River Water Sampling Manual

Prepared by:

Merrimack River Watershed Council

60 Island St #246

Lawrence, MA 01840

(978) 655-4742

Merrimack.org

Last updated: 3/16/2022

TABLE OF CONTENTS

1. INTRODUCTION

Bacteria in local water bodies presents a serious threat to local populations. High bacteria levels make recreational activities, such as swimming or boating, potentially unsafe. Furthermore, research has shown a correlation between large rain events and emergency room visits for gastrointestinal illness in areas where a drinking water source receives combined sewer system discharges (Jagai, 2015).

High bacteria concentrations can derive from several sources, including urban stormwater, illicit sewer connections, agricultural runoff, and wildlife. Some of the highest spikes in bacteria contamination comes from combined sewer overflows (CSOs). During heavy rain events in cities with combined sewer systems, wastewater treatment plants release untreated sewage into local waterways to prevent the high volumes of stormwater from overwhelming the sewer system.

To address this significant threat to water quality, the Merrimack River Watershed Council samples the Merrimack River to study the bacteria concentrations. With the help of amazing local volunteers, MRWC monitors the *e. coli* and *enterococcus* concentrations in the river. These are indicators of sewage contamination. The water sampling program currently tests 13 sites along the Merrimack River from Manchester, NH to the mouth of the river by Newburyport and Salisbury, MA.

MRWC is so grateful to have such a great group of volunteers. We hope this manual will make volunteer monitoring clear and simple. All volunteers are required to have a brief in-person training before they begin water sampling, although we also permit same day training. If you would like a refresher course on how to do water quality monitoring or have any questions, please email the water quality monitoring coordinator

2. STRATEGY AND LOGISTICS

MRWC currently samples for water quality at 11 sites on the Merrimack River in Massachusetts and 2 sites in New Hampshire (See APPENDIX A). Our volunteer monitors are paramount to the success of the program. We understand that the sampling schedule is challenging; however, it is extremely important to our work that we are able to collect a complete data set. If these schedules aren't for you, we are happy to have you assist with another one of our volunteer programs!

The water quality program has two different sampling strategies: 1) Baseline Freshwater / Brackish Water, and 2) Combined Sewer Overflow.

2.1. General Safety Precautions

The safety of volunteers is of the utmost importance. All volunteers must complete the safety training before beginning sampling activities. The MRWC staff should be contacted if there

are any safety concerns. Below are general safety rules:

- Check weather reports prior to sampling
- Do not wade in swift or high water
- Do not enter private property without permission of the landowner
- Confirm sampling is performed at the correct site, by checking maps, site descriptions, or directions. See the pictures of each sampling site at the end of this manual for more information on each site.
- Watch out for plants that cause rashes and irritation, including poison ivy, poison oak, and sumac
- Avoid unstable stream banks, including eroding soils and unstable rocks
- Read the safety and operation materials for any equipment prior to use
- Wearing gloves is required when sampling river water
- Take care to minimize contamination of the samples with bacteria from your hands

2.2. Equipment and Supplies

Each volunteer will be provided with a site sampling bag containing the following:

- 1 pocket Pro+ Multi 2 Tester for pH/Cond/TDS/Salinity/water temperature
- GPS locations - found in the email and in paper
- 1 forms to record data and sampling information
- 1 clipboard with binder clip (to hold paper if windy)
- 1 Sampling bottle to collect river water samples (you may have 2 if asked to collect a blank)
- 1 spray bottle with DI water
- 2 pairs gloves
- 2 pencils
- 1 pen
- 1 graduated cylinder
- 1 pipet
- MRWC volunteer ID badge
- magnifying glass (to see small numbers and letters on Hach Pro)
- pH and Conductivity calibration packets *
- Bridge Sampler contraption **
- Reflective vest **
- Cooler/bag with Ice - supplied by volunteer

NOTE: (*) only for those taking home the kits, (**) Only for those sampling at bridges

2.3. Data and Records Management

During the collection of each sample, the appropriate forms (provided by the MRWC staff)

will be filled out by the volunteer. The forms will remain with the samples until they are dropped off at the laboratory, at which time the MRWC staff will collect the forms. The forms will both be stored physically in a secure cabinet and scanned to be stored digitally (See Appendix C for an example of the data sheets).

2.4. Cancellation Policy

We ask that volunteers notify MRWC within 48 hours of receiving the 1 week reminder email if they are unable to make a sampling event. We want to ensure that sites are covered. If you have two or more absences in a six-month period without notifying MRWC, we will ask that you switch to a different MRWC volunteer opportunity

3. BASELINE WATER SAMPLING PROCEDURE

In order to establish a clear baseline data set, volunteers sample water quality at their assigned sites twice a month (March - November) and once a month (December – February), regardless of weather conditions (except for local thunderstorms).

3.1. Preparation

MRWC staff will email you a reminder 1 week and 1 day prior to water sampling with the manual, your sampling time, and your site's GPS location. If you are unable to sample during this week, please let MRWC staff know ASAP so we can find a replacement.

3.1.1. Calibration

Every time we go out to water test the meters must be calibrated. If you pick up your kit from the office before sampling, MRWC staff will calibrate the meters for you. ONLY VOLUNTEERS WHO TAKE HOME KITS WILL NEED TO CALIBRATE THE METERS THEMSELVES. You may calibrate 1-3 days in advance of water sampling. If you have any issues calibrating, call the water quality monitoring coordinator. Their information will be included in the email sent 1 week before sampling. Items needed for calibration include one, two or three calibration standard solutions, and the Hach Pocket Pro.

