MERRIMACK RIVER WATERSHED COUNCIL

2025 WATER QUALITY MONITORING REPORT

BASELINE PARAMETERS AND CSO / HEAVY RAIN EVENTS



Acknowledgements

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MRWC 2025 Water Quality Report

Table of Contents

Executive Summary 1

How to Use This Report 7

Introduction 9
- Understanding Sources of Bacteria 11
- Field Methods 16

Environmental Conditions 17
- Rainfall 17
- Combined Sewer Overflows 19
- Streamflow 23

2025 Monitoring Program Results 25
- pH 26
- Temperature 28
- Specific Conductivity 30
- Total Dissolved Solids 32
- Salinity 34
- Bacteria 36
  - Baseline Monitoring 37
  - CSO Event Monitoring 43
  - Cloud-Based Sensor Monitoring 49

Test Site Profiles 55
- Greater Manchester, New Hampshire – Merrimack Footbridge 58
- Greater Manchester, New Hampshire – USGS Guage 62
- Greater Nashua, New Hampshire – Greeley Park Boat Ramp 66
- Greater Nashua, New Hampshire – Independence Rowing Club 68
- Greater Lowell, Massachusetts – Pawtucket Blvd 70
- Greater Lowell, Massachusetts – Hunts Falls Bridge 74
- Greater Lowell, Massachusetts – Dracut Gravel Pit 78
- Greater Lawrence, Massachusetts – Bashara Boathouse 82
- Greater Lawrence, Massachusetts – Riverview Blvd (Methuen) 86
- Greater Haverhill, Massachusetts – 285 Lincoln Ave Bridge 90
- Greater Haverhill, Massachusetts – Ferry Park (West Newbury) 94
- Coastal Region, Massachusetts – Deer Island 98
- Coastal Region, Massachusetts – Bridge Road (Newburyport Drawbridge) 102
- Coastal Region, Massachusetts – Newburyport Harbormaster Peir 106
- Coastal Region, Massachusetts – Plum Island (Lighthouse) 112
- Coastal Region, Massachusetts – Salisbury Beach State Reservation 116

Data Qualifications and Limitations 121

References 123

EXECUTIVE SUMMARY

Executive Summary

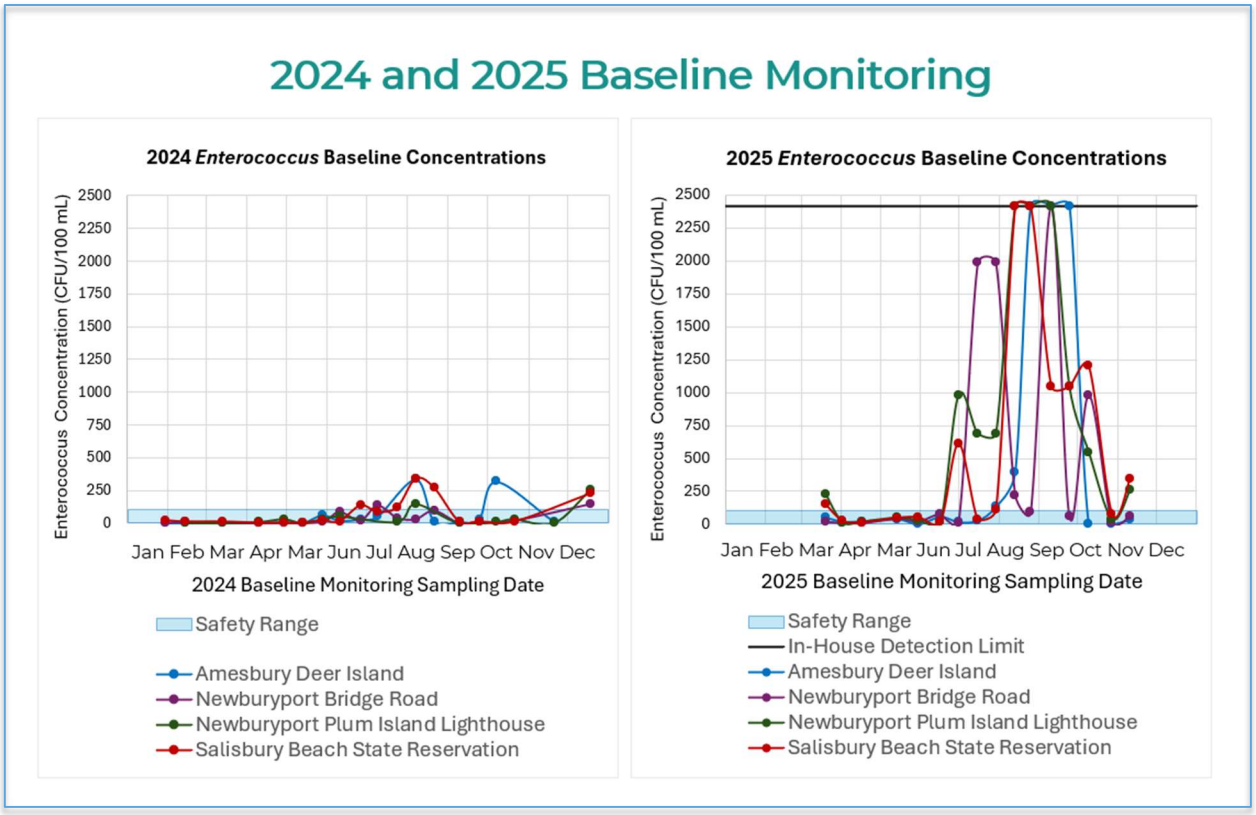
In 2025, the Merrimack River Watershed Council (MRWC) continued all of its 2024 water quality monitoring programs: our traditional monthly baseline monitoring, our combined sewer overflows (CSOs) and heavy rain event research, and our pilot program to explore the use of remote cloud-based sensors.

While MRWC focuses on basic physical/chemical parameters and fecal bacteria indicators, several other potential pollutants impact the Merrimack River that MRWC's water monitoring program does not monitor currently, such as PFAS/PCBs (long-term persistent chemicals), mercury, and microplastics. Within this report, when MRWC refers to the river being safe or unsafe, it is only in reference to baseline parameters and bacteria levels.

Primary Takeaways from 2025 Data

Frequent high bacteria levels in Newburyport Harbor with unidentified source(s) - 2024 data raised concerns for Newburyport Harbor with high bacteria levels in both wet and dry weather. In 2025, during baseline testing, bacteria levels were alarmingly higher with the chart below illustrating the increase.

Newburyport Harbor also saw significant bacteria levels after heavy rain events. These elevated results are likely due to stormwater runoff and not caused by CSOs since the closest CSO outfalls in Haverhill have limited downstream bacteria impact[33].



EXECUTIVE SUMMARY

Dracut and Methuen test sites experienced unsafe bacteria levels 100% of the time after CSOs – These sites are the first sites downstream of the Lowell and Lawrence CSO outfalls (respectively). They both have relatively low baseline bacteria readings (unsafe 7% and 6% of the time, respectively). West Newbury, another site immediately downstream of a CSO municipality (Haverhill) also had unsafe readings after CSOs (unsafe 80% of the time) and no unsafe readings during baseline testing (unsafe 0% of the time).

New Hampshire sites raise questions – The two monitoring sites in Manchester and the two monitoring sites in Nashua are located relatively close to each other but resulted in varying bacteria levels during baseline monitoring. In Manchester, the Merrimack Footbridge site had unsafe bacteria levels 25% of the time during baseline monitoring, while the USGS site (just 2.7 miles downstream) was unsafe only 8% of the time during those same test days. Similarly, in Nashua, the Greeley Park Boat Ramp site had unsafe bacteria levels 21% of the time during baseline monitoring, while the Independence Rowing Club (just 1.8 miles downstream) was unsafe 0% of the time during those same test days. This suggests potential hot spots at both the Merrimack Footbridge and Greeley Park Boat Ramp that merit further investigation.

More data is needed to understand the impacts of CSOs and heavy rain events – To truly begin to grasp how bacteria is originating and functioning in the river, a full season of more robust testing is required (significantly more test days and tests during varying conditions). Current limitations include:

- **Delayed sample initiation time** – The immediate impacts of CSOs are still unknown due to MRWC's 2024/2025 process of waiting for CSO activation before initiating on-call volunteer sample collection. This resulted in the first samples being collected between 14 to 38 hours after a CSO discharge notice was issued.
- **Limited sampling days** – Without continual testing, data which could illustrate the compounding impacts of multiple successive CSOs is not captured (financial resources limited MRWC to one 3-day CSO test period per week).
- **Limited testing during dry weather** – MRWC's current dataset lacks sufficient information from dry periods. MRWC's limited baseline data during dry periods frequently shows high bacteria readings; however, MRWC is missing the opportunity to document the full impact of stormwater runoff and identify illicit discharges.
- **Inability to differentiate fecal bacteria sources** – To date, due to financial limitations, MRWC has not been able to deploy eDNA testing which can identify human fecal bacteria. Incorporating these tests may help to differentiate between bacteria caused by sewage or bacteria caused by other sources.

EXECUTIVE SUMMARY

Program Activity

The **Baseline Monitoring Program** (16x per year) collected water quality data at 15 baseline sites along the mainstem of the Merrimack River, from Manchester, NH to Newburyport and Salisbury, MA. These sites include two new testing location in Nashua, NH that were added to the program in 2025. Data on pH, salinity, total dissolved solids, conductivity, temperature and two types of fecal indicator bacteria (*E. coli a*nd *Enterococcus*) were collected up to twice a month between January and December 2025.

The **CSO and Heavy Rain Event Research Program** collected data on either *E. coli* or *Enterococcus* at the same 15 baseline test sites and *E. coli* at 1 sensor site in Newburyport Harbor. Monitoring was conducted April to September for 3 days after a significant CSO event or heavy rain event with safety results made available to the public via an interactive webpage. Sites at West Newbury and upstream were tested when their applicable CSO municipality had a significant release. Sites at Amesbury and downstream to the mouth were tested for fecal bacteria after heavy rain events as indicated by Haverhill CSOs.

The **Cloud-Based Sensor Pilot Program** collected data on *E. coli* from June through October at 1 site at the Newburyport Harbormaster's Dock with safety results made available to the public via Facebook. Monitoring was conducted to provide data on Fridays, holidays and for 3 days after significant heavy rain events.

Results

For all test sites, the conditions for pH, salinity, total dissolved solids, conductivity, and temperature were supportive of aquatic ecosystems. However, although fecal bacteria levels in the Merrimack were safe most of the time, **high bacteria levels frequently occurred at some testing sites,** especially in Newburyport Harbor**.** The presence of fecal contamination in local water bodies (from stormwater runoff, illicit sewer connections and CSOs) presents a serious threat to both human and ecological communities.

pH	**WITHIN RECOMMENDED LIMITS**
Salinity	**WITHIN RECOMMENDED LIMITS**
Total Dissolved Solids	**WITHIN RECOMMENDED LIMITS**
Conductivity	**WITHIN RECOMMENDED LIMITS**
Temperature	**WITHIN RECOMMENDED LIMITS**
Bacteria	**DANGEROUS LEVELS FREQUENTLY OCCURRED**

EXECUTIVE SUMMARY

During Baseline testing, 10% of freshwater samples and 48% of brackish samples were unsafe for recreational activities, such as swimming or boating.

During CSO and heavy rain event testing, results from test sites varied greatly. For example, some sites had a minimal number of unsafe tests and we are re-evaluating whether they are within the geographic range of impact from their upstream CSO outfall. Other sites recorded unsafe conditions after some but not all of their upstream CSO events (Haverhill recorded unsafe conditions after 60% of their upstream CSO events). And other sites (Dracut and Methuen) recorded unsafe conditions after 100% of their upstream CSO events.

- **This variation between sites and between CSO events reinforces the inability to predict the bacterial impact of CSO events due to the complexity of factors impacting results.** Bacteria levels after a given CSO event can vary greatly depending on multiple determining factors within each of the following characteristics: the rainfall within the specific sewershed (amount, duration, intensity), the CSO outfall(s) discharge (volume, duration), the coinciding stormwater runoff, the streamflow, and the water temperature. Additionally, each test site is a unique distance from differing municipalities' CSO outfall(s), with significantly different hydrology (patterns of water movement/currents) in the intervening river segments. The bottom line is that each CSO event is different in its impact on the safety of the river. No two sites will respond the same to any given CSO and no one site will respond the same to two different CSOs.
- **Correlation, not causation.** CSOs release fecal bacteria into the river. So does stormwater runoff. Due to the co-occurrence of CSOs and stormwater runoff, MRWC cannot at this time prove the extent to which the CSOs (rather than stormwater runoff) caused any given high bacteria reading. 2025 was MRWC's second full year of its CSO and Heavy Rain Event Testing program, and future years will hopefully have the resources to provide more definitive answers.

During Cloud-Based Sensor testing in Newburyport Harbor, some results were alarmingly higher than the *E. coli* safety level of 235 CFUs (colony forming units) per 100 milliliters of sample water. MRWC recorded several results over 15x the safety limit (4,017 CFUs, 4,292 CFUs, and 5,151 CFUs) and one reading at 50x the safety limit (11,794 CFUs). These very high results indicate an unknown and intermittent source of bacterial contamination in the vicinity of the testing site requiring a more robust and focused investigation.

- **29% of regular Friday tests were unsafe.**
- **67% of heavy rain events tested had at least one unsafe reading in the following 3 days.**
- **46% of tests were unsafe in two one-week daily test periods during a dry period in the fall.**

EXECUTIVE SUMMARY

Observations

Impacts of low rainfall: 2025 was a below-average rainfall year. Total rainfall was 13% lower than in 2024 and 12% lower than the long-term average. 2025 also saw a relatively low CSO discharge volume (520 million gallons), the fourth lowest volume on record since 2016 and 42% lower than 2024.
However, even in a year with low rainfall and low CSO discharge, bacteria results on testing days in 2025 were more frequently unsafe and up to 5X higher than in 2024. Although an apparent contradiction, it is a reasonable outcome. One explanation is the fact that Annual trends cannot be compared to individual testing dates, especially given MRWC's limited 2025 testing schedule. Additionally, it is unknown at this point as to whether CSOs and rainfall are the major contributors to the higher bacteria levels.

Further research is needed to identify potential sources including illicit discharge, infrequent but intense rainfall events throughout the year, or other unknown sources. MRWC's limited 2025 data does not explain why these high results occurred.

To address bacteria, we need to think beyond CSOs: CSOs are widely assumed to impact the bacteria level for the full length of the river downstream of the CSO outfall site. However, engineering studies and MRWC's data indicate the range of impact from any given CSO is limited to only a portion of the downstream river. When considering the causes of dangerous bacteria levels throughout the river in all weather conditions, CSOs are likely dwarfed by the impacts of stormwater runoff, illicit discharges, broken storm drain/sewer pipes and other causes. CSOs are a significant identifiable contributor to dangerous bacteria levels, but only one part of the bacteria problem.

Outstanding Questions and Next Steps

MRWC wants to better understand what is causing high bacteria readings in the river so that we can help determine the best ways to address it. One pressing question is:

What is causing unexplained spikes in bacteria in Newburyport Harbor and the Essex Dam impoundment?

This report was written in October 2026. Selected parts of this report were pre-released in draft form and shared with the Massachusetts legislature and select foundations. To date, MRWC has succeeded in securing additional funds to hire a new Lead Scientist who will design and implement large-scale multi-year investigations to identify the sources of the bacteria in Newburyport and Lawrence for mitigation.

In 2026, MRWC launched a US-EPA funded Hot Spot Investigation Program, which as of October, has already successfully identified the source of a dangerously high fecal bacteria episode on the Shawsheen River (read next year's report for the full details!).

***

Please take time to read the full 2025 Water Quality Report. MRWC has worked to make the scientific information approachable for the lay person while maintaining the scientific integrity of the data. The report goes into detail about our testing parameters and specific test results. The last half of the report is a series of profiles of our test sites providing the reader with more in-depth site-specific information.

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HOW TO USE THIS REPORT

This report is written to provide information in a scientific format, but that is approachable for the general audience. Depending on your purpose for viewing the report, you may read the report from start to finish or visit each of the standalone sections to find only the information you are looking for. Below is a guide to each section.

Introduction

This section provides information about how we run our program and why, including explanations on where bacteria in the Merrimack come from, and how we work to understand them with our sampling program.

Environmental Conditions

This section explains the conditions within the watershed during 2025 that provide context for our sampling. This includes how much rain fell and streamflow patterns in the river in 2025 and how that compares to other years, as well as the volume of CSO discharge into the river and where. By understanding the context within which we collected data, we can draw better conclusions about our findings.

2025 Monitoring Program Results

This section provides and explains the data we collected in 2025 for all sites along the Merrimack River. Test results for each physical/chemical parameter (pH, specific conductivity, salinity, total dissolved solids, and temperature) and bacteria are described in detail.

Test Site Profiles

This section interprets the bacteria results at each testing site. Skip to this section if you only want to learn about bacteria conditions in the area where you live.

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INTRODUCTION

Who is MRWC

The Merrimack River Watershed Council (MRWC) was founded in 1976 to address the issue of pollution throughout the Merrimack River Watershed (Figure 1). At the time, the river turned green, or red, or orange, depending on the color dye that was used in the mills that day. While the dyes are gone, the river still faces significant threats. Known impairments include mercury, aluminum, phosphorous, fecal coliforms, and PCBs. Issues directly impacting water quality in the Merrimack are related to increased human activities across the watershed and aging sewer infrastructure, which can alter physical, chemical, and bacteria conditions in the Merrimack River. Of these and many other issues, MRWC is currently focusing our water quality monitoring on fecal indicator bacteria (*E. coli* and *Enterococcus*).

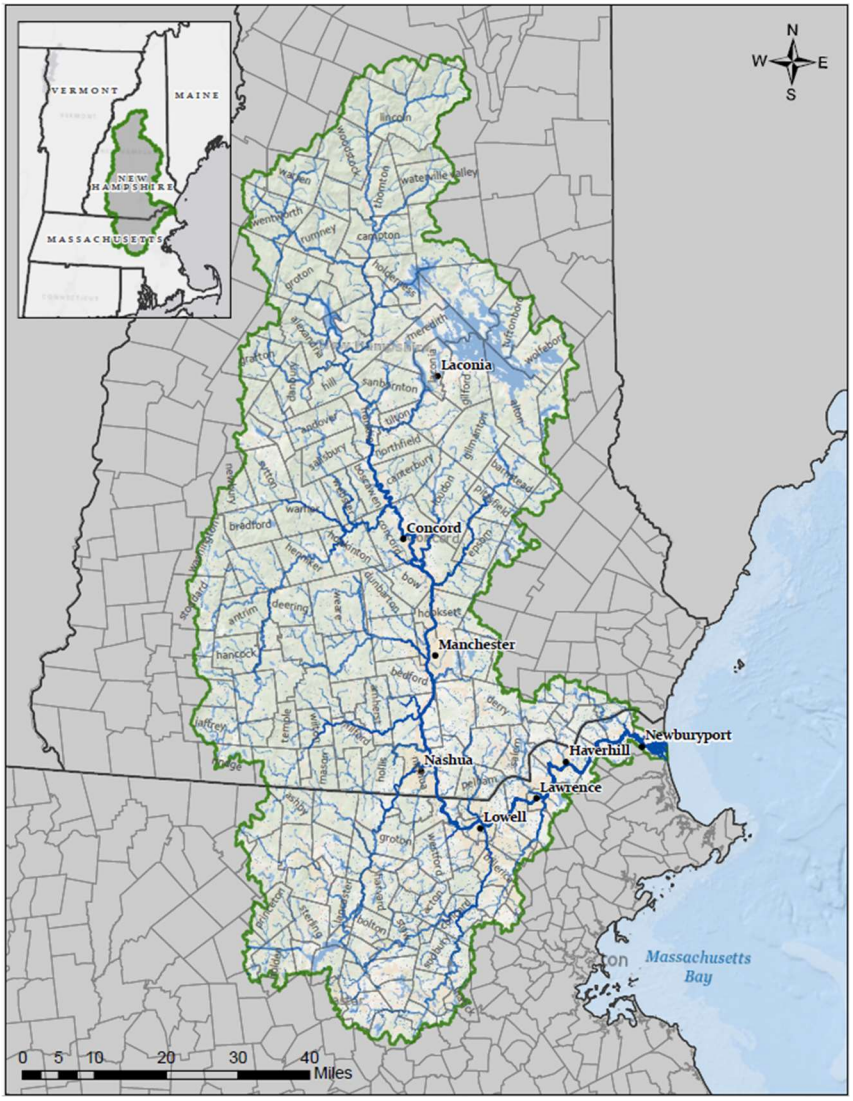


Figure 1. Map of the Merrimack River Watershed



Collecting Data to Improve Decision Making

MRWC collects water quality data at sites along the mainstem of the Merrimack River, from Manchester, NH to Newburyport and Salisbury, MA.

MRWC collects data on pH, salinity, total dissolved solids, conductivity, temperature, and concentrations of two types of fecal indicator bacteria. **While there are many types of bacteria, MRWC tests for Escherichia coli (*E. coli)* and *Enterococcus* which indicate if the river has been contaminated with fecal matter and to what extent.** Fecal contamination is especially important because it presents a serious threat to both human and ecological communities and can make people sick. High fecal indicator bacteria levels indicate that recreational activities, such as swimming or boating, may be unsafe. **Throughout this report "bacteria" is used for brevity but is referring to the fecal indicator bacteria of *E. coli* and *Enterococcus*.**

What about drinking water?
The Merrimack River is the second largest surface-based drinking water source in New England, with more than 700,000 people getting their drinking water from the river. However, drinking water is heavily treated and it is unlikely that water coming out of the tap from city supplied water will be contaminated with bacteria. A 2020-2024 study by the US Geological Survey did not find contaminants at reportable levels in treated drinking water, despite finding some in source water on the Merrimack. This suggests that water treatment methods are working correctly to eliminate contaminants from CSOs in drinking water.[1]

While we know there are periods when bacteria concentrations in the river are higher than the level considered safe for recreation, we also recognize that concentrations are below this level much of the time as well. There is still a major gap in understanding when, where, and for how long the river is unsafe to use after CSOs, rain events, or when snow is melting. The monitoring program at MRWC aims to fill that gap in understanding. By collecting data consistently, MRWC can better understand how changing environmental conditions and increasing human impacts affect the water quality of the Merrimack River. This data helps MRWC inform residents about the conditions of the Merrimack; advocate for the right solutions to improve conditions; inform the development of regulations; remediate pollution hot spots; and promote pollution reduction.

What is a combined sewer overflow (CSO)?

A combined sewer system collects rainwater and wastewater into one pipe. Under normal conditions, it transports all of this water to a sewage treatment plant before discharging into a water body, keeping our rivers clean. Sometimes, during heavy rainfall and snowmelt, the volume of the combined storm and wastewater can exceed the capacity of the system, and it discharges directly to nearby water bodies. ***Learn more at merrimack.org/cso***

INTRODUCTION

Understanding Sources of Bacteria

Bacteria in the Merrimack typically comes from one of three sources: nonpoint sources (like stormwater runoff), CSOs, and illicit sewer connections. By collecting water quality data over time and at different sites, we can see trends in bacteria concentrations that may help us to understand the source. While this sounds relatively simple, the process of identifying the source of contamination is complex. Bacteria concentrations vary greatly, and any given location in the river might receive bacteria from more than one source. Bacteria also flow downstream with the current (which can move fast some days and slower others), and rainfall is a driver for both nonpoint sources and CSOs, making them hard to differentiate. The methods we use to quantify bacteria only count living bacteria. Water temperature, exposure to light, salinity and other environmental conditions can affect how quickly bacteria die off. All of these conditions are changing all the time, making for a lot of factors when comparing the results of one day of sampling to another.

In order to see trends in the data and determine the source(s) of bacteria, a large dataset is required. To build this dataset, MRWC's baseline monitoring program collects samples at the same locations regularly (every two weeks April – October and once a month November – March) and will continue to monitor for many years into the future. Already, we can see trends in the data as outlined in this report, and we are working with communities to resolve known and suspected sources of fecal contamination. For example, since we know CSOs happen because of rain events, sites that have high bacteria concentrations during both wet and dry weather conditions are likely impacted by an illicit sewer connection or another point source. In 2020, MRWC found that our sample site in Methuen fell within this category. The EPA investigated the area, found the source of pollution, and has been working with the City of Methuen to fix this issue. This demonstrates the potential impact of data collection.



BACTERIA SOURCES IN THE MERRIMACK RIVER

NONPOINT SOURCES:







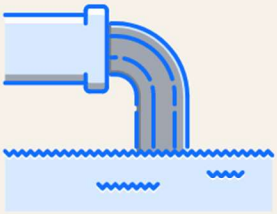
When rain runs over the land into rivers, it picks up and carries bacteria and other pollution. This might be animal waste from wildlife, your dog, or manure spread on agricultural fields. Wildlife that live in/on the Merrimack contribute fecal matter directly into the river.

In natural environments, rain falls on vegetated areas and seeps into the soil. As the water flows to the river, some pollutants and bacteria can be filtered out of the water by natural processes.

In urban areas, rainwater and snowmelt runs over parking lots and other impervious surfaces, where this natural filtration process doesn't happen.

POINT SOURCES:

Combined Sewer Overflows



Combined Sewer overflows (CSOs) occur when the combined sewer system that collects rainwater runoff, domestic sewage, and industrial wastewater into one pipe overflows.

Under normal conditions, these systems transport all the water to a sewage treatment plant. When the system works, it is best for the environment and our water bodies because it treats both stormwater and wastewater.

During heavy rainfall and snowmelt, the volume of combined storm and wastewater can exceed the capacity of the system. When this occurs, untreated stormwater and wastewater discharge directly into the Merrimack River.

Illicit sewer connections



Illicit sewer connections are when older septic system or sewer pipes are leaking or directly flowing into the river.

HOW DO WE TRY TO UNDERSTAND SOURCES OF BACTERIAL CONTAMINATION IN OUR RIVER?

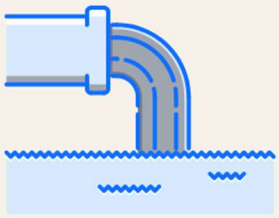
OBSERVATION IN MONITORING DATA	LIKELY SOURCE OF BACTERIA

Time + Space



High bacteria levels after a known CSO event at sites downstream of a CSO outfall are likely caused by that that outfall. However, since nonpoint source pollution also occurs when it rains, we can't know whether high levels of fecal indicator bacteria are caused 100% by nonpoint pollution or a CSO outfall.

CSO



Time / Space

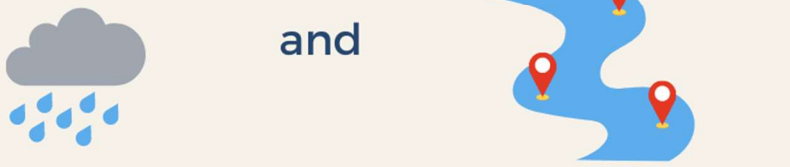


High bacteria levels during all weather events at the same site consistently, are likely caused by an illicit sewer connection.

Illicit connection



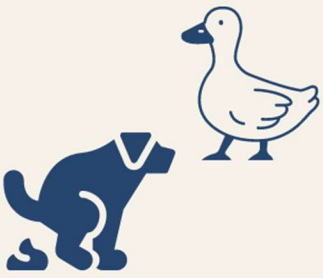
Time and Space



or



Nonpoint source





High bacteria levels during or after rainstorms (without a CSO) anywhere in the river or high levels after a CSO at sites upstream of a CSO outfall, are likely caused by nonpoint source pollution.

Monitoring Approach: Volunteer Powered



16 monitoring locations



18 volunteers and back-up volunteers



Samples collected 1 to 2 times per month and during CSOs/heavy rain events



882 samples analyzed in 2025

MRWC's water quality monitoring program relies on community science. Most data are collected by community members who are trained by MRWC staff scientists to gather quality-controlled data in a standardized and reliable way. Each volunteer takes samples regularly at their assigned site. Each volunteer receives a 1.5-hour training along with a testing kit. Volunteers are responsible for calibrating, using, cleaning, and storing their kit.

In 2025, MRWC volunteers collected water quality data at 15 sites on the mainstem of the Merrimack River for baseline monitoring: 11 sites in MA and 4 sites in NH (See Table 2 Figure 1). Additionally, MRWC continued its second year of piloting a cloud-based sensor at 1 site in Newburyport Harbor. These locations were selected based on a variety of criteria, including their location upstream or downstream of cities (and known CSOs), proximity to recreation areas (for activities such as swimming, kayaking, motor boating, and fishing), and the safety of our volunteers when accessing the river.

Of these 16 total monitoring locations, some are freshwater sites (not influenced by ocean water) and others are brackish sites (experience changing salinity and streamflow due to the tides). Freshwater monitoring locations begin at West Newbury, MA and continue upstream to Manchester, NH, while the brackish monitoring sites begin at the mouth of the river and continue up to Deer Island in Amesbury, MA. However, tidal influence can be seen as far upstream as the Essex Dam in Lawrence, as the downstream tides can increase water volume upstream, creating a tide-like state.

Beginning in July 2021, MRWC modified the baseline monitoring program to collect water samples within two hours before low tide to ensure that results are monitoring what contaminants are coming downstream, rather than what is coming in from the ocean.

Given the unpredictability of CSO/heavy rain event occurrence, the CSO/Heavy Rain Event testing program cannot schedule sampling to occur in the same low tide window. To maintain data consistency, CSO/heavy rain event samples are collected in the same time-window each day following a significant event. Due to capacity issues, MRWC only tests one CSO/heavy rain event in any given 7-day period, so not all significant events are tested. Testing occurs for only the three-day period regardless of whether another event occurs during that time; thus, a subsequent event may only be tested for the remaining days of the original 3-day period.

Our cloud-based sensor pilot program can pre-program the sensor to take samples at anytime of day or night, so samples are always taken in the low tide window.

