk side of the Runnins River.

   This issue should be addressed as a last resort in the event that other approaches to identifying the bacteria sources in the lower Runnins River are not successful. The area bounded by Mink-School-Leavitt Street is within the hot spot area of high fecal coliform concentrations, which exceed water quality standards during the summer months. A groundwater characterization of this area would give an indication as to the likelihood of septic system impacts to the Runnins River.

4) Investigate the cause of elevated dry/wet weather fecal coliform concentrations at Pleasant Street (Massachusetts).

   MADEP conducted sampling during 1999 that confirmed the RIDEM findings and has indicated its concurrence on this issue.

5) Deter waterfowl from the Grist Mill Pond.

   A large population of domestic and wild waterfowl congregates in the Grist Mill Pond and in the adjacent parking lot. Loadings from waterfowl are largely attenuated by detention in Grist Mill Pond and downstream by Burrs Pond, however, improvement to the downstream mean value would be expected if this source was removed.

6) Stormwater Phase II Permit Program

   RIDEM has amended the existing Rhode Island Pollution Discharge Elimination System (RIPDES) regulations to include Phase II Storm Water Regulations. The new regulations became effective in March 2002. Under the program, operators of municipal separated storm sewer systems (MS4s) must develop stormwater management programs, control runoff from small construction sites, investigate and eliminate illicit discharges, utilize pollution prevention/good housekeeping practices, and educate and involve the public in stormwater related issues. These aspects of the Phase II program should have a positive impact on water quality in the Runnins River watershed, however, it is difficult to assign load reductions resulting from these actions.

   The RIPDES Phase II Regulations require operators of municipal separate storm sewer systems (MS4s) within urbanized areas (UAs) or densely populated areas (DPAs) to develop Stormwater Management Program Plans (SWMPP) and obtain permits for areas in their UA or DPA by March 10, 2003. The MS4s that discharge to the Runnins River are owned and operated by the City of East Providence and RIDOT. Areas in Rhode Island adjacent to the Runnins River are designated as a UA. Accordingly, the City of East Providence and RIDOT will be required to apply for RIPDES permits for those portions of their MS4s located within the UA by March 10, 2003.

   The Phase II Program establishes six minimum measures that must be addressed by all SWMPPs. This TMDL also specifies that the SWMPPs submitted by East Providence and RIDOT provide for the design and installation of structural BMPs at the locations identified in Table 7 below. The BMP designs must reflect treatment levels needed to meet the reduction targets of this TMDL, focusing on methods to reduce peak stormwater flows reaching the creek through improved detention and infiltration. RIDEM will continue to work with RIDOT and East Providence evaluate locations and designs for storm water control BMPs throughout the watershed. In accordance with the requirements of this phased TMDL, monitoring of the Runnins River will continue so that the effectiveness of ongoing remedial activities can be gauged.

A summary of the current and proposed work in the Runnins River watershed is shown below in Table 7.

9. Proposed plan for future monitoring

Continued monitoring of the Barrington, Runnins, and Palmer River is needed to confirm whether or not desired water quality standards have been met. The monitoring conducted by volunteers, such as the Pokanoket Watershed Alliance, will be valuable in gauging the effectiveness of the BMPs.

During the implementation phase of the TMDL, RIDEM has recruited volunteers through the Pokanoket Watershed Alliance to sample four stations in the Runnins River and one station in the Barrington River. The Runnins River stations are located below the Burrs Pond Dam and at School Street. The stage of the river should be recorded at School Street during each sampling survey. RIDEM also recommends periodic sampling of Orange Juice Creek at Catamore Boulevard during or after periods of wet weather to verify that improvements at the Wannamoissett Street pump station and improvements in stormwater management in the watershed have improved the wet weather condition of the creek. RIDEM also recommends that a water quality station be located near the Tongue in the Barrington River. At these two stations, volunteers will collect fecal coliform samples and record instream temperatures on a monthly basis from July through October.

The Barrington and Palmer Rivers are sampled monthly by the Shellfish Growing Area Water Quality Monitoring Program. At the present time, all stations in the Barrington River exceed water quality standards. If the numerical water quality target set by this TMDL is met for the Runnins River, the Barrington River shellfish stations should meet standards. When these stations begin to meet water quality standards, additional monitoring for the northernmost shellfish stations will be performed by RIDEM.

10. Public participation

The New England Interstate Water Pollution Control Federation (NEIWPCC) established the Runnins River Steering Committee in 1993. This group of stakeholders includes participants from municipalities, states, EPA, and volunteer monitoring groups. The group was formed to facilitate communication among interested parties in the Runnins River watershed, which is part of the Barrington River watershed. The group has bimonthly meetings that are open to the public. The Runnins River Steering Committee participated in the 1995 wet weather study of the Runnins River and has contributed actively to the content of the ongoing work by RIDEM. The committee has ensured that improvements to the water quality of the Runnins and Barrington Rivers have remained on the agendas of the state and federal agency agendas.

RIDEM has been involved with the Runnins River Steering Committee from its creation. RIDEM routinely presents information on its activities in the watershed at the bimonthly meetings. The members of the committee help shape RIDEM's activities in the watershed by identifying areas that need more study. Members of the Pokanoket Watershed Alliance, a volunteer monitoring group, present information on routine water quality monitoring at stations in the Runnins and Barrington Rivers. RIDEM used this information in the development of the TMDL endpoints.

Public meetings and comment are an important component of the TMDL process. In addition to participating in the Runnins River Steering Committee meetings, RIDEM held an initial public meeting in July 1999 prior to developing the draft TMDL that was attended by interested public, private, and government entities. The goal of the meeting was to provide information regarding the TMDL issues in the watershed and to solicit input regarding pollution sources and/or other concerns. The draft Runnins and Barrington TMDLs were presented in a public meeting in June 2000. Public comment was solicited for a thirty-day period during and after the meeting. EPA comments on the draft Barrington River TMDL made it necessary to hold a final public meeting and notice period for both TMDLs in July - August 2002. Stakeholders were again given thirty days to review and submit comments on the draft Runnins and Barrington River TMDLs. RIDEM's response to comments made during the 2000 and 2002 comment periods are contained in Appendix F to this document.

Table 7: Summary of current and proposed work in the Runnins River watershed

Known (K) or Potential (P) Source or Vegetation (V) Problem	Jurisdiction	Abatement Measure	Status
County Street Culvert (K)	RIDOT	Storm water BMP	Completion pending availability of funds
Route 195 Stream (K)	RIDOT	Pigeon Deterrent BMP	Completion pending availability of funds
Route 6 Culvert (K)	RIDOT	Storm water BMP	Completion pending availability of funds
OJ Creek (K)	City of East Providence	Repair Wannimoisett pump station	I/I study, capacity study, pump study completion in 2001
OJ Creek (K)	City of East Providence/ RIDOT	Storm water BMPs	To be implemented under Phase II Stormwater Program
Septic system - East Providence (P)	RIDEM	Repair failing septic system near Mink Street	Completed (3/2000)
Illegal sewer connections (P)	City of East Providence	Investigate illegal connections to storm drains/Map storm drain network	Completion in 2002
Route 6 Stream #2 (K)	MADEP	Storm water BMP	MA EOEA has obtained 604(b) grant to evaluate sources and potential remedies.
	Town of Seekonk	Map storm drain network. Delineate boundaries of storm drain catchments/ Investigate illegal connections to storm drains	Recommended by RIDEM
Septic systems – Seekonk (P)	MA EOEA and MADEP	Resolve authority to investigate cesspool under Clean Water Act	Recommended by RIDEM
	MADEP	Groundwater monitoring in the vicinity of Mink, School, and Leavitt Street ("the triangle")	Recommended by RIDEM. To be conducted if other abatement measures fail.
	Town of Seekonk	ISDS investigations and repairs.	Conduct investigations as indicated.
Lower Runnins River (V)	East Providence/ Seekonk, MA EOEA, RIDEM, RI CRMC	Reduce Phragmites densities to restore habitat	MA EOEA, RIDEM, EPA are resolving scope and level of effort issues.
Pleasant Street (P)	MADEP	Investigate cause of elevated dry/wet weather fecal coliform	MADEP has confirmed the elevated concentrations.
Grist Mill Pond (P)	Seekonk animal control office	Remove and deter waterfowl from pond.	Recommended by RIDEM

1.0 INTRODUCTION

The State of Rhode Island's 1998 303(d) List of Impaired Waters identified the Runnins River as being impaired by pathogens, as evidenced by the presence of high fecal coliform concentrations. The purpose of this report is to establish a Total Maximum Daily Load (TMDL) addressing fecal coliform loads to the Runnins River.

1.1 Background

Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting designated uses. The goal of a TMDL is to establish water-quality-based limits for pollutant loadings that will permit water quality to be restored to a point where water quality standards are met and uses are restored. The TMDL analysis examines point sources, such as industrial and municipal wastewater treatment facility discharges, and nonpoint sources, such as storm runoff from urban and agricultural areas. Natural background sources are included in the analysis, along with a margin of safety to account for variability in the data used to characterize the water body and the sources, and the modeling analysis. The objective of a TMDL is to establish loading limits for the water body that will permit it to remain within the water quality standards set by the state, thereby restoring the designated uses and suitability as habitat.

This TMDL addresses the Class B waters of the Runnins River, water body ID RI0007021R-01, from the County Street Bridge at the Rhode Island – Massachusetts border where the river enters the state, to the Mobil Dam, where the river forms the head of the Barrington River.

1.2 Pollutant of concern

The Runnins River has been found to violate the State's water quality criteria for fecal coliform bacteria. The fecal coliform concentrations are of concern because elevated fecal coliform concentrations indicated increase risk to human health through direct contact with the waters of the river. As a result, the river was placed on the State's 303(d) list of impaired waters as impaired over a distance of 2.807 miles.

1.3 Applicable water quality standards

All surface waters of the state have been categorized according to a system of water quality classification based on consideration for public health, recreation, propagation and protection of fish and wildlife, and economic and social benefit. Each class is identified by the most sensitive, and therefore governing, water uses to be protected. Surface waters may be suitable for other beneficial uses, but are regulated to protect and enhance designated water uses. It should be noted that water quality classifications reflect water quality goals for a water body and may not represent existing conditions (RIDEM, 1997a).

One of the major components of a TMDL is the determination of a pollutant load or load reduction necessary to ensure that the waterbody will attain and maintain water quality standards. In this document, the allowable loads are linked to the achievement of instream numeric concentration endpoints, which are used to evaluate the attainment of acceptable water quality. The concentration endpoints represent the water quality goals to be achieved by implementing the load reductions specified in the TMDL. The endpoints allow for a comparison between current instream conditions and conditions that are expected to restore beneficial uses. The endpoints are usually based on either the narrative or the numeric criteria available in State Water Quality Standards.

The water quality designation for the Runnins River is Class B. These waters are designated as suitable for such uses as fish and wildlife habitat and primary and secondary recreational activities. The Rhode Island state standard for Class B waters specifies that the geometric mean concentration of fecal coliforms in a water sample may not exceed most probable number (MPN) value of 200/100 ml. Concentrations also must not exceed 500 MPN /100 ml in more than 20 percent of samples collected (RIDEM, 1997a). In general, the TMDL endpoints are determined directly from the State Water Quality Regulations. However, in some cases, if the impaired water of concern empties into a water body of a higher water quality class, downstream water quality should be factored in the development of a TMDL endpoint goal for the upstream water body.

The Barrington River is discussed in this document because the Runnins River has been found to exert a significant influence on its water quality. The Barrington River is formed at the mouth of the Runnins River in East Providence where the Runnins discharges over the Mobil Dam. The Barrington River extends in a southeasterly direction approximately 5 miles to the confluence with the Palmer River where the Warren River begins. Between the Mobil Dam and the East Bay Bike Path in Warren, the Barrington River is Class SA. The remainder of the River south of the Bike Path is classified as SB1.

The northern portion of the Barrington River, which is directly impacted by the Runnins River, does not currently meet the designated use for Class SA waters. Uses for Class SA waters are waters designated for shellfish harvesting for direct human consumption, primary and secondary contact recreational activities, and fish and wildlife habitat. The State standard for Class SA waters specifies that the maximum allowable level of fecal coliform may not exceed a geometric mean of 14 MPN/100 ml and not more than 10% of the samples shall exceed 49 MPN/100 ml.

2.0 DESCRIPTION OF THE RUNNINS RIVER WATERSHED

The Runnins River lies in a 10.2 square mile (6,545 acre) subwatershed within the Warren River basin. The watershed contains the City of East Providence, Rhode Island and the Towns of Rehoboth and Seekonk, Massachusetts (Figure 2.1). The river rises in Rehoboth and flows generally in a southerly direction a distance of approximately 7.5 miles to its mouth. Portions of the lower river form the boundary between East Providence, Rhode Island and Seekonk, Massachusetts. The lower river forms the boundary between East Providence, Rhode Island and Seekonk, Massachusetts. At its mouth, the Runnins River flows over the Mobil dam to form the Barrington River, a tributary estuary to Narragansett Bay. Land use in the Runnins River watershed is approximately 44.4% vacant land, 20.6% residential, 10% industrial (dominated by the 1.25 square mile Mobil Oil facility), 8.3% commercial (90% attributed to Seekonk), 7.1% public parks, 3.7% open space, and 5.9% agriculture (USACOE, 1994) as summarized in Figure 2.2.

The Town of Seekonk comprises the majority of the Runnins River watershed (70%) while East Providence and Rehoboth make up approximately 23% and 7% of the watershed, respectively., North of Pleasant Street in Massachusetts, the watershed consists mostly of wetlands, forested areas, and areas of undeveloped land, residential neighborhoods and agricultural uses (NEIWPCC, 1994). Annual peak stages at a United States Geological Survey (USGS) staff gage located at Pleasant Street were measured from 1967 through 1983 by the USGS. Results of discharge analysis for the 2, 10 50, and 100-year 24 hour events show peak flows of 97, 140, 190, and 220 cubic feet per second (cfs) respectively (USACOE, 1994). The average slope upstream of the gage is approximately 11 feet per mile for its 4.5 mile length. The average elevation in this region is approximately 87 feet above mean sea level. Approximately one quarter of this area provides storage of runoff during rainfall events either in wetlands, lakes, or ponds.

Downstream of Pleasant Street, the watershed changes to mostly commercial and industrial uses. Substantial storage is provided immediately downstream of Pleasant Street by a large wetland area, the Grist Mill Pond and Burrs Pond. There is little storage past this point where commercial development is most concentrated. East Providence, on the west bank of the river, is an established mature urbanized area. Seekonk, on the east bank of the river, is a rapidly developing urbanized area. The average slope of the river from Pleasant Street to the Mobil dam changes to approximately 13 feet per mile for its 3 mile length. The average elevation in this reach is approximately 37 feet.

The Runnins River ends at the Mobil dam, which was built in the 1920's by the Mobil Corporation to divert water to a pump house for industrial use at the Mobil facility. The concrete dam is approximately 85 feet long and 2 feet wide, with a spillway crest estimated to be 4.5 feet NGVD (National Geodetic Vertical Datum). During average tide ranges, the dam is the upstream limit of tidal influence, however the tidal influence will overtop the dam and can extend beyond Mink Street during spring tides. The tidal influence can be expected to reach as far as elevation 10 feet NGVD, or just downstream from Highland Avenue (Route 6) during storm events (USACOE, 1994).

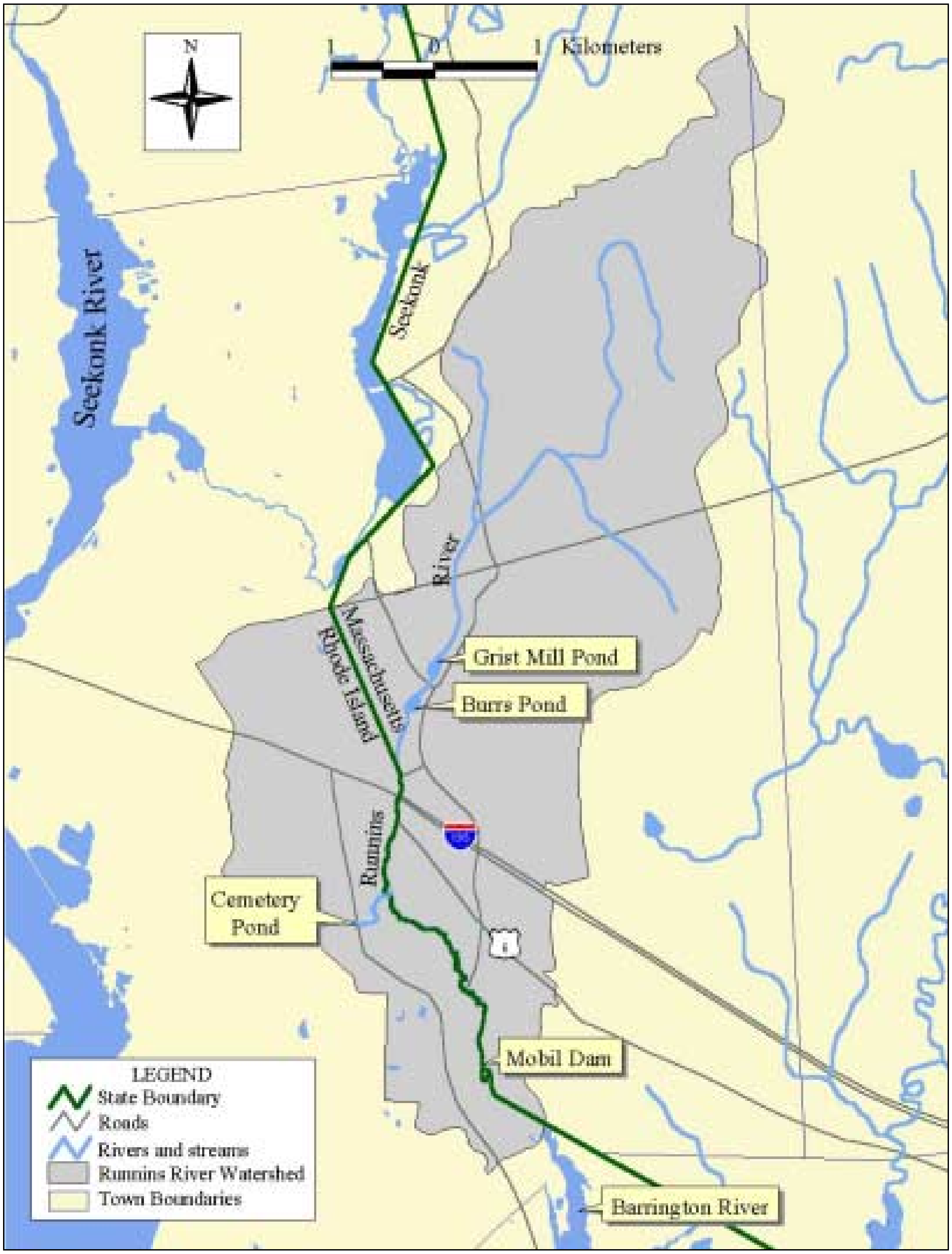

Figure 2.1: Runnins River watershed.

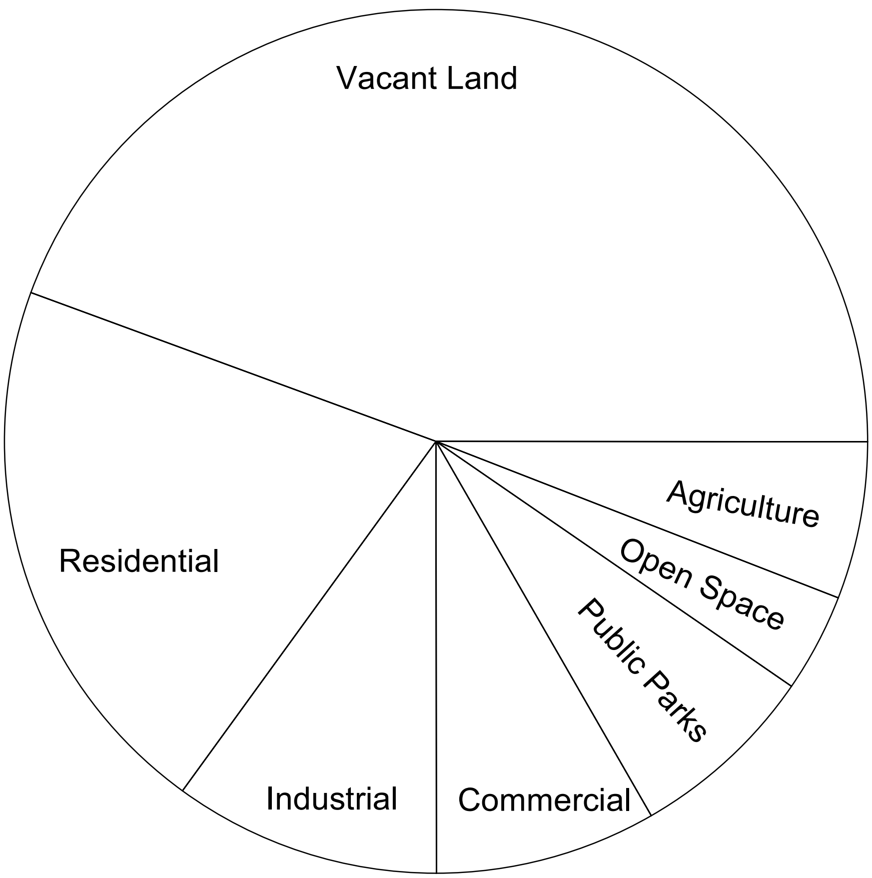

Figure 2.2: Land use in the Runnins River watershed (USACOE, 1994).

The majority of wet and dry weather impairments exist within the industrial and commercial portion of the watershed, located between County Street and School Street. The increase in urbanization within the last decade in Seekonk, Massachusetts has led to a significant increase in impervious areas. Large impervious surface areas increase storm water flows, which can damage wetlands, reduce floodplain capacity and cause erosion of stream banks. In general, sediment deposition is significantly higher in wetlands receiving urban runoff. Sediments carry pollutants and increase turbidity, altering the capacity of the wetlands to provide flood storage and decreases the efficiency of pollutant removal. Suspended or deposited sediments can significantly increase the severity and persistence of bacterial contamination.

The majority of the City of East Providence is serviced by a sewerage collection system. The City of East Providence Wastewater Treatment Facility discharges out of the basin into the Providence River. The Town of Seekonk, which contains significant commercial and residential land, does not have municipal sewers. Wastewater is treated on site via individual sewage disposal systems (ISDS). Soils in various areas of the watershed are generally considered undesirable for development because of poor drainage characteristics and the effects of erosion (USDA, 1981). The hydric soils in surrounding wetland areas are characterized as soils that are capable of storing flood waters but are not suitable for structures.

3.0 DESCRIPTION OF WATER QUALITY ACTIVITIES

The public has actively participated in water quality issues in the Runnins River watershed. The Pokanoket Watershed Alliance (PWA) as well as the Massachusetts Department of Environmental Protection (MADEP), the National Park Service (NPS), the New England Interstate Water Pollution Control Commission (NEIWPCC), the United States Environmental Protection Agency (USEPA), the Massachusetts Riverways Program (an agency of the Department of Fisheries, Wildlife & Environmental Law Enforcement), Mobil Oil Corporation, and RIDEM have conducted various water quality related activities within the watershed. For the purpose of the development of a TMDL, the RIDEM and the PWA data (Rayner, unpublished) was used to characterize current water quality in the Runnins River.

3.1 RIDEM water quality monitoring

RIDEM began a dry weather monitoring program for the Runnins River in 1995 with Section 319 funding. The purpose of the monitoring program was to identify dry weather sources of fecal coliform and their loadings to the Runnins River. Samples were typically collected at 8 stations in the Runnins River and 14 stations at streams or storm drains discharging to the river (Figure 3.1). Stage readings were recorded at the Pleasant Street Bridge, Route 6 Bridge, Mink Street Bridge, and School Street Bridge (stations UR16, R12, R31, and R40). Five dry weather surveys were completed between June 1995 and October 1997. One winter season dry weather survey was completed in January (1997).

RIDEM performed three additional dry weather fecal coliform surveys in June, August, and October of 1999. The primary objective of these surveys was to monitor fecal coliform, temperature, specific conductance, salinity in the reach between Route 6 Stream #2 and School Street on both the east bank and the west bank of the river to find any emerging groundwater plumes. Stages were recorded at the Mink Street Bridge and School Street Bridge (R31 and R40), and discharge measurements were determined for tributary stations entering between Mink Street and School Street. An additional set of water quality samples was collected by disturbing vegetation (Phragmites) in conjunction with the routine monitoring. A stage recorder that also measured stream temperature was deployed during a week-long dye study of the Barrington River to provide information on summer instream temperatures. The dry weather data are used to establish the dry weather concentration at School Street, the mean dry weather discharge of the river, and the dry weather load to the Barrington River in section 4.1 below.

The June and August 1999 surveys also used coliphage/bacteriophage test methods in an attempt to identify non-point pollution sources. Coliphage and bacteriophage are viruses that infect the enteric bacterial species *Escherichia coli (E-coli)*. The F-specific RNA coliphage viruses infect *E-coli* by attaching to the F pili. In general, F-RNA phage are consistently present in sewage and sewage-polluted waters (liquid and solid waste from domestic source, animal processing and combined sewage overflows). F-RNA phage are not consistently present in human feces, but attach after the feces are introduced to the waste stream. The F-RNA phage parameter is therefore considered an indicator of sewage pollution. This method is presently an experimental tool; it is not currently an EPA approved method.

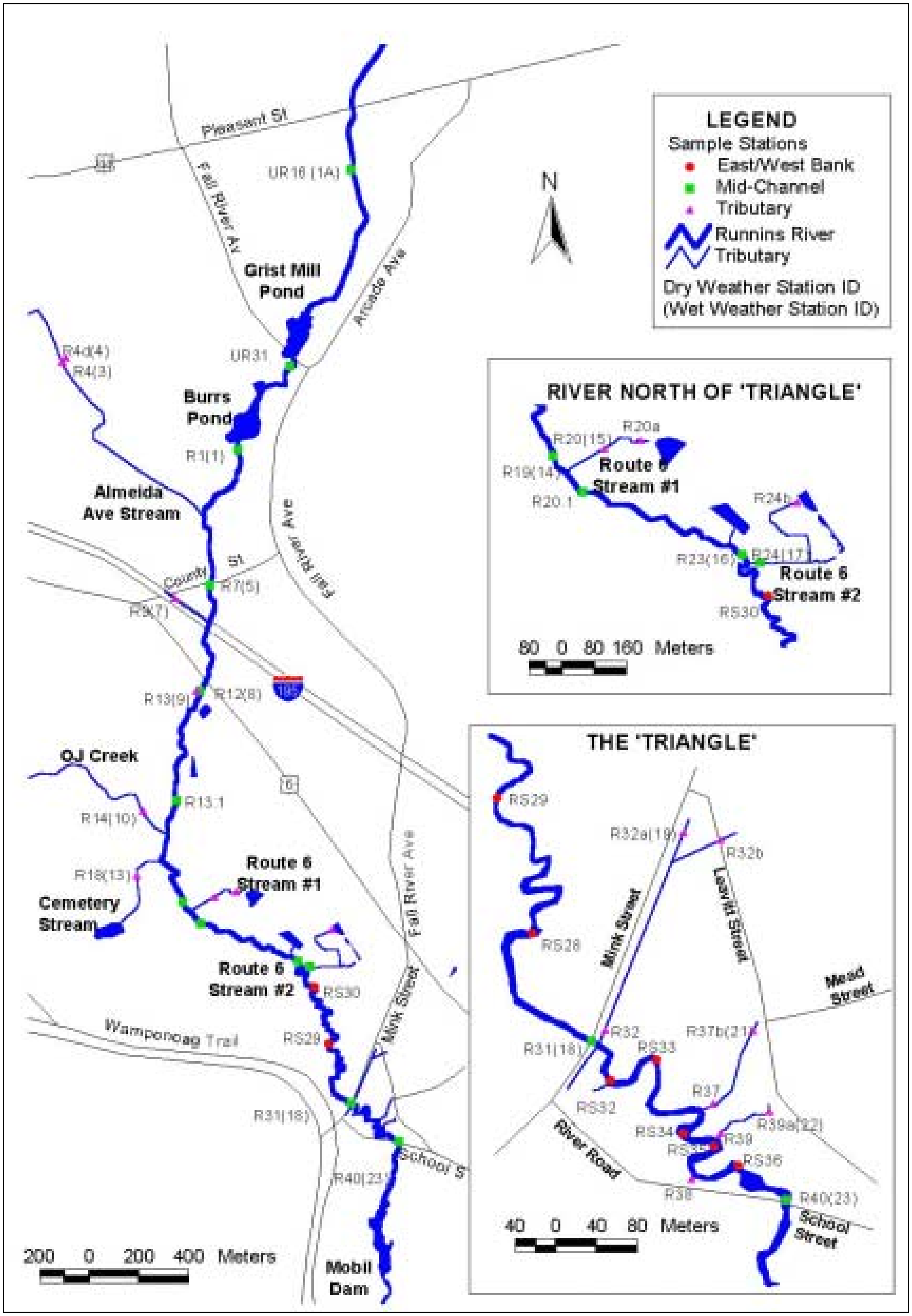

Figure 3.1: RIDEM dry weather sampling stations.