For a visual, watch this video -> How to Calibrate the Hatch PocketPro Monitors

1. Fill out the top section of your datasheet under “Calibration record”: date, your name, the number on the top of your Hach Pro and the standard you are using (7.01 for pH and 1413 for conductivity).
2. Set the power on the Hach Pro to on (hold bottom button).
3. Push and hold the top button until Conductivity or pH shows on the screen.
4. Tap the middle button once to go to calibration mode (small graph shows in the bottom left corner).
5. Remove the cap from the sensor and rinse the sensor and cap with deionized water.

6. Pour the calibration standard solution shown on the screen (7.01 for pH, 1413 for conductivity) into the cap to the fill line.
7. Put the sensor fully into the cap.
8. The number on the bottom should match the calibration standard solution (7.00 for pH, 1413 or conductivity). Note: If "C1" shows on the bottom line, do not continue. Set the tester to auto calibration mode. Refer to Configure the settings on page 11 of the Hach Pocket Pro User's Manual.
9. When the measurement is stable, tap the middle button once to save the calibration, the number should flash three times and then stop.
    a. If you are calibrating conductivity, it will say "END" and return to measuring mode. Record the number on the screen in measurement mode once it stabilizes on your data sheet under "reading after cond calib". Go to step 10.
    b. If you are calibrating pH it will say either 4.00 or 10.00 on the bottom of the screen. Hold the middle button to return to continuous measurement mode. Then, "END" shows on the display. Record the number on the screen in measurement mode once it stabilizes on your data sheet under "reading after pH calib".
10. Rinse the sensor and cap with deionized water
11. Used Calibration solution can be poured down the sink while running the water.
12. Complete steps 3-11 for the other calibration (pH or conductivity, whichever you did not already calibrate)
13. If you had any issues calibrating, record them on your data sheet under "calibration notes".

3.2. Sampling Day Procedure

3.2.1. Pick up supplies/Equipment check

If you do not take your kit home, meet MRWC staff at the office the morning of sampling to collect all sampling supplies. The time and meeting location will be provided to you in an email 1 week and 1 day before sampling.

If you take your kit home, make sure all equipment is accounted for and operational. The test kit should include all the items listed in Section 2.2 EQUIPMENT AND SUPPLIES.

3.2.2. Confirm that you are the sampling location

A sampling location will be provided by the MRWC staff. Drive to the sampling location so that you arrive at your scheduled sampling time. Use the GPS coordinates, photos and descriptions in APPENDIX A and B to ensure samples you are collecting the sample from the exact location indicated.

3.2.3. Prepare data sheet

Record the date, your name, the weather, and any other observations on the data sheet. Observations may include if there are geese nearby, boats driving nearby, or anything else that may impact your sample. An example data sheet is provided in APPENDIX C.

3.2.4. Collect a Field Blank

[Only do these steps if the water monitoring coordinator asks you to collect a field blank]

To ensure scientific legitimacy, all sites throughout the year will eventually be required to collect a field blank. These are meant to be a check for cross contamination and accuracy in our procedures. The bottles will be the grab sample bottles, but labeled "Blank".

To collect a blank from a *Bridge site* (with the Bridge Sampling Contraption):

1. Put on gloves to prevent contamination. These should remain on the entire time you are at your sampling site.
2. Generously spray the bridge sampler completely, the basket, and outside and inside of the jar with DI water.
3. Pour out the DI water from the Bridge Sampling Contraption.
4. Unscrew the nozzle from the spray bottle, making sure not to let the inside of the nozzle touch anything to avoid contamination.
5. Pour roughly 100 mL of DI water directly from the bottle into the Bridge Sampling Contraption jar. This will be a rough estimate. Place the nozzle back onto the spray bottle.
6. Carefully, open the sample bottle labeled "Blank", without touching the inside of the bottle or cap.
7. Pour the DI water from the Bridge Sampling Contraption into the 100 mL sample bottle labeled "Blank"
8. Seal the sample bottle, and record the site, time, and date on the bottle's label.
9. Place the sample in the cooler/bag with ice immediately.

To collect a blank from a *non-bridge site*:

1. Put on gloves to prevent contamination. These should remain on the entire time you are at your sampling site.
2. Unscrew the nozzle from the spray bottle, making sure not to let the inside of the bottle nozzle touch anything to avoid contamination
3. Carefully, open the sample bottle labeled "Blank", without touching the inside of the bottle or cap.

4. Pour 100mL of DI water directly from the spray bottle into the Sample Bottle labeled "Blank".
5. Seal the sample Bottle and record the site, time, and date on the label
6. Replace the spray nozzle on the spray bottle.
7. Place the sample in the cooler/bag with ice immediately.

1.1.1. Collect grab samples

Use the following steps for collecting samples. Take note of how many samples must be taken at each site. If there are any deviations from this procedure, record them in the notes section of the Field Data Sheet. For a visual see the video -> How to Collect bacteria Samples**.**

Sites with bridges will require an additional step. MRWC will provide a bridge sampler contraption for this site.

1. Put on gloves to prevent contamination. These should remain on the entire time you are at your sampling site.
2. Fill in the bottle label with the site abbreviation, date and time.