INTRODUCTION

Table 1. 16 MRWC water quality monitoring locations. 15 baseline sites and 1 sensor site (Site 14)

Site	Site #	Site Type	Location	GPS Coordinates
Manchester - Merrimack Footbridge	1	Freshwater	Bridge	42.979072, -71.469388
Manchester - USGS Gauge	2	Freshwater	Shore	42.948027, -71.463148
Nashua – Greeley Park Boat Ramp	3	Freshwater	Shore	42.784062, -71.458815
Nashua – Independence Rowing Club	4	Freshwater	Shore	42.761261, -71.443859
Lowell - Pawtucket Blvd	5	Freshwater	Shore	42.6411911, -71.3460007
Lowell - Hunts Falls Bridge	6	Freshwater	Bridge	42.64649, -71.29923
Dracut - Gravel Pit	7	Freshwater	Shore	42.66614, -71.2417
Lawrence - Bashara Boathouse	8	Freshwater	Dock/Shore	42.6922158, -71.1773753
Methuen - Riverview Blvd	9	Freshwater	Shore	42.7273583, -71.1290352
Haverhill - Lincoln Ave Bridge	10	Freshwater	Bridge	42.7642673, -71.0345758
West Newbury - Ferry Park	11	Freshwater	Shore	42.8101931, -70.9963550
Amesbury - Deer Island	12	Brackish	Shore	42.8348062, -70.9068175
Newburyport – Bridge Road	13	Brackish	Bridge	42.815705, -70.872899
Newburyport – Habor Master Pier	14	Brackish	Sensor	42.812778, -70.867778
Newburyport - Plum Island	15	Brackish	Dock/Shore	42.816798, -70.820559
Salisbury Beach State Reservation	16	Brackish	Shore	42.8218847, -70.8212684

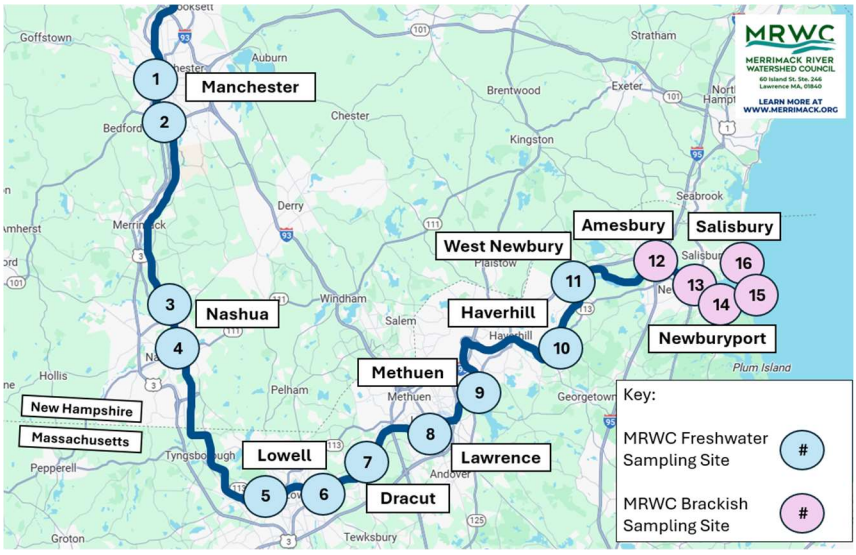


Figure 2. Map of MRWC water quality monitoring sites along the Merrimack River (2025). *15 baseline sites and 1 sensor site (Site 14)*

INTRODUCTION

Field Methods – Baseline Monitoring

Water quality samples and data are collected bi-monthly at each site. During the winter months (November through March) testing is reduced to once a month due to difficulty accessing sites during winter weather.

The samples are collected by volunteers either from a bridge (using a rope and bucket) or from the riverbank (obtaining the sample an arm's length into the river). Five physical and chemical water quality measurements are recorded on site using a handheld Hach Pocket Pro+ Multi 2 Tester: 1) pH, 2) conductivity, 3) total dissolved solids (TDS), 4) salinity, and 5) temperature. Prior to testing, Hach sensors are calibrated by MRWC or volunteers to ensure accuracy.

Quality Assurance Project Plan

Our field and lab methods follow our Quality Assurance Project Plan (QAPP) which was approved by the EPA and MassDEP.

Within our QAPP, we use approved standard operating procedures for sample collection, parameter measurements, and sample analysis.

At each site, three readings are collected for each of the five physical/chemical properties to ensure precision of measurements. Volunteers record measurements on datasheets with observations about the ambient conditions and nearby activity that may impact the sample.

A grab sample is collected in a sterile bottle with a sodium thiosulfate preservative. Samples are stored on ice, transported to the MRWC office, and then analyzed in MRWC's in-house laboratory. Datasheets and the bacteria data are reviewed by MRWC staff for reasonableness and completeness before being entered into the MRWC water quality database.

Field Methods – CSO/Heavy Rain Event Monitoring

From April – September, after select significant CSO/heavy rain events, water quality samples are collected by volunteers and staff. Heavy rain events are indicated by Haverhill CSOs and are used to initiate sampling in the mouth. Samples are collected for the three days following a CSO/heavy rain event using the same grab sample procedure as outlined in the baseline monitoring program. These samples are analyzed in MRWC's in-house laboratory and data is reviewed by MRWC staff for reasonableness and completeness before being entered into MRWC's water quality database.

Field Methods – Sensor Pilot Program

The sensor pilot program was originally initiated in 2024 and operated in 2025 from June through October. There are three data sets from the sensor, all samples taken at low tide. First, samples are collected prior to the weekend, the timing of which is set so results are available online by 5pm on Fridays and the day before major holidays. Second, samples are collected after significant heavy rain events for three days. Third, samples were run daily for one-week periods in August and September to utilize otherwise expiring cartridges. Sensor samples are collected, incubated and analyzed within the Fluidion Sensor with results available to MRWC online. The results are reviewed by MRWC staff for reasonableness and completeness before being entered into the MRWC water quality database.

EPA Region 1 Lab analyzed most baseline monitoring samples for 2024 and March of 2025, reporting results as "most probable number per 100 milliliters" (MPN/100 mL). For the rest of 2025, MRWC analyzed all samples, reporting results as "colony forming units per 100 milliliters" (CFU/100 mL). These two units are considered interchangeable.

ENVIRONMENTAL CONDITIONS

Many conditions within the natural and human-made environment contribute to the water quality of the Merrimack River. These conditions influence changes in water quality parameters over time and space and should always be considered when interpreting water quality data.

Rainfall

Rainfall has a significant impact on river flows and water quality conditions. In vegetated places in the Merrimack River Watershed, rain falls on the ground and either absorbs into the soil or runs off directly into the river, carrying sediments, nutrients, and bacteria with it. In urban areas, there is very little soil to absorb the rain, so it often flows over paved surfaces into stormwater infrastructure. In most towns and cities, this untreated stormwater runs directly into the river, carrying with it everything that it picks up along the way. However, five regions along the Merrimack have combined sewer systems, which operate differently. In these systems, both stormwater and sewage flow to the wastewater treatment plant and are treated before being discharged into the river. If it rains enough or there is enough snowmelt to overwhelm the system, a CSO occurs, causing a mix of stormwater and sewage to flow directly into the river untreated.

Rainfall is measured daily at various rainfall gauges across the region. The gauges used in this section are maintained by the National Oceanic and Atmospheric Administration. For this analysis, we selected 5 stations along the Merrimack River in Concord and Manchester, NH and Lawrence, Haverhill, and Newburyport, MA, and compared the annual and monthly values for 2025 to the 10-year average (2016-2025) as well as the long-term average (1953-2025)[2]. The Lawrence, MA rain gauge did not record levels for October 1st through December 31st so instead the rain values from the nearby Lawrence Municipal Airport rain gauge were used for these missing dates.



Total Rainfall

Rainfall records from 2025 showed that it was relatively dry, with total rainfall being 14% lower than the 10-year average rainfall and 12% lower than the long-term average rainfall. In the three downstream locations of Lawrence, Haverhill, and Newburyport, MA, the total rainfall was between 16% and 25% lower than the long-term average, indicating that the lower watershed received less rainfall than normal. Conversely, the upper watershed experienced relatively normal levels compared to the average long-term rain levels, with Concord, NH receiving 1% more rainfall and Manchester, NH receiving 0% more rainfall (Table 2).

Table 2. Rainfall data from 5 stations in the Merrimack River Watershed[2].

Rainfall Station	Elevation (m)	Total 2025 Rainfall (in)	10-year Average Rainfall (in)	10-year % Difference	Long-term Average Rainfall (in)	Long-term % Difference
CONCORD, NH	103.1	39.6	42.7	-7%	39.4	1%
MANCHESTER, NH	77.1	39.8	43.9	-9%	39.9	0%
LAWRENCE, MA	15.2	36.4	44.0	-17%	43.5	-16%
HAVERHILL, MA	6.1	34.4	46.6	-26%	45.9	-25%
NEWBURYPORT, MA	16.8	37.3	41.0	-9%	46.3	-20%
Average		**37.5**	**43.6**	**-14%**	**43.0**	**-12%**

Monthly Rainfall

Looking at monthly rainfall helps provide context for understanding CSO discharges. When comparing the monthly rainfall amounts in Haverhill, the 2025 monthly values show a high peak above the 10-year average in May. For the rest of the year, it is either at or below the 10-year average. Included for comparison is the monthly rainfall for 2023, a year which, with a particularly rainy summer, saw a record-breaking 2 billion gallons of CSO discharge (Figure 3).

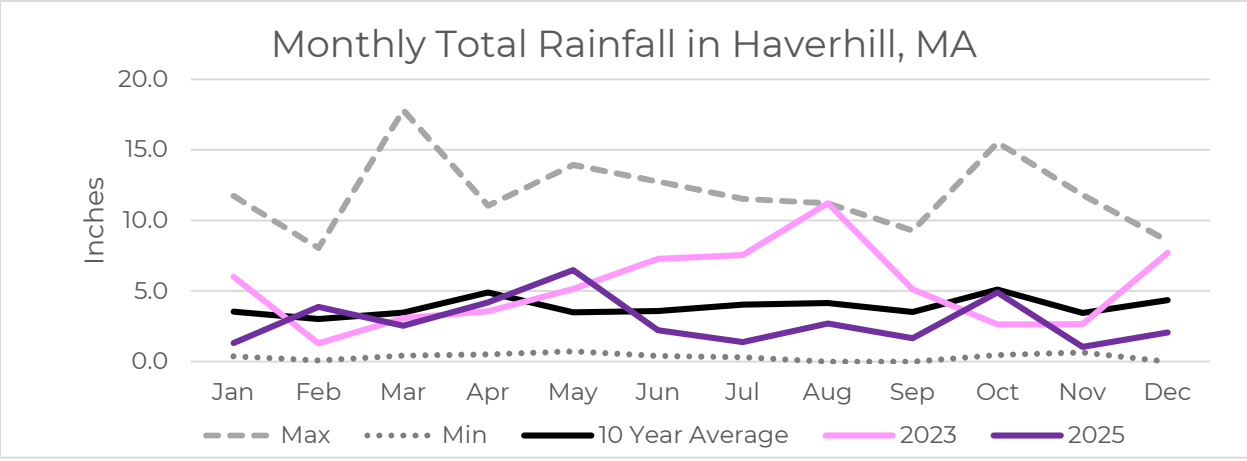


Figure 3. Monthly rainfall at the Haverhill rainfall station[2].

Combined Sewer Overflows (CSOs)

CSO volumes can fluctuate annually depending on the rainfall and any changes made to combined sewer systems. CSO discharge volume also varies from event to event due to factors like rainfall intensity, rainfall duration, and soil saturation. There are five areas with combined sewer systems on the mainstem of the Merrimack River: Manchester and Nashua in NH and Lowell, the Greater Lawrence Sanitary District (GLSD), and Haverhill in MA.

Based on CSO volume data reported by wastewater treatment facilities in each of the five areas from 2016 to 2025, the year 2025 saw a relatively low annual volume of CSOs into the Merrimack compared to the past 10 years with a total of 520 million gallons (Figure 4, Table 3)[3-7]. The largest contributor in 2025 was Manchester with 384 million gallons (Table 3). On average, Manchester contributes approximately 332 million gallons per year (45%) and Lowell contributes 297 million gallons per year (40%) for a total of 85% of the CSO volume in the last 10 years (Figure 4, Table 3). The smallest contributor in 2025 was Haverhill with a total of 3 million gallons (1% of the total 2025 volume and the lowest Haverhill discharge volume in the past 10 years) (Figure 4, Table 3). In addition to the largest CSO volume, Manchester also had the largest number of CSO activations in 2025 at 158 (Figure 5).

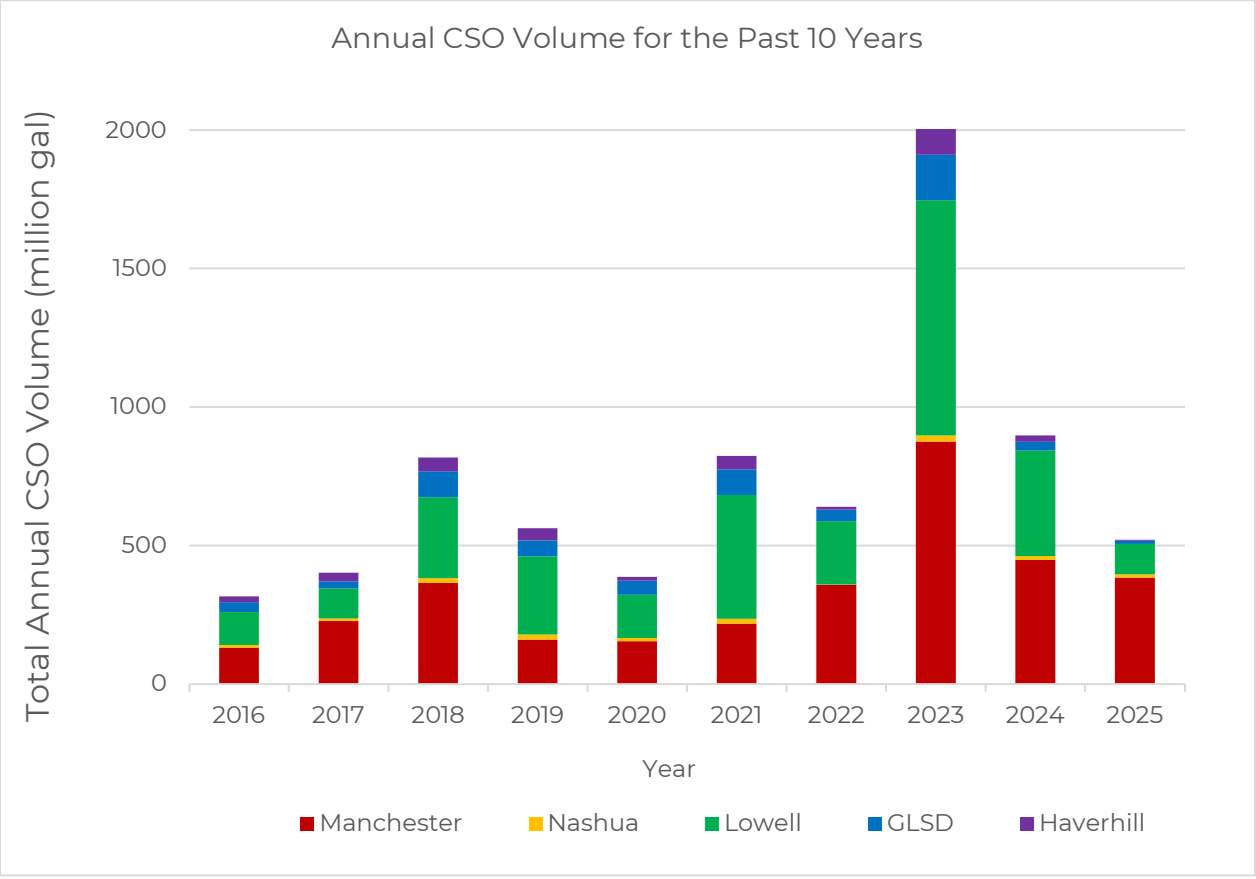


Figure 4. Total annual CSO volume from the five combined systems on the Merrimack River[3-7]. These values do not include discharge that was partially treated.

Table 3. Annual CSO volume by year and combined sewer system[3-7]. These values do not include discharge that was partially treated.

	Total Annual CSO Volume (million gal)					
Year	**Haverhill**	**GLSD**	**Lowell**	**Nashua**	**Manchester**	**Total**
2016	21	36	118	10	131	**316**
2017	31	26	108	10	227	**401**
2018	50	93	292	18	364	**817**
2019	44	58	282	19	160	**562**
2020	15	50	157	11	154	**387**
2021	48	93	447	17	218	**823**
2022	11	42	229	1	358	**640**
2023	97	164	850	21	876	**2,008**
2024	23	31	381	14	447	**897**
2025	3	11	110	12	384	**520**
2025 Percent	1%	2%	21%	2%	74%	
Average Volume	**34**	**60**	**297**	**13**	**332**	**737**
Average Percent	**5%**	**8%**	**40%**	**2%**	**45%**	

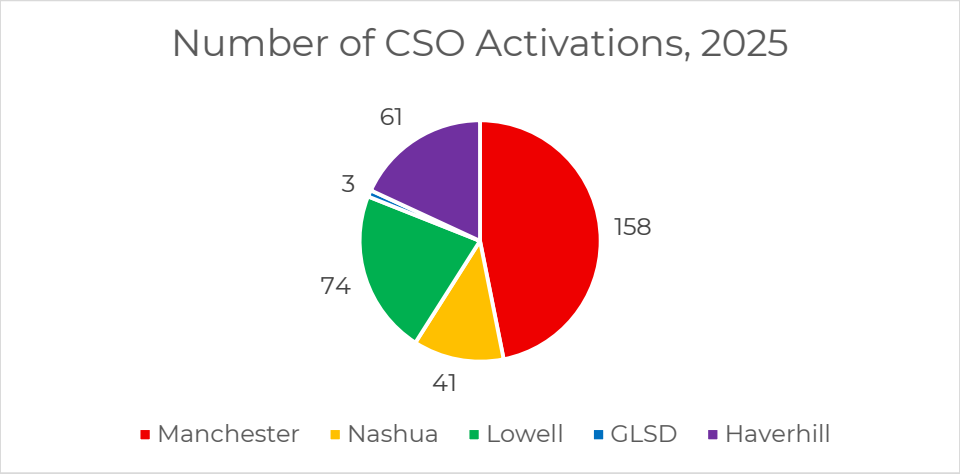


Figure 5. Annual number of CSO activations from the five combined systems on the Merrimack[3-7]. These activations do not include discharge that was partially treated.

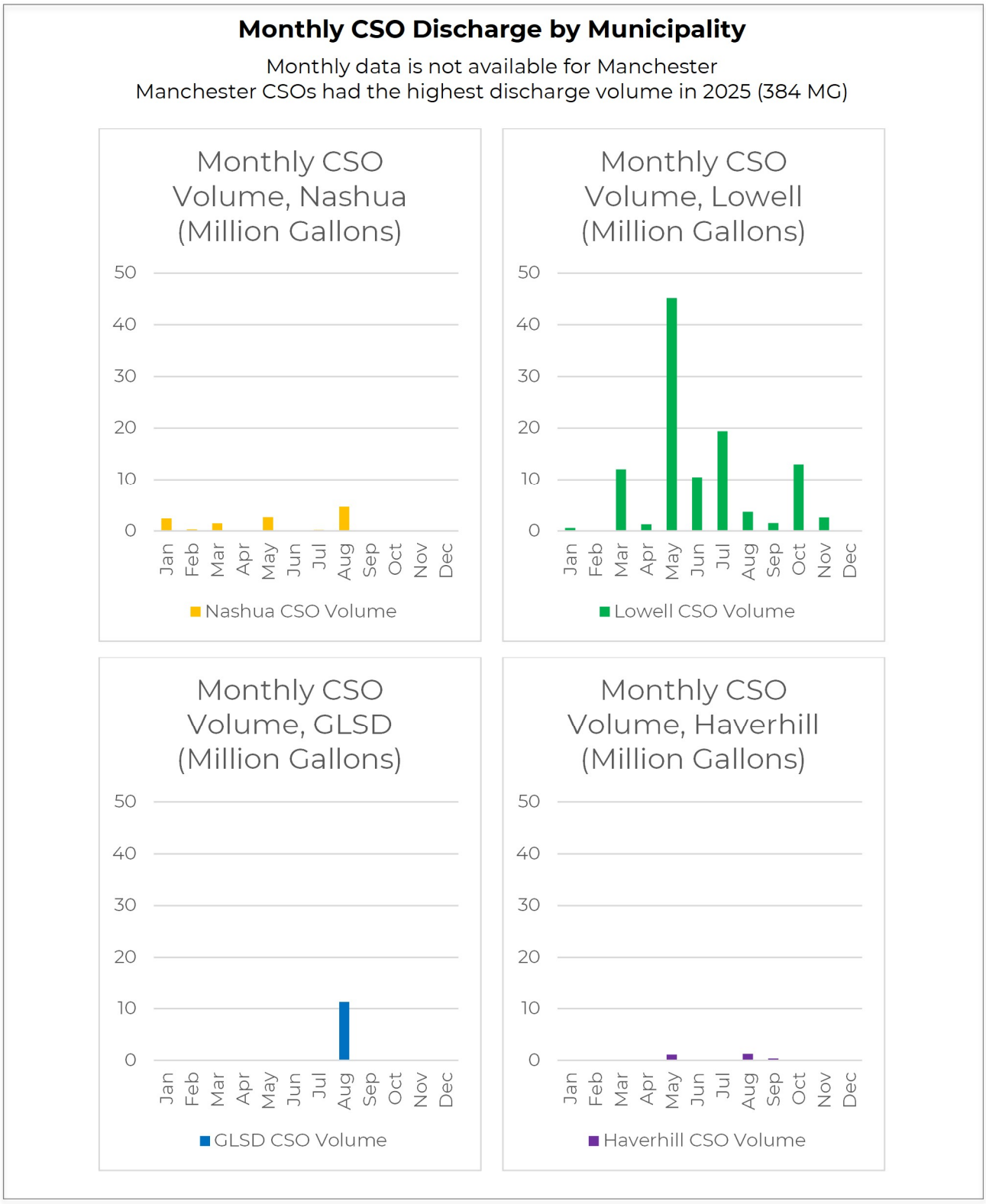


Figure 6. 2025 monthly CSO volume by municipality. Manchester is not included as data is unavailable[3-6]. These values do not include discharge that was partially treated.

CSO Events Driven by Rainfall

Heavy rainfall causes CSO events in the Merrimack River. Combined sewer systems vary in how they respond to rainfall. In Figure 7 below the CSO systems of Nashua and Haverhill are compared with the amount of rain each month. In both cities, May had the largest amount of rain and the highest number of CSO activations.

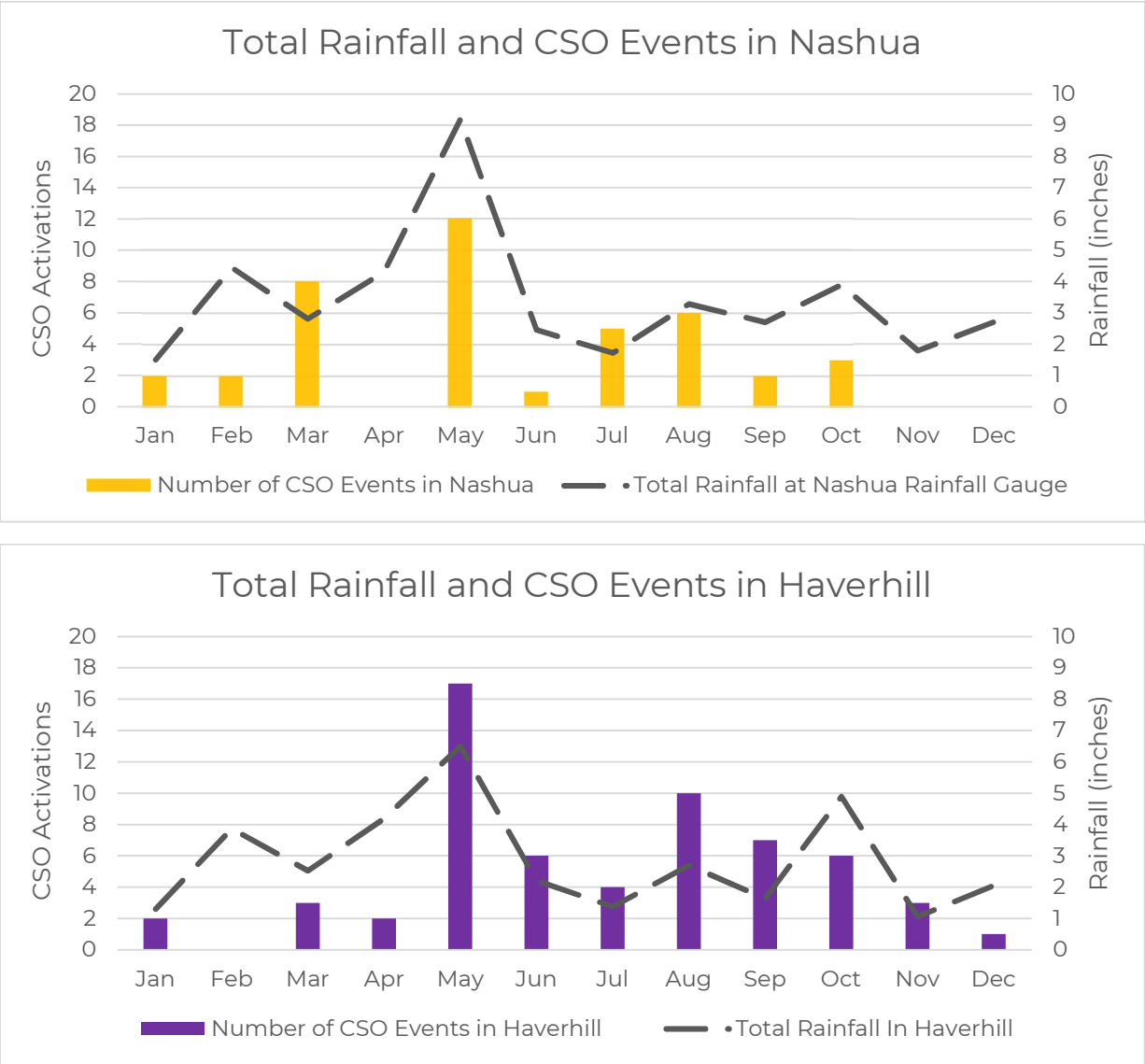
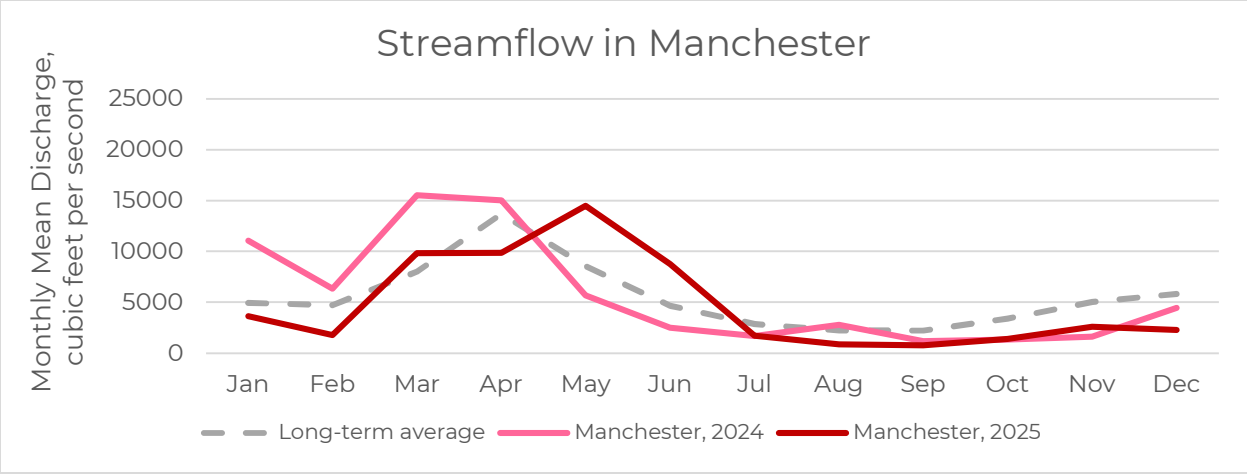


Figure 7. Monthly CSO events compared to rainfall data[2].

Streamflow

Streamflow, or the amount of water moving through the river at a certain location, is closely linked to snowmelt and rainfall. Once rainfall and snowmelt carry bacteria from the source to the river, streamflow determines how quickly it will move downstream. There are two gauges in the Merrimack that measure streamflow, one in Manchester, NH and one in Lowell, MA (Figure 8)[8-9].

In 2025, higher than average flows in May through July reflect a wet spring. In 2024, the higher flows in February through April were due to snowmelt. Streamflow in the summer of 2025 was similar to 2024 and below the long-term average, reflecting a drier summer.



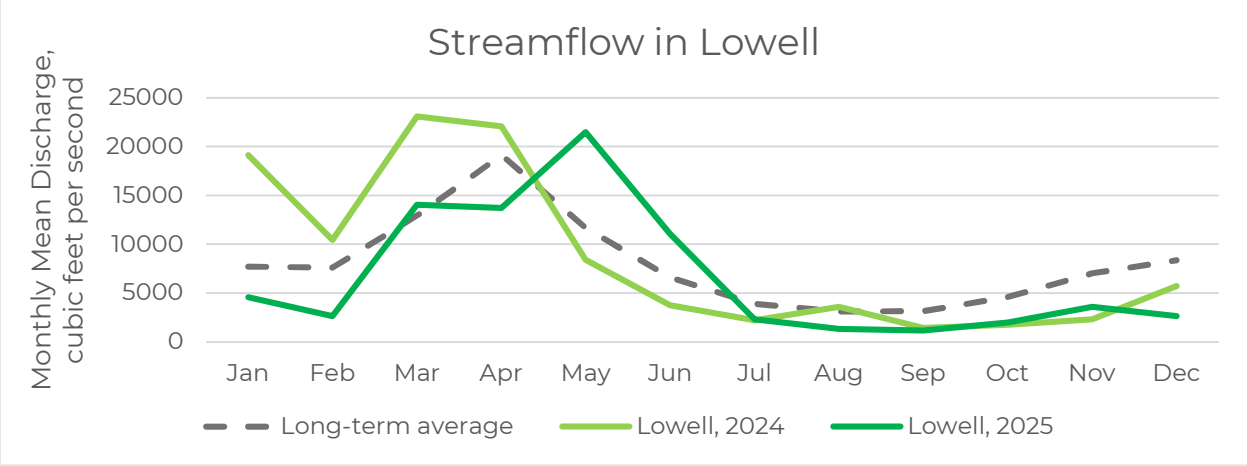


Figure 8. Average monthly streamflow at the USGS Gauge in Manchester and Lowell, for 2024 and 2025, compared to the long-term average[8-9].

Impact of Environmental Conditions on Bacteria Levels

Understanding the conditions/thresholds that trigger CSOs, the correlations between those conditions and the resulting volume of CSO discharged, the correlations between volume discharged and the resulting bacterial impact, and differentiating between the impacts of CSOs and stormwater runoff is not possible with the currently available data.