Four serotypes were identified that may indicate human or animal origin, depending upon the serotype or group identified. Groups 1 and 4 phage are predominantly associated with animals. Groups 2 and 3 phage are predominately associated with humans and pigs.

Samples for coliphage analysis were collected at Mink Street, School Street, and Monarch Drive in the Barrington River. The samples were composited from grab samples collected at 8 minutes intervals for 1 hour at low tide. Additional grab samples for coliphage analysis were taken at the Route 6 Stream #2, RS33 and RS35 during the June survey, and Route 6 Stream 32, and the Leavitt North Stream (station R32b) during the August survey. The results of this work are used to infer the nature of dry weather sources to the lower reach of the river in section 4. 1.1.

During October 1995, RIDEM conducted a wet weather survey in the Runnins Rivers sub-basin to assess the nature and locations of bacterial sources (RIDEM, 1996). The characterization was performed by making repeated measurements of river or point source volume flow rate (discharge) and fecal coliform concentration before and during the storm event. Nine instream stations and 13 tributary stations, consisting of streams or storm drains discharging to the river were sampled for fecal coliform and flow rate (Figure 3.1). Measurements were made at regular intervals during the first 4.5 hours following the start of the storm and were preceded by one set of similar measurements made the afternoon before the event. The 1995 study was successful in identifying the specific sources responsible for wet weather impairment of the Runnins River. Because its duration was limited, and because the tide was flooding during nearly all the storm, the 1995 study was not able to provide an estimate of the bacterial loadings from the Runnins to the Barrington River. The 1995 RIDEM wet weather are used to identify the sources that significantly impact wet weather quality in section 4.4.

To address that data gap, RIDEM monitored wet weather fecal coliform loadings from the mouth of the Runnins River, the lower Palmer River, and Rocky Run between October 14 – 17, 1998. The measurements were made to characterize the relative increase in bacterial loadings that accompanied the storm. River stage measurements and water sample collections were made in the Runnins River over three days before, during and after the storm. River stage and temperature were recorded every 15 minutes with a continuous stage recorder. Stages were subsequently converted to volume flow rates using a stage-discharge relationship. Water samples were collected from each tributary as discrete samples using ISCO samplers. The loadings from the upper Palmer River to its estuarine area were also made, however, because the river is tidal at the measurement point, stage measurements were combined with continuous current measurements under the Route 6 bridge in Swansea to capture the direction and magnitude of flow. The discharge was then calculated at 5 minute intervals using the method defined in (RIDEM, 1999). An ISCO sampler was used to sample the in-stream concentration in the manner followed for the Runnins River. Sampling in Rocky Run consisted of concentration sampling, again with an ISCO sampler, and continuous stage measurements. Because Rocky Run was tidal at the sampling location, no effort was made to establish a discharge time series.

Additional sampling was conducted in the Barrington and Palmer River estuaries between October 14 – 20 before, during and after the storm to quantify impacts of the event loadings on fecal coliform levels in the Barrington, Palmer, and Warren Rivers. The 1998 RIDEM wet weather data are used to establish the influence of wet weather loads from the river on the downstream waters of the Barrington River in section 4.2.

3.2 RIDEM survey of area septic systems

The areas of Seekonk adjacent to the Runnins River dispose of sewage using onsite Individual Sewage Disposal Systems (ISDS). Many systems are located in highly permeable soil, with high groundwater tables within 300 to 400 meters of the Runnins River. RIDEM conducted a study into these systems to determine if a relationship could be established between the systems and elevated fecal coliform levels in the River.

The Runnins River Report (NEIWPCC, 1994) included information about septic systems in the Route 6 area that treat over 2,000 gallons per day. RIDEM updated this list by researching the changes in property use as well as adding systems installed since the NEIWPCC study. RIDEM also investigated water consumption rates, the percolation rates used in designing the systems, the systems' ages, and the history of failures to isolate potential problematic septic systems.

RIDEM began its assessment of the septic systems in the area by defining the study area using a 1995 digitized orthographic photograph. The area selected for the analysis was bounded by the intersection of Route 6 and the Runnins River to the north, the intersection of Route 6 and School Street to the south, the Runnins River to the west, and Interstate 195 to the east (Figure 3.2). The area included over 80 buildings whose uses included hotels, restaurants, shopping centers, and gas stations.

Information was not collected on all the facilities because a considerable amount of time was needed to research each facility. Priority was given to those facilities between the Runnins River and Route 6. Design water use, design soil percolation rate, and system age data were obtained from ISDS permit applications filed at the Seekonk Town Hall. Actual water use information was gathered from the Seekonk Water Board. For the facilities in Rhode Island, ISDS information was collected from RIDEM records, while water use information was collected from the East Providence Water Department. The results of the septic system survey are used in section 4.1.2 to evaluate their potential for affecting fecal coliform concentrations in the river.

3.3 Pokanoket Watershed Alliance water quality sampling

Mr. Doug Rayner, a member of the Pokanoket Watershed Alliance, has collected and analyzed fecal coliform samples in the Runnins River watershed on a routine basis since 1990. Mr. Rayner periodically has split samples and had them analyzed by a certified laboratory for quality assurance. Rayner's results have been consistent with those from the laboratory and are considered reliable. Approximately 280 samples were collected during dry weather conditions (not within 3 days of less than 0.20 inches of rain) at station R31, Mink Street, and station R40, School Street since 1990. In 1997, Mr. Rayner began to record river stage and instream temperature during sample collection. Samples were periodically collected at station R12, the Route 6 Bridge. The Rayner dry weather data are used in section 4 to illustrate historical trends, seasonal variations, and provide a comparison with data collected by RIDEM. RIDEM data, however, were used to evaluate compliance with the geometric mean part of the water quality standard for developing the TMDL. Mr. Rayner also collected samples during wet weather conditions, defined as at least 0.20 inches of rain during the previous three days at Mink Street

(R31), and School Street (R40). Over 265 wet weather samples were collected during 1991 through 1999. Several wet weather events were monitored in which samples were collected throughout the event.

Associated rainfall data recorded at T.F. Green State Airport, Warwick, RI (NOAA Climatological Data) were used to differentiate between samples collected during wet weather and dry weather. Stage measurements and instream temperature were measured concurrently at Mink Street and School Street with the water samples collected after August 1997.

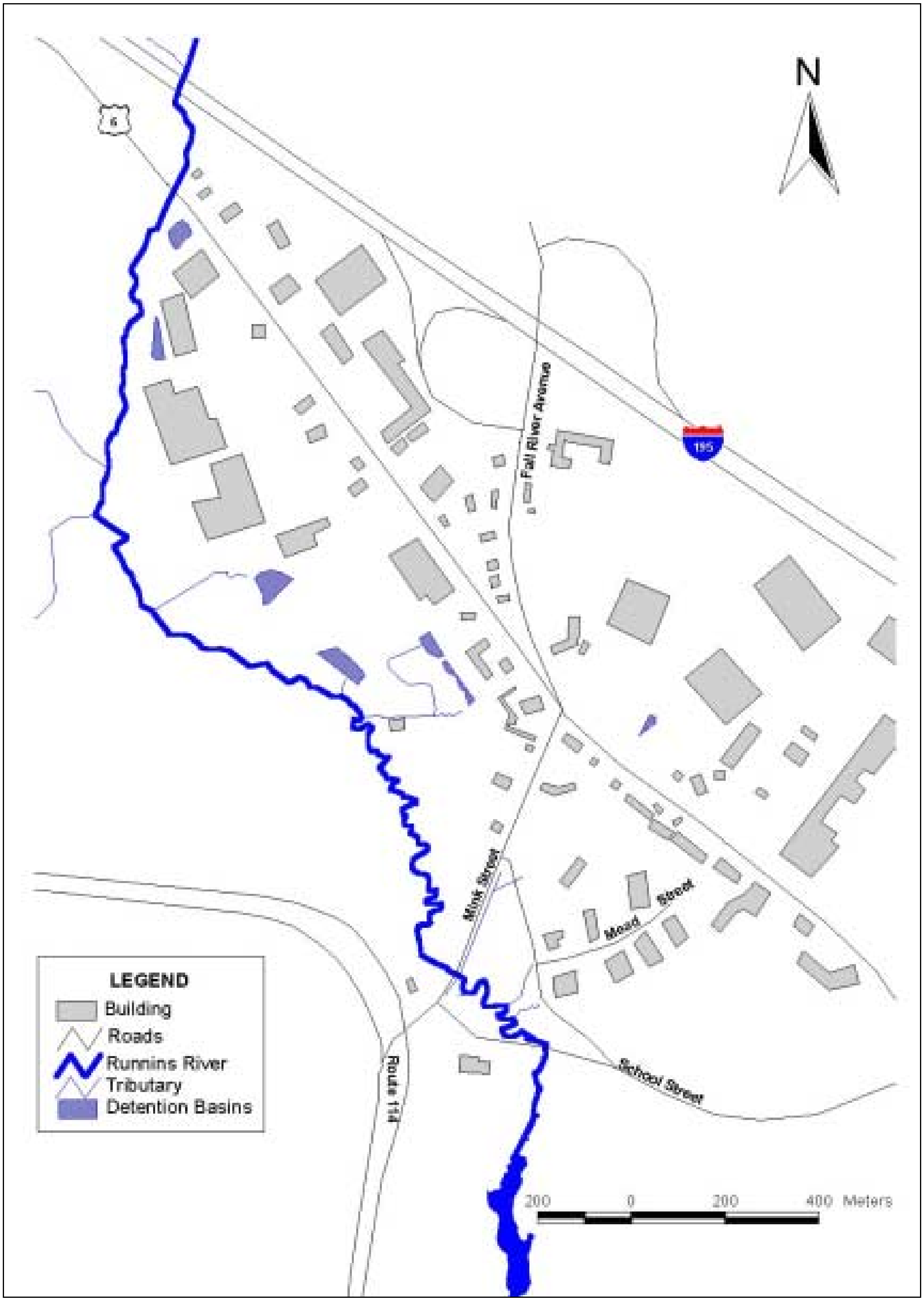

Figure 3.2: Septic system study area.

4.0 WATER QUALITY CHARACTERIZATION

This TMDL examines the reach of the river between the County Street Bridge and the Mobil Dam. Section 4 uses the results of the monitoring activities described in Section 3 to characterize the present condition of the Runnins River.

4.1 Dry weather characterization

During dry weather, the 1995 - 1997 RIDEM data indicate that concentrations at Pleasant Street in Massachusetts (UR16), Mink Street (R31), and School Street (R40) exceed the Class B standard for the geometric mean concentration (Figure 4.1). Samples collected at Burrs Pond Dam (R1) have a geometric mean concentration 48 fc/100ml, well below the Class B standard, and range between 22 and 77 fc/100 ml. Concentrations rise slightly downstream of Burrs Pond to a geometric mean concentration of 72 fc/100ml at County Street (R7). At County Street, land use changes from predominantly residential and forest land uses to predominantly commercial and industrial land uses south of County Street (NEIWPCC, 1994).

Instream fecal coliform concentrations rise to a geometric mean concentration of 126 fc/100ml at the Route 6 Bridge (R12). This rise may be associated with Route 195 stream (R9) which has a geometric mean concentration of 142 fc/100 ml. The relatively high concentration in the Route 195 stream was traced to the large number of pigeons roosting under the 195 overpass.

Below Route 6, the Runnins passes behind a large commercial shopping complex. Instream fecal coliform concentrations drop to a geometric mean concentration of 75 fc/100ml to a point immediately above a stream that drains parts of this area called the Route 6 Stream #1 (R19). The geometric mean dry weather concentration above R19 was 75 fc/100 ml. Below R19, the mean concentration rose continuously to the lowest station in the river at School Street. Instream concentrations at the Route 6 Stream #2 station (R23) were 123 fc/100 ml, increasing to 208 fc/100 ml at Mink Street, and 483 fc/100 ml at School Street. With the exception of the Route 195 Stream (R9), all tributary stations sampled during dry weather had geometric mean fecal coliform concentrations below that of the adjacent waters of the River. No dry weather source was discovered that would account for the concentration rise in the Mink Street - School Street vicinity.

Between June - November 1999, RIDEM targeted the reach below Route 6 Stream # 1 to School Street for more detailed surveys. Station locations are identified on Figure 3.1. Samples were collected near the east and west bank in this reach to identify the locations of concentration changes due to local sources. This approach was not successful, in that it did not reveal any significant differences in samples collected on the east bank compared to samples collected on the west bank (Figure 4.2). During this period, fecal coliform concentrations in tributary streams discharging to the river were lower than instream concentrations. Two streams (stations R32a and R32b) entering the river between Mink Street and School Street were sampled during dry weather conditions approximating base flow conditions. Two streams south of these stations (stations R37b and R39a) are predominately dry or stagnant during the summer periods and were not sampled. Fecal coliform concentrations were as high as 55,000 fc/100 ml within the Mink Street - School Street vicinity in the August survey. Again, no source was discovered that would account for the concentration rise in the Mink Street - School Street vicinity. The dry weather concentration condition at School Street was established from the 1995-1997 and 1999 RIDEM

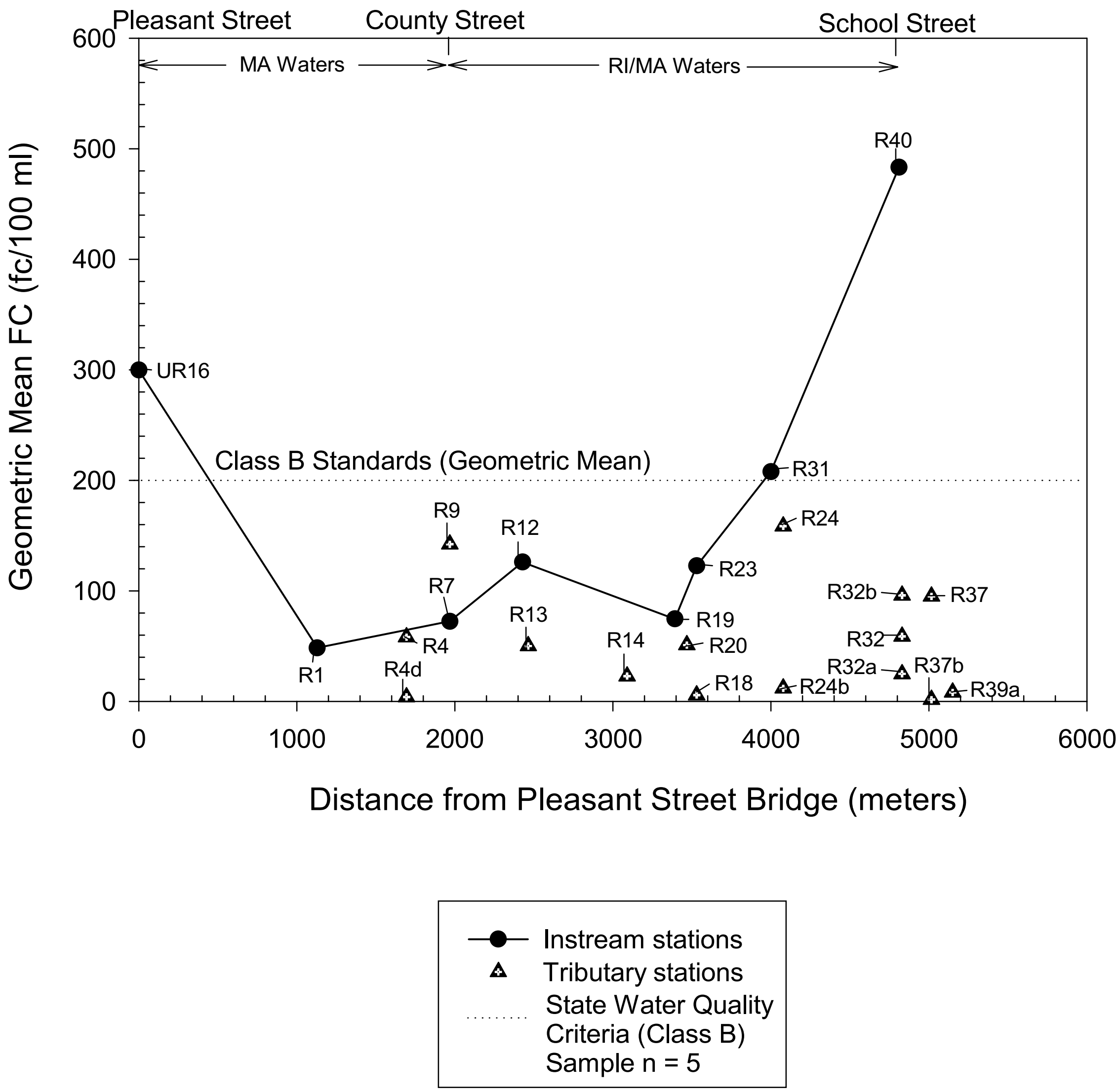

Figure 4.1: Geometric mean fecal coliform concentrations of instream and tributary stations (RIDEM 1995-1997).

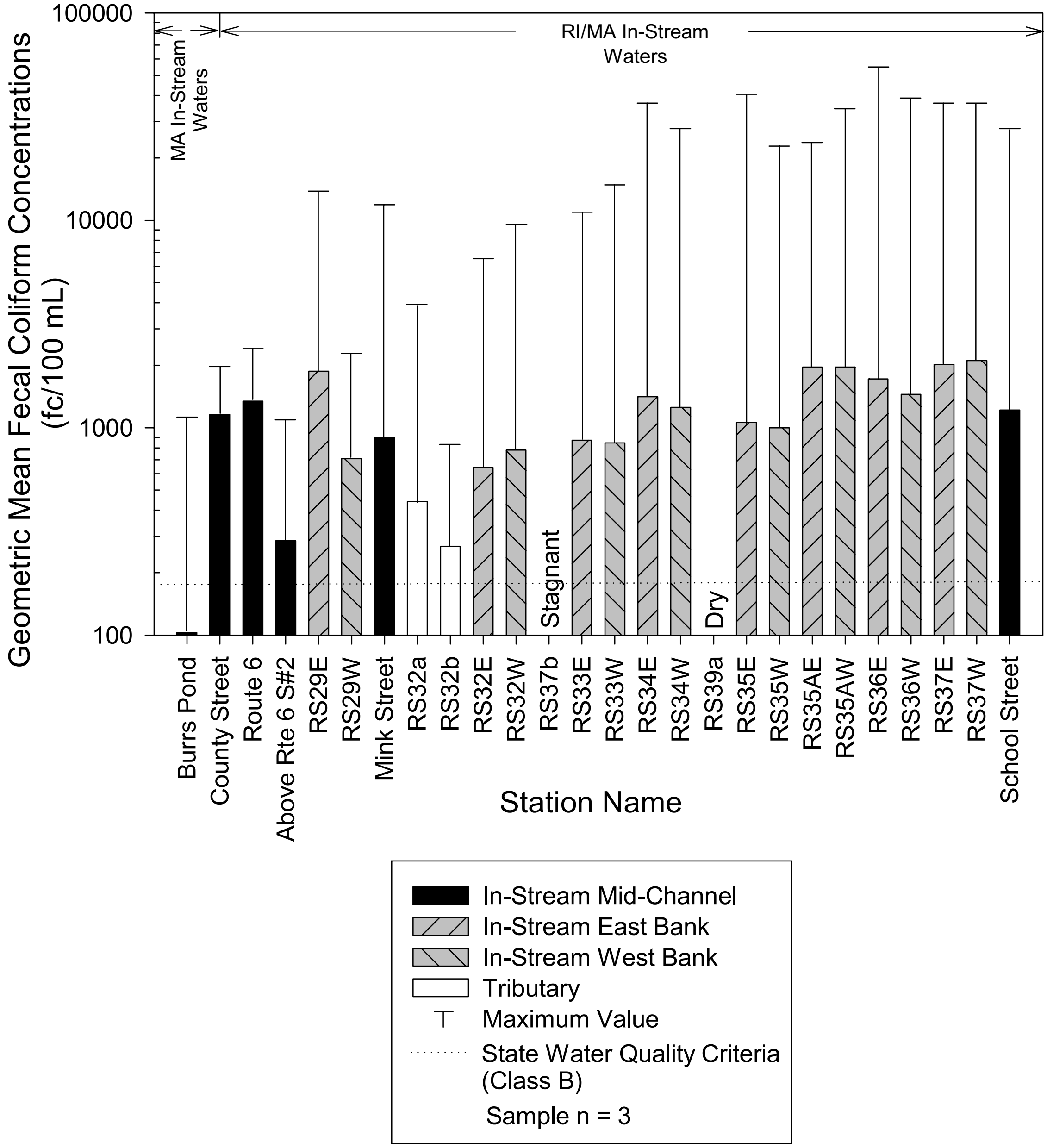

Figure 4.2: Geometric mean fecal coliform concentrations of instream and tributary stations (RIDEM 1999, June - October).

studies as 1576 fc/100 ml.

A subset of paired samples were collected at Mink and School Streets before and after the floating mats of Phragmites in the river were mechanically disturbed by the sampler. In all cases, the water samples collected after the disturbance of the mats were higher than those collected beforehand (Figure 4.3). The conclusion drawn from this exercise is that the Phragmites mats provide surfaces onto which bacteria are adsorbed. A similar response was found by Simmons et al (1995) in a Virginia marsh. The study concluded that the marsh behaved as a natural biological filter for fecal coliform bacteria introduced by the local raccoon population. After the investigators trapped and removed approximately 180 raccoons in the surrounding area, fecal coliform concentrations were reduced by 80%.

While the Phragmites mats provide for mechanical retention of the bacteria, the area may also create an environment favorable for growth of bacteria. During the summer months, the flow of the Runnins decreases. The continuous temperature measurements made during 1999 found that water temperatures frequently rose above 24°C to a maximum of 30°C. Researchers have reported that bacterial growth can occur in the environment in temperatures as low as 24°C (Gerba and McLeod, 1975, Hazen et al, 1988). The anoxic environment, warm temperature, and highly organic sediment found in the brackish waters containing thick mats of Phragmites may provide for ideal conditions for the accumulation and growth of fecal coliform bacteria. It has also been demonstrated that fecal coliform may survive along the shore in coastal embayments prolonged periods (between spring tides) in vegetative wrack which consists primarily of decaying eelgrass (Heufelder et al, 1996, Valiela et al, 1991, Heufelder, 1988). Heufelder hypothesized that growth of bacteria in the wrack was also a possibility, and that the washing of the wrack by tides can add a significant fecal coliform loading to the water column.

The current dry weather water quality condition of the Runnins River using RIDEM data collected at School Street is shown in Table 4.1.

Table 4.1: Dry weather water quality characterization (RIDEM, 1995-1997)

Station	Seasonal[1]	Seasonal[1]	Seasonal[1]
School Street	FC Geometric Mean (fc/100ml)	FC Load[2] (fc/day)	% Exceeding 500 (fc/100ml)
	1576	3.30×10^{11}	50

[1] Seasonal warm weather period is July - October, 1995-1999.
[2] Mean discharge July - October = 0.242 m^3/s.

The Rayner summer season dry weather School Street data for the years between 1990 and 1999 are summarized in Table 4.2. Geometric mean fecal coliform concentrations increase by approximately a factor of 5 from 300 fc/100 ml annually to 1485 fc/100 ml seasonally. The percentage of samples exceeding 500 fc/100 ml approximately doubles from 36% annually to 77% during the seasonal period.

The Rayner data are slightly lower but are similar to the RIDEM data for the summer season. The values reported in Table 4.1 will be used to characterize the condition at School Street, which is the critical (most impaired) water quality station for the river.

Table 4.2: Dry weather water quality characterization (Rayner, 1990-1999)

Station	Seasonal[1]	Seasonal[1]	Seasonal[1]
School Street	FC Geometric Mean (fc/100ml)	FC Load[2] (fc/day)	% Exceeding 500 (fc/100ml)
	1485	3.10×10^{11}	77

[1] Seasonal warm period is July - October, 1990-1999. [2] Mean discharge July - October = 0.242 m^3/s.

4.1.1 Dry weather coliphage conditions

The June 1999 coliphage samples collected in the Runnins River indicated the presence of group II and III type coliphage, which are predominantly associated with humans and pigs. Coliphage concentrations in samples collected between Route 6 Stream #2 and School Street ranged from 0.3 - 0.9 PFU/100 ml (PFU = plaque forming units). Dutka et al (1987) suggests a recreational water quality standard of 20 coliphage per 100 ml. A study conducted in Mount Hope Bay found F-RNA phage concentrations ranging from 10 to 100 PFU/100 ml in bay stations and 1000 to >100,000 PFU per 100 ml for CSO/point sources (Rippey et al, 1987). A study performed in the Upper Narragansett Bay from Conimicut Point to Prudence Island found geometric mean F-RNA phage concentrations in surface water ranging from ND (non detect) to 100 PFU/100 ml (Cabelli, 1990). Relative to these and other studies, coliphage concentrations in the Runnins River are low in comparison. It is also not clear where the coliphage viruses originate. Septic systems are potential sources, however birds may become possible carriers of group II and III coliphage after feeding on human trash/waste found in dumpsters from various restaurant and other commercial sites located nearby on Route 6.

Coliphage samples collected during the August 1999 survey indicate the presence of group I type coliphage, predominantly associated with animals. Coliphage concentrations ranged from 14.4 - 347 PFU/100 ml at Mink Street and School Street respectively. Coliphage concentrations in tributaries ranged from 0.03 PFU/100 ml in the Leavitt North Stream to 0.07 CFU/100 ml in the Route 6 Stream #2. Coliphage in the Route 6 Stream #2 sample were of an unknown type. The results for the remaining stations suggest that the predominantly occurring coliphage may be attributed to animals since only group I phage were recovered. The relatively high concentrations of coliphage at Mink Street and School Street relative to the tributary stations indicate that these tributary streams are not the cause for the high coliphage concentrations.

The low summer flows and dense Phragmites growth may lead to a filtering or buildup of fecal coliform during the summer months. The literature support a hypothesis that fecal coliform bacteria may proliferate in an environment with warm water column temperatures and low sunlight levels. The documented minimum temperature for E-coli host cell growth and coliphage replication is 25°C (Woody et al, 1995). It is possible that coliphage replication also contributed to the elevated coliphage concentrations in the Runnins River as a result of the instream conditions recorded in the study area during August.