[skip to step 3 if you are not at a bridge site]

   a. Generously spray the bridge sampler completely, the basket, and outside and inside of the jar with DI water (you may skip this is you already did this during a field blank).
   b. Drop the river sampler down and haul up the water, then dump the water out
   c. Drop the river sampler down and haul up the water, then dump the water out
   d. Lower the river sampler down again and only on the third time will you take a sample and measure the parameters.
   e. Follow the rest of the steps below, sampling water from the jar rather than directly from the river.

3. Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap, to prevent contamination.
4. When collecting samples, disturb as little sediment as possible. Avoid collecting water that has sediment from bottom disturbance.
5. Stand facing upstream and collect the sample from your upstream side, to avoid collecting contamination from your boots. Depending on the depth of the water, you may also tape your bottle to an extension pole to sample from deeper water. Reach out into the flowing water to collect the sample, or as close as possible.
6. There will be a small tablet in the bottle, be sure to keep this in the bottle.

Figure 3: Pocket Pro cap filled to the "fill line".

7. Hold the bottle near its base and plunge it below the water surface with the opening facing upstream.
8. Fill the bottle to the 100mL line
9. Recap the bottle carefully, remembering not to touch the inside.
10. Fill in the bottle site abbreviation, date and collection time on the field data sheet.
11. Place the samples in the cooler/bag with ice immediately.
12. Rinse the bridge sampler thoroughly with DI water if you are using it.

1.1.2. Parameter Measurements Using the Hach Pro

Sampling method using the Hach Pro meters. DO NOT PRESS THE MIDDLE BUTTON DURING SAMPLING. Your gloves should still be on. For a visual see the video -> Freshwater Sampling Procedure For more information about the parameters you are measuring, see APPENDIX D.

1. Set the power to on (hold bottom button).
2. Remove the cap from the sensor.
3. Rinse the sensor and cap with deionized water.
4. Fill the cap completely with river water, and empty. Fill again with river water to the fill line (see Figure 3).
5. Put the sensor fully into the cap. The measured value shows on the top line of the screen and temperature always shows on the bottom. of the screen.
6. If the lock icon shows on the display, push the top button to go to continuous measurement mode.
7. Record the temperature and units on your data sheet.
8. Push and hold the top button to select the parameter to measure (i.e., Conductivity, pH, Salinity, and TDS).
9. When the number stabilizes for 3 seconds, record the measurement and units on the provided data sheet. THE UNITS MAY CHANGE WITHOUT NOTICE. USE YOUR MAGNIFYING GLASS TO ENSURE YOU HAVE RECORDED THE UNITS AND DECIMAL POINT CORRECTLY. If an error or dashes are shown and you are at a brackish water site, skip to section *3.2.7: Brackish Water Parameter Measurements.*
10. Hold the top button to read the next parameter.
11. Repeat steps 8-10 for all parameters.
12. Rinse the sensor and cap with deionized water between each sample.
13. Complete steps 3–12 two more times for this site. *THREE samples and their parameters measurements at each location* must be taken. This means three rows of data on the data sheet must be filled out for EACH SITE. An example data sheet is provided in APPENDIX C.
14. When done with measurements:
15. Rinse the sensor and cap with deionized water (and bridge sampler if using it).
16. Put the cap on the sensor.

17. Set the power to off (bottom button).
18. Put everything back in the bag
19. Continue onto the next site or drop off location.

1.1.3. Parameter Measurements Using the Hach Pro at a brackish water site

(only needed when seeing an error on the Hach Pro at a brackish water site after beginning the sampling procedure above)

Sampling method using the Hach Pro meters at brackish water sites when you see an error on the Hach Pro screen during sampling. DO NOT PRESS THE MIDDLE BUTTON DURING SAMPLING. Your gloves should still be on. For a visual see the video ->Brackish Water Sampling Procedure For more information about the parameters you are measuring, see APPENDIX D.

1. Set the power to on (hold bottom button).
2. Remove the cap from the sensor.
3. Rinse the sensor and cap with deionized water.
4. Fill the cap completely with river water, and empty. Fill again with river water to the fill line (see Figure 3).
5. Put the sensor fully into the cap. The measured value shows on the top line of the screen and temperature shows on the bottom.
6. If the lock icon shows on the display, push top button to go to continuous measurement mode.
7. Record the temperature and units on your data sheet.
8. Push and hold top button to select the parameter to measure PH.
9. When the number stabilizes for 3 seconds, record the measurement for pH on the provided data sheet.
10. Repeat steps 5 to 8 three times.

**Dilution - Because our monitors cannot read high salinity, sometimes we must dilute the samples at brackish water sites.

11. Rinse the sensor, pipette, and cap and graduated cylinder with deionized water. (To rinse the pipette fill the cap with deionized water, fill the pipet and then eject the water on the ground).
12. Fill the graduated cylinder with deionized water up to 8ml.
13. Fill the pipette with 2mL of river water then empty. Fill again, and and add it to the graduated cylinder for a combined 10mL of river water and DI water (Break down, 8 ml of DI water + 2 ml of river water).
14. Pour all 10 ml of liquid in the cylinder to the cap.
15. Put the sensor fully into the cap.
16. Press and hold the top button to go to the next parameter.