The factors that contribute to initiating a CSO and determining its discharge volume include but are not limited to 1) how much it rains (total precipitation), 2) how hard it rains (intensity), and 3) how long it rains (duration). Additionally, for accurate prediction/correlation, these rainfall conditions would have to be measured within each separate sewershed that discharges CSOs, and the thresholds for triggering a CSO (and for determining how long it lasts and the volume to be discharged) is likely different not only for each municipality, but for each outfall within the municipality as well.

Further complicating MRWC's ability to understand the link between rainfall and fecal indicator bacteria in the Merrimack are the many factors that influence the bacteria level (and its duration and range) once the CSO is discharged. These factors include but are not limited to:

- Volume of discharge
- Rate of discharge
- Duration of discharge
- Rate of streamflow
- Co-occurring storm or CSO in the immediate days prior to or following the initial CSO
- Water temperature
- Hydrology of the specific section of river involved

Finally, to fully understand the impact of the CSO-caused bacteria, one needs to differentiate the bacteria from sewage and bacteria from stormwater runoff.

MRWC is only beginning to answer these questions in the Merrimack River and the current datasets need to be collected over a longer period and with significantly greater frequency.

The public can be alerted about CSOs when they are occurring via email. Currently, you must sign up for notifications from each wastewater treatment facility individually. You may also download reports about all CSO events in a month, quarter or year, depending on the facility.

2025 MONITORING PROGRAM RESULTS

The five parameters that MRWC measures include pH, specific conductivity, salinity, total dissolved solids, and temperature. These measurements are recorded using a Hach Pocket Pro+ Multi 2 Tester (Figure 9) as a part of the baseline monitoring program. The overall goal is to measure the baseline levels along the Merrimack River to monitor long-term changes over time and identify any specific locations that exceed the expected values. Any significant changes in these values could be due to excess pollutant loading.

The next section reviews the five different parameters that MRWC measures as part of our baseline monitoring program. It includes information and context about each parameter as well as a review of the conditions in the Merrimack River in 2025.

Specific conductivity, salinity, and total dissolved solids follow similar trends since they are all based on the number of various substances that are dissolved in the water. The corresponding graphs are split between freshwater and brackish results as the normal conditions for these parameters in brackish waters are higher than in freshwater and need to be viewed on a different scale.



Figure 9. Hach sensor measuring pH, specific conductivity, salinity, total dissolved solids, and temperature in the field.

pH

What is pH?

- pH is a measurement of how basic or acidic water is, or more specifically, the concentration of hydrogen ions in water; pH has no units
- pH ranges from 0 (most acidic) to 14 (most basic), with 7 being neutral
- pH is based on a logarithmic scale, so a pH of 5 is 10 times more acidic than a pH of 6 and a pH of 9 is 10 times more basic than a pH of 8

Why is it important?

- Water that is too basic or too acidic can impact aquatic plants and wildlife, causing stress and reducing their overall growth, reproduction, and survival rates, and can lead to a reduction in biodiversity[10-11]
- Water with pH that is too high or too low can also corrode water pipes and make it harder to treat drinking water[10]

What changes pH values?

- The background pH in waterbodies is influenced by the types of rocks and soils present in a watershed. For example, streams in areas that have soils with high levels of carbonate often have slightly basic pH[10]
- Human activities, such as mining runoff, industrial pollution, and the burning of fossil fuels, can cause a decrease in pH, making waters more acidic[10-12]
- Industrial pollution dumped directly into the river can also affect the pH
- The pH of seawater typically has a range between 7.5 and 8.5, freshwater between 6 and 8, and natural precipitation around 5.6. However, due to the acidification of atmospheric water from coal fired power plants in the Midwest, rainwater in New England has a pH between 4.5 and 4.7[10-12]

What are important values for environmental or human health?

- The US EPA suggests an optimal pH range of 6.5 to 8.5 to support aquatic organisms[11]
- Between 6.5 and 8.5 is often considered ideal for drinking water for people[13]

What were the conditions in the Merrimack River in 2025?

Besides the Nashua sites, all other sites had a median pH within the EPA's water quality criteria between 6.5 and 8.5 (Table 4, Figure 10). The median pH values for the Nashua sites were slightly below this range at 6.40 for the Greeley Park Boat Ramp and 6.43 for the Independence Rowing Club. Since these sites are new as of 2025, MRWC will continue to monitor the pH results to see if this is a long-term trend. A couple of other sites had singular pH readings slightly below 6.5 but these low results are only slightly below the guidelines and are unlikely to have an impact on aquatic species. All sites had a median pH value below that max of 8.5.

Table 4. Minimum, maximum and median pH measurements from all monitoring sites 2025.

Site	Water Type	River Mile	Min pH	Max pH	Median pH
Manchester - Merrimack Foot Bridge	Freshwater	70.55	6.30	7.60	7.09
Manchester - USGS Gauge	Freshwater	67.86	5.96	7.52	6.92
Nashua – Greeley Park Boat Ramp	Freshwater	55.75	6.16	7.55	6.40
Nashua – Independence Rowing Club	Freshwater	53.92	5.88	7.02	6.43
Lowell - Pawtucket Blvd	Freshwater	47.75	6.27	7.74	6.94
Lowell - Hunts Falls Bridge	Freshwater	43.00	6.36	7.27	7.05
Dracut - Gravel Pit	Freshwater	34.00	6.57	7.77	6.95
Lawrence - Bashara Boathouse	Freshwater	29.02	6.40	7.73	7.09
Methuen - Riverview Blvd	Freshwater	26.20	6.28	7.78	6.98
Haverhill - Lincoln Ave Bridge	Freshwater	16.24	6.54	7.82	7.04
West Newbury - Ferry Park	Freshwater	12.43	6.95	7.51	7.18
Amesbury - Deer Island	Brackish	5.67	6.69	7.56	6.85
Newburyport - Road Bridge	Brackish	3.47	6.15	7.62	7.06
Newburyport - Plum Island	Brackish	0.74	6.72	8.15	7.16
Salisbury - Beach State Reservation	Brackish	0.72	6.52	7.45	7.01

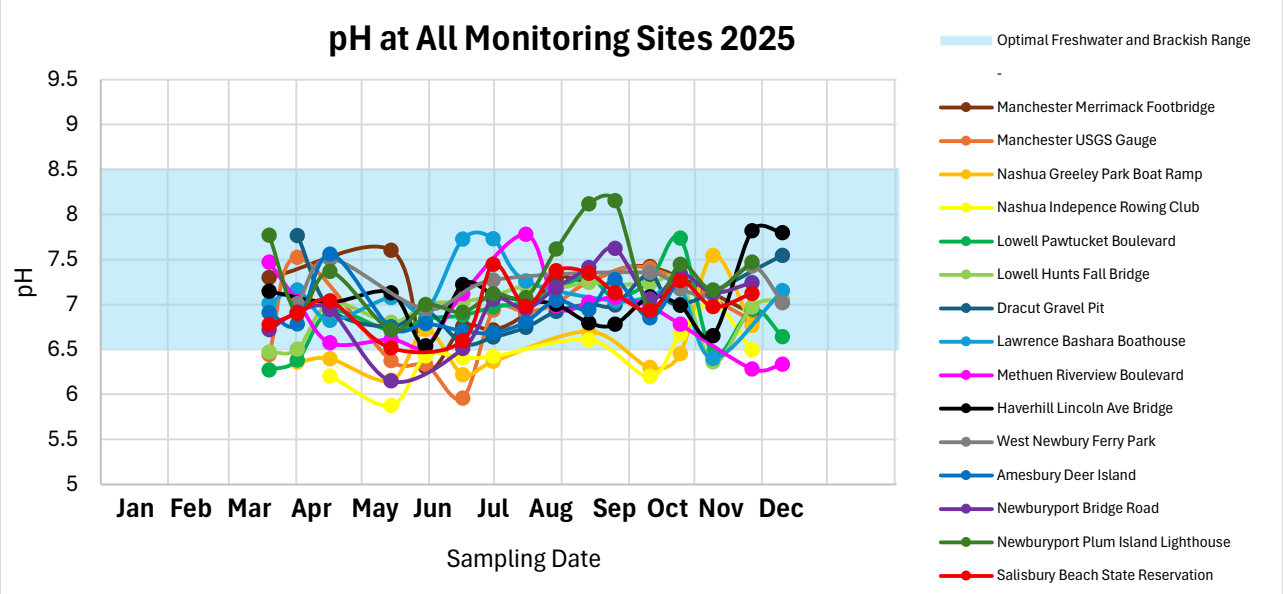


Figure 10. pH measurements from all monitoring sites in 2025. See data qualifications at the end of the report

Temperature

What is temperature?

- Temperature is a measurement of thermal energy, measured in degrees Celsius (˚C) or degrees Fahrenheit (˚F)

Why is it important?

- Aquatic plants and wildlife species have a preferred temperature range[14]
- Water bodies with higher temperatures contain less dissolved oxygen, which is important for aquatic organisms[14,15]
- Water bodies with high temperatures may also result in higher levels of toxicity from heavy metals[15]

What changes temperature?

- Temperatures naturally fluctuate with the seasons and can be influenced by tides containing ocean water
- Human actions, such as building dams, running thermoelectric power plants, and cutting down riparian forests, can increase the temperature of rivers and water bodies[15]

What are important values for environmental or human health?

- The State of Massachusetts has established protective water quality standards for the Merrimack River where freshwater temperatures should not exceed 28.3°C (82.9°F)[16]
- The state of Massachusetts has established protective water quality standards for the Merrimack River where brackish water temperatures should not exceed 29.4°C (84.9°F)[16]

What were the conditions in the Merrimack River in 2025?

Comparing all monitoring sites, the surface temperatures are relatively similar (Table 5, Figure 11). During spring, fall, and winter, the Merrimack River is well below the temperature limit of 28.3˚C for freshwater. This means that the water temperature is suitable for contact recreation, fishing, and aquatic life. During the summer months, some of the sites get extremely close to the limit. This includes Methuen Riverview Boulevard and West Newbury Ferry Park which pass the brackish water limit of 29.4˚C. It should also be noted that the samples were taken near the surface of the water, which tends to be warmer due to heating from the sun. The water further down in the water column is likely much cooler and able to support important fish species, even in the warm summer months.

Table 5. Minimum, maximum, and median temperature from all monitoring sites in 2025.

Site	Water Type	River Mile	Min Temp (˚C)	Max Temp (˚C)	Median Temp (˚C)
Manchester - Merrimack Footbridge	Freshwater	70.55	5.1	27.9	19.6
Manchester - USGS Gauge	Freshwater	67.86	4.0	27.8	19.4
Nashua – Greeley Park Boat Ramp	Freshwater	55.75	7.3	27.3	17.8
Nashua – Independence Rowing Club	Freshwater	53.92	9.3	27.6	18.9
Lowell - Pawtucket Boulevard	Freshwater	47.75	5.1	26.2	18.0
Lowell - Hunts Falls Bridge	Freshwater	43.00	6.1	27.0	17.9
Dracut - Gravel Pit	Freshwater	34.00	5.5	27.9	20.2
Lawrence - Bashara Boathouse	Freshwater	29.02	3.5	27.5	18.8
Methuen - Riverview Boulevard	Freshwater	26.20	4.7	29.5	19.0
Haverhill - 285 Lincoln Ave Bridge	Freshwater	16.24	8.2	28.3	19.7
West Newbury - Ferry Park	Freshwater	12.43	7.9	30.4	20.7
Amesbury - Deer Island	Brackish	5.67	5.9	27.1	20.1
Newburyport - Road Bridge	Brackish	3.47	6.0	25.0	19.4
Newburyport - Plum Island	Brackish	0.74	6.6	20.3	16.9
Salisbury - Beach State Reservation	Brackish	0.72	7.4	19.9	17.2

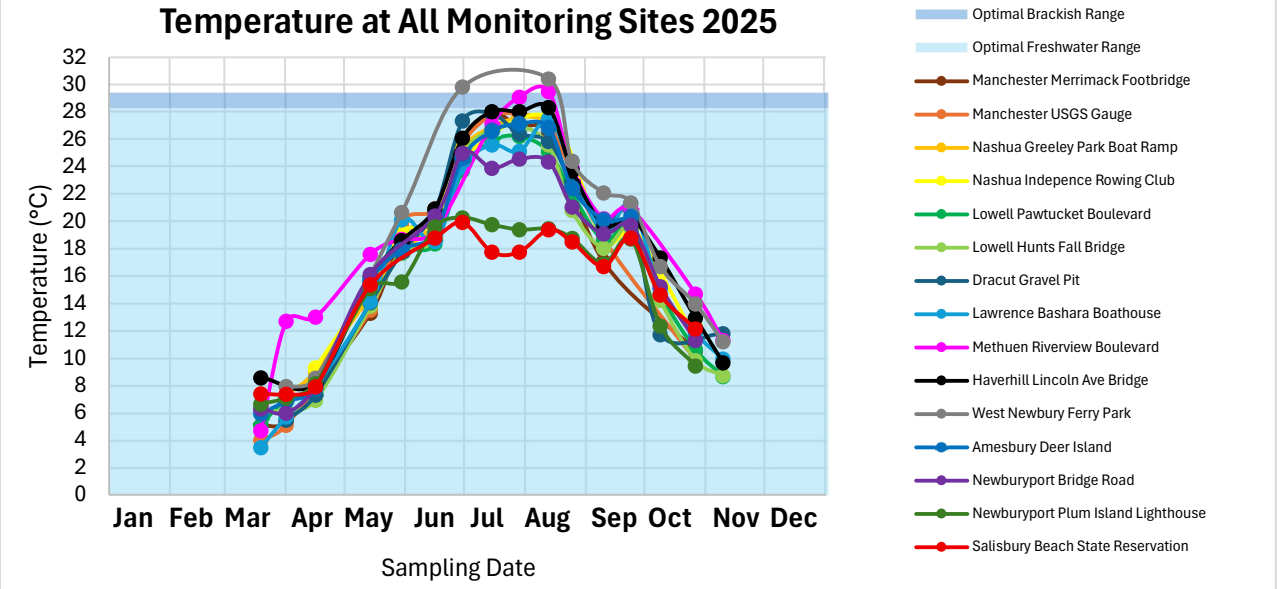


Figure 11. Temperature measurements from all monitoring sites in 2025. See data qualifications at the end of the report

Specific Conductivity

What is specific conductivity?

- Specific conductivity (also referred to as conductivity) is a measure of water's ability to conduct electricity, measured in micro-Siemens per centimeter (µS/cm) at 25˚C
- Conductivity is dependent on the amount of positive and negative ions in the water, usually due to the presence of dissolved salts
- Conductivity is closely linked to salinity and total dissolved solids

Why is it important?

- Rivers and streams usually have a relatively consistent conductivity value that is unique to that water body, and any significant change in conductivity measurements may indicate pollutants entering the river[17]
- Background levels of conductivity are dependent on the surrounding geology, with clay soils increasing conductivity and granite bedrock reducing it[17]

What changes conductivity?

- Agricultural runoff and sewage leaks may increase conductivity, while oil spills or other organic compounds may decrease conductivity[17]

What are important values for environmental or human health?

- Freshwater rivers in the US typically range between 50 and 1,500 µS/cm[18]
- Brackish water is typically between 1,500 and 5,000 µS/cm, but can range higher to 35,000 µS/cm as it mixes with seawater[19]
- Industrial wastewater can measure 10,000 µS/cm or more[17,18], while seawater can measure up to 55,000 µS/cm or more[17]

What were the conditions in the Merrimack River in 2025?

The median conductivity results of all freshwater sites in the Merrimack River were within the typical range for freshwater rivers (Table 6, Figure 12). As much of the watershed contains granite bedrock and granitic soils, it is expected that the background conductivity levels will be relatively low, which is shown in the results.

The median conductivity for all brackish sites were within the optimal brackish range. However, the test results for Newburyport Plum Island from June through August were significantly higher than typical ocean values (see data qualifications at the end of the report). All other samples above 10,000 µS/cm had salinities greater than 1 ppt, which indicates that the increased conductivity was likely due to the presence of seawater and not industrial pollutants.

Table 6. Minimum, maximum and median specific conductivity from all monitoring sites in 2025.

Site	Water Type	River Mile	Min Cond (µS/cm)	Max Cond (µS/cm)	Median Cond (µS/cm)
Manchester - Merrimack Footbridge	Freshwater	70.55	58.9	169.7	115.2
Manchester - USGS Gauge	Freshwater	67.86	69.2	167.2	121.6
Nashua – Greeley Park Boat Ramp	Freshwater	55.75	81.5	237.3	154.8
Nashua – Independence Rowing Club	Freshwater	53.92	129.0	263.0	229.7
Lowell - Pawtucket Boulevard	Freshwater	47.75	88.3	268.7	187.7
Lowell - Hunts Falls Bridge	Freshwater	43.00	93.9	280.0	184.2
Dracut - Gravel Pit	Freshwater	34.00	103.2	373.5	258.5
Lawrence - Bashara Boathouse	Freshwater	29.02	129.2	362.3	212.0
Methuen - Riverview Boulevard	Freshwater	26.20	148.0	338.0	248.8
Haverhill - 285 Lincoln Ave Bridge	Freshwater	16.24	117.9	391.5	286.0
West Newbury - Ferry Park	Freshwater	12.43	219.5	599.5	314.8
Amesbury - Deer Island	Brackish	5.67	127.5	7,020.0	359.6
Newburyport - Road Bridge	Brackish	3.47	105.0	17,250.0	12,750.0
Newburyport - Plum Island	Brackish	0.74	1370.0	95,233.3	35,466.7
Salisbury - Beach State Reservation	Brackish	0.72	12200.0	36,550.0	32,250.0

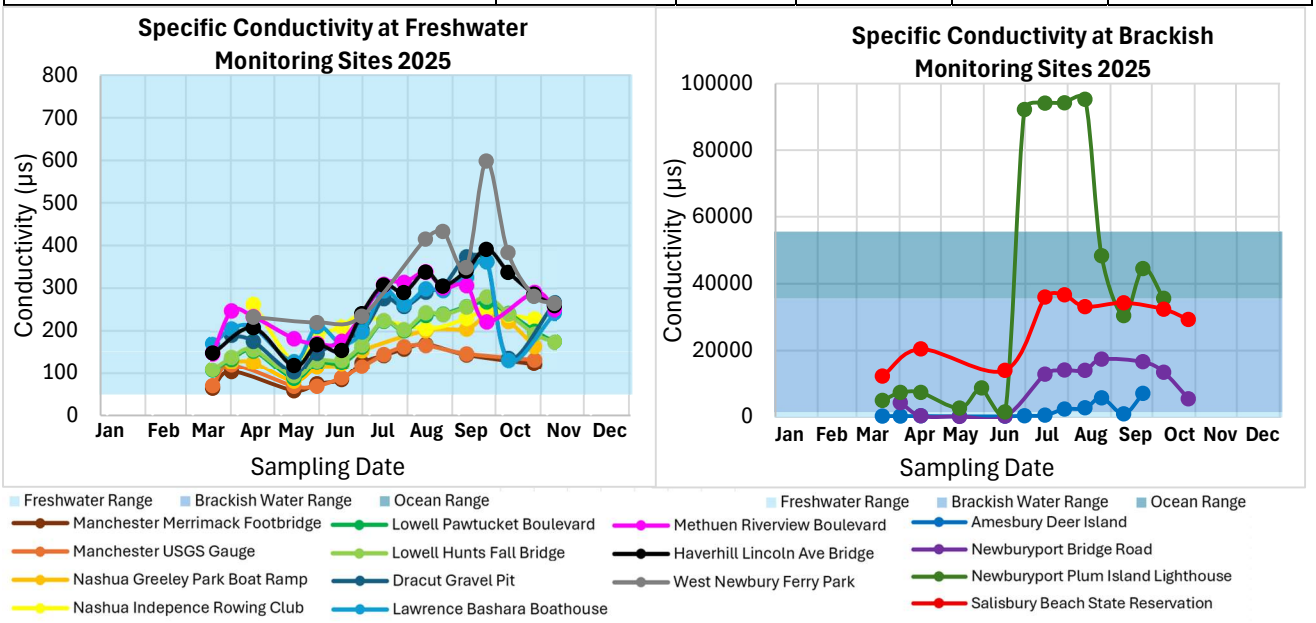


Figure 12. Conductivity measurements from all monitoring sites in 2025. Newburyport Plum Island conductivity results for June through August are considered statistical outliers. See data qualifications at the end of the report

Total Dissolved Solids

What are total dissolved solids (TDS)?

- TDS are the number of all ions in water that are less than 2 microns (0.0002 cm) in length, measured in milligrams per liter of water (mg/L)
- TDS includes positive and negative ions, dissolved salts, and dissolved organic matter

Why is it important?

- If TDS levels are too high or too low, it could impact an organism's ability to move up and down in the water column, as well as limit the growth and lifespan of aquatic species[20,21]

What changes total dissolved solids?

- Heavy rains and large amounts of industrial and/or agricultural runoff from the watershed can temporarily increase total dissolved solids[17]
- However, high levels of total dissolved solids in freshwater during a dry period can be a sign of point source pollution[17]

What are important values for environmental or human health?

- There is no EPA recommendation for TDS limits for aquatic species, but TDS measurements over 1,000 mg/L in freshwater could impact fish reproduction[18]
- TDS values over 500 mg/L require secondary treatment before being used as drinking water for humans[22]
- Freshwater TDS is typically 0 – 1000 mg/L while ocean water can be between 30,000 – 40,000 mg/L. Brackish water TDS is anywhere between this range, typically around 1,000 – 10,000 mg/L[23]

What were the conditions in the Merrimack River in 2025?

All freshwater sites in the Merrimack were well below the 1,000 mg/L threshold, indicating the levels of TDS do not threaten freshwater aquatic species (Table 7, Figure 13). Measurements at brackish sites were much higher, as would be expected with the introduction of ocean water. The median TDS for Newburyport Plum Island and Salisbury Beach State Reservation were above the typical range for brackish water but still within range for typical levels in the ocean. Any aquatic species living in these zones are tolerant of changes in TDS and would not be drastically impacted by these levels.

Table 7. Minimum, maximum and median total dissolved solids from all monitoring sites in 2025.

Site	Water Type	River Mile	Min TDS (mg/L)	Max TDS (mg/L)	Median TDS (mg/L)
Manchester - Merrimack Foot Bridge	Freshwater	70.55	31.7	128.3	81.2
Manchester - USGS Gauge	Freshwater	67.86	29.9	117.7	84.5
Nashua – Greeley Park Boat Ramp	Freshwater	55.75	57.9	169.0	110.3
Nashua – Independence Rowing Club	Freshwater	53.92	91.7	179.5	162.7
Lowell - Pawtucket Blvd	Freshwater	47.75	62.7	190.7	133.0
Lowell - Hunts Falls Bridge	Freshwater	43.00	66.7	199.0	130.8
Dracut - Gravel Pit	Freshwater	34.00	73.3	265.5	184.5
Lawrence - Bashara Boathouse	Freshwater	29.02	91.8	260.3	151.0
Methuen - Riverview Blvd	Freshwater	26.20	81.5	240.3	124.7
Haverhill - 285 Lincoln Ave Bridge	Freshwater	16.24	83.1	278.5	203.5
West Newbury - Ferry Park	Freshwater	12.43	154.0	425.5	198.5
Amesbury - Deer Island	Brackish	5.67	90.4	4,990.0	186.3
Newburyport - Road Bridge	Brackish	3.47	71.5	30,500.0	7,637.5
Newburyport - Plum Island	Brackish	0.74	974.3	36,266.7	24,883.3
Salisbury - Beach State Reservation	Brackish	0.72	7316.7	26,150.0	23,212.5

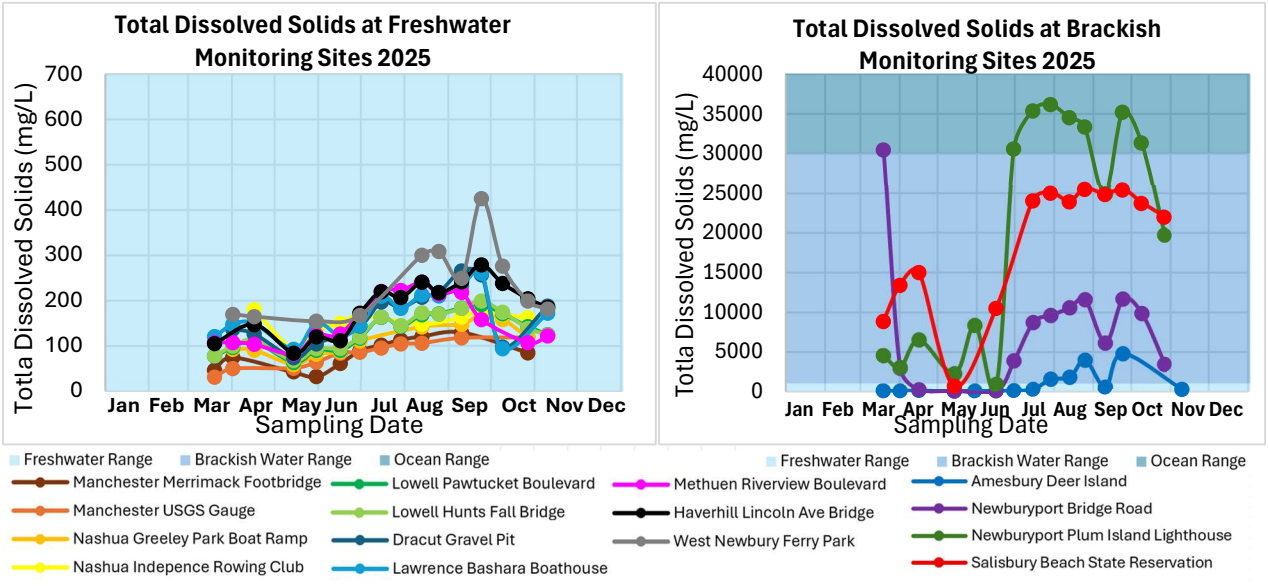


Figure 13. Total dissolved solids measurements from all monitoring sites in 2025. See data qualifications at the end of the report

Salinity

What is salinity?

- Salinity is the number of dissolved salts in the water, measured in parts per thousand (ppt)
- Salinity is closely linked with conductivity and total dissolved solids

Why is it important?

- Measuring salinity can help determine how far the tides flow up the Merrimack River
- Salinity levels impact the types of aquatic species that live in different parts of the river[24]

What changes salinity?

- Increases in salinity are most commonly caused by saltwater mixing with a freshwater body (like during high tides in an estuary), and salinity can decrease through dilution when a large volume of freshwater is added to a water body (such as during heavy rainfall or snowmelt)
- Salinity can also increase in terminal river basins and lakes as freshwater evaporates and leaves behind natural salts, which can build up over time
- In smaller streams and tributaries to the Merrimack, salinity can increase due to runoff from road salts used in the winter

What are important values for environmental or human health?

- Freshwater habitats typically have a salinity value of less than 0.5 ppt[17,24]
- Brackish water habitats (a mix of freshwater and ocean water) typically have a salinity value between 0.5 and 17 ppt[17,24]
- Ocean water typically has a salinity value around 30 to 35 ppt[17,24]

What were the conditions in the Merrimack River in 2025?

All freshwater monitoring sites had a median salinity of 0.15 ppt or less, with the highest single freshwater recording of 0.31 ppt at West Newbury Ferry Park (Table 8, Figure 14). This is within the normal range for freshwater sources and is expected to be a short-term event. The brackish sites have higher average values with the highest reading at the farthest downstream sites. The highest brackish water readings were 25.38 ppt for Newburyport Plum Island and 18.00 ppt for Salisbury Beach State Reservation. It should be noted that water quality testing is usually scheduled within two hours of low tide. This means that high tide conditions, which would increase salinity at some sites, are not represented in this data.

Table 8. Minimum, maximum and median salinity from all monitoring sites in 2025.

Site	Water Type	River Mile	Min Salinity (ppt)	Max Salinity (ppt)	Median Salinity (ppt)
Manchester - Merrimack Foot Bridge	Freshwater	70.55	0.03	0.09	0.06
Manchester - USGS Gauge	Freshwater	67.86	0.03	0.08	0.07
Nashua – Greeley Park Boat Ramp	Freshwater	55.75	0.04	0.12	0.08
Nashua – Independence Rowing Club	Freshwater	53.92	0.07	0.13	0.11
Lowell - Pawtucket Blvd	Freshwater	47.75	0.04	0.13	0.10
Lowell - Hunts Falls Bridge	Freshwater	43.00	0.05	0.13	0.10
Dracut - Gravel Pit	Freshwater	34.00	0.05	0.19	0.13
Lawrence - Bashara Boathouse	Freshwater	29.02	0.07	0.18	0.11
Methuen - Riverview Blvd	Freshwater	26.20	0.07	0.17	0.12
Haverhill - 285 Lincoln Ave Bridge	Freshwater	16.24	0.06	0.21	0.15
West Newbury - Ferry Park	Freshwater	12.43	0.11	0.31	0.15
Amesbury - Deer Island	Brackish	5.67	0.06	3.40	0.13
Newburyport - Road Bridge	Brackish	3.47	0.05	3.19	1.25
Newburyport - Plum Island	Brackish	0.74	0.68	25.38	17.52
Salisbury - Beach State Reservation	Brackish	0.72	0.50	18.00	16.81

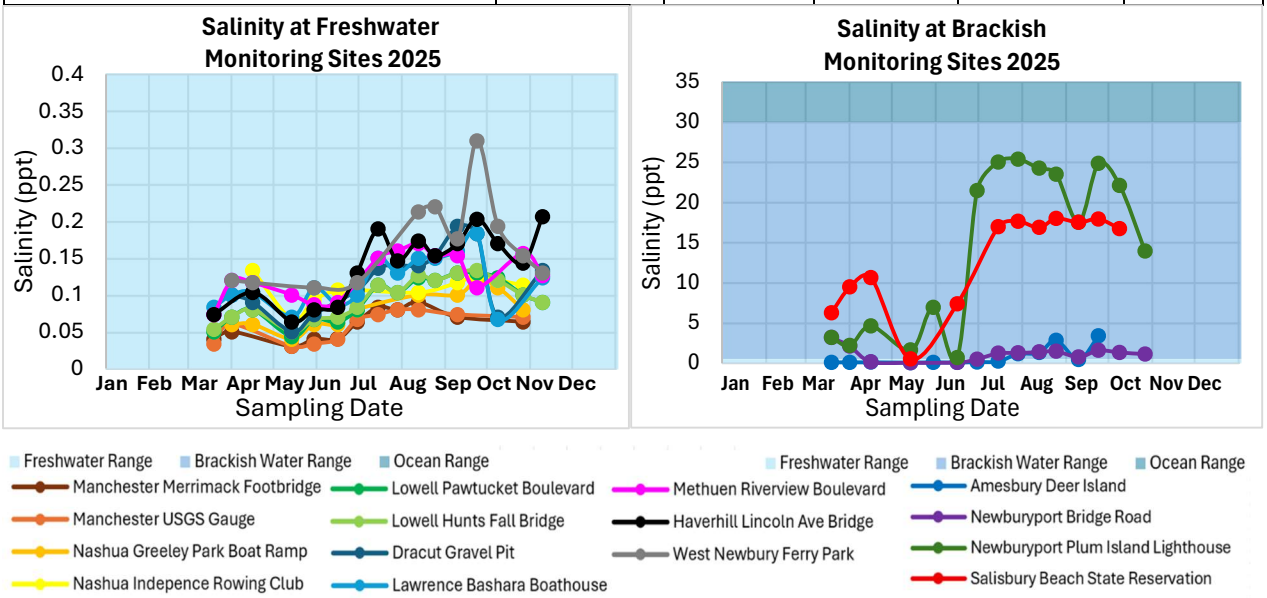


Figure 14. Salinity measurements from all monitoring sites in. See data qualifications at the end of the report

Bacteria – *Escherichia coli (E. coli) and Enterococcus*

What are pathogens and fecal indicator bacteria?