4.1.2 Septic system survey results

The septic system investigation was conducted to determine whether a connection could be made between onsite wastewater treatment systems in commercial developments adjacent to the Runnins River and the elevated fecal coliform levels in the river. Nearby systems were evaluated to determine if they showed potential signs of failing based on age, design

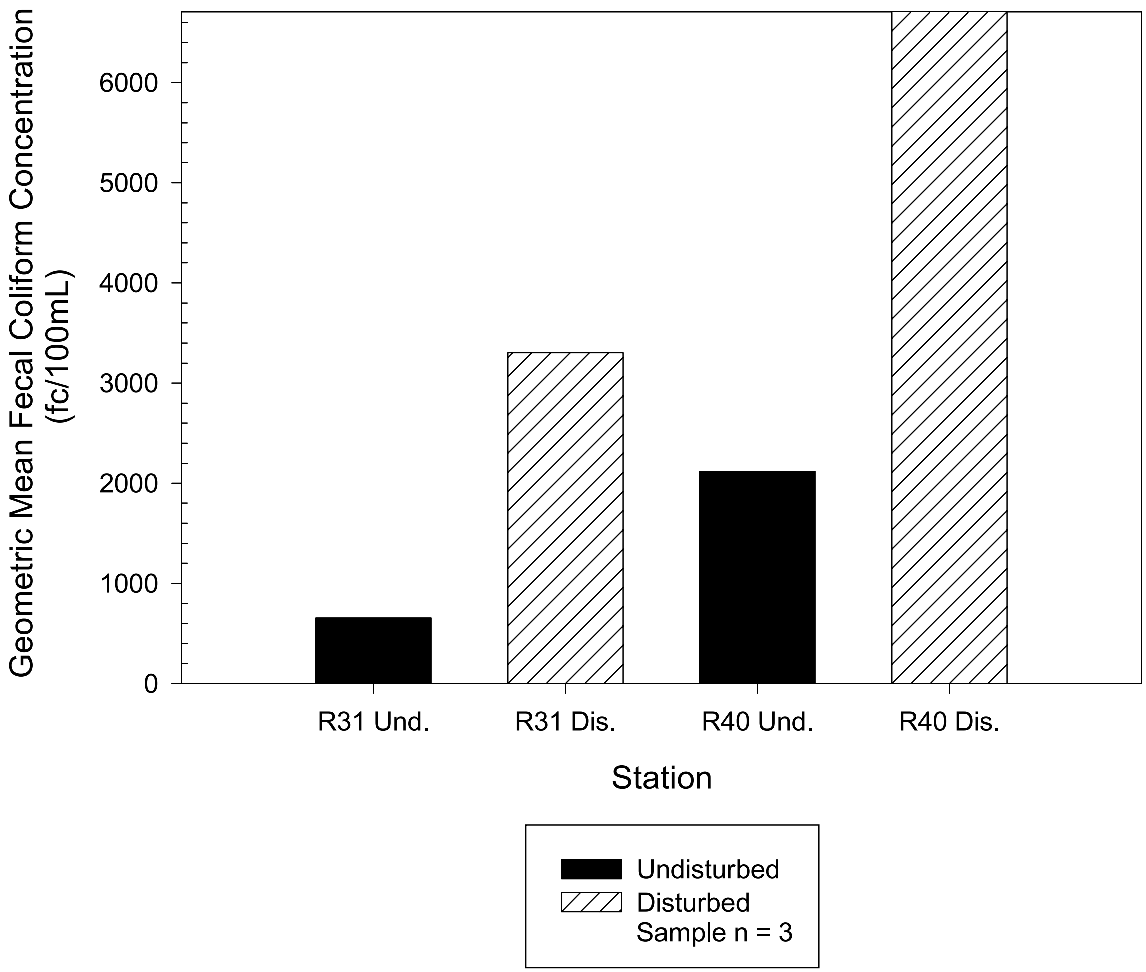

Figure 4.3: Comparison of undisturbed and disturbed samples (RIDEM, June - October, 1999).

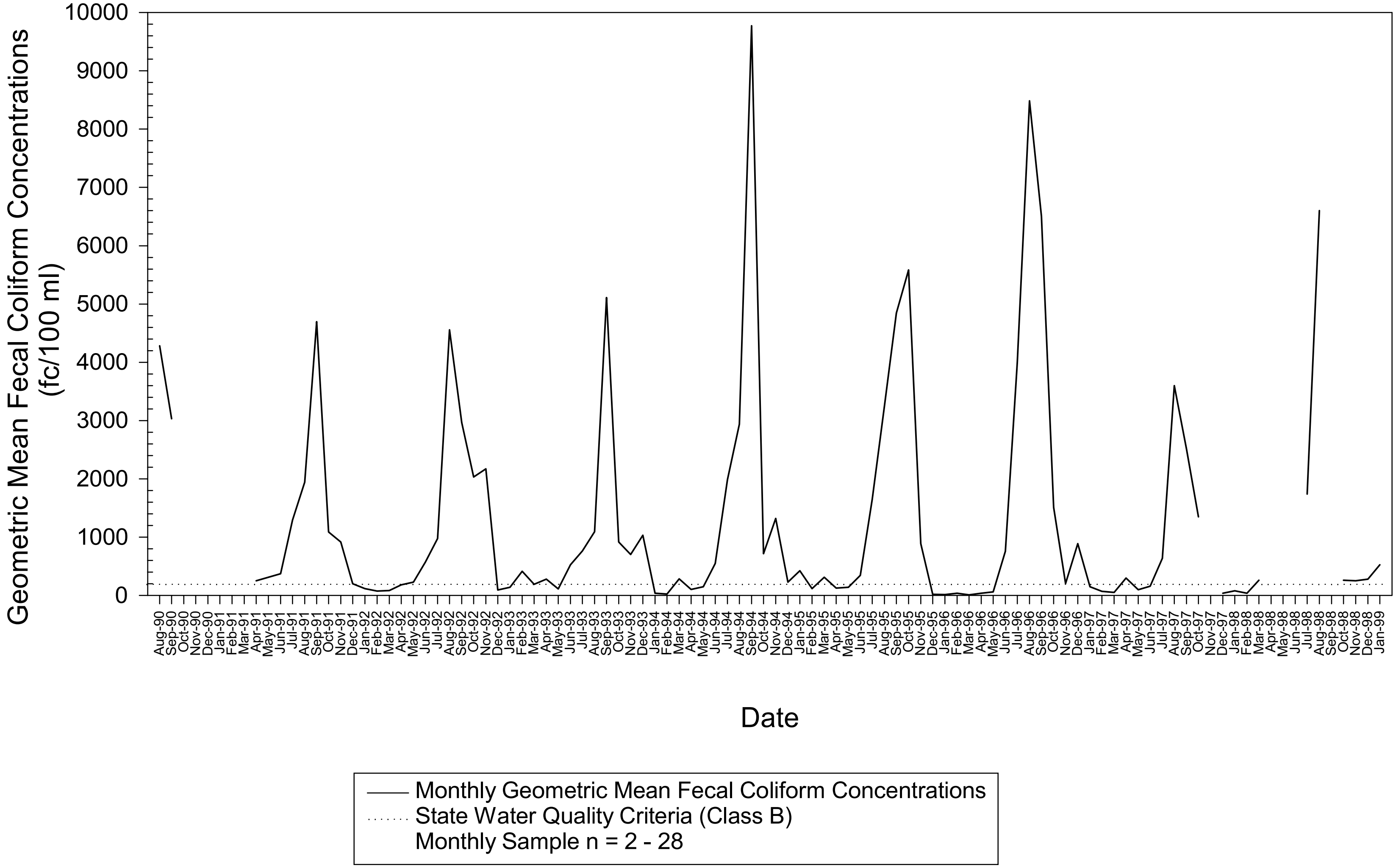

Figure 4.4: Geometric mean monthly fecal coliform concentrations at School Street (Rayner, 1990 - 1999).

assumptions, and current water use. Water use data were obtained from the Seekonk Water Board and the East Providence Water District. Septic system information was obtained from the records kept by the Public Health Agent in Seekonk, MA and by RIDEM.

A summary of system ages is presented in Figure 4.5. As a system ages, it tends to operate less efficiently. The date listed on Figure 4.5 reflects the date of the most recent installation, repair, or upgrade for each facility's septic system. Of the systems examined, over seventy-five percent of the systems had been installed, repaired, or upgraded within the last ten years. The oldest septic systems are located on Mead Street, near the triangle area between Mink, Leavitt, and School Streets. Six systems on Mead Street are more than fifteen years old, including three that are over than twenty-five years old.

When properly designed, installed, and maintained, individual sewage disposal systems (ISDS) provide effective wastewater treatment. In traditional septic system designs, partially treated wastewater is discharged underground into trenches, beds, or chambers where it is absorbed and treated by the soil as it percolates to the groundwater (EPA, 1980). One of the most important factors affecting ISDS design is the soil percolation rate. Soil percolation is a measure of how quickly water percolates through saturated soil. Soils that accept water too quickly do not allow effluent to be adequately treated before it reaches the groundwater. As soil percolation rate increases, the size of the required leaching area decreases. In the study area, the soils have high percolation rates.

Massachusetts revised its septic system design criteria in the State Environmental Code, Title 5 in 1995. Title 5 called for a minimum percolation time of 5 min/in when sizing leach fields. Prior to the implementation of the revisions, leach fields could be designed using a percolation time of 2 min/in, which represents a higher percolation rate. A leach field designed with a 2 min/in percolation rate would be smaller than one designed for the same flow with an assumed percolation time of 5 min/in, potentially resulting in less protection to the groundwater. Figure 4.6 shows that many septic systems in the area were designed using a percolation rate of 2 min/in. Depending on water use, these systems may not be providing adequate treatment to wastewater before it reaches the river. Only those systems installed or repaired since 1995 used the higher percolation time of 5 min/in (lower rate) to size their leach fields.

Figure 4.7 shows the actual water use of the commercial and industrial facilities located in close proximity to the Runnins River. The actual average daily water use is the average daily water use from May 1, 1998 to October 31, 1998. The May through October time period was chosen because the highest fecal coliform concentrations in the river occur during this time. Many facilities use more water during these months, increasing their hydraulic loading to their septic system. The water use number on Figure 4.7 includes a peak factor of 1.5. The peak factor is an engineering safety factor that reflects the fluctuations in water use over a day. From the figure, it is apparent that heavy water use exists along the entire reach of the river. The southern section of the study area has more large capacity systems per unit area. The systems having the smallest demand (less than 2,000 gpd) are located on Mead Street.

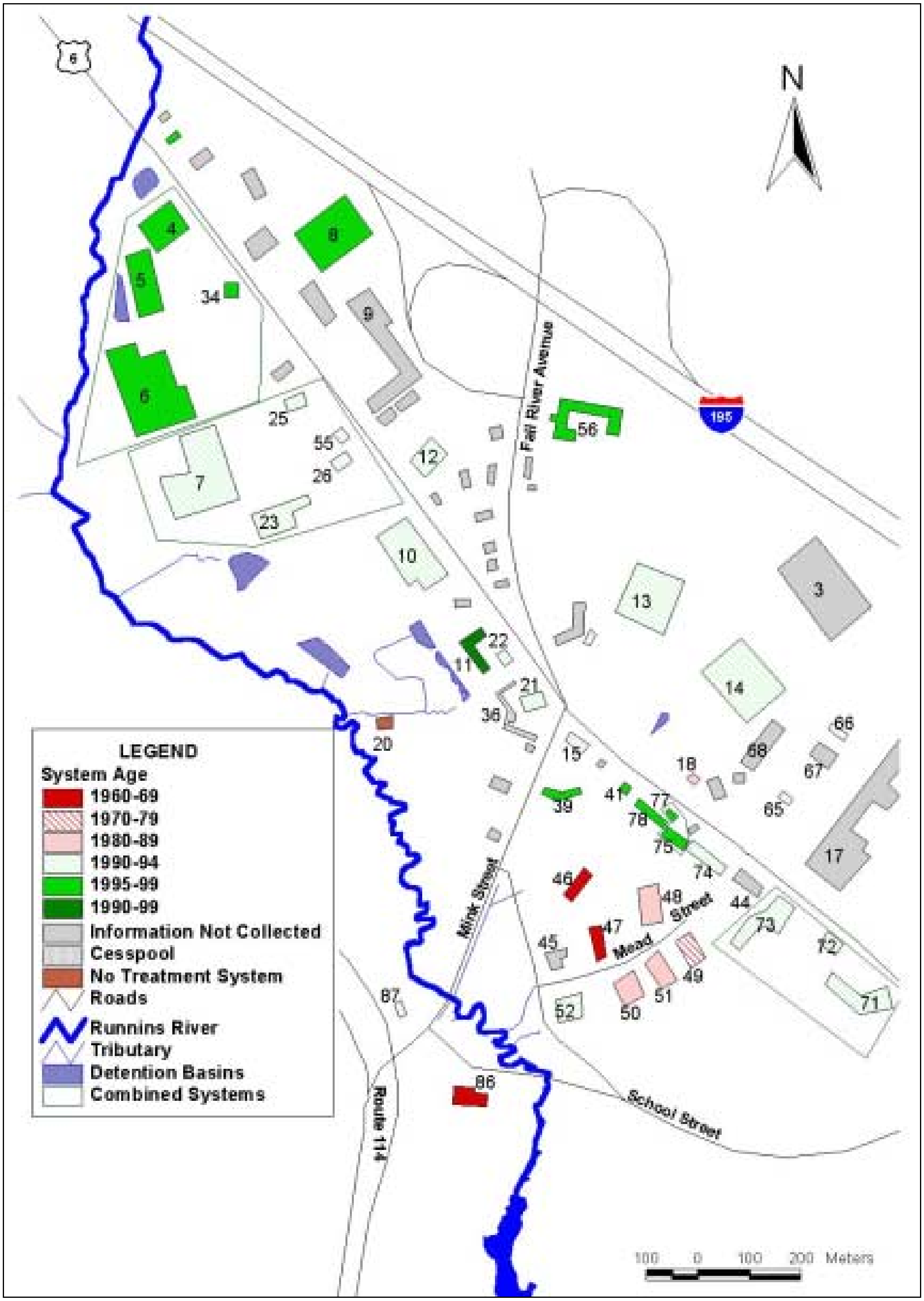

Figure 4.5: Age of septic system.

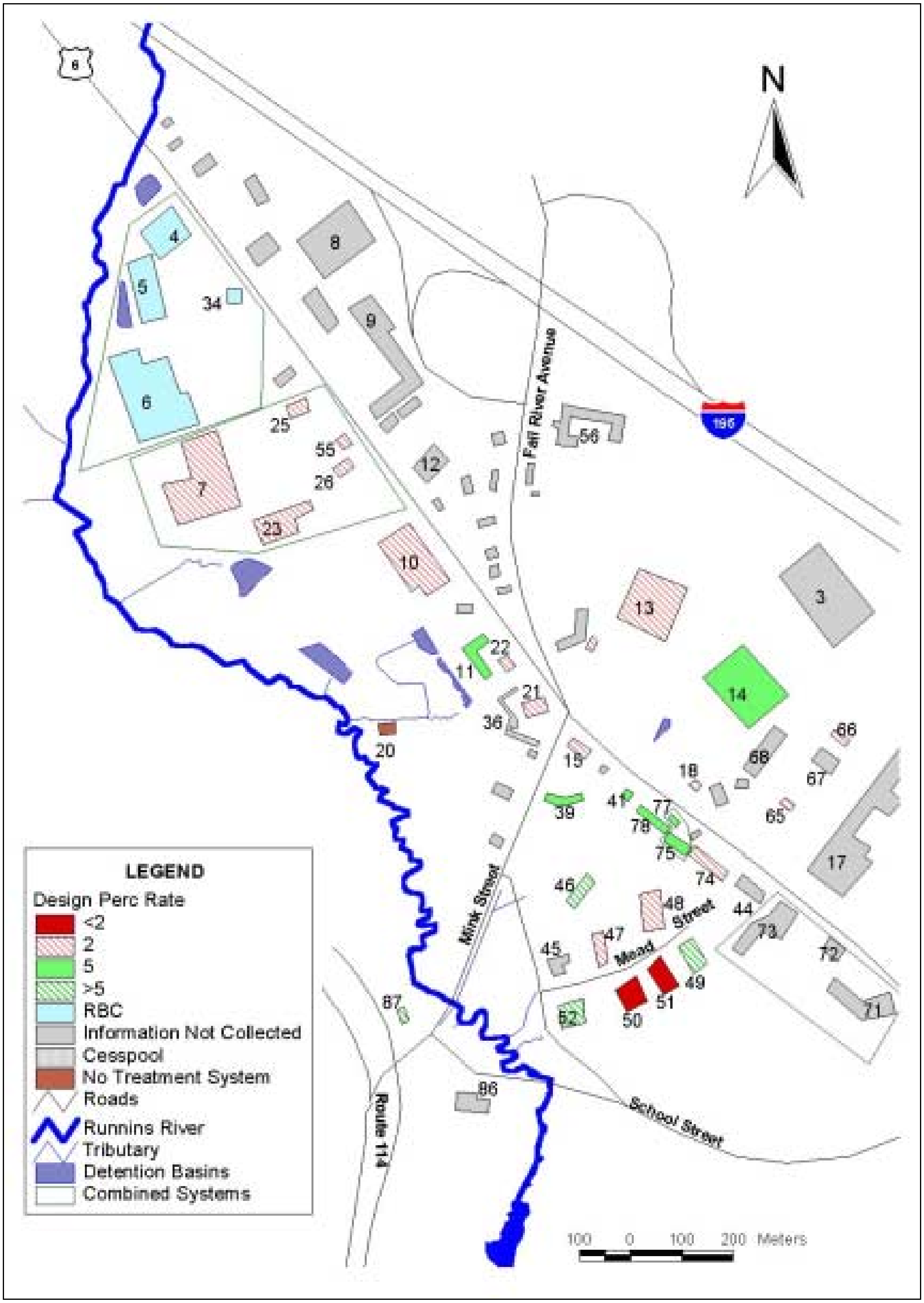

Figure 4.6: Septic system design percolation rate.

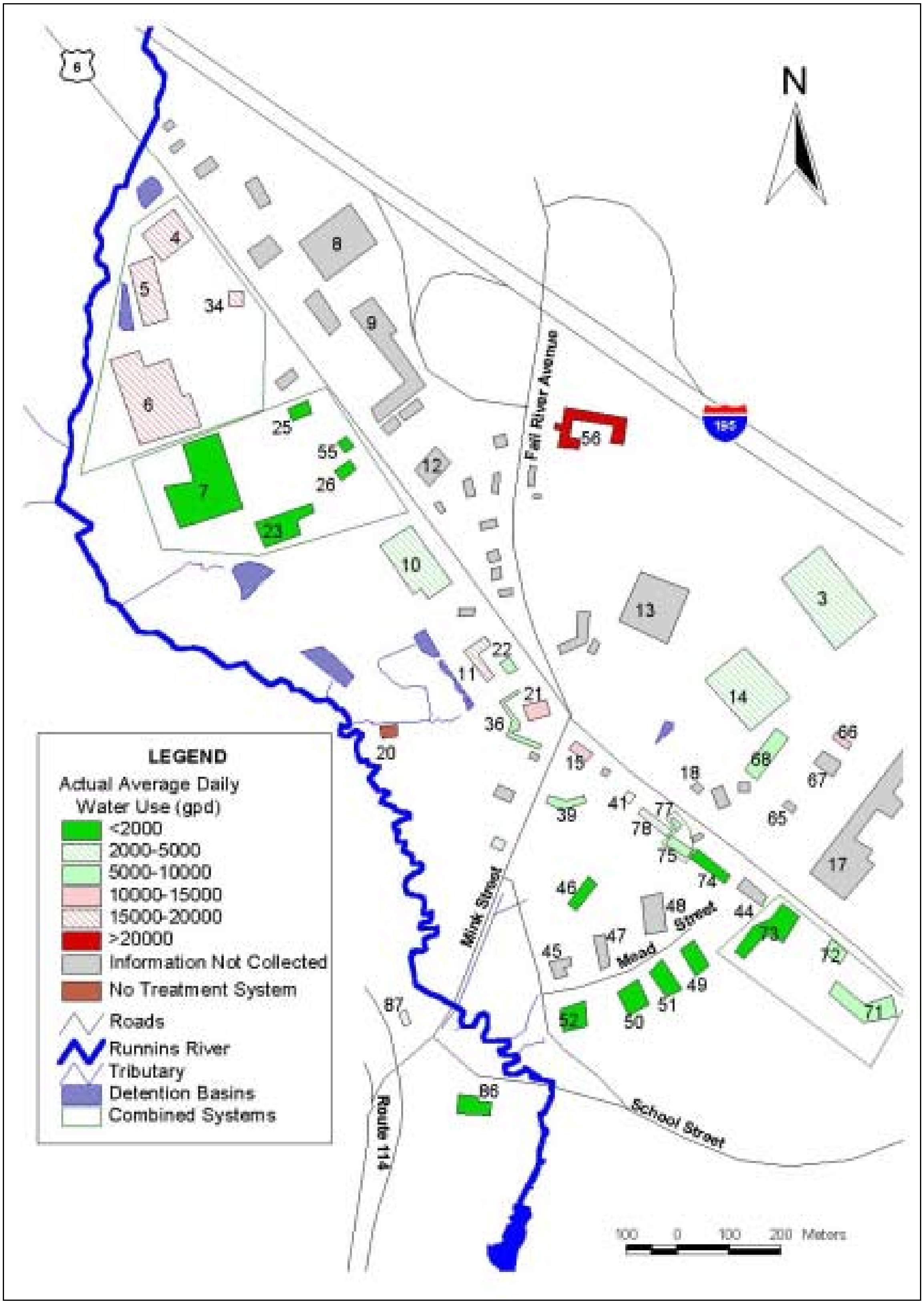

Figure 4.7: Actual average daily water use.

After the actual average daily water use was determined, the required leach field area was calculated by dividing the water use by 0.74 gpd/ft^2 (National Small Flows Clearinghouse, 1997), which corresponds to a soil percolation rate of 5 min/in. The required leach field area was then compared to the actual leach field area. Figure 4.8 indicates, in red, which systems have leach fields that are smaller than that which would be required based on water use and current regulations. Eight systems within the vicinity of Mink Street and School Street have water uses that exceed their design capacity. One of these systems is in East Providence.

Two of the largest capacity systems abut the Runnins River in the northern section of the study area. The Ann and Hope system treats close to 20,000 gpd and is designed to treat over 25,000 gpd. The system is not a traditional ISDS and uses rotating biological contactors. Although, the Price Club system was designed for over 15,000 gpd with a soil percolation rate of 2 minutes per inch, its actual water is less than 2,000 gpd. As shown by the 1995-1997 RIDEM data, water quality along this stretch of the river meets class B standards. All indications are that these two systems are operating properly.

The Mead Street area of the study needs further investigation. Mead Street is located in between School and Mink Street, less than 300 meters from the Runnins River. The facilities on Mead Street use under 2,000 gpd of water. These facilities include some of the oldest systems in the study area. Design percolation rates were 2 min/in in many cases. In the Mead Street area, of the five buildings where enough information was collected to compare actual water use to the leach field capacity, four facilities exceeded their leach field capacity.

Another area of concern is a hotel near the intersection of Route 6 and Mink Street that relies on a cesspool instead of an ISDS for wastewater treatment. No evidence exists that it is failing, but it is adjacent to an isolated wetland area where a failure would be difficult to detect during dry weather. The wetland area drains to Route 6 Stream #2, the largest wet weather source to the Runnins River (RIDEM, 1996).

On the East Providence side of the river, the Mobil Gas Station was cited in October of 1999 for a septic system failure. A new system design approved by RIDEM became operational in April 2000.

The Route 6 commercial area in Seekonk has many large capacity septic systems. For the most part these systems have been repaired or upgraded within the last ten years. In some cases, the upgrade occurred when the facility's use changed, but in many cases, repair came after documented failure of the system. The Seekonk Health Agent, working closely with the Massachusetts DEP identified many septic systems in the study area that were in need of repair and were subsequently upgraded by the landowner. In addition, the town of Seekonk established a $450,000 Betterment Fund to assist landowners in the voluntary upgrade of septic systems. All of these funds have been expended and a waiting list has been established for additional loans.

A relative water use factor was computed from water consumption information gathered in the RIDEM septic system survey of the area. The water use factor represents the seasonal trend in combined water consumption in m^3/sec by 27 commercial and industrial users in the Route 6

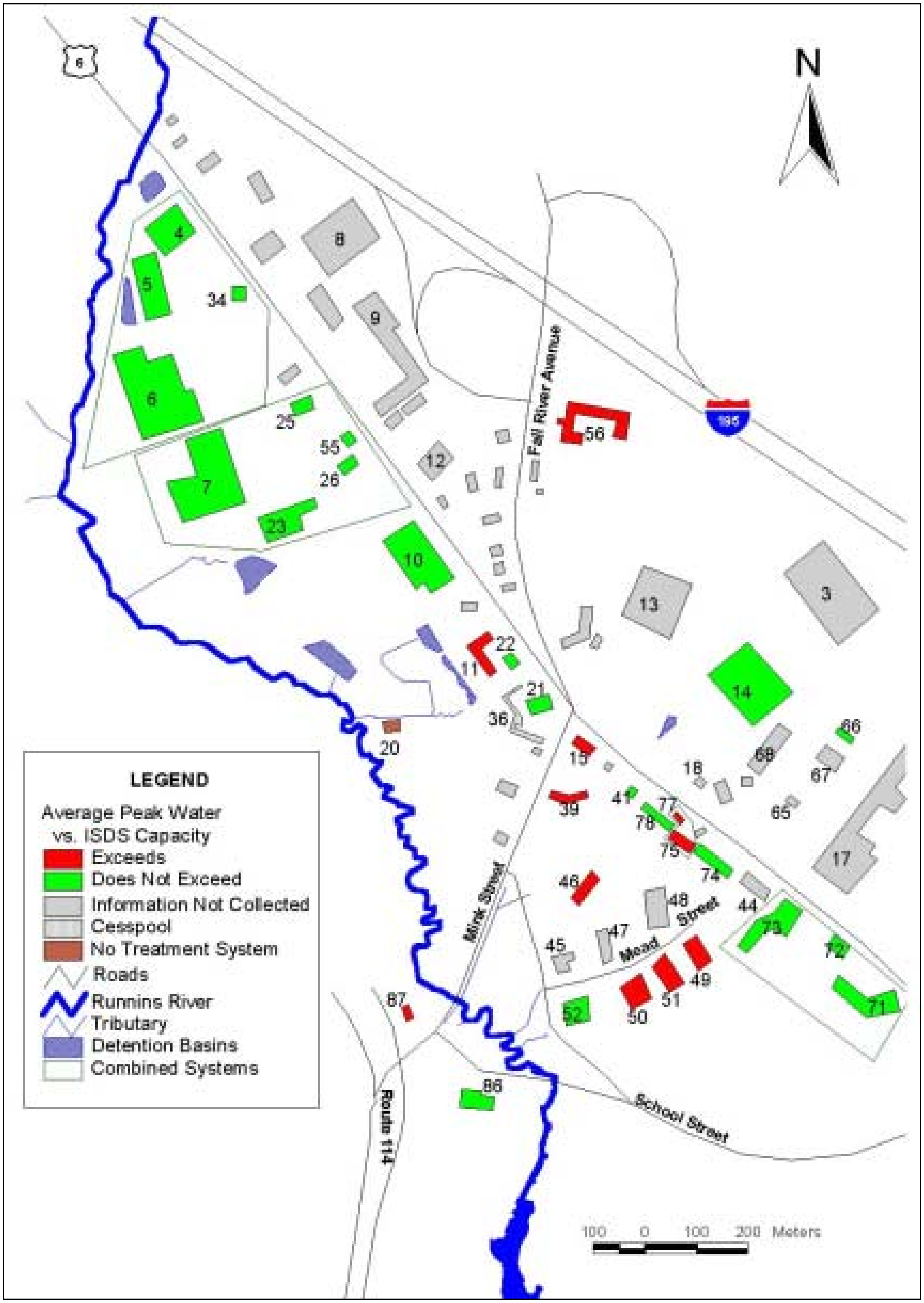

Figure 4.8: Actual average use versus design septic system capacity.

area of Seekonk for whom data was collected. A list of these users is provided in Appendix B. Water use data was not available for all users in the Seekonk area, so this factor should be interpreted to represent monthly trends in water use for the watershed, rather than the actual water consumption.

