# 4.0 Problem Assessment

Pathogen impairment has been documented at numerous locations throughout the Concord River watershed, as shown in Figure 1-1. Excessive concentrations of indicator bacteria (e.g., fecal coliform, enterococci, *E. coli* etc.) can indicate the presence of sewage contamination and possible presence of pathogenic organisms. The amount of indicator bacteria and potential pathogens entering waterbodies is dependent on several factors including watershed characteristics and meteorological conditions. Indicator bacteria levels generally increase with increasing development activities, including increased impervious cover, illicit sewer connections, and failed septic systems.

Indicator bacteria levels also tend to increase with wet weather conditions as storm sewer systems overflow and/or storm water runoff carries fecal matter that has accumulated to the river via overland flow and storm water conduits. In some cases, dry weather bacteria concentrations can be higher when there is a constant source that becomes diluted during periods of precipitation, such as with illicit connections. The magnitude of these relationships is variable, however, and can be substantially different temporally and spatially throughout the United States or within each watershed.

Tables 4-1 and 4-2 provide ranges of fecal coliform concentrations in storm water associated with various land use types. Pristine areas are observed to have low indicator bacteria levels and residential areas are observed to have elevated indicator bacteria levels. Development activity generally leads to decreased water quality (e.g., pathogen impairment) in a watershed. Development-related watershed modification includes increased impervious surface area, which can (USEPA 1997):

- Increase flow volume,
- Increase peak flow,
- Increase peak flow duration,
- Increase stream temperature,
- Decrease base flow, and
- Change sediment loading rates.

Many of the impacts associated with increased impervious surface area also result in changes in pathogen loading (e.g., increased sediment loading can result in increased pathogen loading). In addition to increased impervious surface impacts, increased human and pet densities in developed areas increase potential fecal contamination. Furthermore, storm water drainage systems and associated storm water culverts and outfall pipes often result in the channelization of streams which leads to less attenuation of pathogen pollution.

**Table 4-1. Wachusett Reservoir Storm Water Sampling (as reported in MADEP 2002) Original Data Provided in MDC Wachusett Storm Water Study (June 1997).**

| Land Use Category | Fecal Coliform Bacteria[1] Organisms / 100 mL |
|---|---|
| Agriculture, Storm 1 | 110 – 21,200 |
| Agriculture, Storm 2 | 200 – 56,400 |
| "Pristine" (not developed, forest), Storm 1 | 0 – 51 |
| "Pristine" (not developed, forest), Storm 2 | 8 – 766 |
| High Density Residential (not sewered, on septic systems), Storm 1 | 30 – 29,600 |
| High Density Residential (not sewered, on septic systems), Storm 2 | 430 – 122,000 |

[1] Grab samples collected for four storms between September 15, 1999 and June 7, 2000

**Table 4-2. Lower Charles River Basin Storm Water Event Mean Bacteria Concentrations (data summarized from USGS 2002)[1].**

| Land Use Category | Fecal Coliform (CFU/100 mL) | Enterococcus Bacteria (CFU/100 mL) | Number of Events |
|---|---|---|---|
| Single Family Residential | 2,800 – 94,000 | 5,500 – 87,000 | 8 |
| Multifamily Residential | 2,200 – 31,000 | 3,200 – 49,000 | 8 |
| Commercial | 680 – 28,000 | 2,100 – 35,000 | 8 |

[1] An Event Mean Concentration (EMC) is the concentration of a flow proportioned sample throughout a storm event. These samples are commonly collected using an automated sampler which can proportion sample aliquots based on flow.

Pathogen impaired river segments represent 32.7% of the total river miles assessed (51 miles of impairment; 156 miles assessed). Pathogen impaired lakes segments represent 0.7% of the total lake acres assessed (44 acres of impairment; 6712.6 acres assessed). In total, 12 segments, each in need of a TMDL, contain indicator bacteria concentrations in excess of the Massachusetts WQS for Class A or B waterbodies (314 CMR 4.05)[1] and/or the MADPH standard for bathing beaches[2]. The basis for impairment listings is provided in the *2002 List* (MADEP 2003). Data presented in the WQA and other data collected by the MADEP were used to generate the *2002 List*. For more information regarding the basis for listing particular segments for pathogen impairment, please see the Assessment Methodology section of the MADEP WQA for this watershed.

A list of pathogen impaired segments requiring TMDLs is provided in Table 4-3. Segments are listed and discussed in hydrologic order (upstream to downstream) in the following sections. Additional details regarding each impaired segment including water withdrawals, discharges, use assessments and recommendations to meet use criteria are provided in the MADEP WQA.

This TMDL was based on the current WQS using fecal coliform as an indicator organism for fresh and marine waters and enterococci for marine beaches. The MADEP is in the process of developing new WQS incorporating *E. coli* and enterococci as indicator organisms for all waters other than shellfishing and potable water intake areas.

An overview of the Concord River watershed pathogen impairment is provided in this section to illustrate the nature and extent of the impairment. Since pathogen impairment has been previously established and documented on the *2002 List*, it is not necessary to provide detailed documentation of pathogen impairment herein. Data from the MADEP, ENSR International, and the Organization for the Assabet River (OAR) were reviewed and are summarized by segment below for illustrative purposes. Not all data presented herein were used to determine impairment listing due to a variety of reasons (including data quality assurance and quality control). The MADEP used only a subset of the available data to generate the *2002 List*. Other data presented in this section are for illustrative purposes only.

[1] Class A: Fecal coliform bacteria shall not exceed an arithmetic mean of 20 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 100 organisms per 100 mL.
Class B, Class SA & Class SB (waters not designated for shellfishing): Fecal coliform bacteria shall not exceed a geometric mean of 200 organisms per 100 mL in any representative set of samples, nor shall 10% of the samples exceed 400 organisms per 100 mL. The MADEP may apply these standards on a seasonal basis.

[2] Freshwater bathing beaches: No single *E. coli* sample shall exceed 235 colonies per 100 mL and the geometric mean of the most recent five *E. coli* samples within the same bathing season shall not exceed 126 colonies per 100 mL; or No single enterococci sample shall exceed 61 colonies per 100 mL and the geometric mean of the most recent five (5) enterococci samples within the same bathing season shall not exceed 33 colonies per 100 mL.

**Table 4-3. Concord River Pathogen Impaired Segments (adapted from MassGIS 2005 and MADEP 2005).**

| Segment ID | Segment Name | Length (miles) | Segment Description |
|---|---|---|---|
| **Assabet River Subbasin** | | | |
| MA82B-01 | Assabet River | 1.2 | Outlet Flow Augmentation Pond to Westborough WWTP, Westborough. |
| MA82B-02 | Assabet River | 3.8 | Westborough WWTP, Westborough to Route 20 Dam, Northborough. |
| MA82B-03 | Assabet River | 2.4 | Route 20 Dam, Northborough to Marlborough West WWTP, Marlborough. |
| MA82B-04 | Assabet River | 8.0 | Marlborough West WWTP, Marlboro to Hudson WWTP, Hudson. |
| MA82B-05 | Assabet River | 8.2 | Hudson WWTP Hudson to Routes 27/62 at USGS Gage, Maynard. |
| MA82B-07 | Assabet River | 6.4 | Powdermill Dam, Acton to confluence with Sudbury River, Concord. |
| **Sudbury River Subbasin** | | | |
| MA82055 | Grist Mill Pond | 17 acres | Sudbury/Marlborough |
| MA82056 | Hager Pond | 30 acres | Marlborough |
| MA82A-06 | Hop Brook* | 3.0 | Confluence of Allowance Brook, Sudbury to the confluence with the Sudbury River, Wayland. |
| **Concord River Subbasin** | | | |
| MA82A-07 | Concord River | 10.4 | Confluence with Assabet and Sudbury Rivers in Concord to Billerica Water Supply Filtration Plant building in Billerica. |
| MA82A-10 | River Meadow Brook | 6.4 | Outlet Russell Mill Pond, Chelmsford to confluence with Concord River, Lowell. |
| MA82A-09 | Concord River | 0.9 | Rogers Street bridge in Lowell to confluence with Merrimack River, Lowell. |

* Formerly Wash Brook

Data summarized in the following subsections may be found at:

- **MADEP 2005** - SuAsCo Watershed 2001 Water Quality Assessment Report – Final Draft
- **ENSR 2003 -** SuAsCo Watershed Concord River TMDL Study Assessment Final Report. February 2003
- **ENSR 2004a -** Sudbury River Quality Study 2002-2003 Final Report. November 2004.
- **ENSR 2004b -** 2004 Sudbury River Targeted Sub-Basin Bacteria Sampling
- **Organization for the Assabet River (OAR) 2003 -** Streamwatch and Water Quality Monitoring Program Final Report – Summer 2002. December 2003.

The MADPH publishes annual reports on the testing of public and semi-public beaches for both marine and fresh waters. These documents provide water quality data for each bathing beach by community and note if there were exceedances of water quality criteria. There is also a list of communities that did not report testing results. These reports can be downloaded from http://www.mass.gov/dph/beha/tox/reports/beach/beaches.htm. Marine and freshwater beach status is highly variable and is therefore not provided in each segment description. Please see the MADPH annual beach report for specific details regarding swimming beaches.

When available, data are broken down into two weather conditions: wet and dry. When data were not categorized as such in individual reports, data collected on days when there was measurable precipitation were considered wet weather conditions and data collected on days when no or "trace" amounts of precipitation were reported were considered dry weather conditions. It should be noted that some reporting entities require a minimum amount of precipitation (i.e. 0.1 or 0.2 inches) before it is considered wet weather. Therefore, data between reporting entities may not be directly comparable, but overall conclusions for each segment are consistent.

Summary tables from studies performed by ENSR and OAR are provided for the three major river basins are provided in this section on a sub-watershed scale. These tables generally contain the following information:

**Site #** - column displays the sampling location identifier issued by sampling organization;
**River Miles** - column provides the river mile samples where samples were collected;
**Description** - column provides a short narrative description of the sampling location;
**Town** - column provides the town name in which samples were collected.

Columns following the descriptive details provide statistics relating to the sampling conducted. These columns may include "Min" where the minimum value reported is displayed, "Max" where the maximum value reported is displayed and "n" where the number of samples analyzed at that site over the time frame indicated. Some summary tables do not follow the same format, but the column headings and data still apply.

Information from the MADEP WQA is provided by segment. This information includes waterbody classification of each segment and a list of permitted withdrawal and wastewater dischargers. Indicator bacteria sampling data are also provided when available. Please see the SuAsCo Watershed 2001 Water Quality Assessment Report – Final Draft (MADEP 2005) for additional information regarding each segment.

The purpose of this section of the report is to briefly describe the impaired waterbody segments in the Concord River watershed.