- Pathogens are disease-causing microorganisms, which can be bacteria (single-celled organisms), viruses, fungi, and protozoa
- Two common bacteria used in water quality monitoring are *Escherichia coli* (*E. coli*) and *Enterococcus*, which are found in the gut and feces of warm-blooded animals
- While *E. coli* and *Enterococcus* themselves are not particularly dangerous to humans, they often indicate the presence of more harmful pathogens such as norovirus and *Cryptosporidium*, which can make people sick
- *E. coli* is a good indicator of health impacts for humans in freshwater samples, while *Enterococcus* can be used as an indicator in freshwater and marine samples[25]

Why are they important?

- When humans come into contact with pathogens, they can cause illnesses ranging from gastrointestinal discomfort to infections, and even death, with the very young, the very old, and those with weakened immune systems at greatest risk [26,27]
- A wide variety of pathogens can cause illness in humans and animals, but *E. coli* and *Enterococcus* are commonly found, relatively easy to monitor, and have shown a correlation with cases of gastrointestinal illness among swimmers in waterbodies contaminated with human-sourced fecal matter[28]

What changes bacteria concentrations?

- The concentration of bacteria measured at a specific site on a given day is influenced by many factors such as contamination from nearby sources, dilution, streamflow, dispersion, sedimentation, temperature, decay/die off, and tides

What are important values for environmental or human health?

- NH and MA have their own state standards for water and environmental quality, and they do not align completely in numerical value or in theoretical approach, making them difficult to compare. Therefore, in this report, the monitoring results have been compared to a national standard: the US EPA's 1986 Ambient Water Quality Criteria for Bacteria
- The US EPA's 1986 Ambient Water Quality Criteria for Bacteria sets a standard for safe bacteria levels for designated beach areas (or "safe for recreational use" in this report): a maximum value of 235 CFUs/100 ml for *E. coli* in freshwater samples and 104 CFUs/100 ml for *Enterococcus* in freshwater and brackish samples[29]

Bacteria – Baseline Monitoring

In 2025, MRWC reported data on *E. coli* at freshwater sites and *Enterococcus* at the brackish sites. Our baseline monitoring program follows the bacteria limit guidelines (235 CFU/100 mL for *E. coli* and 104 CFU/100 mL for *Enterococcus*) set by the EPA (Table 9).

Table 9. Maximum limit for bacteria levels set by the EPA[29]

Water Type	Bacteria Measured	Single Sample Bacteria Safety Limit (CFU / 100 mL)
Freshwater (Minimal influence from saltwater)	***E. coli***	**235**
Brackish (Mix of freshwater and saltwater)	***Enterococcus***	**104**

Results from our baseline monitoring program include all regularly scheduled sampling days. It may happen that some of these days did follow CSO/heavy rain events and are still included in this dataset. The purpose of this dataset is to provide an unbiased view of the river's conditions, so sampling days are not selected based on weather, but are prescheduled at the beginning of the year.

What were the conditions in the Merrimack River in 2025?

During our baseline monitoring program, 15 out of 156 *E. coli* samples (10%) were considered unsafe for recreational use (Table 10 and Figure 15), while for *Enterococcus*, 29 samples out of 61 samples (48%) were considered unsafe for recreational use (Table 11 and Figure 16). The freshwater sites had elevated results from May to September, and the brackish sites had elevated results from June to October. Since these sampling dates were predetermined, the elevated results could be due to stormwater runoff, CSOs, non-point pollution or other sources. The CSO/Heavy Rain Event monitoring program collects samples within these elevated months of April through October and provides additional information on bacteria levels directly after a CSO/heavy rain event occurs.

The baseline results for March were analyzed by the EPA and the rest of the baseline samples were analyzed in-house by MRWC staff. The in-house analysis uses the IDEXX Quanti-Tray System for both *E. coli* and *Enterococcus* samples and has a detection limit of 2419.6 CFU/100 mL. This detection limit is represented as a black line in the bacteria results in this section and the Site Profiles section. Bacteria results that are shown at this limit could be exponentially larger than 2419.6 CFUs/ 100 mL.

Table 10. Baseline Monitoring sampling program results. Minimum, maximum, and median bacteria concentrations measuring E. coli for all freshwater sites in 2025.

Site	Water Type	River Mile	Min Bacteria (CFU/100 mL)	Max Bacteria (CFU/100 mL)	Median Bacteria (CFU/100 mL)
Manchester - Merrimack Footbridge	Freshwater	70.55	8.0	1,986.3	41.3
Manchester - USGS Gauge	Freshwater	67.86	17.5	410.6	56.4
Nashua – Greeley Park Boat Ramp	Freshwater	55.75	14.8	461.1	36.2
Nashua – Independence Rowing Club	Freshwater	53.92	1.0	82.3	29.8
Lowell - Pawtucket Boulevard	Freshwater	47.75	2.0	125.9	14.0
Lowell - Hunts Falls Bridge	Freshwater	43.00	5.0	387.3	33.6
Dracut - Gravel Pit	Freshwater	34.00	6.3	727.0	36.4
Lawrence - Bashara Boathouse	Freshwater	29.02	6.2	2,419.6	30.3
Methuen - Riverview Boulevard	Freshwater	26.20	21.8	365.4	77.9
Haverhill - 285 Lincoln Ave Bridge	Freshwater	16.24	6.3	344.1	44.8
West Newbury - Ferry Park	Freshwater	12.43	9.5	148.3	29.0

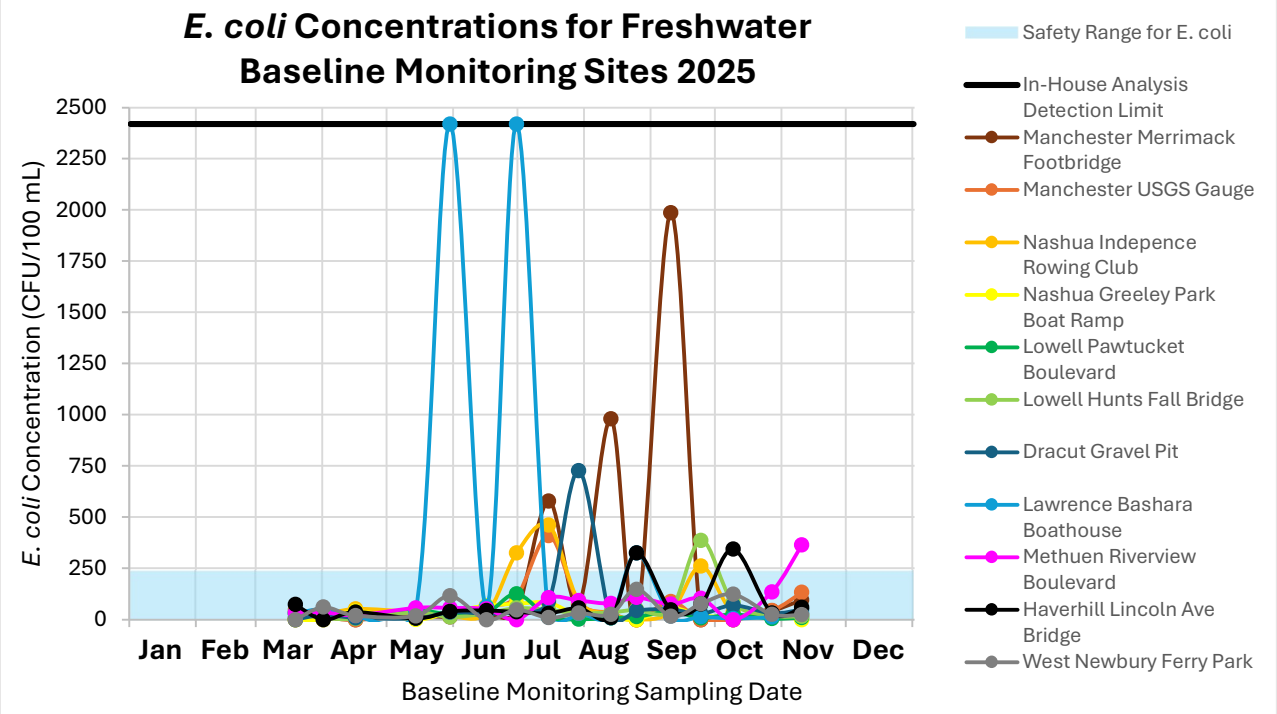


Figure 15. *E. coli* bacteria measurements from all baseline monitoring sites in 2025. The blue range represents the E. coli safety limit set by the EPA of 235 CFU/ 100 mL

Table 11. Baseline Monitoring sampling program results. Minimum, maximum, and median bacteria concentrations measuring Enterococcus for all brackish sites 2025.

Site	Water Type	River Mile	Min Bacteria (CFU/100 mL)	Max Bacteria (CFU/100 mL)	Median Bacteria (CFU/100 mL)
Amesbury - Deer Island	Brackish	5.67	16.3	2419.6	52
Newburyport – Bridge Road	Brackish	3.47	9.1	2419.6	61.8
Newburyport - Plum Island Lighthouse	Brackish	0.74	14.5	2419.6	403.2
Salisbury - Beach State Reservation	Brackish	0.72	13.9	2419.6	129.8

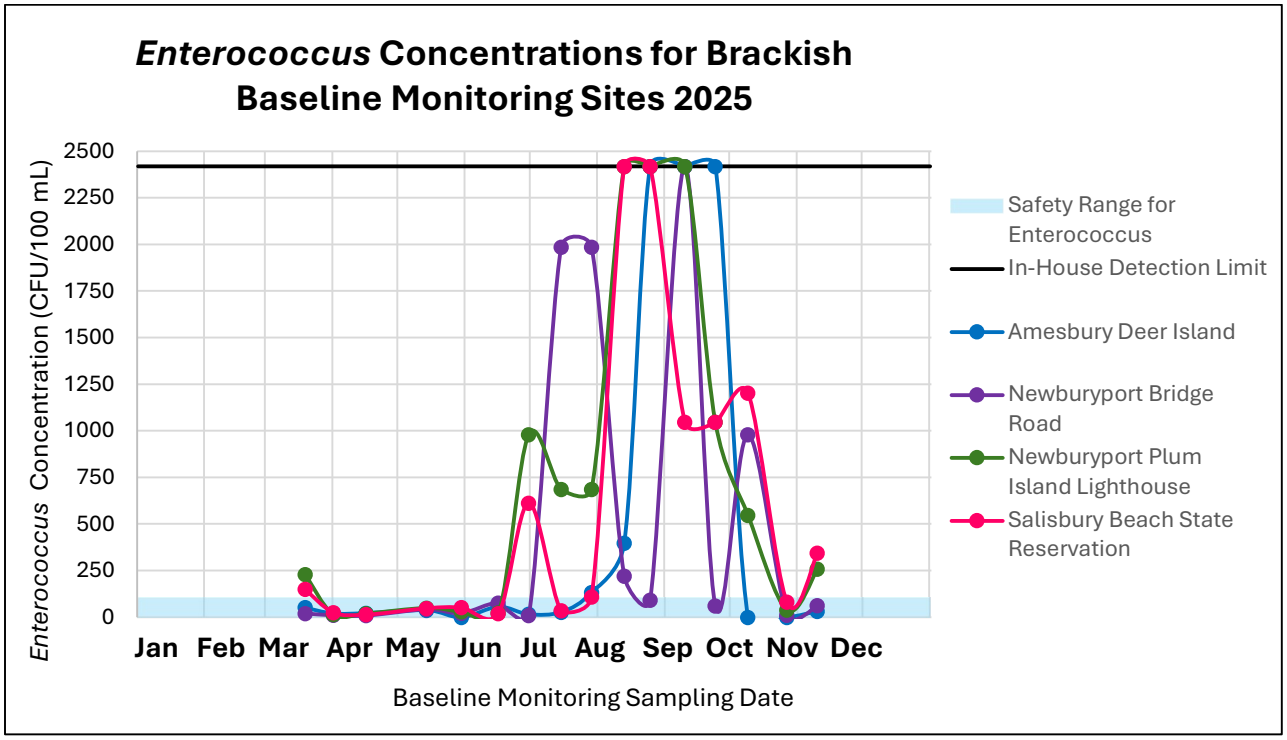


Figure 16. *Enterococcus* bacteria measurements from all baseline monitoring sites in 2025. The blue range represents the *Enterococcus* safety limit set by the EPA of 104 CFU/ 100 mL

In comparison to the 2024 baseline results, the freshwater unsafe bacteria results decreased from 15% to 10% and the brackish unsafe results increased from 18% to 48%. A side-by-side comparison of the 2024 and 2025 baseline results are shown in Figure 17. It is not unreasonable for there to be a couple of high results in the baseline data due to predetermined sampling days landing near rain events or CSOs. The drastic increase in the number of unsafe brackish samples is concerning though, especially since a majority of the unsafe brackish samples are at the detection limit of the procedure used in 2025 and could potentially be much higher.

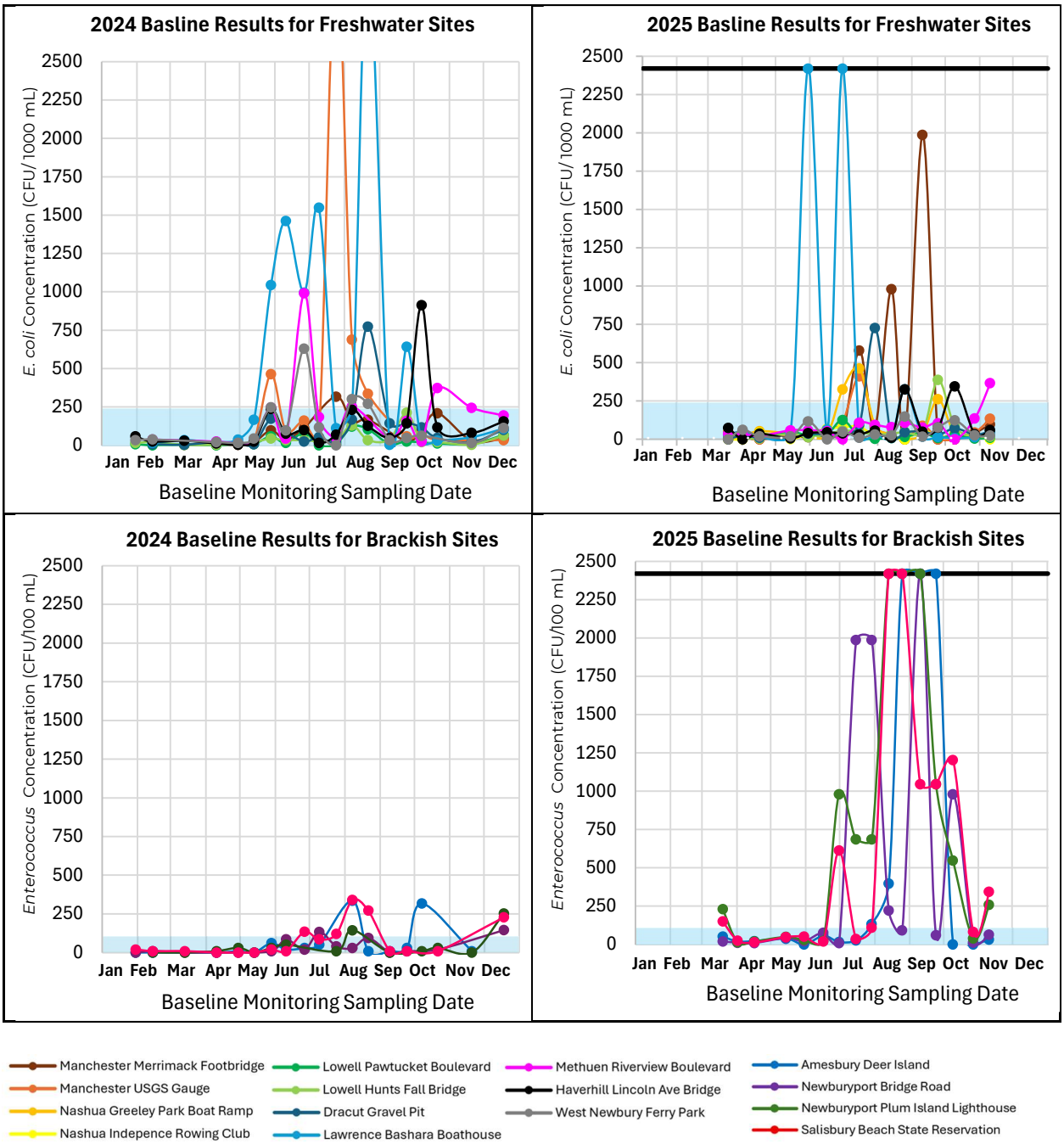
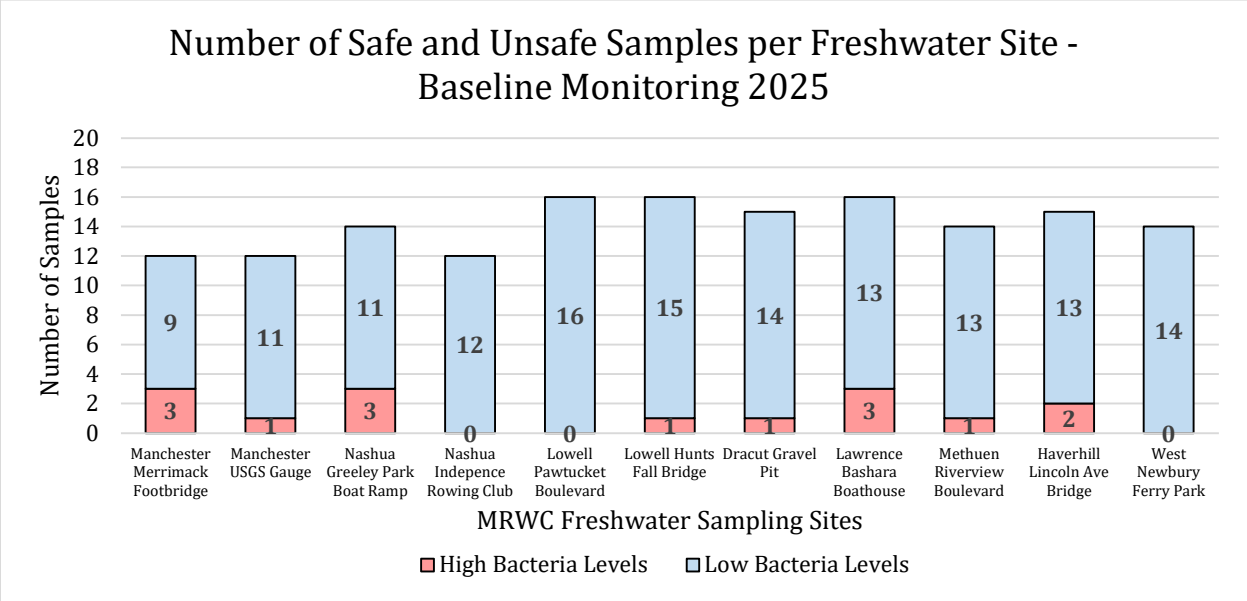


Figure 17: Comparison of 2024 and 2025 baseline bacteria results

Looking at the 2025 baseline monitoring results by site, most samples are considered safe throughout the Merrimack (Figure 18). It is worth noting that Nashua Greeley Park Boat Ramp, Lowell Pawtucket Boulevard, and West Newbury Ferry Park had no unsafe samples during baseline monitoring activities, while Newburyport Plum Island had the highest number of unsafe samples. Further site-specific analyses on potential reasons for elevated results are provided in the site profiles section. In 2024, Lowell Pawtucket Boulevard and Lowell Hunts Falls Bridge had no unsafe samples, while Lawrence, Methuen, and Salisbury all had the highest number of unsafe samples.



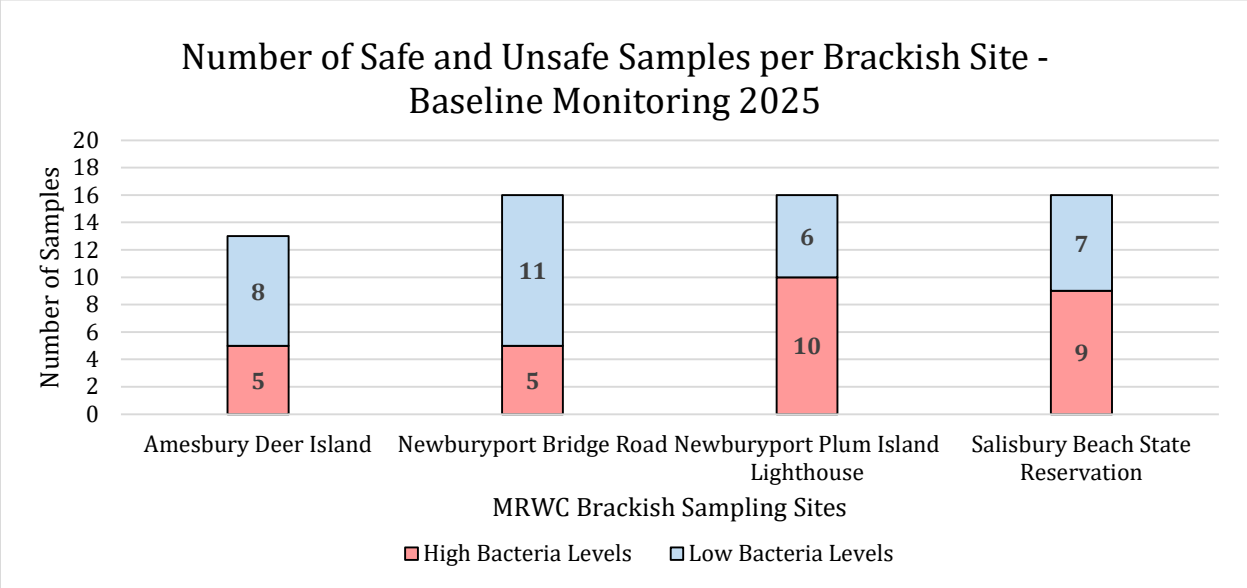
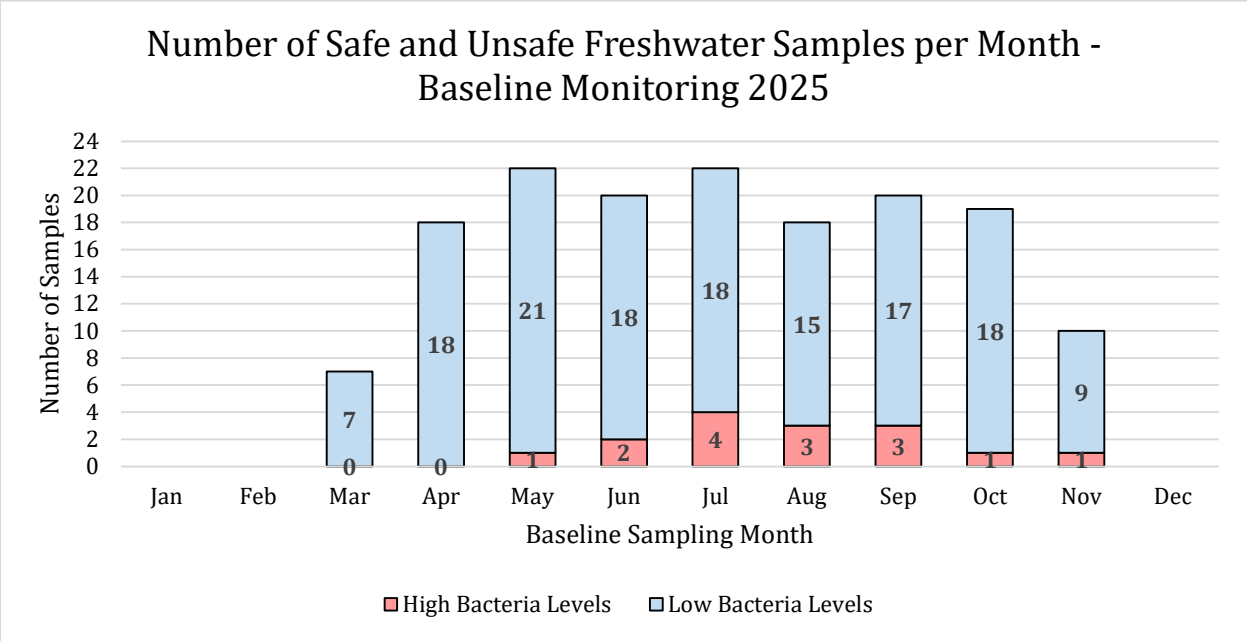


Figure 18. Number of safe and not safe samples by monitoring site for *E. coli* at freshwater monitoring sites and *Enterococcus* at brackish water monitoring sites in 2025. These results are for baseline monitoring program samples.

Looking at the 2025 baseline monitoring results by month, the summer months of July-September had more unsafe samples than other months (Figure 19). These are the months when many recreational activities take place, increasing the exposure risk to humans. This is the period with frequent large rain events (such as summer thunderstorms) and CSO events. As such, these higher numbers could be because some of our regularly scheduled baseline monitoring days occurred during rain events or CSO events.



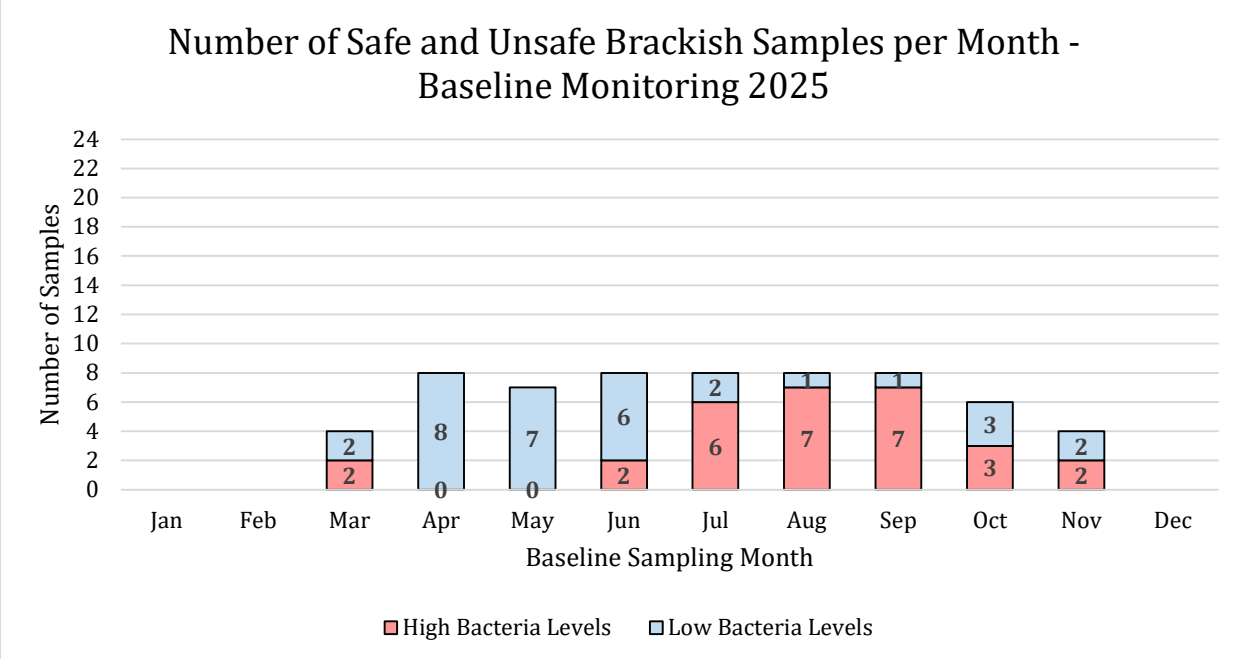


Figure 19. Number of safe and not safe samples by month for *E. coli* at freshwater monitoring sites and *Enterococcus* at brackish water monitoring sites in 2025. These results are for baseline monitoring program samples.

Bacteria – CSO/Heavy Rain Event Monitoring

In 2025, MRWC collected bacteria samples after 14 CSOs and heavy rain events. For test sites upstream of Amesbury, MRWC tested after CSOs from Manchester, Nashua, Lowell, Lawrence, and Haverhill. For test sites from Amesbury to the mouth of the river, MRWC tested after heavy rain events. Heavy rain events were periods of intense rain that could wash non-point bacteria into the Merrimack River. Although these sites near the mouth of the river are not believed to be affected by CSOs, the closest CSO outfalls are in Haverhill, so a Haverhill CSO was used to indicate a period of heavy rain in the area. This proxy has limitations since rainfall in Haverhill does not always correlate with rainfall in Newburyport.

Triggering sampling at all sites: The first step in initiating sampling was receiving a notification email from at least one of the five municipalities stating that a CSO event had occurred. For a Manchester CSO to initiate sampling, at least two outfalls had to go off for over an hour. This information was obtained in real-time by viewing Manchester's CSO Discharge Map. A Haverhill CSO initiated sampling if it went off for over an hour as indicated by the real-time Haverhill CSO Notification Map. For Nashua, Lowell, and Lawrence CSOs, email notifications dictating how long the CSO occurred were not in real-time. As such, if any of these CSOs went off, it would trigger sampling.