17. When the number stabilizes for 3 seconds, record the measurement and units on the provided data sheet and indicate that dilution was needed. THE UNITS MAY CHANGE WITHOUT NOTICE. USE YOUR MAGNIFYING GLASS TO ENSURE YOU HAVE RECORDED THE UNITS AND DECIMAL POINT CORRECTLY.
18. Repeat steps 16 -17 for each of the remaining parameters.
19. Repeat steps 11 -18 three times. *THREE measurements of each parameter at each location* must be taken. An example data sheet is provided in APPENDIX C.
20. When done with measurements:
21. Rinse the sensor, cap, graduated cylinder and the pipet with deionized water. Put the cap on the meter.
22. Set the power to off (bottom button).
23. Put everything back in the bag
24. Continue onto the next site or drop off location.

1.1.4. Drop off

All samples should be in sealed containers and placed in the cooler. The sample and data sheets should then be transported to the drop off location at the MRWC Office. MRWC staff will meet the volunteer at the site to collect the samples. Details for drop off locations should be included in your 1 day reminder email. Volunteers who don't take kits home will leave their kits with MRWC staff. Volunteers who take their kits home will re-stock on calibration and sampling supplies for the next sampling day. **During sample drop-off, necessary precautions should be taken to avoid the transmission of COVID19, including wearing face masks and disinfecting the cooler.** Following drop-off, the samples will be transported directly to the laboratory for testing, by MRWC staff.

2. COMBINED SEWER OVERFLOW WATER SAMPLING PROCEDURE

After select Combined Sewer Overflow events that meet our testing criteria, we will contact volunteers to sample for two to four days directly after the event occurs, at both brackish and freshwater sites. The purpose of this is to track the change in bacteria levels after a CSO event. Because we sample up to four days in a row, we do a simplified sampling method during CSO sampling which is less time consuming.

2.1. Preparation

MRWC staff will email you after a CSO to ask about your availability for sampling. Each day prior to sampling you will receive an email with instructions on your sampling site and time, and any additional information.

2.2. Sampling Day Procedure

2.2.1. Equipment check

In preparation for site sampling make sure all equipment is accounted for and operational. For CSO testing, only sample bottles, gloves and a writing utensil are needed.

2.2.2. Confirm that you are the sampling location

A location will be provided by the MRWC staff. To ensure samples are consistently collected from the same location, use local landmarks to confirm your location. Also consider downloading a GPS application on your smartphone, as necessary. See the APPENDIX B for more information about the specific sites.

2.2.3. Collect a Field Blank

[Only do these steps if the water monitoring coordinator asks you to collect a field blank]

To ensure scientific legitimacy, all sites throughout the year will eventually be required to collect a field blank. These are meant to be a check for cross contamination and accuracy in our procedures. The bottles will be the sample bottles labeled "Blank".

To collect a blank from a *Bridge site* (with the Bridge Sampling Contraption):

1. Put on gloves to prevent contamination. These should remain on the entire time you are at your sampling site.
2. Generously spray the bridge sampler completely, the basket, and outside and inside of the jar with DI water.
3. Pour out the DI water from the Bridge Sampling Contraption.
4. Unscrew the nozzle from the spray bottle, making sure not to let the inside of the nozzle touch anything to avoid contamination.
5. Pour roughly 100 mL of DI water directly from the bottle into the Bridge Sampling Contraption jar. This will be a rough estimate. Place the nozzle back onto the spray bottle.
6. Carefully, open the sample bottle labeled "Blank", without touching the inside of the bottle or cap.
7. Pour the DI water from the Bridge Sampling Contraption into the 100 mL sample bottle labeled "Blank"
8. Seal the sample bottle, and record the site, time, and date on the bottle's label.
9. Place the sample in the cooler/bag with ice immediately.

To collect a blank from a *non-bridge site*:

1. Put on gloves to prevent contamination. These should remain on the entire time you are at your sampling site.

2. Unscrew the nozzle from the spray bottle, making sure not to let the inside of the bottle nozzle touch anything to avoid contamination
3. Carefully, open the sample bottle labeled “Blank”, without touching the inside of the bottle or cap.
4. Pour 100mL of DI water directly from the spray nozzle into the Sample Bottle labeled “Blank”.
5. Seal the sample Bottle and record the site, time, and date on the label
6. Place the sample in the cooler/bag with ice immediately.

2.2.4. Collect grab samples

Use the following steps for collecting samples. Take note of how many samples must be taken at each site. If there are any deviations from this procedure, record them in the notes section of the Field Data Sheet. For a visual see the video -> How to Collect bacteria Samples**.**

Sites with bridges will require an additional step. MRWC will provide a bridge sampler contraption for this site.

1. Put on gloves to prevent contamination. These should remain on the entire time you are at your sampling site.
2. Fill in the bottle label with the site abbreviation, date and time.

[skip to step 3 if you are not at a bridge site]

   a. Generously spray the bridge sampler completely, the basket, and outside and inside of the jar with DI water (you may skip this is you already did this during a field blank).
   b. Drop the river sampler down and haul up the water, then dump the water out
   c. Drop the river sampler down and haul up the water, then dump the water out
   d. Lower the river sampler down again and only on the third time will you take a sample and measure the parameters.
   e. Follow the rest of the steps below, sampling water from the jar rather than directly from the river.

3. Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap, to prevent contamination.
4. When collecting samples, disturb as little sediment as possible. Avoid collecting water that has sediment from bottom disturbance.
5. Stand facing upstream and collect the sample from your upstream side, to avoid collecting contamination from your boots. Depending on the depth of the water, you may also tape your bottle to an extension pole to

Figure 3: Pocket Pro cap filled to the “fill line”.

sample from deeper water. Reach out into the flowing water to collect the sample, or as close as possible.

6. There will be a small tablet in the bottle, be sure to keep this in the bottle.
7. Hold the bottle near its base and plunge it below the water surface with the opening facing upstream.
8. Fill the bottle to the 100mL line
9. Recap the bottle carefully, remembering not to touch the inside.
10. Fill in the bottle site abbreviation, date and collection time on the field data sheet.
11. Place the samples in the cooler/bag with ice immediately.
12. Rinse the bridge sampler thoroughly with DI water if you are using it.

2.2.5. Drop off

All samples should be in sealed containers and placed in the cooler. The samples should then be transported to the drop off location at the MRWC Office. MRWC staff will meet the volunteer at the site to collect the samples. Details for drop off locations should be included in your 1 day reminder email. Volunteers who don't take kits home will leave their kits with MRWC staff. Volunteers who take their kits home will re-stock on calibration and sampling supplies for the next sampling day. **During sample drop-off, necessary precautions should be taken to avoid the transmission of COVID19, including wearing face masks and disinfecting the cooler.** Following drop-off, the samples will be transported directly to the laboratory for testing, by MRWC staff.

3. APPENDICES

APPENDIX A: Map and Table of Sampling Locations

Map of Sampling Locations

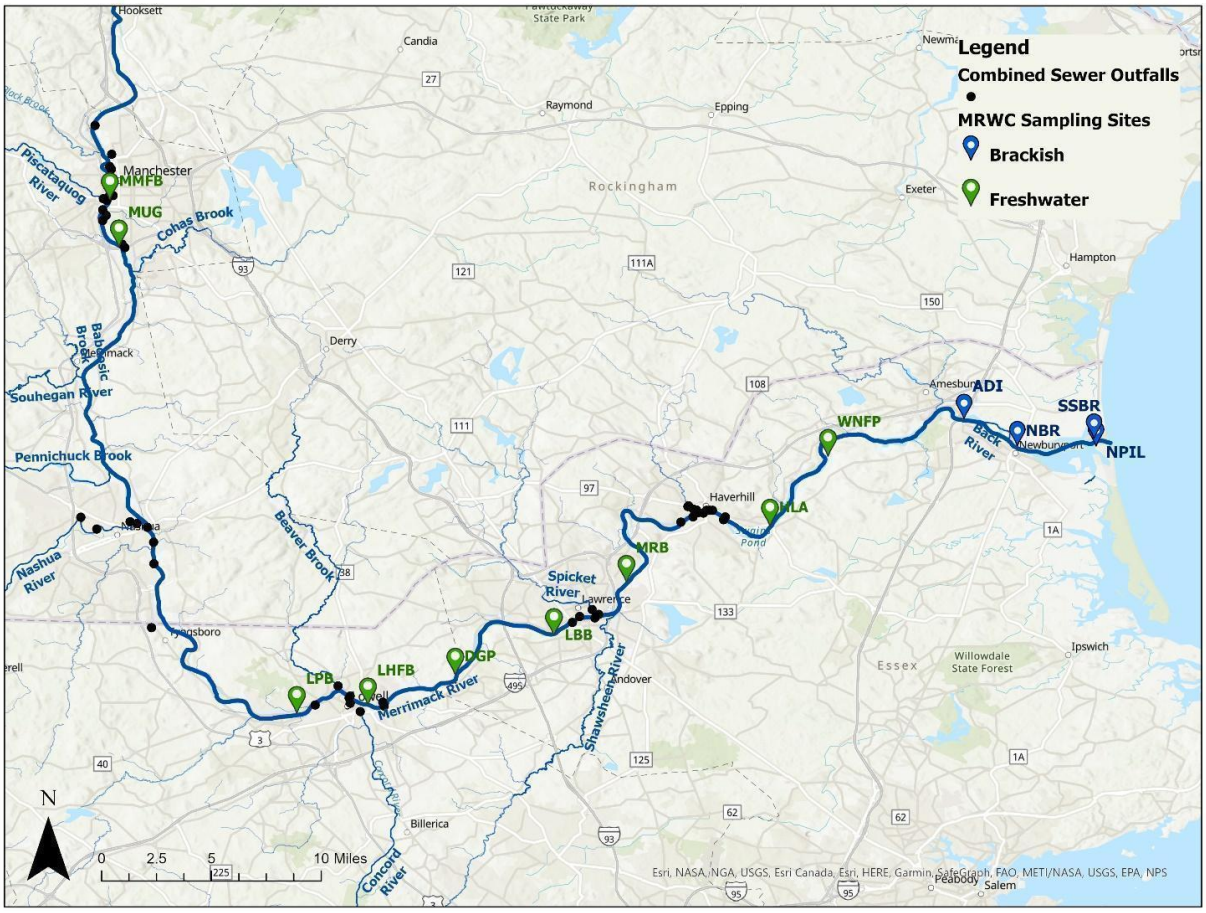


Table 1: Sites, site abbreviations, GPS coordinates and the bacteria of interest for each site. All of the sites including winter sites and spring, summer, and fall sites

