River Water Sampling Manual

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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 tomas@merrimack.org

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 monthly 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 the equipment prior to use
- Wearing gloves is recommended when calibrating the Pocket Meter or sampling river water following major storms
- 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
- 2 pairs gloves
- 2 Sampling bottles to collect river water samples, (only use 1 unless duplicate or blank is needed)
- 2 pencils
- 1 pen
- 1 forms to record data and sampling information
- 1 clipboard
- 1 binder clip
- 1 graduated cylinder**
- 1 pipet**
- 1 spray bottle with DI water
- Cooler/bag with Ice - supplied by volunteer
- pH and Conductivity calibration packets *
- Bridge Sampler contraption ***
  NOTE: (*) only for those taking home the kits, (**) only for those sampling brackish water (***) 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 (1 week to 1 day before sampling)

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 (Only for volunteers who take their kits home)

Every time we go out to water test the monitors must be calibrated. Open up your calibration packets. and follow these written instructions or the linked video below. ONLY VOLUNTEERS WHO TAKE HOME KITS WILL NEED TO DO THIS. You may calibrate 1-3 days in advance of water sampling. If you have any issues calibrating, call the water quality program 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, Hach Pocket Pro.

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

1. Set the power to on (hold bottom button).
2. Push and hold the top button until Conductivity or pH shows on the screen.
3. Push the middle button once to go to calibration mode (small graph shows in the bottom left corner).
4. 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.
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. When the measurement is stable, tap the middle button once to save the calibration, the number should flash three times and then stop.
9. Hold the middle button to return to continuous measurement mode. Then, "END" shows on the display.
10. Rinse the sensor and cap with deionized water
11. Used Calibration solution can be poured down the sink while running the water. It is safe

to put down the drain.

12. Complete steps 2-11 for the other calibration (pH or conductivity, whichever you did not already calibrate)

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 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. 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 A and B for more information about the specific sites.

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. Bridge site collection (skip if you are not at a bridge site)

Sites with bridges will require an additional step. MRWC will provide a bridge sampler container and rope.

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. If you are required to collect a field blank (skip if you are not required to collect this):
    a. Pour 100 mL of DI water from your squirt bottle into the bridge sampler.
    b. Carefully open one of your sample bottles without touching the inside of the bottle. Pour the water from the jar into one of your sample bottles.
    c. Leave a 1-inch air space. Do not fill the bottle past the 100mL line (so that the sample can be shaken just before analysis). Recap the bottle carefully, remembering not to touch the inside.
    d. Write “field blank”, the date and time on the bottle.
    e. Place the sample in the cooler/bag with ice for transport to the central meeting location.

4. Drop the river sampler down and haul up the water, then dump the water out
5. Drop the river sampler down and haul up the water, then dump the water out
6. Lower the river sampler down again and only on the third time will you take a sample and measure the parameters.
7. Follow the rest of the steps below, sampling water from the jar rather than directly from the river.

3.2.5. 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 comment section of the Field Data Sheet. For a visual see the video -> How to Collect bacteria Samples

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

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 Collection Site abbreviation, date and time.
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. 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.
5. Hold the bottle near its base and plunge it (opening downward) below the water surface. If you are using an extension pole, remove the cap, turn the bottle upside down, and plunge it into the water, facing upstream.
6. Turn the bottle underwater into the current and away from you.
7. Leave a 1-inch air space. Do not fill the bottle past the 100mL line (so that the sample can be shaken just before analysis). Recap the bottle carefully, remembering not to touch the inside.
8. Fill in the bottle site abbreviation, date and time on the field data sheet. This is important because it tells the lab coordinator which bottle comes from which site.
9. Place the samples in the cooler/bag with ice for transport to the central meeting location.

3.2.6. Fresh water parameter measurements (try this first regardless of which site you are visiting).

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. If the lock icon shows on the display, push the top button to go to continuous measurement mode.
4. Push and hold the top button to select the parameter to measure (i.e., Conductivity, pH, Salinity, and TDS). Temperature should always show on the bottom.
5. Rinse the sensor and cap with deionized water.
6. Fill the cap completely with river water, and empty. Fill again with river water to the fill line (see Figure 3).
7. Put the sensor fully into the cap. The measured value shows on the top line of the screen.
8. When the number stabilizes for 3 seconds, record the measurement and units on the provided data sheet. If an error is shown and you are at a brackish water site, skip to section *3.2.7: Brackish Water Parameter Measurements.*
9. Hold the top button to read the next parameter.
10. Repeat steps 8-9 for all parameters.
11. Rinse the sensor and cap with deionized water between each sample.
12. Complete steps 3–12 three 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.
13. When done with measurements:
    a. Rinse the sensor and cap with deionized water (and bridge sampler if using it).
    b. Put the cap on the sensor.
    c. Set the power to off (bottom button).
14. Put everything back in the bag
15. Continue onto the next site or drop off location.