Figure 4.9 compares monthly trends in instream fecal coliform concentration, water temperature, and discharge of the Runnins River during 1997 against the water use factor. The figure shows instream fecal coliform concentrations remaining low in the river, at or below the water quality standard until July, increasing to a peak value of nearly 4000 fc/100 ml during August. Concentrations then declined to the point where the standard was met during December. Discharge peaked in April 1997, then decreased to low annual values from July through October. Instream temperature started at a low value in January and increased steadily through the spring, reaching a peak in late summer before dropping. The water use factor shows peak water use steadily increasing from a low value in February through the spring and summer, reaching a peak during August and September, then declining through the fall and winter.

The same parameters are shown in Figure 4.10 for 1998. The monthly instream fecal coliform concentrations show a late summer peak value of nearly 7000 fc/100 ml in August. The high fecal coliform concentrations again coincided with low discharge and high stream temperature during the summer months. Seekonk water use decreased from January to March 1998 then increased to high values in August and September. From these comparisons, one would deduce that fecal coliform concentrations would vary directly with the water use factor and temperature, where an increase in temperature or water use would produce an increase in concentration. If in-ground systems contribute a bacterial loading to the river, an increase in water consumption would be expected to produce increased concentrations in the river. Increased temperature, perhaps above some threshold value, would be expected to contribute increased ambient concentrations. Conversely, if the coliform sources were constant, one would also deduce that concentrations in the river at School Street would decrease with increased discharge, because the dilution of the sources would be higher.

The comparisons visually demonstrate that the parameter having the strongest correlation with the ambient fecal coliform concentration is stream temperature. Discharge also shows a strong inverse correlation with fecal coliform concentrations, however the influence of low discharge during the winter months, such as March 1997 and January 1998, was overwhelmed by the influence of temperature. The influence of water use also appears to be overwhelmed by temperature effects, because relatively higher consumption during some winter months (January 1997, January-February 1998) is not reflected in instream concentrations. Water use in January and October through December 1998, was greater than that during July, while mean instream flows were comparable. The fecal coliform concentration during July (1739 fc/100 ml) was considerably higher than that during January (80 fc/100 ml), October (260 fc/100 ml), November (253 fc/100 ml), or December (280 fc/100 ml).

RIDEM's evaluation does not conclusively establish a direct connection between dry weather fecal coliform concentrations in the Runnins River and onsite treatment systems in adjacent areas of Seekonk and East Providence. The analysis found that businesses having one or more of the

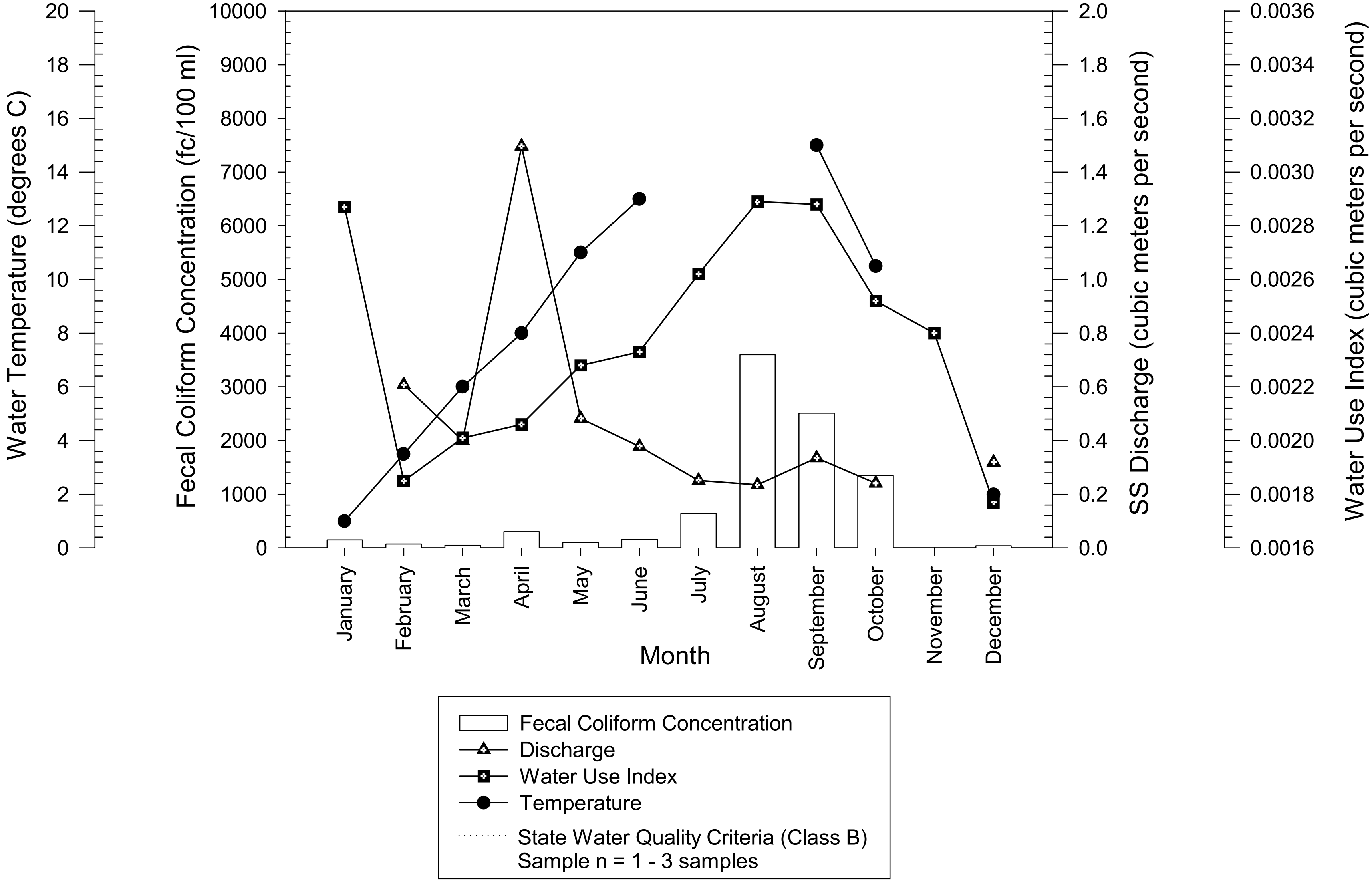

Figure 4.9: Comparison of fecal coliform concentrations, discharge, water use, water temperature at School Street during 1997.

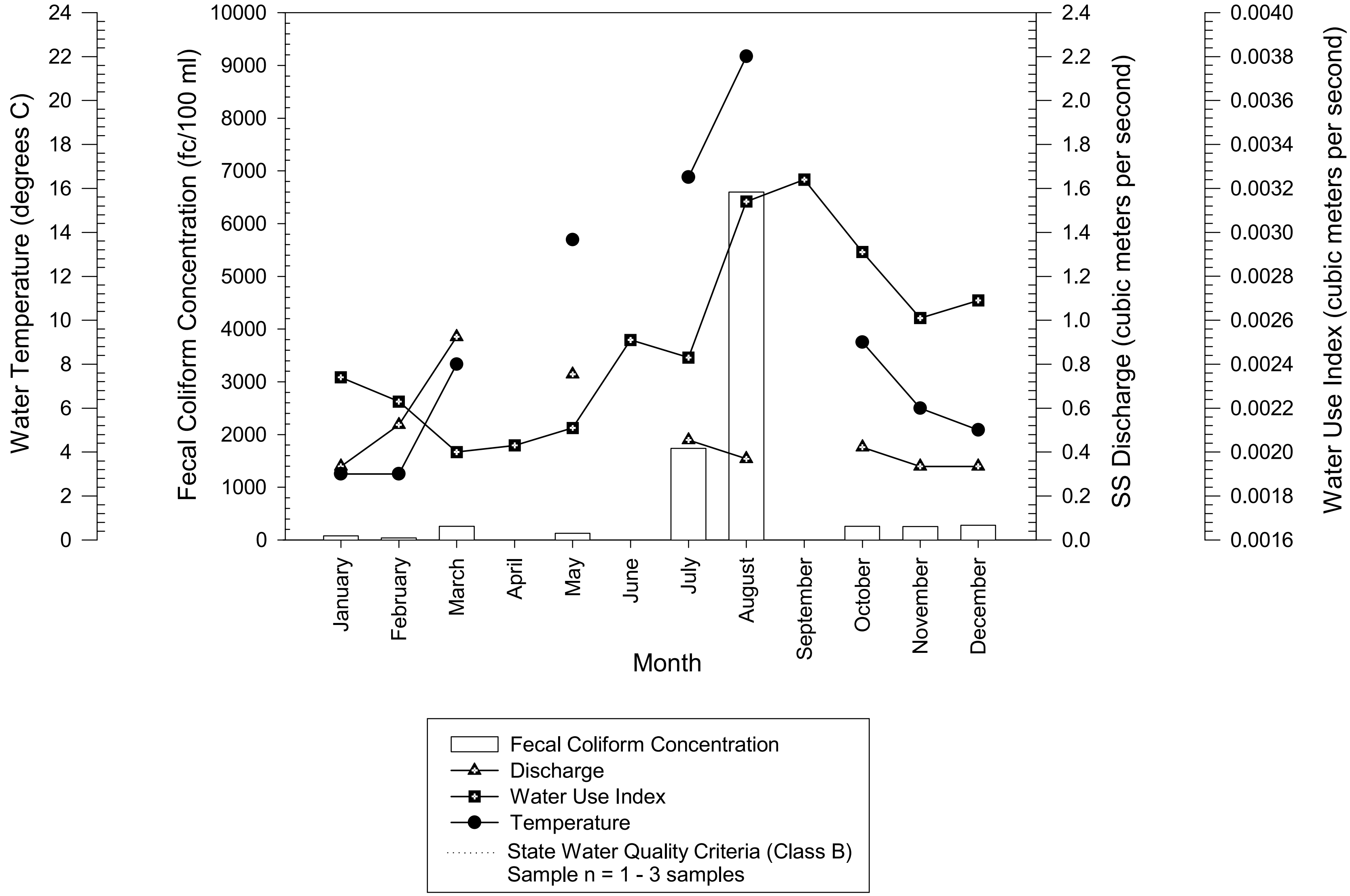

Figure 4.10: Comparison of fecal coliform concentrations, discharge, water use, water temperature at School Street during 1998.

following potential problems were concentrated near the area where instream fecal coliform concentrations rise rapidly:

- Old systems or a cesspool,
- Systems that would therefore be undersized because a high leaching rate was assumed in the design process,
- Systems that had a documented history of failures, and
- Systems that were presently subjected to wastewater loads beyond their design capacity.

The comparison between instream concentrations and environmental factors indicated that a positive correlation does exist between expected source loadings from in-ground systems and fecal coliform concentrations at School Street. The analysis concluded, however that the influences of temperature and river discharge appeared to exert the controlling influence, with temperature the dominant factor. We conclude that while underground loadings may exist, that environmental factors in the river dominate, with the result that fecal coliform bacteria flourish during the summer when the following factors favorable to growth occur:

- Ambient water temperatures are higher,
- Excessive Phragmites growth blocks the penetration of ultraviolet radiation, reducing bacterial die-off rates.
- Phragmites acts either as a filter or a base for the accumulation of bacteria,
- Higher temperatures promote bacterial longevity or growth.

4.2 Wet weather characterization

The 1995 RIDEM wet weather study took place during a 0.93 inch rain storm that lasted approximately 5 hours. Event mean instream concentrations in the Runnins River station are presented in Figure 4.11 and listed in Table 4.3. The lower line in Figure 4.11 represents the pre-storm condition of the river. The data collected during and after the storm show mean concentrations rising from a low value of 290 fc/100 ml at Burrs Pond Dam to an initial peak value of 5569 fc/100 ml at County Street. This station represents the existing wet weather condition of the river as it enters Rhode Island. During the study, samplers observed that the flow direction was reversed as a result of the large influx of water from the County Street culvert, located a short distance downstream. The high instream value at County Street is attributable to loads from the County Street Culvert. Concentrations declined through the next two downstream stations at Route 6 and above Route 6 Stream #1. This decline apparently occurred as a result of dilution by the river in the wetlands complex between the County street bridge and Route 6, and because no significant large sources were present between Route 6 and Route 6 Stream #1. Concentrations then rose slowly to the station above Route 6 Stream #2, then increase sharply to a maximum value at School Street.

The bacterial contributions from 15 sources, including tributaries and storm drains, were measured as mass loadings by teams of volunteers stationed at each source. Loadings were calculated as the product of discharge measurements, typically made at 15 minute intervals, with concentrations, typically at hourly intervals. Net loads from each of the sources are shown in

Table 4.3: Mean wet weather concentrations at instream stations in the Runnins River (RIDEM, 1996)

Station Number	Location	Event mean concentration (fc/100 ml)
1A		63615
1	Burrs Pond Dam	286
5	County St. Bridge	5569
8	Route 6 Bridge	3416
14	Above Route 6 Stream #1	772
16	Above Route 6 Stream #2	1325
18	Mink St. Bridge	5367
23	School St. Bridge	6813

Figure 4.12 and listed in Table 4.4. Four significant sources were identified in the reach below County Street: the Route 6 stream #2, the County Street storm drain, the Route 195 stream, and Orange Juice Creek. Route 6 stream #2, the largest source with an estimated loading of 3.84 x 10^{11} fc, empties into the lower Runnins River a few hundred meters upstream of Mink Street bridge. The stream drains areas of Seekonk, MA near the Route 6 - Mink Street intersection. The second largest source with a loading of 2.73 x 10^{11} fc was the County Street Culvert, which empties to the river at the upper end of the study area. Its drainage area includes a section of Waterman Avenue in East Providence and a portion of County Street in Seekonk. The third largest source, with a loading of 1.92 x 10^{11} fc was a stream that runs along the north side

Table 4.4: Loads from wet weather sources to the Runnins River during the October 1995 storm (RIDEM, 1996)

Location	Station ID	Mean Flux (fc/sec)	Total Bacterial Loading (fc)
Leavitt south stream	22	1.46E+04	2.75E+08
Leavitt middle stream	21	2.21E+06	1.35E+10
Leavitt north stream	20	2.41E+05	4.26E+09
Mink St culvert	19	1.17E+06	1.98E+10
Route 6 stream #2	17	2.37E+07	3.84E+11
Route 6 stream #1	15	1.69E+06	2.62E+10
Cemetery stream	13	2.46E+04	4.04E+08
OJ Creek parking lot	11	1.14E+04	1.98E+08
OJ Creek	10	8.85E+06	1.77E+11
Route 6 culvert	9	4.02E+05	5.85E+09
Route 195 stream	7	1.18E+07	1.92E+11
County St culvert	6	2.74E+07	2.73E+11
Almeida Ave culvert	4	4.28E+05	7.09E+09
Almeida Ave stream	3	6.22E+06	1.02E+11
Rt 114A culvert	2	6.57E+04	9.84E+08

of Route 195 and empties into the river approximately 100 meters below County Street. Follow-up work identified the source as pigeons roosting under the Route 195 overpass. The final source, with an estimated loading of 1.77×10^{11} fc was Orange Juice Creek, which drains a large area of East Providence. Subsequent investigation revealed that East Providence Pump Station has an overflow problem. When sewer flows were too high in the East Providence sewer system, the interceptor surcharged at the pump station, and bypassed to the Creek as overland flow. It is not known if the pump station was failing at the time of the comprehensive wet weather survey.
The relatively large loading attributed to Orange Juice Creek by the 1996 wet weather study is in part due to the relatively high discharge of the Creek, although fecal coliform concentrations were also relatively elevated. Field investigations by RIDEM personnel indicated that other potential wet weather sources are present in the upper watershed. The Creek rises from a wetland area that receives stormwater runoff from the area in East Providence bounded by Wamponaug trail to the south, Dover Avenue to the West, and East Shore Expressway to the East. Based on observations of DEM staff, the wetland area receives a significant amount of storm runoff and bacterial loadings from these surrounding areas. This runoff receives some detention before entering the Creek. Downstream of the wetland, the Creek receives additional runoff and loadings from Route 114 and commercial developments along Amaral Street.
Elevated fecal coliform concentrations upstream of the study area at Pleasant Street indicated that areas contributing to flow at Pleasant Street merit further examination. MADEP sampling of this area during 1999 confirmed the finding of elevated concentrations in this area. Fecal coliform concentrations during the initial stages of the storm were 360,000 fc/100 ml, the highest observed throughout the Runnins River during the study. Loadings from Pleasant Street were not observed in the reach of the river below County Street because of hydraulic detention by Grist Mill and Burrs Ponds. The discharge at Pleasant Street continued to increase as the storm progressed and was highest during the final measurement. The sampling at Pleasant Street may therefore represent a low estimate of storm-related fecal coliform loads from upstream sources, and it is unclear whether the two ponds attenuate the entire load.

The calculated total fecal coliform loading from the Runnins River to the Barrington River during the study was estimated at 1.09×10^{12} fc. Tide levels were high, and the Mobil Dam was overtopped at the start of the study. Consequently, Runnins River flow was in the upstream direction for a majority of the study. The resulting net fecal coliform load from the Runnins to the Barrington River is therefore an underestimate.

RIDEM conducted a second wet weather study between October 14-20, 1998 to quantify the storm related loading of fecal coliform from the Runnins River. A rainfall accumulation of 0.93 inches was recorded in the Warren River Basin. Based on historical data from the National Weather Service in Warwick, 81% of rainfall events are equal to or less than 0.93 inches (Figure 4.13), indicating that the event studied was larger than average. Bacterial loads from the Runnins and upper Palmer River were quantified in mass units as outlined in Section 3.2 above and in RIDEM (1999).

The study found that an initial peak instream concentration of 5800 fc/100 ml was reached at School Street at 20:50 approximately 8 hours after the onset of the first period of heavy rain (RIDEM, 1999). The maximum concentration of 6900 fc/100 ml seen early on the morning of October 15 also followed a second period of intense rain by eight hours. Fecal coliform concentrations dropped rapidly after the peak and returned to pre-storm conditions approximately 2 days after the start of the storm (Figure 4.14). River discharge also required a period of about 2 days to return to pre-storm conditions. Fecal coliform fluxes from the Runnins River were calculated from the discharge and concentration data (Figure 4.15). The maximum fecal coliform flux of approximately 4.5×10^7 fc/sec was 25 times the pre-storm dry weather load. The event geometric mean fecal coliform concentration was 3211 fc/100 ml for this event. The event load used to represent the current wet weather condition of the Runnins River is 1.50×10^{12} fc/day.

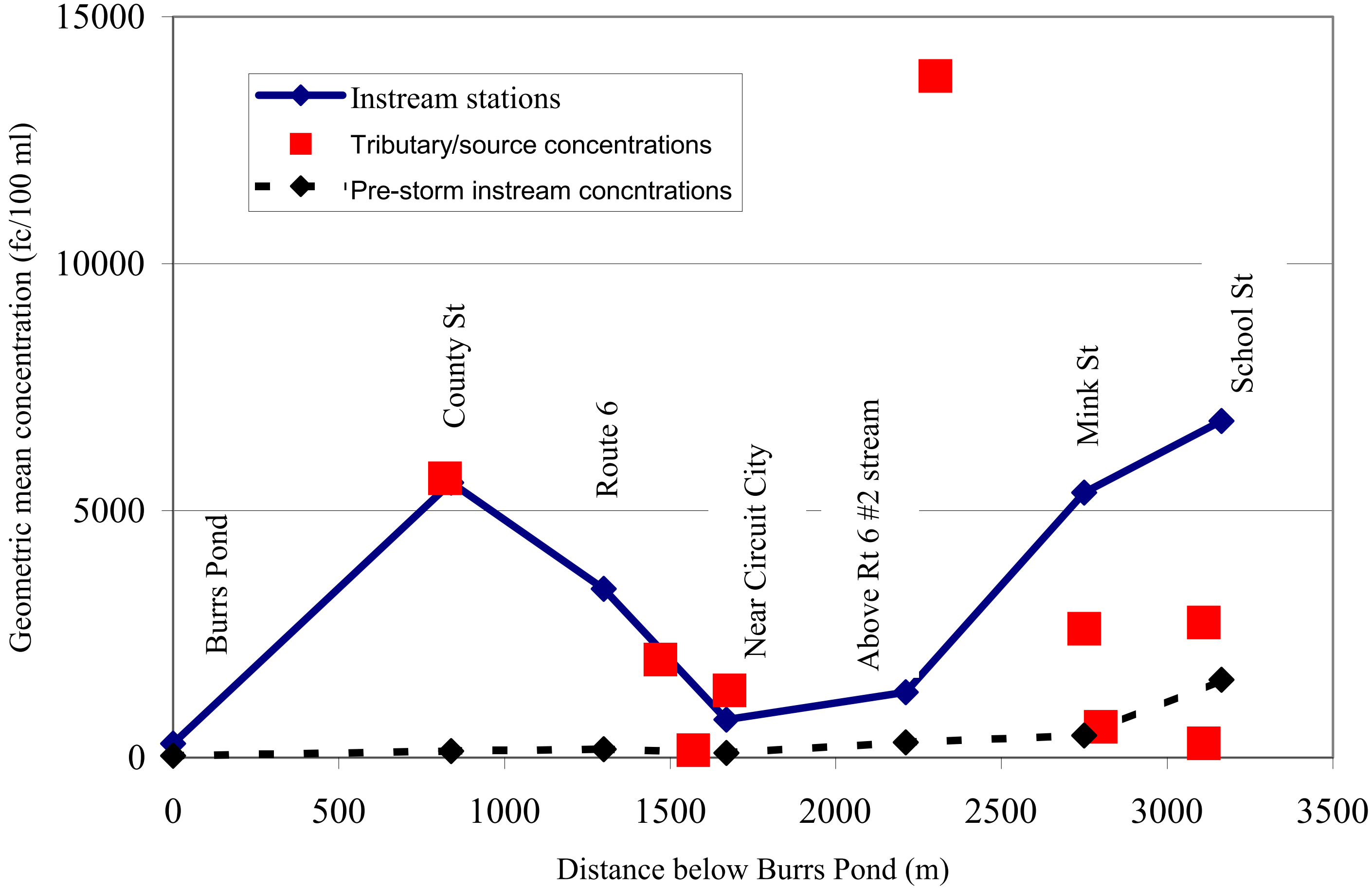

Figure 4.11: Event mean wet weather concentrations at instream stations in the Runnins River (RIDEM, 1996).

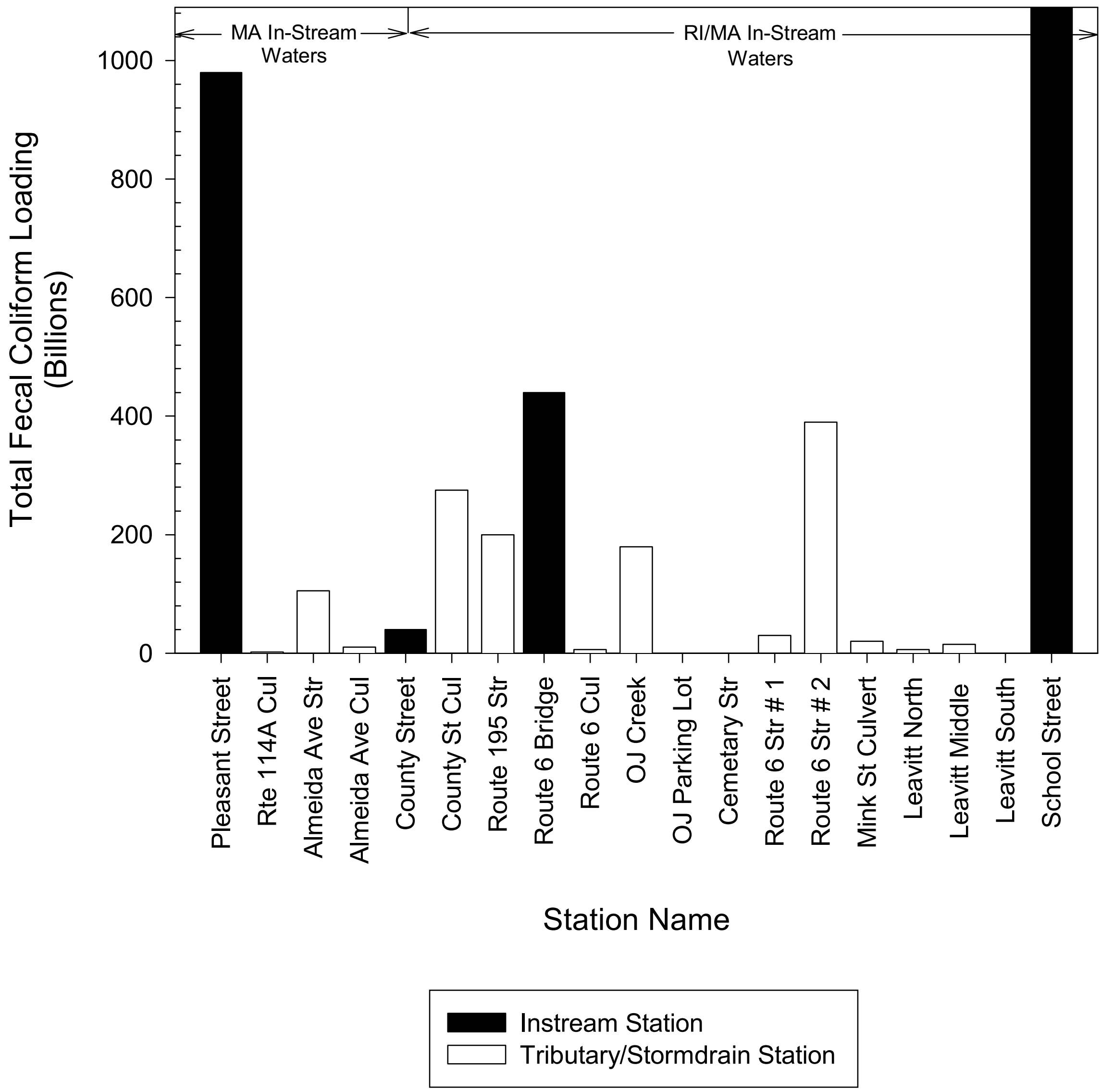

Figure 4.12: Total fecal coliform flux by station (RIDEM, 1996).

Because the number of observations was so extensive, the Rayner fecal coliform data for School Street were used to resolve the rainfall needed to trigger a change to a wet weather condition in the Runnins River. The Rayner data were also used to determine a representative time for the system to recover after an event. The characteristic concentration at School Street during wet weather derived from Rayner data were also compared with the RIDEM wet weather data.

Mr. Rayner collected samples at random times during dry weather and wet weather at School Street. Rayner also targeted several rain events, sampling before, during and after storms at School Street. From this data set, RIDEM found that approximately 0.2 to 0.5 inches of rainfall are necessary to produce significant runoff as evidenced by a significant increase in instream fecal coliform concentrations. The range in rainfall accumulations to trigger elevated instream concentrations seems to be partly due to the intensity of individual events and to the duration of the antecedent dry weather period. RIDEM established a rainfall accumulation of 0.2 inches as a somewhat conservative indicator of wet weather.

A determination of time needed for recovery to dry weather concentration was made by comparing samples collected on the day of storms greater than 0.2 inches (day 0) with samples collected on the first day after the storm (day 1), the second day after (day 2) and the third day after (day 3) as shown in Figure 4.16. The figure shows that for both the summer season and on an annual basis that post-storm fecal coliform concentrations recover to their dry weather values by day 3 after a storm. Wet weather is therefore defined as a rain event that produces at least 0.20 inches of rainfall, and lasts for three days (the day of rainfall and two subsequent days).