## 4.1. Assabet River Segments

The Assabet River is a Class B waterbody with watershed of about 177 square miles, a length of 31.8 miles and an average channel slope of 6 ft/mi. The Assabet River begins in wetlands in Westborough and flows generally northward and northeastward to its confluence with the Sudbury River in Concord. It is a major tributary to the Concord River in eastern Massachusetts and is within EPA's Ecoregion XIV subregion 59, the eastern coastal plain (USGS 2004; OAR 2003). Most sections of the Assabet River as Category 5 Waters: "Waters Requiring a TMDL" (MADEP 2003). The mainstem river suffers primarily from eutrophication caused by excess nutrients entering the river. There are four major municipal wastewater discharges to the Assabet River and these effluents are significant sources of nutrients. These facilities serve the sewered portions of Westborough, Shrewsbury, Northborough, Hopkinton, and Marlborough (West). In addition, there is one NPDES discharge in the Assabet River Watershed, MWRA's Cosgrove Intake, which is permitted to discharge effluent containing intake screen wash water, reservoir foundation leakage,

test water, pump seal water, non-contact cooling water, hydroelectric turbine bearing lubrication and cooling water and storm water to North Brook. Details for this authorized permittee can be found at http://www.epa.gov/boston/npdes/permits_listing_ma.html.

OAR "*Streamwatch and Water Quality Monitoring Program*" Summer 2002 bacterial data are presented in Table 4-4, Figure 4-1 and is summarized below. A sample location map is provided in Figure 4-2.

Headwater and tributary sites were tested for fecal coliforms on August 20th in the first six hours after 0.44 inches of rainfall following 14 days with trace or no precipitation. Fecal coliform counts at six of the ten sites tested exceeded the recommended secondary contact standard (2000cfu/100ml; MADEP 2002). These results suggest the need for further wet and dry weather sampling on the tributaries.

**Assabet River Segment MA82B-01**

This 1.4 mile segment is a Class B warm water fishery in Westborough. The segment begins at the outlet of Assabet River Reservoir and extends to the Westborough Waste Water Treatment Plant (WWTP). The Westborough Water Department is permitted to withdraw groundwater from a portion of this segment's drainage area. Astra Zeneca discharges industrial wastewater to the Westborough WWTP. The Westborough Water Purification Facility discharges filter backwash to Hocomonco Pond in this segment's drainage area.

OAR's sampling station "ABT-311" is located in this segment. Sampling results are provided in Table 4-4 and Figure 4-1 for this station.

**Assabet River Segment MA82B-02**

This 3.7 mile segment is a Class B warm water fishery. The segment begins at the Westborough WWTP discharge and extends to the Route 20 dam in Northborough. The Westborough Water Department and the Northborough Water and Sewer Department are permitted to withdraw groundwater from a portion of this segment's drainage area. Berberian Farms and Juniper Hill Golf Course have authorization to withdraw surface water in this segment. The Town of Westborough is permitted to discharge treated sanitary wastewater in this segment.

**Assabet River Segment MA82B-03**

This 2.4 mile segment is a Class B warm water fishery. The segment begins at the Route 20 dam in Northborough and extends to the Marlborough WWTP discharge in Marlborough. The Northborough Water and Sewer Department and Westborough Water Department are permitted to withdraw groundwater from a portion of this segment's drainage area. There are no regulated National Pollutant Discharge Elimination System (NPDES) discharges in this segment.

**Table 4-4. Assabet River: OAR Data Summary August 20, 2002.**

| Site/Sample ID | | | Fecal Coliform |
|---|---|---|---|
| **Site ID** | **Site Name** | **Town** | **(cfu/100ml)** |
| ABT-311 | Maynard St | Westboro | >15000 |
| HOP-011 | Hop Brook | Northboro | 150 |
| CLD-030 | Cold Harbor Brook | Northboro | 9000 |
| NRT-009 | North Brook | Berlin | 1300 |
| DAN-013 | Danforth Brook | Hudson | 5250 |
| FTM-012 | Fort Meadow Brook | Hudson | 3300 |
| ELZ-004 | Elizabeth Brook | Stow | 800 |
| TAY-005 | Taylor Brook | Maynard | 200 |
| NSH-002 | Nashoba Brook | Concord | 2500 |
| SPN-003 | Spencer Brook | Concord | 2500 |

**Figure 4-1. Assabet River: OAR Fecal Coliform Summary August 20, 2002 (OAR 2003).**

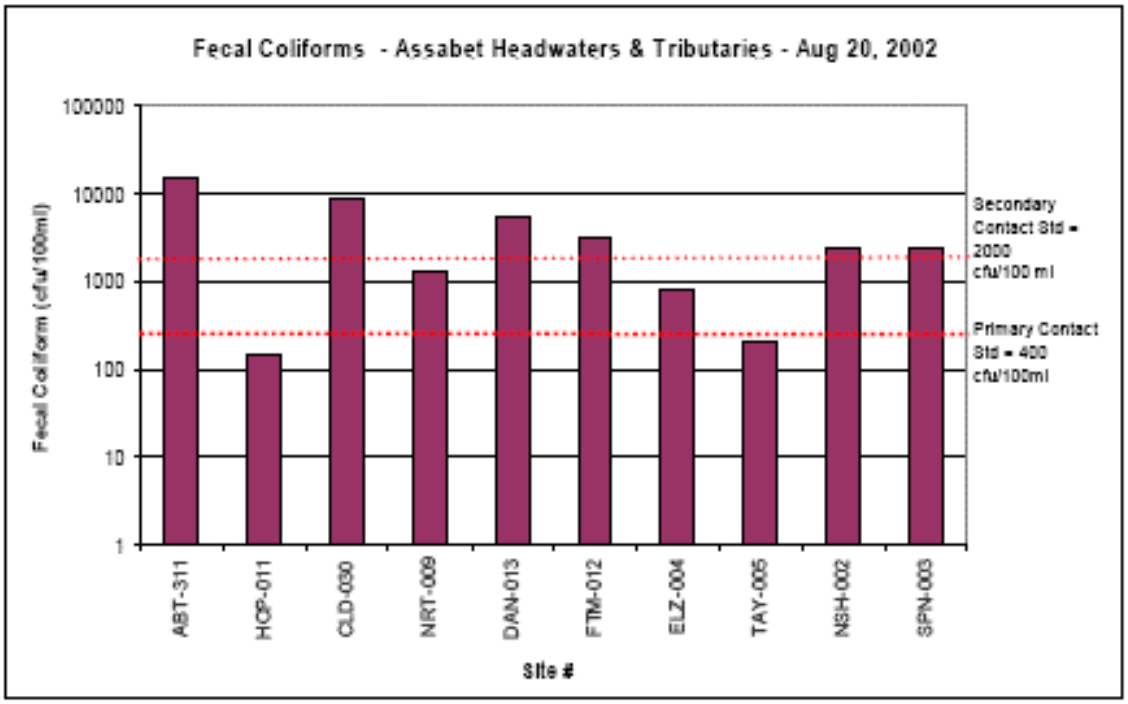


**Figure 4-2. Assabet River: Sampling Stations OAR August 20, 2002 (OAR 2003)**

**Assabet River Segment MA82B-04**

This 7.9 mile segment is a Class B warm water fishery. The segment begins at the Marlborough WWTP in Marlborough and extends to the Hudson WWTP discharge in Hudson. Intel Corp and the Hudson Water Department are permitted to withdraw groundwater from a portion of this segment's drainage area. The City of Marlborough is permitted to discharge treated sanitary wastewater in this segment.

**Assabet River Segment MA82B-05**

This 8.8 mile segment is a Class B warm water fishery. The segment begins at the Marlborough WWTP in Marlborough and extends to the Hudson WWTP discharge in Hudson. Stow Acres Country Club is authorized to withdraw ground and surface water from this segment. The Town of Hudson is permitted to discharge treated sanitary wastewater in this segment.

**Assabet River Segment MA82B-07**

This 6.4 mile segment is a Class B warm water fishery. The segment begins at the Powdermill Dam in Acton and extends to the confluence with the Sudbury River in Concord. The Assabet Sand and Gravel Company Inc. is permitted to withdraw surface water from this segment. The Acton Water Department is permitted to withdraw groundwater from a portion of this segment's drainage area. S/P Acton Realty Trust is permitted to discharge treated sanitary wastewater from the Powder Mill Plaza to this segment. This system will be tying into the Acton sewer system and will be treated at the Action WWTP. The Acton WWTP discharges in the Nashoba Brook subwatershed (MA82B-14). W.R. Grace & Co. is permitted to discharge water from a groundwater remediation system at the Acton Water Supply District Assabet Municipal Well Number 1 in this segment. The Massachusetts Correctional Institute-Concord Wastewater Treatment Plant is permitted to discharge treated sanitary wastewater to the Assabet River.

The MADEP conducted dry weather indicator bacteria sampling on two dates in 2001. Fecal coliform results were 250 and 400 cfu/100 mL. *E. coli* results were 120 and 130 cfu/100 mL.

## 4.2. Sudbury River Segments

The mainstem of the Sudbury River is approximately 32 miles long, and drains a watershed area of 162 square miles, 29 of which drain into MDC reservoirs (ENSR 2004a). The Sudbury River watershed contains all or part of 17 cities and towns. The headwaters of the Sudbury River is in Cedar Swamp in Westborough, at an elevation of 265 feet and the downstream extent is at the confluence with the Assabet River at an elevation of 112 feet; therefore, the average slope of the Sudbury River is 4.8 feet/mile. The steepest reaches along the Sudbury River watercourse extend from the area of Cedar Swamp, downstream through the Saxonville Pond that is impounded by the Colonna Dam. The Sudbury River is gently sloped from the Colonna Dam downstream to the Assabet River confluence. Downstream of the confluence, the combined Assabet and Sudbury Rivers form the Concord River.

The Sudbury River is impounded at seven locations in Westborough, Southborough, Ashland, Framingham, and Saxonville (ENSR 2004a). The impoundments located in Westborough, Southborough, and Ashland are relatively small, but have the potential to receive runoff directly from

highly populated areas. Approximately four miles downstream of the Myrtle Street impoundment in Ashland, there is a series of four relatively large reservoirs, which make up the Sudbury Reservoir system. These reservoirs are part of the Massachusetts Water Resources Authority's (MWRA) water-supply system and were created to supply water during emergencies and high-demand periods. Two of the four reservoirs in the Sudbury Reservoir system are located along the mainstem of the Sudbury River; Framingham Reservoirs #1 and #2 are 134 and 154 acres, respectively. Reservoir #3 and the Sudbury Reservoir are 250 and 1,300 acres, respectively, and are both located upstream of Reservoir #1 in Framingham, within a sub-watershed that is tributary to the main stem of the Sudbury River (ENSR 2004a). While the reservoirs in the Sudbury Reservoir system are no longer used to provide drinking water for the Boston metropolitan area, they are regulated and can have a large impact on flows in the downstream portions of the Sudbury River.

