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## Background

The Sudbury, Assabet, and Concord rivers, a federally-designated Wild and Scenic River system, flow 88 river miles from the headwaters of the Assabet and Sudbury in Westborough to Lowell, where the Concord River joins the Merrimack River flowing to the sea. Despite their proximity to the urban populations of Boston, Lowell and Worcester, the rivers flow through significant natural areas: the Assabet National Wildlife Refuge, Great Meadows National Wildlife Refuge, and Minuteman National Park. These rivers should be a tremendous asset to their region, but they are impacted by point and non-point source pollution and reductions in natural flow. The Assabet River, in particular, receives the discharges from four municipal wastewater treatment plants and at times during the summer over 80-90% of the river's flow can be wastewater. The Sudbury and Concord rivers receive wastewater discharges from two additional municipal wastewater treatment plants. Downstream of five discharges, the town of Billerica draws its drinking water from the Concord River.

Successive upgrades to wastewater treatment plants on the rivers have resulted in major reductions in in-stream phosphorus, reductions in summer duckweed, and other aesthetic improvements. As a result, the rivers have become increasingly used by boaters, anglers, and other passive recreation, and by a secondary school rowing program. It is now important to understand how safe the water is for primary and secondary contact recreation. Is it safe for kayaking and canoeing or rowing? Is it safe for swimming?

Health safety of the water is primarily linked to wastewater contamination and contaminated stormwater runoff. Infectious pathogens can cause gastro-intestinal illnesses, so monitoring organizations are interested in measuring the amount of wastewater contamination in water bodies. Fecal indicator bacteria are used as a proxy for infectious pathogens. By measuring fecal indicator bacteria, such as *E. coli*, Enterococcus, or Fecal Coliform, scientists can estimate the degree of pathogenic contamination in a water body. The EPA has identified thresholds for these fecal indicator bacteria defining whether or not the water is safe for primary contact (swimming) or secondary contact (boating). OARS has developed this bacteria monitoring program in the Sudbury, Assabet, and Concord rivers to evaluate the safety of these rivers for recreational contact and health.

## **OARS' monitoring program**

OARS started collecting chemical and biological water quality data on the Assabet River in 1992. In 2002, we extended our baseline program to include water quality and streamflow measurements on the major tributaries of the basin. In 2004, we added monitoring sites on the Concord River and River Meadow Brook, the largest tributary to the Concord. In 2009 we added sampling on the lower Sudbury River (from Saxonville, Framingham, to the confluence of the Sudbury with the Assabet in Concord). And, in 2019 we added bacteria sampling to two sites on each of the three rivers.

The main goals of the bacteria program are (1) to evaluate summertime suitability of the rivers for recreational contact and (2) to provide timely accurate data to the public and decision makers on the local, state, and federal levels. Toward these goals we will work to:

- Provide sound scientific information to support OARS' advocacy for the rivers.
- Assess whether the rivers meet the EPA's primary and secondary contact thresholds.
- Assess the effect of changes in the management of wastewater and stormwater.
- Identify problem spots for further investigation.
- Raise awareness of the rivers to influence individuals' decisions (like whether to upgrade septic systems at home) and to influence municipal decisions about wastewater management.

Bacteria monitoring is a bi-weekly program from mid-June through mid-September. It is separate from the monthly water quality monitoring program due to frequency and the requirement that samples be delivered to the lab within 6 hours (i.e. it must be done on weekdays).

**Table 1: Sudbury, Assabet and Concord Sampling Sites & Schedule**

	Site #	Location	Approximate street address for GPS or Google Maps	Bi-Weekly
Assabet River	<b>ABT-077</b>	Assabet by USGS gage, Rt. 27/62, Maynard	10 Waltham Road, Maynard	x
	<b>ABT-162</b>	Assabet, Cox Street, Hudson	293 Cox Street, Hudson	x
Sudbury River	<b>SUD-137</b>	Sudbury at Little Farms Rd, Framingham	56 Little Farms Rd, Framingham	x
	<b>SUD-236</b>	Sudbury at Rt. 135, Ashland	60 Chestnut Street, Ashland	x
Concord River	<b>CND-009</b>	Concord at Rogers Street bridge, Lowell	33 Merrill Street, Lowell	x
	<b>CND-093</b>	Concord at Rt. 4 bridge, Billerica	279 Nashua Rd, North Billerica	x
River Meadow Brook Special Study	<b>RVM-001</b>	River Meadow at Lawrence St., Lowell	649 Lawrence St, Lowell	x
	<b>RVM-005</b>	River Meadow at Gorham St., Lowell	1 Chambers St, Lowell	x
	...	other rotating		x
	...	other rotating		x