A summary of geometric means calculated from the Rayner wet weather data for the years 1990 through 1999 are presented in Table 4.5. The table presents geometric means and percentage of samples exceeding the variability criterion of 500 fc/100 ml on an annual basis and for the summer season. For the purpose of comparison, the geometric mean concentration for October surveys is also presented. The summary shows that the characteristic mean fecal coliform

Table 4.5: Wet weather water quality characterization (Rayner data, 1990-1999)

Station	Annual[1]		Summer season[2]		October[3]
School Street	FC Geo. Mean (fc/100ml)	% > 500 (fc/100ml)	FC Geo. Mean (fc/100ml)	% > 500 (fc/100ml)	FC Geo. Mean (fc/100ml)
	1029	63	4246	89	2762

[1] Geometric Mean of yearly data, 1990-1999. [2] Geometric mean of July - October period, 1990-1999.
[3] Geometric mean of October storms ranging between 0.43 and 1.1 inches.

concentration is 1029 fc/100 ml annually, rising to a high value of 4246 fc/100 ml during the months of July through October. The October value is somewhat lower than the summer season value at 2762 fc/100 ml. The Rayner data may be biased because the samples were collected as single grabs at random times during a number of events. The mean values will vary depending with the distribution of sample times during the beginning (first flush), middle, or end of the storm event. The event mean concentration of 3211 fc/100 ml during the October 1998 RIDEM study lies between the October and summer season means. Given the variability seen from event to event, RIDEM considers the two data sets to be equivalent. This comparison is made with the understanding that variability is a prominent feature of wet weather coliform data.

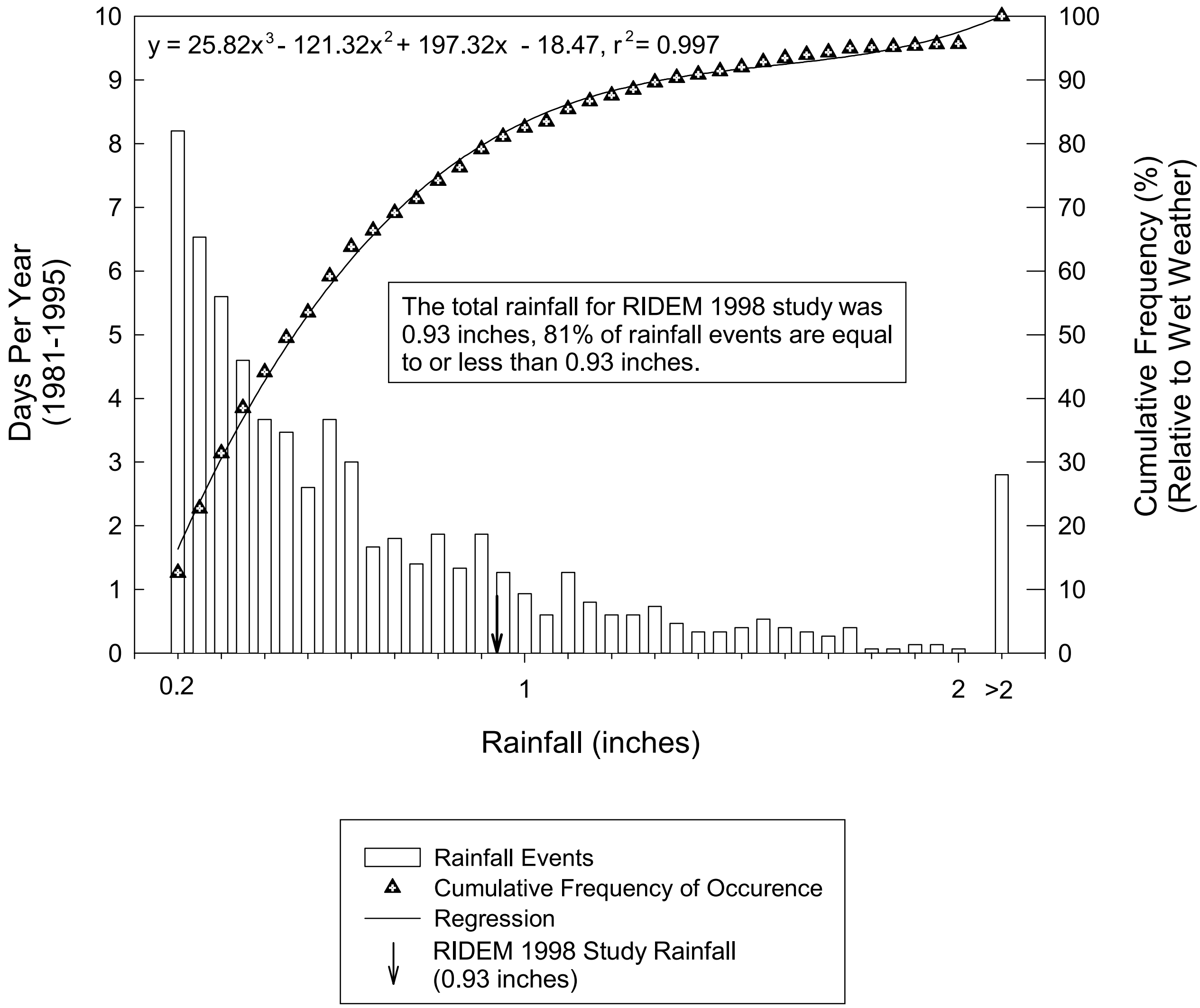

Figure 4.13: Frequency of occurrence of daily rainfall accumulations at T.F. Green Airport, Warwick, (National Weather Service, 1981 - 1995).

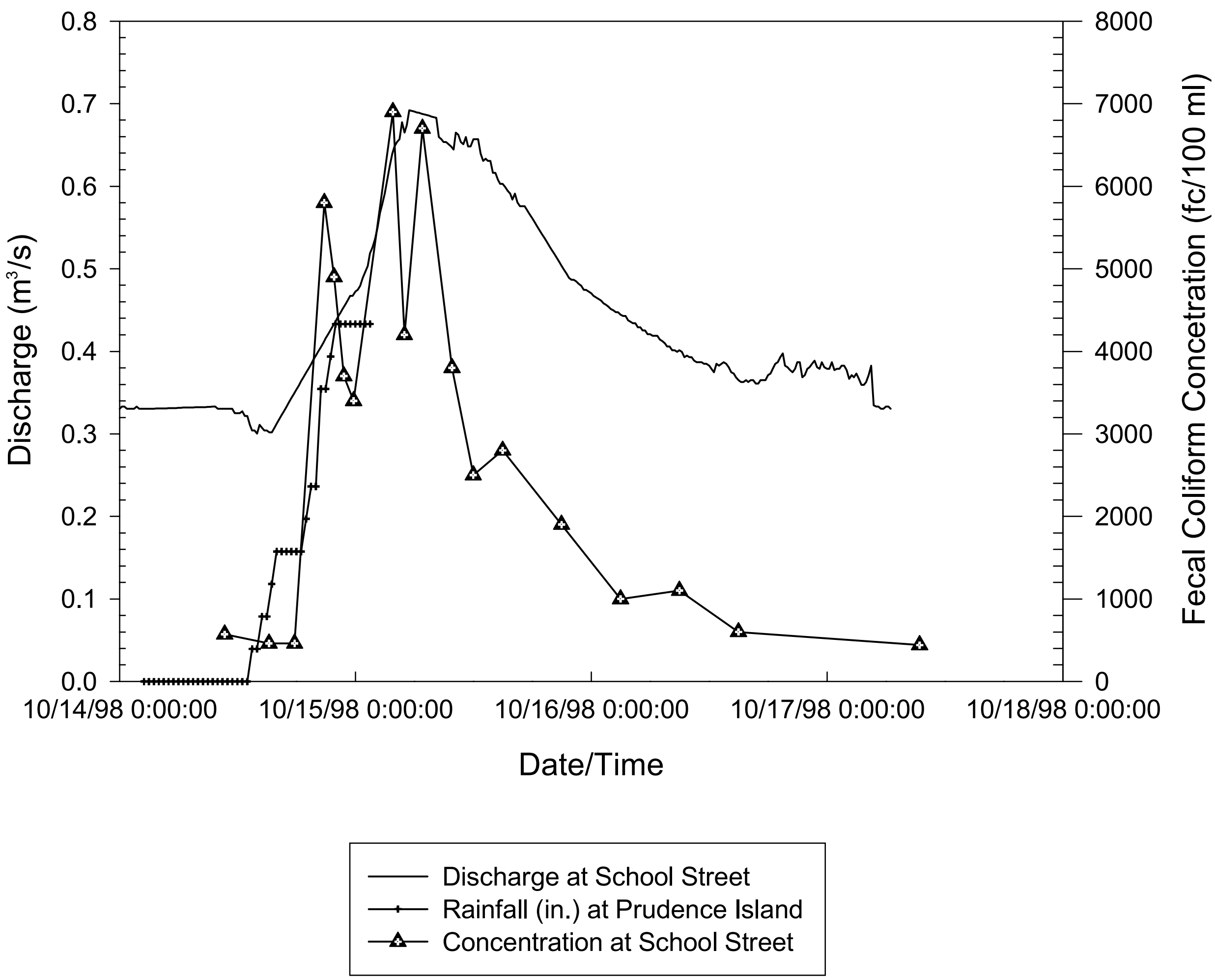

Figure 4.14: Discharge and fecal coliform concentrations at School Street (RIDEM, 1999).

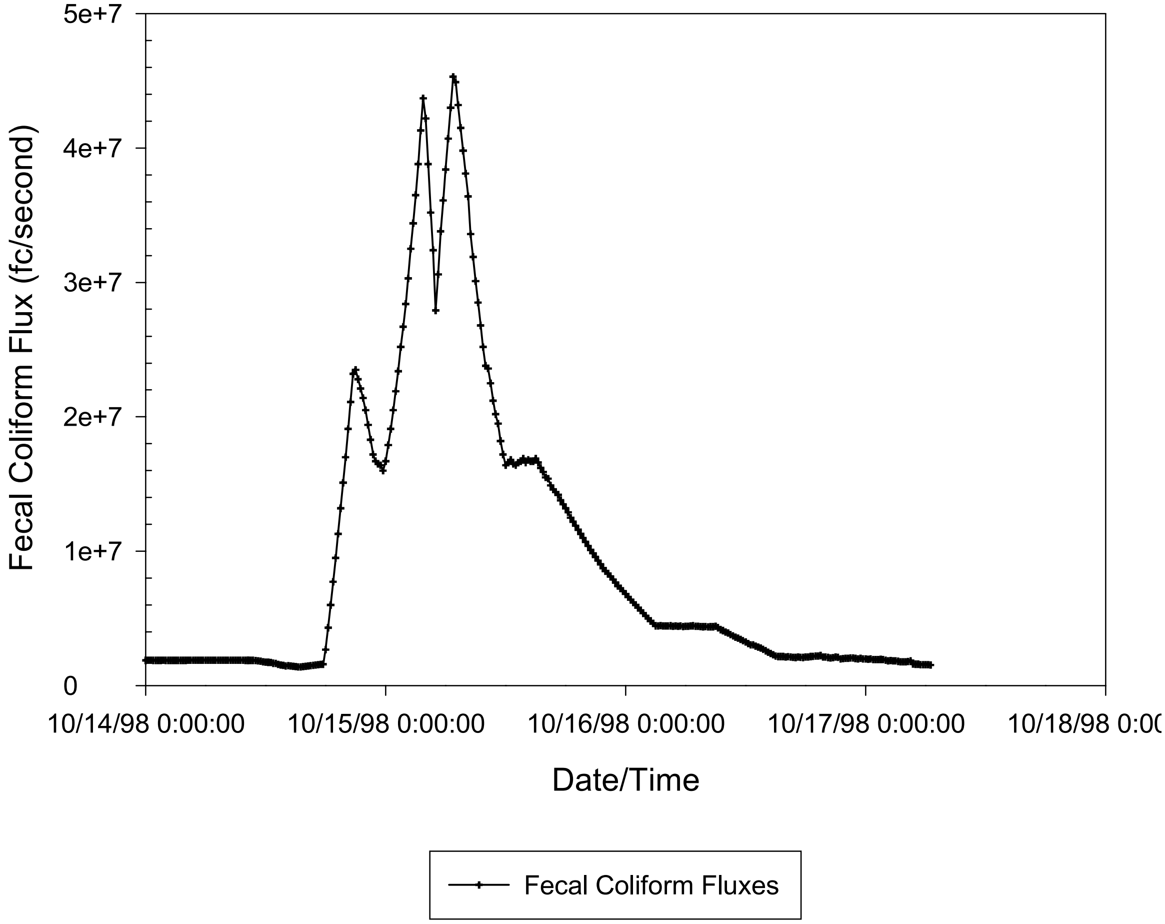

Figure 4.15: Runnins River fecal coliform flux time series at School Street (RIDEM, 1999).

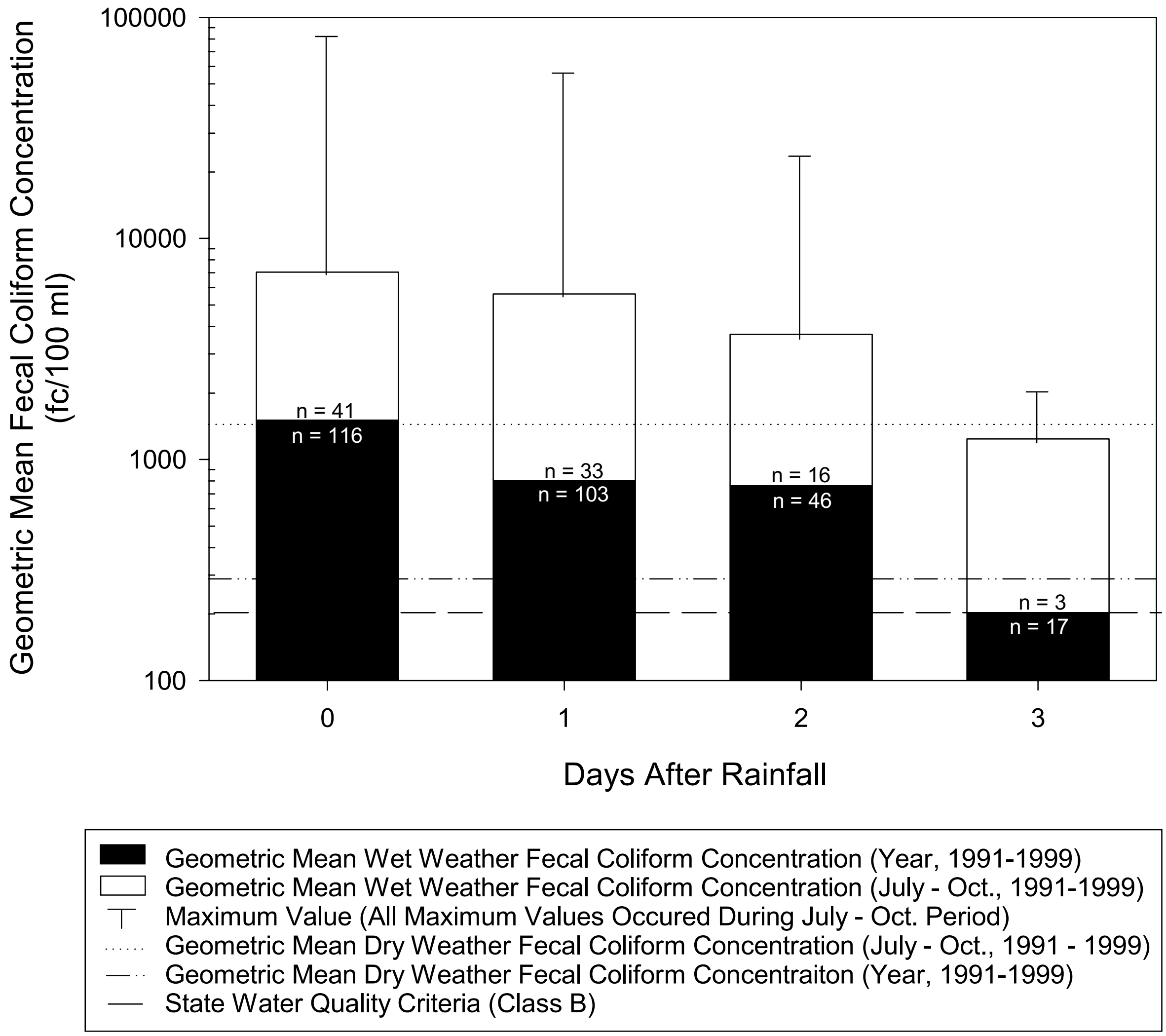

Figure 4.16: Recovery time of Runnins River after rainfall at School Street from Rayner 1990-1999 data.

5.0 WATER QUALITY IMPAIRMENT

This section describes violations of designated uses and water quality criteria found in the State of Rhode Island Water Quality Regulations, and describes the causes of the impairments. The fecal coliform parameter is used as the indicator for potential transmission of disease through contact with water. Fecal coliform bacteria do not necessarily cause disease themselves, but indicate the potential presence of disease-causing microorganisms known as pathogens. Pathogens can infect humans through skin contact or ingestion of water, contaminated fish, and shellfish. The coincidence of pathogens with elevated fecal coliform levels implies an increased health risk to humans from exposure to the river. High fecal coliform concentrations impair the recreational value of the river.

The impairment of the Runnins River is primarily attributable to nonpoint sources. The Wannimoisett pump station in East Providence, which has periodically discharged untreated sewage to Orange Juice Creek, is considered a point source. The School Street Bridge station is the most limited location in the river that is in terms of its dry and wet weather water quality condition. Because the Runnins River is the principal cause of impairment of the downstream waters of the Barrington River, the water quality goals for the river specified in Section 6 will therefore be defined as the values at this location.

5.1 Dry weather impairment

This TMDL is based on data for the months of July through October when fecal coliform concentrations are typically highest. The RIDEM data was selected to represent the existing dry weather condition of the Runnins River during this period. The current dry weather fecal coliform concentration in the Runnins River is 1576 fc/100 ml. The corresponding loading is 3.3×10^{11} fc/day. Fifty percent of samples exceed 500 fc/100 ml in dry weather. The reach of the river between the Route 6 stream #2 and its mouth at the Mobil Dam is presently impaired during dry weather. The dry weather sources to the Runnins River are presented in Table 5.1.

Table 5.1: Known and potential dry weather sources in the Runnins River

Known (K) & Potential (P) Sources/Problems	Existing Load, (fc/day)
Instream bacterial growth (K)	3.30×10^{11}
Route 195 stream (K)	
Suspect septic systems - Seekonk (P)	
Failing septic system - East Providence (P)	
Wildlife[1] (P)	

[1] Wildlife other than the pigeons impacting the Route 195 stream.

5.2 Wet weather impairment

The 1998 RIDEM wet weather study was selected to represent the present condition of the river during wet weather. The fecal coliform loading from the Runnins River and the existing wet weather concentration at School Street used to establish the reductions were established from sampling conducted during the 1998 event. The 1995 storm event could not be used to quantify the characteristic instream concentration or the loading to the Barrington River because the

Runnins was flowing in the upstream direction for the first half of the study. The characteristic wet weather fecal coliform concentration at School Street determined from the 1998 study is 3211 fc/100 ml. The corresponding wet weather fecal coliform loading is 1.5×10^{12} fc/day. The entire river between the County Street Bridge and its mouth is impaired during wet weather. The class B variability standard is exceeded in 89% of samples collected during the summer in wet weather.

The 1995 RIDEM wet weather survey was selected to represent the fecal coliform loads from sources to the river from its watershed. Sources to the Runnins River were not sampled during the 1998 wet weather study. The 1995 study identified the four significant sources in the reach of the river below County Street that are summarized below in Table 5.2.

Table 5.2: Wet weather sources to the Runnins River measured during October 1995 (RIDEM, 1996)

Source	Existing Load (fc/day)	Existing Load (fc/day)
Route 6 Stream #2	3.90×10^{11}	
County Street Culvert	2.75×10^{11}	
Route 195 Stream	2.00×10^{11}	
OJ Creek	1.80×10^{11}	1.16×10^{12}
Route 6 Culvert[1]	6.00×10^{9}	
Above County Street	4.00×10^{10}	
Other nonpoint sources	7.10×10^{10}	

[1] Was not identified as significant source however storm water BMP currently in design process.

5.3 Loss of designated uses

Fecal coliform concentrations presently exceed the State standard during dry weather in the reach of the River below the Route 6 stream #2. The Runnins River is therefore unsuitable for primary and secondary contact activities, which include swimming and boating. During wet weather, the entire river below the County Street Bridge exceeds the standard for primary and secondary contact activities. High fecal coliform concentrations in the Runnins River also impact water quality in the Barrington River, downstream of the Runnins River. The Barrington River, considered by many to represent a valuable shellfish and recreational (swimming and boating) resource, has been permanently closed to shellfishing since 1998 due to elevated fecal coliform levels. RIDEM monitoring indicate that the Runnins River is the largest contributor of fecal coliform to the Barrington River.

6.0 TMDL CALCULATIONS / TARGETED WATER QUALITY GOALS

This section describes the methods used establish reduction goals for the Runnins River. A brief description of the approach used is discussed as well as the allocations or reductions necessary in order to achieve the goals.

6.1 Overview

This TMDL is expressed as a load in units of fc/day, and as a percentage reduction of the existing load, for dry and wet weather conditions. The TMDL load reduction is based on the requirement of meeting water quality standards in the Barrington River immediately below the mouth of the Runnins River. Load reductions for the river are defined for dry and wet weather conditions and in terms of the reduction needed to meet the variability part of the water quality standard. Dry weather loads to the Runnins River are only nonpoint in nature, so the dry weather goal will be met through a load allocation. One point source was determined to exist in wet weather; the remaining wet weather sources are considered to be nonpoint. The wet weather endpoint will therefore be addressed through a waste load allocation and a load allocation.

Load allocation for dry weather

The dry weather load allocation for nonpoint sources is made for School Street, which is the most limited location for water quality in the Runnins River. The allocation is made by comparing current conditions to the numeric dry weather endpoint, then calculating the percent reduction needed to meet the standard. The dry weather load allocation is based on the maximum loading from the Runnins River that would allow the Barrington River to meet the dry weather target for the Barrington River.

The allocation is presented in mass loading and concentration units in Table 6.1 to document conditions used in establishing the load allocation for the Barrington River. The discharge is the summer mean value obtained from RIDEM measurements during 1996 and 1997. The existing concentration was derived from the RIDEM studies conducted between 1995 and 1999. A 99.1% reduction in dry weather loadings to the river is needed to meet the geometric mean target for the river.

Table 6.1: Runnins River dry weather load allocations and reductions

Criterion	Allocated Load (fc/day)	Discharge (m^3/s)	Target Concentration (fc/100 ml)	Existing Load (fc/day)	Existing Concentration (fc/100 ml)	Percent Reduction
Geometric Mean	2.93×10^9	0.242	14	3.30×10^{11}	1576	99.1

Waste load allocation for wet weather

The Wannimoisett Road Pump Station in East Providence is considered a point source due to periodic overflows of partially treated sewage. However, since the overflows are considered a violation, a waste load allocation of zero is assigned to the Wannimoisett station. In this TMDL report, all storm water discharges are treated as nonpoint sources. This TMDL identifies storm sewer outfalls associated with elevated bacteria levels in-stream, and where appropriate provides for structural BMPs to reduce pollutant loads. In the future, actions to achieve the required reductions can be taken voluntarily by the responsible agencies prior to the issuance of RIPDES Phase II Stormwater Permits, or will be required by the Phase II permits.

Load allocation for wet weather

The wet weather load allocation for nonpoint sources is again made for School Street, which is also the most limited location during wet weather. Estimates of the percent reduction are also made in the same manner as for dry weather, with the allowable loading and target concentration again controlled by downstream conditions in the Barrington River.

The wet weather reduction target for the Runnins River is presented in Table 6.2. The geometric mean allocation is controlled by the need to meet the SA standard at the head of the Barrington River. Existing discharge and geometric mean concentrations were obtained from the RIDEM 1998 wet weather study. The resulting load reduction is 99.6%.

Table 6.2: Runnins River wet weather load allocations and reductions

Criterion	Allocated Load (fc/day)	Discharge (m^3/s)	Target Concentration (fc/100 ml)	Existing Load (fc/day)	Existing Concentration (fc/100 ml)	Percent Reduction
Geometric Mean	6.5×10^9	0.54	14	1.50×10^{12}	3211	99.6

Table 6.3 presents the load allocations for the Runnins River based on meeting the variability criterion of the water quality standard. The limiting condition was determined to be that for the downstream waters of the Barrington River, which requires that less than 10% of samples in the Runnins River at School Street may exceed a concentration of 49 fc/100 ml. This condition is more likely to occur during wet weather, and would be therefore be attended by a higher flow condition. Runnins discharge was set at levels observed during the October 1998 storm. When the flow and concentration conditions outlined above exist in the Runnins River, a concentration of 49 fc/100 ml will be exceeded in less than 10% of samples collected at the upstream boundary of the Barrington River. The criterion of <10% of samples exceeding 49 fc/100 ml is more restrictive than the variability standard for Class B waters of less than 20% of samples exceeding 500 fc/100 ml.

The Pokanoket Watershed Alliance (Rayner) wet and dry weather data were used to determine the 90th percentile concentration at School Street because a considerably larger number of samples were available from this data set. RIDEM decided to restrict the use of the Rayner data to providing estimates of the variability of the data. Corresponding discharge data were not available for the Rayner data, so the comparison could only be made on a concentration reduction basis. The 90th percentile value from the Rayner data was determined to be 12,100 fc/100 ml. The 99.6% reduction needed to the existing 90th percentile concentration from 12,100 fc/100 ml to 49 fc/100 ml is equivalent to that needed to meet the geometric mean standard in Tables 6.1 and 6.2.

Summary

The variability criterion, which is based on both dry and wet weather data, was found to be the most limiting criterion. The loading reduction needed to meet all criteria is 99.6%.

Table 6.3: Runnins River load allocation and reduction based on the variability criterion.

Criterion	Discharge (m^3/s)	Target Concentration (fc/100 ml)	Existing Concentration (fc/100 ml)	Percent Reduction
90^{th} Percentile	0.54	49	12100	99.6

6.2 Margin of safety

The MOS for this TMDL is incorporated implicitly into estimates of current pollutant loads, the targeted water quality goal (i.e., the instream numeric endpoint), and the load allocations. This is done by making conservative assumptions throughout the TMDL development process. Key assumptions are described below.

1) The geometric mean numeric target value for the Runnins River at the point of discharge to the Barrington River is 14 fc/100 ml, which is considerably lower than the standard of 200 fc/100 ml for Class B waters.

2) The 90^{th} percentile concentration target of 49 fc/100 ml is also significantly lower than the 80^{th} percentile criterion of 500 fc/100 ml for Class B waters.

3) Reduction targets are based on conditions at School Street, which is the most impaired location in the river. If the targets are met at this location, they will also be met in the rest of the river.

3) Wet weather conditions were based on storm flow data from a rainfall event of 0.93 inches. Based on the frequency of rainfall events recorded at T.F. Green Airport (Warwick), 81% of rainfall events are equal to or less than 0.93 inches.

4) The TMDL was developed for the July - October period, a period in which fecal coliform concentrations are significantly elevated relative to other seasons.

6.3 Natural background

The geometric mean dry weather fecal coliform concentration at Pleasant Street, the northernmost station in the watershed, is 300 fc/100 ml. Below Pleasant Street, the river runs through Grist Mill and Burrs Ponds. Below the two ponds, the river winds through a largely undeveloped area. The river emerges from this area at County Street, where the geometric mean concentration is 72 fc/100ml. The condition at County Street is considered to be representative of the background condition of the river. Because the time required for water to travel through the two ponds and the associated reaches of the Runnins River down to County Street are not known, the contributions of sources in the Pleasant Street and Grist Mill Pond areas on downstream areas cannot be quantified or separated from other nonpoint sources.

Land uses become predominantly high intensity commercial uses downstream of County Street. Fecal coliform concentrations show a distinct seasonal elevation during the summer months particularly in the reach below Route 6 Stream #1. The cause of the seasonal elevation is not clearly understood. As previously mentioned, it has been documented that *Phragmites* in the reach between Route 6 Stream #2 and School Street can trap fecal coliform. It is hypothesized that fecal coliform may survive longer and perhaps even proliferate during the summer months. However, it is unclear if a source to this area maybe attributed to a 'natural' source (e.g. birds and other warm blooded animals) and/or to failing septic systems. At present, the natural background loads or concentrations therefore could not be quantified and separated from nonpoint loads.