Downstream of the Sudbury Reservoir system, in the Saxonville area of Framingham, is the approximately 65 acre Saxonville Pond. Another significant feature of the Sudbury River watershed is the Great Meadows National Refuge that extends for approximately six miles through much of Sudbury and Wayland. This area is largely unpopulated and provides significant habitat for both aquatic and terrestrial wildlife. Furthermore, this relatively flat area can provide for a significant degree of storage during periods of elevated flow in the Sudbury River (ENSR 2004a). There is one listed NPDES discharge in the Sudbury River Watershed, Ashland Sand and Stone Inc, which is permitted to discharge treated wastewater from sand and gravel washing. Details on this authorized permittee can be found at http://www.epa.gov/boston/npdes/permits_listing_ma.html.

ENSR performed two bacteria sampling programs in the Sudbury River subwatershed for the MADEP and United States Army Corps of Engineers (USACE). The large program, conducted during the summers of 2002 and 2003, included a set of six water quality sampling surveys. Up to 62 locations, including stations on the Assabet and Concord Rivers were sampled in this field program. Both wet and dry weather data were collected.

Data from the 2002 – 2003 sampling program are provided below (Tables 4-5 and 4-6). Sampling location maps are provided in Figures 4-3 and 4-4. Most of this information is taken directly from the "*Sudbury River Water Quality Study 2002 – 2003 Final Report*" (ENSR 2004a).

> "The following observations were made based on the dry-weather bacteria data collection results:
>
> 1. In 2002, fecal coliform concentrations ranged from <100 to >3,000 org/100 mL.
> 2. In 2002, 81% of fecal coliform samples collected at the mainstem locations exceeded the 400 org/100 mL standard.
> 3. In 2002, 75% of fecal coliform samples at tributary locations exceeded the 400 org/100 mL standard.
> 4. In 2002, *E. coli* concentrations ranged from <100 to >3,000 org/100 mL
> 5. In 2002, 29% of *E. coli* samples collected in the mainstem exceeded the EPA recommended standard for recreational use of 235 org/100mL.
> 6. In 2003, fecal coliform concentrations ranged from <100 org/100 mL to 9,500 org/100 mL.

7. In 2003, only one Sudbury River fecal coliform sample (at SR12) contained fecal coliform levels greater than the 400 org/100 mL standard.
8. In 2003, 24% of the tributary fecal coliform samples contained fecal coliform levels greater than the 400 org/100 mL standard.
9. In 2003, *E. coli* levels were all below the 100 org/100 mL detection limit.

In general, bacteria concentration measurements collected in July 2002 were substantially higher than those of July 2003. This difference is likely due to several factors including significantly lower streamflow in July 2002. Bacteria were detected throughout the Sudbury River study at levels above the State water quality standard.

The following observations were made based on the wet-weather bacteria data collection results:

1. In 2002, fecal coliform concentrations ranged from <100 to >3,000 org/100 mL.
2. In 2002, 19% of fecal coliform samples collected at the mainstem locations exceeded the 400 org/100 mL standard.
3. In 2002, *E. coli* concentrations ranged from <100 org/100 mL to 2,200 org/100 mL.
4. In 2002, 14% of the mainstem *E. coli* sample concentrations exceeded the EPA recommended threshold of 235 org/100 mL.
5. In 2003, fecal coliform concentrations ranged from 300 org/100 mL to 50,000 org/100 mL.
6. In 2003, 92% of fecal coliform samples collected at the mainstem locations exceeded the 400 org/100 mL standard.
7. In 2003, all tributary fecal coliform samples exceeded the State Standard of 400 org/100 mL with values ranging from 2,600 to 50,000 org/100 mL.
8. In 2003, *E. coli* concentrations ranged from <100 org/100 mL to 3,470 org/100 mL.
9. In 2003, 75% of *E. coli* samples collected in the mainstem exceeded the EPA recommended standard of 235 org/100 mL.
10. In 2003, all tributary *E. coli* concentrations exceeded the EPA recommended standard of 235 org/100 mL with values ranging from 510 to 3,470 org/100 mL.

Bacteria data collection results do not reveal simple trends in bacteria data in the Sudbury River. Elevated levels of bacteria were detected throughout the study area with frequent exceedances above water quality standard and guidelines. No clear trend was observed in terms of spatial locations of elevated bacteria measurements. Dry-weather and wet-weather surveys both revealed elevated bacteria levels and the level of bacteria detected varied by several orders of magnitude from survey to survey" (ENSR 2004a).

**Table 4-5. Sudbury River: Summary of Fecal Coliform Measurements (ENSR 2004a).**

| Mainstem (Sudbury & Concord River) Stations Fecal Coliform (#/100 ml) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RM & Station** | **July 22 2002 (dry weather)** | **August 30 2002 (wet weather)** | **July 29 2003 (dry weather)** | **Sept. 16 2003 (wet weather)** | **Min** | **Max** | **n** |
| RM -0.15 - CR01 | | | 100 | 23700 | **100** | **23700** | **2** |
| RM 0.45 - SR01 | >3000 | 100 | <100 | 13300 | **<100** | **>3000** | **4** |
| RM 2.42 - SR02 | 700 | <100 | <100 | | **<100** | **700** | **3** |
| RM 4.63 - SR03 | >3000 | <100 | 100 | | **<100** | **>3000** | **3** |
| RM 7.08 - SR04 | >3000 | <100 | <100 | 4300 | **<100** | **>3000** | **4** |
| RM 9.79 - SR05 | >3000 | <100 | 300 | | **<100** | **>3000** | **3** |
| RM 10.85 - SR06 | 1500 | <100 | 200 | 3500 | **<100** | **3500** | **4** |
| RM 11.41 - SR07 | >3000 | 800 | 100 | 6500 | **100** | **>3000** | **4** |
| RM 14.72 - SR08 | 2000 | <100 | 300 | 19500 | **<100** | **19500** | **4** |
| RM 15.72 - SR09 | 850 | <100 | 400 | | **<100** | **850** | **3** |
| RM 15.99 - SR10 | 1000 | <100 | <100 | | **<100** | **1000** | **3** |
| RM 16.46 - SR11 | 100 | <100 | 100 | | **<100** | **100** | **3** |
| RM 17.92 - SR12 | >3000 | 900 | 500 | 35100 | **500** | **>3000** | **4** |
| RM 18.97 - SR13 | >3000 | <100 | 200 | | **<100** | **>3000** | **3** |
| RM 19.74 - SR23 | | | 300 | 3100 | **300** | **3100** | **2** |
| RM 20.05 - SR14 | >3000 | 4500 | 200 | | **200** | **>3000** | **3** |
| RM 20.2 - SR24 | | | <100 | | **<100** | **<100** | **1** |
| RM 20.48 - SR25 | | | <100 | | **<100** | **<100** | **1** |
| RM 20.9 - SR15 | 20 | <100 | <100 | 300 | **<100** | **300** | **4** |
| RM 22.7 - SR26 | | | 100 | | **100** | **100** | **1** |
| RM 23.75 - SR16 | >3000 | <100 | 400 | | **<100** | **>3000** | **3** |
| RM 24.16 - SR17 | 300 | <100 | <100 | | **<100** | **300** | **3** |
| RM 24.82 - SR27 | | | <100 | 900 | **<100** | **900** | **2** |
| RM 25.54 - SR18 | >3000 | 1900 | 300 | | **300** | **>3000** | **3** |
| RM 26.48 - SR19 | 850 | <100 | <100 | 3100 | **<100** | **3100** | **4** |
| RM 27.93 - SR20 | 300 | <100 | 200 | | **<100** | **300** | **3** |
| RM 28.66 - SR21 | | | 100 | | **100** | **100** | **1** |
| RM 29.64 - SR22 | 2500 | <100 | <100 | 4000 | **<100** | **4000** | **4** |
| **Minimum** | **20** | **<100** | **<100** | **300** | | | |
| **Maximum** | **>3000** | **4500** | **500** | **35100** | | | |
| **n** | **21** | **21** | **28** | **12** | | | |

**Table 4-5. Sudbury River: Summary of Fecal Coliform Measurements (Cont'd).**

| Tributary Stations Fecal Coliform (#/100 ml) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RM & Station** | **July 22 2002 (dry weather)** | **August 30 2002 (wet weather)** | **July 29 2003 (dry weather)** | **Sept. 16 2003 (wet weather)** | **Min** | **Max** | **n** |
| RM 0 - AR01 | | | 100 | 29200 | **100** | **29200** | **2** |
| RM 1.81 - T09 | | | <100 | 44800 | **<100** | **44800** | **2** |
| RM 4.66 - T10 | | | 2000 | 47800 | **2000** | **47800** | **2** |
| RM 5.93 - T06 | >3000 | 100 | 800 | 50000 | **100** | **>3000** | **4** |
| RM 5.93 - T11 | | | 300 | 24600 | **300** | **24600** | **2** |
| RM 10.96 - T08 | 200 | 100 | 100 | 18900 | **100** | **18900** | **4** |
| RM 10.96 - T12 | | | 400 | | **400** | **400** | **1** |
| RM 10.96 - T13 | | | 100 | | **100** | **100** | **1** |
| RM 10.96 - T14 | | | 100 | | **100** | **100** | **1** |
| RM 11.45 - T07 | 500 | 100 | <100 | 26400 | **<100** | **26400** | **4** |
| RM 11.45 - T15 | | | 100 | 6800 | **100** | **6800** | **2** |
| RM 15.89 - T02 | >3000 | 200 | 200 | 44000 | **200** | **>3000** | **4** |
| RM 15.89 - T05 | 800 | <100 | <100 | | **<100** | **800** | **3** |
| RM 18.69 - T16 | | | 700 | 32700 | **700** | **32700** | **2** |
| RM 18.95 - T17 | | | <100 | 22100 | **<100** | **22100** | **2** |
| RM 19.7 - T19 | | | 1000 | 35600 | **1000** | **35600** | **2** |
| RM 20.53 - T01 | >3000 | 200 | 100 | 6700 | **100** | **>3000** | **4** |
| RM 20.53 - T18 | | | 6400 | | **6400** | **6400** | **1** |
| RM 20.87 - T20 | | | 9500 | | **9500** | **9500** | **1** |
| RM 20.87 - T21 | | | 1200 | 18700 | **1200** | **18700** | **2** |
| RM 20.87 - T22 | | | 300 | | **300** | **300** | **1** |
| RM 20.87 - T23 | | | 200 | | **200** | **200** | **1** |
| RM 21.63 - T24 | | | 1700 | | **1700** | **1700** | **1** |
| RM 23.96 - T25 | | | <100 | 17300 | **<100** | **17300** | **2** |
| RM 24.38 - T26 | | | 100 | 2600 | **100** | **2600** | **2** |
| RM 25.37 - T27 | | | 100 | 11400 | **100** | **11400** | **2** |
| RM 25.43 - T28 | | | 100 | 19700 | **100** | **19700** | **2** |
| RM 25.88 - T29 | | | 100 | 16400 | **100** | **16400** | **2** |
| RM 26.3 - T04 | 200 | <100 | 200 | | **<100** | **200** | **3** |
| RM 27.82 - T30 | | | <100 | 12500 | **<100** | **12500** | **2** |
| RM 31.02 - T03 | 1300 | 300 | 100 | 12900 | **100** | **12900** | **4** |
| RM 31.44 - T31 | | | 100 | | **100** | **100** | **1** |
| RM 31.95 - T32 | | | 100 | | **100** | **100** | **1** |
| RM 31.95 - T33 | - | | <100 | | **<100** | **50** | **1** |
| **Minimum** | **200** | **<100** | **<100** | **2600** | | | |
| **Maximum** | **>3000** | **300** | **9500** | **50000** | | | |
| **n** | **8** | **8** | **34** | **21** | | | |