Site	Site Abbreviation	GPS Coordinates of sampling location	Number of Sample Bottles	Tests
Manchester, Merrimack Foot Bridge	MMFB	42.979072, -71.469388	1	1 E. Coli / Enterococcus
Manchester, USGS Gage	MUG	42.948027, -71.463148	1	1 E. Coli / Enterococcus
Lowell, Pawtucket Boulevard	LPB	42.6411911, -71.3460007	1	1 E. Coli / Enterococcus
Lowell, Hunts Falls Bridge	LHFB	42.64649, -71.29923	1	1 E. Coli / Enterococcus
Dracut, Gravel Pit	DGP	42.66614, -71.2417	1	1 E. Coli / Enterococcus
Lawrence – Bashara Boathouse	LBB	42.69221588446073, -71.17737539512864	1	1 E. Coli / Enterococcus
Methuen - 81 Riverview Blvd	MRB	42.7273583, -71.1290352	1	1 E. Coli / Enterococcus
Haverhill - 285 Lincoln Ave, Bridge	HLA	42.7642673, -71.0345758	1	1 E. Coli / Enterococcus
West Newbury – Ferry Park	WNFP	42.8101931, -70.9963550	1	1 E. Coli / Enterococcus
Amesbury-Deer Island	ADI	42.835229, -70.907292	1	1 E. Coli / Enterococcus
Newburyport - Bridge Road, Bridge	NBR	42.815705, -70.872899	1	1 E. Coli / Enterococcus
Newburyport-Plum Island Lighthouse	NPIL	42.816798, -70.820559	1	1 E. Coli / Enterococcus
Salisbury Beach State Reservation	SBSR	42.8218847, -70.8212684	1	1 E. Coli / Enterococcus

APPENDIX B: VOLUNTEER SAMPLING LOCATION DETAILS

Manchester - Merrimack Foot Bridge:

GPS Coordinates for sampling location: 42.979072, -71.469388

Parking Address (enter this into GPS navigation): 148 3rd Street, Manchester, NH

Google Maps Location to parking: https://goo.gl/maps/qkefpunwpxayU1zM7

Parking: Along Street. Use address 148 3rd Street as reference

Sampling: Walk southeast down the bike trail towards the river. If you parked on the right side of 3rd street, it should be the left entrance. Test from as close to the middle of the foot ridge as possible.

Left: Parking location Right: Walkway entrance to bridge from parking location

Sampling location

Manchester - USGS Gage (Actually Bedford):

GPS Coordinates for sampling location: 42.948027, -71.463148

Google maps link for navigation: Trinity Early Learning Center - Google Maps

Parking and navigation: Use "Trinity Early Learning Center, Bedford NH" in your GPS for directions, pass the learning center on your left and continue down Station Road. Turn left onto the dirt road, you will pass underneath the 293 bridge on the way to the site. Park anywhere in the gravel clearing. There will be a gravel ramp that drops into the water, test from this ramp.

Left: dirt road and 293 bridge where you should drive under to reach parking area

Right: View to the right when you are at the sampling location on the ramp

Lowell - Pawtucket Boulevard:

GPS Coordinates to sampling location: 42.6411911, -71.3460007

Google Maps Location for sampling location (close to parking location): https://www.google.com/maps/place/42%C2%B038'28.3%22N+71%C2%B020'45.6%22W/@42.6411911,-71.3460007,17z/data=!3m1!4b1!4m5!3m4!1s0x0:0x0!8m2!3d42.6411911!4d-71.3460007

Parking: Along Pawtucket Boulevard

Left: sampling location from parking location Right: stairs to access sampling location

Sampling location

Lowell - Hunts Fall Bridge:

GPS Coordinates for sampling location: 42.64649, -71.29923

Google Maps Location to parking: 42.648048, -71.301412

Parking: Centreville Dog Park, 61 1st St, Lowell, MA 01850

Sampling: Park at the dog park, walk up the ramp to the bridge. Sample between the second and third light posts (in the middle of the bridge, there are 4 light posts), get as close to the middle as possible on the upstream side of the bridge (towards Lowell).

Location to sample from

Dracut - Gravel Pit:

GPS Coordinates for parking and sampling location: 42.66614, -71.2417

Google Maps Location for navigation to parking and sampling: 42°39'58.1"N 71°14'30.1"W - Google Maps

Parking: Dirt pull-off to the river side of Rt. 110. Across the street you'll see AGRETECH/New England Cement Co.

Sampling: When looking at the river, to the right of the small parking area, follow the short trail slightly right and take a sample from the bank of the river.

Left: Sign across the street from parking location Right: parking location

Sampling location

Lawrence – Bashara Boathouse:

GPS Coordinates to sampling location: 42.69221588446073, -71.17737539512864

Google Maps Location to parking for navigation: https://www.google.com/maps/place/42%C2%B041'32.6%22N+71%C2%B010'36.2%22W/@42.69238,-71.17673,17z/data=!3m1!4b1!4m5!3m4!1s0x0:0x0!8m2!3d42.69238!4d-71.17673

Parking: In boathouse parking lot (shown in first picture when the boathouse is open, park on Eaton street of boathouse is closed (gate will be closed).

Directions to sampling location: walk behind the boathouse along the path (shown in second picture) to the crew dock. Sample off the dock in the summer when the dock is there, or off the bank in the winter when the dock is out.