\* Mainstem sites are designated by “ABT” (for Assabet River sites), “CND” (for Concord River sites), or “SUD” (for Sudbury River) plus a three digit number measuring rivermiles to the tenth upstream from the confluence of the Assabet with the Sudbury or the Concord with the Merrimack. E.g. ABT-162 is the mainstem site 16.2 miles upstream of the confluence. Tributary sites are designated by a three letter code plus rivermiles upstream from the confluence of that tributary and the mainstem.

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## Sampling Sites / Directions

**Detailed driving directions and site descriptions are in each sampling kit.** “Left” and “Right” banks are left and right as you stand looking downstream, as if you were boating downstream.

### OARS’ Office

The office is at 23 Bradford Street off Rt. 62 (Main Street) in West Concord. From Rte. 2, take Rte. 62 West (toward West Concord), bearing right onto Commonwealth Avenue/Main Street at the “99 Restaurant.” Cross the railroad tracks and take a left onto Bradford Street. Park in the lot for #23. The office is on the second floor.

### Online Driving Directions

Access the online version of this manual and links to driving directions on the OARS website:

*Get Involved → Volunteer → Citizen Scientist (click to learn more) → (at bottom of page) Citizen Scientist Information Library*

[oars3rivers.org/get-involved/volunteer/citizen-scientist-volunteers/](https://oars3rivers.org/get-involved/volunteer/citizen-scientist-volunteers/)

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## Safety

*OARS volunteer and staff safety is the top priority. Please read the following safety precautions carefully. Do not put yourself in harm's way to complete the sampling.*

### Automobiles and Roadways

Many sites are located on bridges and busy roadways, which are not commonly used by pedestrians. Your presence may be a surprise to motorists. Warn approaching traffic of your presence by parking on the same side that you're working on, if possible, and use caution when crossing the street.

### Personal Protective Equipment

Wear high-visibility clothing such as reflective jogging vests or hunter's vests when sampling. Always wear long pants and closed boots or closed shoes (not sandals) when wading into the river to protect from poison ivy and sharp objects.

### Bridges

Always use extreme caution at the edge of a bridge. Test railings before leaning against them. Do not climb or sit on railings.

### Ticks

Check for ticks on yourself and your clothing, particularly after walking through brushy areas.

### Wading

Wading is necessary at most sites. Wading should only be done when the water is less than waist deep and not fast moving. Do not wade alone. If the river's flow is too high or fast moving to allow for safe wading, take the samples using the sample collection rod or basket. **Do not wade in the river when river depth (in feet) times velocity (feet per second) appear to equal 5 or greater (e.g. 1.5 foot depth \* 4 feet/second velocity = 6 = unsafe conditions!).**

### Weather Conditions

We do sample in cold and/or rainy conditions. Volunteers should expect to be out for up to two hours and should dress appropriately. If there is lightning, suspend sampling and notify OARS.

### Emergency Numbers

In case of emergency while monitoring, **call 911 first.**

After notifying emergency services, contact OARS at the numbers below.

### Non-emergency Numbers

For non-emergency sampling day problems call the OARS office 978-369-3956 or Ben's cell phone 617-390-3151.

### Liability Waiver Forms

Participation in the water quality sampling is strictly voluntary and is done at your own risk. We require that all volunteers (or their guardians for those under 18) sign a liability waiver form before participating in any sampling events.

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## General Sampling Notes

### Bacteria Sampling Kit

1 thermometer	1 cooler with ice and temperature blank bottle
2 pens	1 sterile water (if needed)
2 black Sharpie permanent markers	1 sampling pole
1 clip board with plastic cover sheet	1 Bacteria Monitoring Manual
Field Data sheets (one per site)	1 extra bottle for river water temperature
Chain of Custody record sheets	nitrile gloves (one per site)
sample bottles (one per site plus duplicates if needed)	

Optional:

1 sampling basket with rope

### Keeping Records

Record all observations on the data sheets provided with a permanent pen or marker. Never erase a mistake. Instead cross it out, neatly with a single line, and write the correct entry next to or above it.

### Photographs

If you have a digital camera available, please take photographs of anything unusual at a site and email them to Ben ([bwetherill@oars3rivers.org](mailto:bwetherill@oars3rivers.org)).