6.4 Seasonal variation/critical conditions

Critical conditions in the Runnins River occur during the months of July through October, when violations of fecal coliform water quality criteria occur most often. The TMDL endpoint was set to achieve water quality criteria during this critical period and will therefore be protective throughout the year.

7.0 ASSURANCE OF IMPLEMENTATION

In a waterbody impaired primarily by nonpoint sources as is the Runnins River, EPA guidance does not call for reasonable assurances that load reductions will be achieved in order for a TMDL to be approved. However, EPA strongly suggests that States/Tribes provide reasonable assurances regarding achievement of load reductions as part of a implementation plan. The implementation plans presented below are currently being developed through the Runnins River Steering Committee.

7.1 Best Management Practices and initiatives under development

Plans are already in place to reduce a significant portion of the current load. Key areas in which progress is already underway are described below.

1. County Street Culvert - The County Street Culvert was identified as the second largest wet weather source of fecal coliform to the Runnins River (RIDEM, 1996). RIDOT has preliminary plans for a storm water BMP to remove sediments. Plans have been made between RIDOT and RIDEM for RIDOT to further sample the storm drain system once the Route 195 Bridge pigeon deterrent system is in place. The City of East Providence will also be mapping the County Street storm drain system and inspecting for illicit connections as part of an SEP.

2. Route 195 Stream - Under a RIDOT contract, a pigeon deterrent BMP is currently being designed to prevent pigeons from nesting under the Route 195 Bridge. The Route 195 Stream was the sole identified dry weather source and the third largest wet weather contributor of fecal coliform to the Runnins River (RIDEM, 1996). This BMP may also reduce loadings at County Street because runoff from the bridge does flow to the County street drain

3. Orange Juice Creek - On December 29, 1998, a Notice of Violation (NOV) was issued to the City of East Providence (NOVCI1342) for periodic overflows of partially treated sewage and rain water from the Wannimoisett Road Pumping Station, as well from a manhole on the corner of Boyd Avenue and Howland Avenue. Past overflows entered a wetland and Orange Juice Creek, identified as the fourth largest wet weather fecal coliform source to the Runnins River (RIDEM, 1996). To resolve the NOV, the City of East Providence and RIDEM entered a Consent Agreement, which requires that the City implement short and long term measures to eliminate these discharges. The City of East Providence is currently adding hypochlorite to bypassed effluent and is monitoring all bypass events as a temporary measure until the bypass problems are resolved.

   The City of East Providence is currently investigating the cause of high infiltration and inflow (I/I) into the facility collection system. It is hypothesized that flow is entering the system by illegal connections to storm drains (discharging sump pump water) and/or infiltration of groundwater at high groundwater table levels. As part of the infiltration study, suspect locations in East Providence will be investigated to locate sources of illegal discharges to the system. Infiltration of groundwater into the system will also be investigated.

The results of the investigation were due in August 2000. Additional work may be required pending results of the study.

In addition to the I/I study, a pump efficiency study will be conducted to minimize bypass volumes. This study will be completed by November 2000. Also, a sewer capacity study will be conducted to determine the capacity of the sewer system, and to determine if any blockages or obstructions may be causing problems. The sewer capacity study was scheduled for completion in July 2000.

The consent agreement also requires that the City of East Providence survey the stormwater drainage system and incorporate it into GIS as a Supplemental Environmental Project (SEP). As part of the SEP, the City will eliminate all illegal discharges to the storm drainage system that pose a threat to public health or the environment (that is, sewage discharges, floor drains, etc.).

4. Route 6 Culvert - A storm water BMP is currently being designed under a RIDOT contract, to remove sediments from a culvert draining the area along Route 6 in East Providence next to the river. The Route 6 Culvert was not identified as a significant source of fecal coliform, however, sedimentation of this area has been observed.

7.2 Planned BMPs and initiatives

Additional work by the State of Rhode Island, Commonwealth of Massachusetts, and by EPA New England Region will be needed for the Runnins River load reduction targets to be met. The following actions to further improve water quality are identified for the remaining problems areas, which are primarily located in Massachusetts:

1) Design and construct a stormwater BMP for Route 6 Stream #2. Route 6 Stream # 2 was identified as the largest wet weather contributor of fecal coliform to the Runnins River (RIDEM, 1996).

   The surrounding wetland presently provides little storage for storm water runoff. The wetland also functions poorly as a pollutant buffer for the Runnins River. For example, the Route 6 Stream #1 which is also adjacent to the Seekonk commercial district drains a larger area, which extends past Route 195 to the north. This stream had similar flows during the 1995 storm because a significant amount of runoff was diverted into retention ponds. Fecal coliform concentrations entering the River from Route 6 Stream #1 were an order of magnitude lower than those in Route 6 Stream #2 (RIDEM, 1996). A BMP to collect storm water runoff will reduce storm-related loadings to the River by reducing the volume of runoff and fecal coliform concentrations entering the River during rain events. An effort to investigate illegal connections to storm drains in this area is also recommended.

2) Evaluate the sustainable transition from Phragmites to other wetland plant species in area between Route 6 Stream #2 and School Street.

   The wetland is comprised almost entirely of Phragmites, which has little habitat or food value for wildlife and has been shown to create conditions that promote instream growth of bacteria. While improving the area's value as a habitat, the transition to other wetland plant species would reduce the instream growth of bacteria by exposing the area to sunlight and improving water movement.

3) Characterize ground water quality in the Mink-School-Leavitt Street area on the Seekonk side of the Runnins River.

   In dry weather, instream fecal coliform concentrations rise sharply in the area bounded by Mink, School, and Leavitt Streets. Investigations of surface sources during have concluded that surface sources do not account for this rise. It has been hypothesized that bacteria may grow in the River. This action should be considered a last resort to be pursued if other initiatives do not uncover the bacterial source in this reach. If continued investigations refute the internal growth hypothesis, MADEP should focus its attention on the characterizing the influxes of bacteria in groundwater in this reach of the River.

4) Investigate the cause of elevated dry and wet weather fecal coliform concentrations at Pleasant Street (Massachusetts).

   Instream fecal coliform concentrations measured during the initial phase of the 1995 storm at Pleasant Street indicate the likelihood of sewage runoff to the River, perhaps from failing septic systems. MADEP followed up with sampling during 1999 that confirmed this problem. Further investigation of this area to locate sources is recommended during dry and wet weather

5) Deter waterfowl from the Grist Mill Pond.

   A large population of domestic and wild waterfowl congregates in the Grist Mill Pond and in the adjacent parking lot. The impacts of this condition were not observed downstream at the Burrs Pond outlet, probably as a consequence of bacterial die-off during detention in Grist Mill and Burrs Ponds. Some improvement in the downstream mean value would be expected if this source were removed.

6) Stormwater Phase II Permit Program

   RIDEM has amended the existing Rhode Island Pollution Discharge Elimination System (RIPDES) regulations to include Phase II Storm Water Regulations. The new regulations became effective in March 2002.Under the program, operators of municipal separated storm sewer systems (MS4s) must develop stormwater management program plans (SWMPPs) that describe the Best Management Practices (BMPs) for each of the following minimum control measures:

   1. a public education and outreach program to inform the public about the impacts of storm water on surface water bodies,
   2. a public involvement/participation program,
   3. an illicit discharge detection and elimination program,

4. a construction site storm water runoff control program for sites disturbing more than 1 acre,
5. a post construction storm water runoff control program for new development and redevelopment sites disturbing more than 1 acre and
6. a municipal pollution prevention/good housekeeping operation and maintenance program.

The SWMPP must include the measurable goals for each control measure (narrative or numeric) that will be used to gauge the success of the overall program. It must also contain an implementation schedule that includes interim milestones, frequency of activities and reporting of results. The Director of RIDEM can require additional permit requirements based on the findings of a TMDL.

Operators of municipal separate storm sewer systems (MS4s) within urbanized areas (UAs) or densely populated areas (DPAs) must develop a SWMPP and obtain a permit for areas in their UA or DPA by March 10, 2003. The MS4s that discharge to the Runnins River are owned and operated by the City of East Providence and RIDOT. Areas in Rhode Island adjacent to the Runnins River within a UA. Accordingly, the City of East Providence and RIDOT will be required to apply for RIPDES permits for those portions of their MS4s located within the UA by March 10, 2003.

This TMDL specifies that the SWMPPs submitted by East Providence and RIDOT provide for the design and installation of structural BMPs at the locations identified in Table 7.1 below. The BMP designs must reflect treatment levels needed to meet the reduction targets of this TMDL, focusing on methods to reduce peak stormwater flows reaching the creek through improved detention and infiltration. RIDEM will continue to work with RIDOT and East Providence to evaluate locations and designs for storm water control BMPs throughout the watershed. In accordance with the requirements of this phased TMDL, monitoring of the Runnins River will continue so that the effectiveness of ongoing remedial activities can be gauged.

Table 7.1: Summary of current and proposed work in the Runnins River watershed

Known (K) or Potential (P) Source or Vegetation (V) Problem	Jurisdiction	Abatement Measure	Status
County Street Culvert (K)	RIDOT	Storm water BMP	Completion pending availability of funds
Route 195 Stream (K)	RIDOT	Pigeon Deterrent BMP	Completion pending availability of funds
Route 6 Culvert (K)	RIDOT	Storm water BMP	Completion pending availability of funds
OJ Creek (K)	City of East Providence	Repair Wannimoisett pump station	I/I study, capacity study, pump study completion in 2001
OJ Creek (K)	City of East Providence/ RIDOT	Storm water BMPs	To be implemented under Phase II Stormwater Program
Septic system - East Providence (P)	RIDEM	Repair failing septic system near Mink Street	Completed (3/2000)
Illegal sewer connections (P)	City of East Providence	Investigate illegal connections to storm drains/Map storm drain network	Completion in 2002
Route 6 Stream #2 (K)	MADEP	Storm water BMP	MA EOEA has obtained 604(b) grant to evaluate sources and potential remedies.
	Town of Seekonk	Map storm drain network. Delineate boundaries of storm drain catchments/ Investigate illegal connections to storm drains	Recommended by RIDEM
Septic systems - Seekonk (P)	MA EOEA and MADEP	Resolve authority to investigate cesspool under Clean water Act	Recommended by RIDEM
	MADEP	Groundwater monitoring in the vicinity of Mink, School, and Leavitt Street ("the triangle")	Recommended by RIDEM. To be conducted if other abatement measures fail.
	Town of Seekonk	ISDS investigations and repairs.	Conduct investigations as indicated.
Lower Runnins River (V)	East Providence/ Seekonk, MA EOEA, RIDEM, RI CRMC	Reduce Phragmites densities to restore habitat	MA EOEA, RIDEM, EPA are resolving scope and level of effort issues.
Pleasant Street (P)	MADEP	Investigate cause of elevated dry/wet weather fecal coliform	MADEP (1999) has confirmed the elevated concentrations.
Grist Mill Pond (P)	Seekonk animal control office	Remove and deter waterfowl from pond.	Recommended by RIDEM

8.0 PROPOSED MONITORING

Continued monitoring of the Barrington, Runnins, and Palmer River is needed to confirm whether or not desired water quality standards have been met. The monitoring conducted by volunteers, such as the Pokanoket Watershed Alliance, will be valuable in gauging the effectiveness of the recommended BMPs.

During the implementation phase of the TMDL, RIDEM has recruited volunteers through the Pokanoket Watershed Alliance to sample four stations in the Runnins River and one station in the Barrington River. The Runnins River stations are located below the Burr's Pond Dam, at Route 6, and at School Street. The stage of the river should be recorded at School Street during each sampling survey. RIDEM also recommends periodic sampling of Orange Juice Creek at Catamore Boulevard during or after periods of wet weather to verify that improvements at the Wannimoisett Street pump station and improvements in stormwater management in the watershed have improved the wet weather condition of the creek. RIDEM also recommends that a water quality station be located near the Tongue in the Barrington River. At these two stations, volunteers will collect fecal coliform samples and record instream temperatures on a monthly basis from July through October.

The Barrington and Palmer Rivers are sampled monthly by the Shellfish Growing Area Water Quality Monitoring Program. At the present time, all stations in the Barrington River exceed water quality standards. If the numerical water quality target set by this TMDL is met for the Runnins River, the Barrington River shellfish stations should meet standards. When these stations begin to meet water quality standards, additional monitoring for the northernmost shellfish stations will be performed by RIDEM.

9.0 PUBLIC PARTICIPATION

The New England Interstate Water Pollution Control Federation (NEIWPCC) established the Runnins River Steering Committee in 1993. The group was formed to facilitate communication among interested parties in the Runnins River watershed, which is part of the Barrington River watershed. Its members include participants from municipalities, states, EPA, and volunteer monitoring groups. The committee holds bimonthly meetings that are open to the public. The committee has ensured that improvements to the water quality of the Runnins and Barrington Rivers have remained on the agendas of the state and federal agency agendas.

RIDEM has been involved with the Runnins River Steering Committee from its creation. RIDEM routinely presents information on its activities in the watershed at the bimonthly meetings. The members of the committee help shape RIDEM's activities in the watershed by identifying areas that need more study. Members of the Pokanoket Watershed Alliance, a volunteer monitoring group, present information on routine water quality monitoring at stations in the Runnins and Barrington Rivers.

Public meetings and comment are an important component of the TMDL process. In addition to participating in the Runnins River Steering Committee meetings, RIDEM held an initial public meeting in July 1999 prior to developing the draft TMDL that was attended by interested public, private, and government entities. The goal of the meeting was to provide information regarding the TMDL issues in the watershed and to solicit input regarding pollution sources and/or other concerns. The draft Runnins and Barrington TMDLs were presented in a public meeting in June 2000. Public comment was solicited for a thirty-day period during and after the meeting. EPA comments on the draft Barrington River TMDL made it necessary to hold a final public meeting and notice period for both TMDLs in July - August 2002. Stakeholders were again given thirty days to review and submit comments on the draft Runnins and Barrington River TMDLs. RIDEM's response to comments made during the 2000 and 2002 comment periods are contained in Appendix F to this document.

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APPENDICES

Appendix A: Dry Weather Data

Dry Weather Data: School Street (RIDEM, 1995-1999)

Month	Date	Stage (ft)	Discharge m^3/s	Fecal Coliform (fc/100 ml)	Load (FC/day)	Mean Load by Month
January	1/22/97	1.32	0.352	17	8.97E+08	8.97E+08
June	6/8/99	1.18	0.248	380	1.41E+10	
	6/21/97	1.82	0.958	3900	5.60E+11	2.87E+11
July	7/30/97	1.16	0.235	2800	9.87E+10	9.87E+10
August	8/19/99	1.15	0.229	28000	9.61E+11	9.61E+11
September	9/21/98	1.99	1.265	10000	1.90E+12	1.90E+12
October	10/8/96	1.23	0.282	250	1.06E+10	1.06E+10
	10/10/97	1.18	0.248	460	1.71E+10	
	10/29/99	1.26	0.304	170	7.76E+09	1.24E+10
November	11/5/98	1.19	0.254	5100	1.95E+11	1.95E+11

Seasonal Period = July - October

Geometric Mean: 1070 fc/100 ml
Geometric Mean Seasonal: 1576 fc/100 ml
% Exceeding 500 fc/100 ml: 50
% Exceeding 500 Seasonal: 50

Dry Weather Data: Runnins River Watershed (RIDEM, 1995-1997)

St.#	Name	10/20/95	10/27/95	10/8/96	1/22/97	7/30/97	10/10/97	10/10/97	10/10/97	GeoMean
UR16	**Pleasant St. Bridge**	**490**	**290**	**120**	**23**	**7,400**	**250**			299.76
UR31	**Fall River Avenue Bridge**						**150***			
R1	**Burrs Pond Dam**	**23**	**79**	**70**	**77**	**60**	**22**			48.45
R4	Almeida Ave. Stream @ Bridge	98	84	23	16	220				58.18
(R4X)	(After stirring sediments)				(90)					
R4d	Almeida Ave. Pipe (2)	6	11	<1	1	<1				4.04
R7	**County St. Bridge**	**64**	**61**	**110**	**40**	**110**	**76**			72.36
R9	Route 195 Stream	360	150	190	8	280	360			142.22
R12	**Route 6 Bridge**		98	**120**	**39**	**300**	**230**			125.91
(R12X)	(After disturbing stream bank)				(<1)					
R13	Route 6 Pipe (3)	14	180							50.20
R13.1	**Above OJ Creek**						**110***			
R14	OJ Creek	27	25	33	3	42	51			22.87
R18	Cemetery Stream	4	3	3	<1	30				5.73
R19	**Above Route 6 Stream #1**	**76**	**94**	**120**	**36**					74.53
R20	Route 6 Stream #1	140	87	150	1		190			51.06
R20.1	**Below Route 6 Stream #1**						**180***			
R20a	Route 6 Stream #1 @ Culvert					150*				
R23	**Above Route 6 Stream #2**	62	***1,000***	**130**	**28**					122.57
R24	Route 6 Stream #2	440	*3,300*	87	5					158.53
R24b	Home Depot Pipe			47	3					11.87
R31	**Mink St. Bridge**	**130**	**1,200**	**120**	**25**	**760**	**130**	**210**	**360**	207.94
R32	Mink St. Stream @ River			150	2	470	85			58.84
R32a	Mink St. Storm Drain	40	13	30	<1	110[3]				24.99
R32b	Leavitt North Stream @ Leavitt	390	750	170	2	260	30			95.86
R37	Meade St. Stream @ River			390	50		44			95.02
R37b	Meade St. Stream @ Leavitt	2	1	6	<1	1	1			1.64
R39	Leavitt South Stream @ River			240*						
R39a	Leavitt South Stream @ Leavitt	<1		<1	<1	5	13			8.06
R40	**School St. Bridge**		**4,800**	**250**	**17**	**2,800**	**460**	**530**	**240**	482.96

Dry Weather Data: Runnins River Watershed (RIDEM, 1995-1997) Continued

St.#	Name	10/20/95	10/27/95	10/8/96	1/22/97	7/30/97	10/10/97	10/10/97	10/10/97	GeoMean
B12	**Sportsmen's Club**			**820**		**3,900**	**560**			1214.38
B16	Monarch Dr. Stream						14,000			14000.00
B24	**Osprey Nest**			**24**		**370**	**10**			44.61
B26	**Block House (HA Cove)**				**15**					15.00

Italics on stations R23 and R24 indicate samples taken on morning of 10/28/95 prior to onset of rain
Samples highlighted in gray exceed 500 fc/100 ml
Samples highlighted in yellow exceed 200 fc/100 ml

Dry Weather Data: Runnins River Watershed (RIDEM, 1999)

Station	Distance (meters)	Survey 1: 6/8/99 (fc/100 ml)	Survey 2: 8/23/99 (fc/100 ml)	Survey 3: 11/1/99 (fc/100 ml)
R1	1130	48	20	150
R7	1969	490	1600	29
R12	2429	1000	1000	29
R23	3341	No sample	1100	55
RS28E	3351	230	No sample	160
RS28W	3351	150	No sample	200
RS29E	3670	250	14000	No sample
RS29W	3670	220	2300	92
R31	3879	290	12000	210
RS32E	3929	250	6600	160
RS32W	3929	260	9600	190
RS33E	3984	260	11000	230
RS33W	3984	210	15000	190
RS34E	4114	290	37000	260
RS34W	4114	270	28000	260
RS35E	4144	290	41000	100
RS35W	4144	290	23000	150
RS35AE	4180	No sample	24000	160
RS35AW	4180	No sample	35000	110
RS36E	4208	420	55000	220
RS36W	4208	260	39000	300
RS37E	4240	No sample	37000	110
RS37W	4240	No sample	37000	120
R40	4294	380	28000	170
R32a*	3879	50	Dry	Stagnant
R32b*	3879	560	840	41
R37b*	Dry	Dry	Dry	Dry
R39a*	Dry	Dry	Dry	Dry

* Tributary sample

Dry Weather Data: School Street (Rayner, 1990-1999)

Date	FC (fc/100ml)	Date	FC (fc/100ml)
27-Aug-90	2100	26-Oct-91	150
30-Aug-90	2300	04-Nov-91	400
02-Sep-90	1780	04-Nov-91	450
05-Sep-90	5010	05-Nov-91	300
06-Sep-90	14700	06-Nov-91	600
07-Sep-90	6800	08-Nov-91	450
11-Sep-90	2240	14-Nov-91	1400
15-Sep-90	2720	15-Nov-91	1100
26-Sep-90	920	16-Nov-91	200
26-Sep-90	500	17-Nov-91	50
30-Sep-90	880	18-Nov-91	2
03-Oct-90	2420	19-Nov-91	150
5-Oct-90	7660	20-Nov-91	360
7-Oct-90	1520	27-Nov-91	800
25-Feb-91	140	28-Nov-91	450
13-Mar-91	100	29-Nov-91	150
22-Mar-91	260	30-Nov-91	150
03-Apr-91	40	09-Dec-91	200
04-Apr-91	80	27-Dec-91	20
09-Apr-91	120	03-Jan-92	120
20-Apr-91	20	7-Jan-92	250
24-Apr-91	280	11-Jan-92	2
21-May-91	220	12-Jan-92	180
23-May-91	60	21-Jan-92	10
25-May-91	60	26-Jan-92	260
27-May-91	240	28-Jan-92	110
29-May-91	180	05-Feb-92	30
3-Jun-91	300	08-Feb-92	30
08-Jun-91	120	24-Feb-92	50
12-Jun-91	260	01-Mar-92	40
17-Jun-91	540	06-Mar-92	60
18-Jun-91	160	15-Mar-92	40
23-Jun-91	200	25-Mar-92	2
29-Jun-91	340	04-Apr-92	120
10-Jul-91	6500	05-Apr-92	110
21-Jul-91	140	15-Apr-92	20
26-Jul-91	400	16-May-92	160
03-Aug-91	940	21-May-92	140
09-Aug-91	550	29-May-92	140
24-Aug-91	1850	5-Jun-92	440
27-Aug-91	450	14-Jun-92	140
31-Aug-91	1320	19-Jun-92	240
02-Sep-91	3020	23-Jun-92	240
19-Sep-91	7200	11-Jul-92	600
02-Oct-91	500	30-Jul-92	2400

Dry Weather Data: School Street (Rayner, 1990-1999)

Date	FC (fc/100ml)	Date	FC (fc/100ml)
30-Jul-92	1140	28-Nov-93	3400
22-Aug-92	2500	28-Nov-93	40
25-Aug-92	2900	28-Nov-93	520
29-Aug-92	107000	2-Jan-94	2000
31-Aug-92	2940	22-Jan-94	2
31-Aug-92	4640	01-Feb-94	60
19-Sep-92	1260	06-Feb-94	40
30-Sep-92	1000	19-Feb-94	2
05-Oct-92	460	01-Mar-94	20
17-Oct-92	1080	27-Mar-94	20
31-Oct-92	500	02-Apr-94	120
12-Nov-92	60	24-Apr-94	80
10-Dec-92	40	27-Apr-94	60
26-Dec-92	2	14-May-94	260
09-Jan-93	80	21-May-94	80
16-Jan-93	80	30-May-94	40
02-Mar-93	40	03-Jun-94	1040
04-Mar-93	20	05-Jun-94	280
13-Mar-93	1080	11-Jun-94	160
21-Mar-93	387	28-Jun-94	260
27-Mar-93	1520	03-Jul-94	360
10-Apr-93	100	9-Jul-94	4460
20-Apr-93	100	23-Jul-94	4260
24-Apr-93	20	04-Aug-94	1080
07-May-93	110	28-Aug-94	1980
14-May-93	110	04-Sep-94	5480
29-May-93	60	17-Sep-94	8480
12-Jun-93	180	08-Oct-94	2340
26-Jun-93	460	15-Oct-94	980
17-Jul-93	480	21-Oct-94	640
26-Jul-93	60	28-Oct-94	180
06-Aug-93	420	07-Nov-94	680
24-Aug-93	2600	25-Nov-94	100
03-Sep-93	1220	02-Dec-94	280
13-Sep-93	8000	17-Dec-94	100
01-Oct-93	1650	31-Dec-94	120
02-Oct-93	1400	14-Jan-95	640
11-Oct-93	740	22-Jan-95	120
12-Oct-93	1420	28-Jan-95	240
16-Oct-93	1350	04-Feb-95	40
24-Oct-93	1740	11-Feb-95	60
27-Oct-93	300	12-Mar-95	240
27-Oct-93	320	25-Mar-95	400
05-Nov-93	350	02-Apr-95	460
13-Nov-93	150	05-Apr-95	360

Dry Weather Data: School Street (Rayner, 1990-1999)

Date	FC (fc/100ml)	Date	FC (fc/100ml)
26-Apr-95	2	27-May-96	200
06-May-95	80	30-May-96	2
09-May-95	60	15-Jun-96	280
27-May-95	120	29-Jun-96	480
27-May-95	100	10-Jul-96	920
17-Jun-95	200	19-Jul-96	860
20-Jun-95	225	23-Jul-96	1280
24-Jun-95	110	10-Aug-96	3600
29-Jun-95	320	01-Sep-96	3850
01-Jul-95	380	06-Sep-96	3800
05-Jul-95	520	21-Sep-96	3500
09-Jul-95	1380	22-Sep-96	4600
17-Jul-95	1200	27-Sep-96	5100
23-Jul-95	450	05-Oct-96	700
04-Aug-95	7000	01-Nov-96	100
12-Aug-95	7300	8-Nov-96	700
16-Aug-95	1650	15-Nov-96	300
22-Aug-95	1100	23-Nov-96	100
28-Aug-95	3900	30-Nov-96	400
02-Sep-95	2400	14-Dec-96	1800
09-Sep-95	4800	23-Dec-96	550
17-Sep-95	2100	28-Dec-96	850
22-Sep-95	1200	08-Jan-97	150
30-Sep-95	3400	03-Feb-97	100
05-Oct-95	83000	15-Feb-97	100
14-Oct-95	500	28-Feb-97	50
27-Oct-95	250	01-Mar-97	50
24-Nov-95	50	8-Mar-97	100
1-Dec-95	900	08-Apr-97	300
09-Dec-95	160	28-Apr-97	100
23-Dec-95	2	25-May-97	100
29-Dec-95	50	08-Jun-97	320
22-Jan-96	60	15-Jun-97	40
27-Jan-96	2	30-Jun-97	320
18-Feb-96	50	07-Jul-97	400
02-Mar-96	50	12-Jul-97	200
16-Mar-96	2	20-Jul-97	3240
23-Mar-96	50	23-Jul-97	20
28-Mar-96	50	03-Aug-97	3600
07-Apr-96	350	16-Aug-97	3200
14-Apr-96	2	14-Sep-97	2200
20-Apr-96	100	21-Sep-97	9000
28-Apr-96	50	27-Sep-97	800
10-May-96	100	11-Oct-97	1300
25-May-96	50	18-Oct-97	1400

Dry Weather Data: School Street (Rayner, 1990-1999)

Date	FC (fc/100ml)
21-Dec-97	40
05-Jan-98	80
23-Feb-98	40
3-Mar-98	320
27-Mar-98	260
14-May-98	80
19-May-98	100
28-May-98	180
27-Jun-98	6440
10-Jul-98	360
29-Jul-98	8400
06-Aug-98	6600
12-Aug-98	2500
24-Oct-98	260
05-Nov-98	320
16-Nov-98	200
16-Dec-98	280
12-Jan-99	180
21-Jan-99	1540

<u>Year</u>

Count	289
Geo Mean	300
% exceed 500	36

<u>Seasonal</u>

Count	118
GeoMean:	1485
% exceeding	77

Dry Weather Data: School Street (Rayner, 1998)