3.2.7. Brackish water parameter measurements (only needed when seeing an error on the Hach Pro at a brackish water site)

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. If the lock icon shows on the display, push top button to go to continuous measurement mode.
4. Push and hold top button to select the parameter to measure PH. Water temperature should always show on the bottom of the screen.
5. Rinse the sensor and cap with deionized water.
6. Fill the cap completely with river water, and empty. Fill again with river water to the fill line (see Figure 3).
7. Put the sensor fully into the cap. The measured value shows on the top line of the screen.
8. When the number stabilizes for 3 seconds, record the measurement for pH and temperature and units on the provided data sheet.

9. 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.

10. Rinse the sensor, pipette, and cap with deionized water. (To rinse the pipette fill the cap with deionized water, fill the pipet and then eject the water on the ground). Also rinse the bridge sampler if using it.
11. Fill the graduated cylinder with deionized water up to 8ml.
12. 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).
13. Pour all 10 ml of liquid in the cylinder to the cap.
14. Put the sensor fully into the cap.
15. Press and hold the top button to go to the next parameter.
16. When the number stabilizes for 3 seconds, record the measurement and units on the provided data sheet and indicate that dilution was needed.
17. Repeat steps 15 -16 for each of the remaining parameters.
18. Repeat steps 10 -17 three times. *THREE measurements of each parameter at each location* must be taken. An example data sheet is provided in APPENDIX C.
19. When done with measurements:
    a. Rinse the sensor, cap, graduated cylinder and the pipet with deionized water. Put the cap on the tester.
    b. Set the power to off (bottom button).
20. Put everything back in the bag
21. Continue onto the next site or drop off location.

3.2.8. 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.

4. 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.

4.1. Preparation (1 week to 1 day before sampling)

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.

4.2. Sampling Day Procedure

4.2.1. 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.

4.2.2. 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.

4.2.3. Bridge site collection (skip if you are not at a bridge site)

Sites with bridges will require an additional step. MRWC will provide a bridge sampler container and rope.

8. Put on gloves to prevent contamination. These should remain on the entire time you are at your sampling site.
9. Generously spray the bridge sampler completely, the basket, and outside and inside of the jar with DI water.
10. If you are required to collect a field blank (skip if you are not required to collect this):
    a. Pour 100 mL of DI water from your squirt bottle into the bridge sampler.
    b. Carefully open one of your sample bottles without touching the inside of the bottle. Pour the water from the jar into one of your sample bottles.
    c. Leave a 1-inch air space. Do not fill the bottle past the 100mL line (so that the sample can be shaken just before analysis). Recap the bottle carefully, remembering not to touch the inside.
    d. Write “field blank”, the date and time on the bottle.
    e. Place the sample in the cooler/bag with ice for transport to the central meeting location.
11. Drop the river sampler down and haul up the water.
12. Then dump the water out.
13. Lower the river sampler down again and <u>only on the second time</u> will you take a sample and measure the parameters.
14. Follow the rest of the steps below, sampling water from the jar rather than directly from the river.

4.2.4. 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 comment section of the Field Data Sheet. For a visual see the video -> How to Collect bacteria Samples

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

10. Put on gloves to prevent contamination. These should remain on the entire time you are at your sampling site.
11. Fill in the bottle label with Collection Site abbreviation, date and time.
12. Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap, to prevent contamination.
13. When collecting samples, disturb as little sediment as possible. Avoid collecting water that has sediment from bottom disturbance. 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.
14. Hold the bottle near its base and plunge it (opening downward) below the water surface. If you are using an extension pole, remove the cap, turn the bottle upside down, and plunge it into the water, facing upstream.
15. Turn the bottle underwater into the current and away from you.
16. Leave a 1-inch air space. Do not fill the bottle past the 100mL line (so that the sample can be shaken just before analysis). Recap the bottle carefully, remembering not to touch the inside.
17. Fill in the bottle site abbreviation, date and time on the field data sheet. This is important because it tells the lab coordinator which bottle comes from which site.
18. Place the samples in the cooler/bag with ice for transport to the central meeting location.
19. Rinse the bridge sampler thoroughly if you are using it.

4.2.5. 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.