Left: parking area Right: path to sampling location

Red marker shows sampling location

Methuen - 81 Riverview Blvd:

GPS Coordinates to sampling site: 42.7273583, -71.1290352

Google Maps Location: https://www.google.com/maps/place/42%C2%B043'38.5%22N+71%C2%B007'44.5%22W/@42.7273583,-71.1290352,17z/data=!3m1!4b1!4m5!3m4!1s0x0:0x0!8m2!3d42.7273583!4d-71.1290352

Parking: Dirt patch on the side of the road by the sign (shown in first photo)

Sampling: Follow the short path directly to the river. Stay to your left when the path forks and go down the steep path to the river. Sample to the right of the large tree hanging over the water.

Above: Sign at parking location and trail access

Left: path to sampling location Right: sampling location

Haverhill - 285 Lincoln Ave:

GPS Coordinates to sampling location: 42.7642673, -71.0345758

Google Maps Location to parking area: 42°45'53.2"N 71°02'07.9"W - Google Maps

Parking: Market Basket parking lot across the street as well as a closer parking spot on Coffin Avenue (the above link brings you here). Sampling: Sample from the bridge, between Use the provided bucket to grab your samples and measure the parameters using the probe.

Left:parking location, Right: sampling location (between red and white striped gates, ont he side of the bridge closer to the parking area

West Newbury – Ferry Park:

GPS Coordinates to sampling location: 42.8101931, -70.9963550

Google Maps Location to sampling location (right by parking location): https://www.google.com/maps/place/42%C2%B048'36.7%22N+70%C2%B059'46.9%22W/@42.8101931,-70.996355,17z/data=!3m1!4b1!4m5!3m4!1s0x0:0x0!8m2!3d42.8101931!4d-70.996355

Parking: dirt patch on the side of the road.

To sample: Follow the small trail to the sampling site.

Left: parking location, Right: path to the river

Left: path to the river follow the path directly down to the river, and sample from there.

Amesbury-Deer Island:

GPS Coordinates to sampling location: 42.835229, -70.907292

Google Maps Location to parking location: 42°50'04.0"N 70°54'24.2"W - Google Maps

Parking: Parking lot for hiking on Deer Island.

To sample: come out of the parking lot and walk onto the bridge on the right. There should be a small bump out on the bridge.

Left: Overview of parking spot (marked with x) and sampling location (circled). Right: parking lot.

Left: Sidewalk to the bridge and sampling location. Right: Balcony to test off of. Drop bridge sampler as arrow is showing.

Newburyport - Bridge Road:

GPS Coordinates to sampling sight: 42.815705, -70.872899

Google Maps Location to parking: Michael's Harborside - Google Maps

Parking: You can park at Michael's Harborside Restaurant 1 Tournament Wharf, Newburyport, MA 01950

Sampling location: Sample towards the middle of the bridge where this balcony is (shown below). Test from the right corner of the balcony. When you drop the Bridge Sampling Contraption in the water, be sure you are **to the right** of the wooden pylons in the water and **not** in the center of them (see photos).

Above: Sampling location

Left: location to drop the sampling contraption, Right: do not drop sampling contraption here.

Salisbury Beach State Reservation:

GPS Coordinates to sampling location: 42.8218847, -70.8212684

Google Maps Location to parking: 42°49'21.3"N 70°49'17.3"W - Google Maps

Parking: You should not have to pay for parking. If there is an attendant let them know you are collecting a water sampling for MRWC. If you have issues accessing the site, call your water quality monitoring coordinator. Park in an empty spot near the corner of W and Z streets.

Sampling location: Take the path from W and Z streets to the beach. When looking at the river, sample to the left of the rock barrier.

Red marker: parking location, red circle: path to sampling location, red arrow: sampling location

Left: view to left when at the sampling location, Right: view to the right when at the sampling location

Newburyport - Plum Island Lighthouse:

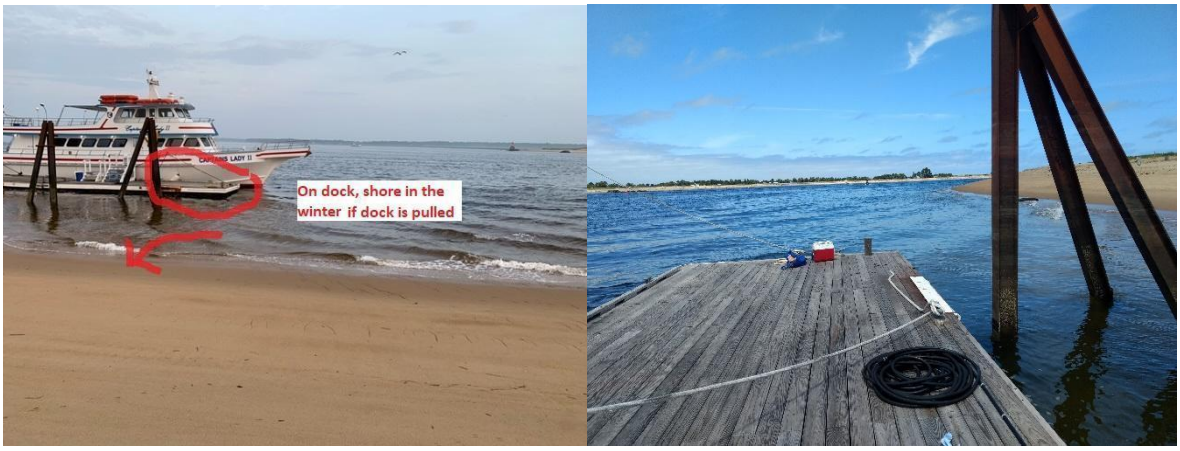
GPS Coordinates to the sampling location: 42.816798, -70.820559

Google Maps Location to parking: Captains Fishing Parties And Cruises - Google Maps

Parking: Parking lots are available. Park at "Captain's Fishing Parties and Cruises" and walk behind it to the pier. You should not have to pay for parking, simply say you are working with MRWC doing water sampling.