Once a CSO triggered sampling, volunteers collected grab samples from all sampling sites for the following three days. If a CSO went off after 4 pm, volunteers would not be notified until the following day, and sample collection would start the next morning. This means that the samples collected on the first day of testing could be collected anywhere between 14 to 38 hours from the time a CSO discharge notice was issued.

CSO significance determined after sampling. Some municipalities release CSOs with minimal amounts of volume which does not meaningfully impact water quality**.** The volume of CSO discharge that led MRWC to designate a CSO as significant was based on the lowest CSO discharge from MRWCs 2024 CSO testing that resulted in at least one unsafe result. The criteria for verifying a CSO or heavy rain event as significant is shown in Table 12. Since Manchester does not consistently report CSO volumes, all CSOs had to be considered significant. For Nashua, since MRWC did not have sampling sites in Nashua in 2024 to base significance on, all 2025 Nashua CSOs were considered significant. While only reporting on significant CSOs helped highlight the more dangerous bacteria results, excluding smaller volume CSOs prevented the significant CSOs cutoff criteria from being validated.

Table 12. Criteria for significant 2025 CSOs and heavy rain events

Municipality	2024 Lowest CSO Discharge Volume to Produce an Unsafe Result	2025 Criteria to Verify Significant CSOs or Heavy Rain Events
Manchester, NH CSOs	Unknown	≥ 0.000 MG
Nashua, NH CSOs	Unknown	≥ 0.000 MG
Lowell, MA CSOs	0.010 MG	≥ 0.010 MG
Lawrence, MA CSOs	0.420 MG	≥ 0.420 MG
Haverhill, MA CSOs	0.048 MG	≥ 0.048 MG
Haverhill, MA CSOs as proxy for heavy rain events	Not Based on CSO Volume	≥ 0.000 MG

Determination of which sites were relevant to significant CSOs and heavy rain events: Table 13 shows which sites were considered relevant to each CSO municipality (yellow) or heavy rain events (purple). A relevant site means that bacteria levels are likely to be impacted by at least one of the CSO locations or heavy rain events. The CSO impact distances for each municipality are based on engineering studies when available and are further detailed in the Site Profile Section.

Table 13. Relevant MRWC sampling sites per CSO municipalities and heavy rain events

MRWC Relevant Sampling Sites	Manchester CSOs	Nashua CSOs	Lowell CSOs	Lawrence CSOs	Haverhill CSOS	Heavy Rain Event Testing Triggered by Haverhill CSOs
Manchester - Merrimack Footbridge	X					
Manchester - USGS Gauge	X					
Nashua – Greeley Park Boat Ramp	X					
Nashua – Independence Rowing Club	X	X				
Lowell - Pawtucket Blvd		X				
Lowell - Hunts Falls Bridge			X			
Dracut - Gravel Pit			X			
Lawrence - Bashara Boathouse			X			
Methuen - Riverview Blvd			X	X		
Haverhill - 285 Lincoln Ave Bridge				X	X	
West Newbury - Ferry Park					X	
Amesbury - Deer Island						X
Newburyport – Bridge Road						X
Newburyport - Plum Island						X
Salisbury - Beach State Reservation						X

MRWC collected *E. coli* results at freshwater sites and *Enterococcus* results at brackish sites across 14 sampling events. Table 14 shows the 14 events and the significant CSOs and heavy rain events that impacted the samples. Not all significant CSOs or heavy rain events throughout the sampling season were tested due to funding/programmatic limitations. Significant events that were tested are shown in red with the sampling dates highlighted in green (Table 14). For Manchester, the dates of the CSOs were not officially reported by the city and instead based on when emails from the city were sent out to alert that a Manchester CSO recently went off. In addition, since the specific discharge volume from each CSO event is not consistently reported for Manchester, average rain data is shown instead to gauge the intensity of the precipitation that triggered the CSO. The rain data is an average of two nearby rain gauge stations including the Massabesic Lake NH Rain Gauge and the Manchester Airport Rain Gauge.

Table 14. Locations and dates of Significant CSOs and heavy rain events in the three days prior and three days during sampling

Sampling Event #	Date	Manchester Rain Average (inches)	Nashua Volume (MG)	Lowell Volume (MG)	Lawrence Volume (MG)	Haverhill Volume for CSOs (MG)	Haverhill Volume for Heavy Rain Events (MG)
1	3/29/2025	0.31					
	3/30/2025						
	3/31/2025	0.20					
	4/1/2025						
	4/2/2025						
	4/3/2025	0.71					
2	4/24/2025						
	4/25/2025						
	4/26/2025	0.57		1.29			0.038
	4/27/2025						
	4/28/2025						
	4/29/2025						
3	5/1/2025						
	5/2/2025						
	5/3/2025		0.639	0.01		0.5602	0.5602
	5/4/2025		1.931				0.0098
	5/5/2025		0.007	2.33			
	5/6/2025						
4	5/8/2025		0.048	11.13			0.0361
	5/9/2025		0.008	30.08			0.0106
	5/10/2025		0.019			0.1915	0.1915
	5/11/2025						
	5/12/2025						
	5/13/2025						
5	5/16/2025						
	5/17/2025	0.24					
	5/18/2025						
	5/19/2025	0.06					
	5/20/2025						
	5/21/2025						
6	5/29/2025						
	5/30/2025						
	5/31/2025	0.70					0.0016
	6/1/2025						
	6/2/2025						
	6/3/2025						
7	6/6/2025			0.83			
	6/7/2025			9.61			
	6/8/2025						
	6/9/2025						
	6/10/2025						
	6/11/2025						

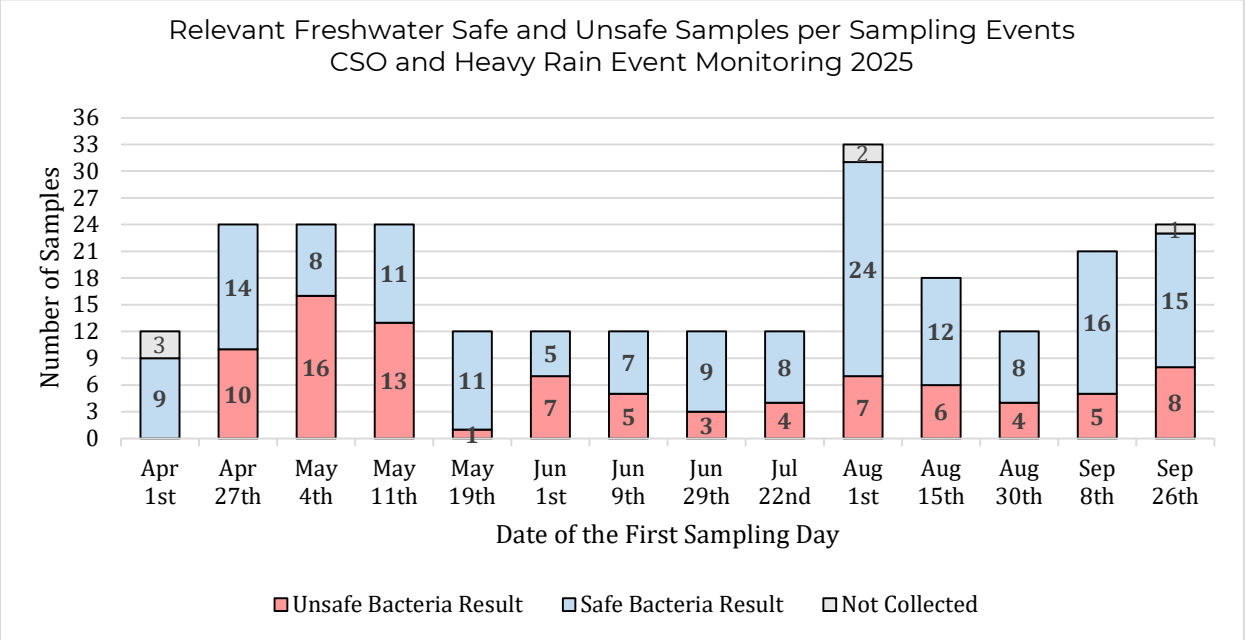
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Table 14 Continued. Locations and dates of Significant CSOs and heavy rain events in the three days prior and three days during sampling

Sampling Event #	Date	Manchester Rain Average (inches)	Nashua Volume (MG)	Lowell Volume (MG)	Lawrence Volume (MG)	Haverhill Volume for CSOs (MG)	Haverhill Volume for Heavy Rain Events (MG)
8	6/26/2025						
	6/27/2025						
	6/28/2025	0.51					0.0236
	6/29/2025						
	6/30/2025						
	7/1/2025						
9	7/19/2025						
	7/20/2025			12.89			
	7/21/2025						
	7/22/2025						
	7/23/2025						
	7/24/2025						
10	7/29/2025						
	7/30/2025						
	7/31/2025	0.37	0.001	6.45		0.073	0.073
	8/1/2025						
	8/2/2025						
	8/3/2025						
11	8/12/2025						
	8/13/2025			3.7	11.252	1.0774	1.0774
	8/14/2025						
	8/15/2025						
	8/16/2025						
	8/17/2025						
12	8/27/2025	0.05					
	8/28/2025						
	8/29/2025	0.07					
	8/30/2025						
	8/31/2025						
	9/1/2025						
13	9/5/2025						
	9/6/2025	0.69	0.019			0.3074	0.3074
	9/7/2025	0.65					
	9/8/2025						
	9/9/2025						
	9/10/2025						
14	9/23/2025						
	9/24/2025						
	9/25/2025	0.64		1.5			0.0152
	9/26/2025						
	9/27/2025						
	9/28/2025						

Comparing the Impact of Different CSOs and Heavy Rain Events

When results are assessed by CSO or heavy rain event, not all events had the same number of elevated unsafe samples (Figure 20). The April 1st event had zero elevated freshwater results out of 9 relevant samples collected (0% unsafe). In contrast, the May 4th event totaled 16 out of 24 elevated freshwater samples (67% unsafe) and 4 out of 11 brackish elevated samples (36% unsafe). This variation reinforces the claim that the resulting bacteria levels from various CSOs and heavy rain events varies depending on the multiple characteristics of the rainfall, the CSO discharge, the streamflow and water temperature.



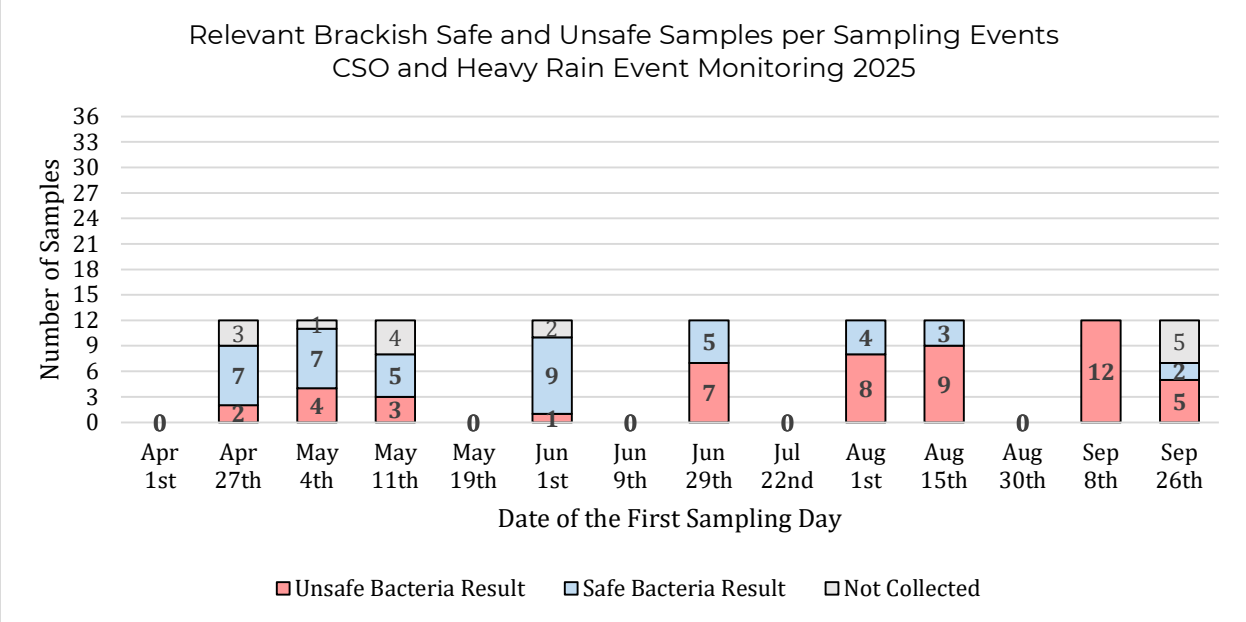


Figure 20. Safe and unsafe samples by CSO event for *E. coli* at freshwater monitoring sites (a) and relevant safe samples for heavy rain event for *Enterococcus* at brackish water monitoring sites (b) in 2025.

Comparing which Sites are Most Frequently Impacted by CSOs and Heavy Rain Events

A CSO/heavy rain event was considered unsafe for a specific site if at least one sample out of the three days of sampling was above the limit (Figure 21). The site with the highest percentage of unsafe CSOs was Methuen Riverview Boulevard (100% unsafe). In contrast, the sites with the lowest percentage of unsafe CSOs were the Manchester Merrimack Footbridge (44% unsafe), Lowell Pawtucket Boulevard (50% unsafe), and Lowell Hunts Falls Bridge (50% unsafe). Few unsafe CSOs for the Manchester Merrimack Footbridge and Lowell Hunts Falls Bridge could be due to the bacteria flowing downstream before sampling Day 1. In addition, few unsafe CSOs for Lowell Pawtucket Blvd could be due to the CSOs upstream in Nashua not reaching the site. These results are similar to the 2024 findings where Methuen had the most amount of unsafe CSOs (100% unsafe) and the Manchester Merrimack Footbridge (25% unsafe) and the Lowell Pawtucket Boulevard (25% unsafe) had the least amount of unsafe CSOs.

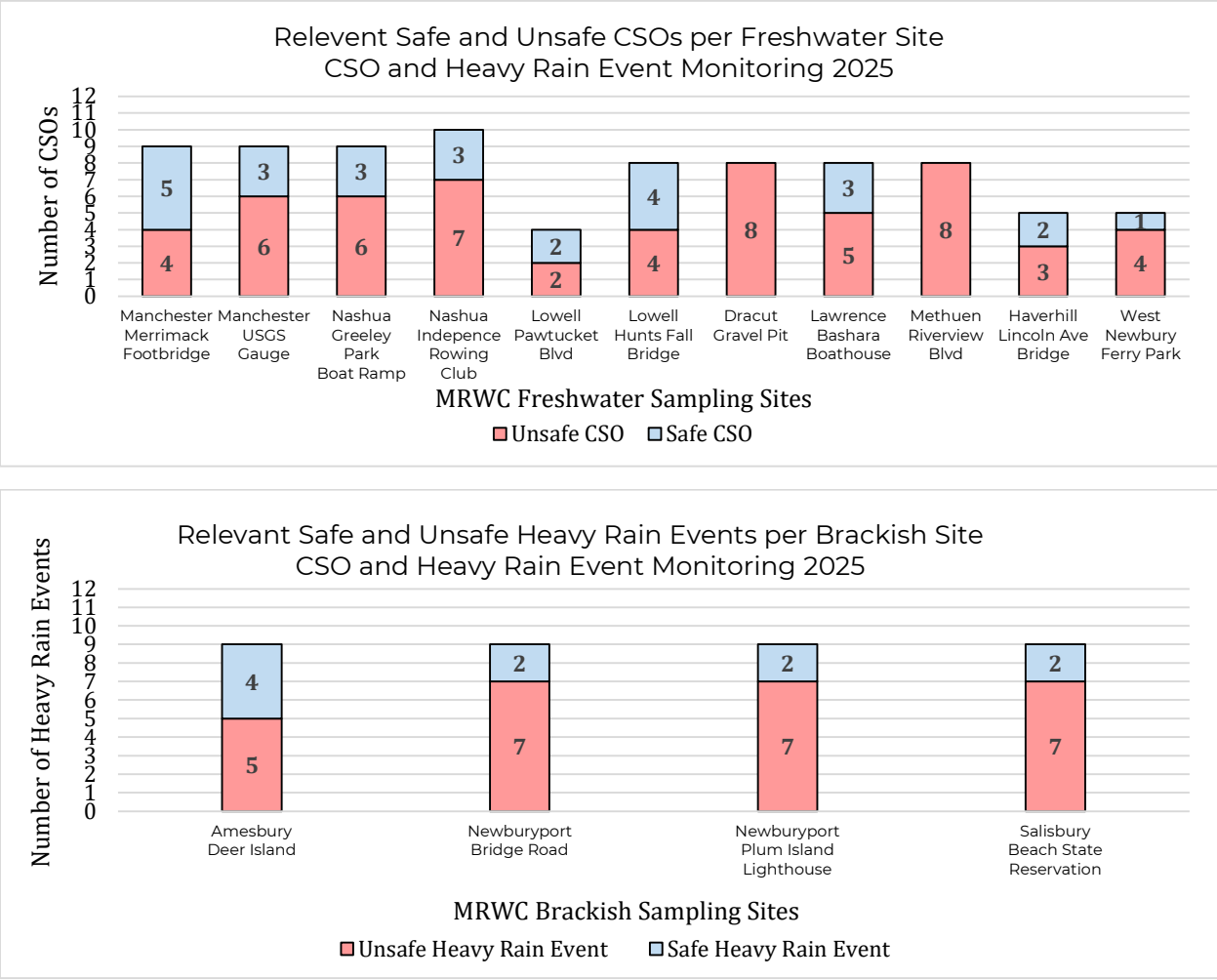
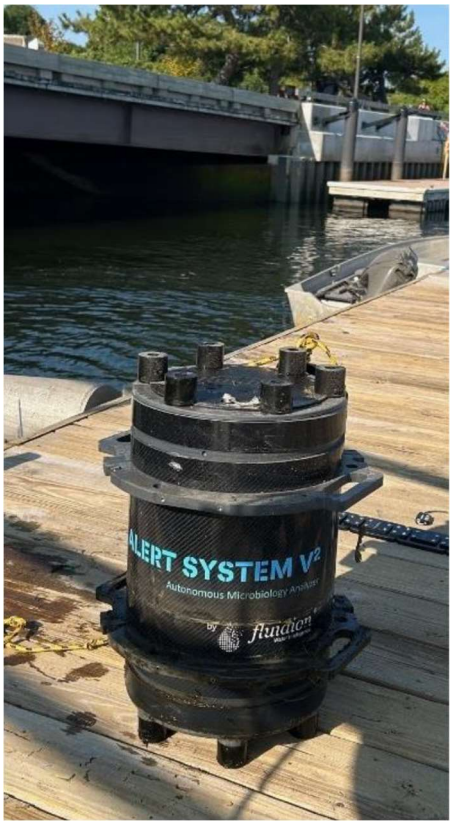


Figure 21. Number of safe and unsafe significant CSOs and heavy rain events.

Bacteria – Cloud-Based Sensor Monitoring, Pilot Program

In 2024, MRWC piloted a remote operated, cloud-based sensor to learn more about emerging technology and explore the possibility of employing multiple automated sensors throughout the river in the future. In 2025, this pilot testing continued and the sensor was activated 46 times.



The opportunity to run the pilot program came from a generous gesture from Lowell's Duck Island Wastewater Treatment Plant to the City of Newburyport. Duck Island loaned a Fluidion ALERT System V2 to the City of Newburyport to provide near-real time public information about the bacteria level in Newburyport Harbor. MRWC agreed to operate the sensor and secure additional funds needed to run the program.

The sensor was installed on the Harbormaster's dock on June 4th and ran from June 6th through October 27th. The sensor was activated every Friday (to check bacteria levels for the weekend), for major holidays, and for 3 days after a significant heavy rain event occurred in Haverhill, MA. Heavy rain events were periods of intense rain that could wash non-point bacteria into the mouth of the Merrimack River in Newburyport, MA. Although not believed to be affected by CSOs, the closest CSO outfalls are in Haverhill, so a Haverhill CSO was used to identify a period of heavy rain in the area. Additionally, the sensor was activated daily for two one-week periods to test for variance between wet and dry days. The first week was in August, and the second week was in September.

Normally, in brackish water, MRWC prefers to test for *Enterococcus* as the fecal bacteria indicator, given its ability to survive better in a saltwater environment. However, there were multiple factors that made testing for *Enterococcus* prohibitive with the sensor at this site. The sensor uses complex cartridges that are custom made for either *E. coli* or *Enterococcus*. There was a cost factor with the *E. coli* cartridges being less expensive. Also, the *E. coli* cartridges are manufactured in the US and have a much longer shelf life, whereas the *Enterococcus* cartridges have a much shorter shelf life and are only manufactured in Europe. Given the fragility of the *Enterococcus* cartridges, they must be shipped by refrigerated air freight every couple of weeks from Europe to maintain viability, adding significantly to the cost. After an analysis with Fluidion, the sensor manufacturer, where the salinity was evaluated at low tide (the maximum point of fresh water washing out the brackish water in Newburyport harbor), it was determined that testing for *E. coli* at low tide would provide an appropriate indicator for fecal bacteria. Given low tide testing could easily be accomplished even in the middle of the night (due to the ability to schedule the sensor to take samples at any specific time), *E. coli* testing procedures were used.

When the sensor is activated, a cartridge takes a single sample, incubates it for 14 hours and then quantifies bacteria in colony forming units (CFUs) per 100 milligrams of sample water. Results could immediately be read by MRWC staff from a computer or cell phone. Results were then posted on MRWC's Facebook page.

As MRWC was piloting new technology and testing *E. coli* in typically brackish water, MRWC publicized sensor data in the broader terms of whether the readings fell within EPA's Primary Contact Recreation Level (at or below 235 CFU/100 mL).

Rain Data: The closest CSO outfalls to the sensor are in Haverhill, MA. Currently MRWC is not led to believe that Haverhill CSOs directly impact Newburyport and instead used Haverhill CSOs as an indicator of heavy rain events. Therefore bacteria results are potentially due to stormwater runoff, non-point sources, or illicit discharges. The varying amount of rain between Haverhill, MA and Newburyport, MA was compared using four different rain gauges including the Haverhill Marginal Pumping Station tipping bucket rain gauge, Haverhill Wastewater Treatment Plant (WWTP) tipping bucket rain gauge, NOAA Haverhill, MA rain gauge, and NOAA Newburyport, MA US rain gauge (Figure 22). The Marginal Pumping Station is located closest to the Haverhill CSO outfalls. The Haverhill WWTP tipping bucket and the NOAA Haverhill, MA rain gauges are both located at the Haverhill Wastewater Treatment Plant ASPN building. The major difference between the results of these two stations is that they use different methods to record rain data. Both Haverhill tipping bucket rain gauges automatically report rain data in 15-minute intervals. In contrast, the Haverhill, MA NOAA rain gauge is manually read once a day[30]. The NOAA Newburyport, MA rain gauge is located at the Newburyport Water Treatment Plant, which is about 2.5 miles from the sensor at the Newburyport Harbormaster's pier.

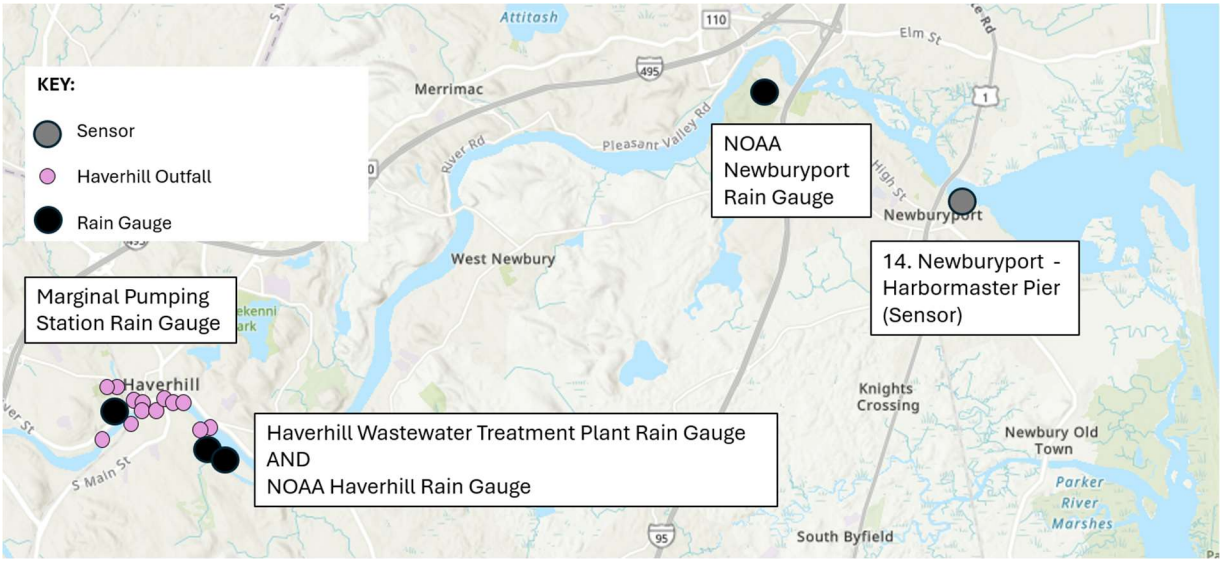


Figure 22. Map of the Fluidion sensor at the Newburyport Harbormaster's pier, Haverhill CSO outfalls, and rain gauges.

Friday Monitoring: MRWC activated the sensor on 19 consecutive Fridays (Table 15, Figure 23). The total rainfall for the three days prior to each test is displayed (significant rain over 0.2 inches highlighted in yellow). Heavy rain events (indicated by Haverhill CSOs) likely impacted bacteria levels in some cases, but there were "unsafe" bacteria levels on occasions when no heavy rain event had recently occurred. Some bacteria results were alarmingly above the safety limit of 235 CFUs with the highest Friday reading being 11,794 CFUs on October 9th. These results indicate that there is an unknown and intermittent source of bacteria in the vicinity of the testing site. More robust and focused investigation is needed.

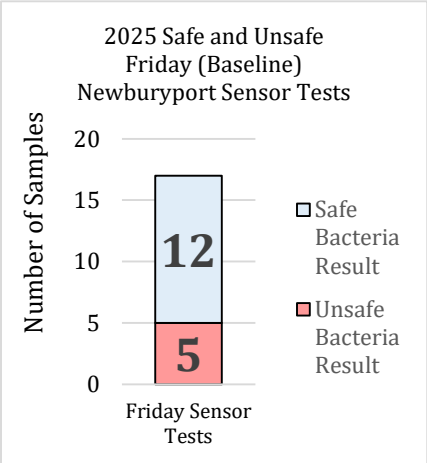


Figure 23. Number of safe and unsafe *E. coli* Friday baseline Newburyport sensor tests

Table 15. *E. coli* levels at Newburyport Harbormaster Pier During Friday (baseline) Monitoring

Friday Date	Bacteria Result	Haverhill CSO discharged in 3 Days Prior to Test?	Total Rain in 3 Days Prior to Sensor Test (inches)			
			Haverhill Marginal Pumping Station Rain Gauge	Haverhill WWTP Rain Gauge	NOAA Haverhill Rain Gauge	NOAA Newburyport Rain Gauge
Jun 20th	Safe	No	0.19	0.02	0.21	0.27
Jun 26th	Safe	No	0.00	0.04	0.03	0.00
Jul 3rd	Safe	No	0.06	0.15	0.14	0.10
Jul 11th	No Data	No				
Jul 17th	Safe	No	0.03	0.07	0.00	0.00
Jul 24th	Safe	No	0.01	0.00	0.15	0.10
Aug 1st	Safe	7/31	0.05	0.32	0.00	0.00
Aug 8th	Safe	No	0.04	0.00	0.00	0.00
Aug 15th	Safe	8/13	0.13	0.38	0.44	0.23
Aug 22nd	No Data	No				
Aug 28th	Safe	8/25	0.27	0.18	0.06	0.37
Sep 4th	Unsafe	No	0.00	0.00	0.00	0.00
Sep 12th	Unsafe	No	0.00	0.09	0.00	0.00
Sep 18th	Safe	No	0.00	0.00	0.00	0.00
Sep 25th	Safe	No	0.16	0.27	0.11	0.18
Oct 2nd	Safe	No	0.00	0.00	0.00	0.00
Oct 9th	Unsafe	No	0.20	0.21	0.00	0.04
Oct 16th	Unsafe	No	1.12	0.63	1.87	1.91
Oct 23rd	Unsafe	10/20 and 10/22	1.15	0.05	0.80	0.90

Heavy Rain Event Monitoring: MRWC conducted tests for 3 days after 6 heavy rain events (Table 16, Figure 24). The total rainfall for the three days prior to each test is displayed (significant rain over 0.2 inches is highlighted in yellow). Overall, two thirds of the heavy rain events had at least one unsafe reading (Figure 25). These 4 heavy rain events that resulted in elevated samples correspond with rain in Haverhill and Newburyport in the three days prior to testing.