**Table 4-6. Sudbury River: Summary of *E. coli* Measurements (ENSR 2004a).**

| Mainstem (Sudbury & Concord River) Stations *E. coli* (#/100 ml) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RM & Station** | **July 22 2002 (dry weather)** | **August 30 2002 (wet weather)** | **July 29 2003 (dry weather)** | **Sept. 16 2003 (wet weather)** | **Min** | **Max** | **n** |
| RM -0.15 - CR01 | | | <100 | 1690 | **<100** | **1690** | **2** |
| RM 0.45 - SR01 | 70 | 100 | <100 | 1020 | **<100** | **1020** | **4** |
| RM 2.42 - SR02 | 130 | <100 | <100 | | **<100** | **130** | **3** |
| RM 4.63 - SR03 | 40 | <100 | <100 | | **<100** | **<100** | **3** |
| RM 7.08 - SR04 | 100 | <100 | <100 | 270 | **<100** | **270** | **4** |
| RM 9.79 - SR05 | 150 | <100 | <100 | | **<100** | **150** | **3** |
| RM 10.85 - SR06 | 200 | <100 | <100 | 190 | **<100** | **200** | **4** |
| RM 11.41 - SR07 | 140 | 500 | <100 | 430 | **<100** | **500** | **4** |
| RM 14.72 - SR08 | 170 | <100 | <100 | 1240 | **<100** | **1240** | **4** |
| RM 15.72 - SR09 | 540 | <100 | <100 | | **<100** | **540** | **3** |
| RM 15.99 - SR10 | 130 | <100 | <100 | | **<100** | **130** | **3** |
| RM 16.46 - SR11 | 20 | <100 | <100 | | **<100** | **<100** | **3** |
| RM 17.92 - SR12 | 700 | <100 | <100 | 2610 | **<100** | **2610** | **4** |
| RM 18.97 - SR13 | 400 | <100 | <100 | | **<100** | **400** | **3** |
| RM 19.74 - SR23 | | | <100 | 1020 | **<100** | **1020** | **2** |
| RM 20.05 - SR14 | 840 | 2200 | <100 | | **<100** | **2200** | **3** |
| RM 20.2 - SR24 | | | <100 | | **<100** | **<100** | **1** |
| RM 20.48 - SR25 | | | <100 | | **<100** | **<100** | **1** |
| RM 20.9 - SR15 | <10 | <100 | <100 | 100 | **<100** | **<100** | **4** |
| RM 22.7 - SR26 | | | <100 | | **<100** | **<100** | **1** |
| RM 23.75 - SR16 | >3000 | <100 | <100 | | **<100** | **>3000** | **3** |
| RM 24.16 - SR17 | 230 | <100 | <100 | | **<100** | **230** | **3** |
| RM 24.82 - SR27 | | | <100 | 160 | **<100** | **160** | **2** |
| RM 25.54 - SR18 | 160 | 900 | <100 | | **<100** | **900** | **3** |
| RM 26.48 - SR19 | 40 | <100 | <100 | 970 | **<100** | **970** | **4** |
| RM 27.93 - SR20 | 260 | <100 | <100 | | **<100** | **260** | **3** |
| RM 28.66 - SR21 | | | <100 | | **<100** | **<100** | **1** |
| RM 29.64 - SR22 | 70 | <100 | <100 | 1350 | **<100** | **1350** | **4** |
| **Minimum** | **<10** | **<100** | **<100** | **100** | | | |
| **Maximum** | **>3000** | **2200** | **<100** | **2610** | | | |
| **n** | **21** | **21** | **28** | **12** | | | |

**Table 4-6. Sudbury River: Summary of *E. coli* Measurements (Cont'd).**

| Tributary Stations E. coli (#/100 ml) | | | | | | | |
|---|---|---|---|---|---|---|---|
| RM & Station | July 22 2002 (dry weather) | August 30 2002 (wet weather) | July 29 2003 (dry weather) | Sept. 16 2003 (wet weather) | Min | Max | n |
| RM 0 - AR01 | | | <100 | 1520 | **<100** | **1520** | **2** |
| RM 1.81 - T09 | | | <100 | 3110 | **<100** | **3110** | **2** |
| RM 4.66 - T10 | | | <100 | 3230 | **<100** | **3230** | **2** |
| RM 5.93 - T06 | 290 | <100 | <100 | 3470 | **<100** | **3470** | **4** |
| RM 5.93 - T11 | | | <100 | 1980 | **<100** | **1980** | **2** |
| RM 10.96 - T08 | 150 | <100 | <100 | 1140 | **<100** | **1140** | **4** |
| RM 10.96 - T12 | | | <100 | | **<100** | **<100** | **1** |
| RM 10.96 - T13 | | | <100 | | **<100** | **<100** | **1** |
| RM 10.96 - T14 | | | <100 | | **<100** | **<100** | **1** |
| RM 11.45 - T07 | 200 | <100 | <100 | 2220 | **<100** | **2220** | **4** |
| RM 11.45 - T15 | | | <100 | 810 | **<100** | **810** | **2** |
| RM 15.89 - T02 | 1270 | <100 | <100 | 3250 | **<100** | **3250** | **4** |
| RM 15.89 - T05 | 150 | <100 | <100 | | **<100** | **150** | **3** |
| RM 18.69 - T16 | | | <100 | 2560 | **<100** | **2560** | **2** |
| RM 18.95 - T17 | | | <100 | 3110 | **<100** | **3110** | **2** |
| RM 19.7 - T19 | | | <100 | 3410 | **<100** | **3410** | **2** |
| RM 20.53 - T01 | 550 | <100 | <100 | 2140 | **<100** | **2140** | **2** |
| RM 20.53 - T18 | | | <100 | | **<100** | **<100** | **1** |
| RM 20.87 - T20 | | | <100 | | **<100** | **<100** | **1** |
| RM 20.87 - T21 | | | <100 | 2850 | **<100** | **2850** | **2** |
| RM 20.87 - T22 | | | <100 | | **<100** | **<100** | **1** |
| RM 20.87 - T23 | | | <100 | | **<100** | **<100** | **1** |
| RM 21.63 - T24 | | | <100 | | **<100** | **<100** | **1** |
| RM 23.96 - T25 | | | <100 | 3070 | **<100** | **3070** | **2** |
| RM 24.38 - T26 | | | <100 | 510 | **<100** | **510** | **2** |
| RM 25.37 - T27 | | | <100 | 2730 | **<100** | **2730** | **2** |
| RM 25.43 - T28 | | | <100 | 2910 | **<100** | **2910** | **2** |
| RM 25.88 - T29 | | | <100 | 2370 | **<100** | **2370** | **2** |
| RM 26.3 - T04 | 190 | <100 | <100 | | **<100** | **190** | **3** |
| RM 27.82 - T30 | | | <100 | 2110 | **<100** | **2110** | **2** |
| RM 31.02 - T03 | 60 | 200 | <100 | 2970 | **<100** | **2970** | **4** |
| RM 31.44 - T31 | | | <100 | | **<100** | **<100** | **1** |
| RM 31.95 - T32 | | | <100 | | **<100** | **<100** | **1** |
| RM 31.95 - T33 | | | <100 | | **<100** | **<100** | **1** |
| **Minimum** | **60** | **<100** | **<100** | **510** | | | |
| **Maximum** | **1270** | **200** | **<100** | **3470** | | | |
| **n** | **8** | **8** | **34** | **21** | | | |