6. APPENDICES

APPENDIX A: Map and Table of Sampling Locations

Map of Sampling Locations

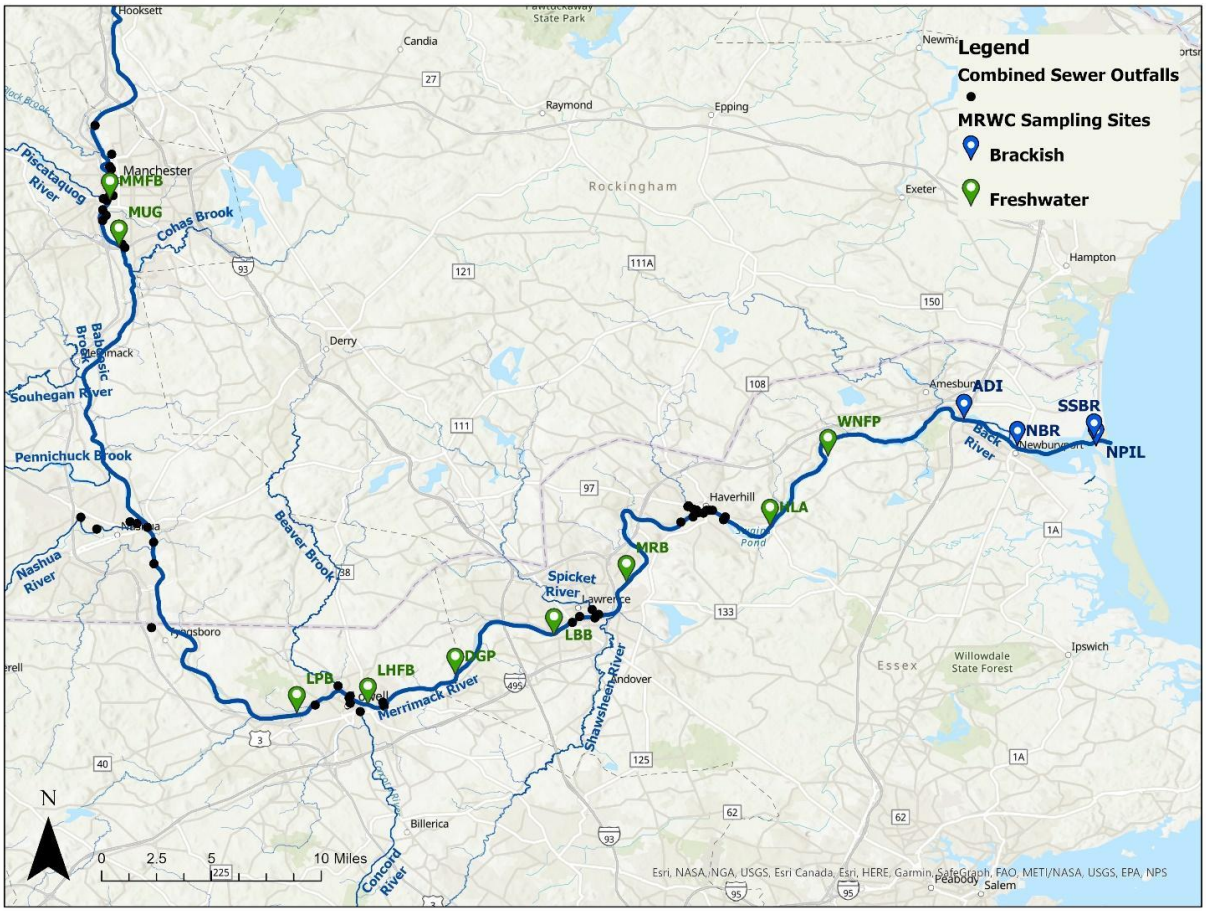


Table 1: Sites, site abbreviations, GPS coordinates and the bacteria of interest for each site. All of the sites including winter sites and spring, summer, and fall sites