Month	Fecal Coliform Geometric Mean (fc/100 ml)	Mean Discharge (m^3/s)	Load (FC/day)	Mean Instream Temp. (°C)	Water Use Index (m^3/s)
January	80	0.335	4.02E+09	1	2.87E-03
February	40	0.524	3.14E+09	3.5	1.85E-03
March	260	0.925	3.61E+10	6	2.01E-03
April				8	2.06E-03
May	123	0.754	1.39E+10	11	2.28E-03
June				13	2.33E-03
July	1739	0.455	1.19E+11		2.62E-03
August	6600	0.369	3.65E+11		2.89E-03
September				15	2.88E-03
October	260	0.422	1.65E+10	10.5	2.52E-03
November	253	0.335	1.27E+10		2.40E-03
December	280	0.335	1.41E+10	2	1.77E-03

Dry Weather Data: School Street (Rayner, 1997)

Month	Fecal Coliform Geometric Mean (fc/100 ml)	Mean Discharge (m^3/s)	Load (FC/day)	Mean Temp (°C)	Water Use (m^3/s)
January	150			3	2.34E-03
February	71	0.607	6.46E+09	3	2.23E-03
March	50	0.400	3.00E+09	8	2.00E-03
April	300	1.496	6.73E+10		2.03E-03
May	100	0.482	7.23E+09	13.67	2.11E-03
June	160	0.378	9.07E+09		2.51E-03
July	638	0.252	2.41E+10	16.5	2.43E-03
August	3600	0.235	1.27E+11	22	3.14E-03
September	2511	0.335	1.26E+11		3.24E-03
October	1349	0.241	4.88E+10	9	2.91E-03
November				6	2.61E-03
December	40	0.319	1.91E+09	5	2.69E-03

Appendix B: Septic System Survey Data

Seekonk Water Use History

Name	Average Use (gpd) 05/01/97 to 11/1/97	Average Use (gpd) 05/01/98 to 11/1/98	Avg Use PF 1.5	Highest Daily Used Dates gpd	from	to
SHOWCASE CINEMA - ROUTE 6		2925	4388	4163	3/2/98	6/2/98
SEEKONK MALL TRUST	9420	11235	16852	13750	7/2/98	8/3/98
PRICE ENTERPRISES (BRADLEY COMPLEX)	887	969	1453	1233	9/1/98	10/1/98
THE HOME DEPOT, USA	1822	1979	2968	2391	6/1/98	9/1/98
CHALET SUSSE INTERNATIONAL, INC.	7648	10255	15382	12866	8/3/98	9/1/98
WAL-MART STORES, INC.	2753	3055	4582	3725	3/4/97	6/3/97
RARE HOSPITALITY INTERNATIONAL, INC. (restaurant)	7031	8559	12839	14913	9/1/98	10/2/98
T.G.I. FRIDAY'S	7981	6701	10051	9406	8/1/97	9/2/97
MARJAN, INC./MARIO'S	4099	3929	5894	4374	6/397	9/2/97
TOWN & COUNTRY MOTEL	4148	3986	5979	5132	9/1/98	12/1/98
D. J. CRONIN, INC.	3139	2413	3620	5077	6/3/97	9/2/97
GATEWAY MOTOR INN	6153	5210	7815	7615	6/3/97	9/2/97
FRIENDLY'S RESTAURANT	1761	1881	2821	2253	6/2/98	9/1/98
ROADWAY PACKAGING SYSTEM	790	772	1158	790	12/23/96	12/4/97
OVERNIGHT TRANSPORTATION COMPANY						
DARLING, FRED						
OLD DOMINION FREIGHT LINE, INC.	570	716	1074	768	6/15/98	12/4/98
CONLON REALTY II		352	528	352	6/15/98	12/4/98
CONLON REALTY II	159	138	207	156	12/4/97	6/15/98
HIGHWAY EXPRESS, INC.	42	164	246	204	6/15/98	12/4/98
RAMADA INN	17004	16663	24994	23333	7/2/97	8/1/97
OLD COUNTRY BUFFET	9417	9627	14440	10733	3/2/98	4/1/98
JOHN J. MC HALE & SONS, INC.	3431	4781	7172	5598	9/1/98	12/2/98
G. CARPET/PIER 1 (c/o: PIC)	5663	5425	8137	6934	12/1/97	3/2/98
OFFICE MAX (c/o: PIC)	278	394	591	685	3/2/98	6/2/98

Seekonk Water Use History (continued)

Name	Average Use (gpd)		Avg Use PF 1.5	Highest Daily Used Dates		
	05/01/97 to 11/1/97	05/01/98 to 11/1/98		gpd	from	to
ARLINGTON REALTY, INC. (SEEK. CNTR.)	588	604	906	703	3/2/98	6/2/98
ARLINGTON REALTY, INC.	4257	3821	5732	4257	4/9/97	12/17/97
MARY'S MOTOR LODGE	1563	1660	2491	1637	6/3/97	9/2/97
MOBIL SERVICE STATION		1367	2051			
ATLAS BOILER		305	457			

Seekonk Septic System Survey Data

ID[1]	Facility Name	Address	Date of Installation or Repair[2]	Design Daily Water Use[2] (gpd)	Actual Average Daily Water Use[3] (gpd)	Design Soil Percolation Rate[2] (min/in)	Design Leach Field Area[2] (ft^2)	Calculated Required Leach Field Area[4] (ft^2)
3	Showcase Rt. 6	100 Commerce Way	[5]	[5]	4,388	[5]	[5]	5,930
4	Stop and Shop[6]	85 Highland Ave	1998	[5]	16,852	RBC[6]	26,500[6]	22,773
5	Michael's[6]	65 Highland Ave	1998	[5]	16,852	RBC[6]	26,500[6]	22,773
6	Ann and Hope[6]	95 Highland Ave	1998	[5]	16,852	RBC[6]	26,500[6]	22,773
7	Sports Authority[7]	165 Highland Ave	1991	18,985	1,453	2	21,816	1,964
8	Alperts	100 Highland Ave	1998	[5]	[5]	[5]	<2000	[5]
9	Bayberry Plaza	150 Highland Ave	[5]	[5]	[5]	[5]	7,500	[5]
10	Home Depot	201 Highland Ave	1991	[5]	2,968	2	7,928	4,011
11	Susse Chalet Inn	341 Highland Ave	1990's	[5]	15,382	5	16,873	20,786
12	Pep Boys	216 Highland Ave	1992	[5]	[5]	[5]	<2000	[5]
13	Sam's Club	1110 Fall River Ave	1991	7,823	[5]	2	8,193	[5]
14	Walmart	1180 Fall River Ave	1994	9,280	4,582	5	14,619	6,192
15	Bugaboo Creek	1125 Fall River Ave	1993	19,016	12,839	2	16,958	17,350
17	Seekonk Square/RoJacks	1 Commerce Way	[5]	[5]	[5]	[5]	13,686	[5]
18	Dunkin Donuts	1200 Fall River Ave	1988	1,260	[5]	2	1,275	[5]
20	Anthony's Trucking	Mink St	[8]	[8]	[8]	[8]	[8]	[8]
21	TGI Fridays	1105 Fall River Ave	1991	10,389	10,051	2	12,152	13,582
22	East Side Marios	353 Highland Ave	1993	6,720	5,894	2	10,417	7,965

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[1] The ID number refers to the Building Labels in Figures 4.3 – 4.6. Information was not gathered for all buildings due to time constraints. Priority was given to buildings closest to the river and to those with higher water uses.
[2] The information was determined from ISDS permit application filed with the Seekonk Town Hall.
[3] The information was gathered from the Seekonk Water District. The Actual Average Daily Water Use is the average daily water use from May 1, 1998 to October 31, 1998 multiplied by a peak factor of 1.5
[4] The Calculated Leach Field Area is the Actual Average Daily Water Use divided by 0.74 gallons per day per square foot.
[5] Due to time constraints, information was not gathered for this system.
[6] Stop and Shop, Michael's, Ann and Hope, and Applebee's share an on-site wastewater treatment system. They use Rotating Biological Contactors (RBC) instead of a traditional ISDS.
[7] Sports Authority, Circuit City, Pier 1 Imports, Big and Tall/Wear-N-Go, and Jennifer Convertibles share an ISDS.
[8] No on-site wastewater treatment system exists. Facility uses a portable toilet.

23	Circuit City[7]	179 Highland Ave	1991	18,985	1,453	2	21,816	1,964
25	Pier 1 Imports[7]	165 Highland Ave	1991	18,985	1,453	2	21,816	1,964
26	Big and Tall/ Wear-N-Go[7]	165 Highland Ave	1991	18,985	1,453	2	21,816	1,964
34	Applebee's[6]	105 Highland Ave	1998		16,852[6]	RBC[6]	26,500	22,773
36	Town and Country Motel	Fall River Ave	[9]	[9]	5,979	[9]	[9]	8,080
39	Gateway Motor Inn	1143A Fall River Ave	1996	5,830	7,815	5	7,920	10,561
41	Friendly's	1151 Fall River Ave	1998	4,410	2,821	5	6,016	3,812
44	Autoshow Volvo	1241 Fall River Ave	[5]	[5]	[5]	[5]	[5]	[5]
45	Autoshow Volvo Fclision Center	1241 Fall River Ave	[5]	[5]	[5]	[5]	[5]	[5]
46	RPS	66 Leavitt St	1,969	[5]	1,158	>5	1,050	1,565
47	Overnight	60 Mead St	1,964	[5]	[5]	2	<2000	[5]
48	Amaral Custom Fabrications	40 Mead St	1,985	225	[5]	2	<2000	[5]
49	Old Dominion Freight Line	21 Mead St	1972	400	1,074	>5	200	1,451
50	Conlon Moving Systems	55 Mead St	1985	225	528	<2	228	714
51	Conlon Moving Systems	55 Mead St	1985	450	207	<2	228	280
52	Highway Express	80 Leavitt St	1993	338	246	>5	408	332
55	Jennifer Convertibles[7]	191 Highland Ave	1991	18,985	1,453	2	21,816	1,964
56	Ramada Inn/Darlings	940 Fall River Ave	1998		24,994	NA	12,525	33,776
65	Taco Bell	11 Commerce Way	1991	4,950		2	5,400	
66	Old Country Buffet	37 Commerce Way	1994	20,790	14,440	2	20,852	19,514
67	Tweeter Etc	30 Commerce Way	[5]	[5]	[5]	[5]	[5]	[5]
68	Aspen Dental	20 Commerce Way	[5]	[5]	7,172	[5]	[5]	9,692
70	Computer Exchange	1204 Fall River Ave	[5]	[5]	[5]	[5]	[5]	[5]
71	Outback Steakhouse Plaza[10]	1275-1375 Fall River	1993	11,694	8,137	RIDEM Data: Seekonk Septic System Survey Data(continued) [5]	[5]	10,996

[9] This facility uses a cesspool.
[10] Outback Steakhouse Plaza, Pier 1 Imports (vacant), and Office Max Plaza share an ISDS. The Office Max Plaza utilizes a separate water meter.

Seekonk Septic System Survey Data (continued)

72	Pier 1 Imports (vacant)[10]	1301 Fall River Ave	1993	11,694	8,137	[5]	[5]	10,996
73	Office Max Plaza[10]	1275-1375 Fall River	1993	1,1694	591	[5]	[5]	799
74	Blockbuster Plaza	1201 Fall River Ave	1992	3,240	906	2	3,270	1,224
75	China Wok Plaza[11]	1165 Fall River Ave	1999	525	5,732	5	1,656	7,746
77	Bell Atlantic Mobile Plaza[11]	1165 Fall River Ave	1999	1,200	5,732	5	1,622	7,746
78	Mary's Motor Lodge	1159 Fall River Ave	1998	2,640	2,491	5	3,584	3,366

[11] The China Wok Plaza and the Bell Atlantic Mobile Plaza share an ISDS.

East Providence Septic System Survey Data

ID [12]	**Facility Name**	**Address**	Date of Installation or Repair[13]	Design Daily Water Use[13] (gpd)	Actual Average Daily Water Use[14] (gpd)	Design Leach Field Area[13] (ft^2)	Calculated Required Leach Field Area[15] (ft^2)
86	Atlas/Acme Boiler Company	10 River Rd	[16]	[16]	457	[16]	618
87	Mobil Service Station[17]	900 Wampanoag Tr.	1,994	545	2,051	599	2,254

[12] The ID number refers to the Building Labels in Figures 4.3 – 4.6.
[13] The information was determined from ISDS permit application filed with the Rhode Island DEM.
[14] The information was gathered from the East Providence Water Department. The Actual Average Daily Water Use is the average daily water use from May 1, 1998 to October 31, 1998 multiplied by a peak factor of 1.5
[15] The Calculated Leach Field is the Actual Average Daily Water Use divided by 0.74.
[16] Due to time constraints, information was not gathered for this system. Priority was given to buildings with higher water uses.
[17] This system will be repaired and upgraded in the winter of 2000. The new system design reflects the higher daily water use at the facility.

Appendix C: Wet Weather Data

Wet Weather Survey: School Street (RIDEM, 1998)

Date/Time	Discharge (m^3/s)	Concentration (fc/ 100 ml)	Flux (FC/s)	Flux (FC/day)
10/14/98 10:42	0.330	570	1.88E+06	1.62E+11
10/14/98 15:13	0.304	460	1.40E+06	1.21E+11
10/14/98 17:50	0.348	460	1.60E+06	1.38E+11
10/14/98 20:50	0.410	5800	2.38E+07	2.06E+12
10/14/98 21:50	0.431	4900	2.11E+07	1.82E+12
10/14/98 22:50	0.452	3700	1.67E+07	1.44E+12
10/14/98 23:50	0.467	3400	1.59E+07	1.37E+12
10/15/98 3:50	0.639	6900	4.41E+07	3.81E+12
10/15/98 5:00	0.665	4200	2.79E+07	2.41E+12
10/15/98 6:50	0.688	6700	4.61E+07	3.98E+12
10/15/98 9:50	0.648	3800	2.46E+07	2.13E+12
10/15/98 12:00	0.657	2500	1.64E+07	1.42E+12
10/15/98 15:00	0.603	2800	1.69E+07	1.46E+12
10/15/98 21:00	0.504	1900	9.57E+06	8.27E+11
10/16/98 3:00	0.444	1000	4.44E+06	3.84E+11
10/16/98 9:00	0.401	1100	4.41E+06	3.81E+11
10/16/98 15:00	0.365	600	2.19E+06	1.89E+11
10/17/98 9:26	0.330	440	1.45E+06	1.25E+11

Wannamoisett Road Pump Station East Providence Bypass Data

Date	Amount (Gallons)	Amount (m^3/s)	Duration (days)	Flow (m^3/s)	Chlorine Used (Gallons)	Fecal Coliform** (fc/100 ml)	Estimated Load (FC/day)	Event Load (FC/day)	Rainfall Amt. (inches)
1/24/98	54000	205	0.313	0.000	10	1.00E+04	1.302E+08	4.069E+07	3.36
3/9-11/98	716400	2715	2.313	0.001	110	1.00E+04	9.635E+08	2.228E+09	3.41
5/10-11/98	172800	655	1.000	0.000	75	1.00E+04	4.167E+08	4.167E+08	2.80
6/14/98	82800	314	0.479	0.000	10	1.00E+04	1.996E+08	9.566E+07	3.42
6/15-18/98	468000	1774	2.708	0.001	60	1.00E+04	1.128E+09	3.056E+09	2.39
6/19-21/98	527400	1999	1.750	0.000	65	1.00E+04	7.292E+08	1.276E+09	1.00

* Amount reported was based on the capacity of the submersible pump and does not include the amount that overflowed form the bypass pipe

** Estimated fecal coliform concentration based on the low end of a range typical values for raw sewage (Horsley & Witten, 1996)

Wet Weather Data: School Street (Rayner, 1990-1999)

Date	Rainfall (inches)	Days after	FC (fc/100ml)
17-Sep-90	0.87	0	4240
9-Oct-90	0.31	0	4360
14-Oct-90	2.53	0	16150
7-Mar-91	0.62	0	660
23-Mar-91	0.39	0	4020
21-Apr-91	1.56	0	1280
3-Jul-91	0.20	0	250
4-Aug-91	0.44	0	6650
1-Nov-91	0.98	0	24500
11-Nov-91	0.74	0	21000
22-Nov-91	0.84	0	4100
23-Nov-91	1.65	0	36300
24-Nov-91	1.70	0	18300
4-Dec-91	1.28	0	1700
10-Dec-91	0.35	0	300
16-Feb-92	1.15	0	40
26-Feb-92	0.64	0	2300
27-Mar-92	0.68	0	1200
11-Apr-92	0.26	0	140
17-Apr-92	1.00	0	1000
8-May-92	0.27	0	60
1-Jun-92	2.12	0	7400
27-Jun-92	0.71	0	680
4-Jul-92	0.28	0	880
9-Aug-92	0.46	0	420
15-Aug-92	0.31	0	2520
10-Oct-92	0.63	0	18500
25-Oct-92	0.37	0	7550
13-Nov-92	1.14	0	9140
23-Nov-92	2.18	0	10750
23-Nov-92	2.18	0	10300
12-Dec-92	3.19	0	2840
20-Dec-92	0.85	0	1060
24-Jan-93	0.62	0	1020
13-Feb-93	2.00	0	7360
5-Mar-93	0.86	0	100
1-Apr-93	0.20	0	120
1-Apr-93	0.89	0	8400
27-Apr-93	1.09	0	2240
1-Jun-93	0.88	0	7560
20-Jul-93	0.45	0	3460
27-Jul-93	0.71	0	2150
26-Sep-93	0.23	0	2400
26-Sep-93	1.06	0	3000
26-Sep-93	1.29	0	75000

Wet Weather Data: School Street (Rayner, 1990-1999) continued

Date	Rainfall (inches)	Days after	FC (fc/100ml)
27-Sep-93	1.53	0	36000
28-Sep-93	2.03	0	6200
27-Oct-93	0.40	0	300
27-Oct-93	0.53	0	500
27-Oct-93	0.53	0	6600
28-Oct-93	0.53	0	2100
6-Nov-93	0.60	0	2450
18-Nov-93	0.58	0	33
28-Nov-93	0.80	0	9200
29-Nov-93	1.50	0	12800
5-Dec-93	2.12	0	9450
12-Dec-93	0.88	0	6850
9-Mar-94	0.74	0	160
10-Mar-94	1.19	0	280
10-Mar-94	2.44	0	2100
11-Mar-94	2.69	0	900
14-Apr-94	0.98	0	560
14-Jun-94	0.44	0	220
15-Jun-94	1.95	0	500
6-Aug-94	1.08	0	7850
15-Aug-94	1.10	0	2200
10-Sep-94	0.22	0	1100
29-Sep-94	0.25	0	78000
10-Dec-94	0.33	0	14300
24-Dec-94	1.72	0	80
2-Jan-95	0.85	0	4250
8-Jan-95	0.92	0	400
24-Feb-95	0.29	0	600
1-Mar-95	1.04	0	100
22-Apr-95	0.98	0	120
9-Jun-95	1.28	0	1440
29-Jul-95	0.41	0	7600
15-Sep-95	0.43	0	8350
15-Oct-95	0.81	0	83000
30-Oct-95	0.95	0	11000
22-Feb-96	0.69	0	50
9-Mar-96	1.05	0	150
4-Jul-96	0.54	0	3200
13-Jul-96	1.40	0	7600
13-Jul-96	1.40	0	26600
24-Jul-96	0.44	0	26400
13-Aug-96	0.93	0	11000
14-Aug-96	0.93	0	55500
26-Oct-96	0.33	0	9000
11-Jan-97	0.22	0	750

Wet Weather Data: School Street (Rayner, 1990-1999) continued

Date	Rainfall (inches)	Days after	FC (fc/100ml)
22-Mar-97	0.23	0	50
18-Apr-97	0.84	0	50
28-Apr-97	0.18	0	100
28-Apr-97	0.51	0	48
10-May-97	0.27	0	48
10-May-97	0.27	0	90
16-May-97	0.37	0	140
22-Jun-97	1.26	0	600
22-Jun-97	1.26	0	20
25-Jul-97	0.42	0	2600
13-Aug-97	0.66	0	4400
5-Oct-97	0.31	0	10400
25-Oct-97	0.82	0	600
2-Nov-97	1.93	0	7100
9-Nov-97	2.09	0	10300
23-Nov-97	0.70	0	420
27-Dec-97	0.68	0	40
13-Jan-98	0.23	0	420
18-Jan-98	0.73	0	300
1-Apr-98	0.84	0	520
2-Apr-98	1.11	0	120
1-May-98	0.31	0	40
14-Jun-98	4.79	0	200
23-Jul-98	0.37	0	5200
26-Nov-98	0.63	0	1520
8-Jan-99	0.39	0	1300
25-Aug-90	1.23	1	16250
16-Sep-90	0.61	1	8560
23-Sep-90	1.20	1	15700
15-Feb-91	1.02	1	400
25-Mar-91	1.63	1	900
16-Apr-91	0.36	1	220
22-Apr-91	3.12	1	2800
1-May-91	1.13	1	940
7-May-91	0.98	1	760
11-May-91	0.66	1	540
18-May-91	0.58	1	1900
1-Jun-91	0.96	1	2420
5-Jun-91	0.28	1	1020
27-Jul-91	1.56	1	7400
11-Aug-91	2.00	1	27500
6-Sep-91	1.10	1	11000
15-Sep-91	0.25	1	2350
27-Sep-91	2.34	1	4050
2-Nov-91	1.00	1	25100

Wet Weather Data: School Street (Rayner, 1990-1999) continued

Date	Rainfall (inches)	Days after	FC (fc/100ml)
12-Nov-91	2.28	1	19300
25-Nov-91	1.17	1	2100
11-Dec-91	0.35	1	50
30-Dec-91	0.59	1	450
5-Jan-92	1.34	1	1150
15-Jan-92	0.85	1	650
24-Jan-92	2.37	1	800
12-Mar-92	1.39	1	1220
28-Mar-92	0.68	1	240
1-Apr-92	0.44	1	1120
12-Apr-92	0.32	1	120
3-May-92	0.26	1	120
9-May-92	0.70	1	3740
24-Jul-92	0.51	1	4420
10-Aug-92	2.73	1	21000
12-Aug-92	2.71	1	2000
4-Nov-92	0.80	1	4100
1-Jan-93	1.13	1	440
6-Mar-93	0.95	1	180
3-Apr-93	1.62	1	880
11-Apr-93	0.48	1	100
21-May-93	0.45	1	220
6-Jun-93	0.25	1	100
4-Jul-93	0.38	1	3640
4-Jul-93	0.38	1	840
14-Aug-93	0.23	1	640
19-Sep-93	0.61	1	3700
29-Sep-93	0.75	1	3700
31-Oct-93	1.03	1	900
17-Nov-93	0.26	1	1750
5-Dec-93	0.87	1	7750
20-Dec-93	0.33	1	450
23-Dec-93	1.10	1	20
19-Jan-94	1.51	1	2
29-Jan-94	1.70	1	250
12-Feb-94	0.59	1	500
3-Mar-94	1.06	1	70
29-Mar-94	1.37	1	1120
17-Apr-94	0.55	1	280
7-May-94	1.00	1	140
16-May-94	0.52	1	400
16-Jul-94	0.72	1	1140
27-Jul-94	0.27	1	4300
13-Aug-94	0.39	1	40000
21-Aug-94	0.51	1	3100

Wet Weather Data: School Street (Rayner, 1990-1999) continued

Date	Rainfall (inches)	Days after	FC (fc/100ml)
23-Sep-94	1.95	1	3840
18-Mar-95	0.50	1	560
14-Apr-95	0.63	1	680
21-Apr-95	0.58	1	320
29-Apr-95	0.58	1	240
12-May-95	0.43	1	320
20-May-95	0.54	1	360
30-May-95	0.55	1	60
4-Jun-95	0.38	1	800
10-Jun-95	0.88	1	1620
22-Jun-95	0.28	1	280
18-Sep-95	2.65	1	22600
6-Oct-95	2.87	1	28100
8-Nov-95	1.09	1	1800
17-Nov-95	1.42	1	7600
15-Dec-95	0.35	1	200
15-Jan-96	1.08	1	2
24-Feb-96	1.10	1	200
4-May-96	0.27	1	2
18-May-96	0.61	1	2
31-May-96	0.23	1	1250
20-Jun-96	0.62	1	2200
1-Aug-96	0.50	1	3060
15-Aug-96	0.93	1	12100
8-Sep-96	1.22	1	3800
9-Sep-96	1.23	1	57000
20-Sep-96	2.61	1	13500
20-Oct-96	2.28	1	9000
8-Dec-96	2.38	1	300
15-Feb-97	0.66	1	100
16-Mar-97	1.04	1	50
2-Jun-97	0.64	1	140
30-Aug-97	1.34	1	1400
26-Oct-97	0.91	1	400
15-Nov-97	1.10	1	200
10-Mar-98	3.41	1	120
21-Apr-98	0.41	1	60
8-Jun-98	0.35	1	20
1-Jul-98	1.65	1	180
16-Mar-91	0.58	2	1160
1-Apr-91	0.33	2	640
23-Apr-91	3.14	2	900
19-May-91	0.58	2	340
28-Jul-91	1.60	2	4440
3-Nov-91	0.66	2	450

Wet Weather Data: School Street (Rayner, 1990-1999) continued

Date	Rainfall (inches)	Days after	FC (fc/100ml)
13-Nov-91	2.28	2	3900
26-Nov-91	0.39	2	1400
31-Dec-91	0.59	2	600
6-Jan-92	1.34	2	150
16-Jan-92	0.90	2	40
28-Feb-92	0.58	2	40
9-Mar-92	1.01	2	80
20-Apr-92	0.45	2	80
27-Apr-92	0.40	2	560
10-May-92	0.70	2	200
26-Jun-92	0.79	2	1100
18-Jul-92	0.97	2	280
13-Aug-92	0.23	2	2180
5-Sep-92	2.04	2	3360
5-Sep-92	2.04	2	2800
10-Sep-92	0.31	2	2350
28-Sep-92	1.86	2	24500
28-Nov-92	0.44	2	420
7-Dec-92	0.24	2	60
31-Jul-93	0.35	2	680
30-Sep-93	0.50	2	2200
9-Jan-94	1.16	2	80
12-Nov-94	0.40	2	6400
19-Nov-94	2.78	2	1120
6-Feb-95	0.81	2	1860
16-Feb-95	0.85	2	160
14-Jun-95	0.67	2	420
13-Jul-95	0.30	2	320
18-Jul-95	0.40	2	5860
3-Nov-95	0.81	2	3200
26-Aug-96	0.46	2	5100
2-Sep-96	0.25	2	2750
14-Sep-96	0.20	2	24000
10-Oct-96	2.36	2	1600
24-Jan-97	0.44	2	100
7-Feb-97	0.93	2	100
12-Dec-97	0.34	2	500
12-Apr-98	0.29	2	360
16-Oct-98	1.23	2	12000
10-Dec-98	0.20	2	240

Year		Seasonal	
Count	265	Count	90
Geo Mean	1054	Geo Mean	4246*
%>500	63	%>500	89

Fecal Coliform Results of Targeted Wet Weather Events (Rayner, 1991-1997)

Date	Fecal Coliform (fc/100ml)	Dry/Wet	Sum of Rain
11/16/91 8:30 AM	200	dry	0
11/17/91 10:30 AM	50	dry	0
11/18/91 8:30 AM	2	dry	0
11/19/91 8:00 AM	150	dry	0
11/20/91 8:15 AM	360	dry	0
11/21/91 8:15 AM	250	wet	0.10
11/22/91 8:00 AM	4100	wet	0.84
11/23/91 8:15 AM	36300	wet	1.65
11/24/91 9:20 AM	18300	wet	1.70
11/25/91 8:30 AM	2100	wet	1.17
11/26/91 8:15 AM	1400	wet	0.39
11/27/91 8:00 AM	800	wet	0.37
11/28/91 8:40 AM	450	dry	0
11/29/91 8:30 AM	150	dry	0
11/30/91 8:00 AM	150	dry	0
4/20/91 2:00 PM	20	wet	0.15
4/21/91 9:00 AM	1280	wet	1.56
4/22/91 9:20 AM	2800	wet	3.12
4/23/91 8:15 AM	900	wet	3.14
4/24/91 9:15 AM	280	wet	1.35
10/27/93 5:00 AM	320	dry	0.00
10/27/93 6:00 AM	200	wet	0.14
10/27/93 8:00 AM	300	wet	0.20
10/27/93 10:00 AM	500	wet	0.40
10/27/93 12:00 PM	6600	wet	0.53
10/27/93 2:00 PM	2100	wet	0.53
10/28/93 8:25 AM	900	wet	0.53
10/31/93 2:30 PM	2450	wet	1.03
11/17/93 2:30 PM	250	wet	0.11
11/17/93 4:30 PM	33	wet	0.26
11/18/93 7:30 AM	3400	wet	0.58
11/28/93 10:00 AM	40	dry	0.00
11/28/93 1:00 PM	9200	wet	0.16
11/28/93 4:00 PM	12800	wet	0.80
11/29/93 7:00 AM	7750	wet	1.50
4/28/97 6:50 AM	48	wet	0.18
4/28/97 12:00 AM	48	wet	0.51

Appendix D: BMP Evaluation

Effectiveness of Storm Water Practices to Treat Bacteria Sources

Storm water Best Management Practice	Fecal Coliform (%removal)	Fecal Streptococci (% removal)	E. Coli (%removal)
Ponds	65% (n=10)	73% (n=4)	51% (n=2)
Sand filters	51% (n=9)	58% (n=7)	no data
Swales	(-)58% (n=5)	no data	no data

Source: Watershed Protection Techniques Vol. 3, No. 1 April 1999

Comparison of Mean bacteria Removal Rates (fc/100 ml) Achieved by Different Storm water Practices

OUTFLOW CONCENTRATIONS			
Storm water Best Management Practice	Fecal Coliform (fc/100 ml)	Fecal Streptococci (fc/100 ml)	E. Coli (fc/100 ml)
Ponds	5144 (n=9)	3381 (n=4)	869 (n=2)
Sand filters	5899 (n=9)	16088 (n=7)	no data
Swales	2506 (n=3)	no data	no data

Source: Watershed Protection Techniques Vol. 3, No. 1 April 1999

Other Source Control Measures to Reduce Bacteria Levels*

a) Pet waste cleanup
b) Marine pumpout facilities to pump boater sewage
c) Discouraging resident waterfowl
d) General urban housekeeping

* Very little monitoring has been conducted to determine if these practices are effective in reducing watershed bacteria levels.