In winter, simply walk down to the beach and test from the shoreline in front of the pier.

Left: parking location, Right: dock to pier



Left: showing sampling location from pier or shore Right: sampling location from pier

APPENDIX C: EXAMPLE DATA SHEET

MRWC Water Quality Monitoring Field Data Sheet

Calibration Record (only fill out if you calibrated the Hach Pro):

Date	Calibrated by	Hach Pro Meter #	pH standard	Reading after pH calib	Cond standard	Reading after cond calib	Calibration Notes (issues, setting changes, etc)
2/22/22	Jane Doe	3	7.00	7.03	1413	1413	

Sampling Site Information:

Date	Sampler Name	Station ID DGP	Sample location (circle)	Hach Pro Meter # 3	Equipment Notes (Hach not functioning properly, not settling, etc)
2/23/22	Jane Doe		Bridge, dock, shore (circled)		

Weather: ___Clear _X_Partly Cloudy ___Cloudy ___Raining ___Recently rained (ground wet) ___Snowing ___Snow on ground

Wind: _X_Calm ___Breeze ___Wind Air Temp: _55_ Units _°F_

Site Notes (animals, trash, people, boats in the water, other)

LITTER @ SITE

Sampling Data:

Time Sampled (HH:MM)	Water Temp (never diluted)	Temp Units (circle one)	PH (never diluted)	Dilution Needed (circle one)	Conductivity	Cond Units (circle one)	TDS	TDS Units (circle one)	Salinity	Sal Units (circle one)
8:55	6.7	°F / °C (circled)	6.9	Y / N (circled)	162.8	µS (circled) / mS	115	ppt / ppm (circled)	0.08	ppt (circled) / %
8:58	5.9	°F / °C (circled)	6.85	Y / N (circled)	155.5	µS (circled) / mS	110	ppt / ppm (circled)	0.08	ppt (circled) / %
[illegible]	4.7	°F / °C (circled)	6.7	Y / N (circled)	155.9	µS (circled) / mS	111	ppt / ppm (circled)	0.08	ppt (circled) / %
9:00 Sample Bottle Collection Time (HH:MM):				8:53AM						

APPENDIX D: Water Quality Parameters

pH	pH is the measure of hydrogen ions, or acidity, in the water. pH has a scale of 0-14, acidic to basic respectively. Pure water is 7.0.
Salinity	Amount of brackish dissolved in a body of water. The units to describe salinity are ‰ or ppt (parts per thousand). Salt waters, such as oceans, contain 35 parts of salt per 1000 parts of water. Fresh waters have salinity measurements of 0.5 ppt or less. The Merrimack River connects to the ocean in Newburyport. Sample data may be subjected to tidal influences, depending on the time samples are taken.
Conductivity	Ability of water to conduct an electrical current, used as an indicator for dissolved substances. The conductance of a liquid is defined by the ratio of current to voltage between any two points within the liquid. Conductivity can also change with temperature changes.
Water Temperature	How much heat is in the water. Water temperature can affect the rate of photosynthesis of aquatic organisms. The higher the temperature the lower amounts of dissolved oxygen in the water and affect the survivability of aquatic organisms. Some pollutants can be more toxic at higher temperatures.
Total Dissolved Solids (TDS)	A secondary parameter that can be an indicator of harmful contaminants.
Metals	Metals are naturally occurring, but heavy concentrations from industrial waste are poisonous to humans and aquatic flora and fauna. As part of this program we plan to test for cadmium, lead, arsenic, copper, and selenium.
Enterococcus faecalis and Escherichia coli (E. coli)	The presence of this bacteria is an indicator of fecal material in water. The standards state that the geometric mean of E. coli concentrations of Class B fishable/swimmable waters should have no more than 126 organisms per 100 ml of water sample (or 126 cfu/100 mL). No single sample should have concentrations exceeding 235 cfu/100 mL. Waters designated for secondary contact (boating) should not have E. coli concentrations exceeding 630 cfu/100 mL and less than 10% of the samples should have concentrations exceeding 1,260 cfu/100 mL.

(Definitions, and guidelines from: "Massachusetts Surface Water Quality Standards" (2006), EPA December 2010, https://www.epa.gov/sites/production/files/2014-12/documents/mawqs-2006.pdf Accessed 2020)

References:

Massachusetts Surface Water Quality Standards" (2006), EPA December 2010, https://www.epa.gov/sites/production/files/2014-12/documents/mawqs-2006.pdf Accessed 2020

Jagai JS, Li Q, Wang S, Messier KP, Wade TJ, Hilborn ED. Extreme Precipitation and Emergency Room Visits for Gastrointestinal Illness in Areas with and without Combined Sewer Systems: An Analysis ofMassachusetts Data, 2003–2007. Environ Health Perspect. 2015;123(9):873-879. doi:10.1289/ehp.1408971