Site	Site Abbreviation	GPS Coordinates	Number of Sample Bottles	Tests
Manchester, USGS Gage	MUG	42.945828, -71.462730	1	1 E. Coli
Manchester, Merrimack Foot Bridge	MMFB	42.980414, -71.472628	1	1 E. Coli
Lowell, Pawtucket Boulevard	LPB	42.6411911, -71.3460007	1	1 E. Coli
Lowell, Hunts Falls Bridge	LHFB	42.64649, -71.29923	1	1 E. Coli
Dracut, Gravel Pit	DGP	42.6585413, -71.2625371	1	1 E. Coli
Lawrence – Bashara Boathouse	LBB	42.69238, -71.17673	1	1 E. Coli
Methuen - 81 Riverview Blvd	MRB	42.7273583, -71.1290352	1	1 E. Coli
Haverhill - 285 Lincoln Ave, Bridge	HLAB	42.7642673, -71.0345758	1	1 E. Coli
West Newbury – Ferry Park	WNFP	42.8101931, -70.9963550	1	1 E. Coli
Amesbury-Deer Island	ADI	42.8348062, -70.9068175	2	1 E. Coli 1 Enterococcus
Newburyport - Bridge Road, Bridge	NBRB	42.816901, -70.871739	2	1 E. Coli 1 Enterococcus
Newburyport-Plum Island Lighthouse	NPIL	42.81681, -70.8199290	2	1 E. Coli 1 Enterococcus
Salisbury Beach State Reservation	SBSR	42.8218847, -70.8212684	2	1 E. Coli 1 Enterococcus

APPENDIX B: VOLUNTEER SAMPLING LOCATION DETAILS

Manchester USGS Gage:

GPS Coordinates: 42.945828, -71.462730

Address: Use “Trinity Early Learning Center”, continue down station road and take the left gravel road and head all the way down till you arrive at a parking clearing/park with waterfront access.

Google Maps Location:

https://goo.gl/maps/2LYkMsiYfqKmXm7F6

Manchester Merrimack Foot Bridge:

GPS Coordinates: 42.980414, -71.472628

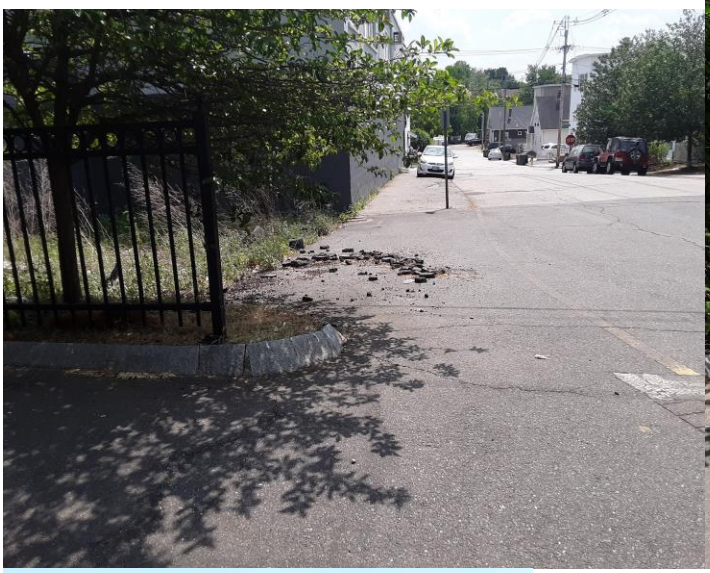
Address: 148 3rd Street, Manchester, NH

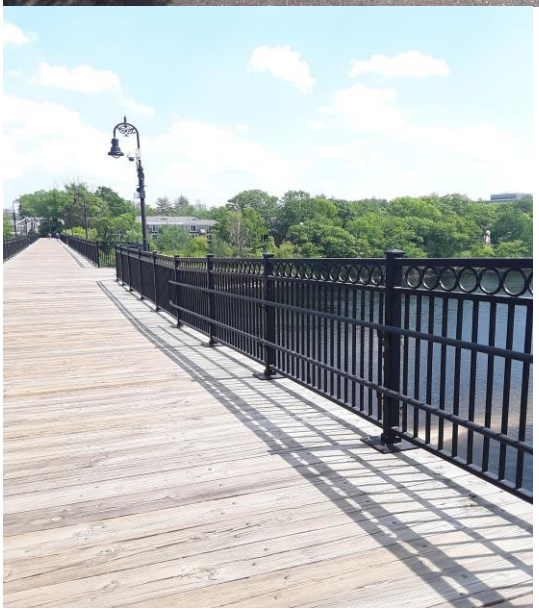
Google Maps Location:

https://goo.gl/maps/qkefpunwpxayU1zM7

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

Sampling: Walk down Bike Trail to center of Bridge





Pawtucket Boulevard:

GPS Coordinates: 42.6411911, -71.3460007

Google Maps 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 street




Gravel Pit, Dracut:

GPS Coordinates: 42.66614, -71.2417

Google Maps Location: 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.