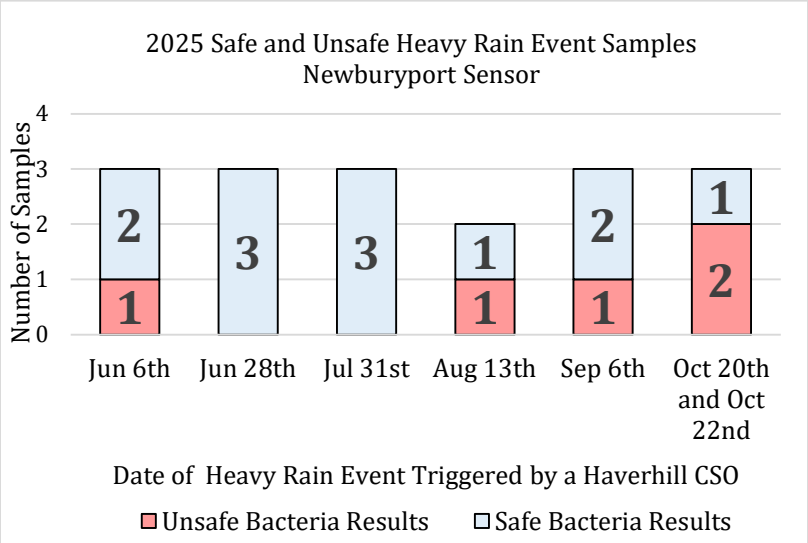


Figure 24. Number of safe and unsafe *E. coli* Newburyport Sensor tests per significant heavy rain event

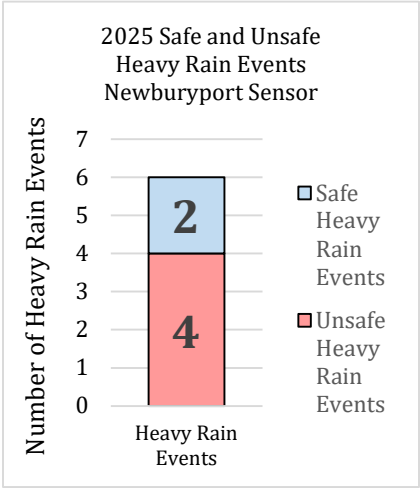


Figure 25. Number of safe and unsafe heavy rain events for the Newburyport Sensor

Table 16. Relevant *E. coli* results at Newburyport Harbormaster Pier following select Heavy Rain Events

Haverhill CSO as Proxy for a Heavy Rain Event	Day 1 Test Date	Safe Results	Unsafe Results	Total Rain in 3 Days Prior to Day 1 Sensor Test (Inches)			
				Haverhill Marginal Pumping Station Rain Gauge	Haverhill WWTP Rain Gauge	NOAA Haverhill Rain Gauge	NOAA Newburyport Rain Gauge
Jun 6th	Jun 9th	2	1	0.60	0.04	0.76	0.48
Jun 28th	Jun 29th	3	0	0.23	0.46	0.01	0.51
Jul 31st	Aug 1st	3	0	0.05	0.32	0.00	0.00
Aug 13th	Aug 15th	1	1	0.13	0.38	0.44	0.23
Sep 6th	Sep 8th	2	1	1.27	1.02	0.61	0.92
Oct 20th / Oct 22nd	Oct 22nd	1	2	0.63	0.03	0.80	0.65
	Totals	12	5				

Final Two Weeks Monitoring MRWC activated the sensor for two one-week periods, one in August and one in September. Alarmingly, 4 out of 8 samples came back unsafe in August and 3 out of 7 samples came back unsafe in September (Figure 26, Table 17). The total rainfall for the day the test was taken is displayed in Table 17 (significant rain over 0.2 inches is highlighted in yellow). Out of these seven elevated bacteria results, only two occurred on days when it had rained more than 0.2 inches in Haverhill or Newburyport in the three days prior to testing. This data set underscores the suspicions raised by the Friday monitoring throughout the season – that there is an unknown and intermittent source of bacterial contamination in the vicinity of the testing site. This issue warrants a more robust and focused investigation.

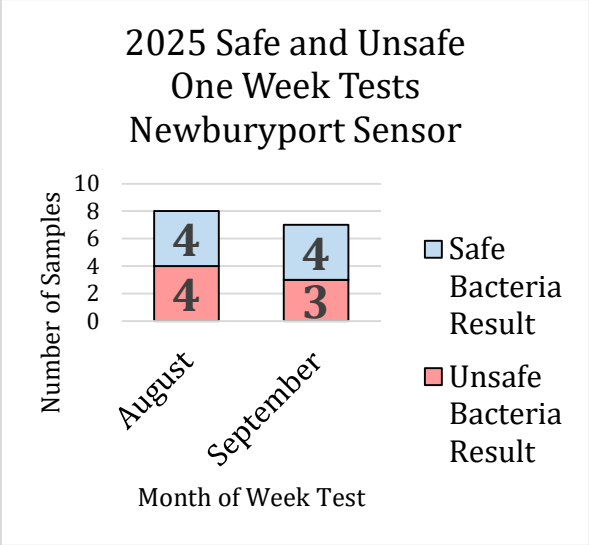


Figure 26. Number of Safe and Unsafe daily sensor tests for two one-week periods

Table 17. Daily Sensor Results for Two Weeks

Week	Date	Test Day	Result	Haverhill CSO Discharged	Total rain on the date of the Sensor Test (Inches)			
					Haverhill Marginal Pumping Station Rain Gauge	Haverhill WWTP Rain Gauge	NOAA Haverhill Rain Gauge	NOAA Newburyport Rain Gauge
1	Aug 8th	1	Safe		0.00	0.00	0.00	0.00
1	Aug 9th	2	Unsafe		0.00	0.00	0.00	0.00
1	Aug 10th	3	Unsafe		0.00	0.03	0.00	0.00
1	Aug 11th	4	Safe		0.00	0.02	0.00	0.00
1	Aug 12th	5	Safe		0.00	0.02	0.00	0.00
1	Aug 13th	6	Unsafe	Yes	0.05	0.27	0.00	0.00
1	Aug 14th	7	Not Collected		0.08	0.09	0.44	0.23
1	Aug 15th	8	Safe		0.02	0.00	0.00	0.06
1	Aug 16th	9	Unsafe		0.02	0.02	0.00	0.00
2	Sep 4th	1	Safe		0.00	0.00	0.00	0.00
2	Sep 5th	2	Not Collected		0.06	0.09	0.07	0.01
2	Sep 6th	3	Not Collected	Yes	0.67	0.5	0.00	0.00
2	Sep 7th	4	Safe		0.54	0.43	0.54	0.91
2	Sep 8th	5	Unsafe		0.00	0.15	0.00	0.57
2	Sep 9th	6	Safe		0.00	0.05	0.00	0.00
2	Sep 10th	7	Safe		0.00	0.04	0.00	0.00
2	Sep 11th	8	Unsafe		0.00	0.00	0.00	0.00
2	Sep 12th	9	Unsafe		0.00	0.00	0.00	0.00

Unlike the previous sensor tables, rain is shown in daily amounts instead of 3-day totals

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2024 VS 2025 TEST SITE PROFILES

By investigating the bacteria results at individual sites when a CSO/heavy rain event occurred upstream, MRWC can better understand the local impacts and risks at each site. Each site profile shares information on the monitoring location, CSOs/heavy rain events upstream, and an analysis of the bacteria data for that site.

When available, the range of impact of each city's CSOs was determined by reports published by wastewater treatment plants on their affected areas. Manchester and Nashua do not have publicly available information on the reach of their CSOs' impact, so an estimate was made based on the Massachusetts cities' reports, which place the affected area from their CSOs from ten to fifteen miles downstream. These affected areas are as follows:

Manchester CSOs: The affected area begins at McPhail St in Manchester. Manchester does not have publicly available information on the impact area of its CSOs. As MRWC did not sample between Manchester and Lowell in 2024, a conservative distance was used in the 2025 sampling season to analyze the impact of Manchester CSOs on the Nashua, NH sites. For this report, Manchester CSOs are indicated as potentially impacting all Manchester and Nashua sampling sites.

Nashua CSOs: The affected area on the mainstem Merrimack begins at the confluence of the Nashua and Merrimack Rivers in Nashua, NH. Nashua does not have publicly available information detailing the end of its affected CSO reach. The Greeley Park Boat Ramp sampling site in Nashua is located upstream of all Nashua CSO outfalls and is not impacted by Nashua CSOs. The Independence Rowing Club site in Nashua is downstream of 6 out of 9 Nashua outfalls and is impacted by Nashua CSOs. Based on MRWC's 2024 data, it is not believed that Nashua CSOs reach Lowell, MA, but since there isn't a distance study to reference, the most upstream Lowell sampling site (Pawtucket Boulevard) was conservatively included in the Nashua CSO impact area.

Lowell CSOs: The affected area starts at Walker St in Lowell and continues to Wingate Ave in Methuen.[31]

Lawrence CSOs: The affected area begins at GLSD wastewater treatment plant at Charles Street in North Andover and continues to Pines Recreation area in Groveland.[32]

Haverhill CSOs: The affected area begins at Varnum St in Haverhill and continues to River Rd in West Newbury.[33]

Heavy Rain Events Upstream of Newburyport Harbor: Heavy rain events are periods of intense rain that could wash non-point source bacteria into the Merrimack River. These events are analyzed in the mouth of the river for the sampling sites in Amesbury, Newburyport, and Salisbury because these sites are not believed to be affected by CSOs. The closest CSO outfalls are in Haverhill, so a Haverhill CSO was used to identify periods of heavy rain in the area.

2025 TEST SITE PROFILES

The location of the 16 MRWC sampling sites (15 baseline sites and 1 sensor site) and CSO outfalls for Manchester, Nashua, Lowell, Lawrence and Haverhill are shown in Figure 27.

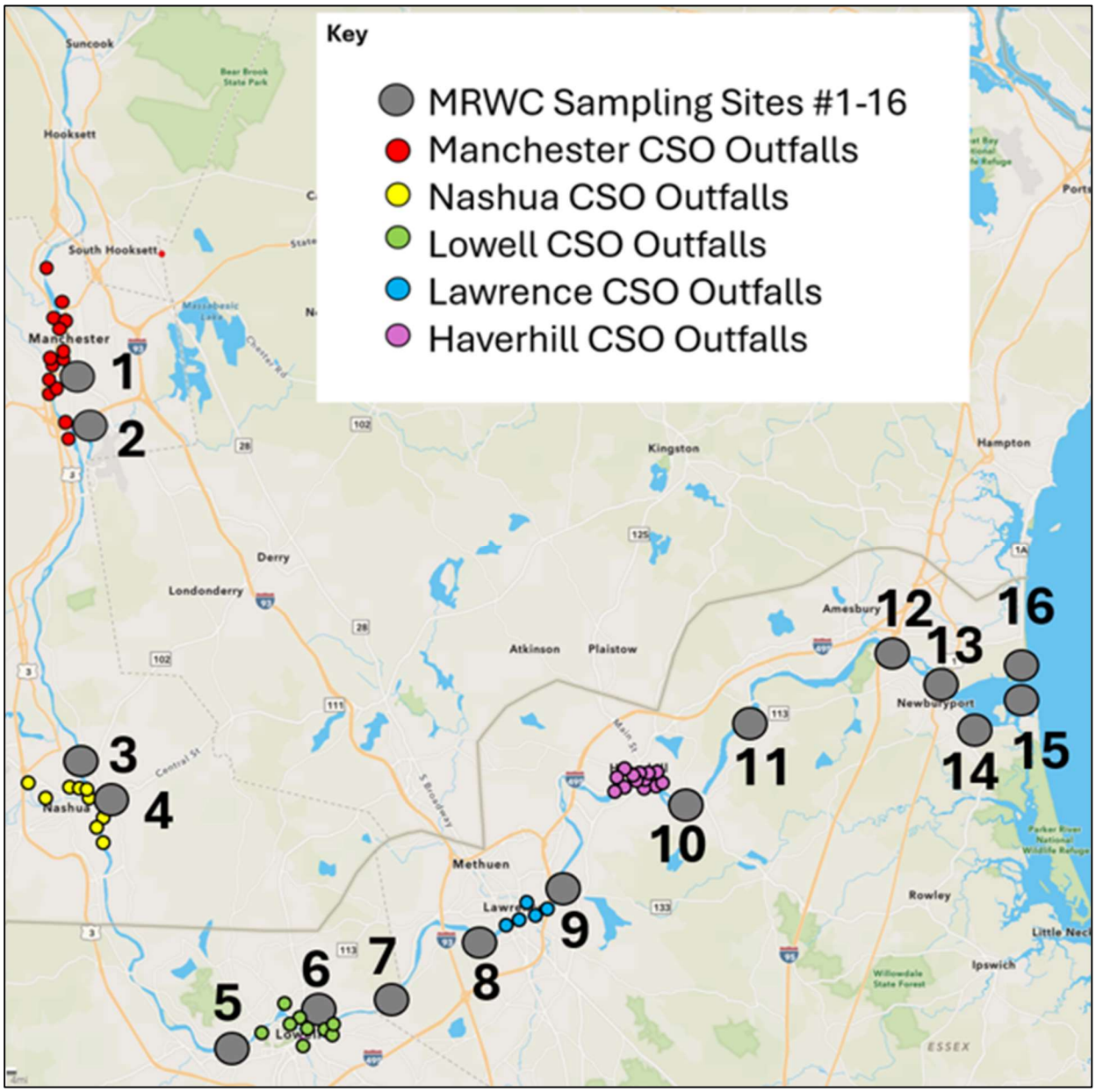


Figure 27: MRWC sampling sites and CSO outfalls on the Merrimack River

2025 TEST SITE PROFILES

The page number for the detailed analysis of each specific site profile is shown in Table 18.

Table 18: MRWC site profile details

Site #	Page #	Greater Region	Site Name
1	58	Manchester, NH	Manchester - Merrimack Footbridge
2	62	Manchester, NH	Manchester - USGS Gauge
3	66	Nashua, NH	Nashua - Greeley Park Boat Ramp
4	68	Nashua, NH	Nashua - Independence Rowing Club
5	70	Lowell, MA	Lowell - Pawtucket Boulevard
6	74	Lowell, MA	Lowell - Hunts Falls Bridge
7	78	Lowell, MA	Dracut - Gravel Pit
8	82	Lawrence, MA	Lawrence - Bashara Boathouse
9	86	Lawrence, MA	Methuen - Riverview Boulevard
10	90	Haverhill, MA	Haverhill - Lincoln Ave Bridge
11	94	Haverhill, MA	West Newbury - Ferry Park
12	98	Coastal Region	Amesbury - Deer Island
13	102	Coastal Region	Newburyport - Bridge Road
14	106	Coastal Region Sensor	Newburyport – Harbormaster Pier Sensor
15	112	Coastal Region	Newburyport - Plum Island Lighthouse
16	116	Coastal Region	Salisbury - Beach State Reservation

Greater Region: Manchester, New Hampshire

Monitoring Site: Manchester - Merrimack Footbridge

(river mile 70.6)

Known CSO Infrastructure

- Manchester Merrimack Footbridge, the most upstream site of our monitoring network, is downstream of 8 Manchester CSO outfalls and upstream of 7 others.
- Manchester reports 15 CSO outfalls, 10 of which were activated at least once in 2025.
- Manchester contributed the largest volume of CSOs to the Merrimack in 2025 (384 million gallons). Over the past decade, Manchester's CSOs discharged an average of 332 million gallons per year.
- Manchester CSO outfall 044, the outfall underneath Fisher Cat's Stadium, is directly upstream of the Merrimack Footbridge site. Outfall 044 released 87% of Manchester's CSO discharge (compared to 90% in 2024). Manchester is currently working on the multi-year Cemetery Brook Drain Tunnel Project which should eliminate the majority of discharge from outfall 044.

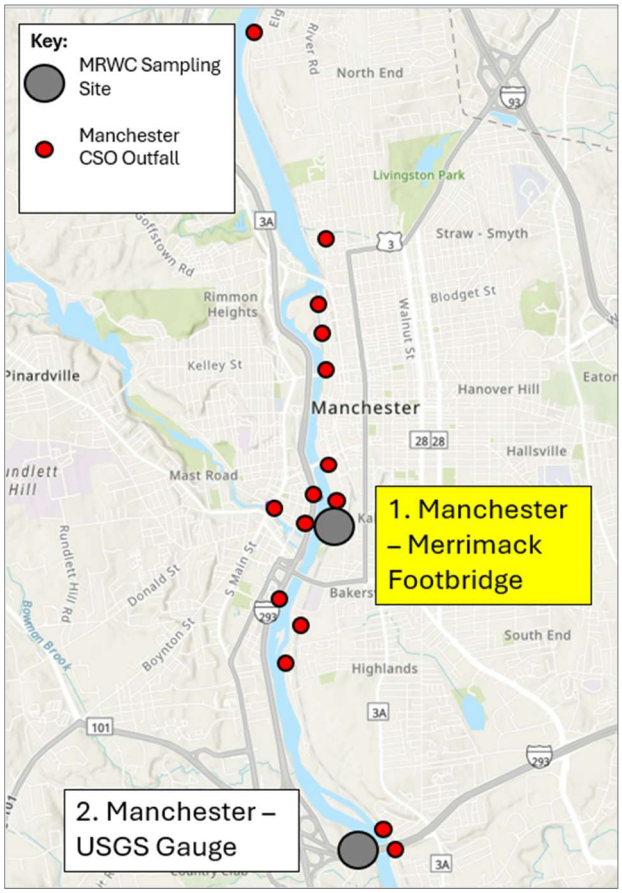


Figure 28: MRWC Manchester - Merrimack Footbridge sampling site and Manchester CSO outfalls

Greater Region: Manchester, New Hampshire

Monitoring Site: Manchester - Merrimack Footbridge

(river mile 70.6)

Water Quality Results

Table 19. 2024 and 2025 bacteria results for the Manchester - Merrimack Footbridge site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	7% Unsafe	25% Unsafe
CSO Events	25% Unsafe	44% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline samples and unsafe CSO events both increased from 2024. The bacteria levels were also significantly higher. Some 2025 samples exceeded the testing cap of 2,419.6 CFUs/100 mL (10x the safety limit).

The two Manchester sites are only 2.7 miles apart but had opposite trends in baseline bacteria levels. The Merrimack Footbridge site increased from 7% unsafe to 25% unsafe while the USGS Gauge site decreased from 25% unsafe to 8% unsafe. Both sites saw increases in unsafe readings after CSO events.

These differences are interesting considering the close proximity of the two sites. Additional in-depth sampling is needed to better understand the bacteria trends in Greater Manchester.

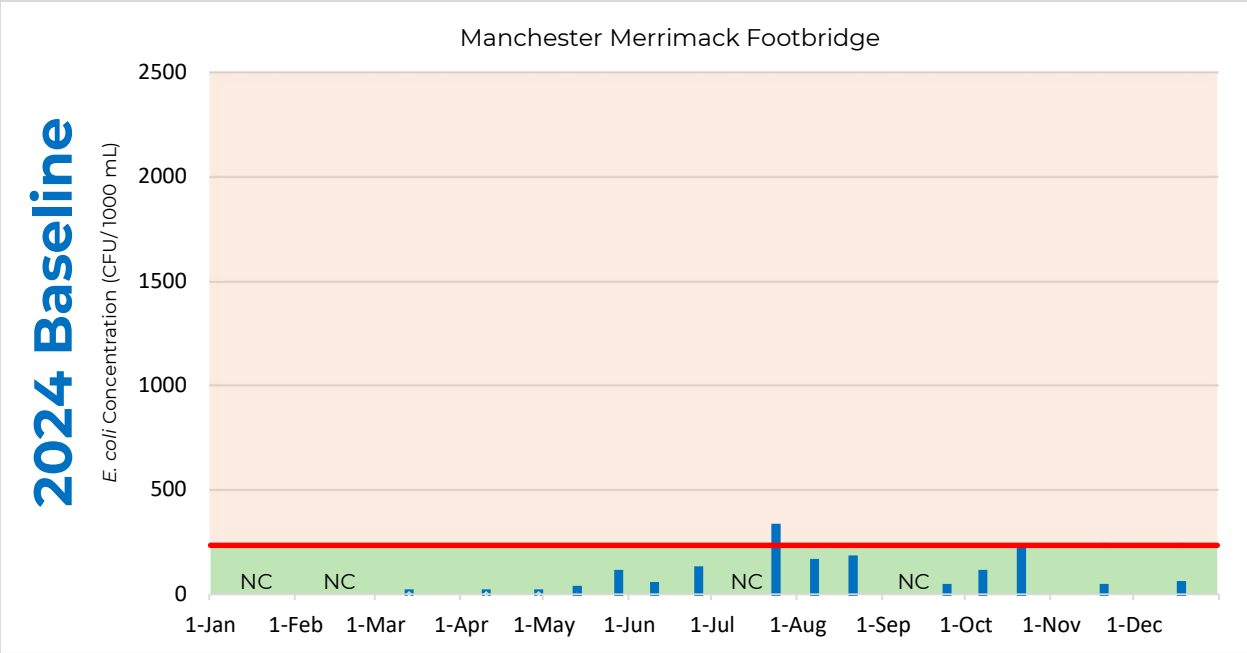


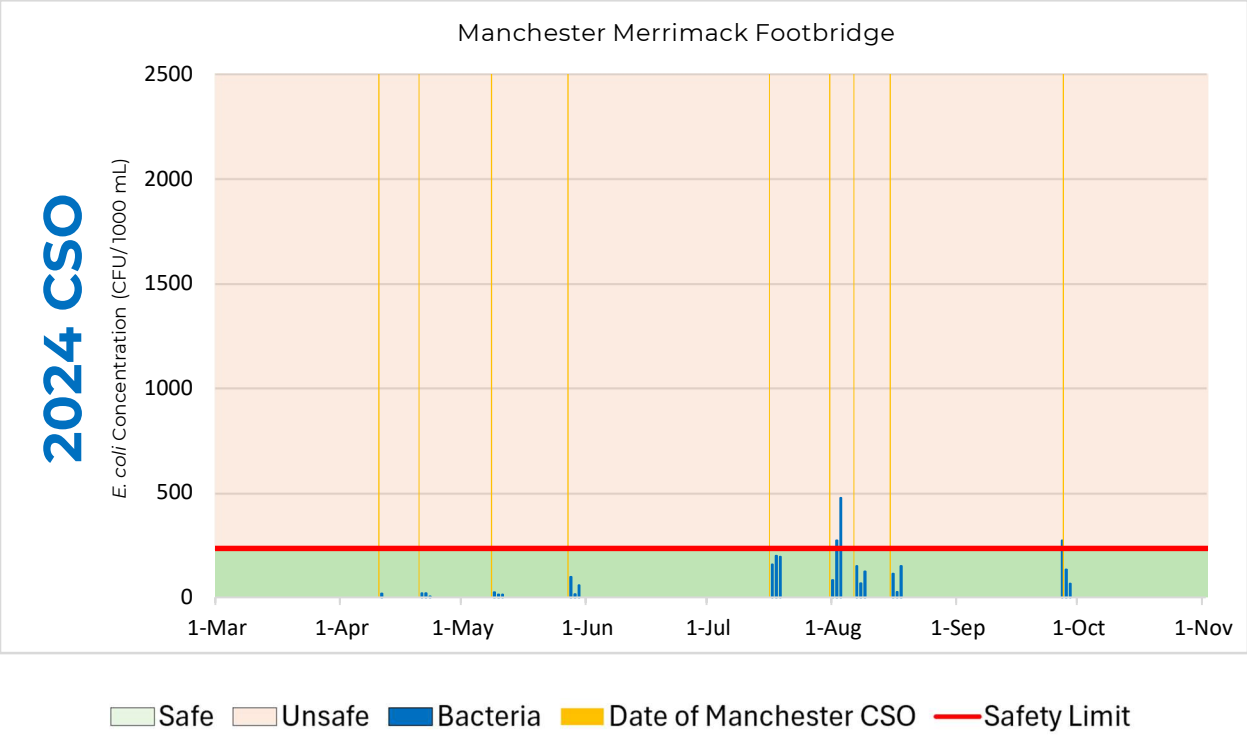
Figure 29: Manchester - Merrimack Footbridge sampling site

Greater Region: Manchester, New Hampshire

Monitoring Site: Manchester - Merrimack Footbridge

2024 Results



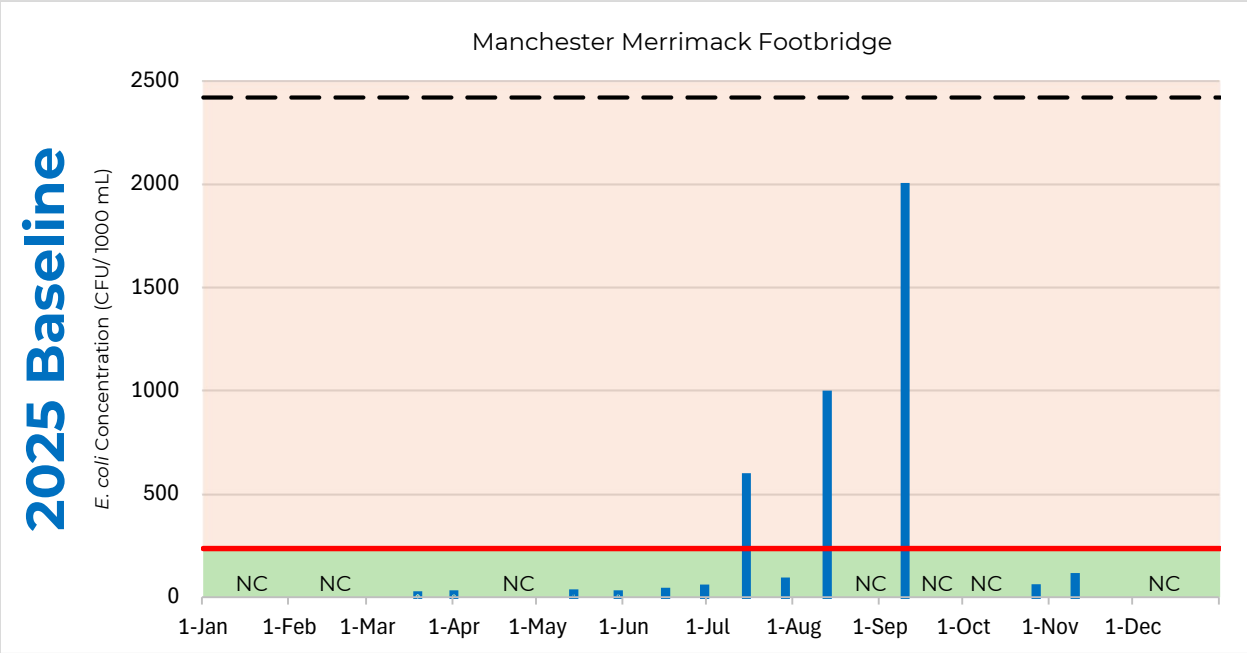


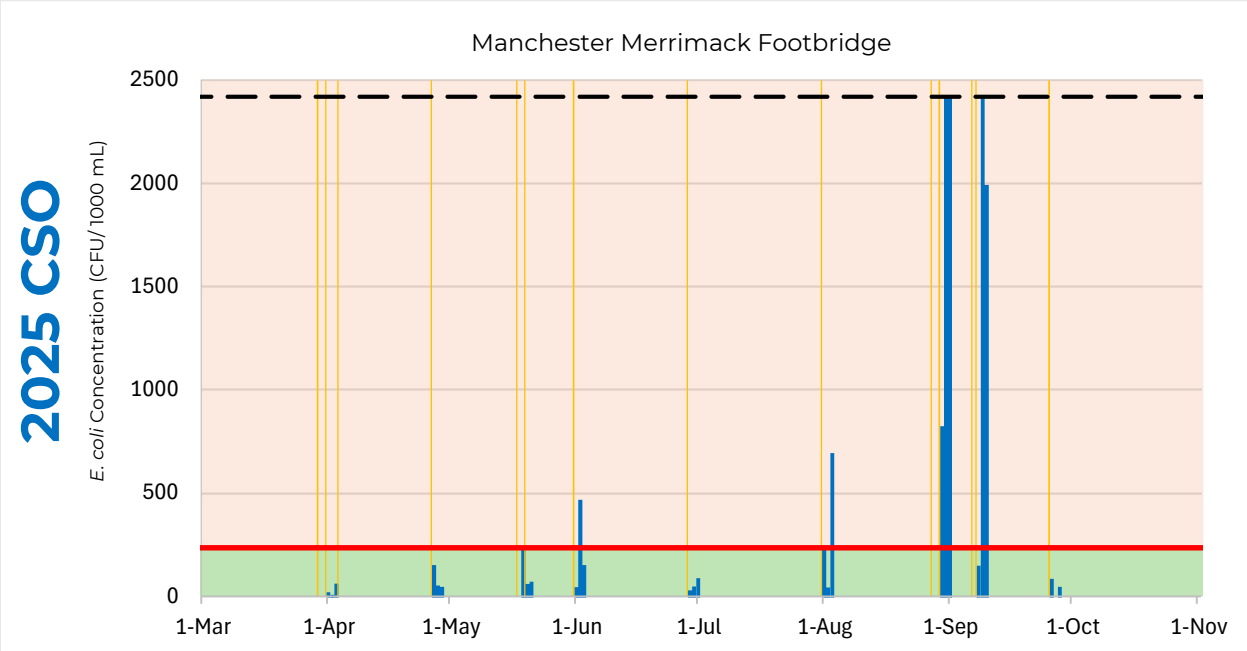
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Manchester, New Hampshire

Monitoring Site: Manchester - Merrimack Footbridge

2025 Results





Safe Unsafe Bacteria Date of Manchester CSO Detection Limit Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Manchester, New Hampshire

Monitoring Site: Manchester - USGS Gauge

(river mile 67.9)

Known CSO Infrastructure

- The Manchester USGS Gauge site is located 2.7 miles downstream of the Merrimack Footbridge site and downstream of 14 of the 15 Manchester CSO outfalls.
- Manchester reports 15 CSO outfalls, 10 of which were activated at least once in 2025.
- Manchester contributed the largest volume of CSOs to the Merrimack in 2025 (384 million gallons). Over the past decade, Manchester's CSOs discharged an average of 332 million gallons per year.
- The Manchester USGS Gauge site is located at the USGS streamflow gauge on a boat ramp roughly straight across from Manchester's CSO outfall 052.

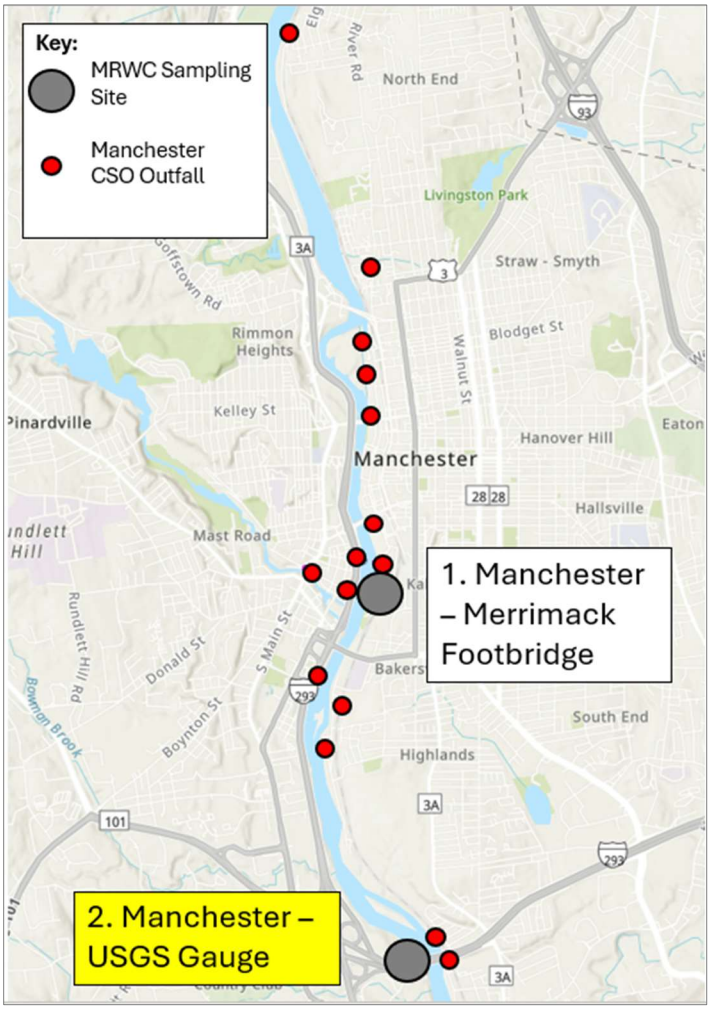


Figure 30: MRWC Manchester – USGS Gauge sampling site and Manchester CSO outfalls

Greater Region: Manchester, New Hampshire

Monitoring Site: Manchester - USGS Gauge

(river mile 67.9)

Water Quality Results

Table 20. 2024 and 2025 bacteria results for the Manchester – USGS Gauge. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	25% Unsafe	8% Unsafe
CSO Events	55% Unsafe	67% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline samples decreased from 2024. However, the bacteria levels for CSO events were significantly higher and the percentage of unsafe CSO events increased from 2024 to 2025.