**Figure 4-3. Sudbury River Sampling Locations Dry Weather Water Quality Study 2002-2003 (ENSR 2004a).**

| River Reach | River Mile | Station Number | Sampling Location |
|---|---|---|---|
| Sudbury River | -0.15 | CR01 | Concord River downstream of confluence |
| | 0.45 | SR01 | Bridge on Nashawtuc Rd, Concord |
| | 2.42 | SR02 | Sudbury Rd, Concord |
| | 4.63 | SR03 | Rt 117, Sudbury |
| | 7.08 | SR04 | Sherman Bridge Rd, Wayland |
| | 9.79 | SR05 | Old Sudbury Rd, Wayland |
| | 10.85 | SR06 | Bridge on Rt 20, Wayland |
| | 11.41 | SR07 | Bridge on Pelham Island Rd, Wayland |
| | 14.72 | SR08 | Stonebridge Rd, Wayland |
| | 15.72 | SR09 | Danforth St, Framingham |
| | 15.99 | SR10 | Concord St, Framingham |
| | 16.46 | SR11 | Above Colonna Dam, Central St, Framingham |
| | 17.92 | SR12 | Fenwich St, Framingham |
| | 18.97 | SR13 | Central St, Framingham |
| | 19.74 | SR23 | Main St, Framingham |
| | 20.05 | SR14 | Union Ave, Framingham |
| | 20.20 | SR24 | Franklin St, Framingham |
| | 20.48 | SR25 | Conrail Crossing, Framingham |
| | 20.90 | SR15 | Above Dam, Winter St, Framingham |
| | 22.70 | SR26 | Fountain St, Framingham |
| | 23.75 | SR16 | Rt 135, Ashland |
| | 24.16 | SR17 | Front St, Ashland |
| | 24.82 | SR27 | Myrtle St, Ashland |
| | 25.54 | SR18 | Cordaville Rd, Ashland |
| | 26.48 | SR19 | Howe St, Ashland |
| | 27.93 | SR20 | Bridge on Cordaville Rd, Ashland/Hopkinton |
| | 28.66 | SR21 | Cedar St Bridge, Hopkinton |
| | 29.64 | SR22 | Below Fruit St, Hopkinton |
| Tributary | 0.00 | AR01 | Assabet River upstream of confluence |
| | 1.81 | T09 | Dugan Br, Old Rd to 9 Ac Corner, Concord |
| | 4.66 | T10 | Unnamed Br, Sudbury Rd, Concord |
| | 5.93 | T06 | Pantry Br, Pantry Rd, Sudbury |
| | 5.93 | T11 | Cold Br, Concord Rd, Sudbury |
| | 10.96 | T08 | Hop Br, Bridge on Elm St, Sudbury |
| | 10.96 | T12 | Allowance Br, Raymond Rd, Sudbury |
| | 10.96 | T13 | Dudley Br, Horse Pond Rd, Sudbury |
| | 10.96 | T14 | Hop Br, Peakham Rd, Sudbury |
| | 11.45 | T07 | Pine Br, Pine Brook Rd, Wayland |
| | 11.45 | T15 | Mill Br, Mill Brook Rd, Wayland |
| | 15.89 | T02 | Coch. Br, Schook St, Saxonville |
| | 15.89 | T05 | Coch. Br, Delmar St, Framingham |
| | 18.69 | T16 | Unnamed Br, Maclean Dr, Framingham |
| | 18.95 | T17 | Unnamed Br, Edgell Rd, Framingham |
| | 19.70 | T19 | Unnamed Br, Main St, Framingham |
| | 20.53 | T01 | Eames Br, Sherwin Terrace, Framingham |
| | 20.53 | T18 | Eames Br, Dudley Rd, Framingham |
| | 20.87 | T20 | Baiting Br, Salem End Rd, Framingham |
| | 20.87 | T21 | Baiting Br, Maple St, Framingham |
| | 20.87 | T22 | Unnamed Br, Belknap Rd, Framingham |
| | 20.87 | T23 | Baiting Br, Belknap Rd, Framingham |
| | 21.63 | T24 | Unnamed Br, Singletary Ln, Framingham |
| | 23.96 | T25 | Cold Spr. Br, Chestnut St, Ashland |
| | 24.38 | T26 | Unnamed Br, Concord St, Ashland |
| | 25.37 | T27 | Unnamed Br, Ponderosa Rd, Ashland |
| | 25.43 | T28 | Unnamed Br, Winter St, Ashland |
| | 25.88 | T29 | Unnamed Br, Southville Rd, Ashland |
| | 26.30 | T04 | Indian Br, Indian Brook Rd, Ashland |
| | 27.82 | T30 | Unnamed Br, Southville Rd, Southborough |
| | 31.02 | T03 | Whitehall Br, Fruit St Hopkinton |
| | 31.44 | T31 | Piccadilly Br, Hopkinton Rd, Westborough |
| | 31.95 | T32 | Jackstraw Br, Hopkinton Rd, Westborough |
| | 31.95 | T33 | Denny Br, South St, Westborough |

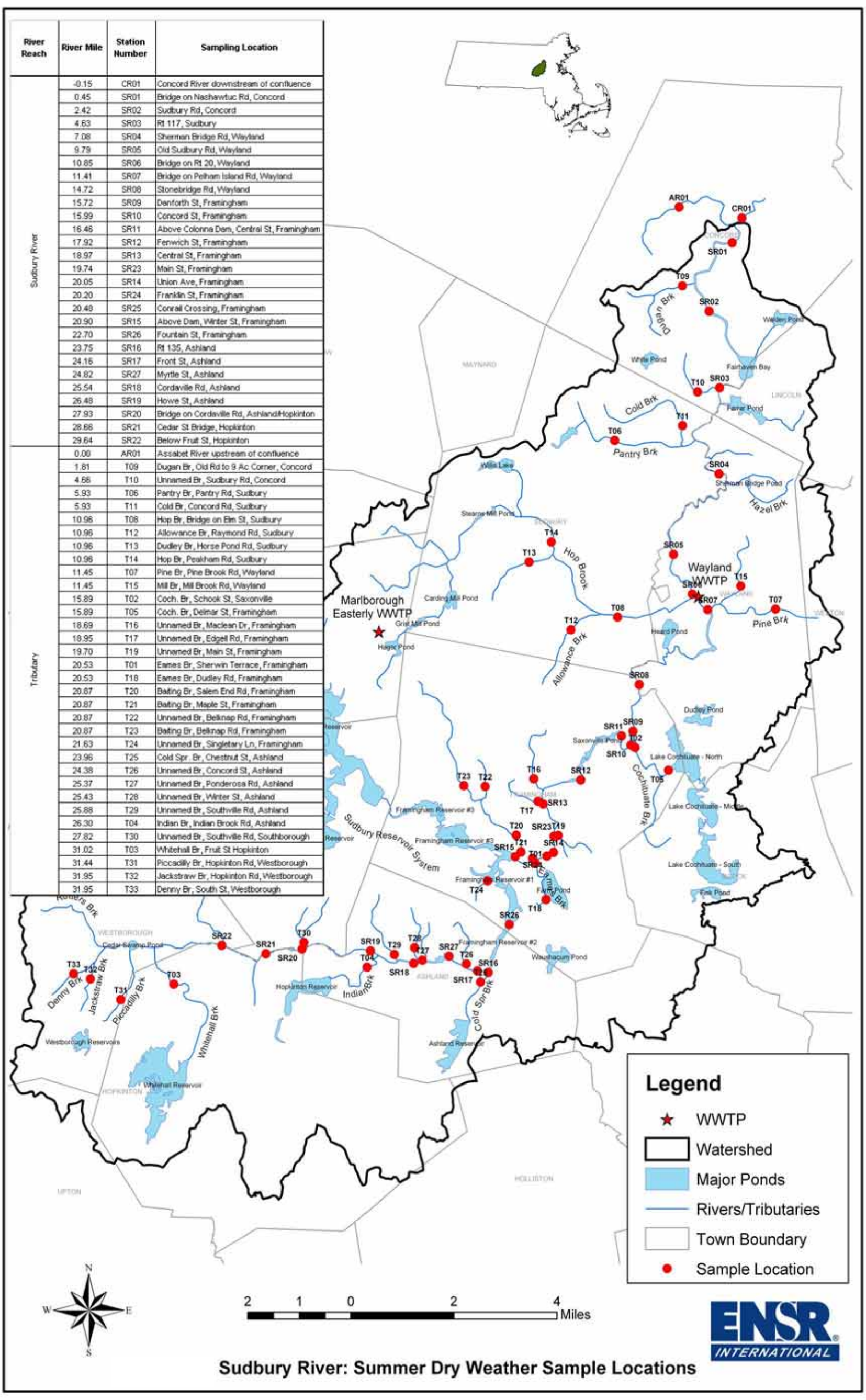
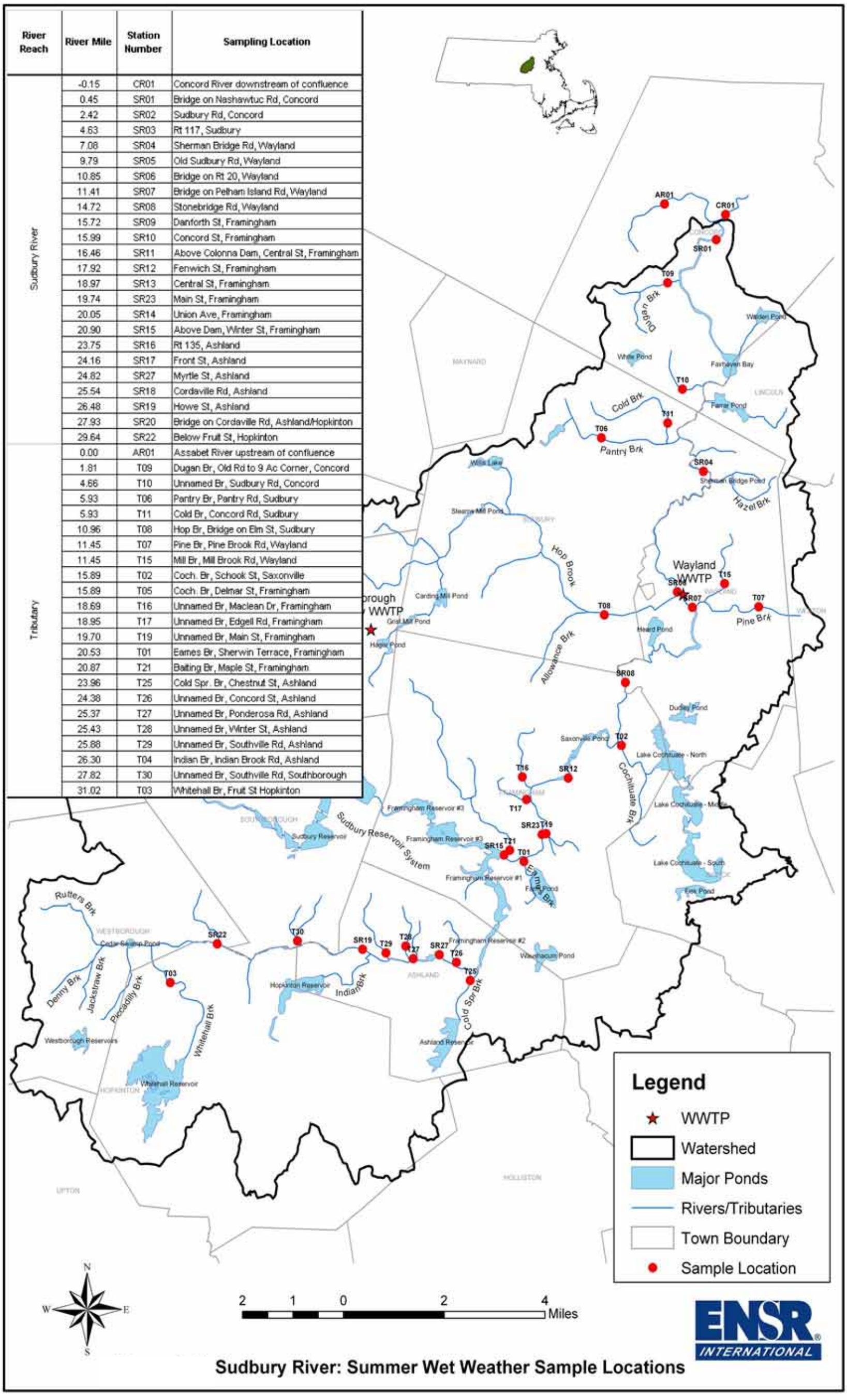