### Duplicate samples

A duplicate sample is simply a second sample, collected in the same way; the results are used to check for any problems in the collection or analysis process. Collect duplicate samples right after the original sample, using exactly the same technique each time. A second sample bottle will be provided for those dates/sites when a duplicate is needed. The duplicate sample bottle will be inside a Ziploc bag with the primary sample bottle, and the site will be designated only as “QC-xx” (QC-01 for example). Do **not** record the sampling time on the bottle or on the Chain of Custody form (to ensure that the sample is “blind” to the laboratory).

### Sterile water samples (quality control “blanks”)

Sterile water samples will be collected periodically to check for contamination from the bottles and from collection techniques. A second sample bottle will be provided for those dates/sites when a sterile water sample is needed. The sterile water sample bottle will be inside a Ziploc bag with the primary sample bottle and the site will be designated as QC-xx (e.g. QC-05). Pour sterile water directly from the bottle of sterile water (supplied with each kit) into each sample bottle.



## Prior to the Sampling Day

- 1) Collect supplies for next sampling event from OARS office: **field data sheets (one per site), chain of custody sheet, sample bottles (one per site plus duplicates), nitrile gloves (one per site), sterile water (if needed), spare bottles (if needed), cooler with temperature blank.**
- 2) Contact your team and agree on meeting place and time! The person picking up the equipment will pick it up ahead of time from the OARS office. The rest of the sampling team will meet at the arranged meeting place (often the first of their sections' sampling sites) at 6:00 am. Designate a courier who will return the samples to the OARS office.
- 3) Review which samples you will be collecting and where. Review sampling procedures.
- 4) Prepare ice for your cooler. One standard tray of ice is usually sufficient, but in warmer weather use two trays of ice. Add some water to the cooler with the ice to help distribute the temperature.
- 5) Make sure that someone in your family knows you are going sampling the next morning.

## Observations

Complete a "Bacteria Sampling Field Sheet" for each site. Be sure to fill in each field.

- WEATHER & OBSERVATIONS: Fill in as appropriate.
- SAMPLES TAKEN: Follow the instructions for Taking Bottle Samples on page 10.
  - Circle the appropriate samples for the site (sample, duplicate, sterile water).
  - Circle the method used and note water color and odor.
  - POSITION IN RIVER: Note the position of the bottle sampling as you face downstream.
  - WATER DEPTH: Measure the total water depth at the bottle sampling site using the markings on the pole. Estimate the depth to the half foot.
- WATER TEMP: Take the water temperature reading at the same location as the sampling collection. If using a pole, collect some water in the extra bottle and measure the temperature from the bottle. Record the result to the nearest degree. Record the thermometer number (from the tag).
- GENERAL SITE COMMENTS: Add any General Comments about the site.

## Taking Bottle Samples

- 1) Write the time (to the nearest 5 minutes of sampling) and your initials on all bottle labels EXCEPT the field duplicate and sterile water samples.
- 2) Put on a clean pair of nitrile gloves.
- 3) Take the required river samples, duplicates, and sterile water (*directions below*).
- 4) Immediately place bottles in cooler on ice. Place bottles in a plastic bag in the ice, so that ice-water is not sloshing around the caps (to avoid contamination). Make sure there is a temperature blank (bottle marked “Temp”) in the cooler.
  - a. The hold time on these samples is 6 hours (4 hours ideally) on ice, so they need to be delivered to the lab within this time. They must be kept on ice below 6°C throughout.
- 5) Repeat the process for any field duplicate or sterile water samples.
- 6) Record sampling time on the Chain of Custody sheets. This should match the time on the bottles.

### **Field Duplicates (labeled on the bag only)**

- a) Repeat the sampling steps exactly for the duplicate bottles. Collect the duplicates right after the first sample. Bottles for duplicate samples will be inside a Ziploc bag with the original field samples; the Ziploc bag will be labeled “DUPLICATE” and the bottles will be labeled “QC-xx” (e.g. QC-01).
- b) Do NOT record a sampling time or initials on the field duplicate bottles or on the Chain of Custody for the duplicate sample (to make sure that the sample is “blind” for the laboratory).