The two Manchester sites are only 2.7 miles apart but had opposite trends in baseline bacteria levels. The USGS Gauge site decreased from 25% to 8% unsafe while the Merrimack Footbridge site increased from 7% unsafe to 25%. Both sites saw increases in unsafe readings after CSO events.

These differences are interesting considering the close proximity of the two sites. Additional in-depth sampling is needed to better understand the bacteria trends in Greater Manchester.

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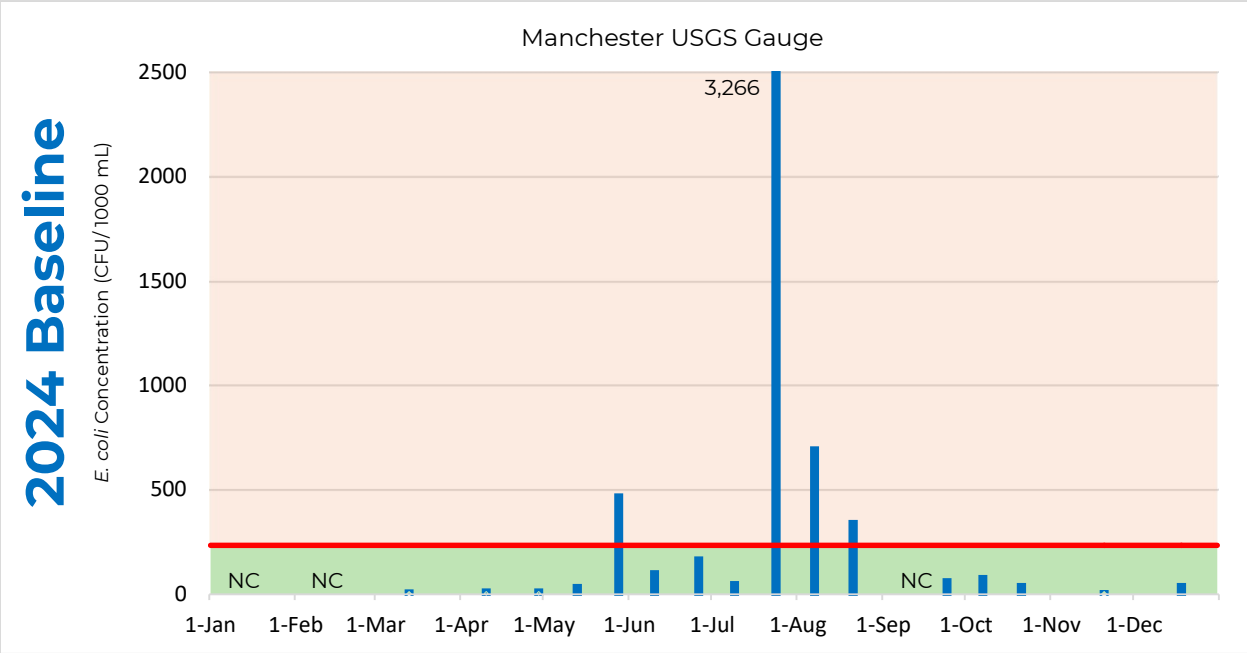


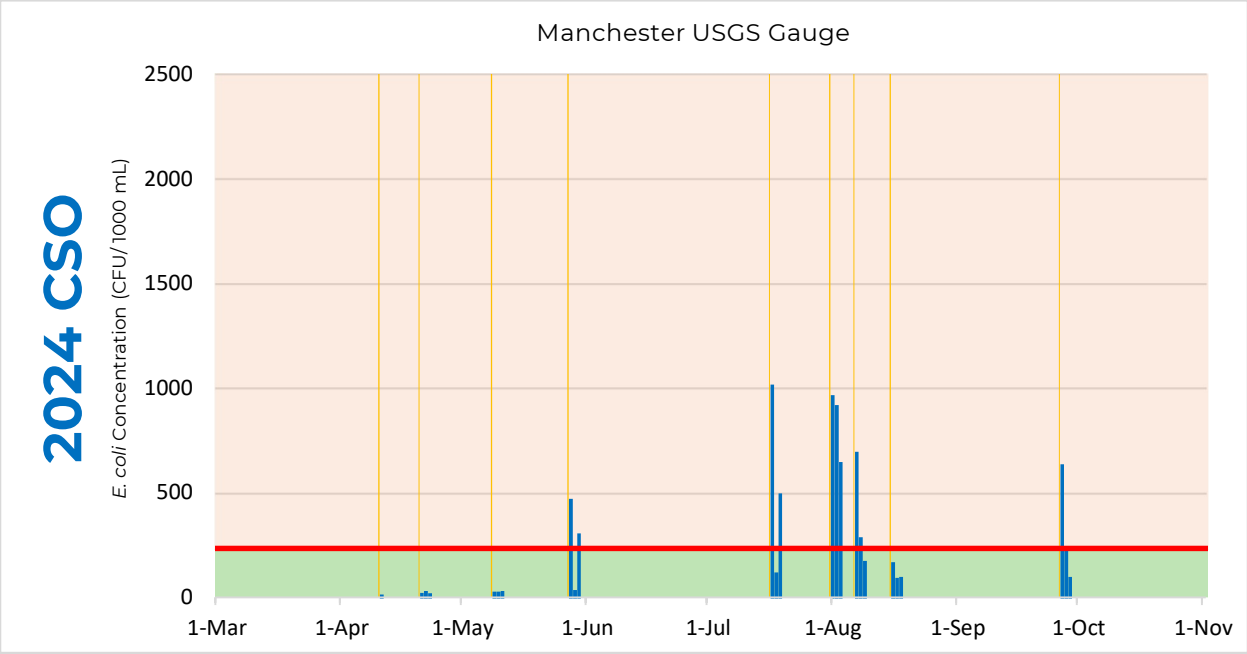
Figure 31: Manchester - USGS Sampling Site

Greater Region: Manchester, New Hampshire

Monitoring Site: Manchester - USGS Gauge

2024 Results





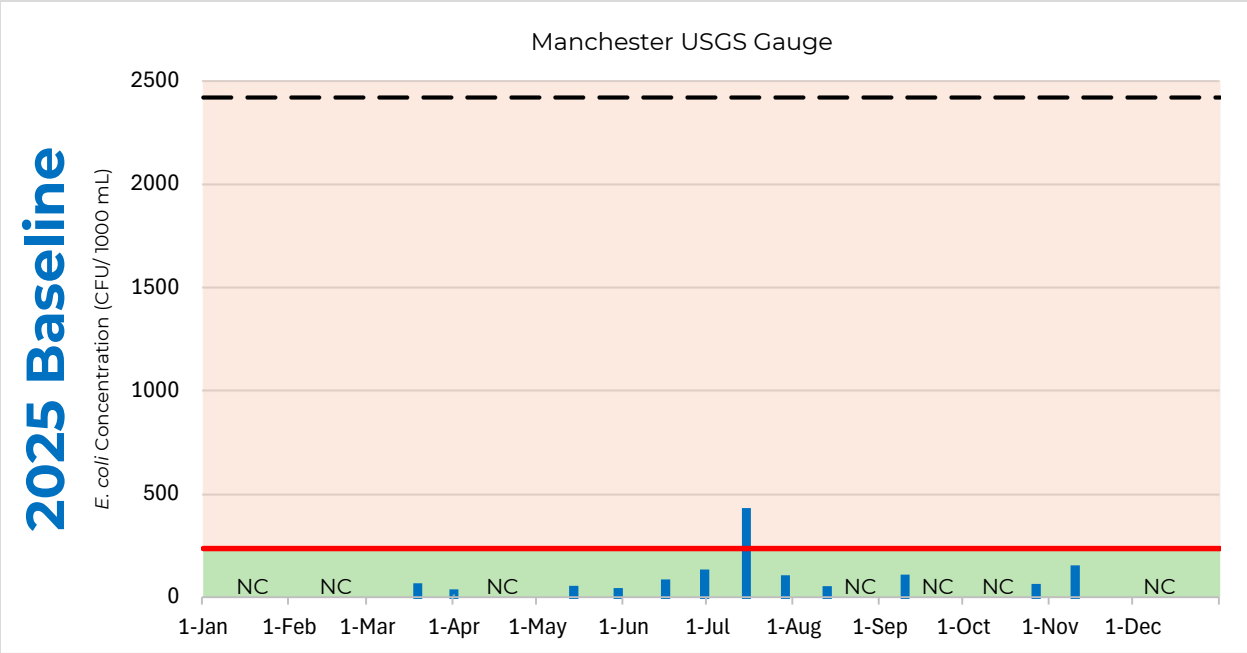
Safe Unsafe Bacteria Date of Manchester CSO Safety Limit

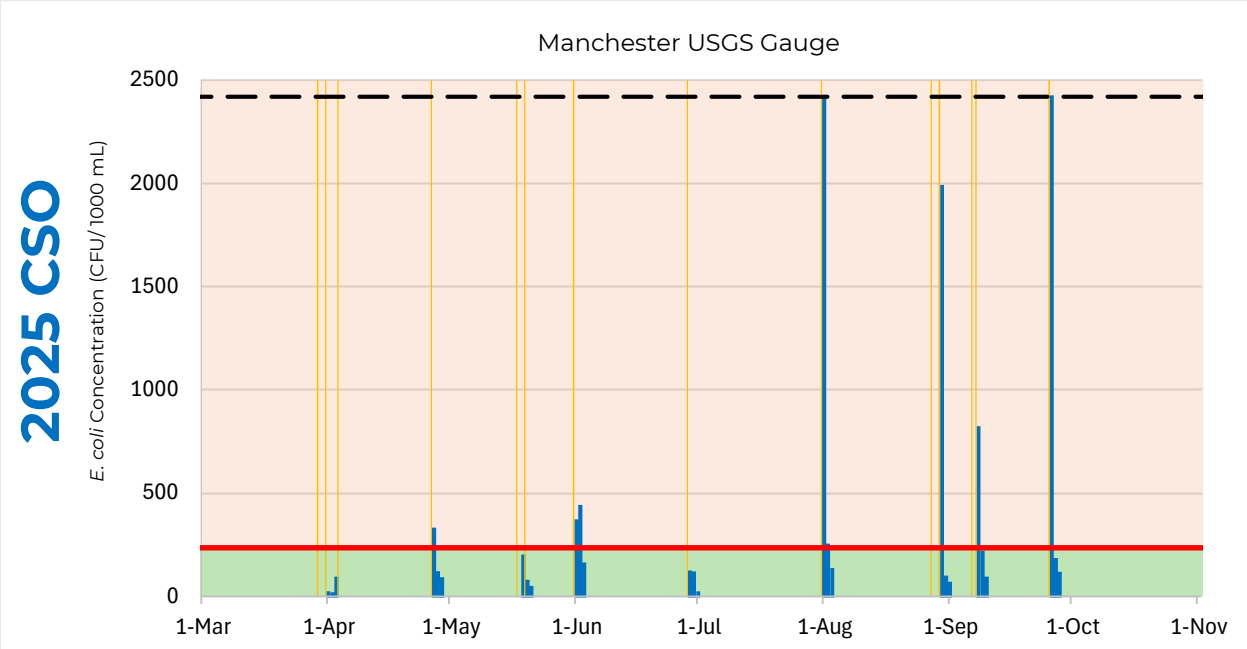
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).
The high July baseline measurement in 2024 was analyzed by the EPA and diluted to be read above MRWCs detection limit.

Greater Region: Manchester, New Hampshire

Monitoring Site: Manchester - USGS Gauge

2025 Results





Safe Unsafe Bacteria Date of Manchester CSO Detection Limit Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Nashua, New Hampshire

Monitoring Site: Nashua - Greeley Park Boat Ramp

(river mile 55.75)

Known CSO Infrastructure

- The Greeley Park Boat Ramp site is 12-18 miles downstream of all 15 Manchester CSO outfalls.
- Manchester reports 15 CSO outfalls, 10 of which were activated at least once in 2025.
- Manchester contributed the largest volume of CSOs to the Merrimack in 2025 (384 million gallons). Over the past decade, Manchester's CSOs discharged an average of 332 million gallons per year.
- The current Manchester CSO impact distance is unknown.
- The Greeley Park Boat Ramp is upstream of all 9 Nashua outfalls and not impacted by Nashua CSOs.

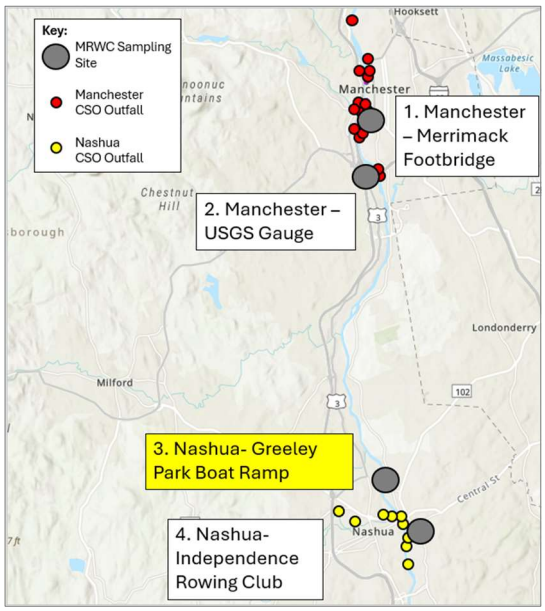


Figure 32: MRWC Nashua - Greeley Park Boat Ramp sampling site, Manchester CSO outfalls and Nashua CSO outfalls

Water Quality Results

Table 21. 2025 bacteria results for the Nashua – Greeley Park Boat Ramp

	2025
Baseline Bacteria Samples	21% Unsafe
CSO Events	67% Unsafe



Figure 33. Nashua site

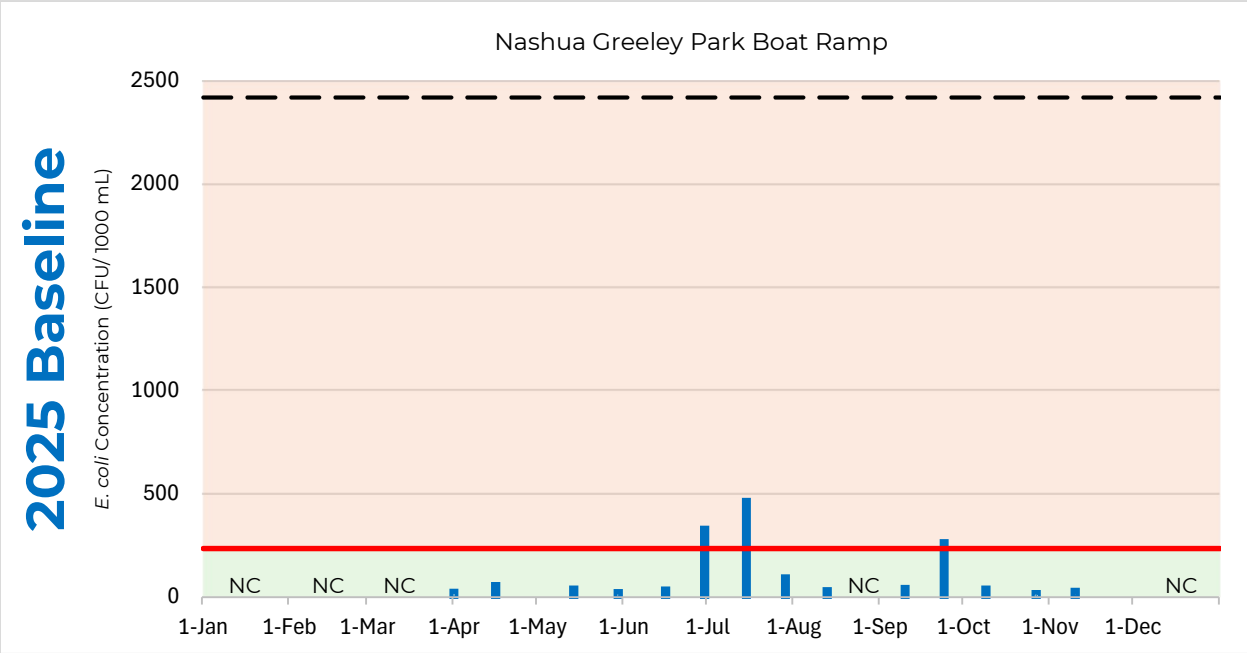
Site Analysis: 2025 was the first time in recent history that MRWC tested at Greeley Park Boat Ramp. The two Nashua sites are only 1.83 miles apart, but the upstream Greeley Park Boat Ramp site had three unsafe baseline results while the downstream Independence Rowing Club site had zero. More sampling is needed to understand why this site has higher baseline readings.

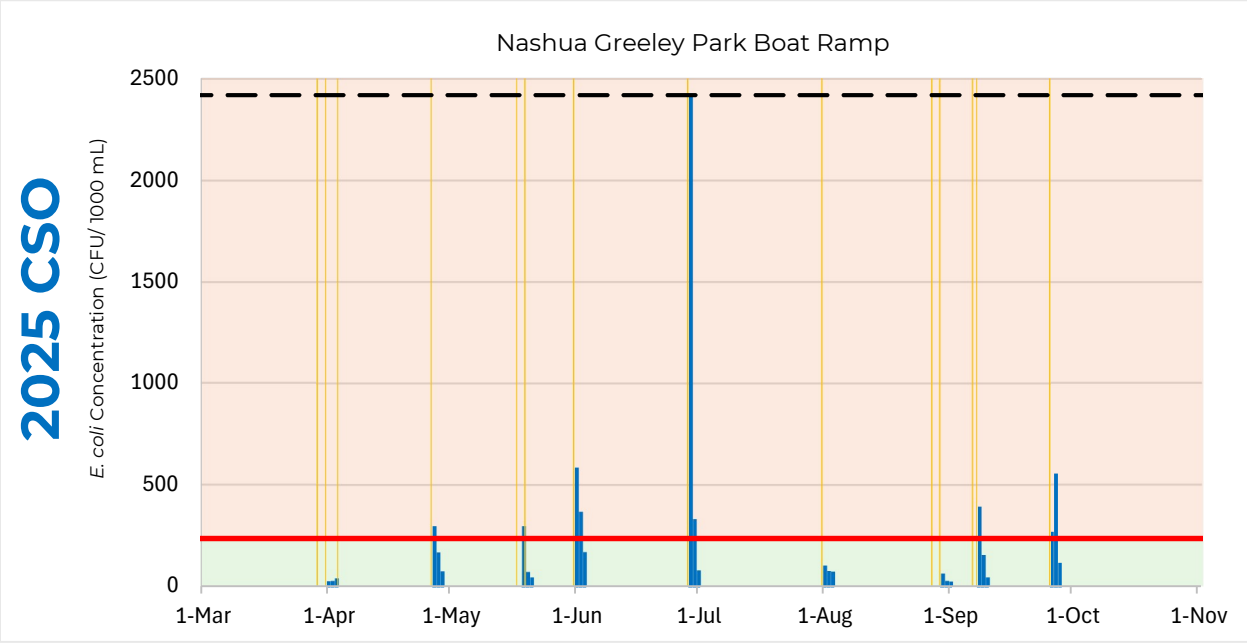
Additionally, the percentage of unsafe CSOs were relatively high for both Nashua sites. The Manchester CSOs had the highest discharge volume in the watershed (384 million gallons), but the CSO outfalls are located 12+ miles upstream. Since this is a relatively far distance for bacteria to travel, further investigation is needed to determine if the high bacteria results are due to the Manchester CSOs or other sources.

Greater Region: Nashua, New Hampshire

Monitoring Site: Nashua - Greeley Park Boat Ramp

2025 Results





Safe Unsafe Bacteria Date of Manchester CSO Detection Limit Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Nashua, New Hampshire

Monitoring Site: Nashua - Independence Rowing Club

(river mile 53.92)

Known CSO Infrastructure

- The Independence Rowing Club site is 14-20 miles downstream of all 15 Manchester CSO outfalls.
- Manchester reports 15 CSO outfalls, 10 of which were activated at least once in 2025.
- Manchester contributed the largest volume of CSOs to the Merrimack in 2025 (384 million gallons). Over the past decade, Manchester CSOs discharged an average of 332 million gallons per year.
- The Independence Rowing Club site is downstream of 6 out of 9 Nashua CSO outfalls.
- Nashua reports 9 CSO outfalls, 8 of which were activated at least once in 2025.
- Nashua contributed the third lowest volume of CSOs into the Merrimack in 2025 (12 million gallons). Over the past decade, Nashua CSOs discharged an average of 13 million gallons per year.
- The current Manchester and Nashua CSO impact distances are unknown.

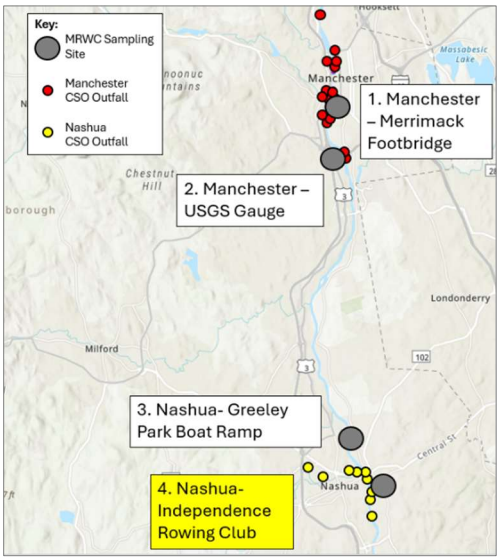


Figure 34: MRWC Nashua – Independence Rowing Club sampling site, Manchester CSO outfalls, and Nashua CSO outfalls

Water Quality Results

Table 22. 2025 bacteria results for the Nashua – Independence Rowing Club

	2025
Baseline Bacteria Samples	0% Unsafe
CSO Events	70% Unsafe



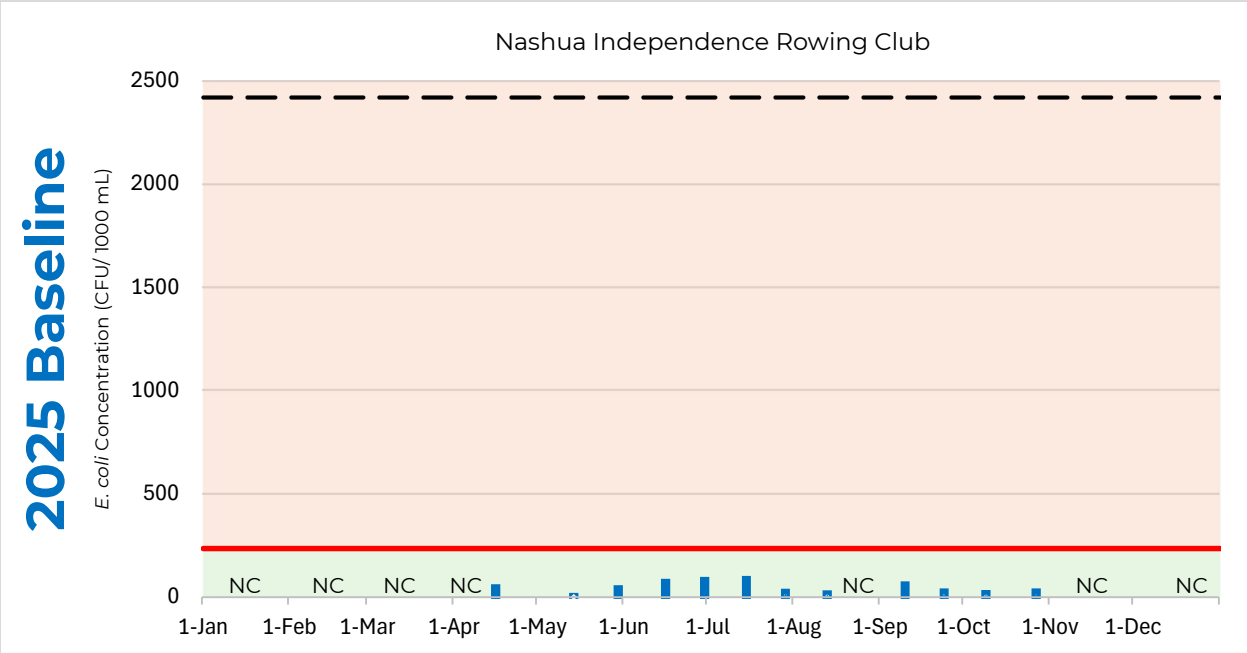
Figure 35. Nashua site

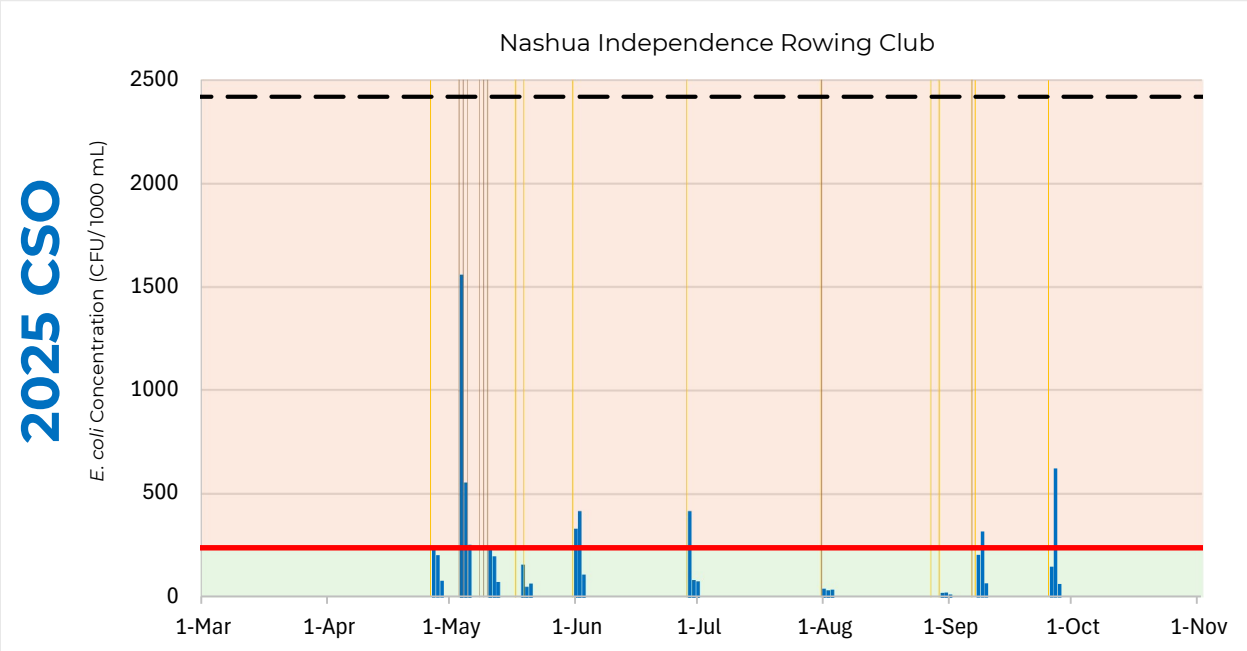
Site Analysis: In 2025, the Independence Rowing Club had zero unsafe baseline readings. However, this site had unsafe readings after 70% of CSO events. This is relatively similar to the 67% of unsafe CSO events at the upstream Greeley Park Boat ramp which is not impacted by Nashua CSOs. This raises the question of whether there is a meaningful impact from the Nashua CSOs, or whether these sites are more impacted by non-point sources after heavy rain or from the large upstream CSO discharges from Manchester.

Greater Region: Nashua, New Hampshire

Monitoring Site: Nashua - Independence Rowing Club

2025 Results





Safe | Unsafe | Bacteria | Date of Manchester CSO | Date of Nashua CSO | Detection Limit | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Lowell, Massachusetts

Monitoring Site: Lowell - Pawtucket Boulevard

(river mile 47.8)

Known CSO Infrastructure

- The Pawtucket Boulevard site is located 11.2 miles downstream of the closest Nashua CSO outfall.
- Nashua reports 9 CSO outfalls, 8 of which were activated at least once in 2025.
- Nashua contributed the third lowest volume of CSOs to the Merrimack in 2025 (12 million gallons). Over the past decade, Nashua discharged an average of 13 million gallons per year.
- The current Nashua CSO impact distance is unknown.
- Although the Lowell Regional Wastewater Utility reports 9 total CSO outfalls, they are all downstream of this site and do not impact it.