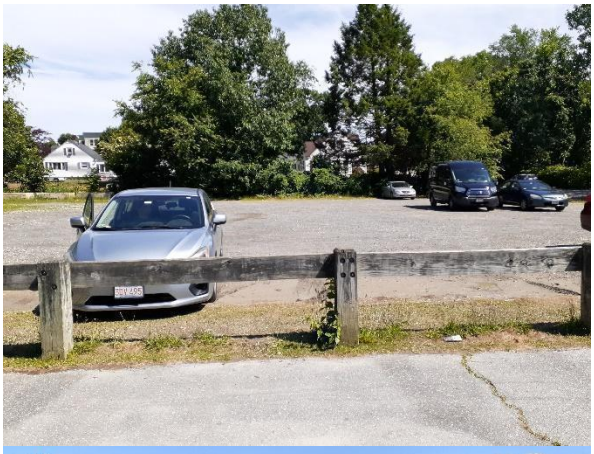
Sampling: To the right of the small parking area, follow the short trail slightly right and take a sample from the bank of the river.

Lawrence – Bashara Boathouse:

GPS Coordinates: 42.69238, -71.17673

Google Maps Location:
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)



Methuen - 81 Riverview Blvd:

GPS Coordinates: 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

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.

Haverhill - 285 Lincoln Ave:

GPS Coordinates: 42.7642673, -71.0345758

Google Maps Location: https://www.google.com/maps/place/42%C2%B045'51.4%22N+71%C2%B002'04.5%22W/@42.7642673,-71.0345758,17z/data=!3m1!4b1!4m5!3m4!1s0x0:0x0!8m2!3d42.7642673!4d-71.0345758

Parking: Market Basket parking lot across the street as well as a closer parking spot on Coffin Avenue. Sampling: Use the provided bucket to grab your samples and measure the parameters using the probe.

(Sampling location bottom left. Parking location bottom right on Old Ferry Rd.)

West Newbury – Ferry Park:

GPS Coordinates: 42.8101931, -70.9963550

Google Maps 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.

Amesbury-Deer Island:

GPS Coordinates: 42.8348062, -70.9068175

Google Maps Location: https://www.google.com/maps/place/42%C2%B050'05.3%22N+70%C2%B054'24.5%22W/@42.8348062,-70.9068175,17z/data=!3m1!4b1!4m5!3m4!1s0x0:0x0!8m2!3d42.8348062!4d-70.9068175

Parking: Parking lot for hiking on Deer Island.

To sample: Follow the trail to the right of the small red brick structure.

Newburyport - Bridge Road:

GPS Coordinates: 42.816901, -70.871739

Sample towards the middle of the bridge where this balcony is.

Google Maps Location: https://goo.gl/maps/2yPefZdjH9MUj1PU8

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

Salisbury Beach State Reservation:

GPS Coordinates: 42.8218847, -70.8212684

Google Maps Location: https://www.google.com/maps/place/42%C2%B049'18.8%22N+70%C2%B049'16.6%22W/@42.8218847,-70.8212684,17z/data=!3m1!4b1!4m5!3m4!1s0x0:0x0!8m2!3d42.8218847!4d-70.8212684

Parking: The reservation charges $14 for parking but there is plenty of room. Non-Massachusetts license plates cost $40.

Newburyport-Plum Island Lighthouse:

GPS Coordinates: 42.81681, -70.8199290

Google Maps Location:
https://www.google.com/maps/place/42%C2%B049'00.5%22N+70%C2%B049'11.7%22W/@42.81681,-70.819929,17z/data=!3m1!4b1!4m5!3m4!1s0x0:0x0!8m2!3d42.81681!4d-70.819929

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.

APPENDIX C: EXAMPLE DATA SHEET

Field Data Sheet * EACH SITE MUST HAVE ITS OWN DATA SHEET

Date: Waterbody: Sampler Name: Tomas Equipment Notes: Sample Bottle Collection Time (HH:MM) 9:00 Site Notes (animals, trash, people, other):

Weather ✓ Clear ___Cloudyw/o Rain ___Rain ___snow ___snow melt ____Temp

Wind ___Calm ✓ Breeze ___Wind

Station ID	Time Sampled (HH:MM)	Dilution needed (Y/N)	PH	Water Temperature	Unit	Conductivity	Unit	TDS	Unit	Salinity	Unit
NBR	9:00	Y	7.55	21.3	°C	6.41	mS	6.17	ppt	3.09	ppt
NBR	9:15	Y	7.58	25.6	°C	6.43	mS	6.21	ppt	3.05	ppt
NBR	9:20	Y	7.51	23.7	°C	6.97	mS	6.25	ppt	3.07	ppt

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 126cfu/100 ml). No single sample should have concentrations exceeding 235cfu/100 ml. Waters designated for secondary contact (boating) should not have E. coli concentrations exceeding 630/100 ml and less than 10% of the samples should have concentrations exceeding 1,260/100 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