### **Sterile water samples (labeled on the bag only)**

- a) To collect a sterile water sample, at the sampling site pour directly from the bottle of sterile water (supplied with each kit and labeled “FB”) into the sample bottle. Bottles for sterile samples will be inside a Ziploc bag with the regular samples for the site; the Ziploc bag will be labeled “STERILE” and the sample bottles will be marked as QC-xx (e.g. QC-04)
- b) Do NOT record a sampling time or initials on the sterile water sample bottles or on the Chain of Custody for the sterile water samples

## General Bottle Sampling Procedure - Wading

- 1) *Be very careful if sampling alone! If it is not safe to wade, use the pole collection method described on page 12. See page 7 for instructions on how to estimate river wading safety.*
- 2) Wade in carefully, moving upstream until you get to the main flow of the stream so that any sediments disturbed don't interfere with the sampling. Sample from midstream if the stream is small. If the stream is larger, go only as far out from shore as is safe. Sample as close to the current as possible. Establish a solid footing before filling a sample (i.e. try not to fall over, it stirs up a lot of sediment and gets your seat wet).
- 3) Stand facing upstream (the water moving towards you). Stand still for a few seconds to allow any disturbed sediments to be carried away by the current.
- 4) Always collect from your upstream side.
- 5) When collecting bacteria samples, always wear nitrile gloves on the hand that is touching the cap (the upstream hand).
- 6) Representative samples are best collected 6 - 12" below the surface, or at half depth if the river is shallower than 6". To take a sample, hold the bottle at a depth of 6" below the surface, remove cap with gloved hand, allow it to fill with water, replace cap, and then remove it from the water.
- 7) After removing from the water, pour out ½ inch of water to allow mixing in the bottle and replace the cap. Water volume must be > 100mL.



### Good sampling technique:

- in the main flow of the river
- facing upstream
- mid-depth
- wait for sediments to settle
- hold bottle 6" below surface
- remove cap and replace cap under water
- pour out ½ inch of water after collecting

Flow direction

## Using a Sampling Pole

Use a sampling pole when conditions will not permit safe wading for direct bottle sampling or the stream bottom is too muddy to allow for collection of a clean sample by wading.

- 1) First rinse the clamp end of the rod three times in the stream you wish to sample. This will reduce the possibility of contamination from the previous station (or contamination from the trunk of your car!).
- 2) Put on nitrile gloves.
- 3) Next, place the sample bottle in the “MegaCuff” and squeeze closed. Remove the cap from the bottle.
- 4) Rotate the rod until the bottle is upside down. Immerse the bottle to the desired depth and then rotate the rod to fill the bottle (see picture). Surface debris should be avoided if possible, but will not contaminate the sample.
- 5) Remove bottle from the water, pour out ½ inch, cap it and remove it from the cuff.
- 6) Fill out all Chain of Custody forms as usual.
- 7) To take a field sterile water sample: Attach the sample bottle to the clamp as usual. Take the sterile water sample by pouring an appropriate amount of sterile water into the sample bottle.
- 8) Store the sample(s) in the cooler.



**CAUTION:** Do not extend the pole too far when sampling high velocity streams. You'd be surprised at how much force there can be on the pole. To avoid damaging (bending) the pole, it is recommended that you leave at least 1-foot un-extended.

**CAUTION:** Since the pole is aluminum, be extra careful around power lines.

## Basket Sampling Procedures

**Basket sampling from a bridge: use ONLY when conditions will not permit safe wading for bottle sampling or use of sample collection rod.**

- 1) First rinse the basket three times in the stream you wish to sample. This will reduce the possibility of contamination from the previous station (or contamination from the trunk of your car!).
- 2) Put on nitrile gloves.
- 3) Next, place the sample bottle in the “MegaCuff” and squeeze closed. Remove the cap from the bottle.
- 4) Ensure that the rope is securely tied onto the basket and stand on loose end of rope (or tie to wrist) before lowering the basket.
- 5) Lower the basket into water on upstream side of bridge. Let water fill the bottle. Surface debris should be avoided if possible, but will not contaminate the sample.
- 6) Raise basket carefully, making sure it does not bump the bridge abutments or other structures. Do not let loose rope fall into bottle.
- 7) Pour out  $\frac{1}{2}$  inch of water from the bottle and replace the cap.
- 8) Fill out all Chain of Custody forms as usual.



**Basket sampler**

## Water Temperature Measurement

Supplies: Alcohol Thermometer

Taking Water Temperature

- 1) Hold the thermometer at the upper end (not the bulb)
- 2) Either hold the thermometer in the water at the sampling depth for 30 seconds, or collect a bottle of water in an extra bottle and hold the thermometer in the bottle for 30 seconds (the thermometer should not touch the edges of the bottle). It is easier to use the bottle method if sampling by pole.
- 3) Read temperature to the nearest degree.