**Figure 4-4. Sudbury River Sampling Locations Wet Weather Water Quality Study 2002-2003 (ENSR 2004a).**

| River Reach | River Mile | Station Number | Sampling Location |
|---|---|---|---|
| Sudbury River | -0.15 | CR01 | Concord River downstream of confluence |
| | 0.45 | SR01 | Bridge on Nashawtuc Rd, Concord |
| | 2.42 | SR02 | Sudbury Rd, Concord |
| | 4.63 | SR03 | Rt 117, Sudbury |
| | 7.08 | SR04 | Sherman Bridge Rd, Wayland |
| | 9.79 | SR05 | Old Sudbury Rd, Wayland |
| | 10.85 | SR06 | Bridge on Rt 20, Wayland |
| | 11.41 | SR07 | Bridge on Pelham Island Rd, Wayland |
| | 14.72 | SR08 | Stonebridge Rd, Wayland |
| | 15.72 | SR09 | Danforth St, Framingham |
| | 15.99 | SR10 | Concord St, Framingham |
| | 16.46 | SR11 | Above Colonna Dam, Central St, Framingham |
| | 17.92 | SR12 | Fenwich St, Framingham |
| | 18.97 | SR13 | Central St, Framingham |
| | 19.74 | SR23 | Main St, Framingham |
| | 20.05 | SR14 | Union Ave, Framingham |
| | 20.90 | SR15 | Above Dam, Winter St, Framingham |
| | 23.75 | SR16 | Rt 135, Ashland |
| | 24.16 | SR17 | Front St, Ashland |
| | 24.82 | SR27 | Myrtle St, Ashland |
| | 25.54 | SR18 | Cordaville Rd, Ashland |
| | 26.48 | SR19 | Howe St, Ashland |
| | 27.93 | SR20 | Bridge on Cordaville Rd, Ashland/Hopkinton |
| | 29.64 | SR22 | Below Fruit St, Hopkinton |
| Tributary | 0.00 | AR01 | Assabet River upstream of confluence |
| | 1.81 | T09 | Dugan Br, Old Rd to 9 Ac Corner, Concord |
| | 4.66 | T10 | Unnamed Br, Sudbury Rd, Concord |
| | 5.93 | T06 | Pantry Br, Pantry Rd, Sudbury |
| | 5.93 | T11 | Cold Br, Concord Rd, Sudbury |
| | 10.96 | T08 | Hop Br, Bridge on Elm St, Sudbury |
| | 11.45 | T07 | Pine Br, Pine Brook Rd, Wayland |
| | 11.45 | T15 | Mill Br, Mill Brook Rd, Wayland |
| | 15.89 | T02 | Coch. Br, Schook St, Saxonville |
| | 15.89 | T05 | Coch. Br, Delmar St, Framingham |
| | 18.69 | T16 | Unnamed Br, Maclean Dr, Framingham |
| | 18.95 | T17 | Unnamed Br, Edgell Rd, Framingham |
| | 19.70 | T19 | Unnamed Br, Main St, Framingham |
| | 20.53 | T01 | Eames Br, Sherwin Terrace, Framingham |
| | 20.87 | T21 | Baiting Br, Maple St, Framingham |
| | 23.96 | T25 | Cold Spr. Br, Chestnut St, Ashland |
| | 24.38 | T26 | Unnamed Br, Concord St, Ashland |
| | 25.37 | T27 | Unnamed Br, Ponderosa Rd, Ashland |
| | 25.43 | T28 | Unnamed Br, Winter St, Ashland |
| | 25.88 | T29 | Unnamed Br, Southville Rd, Ashland |
| | 26.30 | T04 | Indian Br, Indian Brook Rd, Ashland |
| | 27.82 | T30 | Unnamed Br, Southville Rd, Southborough |
| | 31.02 | T03 | Whitehall Br, Fruit St Hopkinton |



In 2004, ENSR conducted the second sampling program in two targeted subwatersheds of the Sudbury River (Cold and Pantry Brooks and an unnamed tributary) for the MADEP and USACE as a continuation of the previous larger survey. Data from the smaller, targeted subwatershed survey are provided in Table 4-7. Sample location descriptions are provided in Table 4-8 with a location map provided in Figures 4-5 and 4-6.

During dry weather, 71-75% of the samples contained fecal coliform concentrations within the Class B WQS. There was only one exceedance (B-03) of the MADPH water quality criteria for *E. coli*. During wet weather, 85% of the samples exceeded the Class B WQS for fecal coliform and 80% exceeded the *E. coli* criteria on August 10, 2004. Eighty-eight percent of the samples violate both the fecal coliform and *E. coli* criteria on August 28th (ENSR 2004b).

**Table 4-7. ENSR 2004 Sudbury River Targeted Sub-Basin Bacteria Sampling Data (ENSR 2004b)**

| | Fecal Coliform (# col/100mL) | | | | | E. coli (# col/100mL) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dry Weather | | Wet Weather | | | Dry Weather | | Wet Weather | | |
| Station | 8/10/2004 | 8/27/2004 | 9/8/2004 | 9/28/2004 | | 8/10/2004 | 8/27/2004 | 9/8/2004 | 9/9/2004 MADEP | 9/28/2004 |
| A-01 | <10 | <10 | >10000 | 8500 | | <2 | <2 | >2000 | 131 | 3600 |
| A-02 | 500 | 160 | 3200 | 1500 | | 140 | 40 | 2000 | >2420 | 800 |
| A-03 | | 100 | | 10000 | | | 30 | | >2420 | 5600 |
| A-04 | | 150 | >10000 | 2900 | | | 48 | >2000 | >2420 | 1700 |
| A-05 | 360 | 120 | 3700 | 1000 | | 170 | 44 | 220 | >2420 | 900 |
| A-06 | | | | | | | | | 687 | |
| T-10 | 260 | 160 | 2400 | 1000 | | 84 | 48 | 2000 | >2420 | 960 |
| B-01 | 30 | 30 | 100 | 1100 | | 12 | 18 | 18 | 167 | 720 |
| B-02 | 230 | 1050 | >10000 | 5600 | | 190 | 128 | >2000 | >2420 | 4000 |
| B-03 | 560 | 400 | 1000 | 5900 | | 300 | 94 | 500 | 1986 | 4200 |
| B-04 | | 250 | 1700 | 7700 | | | 54 | 1000 | 1046 | 4600 |
| B-05 | 60 | 90 | 1200 | 9700 | | 66 | 38 | 700 | 1203 | 4200 |
| B-06 | 170 | 330 | 1200 | 6200 | | 128 | 96 | 600 | >2420 | 4600 |
| B-07 | 370 | 110 | 500 | >30000 | | 180 | 48 | 400 | >2420 | >6000 |
| B-08 | 90 | 60 | 230 | 300 | | 24 | 30 | 110 | >2420 | 120 |
| T-06 | 230 | 510 | 2200 | 500 | | 68 | 90 | >2000 | >2420 | 180 |
| B-09 | 460 | 1250 | 1200 | 9000 | | 92 | 154 | 520 | 2420 | 4000 |
| B-10 | | 390 | 5500 | >30000 | | | 104 | 2000 | >2420 | >6000 |
| B-11 | 960 | 830 | >10000 | >30000 | | 180 | 156 | >2000 | >2420 | >6000 |
| B-12 | | 40 | 400 | 300 | | | 24 | 400 | 6152 | 300 |
| T-11 | | 170 | | 100 | | | 50 | | 147 | 40 |
| SD-01 | | | >10000 | 6000 | | | | >2000 | | 2300 |
| SD-02 | | | 200 | 2500 | | | | 100 | | 900 |
| SD-03 | | | | 3400 | | | | | | 2300 |
| SD-04 | | | | 2500 | | | | | | 480 |
| SF-01 | | | | 8700 | | | | | | 5000 |

Shaded values indicate exceedance of Class B WQS

**Table 4-8. ENSR 2004 Sudbury River Targeted Sub-Basin Bacteria Location Descriptions (ENSR 2004b).**

| Station ID | Sampling Station Location Description |
|---|---|
| **Unammed Tributary Drainage Area** | |
| A-01 | Downstream Powder Mill Road (Nine Acre Corner), Concord (impounded on upstream side) |
| A-02 | Upstream Wheeler Road, Concord |
| A-03 | Upstream Sudbury Road, Concord |
| A-04 | Upstream Fitchburg Turnpike (Rte 117), Concord |
| A-05 | Upstream Fitchburg Turnpike (Rte 117) – West of A-04, Concord |
| A-06 | Upstream Plainfield Road, Concord |
| T-10 | Upstream Sudbury Road, Concord (ENSR's 2002-2003 Station) |
| **Pantry Brook Drainage Area** | |
| B-01 | Upstream Concord Road, Sudbury |
| SD-01 | Storrmwater outfall upstream side of Concord Road, proximal to B-01 |
| B-02 | Upstream of residential driveway corner of Ridge Hill and Hunt, Sudbury |
| SD-02 | Stormwater outfall approximately 25 feet upstream of B-02 |
| B-03 | Upstream Morse Road, Sudbury |
| SD-03 | Storrmwater outfall upstream side of Morse Road, proximal to B-03 |
| B-04 | Upstream Willis Road, Sudbury |
| B-05 | Upstream Willis Road, Sudbury – North of B-04 |
| B-06 | Upstream Mossman Road, Sudbury |
| SF-01 | Sheetflow runoff along Farm Road, sampled on pavement at the intersection of Old Coach Road and Farm Lane |
| B-07 | Upstream Marlborough Road, Sudbury |
| B-08 | Downstream Haynes Road, Sudbury (impounded on upstream side) |
| T-06 | Upstream Pantry Road, Sudbury (ENSR's 2002-2003 Station) |

| Station ID | Sampling Station Location Description |
|---|---|
| **Pantry Brook Drainage Area** | |
| B-09 | Upstream Pantry Road, Sudbury |
| B-10 | Upstream Pantry Road, Sudbury – North of B-09 |
| B-11 | Upstream of North Road (Rte 117), Sudbury |
| B-12 | Upstream of North Road (Rte 117), Sudbury – East of B-11 |
| T-11 | Upstream of Concord Road, Sudbury (ENSR's 2002-2003 Station) |