Effectiveness of Storm water Practices to Treat Bacteria Sources

System	Manufacturer/ Designer	Description	Applications	Performance
Stormfilter	Storm water Management	Passive, flow-through filtration system utilizing rechargeable filter cartridges. Media removes TSS by mechanical filtration, ion exchange, and adsorption.	Parking lots for urban environments, residential to arterial roadways	High level of performance for the removal of TSS**, and approximately 50% removal of fecal coliform
NRCS Nutrient & Sediment Control System	Robert Wengrzynek	Living biological filter or treatment system. Combines marsh/pond components of constructed wetlands with other erosion / sediment management elements to use physical, chemical, and biological processes for the removal of sediment and nutrients.	Livestock and pasture runoff as well as urban storm water runoff	Removes 90-100% of TSS**
Vortechs	Vortechnics Inc.	Storm water introduced into system in a vortex-like flow path. Swirling action directs sediment into the center of the chamber.	Parking lots, roadways	Net total suspended solids (TSS**) removal efficiency rate over the course of storm events of over 80%.
Stormtreat	Stormtreat Systems Inc.	Captures and treats first-flush. System consists of 6 sedimentation chambers and a constructed wetland contained in a 9.5 -ft diameter tank.	Parking lots, residential subdivisions, roadways	315 analyses on 33 samples over 8 independent storm events during both winter and summer. 97% removal of fecal coliform and 99% removal of TSS**.

Appendix E: Summary of Coliphage Results

Coliphage

I. What are "bacteriophage" and "coliphage"?

Viruses that attack bacteria *

(DNA fingerprinting methods are **not** virus methods; they look at genetic patterns of different *E. coli* strains found in different animals and humans)

Somatic Coliphage:

- adsorb to the cell wall of coliforms
- may originate from fecal and non-fecal sources (a heterogenous group)

F-specific (or male specific or F-RNA) RNA Bacteriophage:

- adsorb to pili of coliforms (*Salmonella* and *E. coli* widely used – sometimes called coliphage even if *Salmonella* is used as the host strain which causes some confusion)
- models behavior and survival of human enteric virus (esp. Norwalk) in water/waste treatment process (similar size, shape, resistance to Cl, UV)
- reportedly rarely multiplies in environment
- rarely isolated in human feces *
- consistently found in sewage *
- found in most all animals tested, but in low numbers*
- suspected replication in the *sewage* environment
- relatively long survival in environment * (decrease in die-off during evening) densities lower in summer/higher in winter (survive better infcder waters); densities reported greater in surface water than in bottom water
- 4 serotypes identified which may indicate human or animal origin (not fully validated):

    Group 1 and 4 – predominantly assoc. with animals
    Group 2 and 3 – predominantly assoc. with humans (although also in pigs)

II. F-RNA Phage as indicators

A Sewage Indicator: Consistently present in sewage and sewage-polluted waters *(Sewage*: liquid and solid waste from domestic source, animal processing and storm, CSO)

A (Human) Fecal Indicator: Consistently present in human feces at high levels
An (Animal) Fecal Indicator: Consistently present in animal feces at high levels

(Note: *ideally*, an indicator should be *exclusively* associated with the source)

F-RNA Phage are NOT consistently present in human feces ---- for this reason – NOT a human fecal indicator – they are considered an indicator of sewage pollution

(Note: there is a lack of correlation between fecal coliform and bacteriophage numbers)

III. Phage Enumeration Method

The RIDEM submits samples to The University of North Carolina Environmental Virology Laboratory (Mark Sobsey's lab):

The Method:

Initial screen for presence of coliphage
Trap/concentrate 1500 – 2000 ml onto filter (500-1000 ml portions if turbid)
Elute/remove from filter – additive to suppress somatic coliphage
Mix with host strain (*Salmonella* WG-49) and pour host bacteria, sample and agar onto a bottom agar plate (double agar overlay method)
Incubate (host starts to grow, if phage present, infects and kills host – bursts cell)
Creates spaces/lack of host cell growth (plaques)
Pick 8-10 representative plaques for serotyping (a random sample)
(in low numbers, may represent a high %, but…..)
Eliminate DNA phage/Record reaction to antiserum from the four groups
Numbers reported as PFU – **P**laque **F**orming **U**nits per 100 ml

IV. Limitations:

The Coliphage Method is NOT a standard method – still under development. NOT yet a validated tool for this purpose.

Method Inconsistencies:

- No standardization of host strains*. Review of literature for other reported phage densities in similar environments yield variability of host strain employed (*E. coli* or *Salmonella* strains)

Reported densities: *(note:various host strains were employed!!)*

Dutka, 1987 – suggested recreational water quality standard of 20 coliphage per 100 ml

Cabelli study in Conimicut Point (Prudence & Patience Island)

- Geo. mean F-RNA phage in surface water – ND to100 PFU per 100 ml

Mt .Hope Bay study – F-RNA phage

- CSO/point sources : 1000 to > 100,000 PFU per 100 ml
- Bay stations : 10 to 100 PFU per 100 ml

Kott, 1981 – phage detected in lakes, streams, rivers, wetland and groundwater
2 to 1000 PFU per 100 ml

Hudson River - 0-58 PFU per100 ml (when it received untreated human waste)

<u>V. What do the numbers mean?</u>

It appears that animals are not a significant source when compared to wastewater effluents (Calci et al)* – all animals species tested found to harbor F-RNA phage, although in very low numbers

However, in the absence of wastewater – animals may be the only source.

Relatively high numbers may indicate a fresh source.

In the absence of a sewage source, fecal coliform and F-RNA phage are probably from animals.

Virginia study: Marsh acted as a filter and increased coliform numbers; decreased raccoon population (cited as the only major change) resulted in 80% decrease in fecal coliform the following year (started *E. coli* DNA database) (Simmons, Herbein & James, Managing nonpoint fecal coliform sources to tidal inlets)

<u>VI. Strategy for future use</u>

- Build database of baseline bacteriophage densities during each season
- Increase number of samples: take from closer proximity to WWTP discharge etc..
- Use consistent methodology and compare to previous datasets
- Use in conjunction with a complete site survey – record presence of animals
- Utility of piezometers/assess groundwater?

If there are no sewage/septage sources – then most likely it's an animal source
"To serotype or not to serotype"?

Appendix F: Comment Response Summary

Appendix F.1: Response Summary for the July 2002 Final Runnins River TMDL
July 16, 2002 Public Meeting for the Barrington and Runnins River TMDLs held at the Barrington Public Library Auditorium in Barrington.

Chris Turner presentation:

1. Purpose of tonight's meeting
- The water quality goals for the Runnins and Barrington Rivers submitted for public comment in June 2000 have been revised.
- Provide an update on progress toward reducing pollutant sources and explain activities required by the Phase II Stormwater Program

2. Went over basic information on the TMDL and the process:

3. Discussed state water quality standards for fecal coliform in the waters of the Runnins and Barrington Rivers:

4. Overview of the Barrington and Runnins River system
- Runnins River Dry Weather Impairment:
  - Dry weather concentration increases as approach School Street.
  - General doubling of concentration between Mink and School Streets

- Runnins River Dry Weather Sources
  - Rte. 195 stream is major dry weather source
  - Tributary streams between Mink and School Streets are not significant because concentrations are lower than in-stream.
  - DEM investigation of Seekonk in-ground systems did not yield a link to in-stream elevations. DEM concluded that in-stream growth of bacteria was likely.

- Runnins River Wet Weather Impairment
  - Fecal coliform concentrations measured along length of river in 1995. Peaks occurred at County street and School Street.

- Runnins River Wet Weather Sources
  - 1995 study pointed to four major sources: County Street, Rte 195 stream, OJ Creek, and Rte. 6 Stream #2.

- Barrington River Condition
  - In dry and wet weather, concentrations are highest at the osprey nest where the river tapers.
  - In wet weather, the impairment is principally caused by the Runnins River, but also the Palmer River.

- Change to Barrington River water quality goal
  - Revised goal: 12.6 fc/100 ml, less than <10% of samples exceeding 49 fc/100 ml at The Tongue.
  - Between the Tongue and the Mobil Dam, Barrington River must meet 14 fc/100 ml, with <10% of samples exceeding 49 fc/100 ml.

- Change to Runnins River water quality goal: Runnins must now meet 14 at the dam in both dry and wet weather.

Draft TMDL (June 2000) goal:

- Revised reduction targets:
  - Runnins at School Street is 99.1% dry weather, 99.6% wet weather.
  - Barrington combined wet and dry reduction ranges from 93% at the Tongue (GA2-1) to 74% at the mouth of the river.

- Restoration Measures: Underway/Completed in Rhode Island
  - County Street: storm water treatment structure (RIDOT, 2003)
  - I-195 stream: Discourage pigeon roosting (RIDOT, 2003)
  - Route 6: Storm water treatment structure (RIDOT, 2003)
  - OJ Creek (E. Providence, Ongoing)
    - Stop overflows at Wannamoisett pump station - overflow has been plugged.
    - Pump operation was improved at Wannamoisett station.
    - Interceptor line was cleaned to increase capacity.
    - Illicit connection detection.
    - Reduce infiltration and inflow in sanitary system.

- Phase II stormwater program: Barrington, East Providence, and RIDOT must submit Stormwater Management Program Plans (SWMPPs)for their systems in the Runnins and Barrington watersheds, under the Stormwater Phase II Program.

- Phase II SWMPP elements:
  - Six minimum measures:
  - SWMPPs must include plans to achieve reductions at locations identified in the TMDLs.
  - Plans for reductions must be consistent with the goals of this TMDL, focusing on methods to reduce peak stormwater flows through improved detention and infiltration
    - SWMPPs are to be submitted for DEM approval by March 10, 2003.

- Runnins River Restoration Measures For Massachusetts
  - Route 6 Stream #2: Design and construct stormwater BMP
  - Mink-School area
    - Restore habitat of area, minimize growth of *phragmites* vegetation.
    - Evaluate/eliminate Seekonk septic systems as a coliform source.
  - Reduce upstream sources

- RIDEM will continue to be involved in the area:
  - Pursue restoration issues in the Runnins River
  - Palmer River: Implementation of bacteria TMDL is in progress.

- Complete Barrington and Runnins Rivers TMDL Reports at www.state.ri.us/dem/

Questions and comments on the presentation:
Comment: J.D. Anthony is pursuing a 37 acre development upstream of the RI border near Burrs pond. Mr. Anthony is reportedly also developing a storage facility at his property in the Route 2 stream area.

Comment: The commenter had recently visited the SW runoff ponds for Ann &Hope property. The first pond was unlined and had not been recently maintained. The second pond, which was lined, was full of gray water and had nothing living in it.
DEM Response: DEM can contact the MA watershed coordinator to see what options are available to promote stormwater structure maintenance

Question: What progress has occurred on Woods Pond?
Answer: DOT is presently scheduled to maintenance dredge the pond after Labor Day. The Town's proposal to have an inlet treatment structure (Vortex separator) installed was not approved for TEAC funding.

Question: Why is the Palmer River polluted for bacteria?
Answer: DEM recently completed the Palmer River Bacteria TMDL that concluded that bacterial pollution in the Palmer River is affected by agricultural and urban uses in the watershed. The TMDL identified farms in MA where cattle had access to the river and its tributaries. Similar conditions were found in the tributaries to Belcher Cove in RI.

Storm runoff from urban areas in RI was also a problem. The TMDL identified streets whose storm drains discharged directly to tributary streams that had high wet weather concentrations. DEM also found that dog waste was a significant problem in the Belcher Cove area, both at Jamiel Park, where residents walk their dogs, and at an auto body facility, where a dog was fenced in an area directly on a steam.

Appendix F.2: Response Summary for the Runnins River TMDL

On June 15, 2000 and again on July 16, 2002, the Rhode Island Department of Environmental Management (RIDEM) requested public comment on proposed Total Maximum Daily Loads (TMDL) that would limit bacteria loadings to the Barrington and Runnins Rivers. The first public comment period lasted from June 15, 2000 to July 14, 2000. After comments were received, RIDEM made changes to the TMDL documents, which necessitated another public comment period. The second public comment period lasted from July 16, 2002 to August 14, 2002. RIDEM also held an earlier public meeting on the topic. These meeting took place at the following dates and locations:

Location	Date
East Providence City Hall	July 14, 1999
Barrington Public Library	June 15, 2000
Barrington Public Library	July 16, 2002

While no comments were received during the second public comment period, RIDEM did receive both verbal and written comments submitted during the first comment period. The responses reflect the changes in the July 2002 Runnins River TMDL document.

Comments from Mr. Dennis Dunn, MA DEP

Although we believe that RI DEM did a very good job developing a hydrodynamic and water quality model for the reach of concern we are concerned that the model was not verified in any way with a second set of data. Although we recognize that there wasn't sufficient time to collect an additional data set we see no recommendation that indicates intent to validate the model as a follow-up action. MA DEP suggests that this activity be added to ensure that the proposed reduction in coliform loadings are verified before potentially costly efforts are undertaken to identify and eliminate additional sources. It should be noted however that DEP does support the implementation of a number of the actions identified without awaiting this verification step.

The computer model was validated with an independent data set. Half of the data collected from the Barrington River surveys were used to calibrate the model with the other half being used to validate the model. In addition, the computer model is now being used to determine current conditions in the Barrington River.

It is unclear to MA DEP why RI DEM chose not to address the Barrington River between the Mobil Dam and the Shellfish Closure Line. It appears that there was concern that the model representation was uncertain in this area due to its variable mixing properties. From a modeling perspective this is understandable however there was no discussion as to what sources or potential sources, if any, were identified that contributed to this problem area and, if present, what implementation measures are proposed to reduce those loadings. This issue should be addresses or at a minimum discussed in the final TMDL.

In response to this comment and input from EPA, the Barrington River between the Mobil Dam and the Shellfish Closure Line is now included in the Barrington River TMDL document.

Several of the references in the Jurisdiction column in Tables 6 and 8.1 (in the Runnins River TMDL document) and Tables 7 and 9.1(in the Barrington River document) incorrectly list MADEP as having jurisdiction. The following corrections should be made:

Abatement Measure	***Jurisdiction***
Map Storm-drain network	*City or Town or that owns the System*
ISDS investigations and repairs	*City or Town Board of Health*

The following are not under the jurisdiction of MADEP, and are assumed to be under the jurisdiction of the entities noted; however, this information needs to be verified.

Abatement Measure	***Jurisdiction***
Remove Phragmites	*Town of City DPW assuming appropriate environmental permits/clearances are obtained.*
Remove/deter waterfowl from pond	*Town animal control office*

These recommendations have been incorporated into the tables.

In addition to the items identified above, Tables 7 and 9.1 suggest that MADEP implement a groundwater monitoring network in the vicinity of Mink, School, and Leavitt Streets to identify potential sources of fecal coliform in the groundwater contributing to the river loadings. There are a couple of issues of concern for DEP relative to this recommendation. The first is related to our legal authority and ability to require groundwater monitoring on private property and the second is the technical validity to identify the source through this type of effort. As to the legal authority DEP clearly has the legal authority to require groundwater monitoring to <u>regulated entities</u> such as a permitted groundwater or surface water facilities. In this case however neither of those two situations appears to be present, in fact, it is likely that DEP would have to enter onto private property to conduct such an investigation. The only historical examples of this happening are site investigations under our Hazardous Waste Site program. In any regard such an action would certainly be precedent setting and DEP would have to make sure we had legal standing and the activities were completely necessary before taking such an action.

Second, there are many technical challenges of conducting the field operations and interpreting the data. Past experience has told us that there could be a need to install numerous monitoring wells with varying well screen lengths to obtain a sufficient amount of information about the groundwater hydrology in the area to narrow the field of potential sources of contamination. Not only would this be difficult to do on private property but could be extremely expensive as well. To this end, the Department believes that taking such an action should be a last resort and only considered after all other options have been exhausted. Given this, the MADEP recommends that this requirement be removed from the TMDL and emphasis be placed on individual septic system disposal inspections and dye testing where appropriate by the local

Board of Health as well as testing of the storm water systems in that area to identify possible sources. MADEP believes that such an approach is a much more effective, efficient, and less costly way of determining whether failures are occurring. This information can be used to require upgrades to failed systems or other necessary corrections.

RIDEM concurs that the emphasis on implementation should first focus on ISDSs and testing storm water systems to identify sources. RIDEM acknowledges the technical difficulties and expense associated with ground water investigations. When recommending groundwater monitoring, RIDEM has added the following under the status column, "*To be conducted if other abatement measures fail.*"

It should be noted that RIDEM completed a preliminary study on the septic systems in this area and has identified systems where further inspection may be necessary. The Health Agent in Seekonk has informed RIDEM that he cannot investigate these systems under Title V unless he has prior proof that they are failing. He cannot determine if they are failing without a site visit. At a March 1, 2000 meeting in Worcester, MA between various officials from MADEP, MA EOEA, US EPA and RIDEM, MADEP offered to investigate what authority various federal acts give state or town officials to inspect septic systems.

The town of Seekonk applied for and received funding for a grant to identify pollution sources in the lower Runnins River. The study is intended to evaluate dry and wet weather sources and may provide information on the locations of failing systems. Seekonk also has obtained an intern to review and update the septic system information developed by DEM to further identify failing systems.

Comments from Ms. Andrea Langhauser, MA EOEA
Septic System Survey Results, top of page 51. It should be noted that the Seekonk Health Agent, working closely with Mass. DEP, identified many septic systems in the study area that were in need of repair and were subsequently upgraded by the landowner. Also, the town of Seekonk established a four hundred and fifty thousand-dollar Betterment Fund to assist landowners in the voluntary upgrade of septic systems. All of these funds have been expended and a waiting list has been established for additional loans.

It is understood that the information in this survey was incomplete and for the watershed Team to proceed further on this investigation more research of the Town of Seekonk records would be necessary.

These statements have been incorporated into the TMDL document.

Wet Weather Survey Results – There were two wet weather surveys performed by RIDEM, one in 1995 and again in 1998. On page 72, the top paragraph states that the 1998 data was used to develop the TMDL, yet Table 6.2 summarizes the 1995 data. Please clarify.

The 1998 study was designed specifically to measure the bacteria load from the Runnins River. Discharge was measured continuously in 1998 and a greater number of bacteria measurements were made. The measurements also covered a longer period of time.

On page 60, it is recommended that Pleasant Street be further examined. Mass. DEP has done additional sampling of the upper Runnins River subwatershed during the summer of 1999 and concurs with the need for further investigation to conclusively determine the source(s) of fecal coliform. County Street culvert is also listed on page 60 as a significant source of coliform pollution in the 1995 sampling round. It should be noted that the Town of Seekonk installed storm water BMPs in 1997.

These statements have been incorporated into the TMDL document.

Comments from Mr. Dave Turin, MA DEP

Additional discussion of the relatively high bacteria levels noted at Pleasant Street under "Natural Background" (Runnins River draft TMDL, 6/00, Executive Summary (RES), p. 12) appears warranted.

The information presented about Pleasant Street has been modified to indicate that Pleasant Street is probably a component of, and cannot be separated from, the ambient concentration of the River as it enters Rhode Island

Under Description of the Waterbody (RES, p. 7), DEM should clarify the distinction between the characterization of the waterbody length of 7.5 miles in this TMDL, and 2.807 miles identified as impaired on the 1998 303(d) List.

The phrase "7.5 mile" has been deleted.

In Description of the Waterbody (RES, p. 7), it should also be clarified that primary contact recreation is a designated use.

That wording has been added.

The section, Pollutant of Concern (RES, p. 7), should include a brief discussion of the relationship of bacteria from this waterbody and the shellfishing impairments in the Barrington River, downstream. This will help lay the groundwork for defining the need for more stringent numeric criteria than that required in Class B waters.

This information was presented in section 2 "Numeric Water Quality Target", which is more appropriate for that information.

The term, "Fish and wildlife habitat" should be included as designated, and, if appropriate, existing uses in the discussion of the "Antidegradation Policy" (RES, p. 13). This seems an unintended omission, as the term is included in the discussion of designated uses on the previous page, and in the body of the report.

Changes have been made to the antidegradation paragraph.

DEM appropriately describes the Class B water quality standards in terms of a geometric mean and a measure of variability (i.e. a geometric mean may not exceed 200 cfu/100ml (mean) and no more than 20% of samples shall exceed 500 cfu/100ml). Under the discussion of Numeric Water Quality Targets, DEM describes a numeric target, based on water quality modeling, to meet a more stringent geometric mean criteria downstream in the Barrington River (RES, pp. 12-13). EPA believes that a numeric target to meet the variability counterpart in the Barrington of no more than 10% of samples shall exceed 49 cfu/100ml is also warranted. EPA recommends that the DEM either provide additional justification that the selected water quality targets are sufficient to meet both parts of the Barrington River standard, or alternatively, include an additional numeric water quality target, such as "not more than 10% of the samples shall exceed a value of 394 cfu/100ml" to assure compliance with the 2nd part of the bacteria criteria in the Barrington River. The target of 394 cfu/100ml is the concentration identified in the Barrington River draft TMDL as protective of the variability part of the standard during wet weather (Barrington River draft TMDL, p. 45, 6/13/00). EPA expects that this value would also be protective during dry weather. DEM could also utilize its water quality model to develop a target concentration specifically for dry weather.

The Runnins River and Barrington River documents now set water quality limits at School Street of a geometric mean of 14 fc/100ml (mean) and no more than 10% of samples shall exceed 49 fc/100ml. These goals ensure that water quality is sufficient to meet the designated uses of the Barrington River.

The report identifies a number of dry weather sources as "known" or "potential," including pigeons roosting under a bridge, instream bacterial growth, wildlife and septic systems (RES, Table 4, p.16). No point sources are identified, though as noted under <u>*5. Wasteload Allocations*</u>*, below, storm water outfalls in the watershed are point sources that can be regulated under RI NPDES program. The total existing load dry weather loading ($3.30x10^{11}$ fc/day) is based on a dry weather geometric mean concentration value, July to October, 1995-1999, and a mean river flow rate (RES, p.8). A number of wet weather sources and a daily loading of $1.16x10^{12}$ fc/day is also provided. Percent reductions are based on meeting a numeric water quality target geometric mean of 125 cfu/100ml and 80th percentile value of 500 cfu/100ml.*

As discussed above, EPA is concerned that the selected water quality targets may not result in compliance with the variability portion of the bacteria criteria for the Class SA Barrington River representing variability (i.e. that no more than 10% of samples are to exceed 49 cfu/100ml). EPA recommends that DEM include an additional numeric water quality target for both dry and wet weather, such as "not more than 10% of the samples shall exceed a value of 394 cfu/100ml" *to assure that the variability part of the bacteria criteria in the Barrington River is supported (See 2 - Description of Applicable Water Quality Standards and Numeric Water Quality Target).*

The Runnins River and Barrington River documents now set water quality limits at School Street of a geometric mean of 14 fc/100ml (mean) and no more than 10% of samples shall exceed 49 fc/100ml. These goals ensure that water quality is sufficient to meet the designated uses of the Barrington River.

<u>*Wet Weather*</u>*: The Barrington River draft TMDL indicates that an event mean concentration of 394 cfu/100ml must be attained at School St. in the Runnins River to meet the variability portion of the Barrington criteria (not more than 10% of samples exceeding 49 cfu/100ml) during wet weather. EPA believes that further information is necessary to support DEM's decision to use an event mean concentration of 394 fc/100ml instead of a 90th percentile value to calculate the reductions necessary to meet the variability portion of the criteria.*

The Runnins River and Barrington River documents now set water quality limits at School Street of a geometric mean of 14 fc/100ml (mean) and no more than 10% of samples shall exceed 49 fc/100ml. These goals ensure that water quality is sufficient to meet the designated uses of the Barrington River.

EPA is also concerned with the decision in the Barrington draft TMDL to use the event mean concentration from a single 1998 storm event to calculate the percent removal necessary to meet the numeric target. EPA recommends that DEM use the larger Pokanoket Watershed Alliance data (collected by Mr. Doug Raynor) to characterize the ambient conditions from which necessary percent reductions must be made to meet the standard. Use of this data set would be consistent with the approach taken by DEM to meet the Class B bacteria variability standard in the Runnins River (RES, p17).

The purpose of this analysis was to identify reductions needed to prevent the SA variability standard impairment downstream in the Barrington River. As section 4.6 of the document states, RIDEM wanted to use Mr. Rayner's data cautiously. Mr. Rayner's data set was valuable because it pointed to the Runnins River as the principal cause of the downstream bacterial impairment in the Barrington River. RIDEM does not know if one grab sample per event would be representative of wet weather conditions in general. The 1998 data were collected over the course of an event. Samples were collected at evenly spaced intervals. The continuous stage record allowed us to extract the tidal interference. Given the variability between different wet weather data sets, Mr. Rayner's data and the 1998 storm data are still reasonably consistent with each other. Although the 1998 data set did not depict the worse in-stream condition, its use was indicated because it was continuous and more comprehensive. The use of the 1998 data was also consistent with the use of data in the Barrington River TMDL.

The only identified point source, a sewage pump station is assigned a WLA of zero as any overflows are violation of the applicable NPDES permit.   The draft TMDL, while acknowledging that municipal storm water "can be considered as point sources," treats storm water discharges as nonpoint sources for the purposes of this TMDL because site-specific date was not available for all storm sewer outfalls. While this approach is approvable, EPA believes the TMDL should acknowledge that storm water can be controlled as a point source, and describe circumstances when such controls would be applied.

RIDEM has added language to the waste load allocation to stipulate that although the storm water discharges are currently nonpoint sources, that storm water discharges are potentially subject to permits in the future.