Documentation:

Record the thermometer ID # from its tag.

## After Collecting All Samples

- 1) Make sure all samples are properly labeled, all observations are recorded on the Field Data sheets, and times are entered on the Chain of Custody forms.
- 2) When you bring the samples to the office, the designated check-in person will check all samples against the Chain of Custody forms. Sign your Chain of Custody forms.

## Sample Check-In

- 1) Check sample bottles against Chain of Custody and Field Data forms:
  - a. Bottles: Are the bottle labels consistent with Chain of Custody forms? All samples taken? Times written on the bottles and Chains (except for QC samples)?
  - b. Remove the QC samples from their identifying Ziploc bags and return the bottles to the cooler. (These bottles should NOT have sampler's initials or time recorded on the bottle.)
  - c. Cooler temperature: using the NIST thermometer, measure the temperature of the temperature blank in cooler and record the result on Chain of Custody forms.
  - d. Chain of Custody Forms: First courier and then Check-in person each sign the form.
  - e. Field Data Forms: One for every site? Complete? Good comments?
- 2) Samples for Nashoba Analytical: When all samples are in, put a temperature blank bottle into the cooler, and sign the Chain of Custody forms over to the courier. Samples will be stored, on ice in the coolers until they can be delivered to the lab (within 6 hours maximum of sampling time). At the lab, sign the Chain of Custody forms transferring the samples to the lab, measure the cooler temperature from the temperature blank bottle and bring back completed forms (the lab will keep a copy for their records) and empty cooler.

## Sample Field Data Sheet

*Bacteria Sampling Field Data Sheet*

Site ID: \_\_\_\_\_ Site Name: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_ Sampler's initials: \_\_\_\_\_

**1. WEATHER & OBSERVATIONS**Current Weather (circle one):      *no rain*              *light rain*              *rain*              *heavy rain*Observed Use (circle all):      *none*    *fishing*    *boating*    *swimming*    *other* \_\_\_\_\_River Flow Status (circle one):      *flooding*              *optimal*              *marginal*              *poor*  
(*overflowing*)      (*mostly full*)      (*exposed channel*)      (*very little water*)**3. SAMPLES TAKEN**Sterile bottles (circle all):      *sample*              *field duplicate*              *sterile water*Method (circle one):      *grab*              *pole*              *basket*Water Color (circle one):      *clear*              *silty (gray)*              *green*              *cloudy*  
*light tea*              *tea*              *muddy*              *other* \_\_\_\_\_Water Odor (circle one):      *none*    *musky*    *gas /oil*    *rotten egg*    *other* \_\_\_\_\_Position in river (facing downstream):      *left*              *center*              *right*

Total water depth at the sampling site (estimate to the nearest ½ foot): \_\_\_\_\_ ft.

**4. WATER TEMP**

Water Temperature: \_\_\_\_\_ °C / °F

Thermometer ID \_\_\_\_\_

**5. GENERAL SITE COMMENTS**


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**Sample Chain of Custody**

**Chain of Custody**

Nashoba Analytical, LLC, 31A Willow Rd., Ayer, MA 01460 (Tel. 978-391-4428)  
 Client Name/Project: OARS, 23 Bradford St., Concord, MA 01742 (Tel. 978-369-3956)

Massachusetts Certification: M-MA-1118

Bacteria Sampling 2019 Sampled by: \_\_\_\_\_

Sample #	Date	Time	Location	Container	E. coli						Checked/ Comments
ABT-077			Assabet by USGS gage, Rt. 27/62, Maynard	plastic-HDPE-sterile	X						
ABT-162			Assabet, Cox Street, Hudson	plastic-HDPE-sterile	X						
SUD-096			Sudbury at Rt. 20, Wayland	plastic-HDPE-sterile	X						
SUD-237			Sudbury at Rt. 135, Ashland	plastic-HDPE-sterile	X						
CND-009			Concord at Rogers St. bridge, Lowell	plastic-HDPE-sterile	X						
CND-110			Concord at Rt. 225, Bedford	plastic-HDPE-sterile	X						
QC-____			Quality Control	plastic-HDPE-sterile	X						

Special Notes/Requirements:	Relinquished by:	Date	Time	Received by:	Cooler Temp