**Figure 4-5. Sampling Location Map for the ENSR 2004 Unnamed Tributary Drainage Area Survey (ENSR 2004b).**

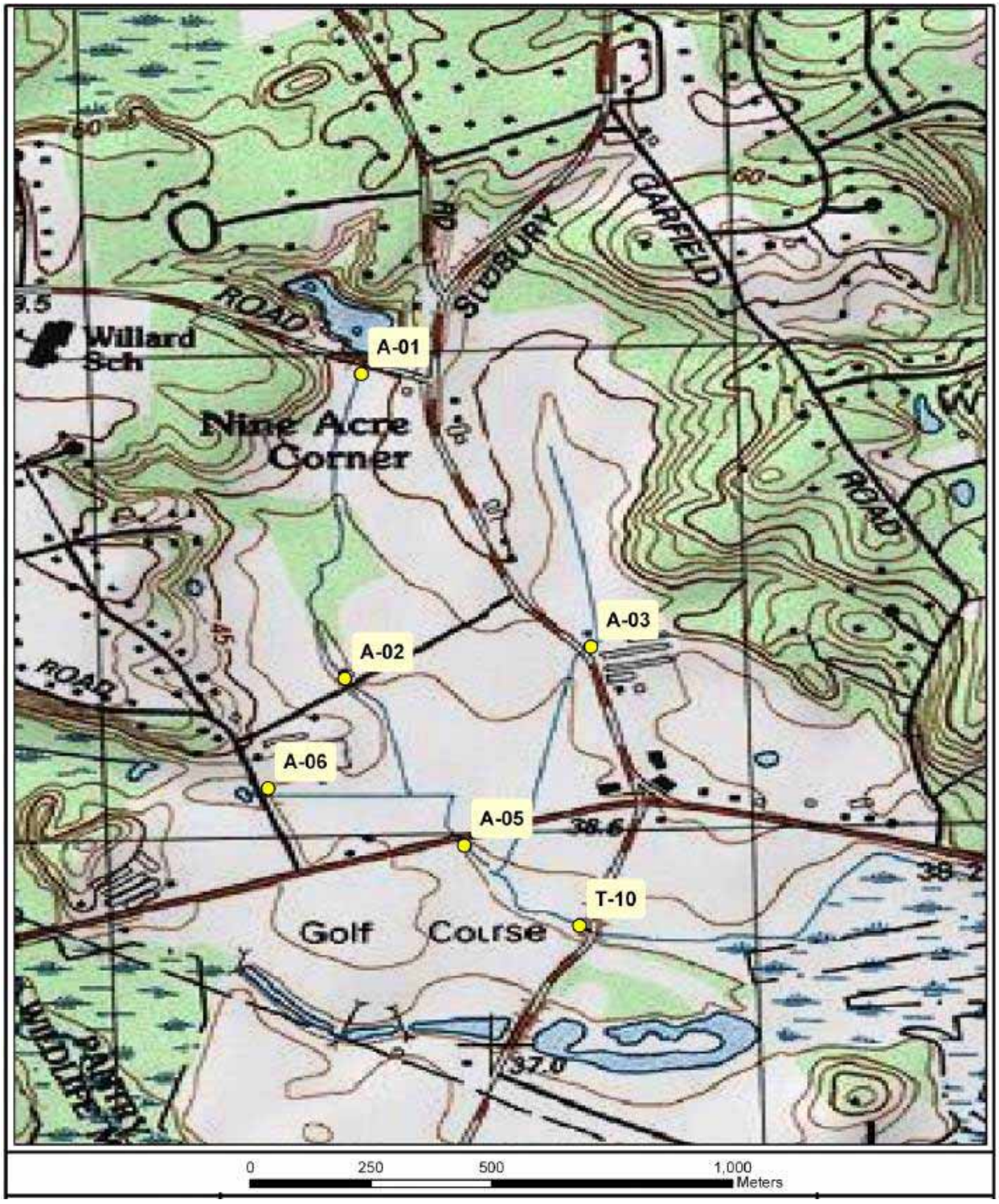
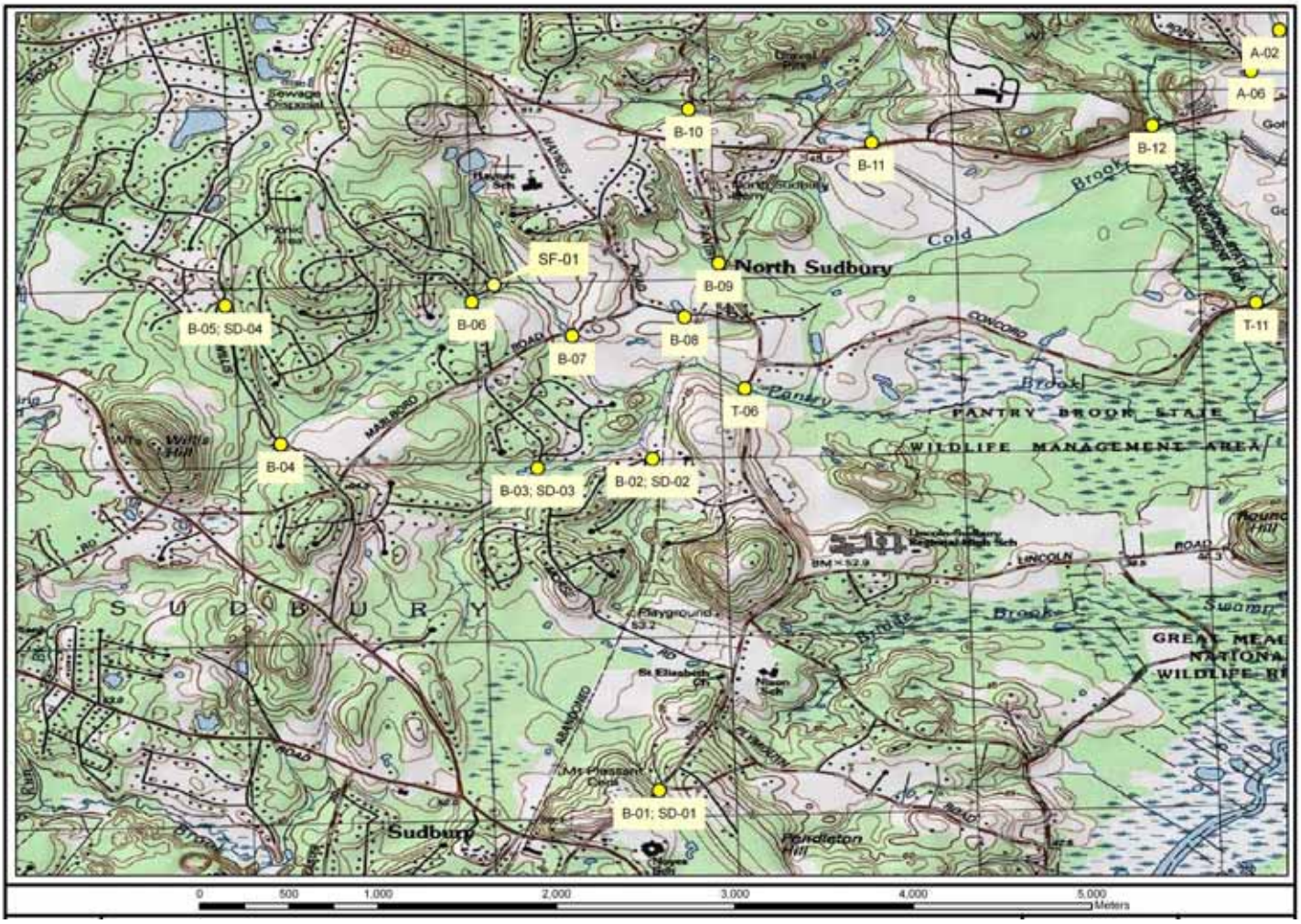


**Figure 4-6. Sampling Location Map for the ENSR Pantry and Cold Brook Tributary 2004 Survey (ENSR 2004b).**



**Hop Brook Segment MA82A-06**

It should be noted that this segment is listed as "Wash Brook" in the *2002 List* but has since been re-identified as Hop Brook. This 3.0 mile segment is a Class B warm water fishery. This segment begins at the confluence of Allowance Brook in Sudbury to the confluence with the Sudbury River in Wayland. The Sudbury Water Department is permitted to withdraw groundwater from a portion of this segment's drainage area. Coatings Engineering Corporation is permitted to discharge to Allowance Brook (formerly Landham Brook) in this segment. The Sudbury Water District is also permitted to discharge to Allowance Brook.

The MADEP conducted dry weather indicator bacteria sampling on two dates in 2001. The average of the sample and the corresponding duplicates were 175 and 225 cfu/100 mL for fecal coliform and <5 and 78 cfu/100 mL for *E. coli.*

**Grist Mill Pond MA82055**

Grist Mill Pond is a 17 acre fresh water pond located in Sudbury and Marlborough. For more information regarding this waterbody, please see the MADEP WQA (MADEP 2005).

**Hager Pond MA82056**

Hager Pond is a 30 acre fresh water pond located in Marlborough. For more information regarding this waterbody, please see the MADEP WQA (MADEP 2005).

## 4.3. Concord River Segments

The Concord River basin covers about 398 $mi^2$ of northeastern Massachusetts. The basin is heavily forested (about 71 percent of the land area), and contains many wetlands, lakes, and ponds. There are a total of 121 lakes and ponds, 75 of which have an area of 10 acres or more. The Class B Concord River begins at the junction of the Assabet and Sudbury Rivers in Concord, and flows about 16 mi northward to the city of Lowell, where it joins the Merrimack River. The main channel is about 47 mi long from the drainage divide in Westborough to its confluence with the Merrimack River in Lowell. The relatively low stream gradient of the river, about 5 ft/mi, causes it to be generally slow moving (USGS 2004).

The headwaters of the Concord River are formed by the confluence of the Sudbury and Assabet Rivers, drawing its characteristics from the two upstream systems. Below the confluence of the Sudbury and Assabet Rivers, the Concord River quickly becomes a wide stream extending approximately 400 feet across (ENSR 2003). The Concord is a wide, shallow river with typical depth between two to eight feet. The upper portion of the River basin is bounded by flat wide flood plains and wetlands. The Concord River is characterized by gently rolling hills and gradual slopes of 5 to 10 percent (ENSR 2003). The Concord River retains its relatively slow moving characteristics until it reaches the Faulkner Dam in Billerica, at river mile 4.5. Below the Faulkner Dam, the river becomes narrower and shallower and flows more rapidly, as it also receives effluent from a number of industrial and municipal discharges in the urbanized center of Lowell (ENSR 2003).

There are three dam structures on the Concord River all located within 4.5 miles upstream from the Merrimack River. The Concord River drops approximately 70 feet in elevation over its 16 mile length for an average slope of 4.5 feet per mile (ENSR 2003). The majority of the Concord River vertical gradient is through Lowell below Faulkner Dam as it descends rapidly through a narrow valley. There are four natural falls along the Concord River, all in lower Concord River reaches. The first natural falls are located at the fordway bar near the Faulkner Dam. The second falls are located at the Centennial Dam, at a natural ledge known as Wamesit Falls for the area's Native Americans. The third falls are the Massic Falls situated in a narrow valley reach and the fourth natural falls are at the location of the Middlesex Dam. In contrast, the slope of the upper Concord River is relatively gradual and its elevation changes by only one foot during the first 10 miles (ENSR 2003). Overall, the Concord River's effective slope is gradual, resulting in relatively slow moving water in most reaches.

Greater than 80 percent of the 400 square miles of watershed area drained by the Concord River Basin empties into the Sudbury and Assabet Rivers before the confluence with the Concord. The Concord River only drains approximately 60 square miles of land (ENSR 2003). The Concord River flows through several highly populated areas including Chelmsford and Billerica, under Interstate 495, and through a heavily industrialized part of Lowell before emptying into the Merrimack River.

Effluent discharged into the Concord River contributes to the impaired health of the system. In particular, two major publicly-owned sewage treatment works (POTWs), located in Billerica and Concord, plus one House of Correction wastewater treatment plant are the primary point sources that discharge to the Concord River. In addition, there is a CSO near the confluence with the Merrimack River in Lowell. Raytheon Corporation discharges treated wastewater to the Concord River from their electric plating process facility located in Lowell. Silicon Transistor Corporation and Nyes Japenamelac Inc., both of Chelmsford, discharge into River Meadow Brook. In comparison to the other major rivers within the Commonwealth, the Concord receives relatively few discharges. However, the unique hydraulic characteristics of the river likely contribute to the disproportionate effect those few discharges may have on the river (ENSR 2003). Furthermore, since the Concord River is formed from the confluence of the Assabet and Sudbury Rivers, the River inherits the water quality characteristics of these two systems including the five municipal wastewater treatment facility discharges to these tributaries.

As part of the assessment portion of a nutrient TMDL for the Concord River "*SuAsCo Watershed Concord River TMDL Study Assessment Final Report*", ENSR collected bacteria data for the MADEP and USACE in 2001 (ENSR 2003). Eight sampling surveys were conducted as part of this sampling program, four during dry weather (June, July, August and September 2001) and four during wet weather (July and August 2001 and two in September 2002. Not all stations were sampled during all surveys. This study also included data from the Assabet and Sudbury Rivers.

Summary data from the SuAsCo TMDL Assessment are provided in Tables 4-9 through 4-14. Figure 4-7 provides a sampling location map for the SuAsCo TMDL Assessment. Fecal coliform counts in the Concord River during dry weather surveys ranged from 20 to 3,000 col/100 mL. In the

Assabet River, fecal coliform counts ranged from 20 to 4500 col/100 mL during two summer surveys. In the Sudbury River, fecal coliform counts ranged from 20 to >3000 col/100 ml during a single summer survey.

**Concord River Segment MA82A-07**

This 10.4 mile segment is a Class B warm water fishery, treated water supply. This segment begins at the confluence of the Assabet and Sudbury Rivers in Concord and extends to the Billerica Water Supply intake in Billerica. The Billerica Water Department and Richard E. Peterson are permitted to withdraw surface water from this segment. The following organizations are permitted to discharge to the Concord River or tributaries along this segment:

1. The Town of Concord – treated sanitary waste water
2. Billerica Water Treatment Plant – treatment plant backwash
3. Billerica Jail and House of Correction – treated sanitary wastewater
4. Town of Billerica – construction dewatering

**River Meadow Brook Segment MA82A-10**

This 6.4 mile segment is a Class B waterbody. This segment begins at the outlet of Russell Mill Pond in Chelmsford and extends to the confluence with the Concord River in Lowell. The East Chelmsford and Chelmsford Water Districts are permitted to withdraw groundwater from this segment. The following organizations are permitted to discharge to the Concord River or tributaries along this segment:

1. UAE Lowell Power LLC – storm water runoff
2. Majilite Manufacturing Incorporated – non-contact cooling water
3. Four-In-One Inc. – non-contact cooling water
4. East Chelmsford Water District – filter backwash

**Concord River Segment MA82A-09**

This 0.9 mile segment is a Class B warm water fishery, combined sewer overflow (CSO) receiving water. This segment begins at the Rogers Street Bridge in Lowell and extends to the Merrimack River in Lowell. There are no regulated water withdrawals in this segment. The Lowell Regional Water and Wastewater Utility is permitted to discharge CSO to this segment.

**Table 4-9. Concord River Dry Weather July 2001 Indicator Bacteria Data Summary (ENSR 2003).**

| | | | | Bacteria (per 100 ml) | |
|---|---|---|---|---|---|
| Station | River Miles | Station Description | Town | *E.coli* | Fecal Col. |
| CR01 | 1 | Rogers St(USGS gage) | Lowell | 1800 | 2000 |
| CR02 | 1.6 | Lawrence St | Lowell | 50 | 300 |
| CR03 | 4.5 | Upstream of Faulkner Dam | Billerica | 70 | 100 |
| CR04 | 7 | Downstream of Rt. 3 | Billerica | 10 | 10 |
| CR05 | 9 | Downstream of Rt. 4 | Billerica | <10 | 300 |
| CR06 | 10.8 | Downstream of Rt. 225 | Bedford | <10 | 10 |
| CR08 | 15.9 | Downstream of Lowell Rd. | Concord | 265* | 295* |
| AR | 16.5 | Assabet River | Concord | 300 | 500 |
| SR | 16.6 | Sudbury River | Concord | 50 | 160 |
| T1 | 1.1 | River Meadow Brook | Lowell | 900* | 1635* |
| T2 | 1.2 | Beaver | P& | 940 | 2800 |
| T3 | 2.2 | Marginal Brook | Lowell | 3000 | 3000 |
| T4 | 8 | Winning Pond Brook | Billerica | 1260 | 1300 |
| T5 | 9.7 | Pages Brook | Carlisle | 30 | 40 |
| T6 | 14.2 | Sawmill Brook | Concord | 3000 | 3000 |
| BWW | 4.3 | Effluent: | Billerica | 60/10 | 160/10 |
| CWW | 15.3 | Effluent: | Concord | <10 | <10 |

* Duplicate Sample - Value shown is the average of duplicate and sample.

**Table 4-10. Concord River Dry Weather September 2001 Indicator Bacteria Data Summary (ENSR 2003).**

| | | | Bacteria (per 100 ml) | |
|---|---|---|---|---|
| Station | River Miles | Station Description | *E.coli* | Fecal Col. |
| CR02 | 1.6 | Lawrence St Lowell | 150 | 300 |
| CR03 | 4.5 | Upstream of Faulkner Dam Billerica | 20 | 300 |
| CR04 | 7 | Downstream of Rt.3 Billerica | <10 | 20 |
| CR05 | 9 | Downstream of Rt.4 Billerica | <10 | 630 |
| CR06 | 10.8 | Downstream of Rt.225 Bedford | <10* | 2300* |
| CR08 | 15.9 | Downstream of Lowell Rd. Concord | 50 | 800 |
| AR | 16.5 | Assabet River Concord | 80 | 250 |
| SR | 16.6 | Sudbury River Concord | <10 | 20 |
| T1 | 1.1 | River Meadow Brook Lowell | 800 | 3000 |
| T2 | 1.2 | Beaver P&F Brook Chelmsford | 60 | 250 |
| T6 | 14.2 | Sawmill Brook Concord | 180 | 685 |
| T3 | 2.2 | Marginal Brook Lowell | 540 | 3000 |
| T4 | 8 | Winning Pond Brook Billerica | 90 | 400 |
| T5 | 9.7 | Pages Brook Carlisle | 30 | 120 |
| BWW | 4.3 | Effluent: Billerica WWTF | ns | 170 |
| CWW | 15.3 | Effluent: Concord WWTF | 8500 | 17000 |

* Duplicate Sample - Value shown is the average of duplicate and sample.

**Table 4-11. Concord Tributary Dry Weather Survey June 28, 2001 (ENSR 2003).**

| | | | Bacteria (per 100 ml) | |
|---|---|---|---|---|
| Station | River Miles | Station Description | *E. coli* | Fecal Col. |
| T1 | 1.1 | River Meadow Brook Lowell | 560 | 1150 |
| T2 | 1.2 | Beaver P&F brook Chelmsford | 190 | 750 |
| T3 | 2.2 | Marginal Brook Lowell | 210* | 425* |
| T4 | 8 | Winning Pond Brook Billerica | 70 | 90 |
| T5 | 9.7 | Pages Brook Carlisle | 20 | 40 |
| T6 | 14.2 | Sawmill Brook Concord | 400 | 700 |
| AR | 16.5 | Assabet River Concord | 70 | 270 |
| SR | 16.6 | Sudbury River Concord | 10 | 50 |
| CR02 | 1.6 | Lawrence St Lowell | 30 | 120 |

* Duplicate Sample - Value shown is the average of duplicate and sample.

**Table 4-12. Concord Tributary Dry Weather Sampling: August 24, 2001 (ENSR 2003).**

| | | | Bacteria (per 100 ml) | |
|---|---|---|---|---|
| Station | River Miles | Station Description | *E. coli* | Fecal Col. |
| T1 | 1.1 | River Meadow Brook Lowell | 770 | 2750 |
| T2 | 1.2 | Beaver P&F Brook Chelmsford | 130 | 280 |
| T3 | 2.2 | Marginal Brook Lowell | 600 | 1100 |
| T4 | 8 | Winning Pond Brook Billerica | 65* | 80* |
| T5 | 9.7 | Pages Brook Carlisle | 50 | 50 |
| T6 | 14.2 | Sawmill Brook Concord | 160 | 500 |
| AR | 16.5 | Assabet River Concord | 100 | 1250 |
| SR | 16.6 | Sudbury River Concord | 30 | 140 |
| CR01 | 1 | Rogers St (USGS gage) Lowell | 840 | 1540 |

* Duplicate Sample - Value shown is the average of duplicate and sample.

**Table 4-13. Concord Tributary Wet Weather Survey: July 17, 2001(ENSR 2003).**

| | | | Bacteria (per 100 ml) | |
|---|---|---|---|---|
| Station | River Miles | Station Description | *E. coli* | Fecal Col. |
| T2 | 1.2 | Beaver P&F Brook Chelmsford | 60 | 560 |
| T3 | 2.2 | Marginal Brook Lowell | 180 | 1350* |
| T5 | 9.7 | Pages Brook Carlisle | <10 | 20 |
| AR | 17 | Assabet River Concord | 20 | 190 |
| SR | 17 | Sudbury River Concord | <10 | 100 |
| CR01 | 1 | Rogers St (USGS gage) Lowell | 60 | 390 |
| CR05 | 9 | Downstream of Rt.4 Billerica | <10 | <10 |

* Duplicate Sample - Value shown is the average of duplicate and sample.

**Table 4-14. Concord Tributary Wet Weather Survey: September 14, 2001(ENSR 2003).**

| | | | Bacteria (per 100 ml) | |
|---|---|---|---|---|
| Station | River Miles | Station Description | *E. coli* | Fecal Col. |
| T2 | 2.1 | River Meadow Brook Lowell | 375 | 6000 |
| T2 | 1.2 | Beaver P&F Brook Chelmsford | 140 | 280 |
| T6 | 14 | Sawmill Brook Concord | 1000 | 2100 |
| T3 | 2.2 | Marginal Brook Lowell | 1260 | 6000 |
| T4 | 8 | Winning Pond Brook Billerica | 1200 | 4200 |
| T5 | 9.7 | Pages Brook Carlisle | 100 | 240 |

**Figure 4-7. Concord River Wet and Dry Weather Sampling Locations (ENSR 2003).**