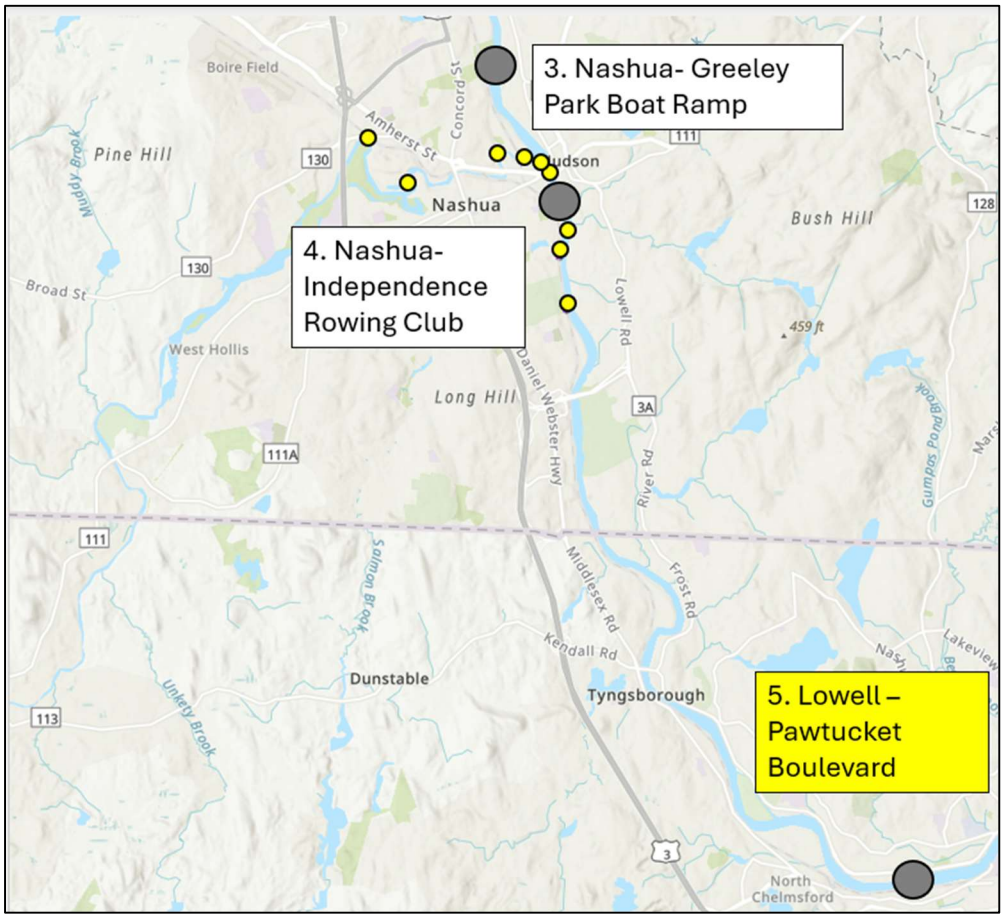


Figure 36: MRWC Lowell – Pawtucket Boulevard sampling site and Nashua CSO outfalls

Greater Region: Lowell, Massachusetts

Monitoring Site: Lowell - Pawtucket Boulevard

(river mile 47.8)

Water Quality Results

Table 23. 2024 and 2025 bacteria results for the Lowell - Pawtucket Boulevard site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	0% Unsafe	0% Unsafe
CSO Events	25% Unsafe	50% Unsafe

Site Analysis: In 2025 there were zero unsafe baseline samples (0% unsafe). This is the same baseline result that was seen in 2024. However, the percentage of unsafe CSO events increased from 2024 to 2025.

The nonexistence of high readings during baseline sampling is encouraging for the recreational value of this stretch of the Merrimack, especially with a public beach, boathouse, and several boat launches near it.

Since Manchester and Nashua do not have CSO impact distance studies, it is uncertain if the unsafe bacteria readings after CSO events are due to CSOs or non-point runoff.

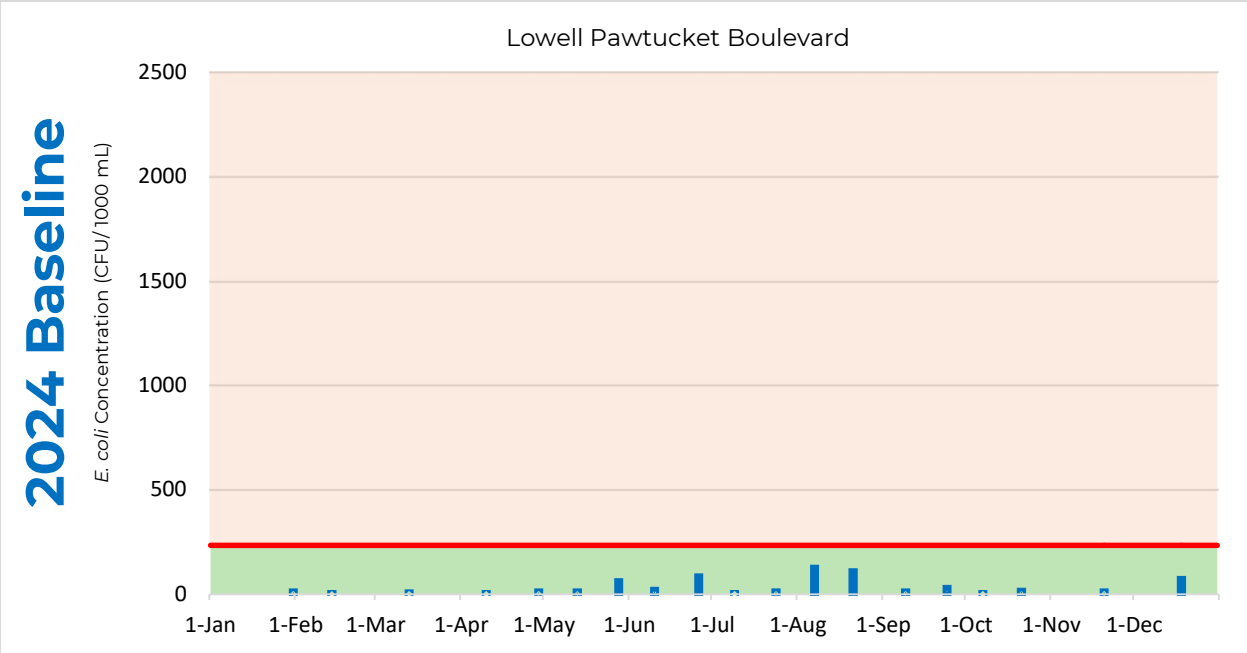


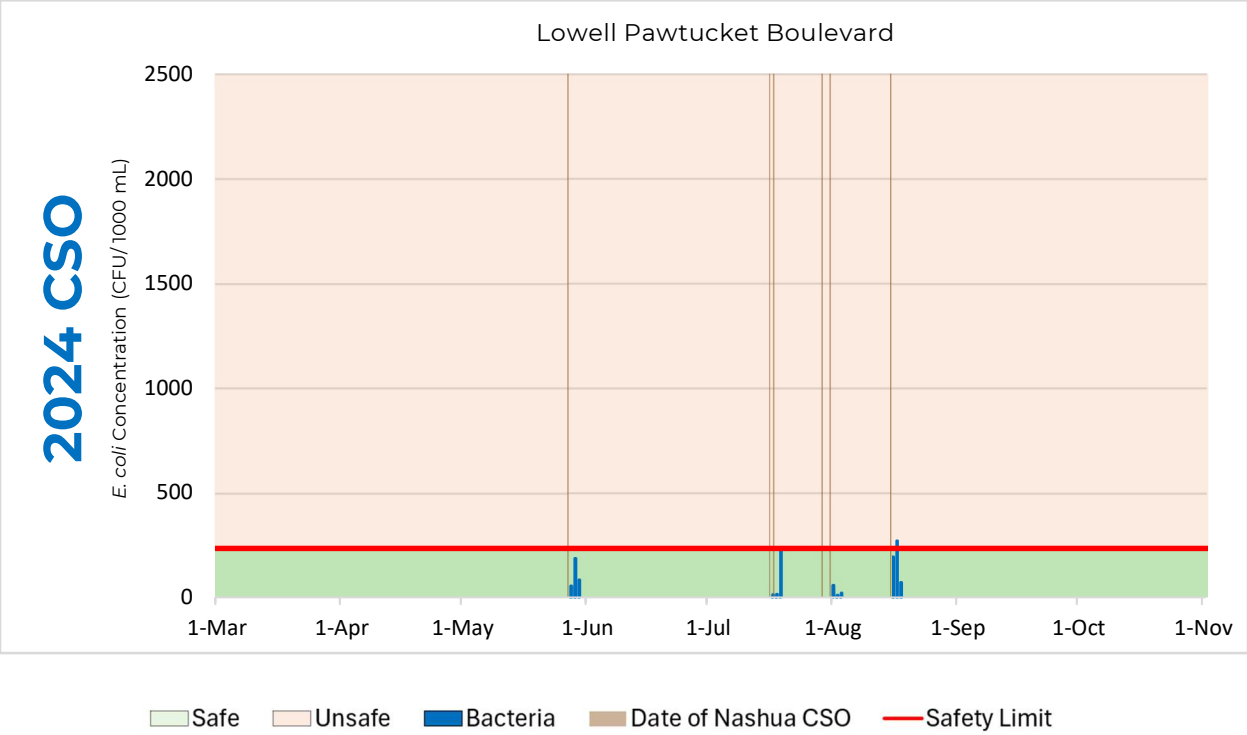
Figure 37: MRWC Lowell – Pawtucket Boulevard sampling site

Greater Region: Lowell, Massachusetts

Monitoring Site: Lowell - Pawtucket Boulevard

2024 Results



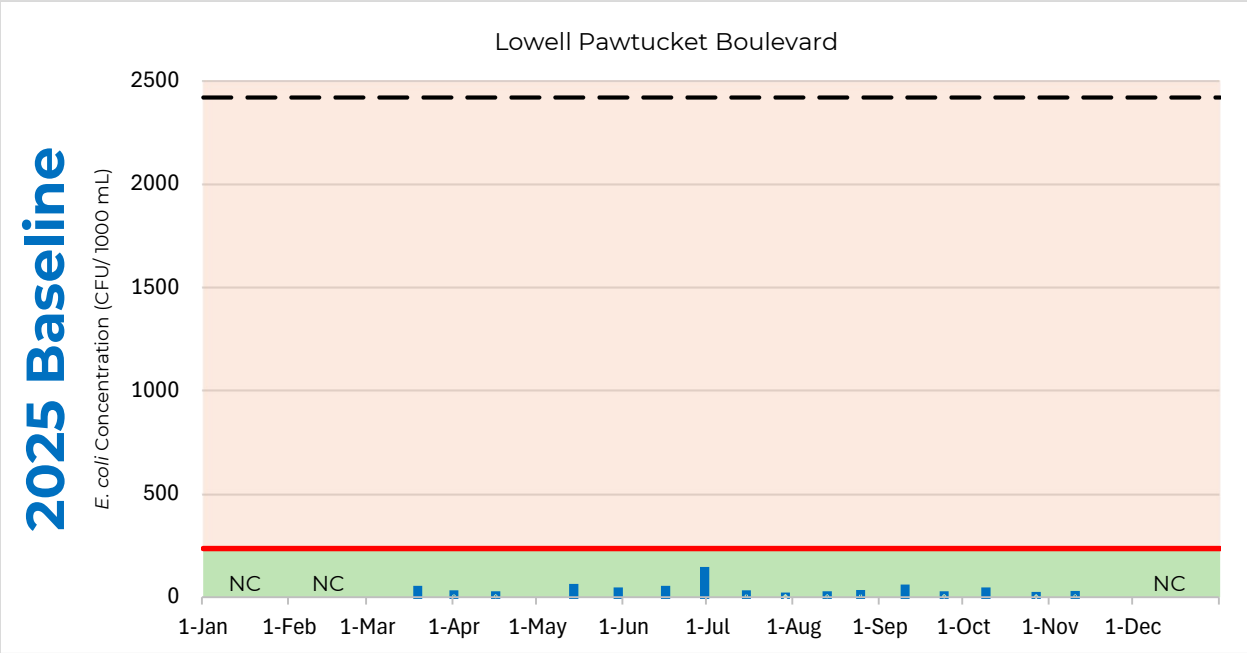


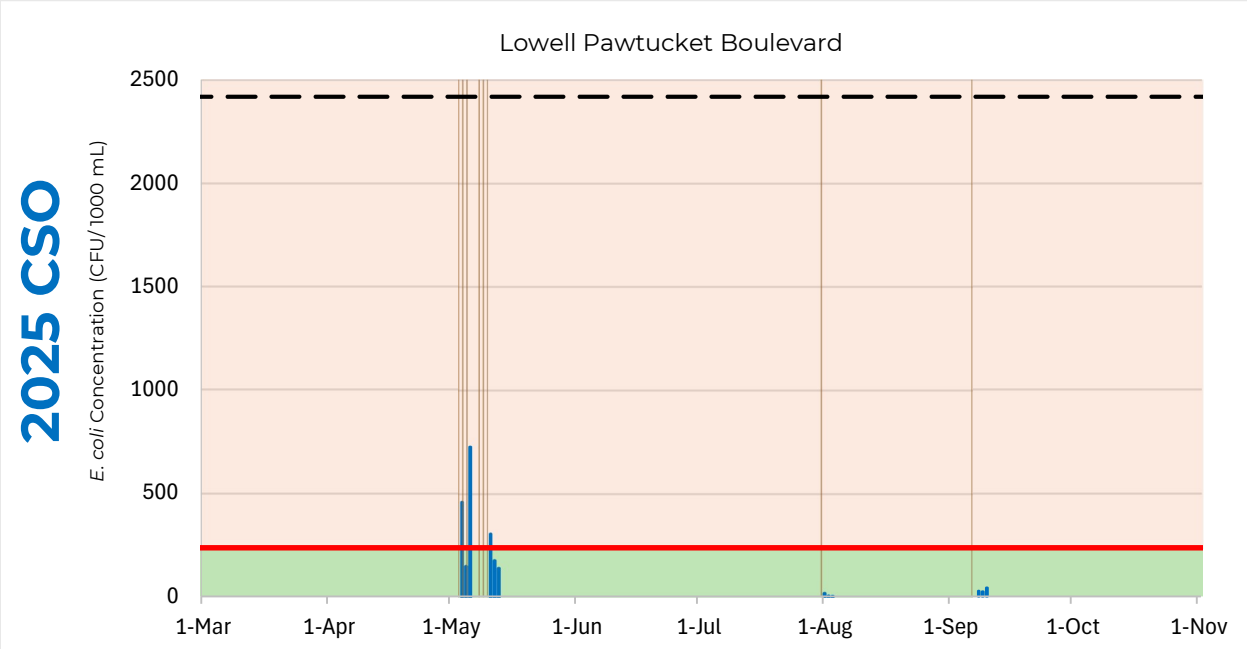
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Lowell, Massachusetts

Monitoring Site: Lowell - Pawtucket Boulevard

2025 Results





Safe Unsafe Bacteria Date of Nashua CSO Detection Limit Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Lowell, Massachusetts

Monitoring Site: Lowell - Hunts Falls Bridge

(river mile 43)

Known CSO Infrastructure

- The Hunts Falls Bridge site is downstream of 6 out of 9 Lowell CSO outfalls, 8 of which were activated at least once in 2025.
- Greater Lowell contributed the second largest volume of CSOs to the Merrimack in 2025 (110 million gallons). Over the past decade, Greater Lowell discharged an average of 297 million gallons of CSOs per year.
- On average, the 6 upstream Lowell outfalls contribute 56% of Lowell's high CSO volume. The Read Station outfall is immediately upstream of this test site.
- Lowell is working on its Centralville Area Sewer Separation Project. Construction began in March 2026 and will add 7+ miles of new drainpipes, separating the sewer and stormwater infrastructure for 400 acres.

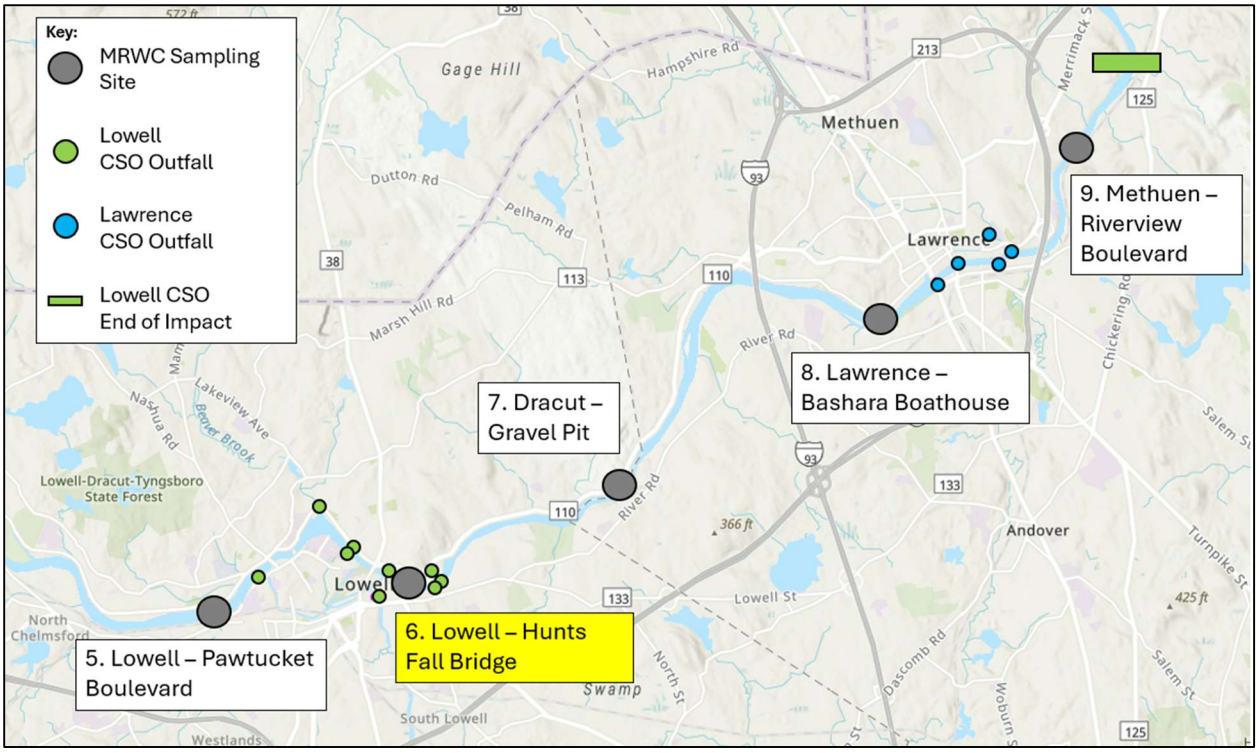


Figure 38: MRWC Lowell – Hunts Falls Bridge sampling site, Lowell CSO outfalls, and Lawrence CSO outfalls

Greater Region: Lowell, Massachusetts

Monitoring Site: Lowell - Hunts Falls Bridge

(river mile 43)

Water Quality Results

Table 24. 2024 and 2025 bacteria results for the Lowell – Hunts Falls Bridge site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	0% Unsafe	6% Unsafe
CSO Events	50% Unsafe	50% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline bacteria samples and unsafe CSO events were relatively similar to 2024. The slight increase in unsafe baseline results was only due to one singular elevated result of 387.3 CFU / 100 mL (1.5X the safety limit) in 2025.

As with the upstream Lowell Pawtucket Boulevard site, the limited high readings during baseline sampling are encouraging for recreational use outside of the immediate 2-3 days following rain events.

This site has a much lower percentage of unsafe CSO events (50% unsafe) compared to the downstream Dracut Gravel Pit site (100%). This could be because it is downstream of fewer Lowell CSO outfalls and impacted by a lower volume of Lowell CSO discharges.

The Lowell Hunts Falls Bridge's lower unsafe CSO percentage could also be due to the close proximity to the Lowell CSO outfalls. Given this proximity and the fact that samples can be taken 14-38 hours after a Lowell CSO begins, bacteria could potentially flow past the site before the first day of testing.

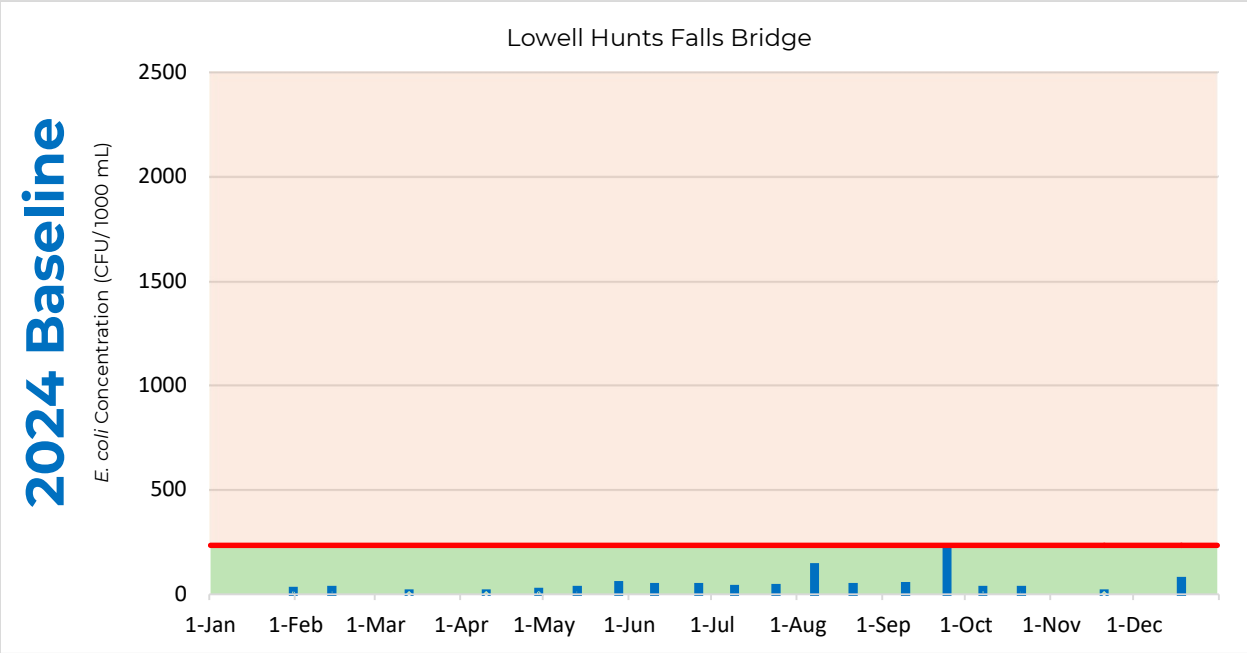


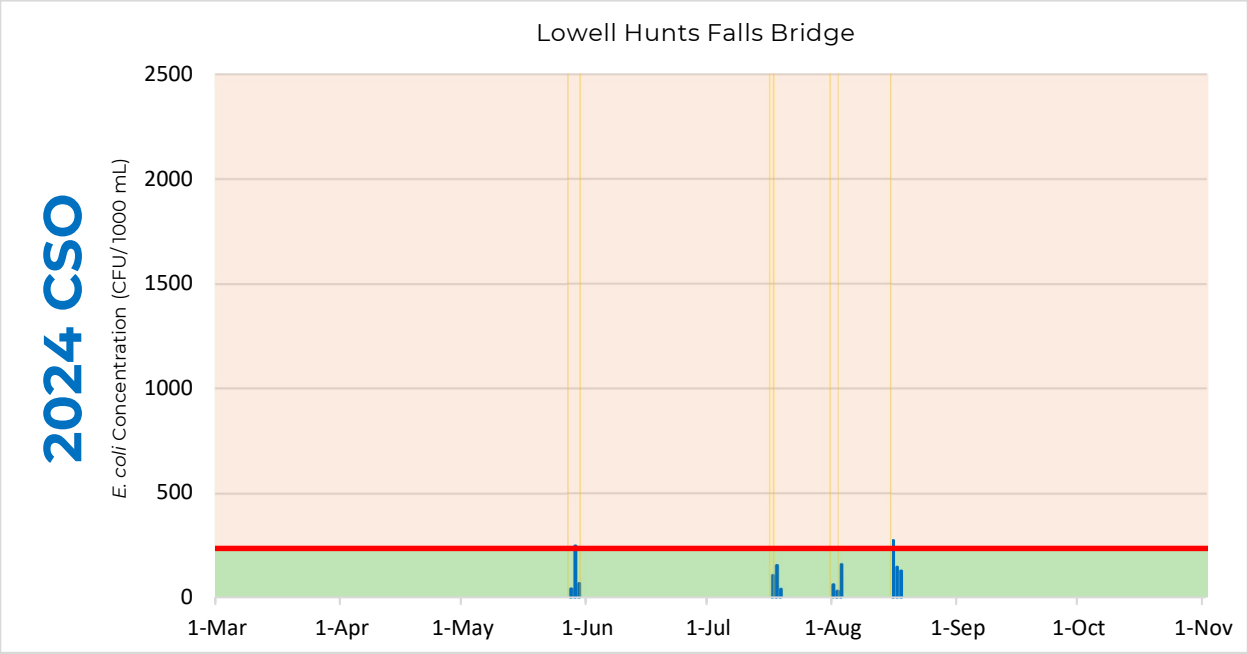
Figure 39: Lowell – Hunts Falls Bridge sampling site

Greater Region: Lowell, Massachusetts

Monitoring Site: Lowell - Hunts Falls Bridge

2024 Results





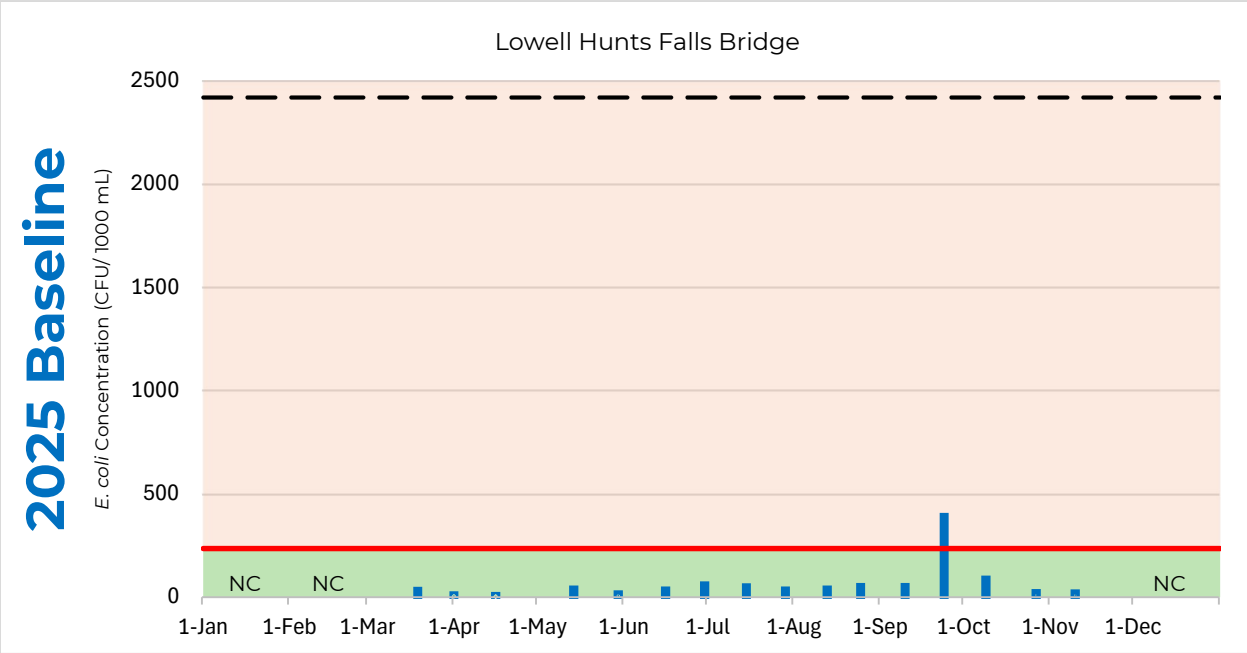
Safe | Unsafe | Bacteria | Date of Lowell CSO | Safety Limit

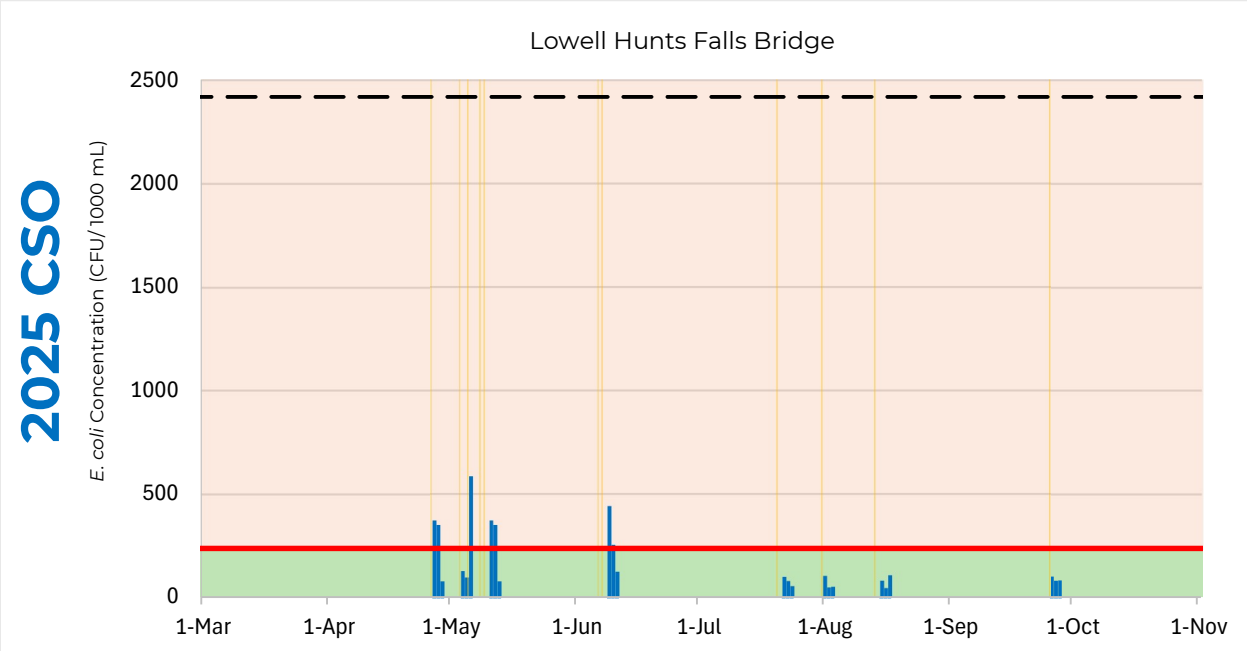
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Lowell, Massachusetts

Monitoring Site: Lowell - Hunts Falls Bridge

2025 Results





Safe Unsafe Bacteria Date of Lowell CSO Detection Limit Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Lowell, Massachusetts

Monitoring Site: Dracut - Gravel Pit

(river mile 34)

Known CSO Infrastructure

- The Dracut Gravel Pit site is downstream of all Lowell CSO outfalls.
- The Lowell Regional Wastewater Utility reports 9 CSO outfalls, 8 of which were activated at least once in 2025.
- Lowell contributed the second largest volume of CSOs to the Merrimack in 2025 (110 million gallons). Over the past decade, Greater Lowell discharged an average of 297 million gallons of CSOs per year.
- Lowell is working on its Centralville Area Sewer Separation Project. Construction began in March 2026 and will add 7+ miles of new drainpipes, separating the sewer and stormwater infrastructure for 400 acres.

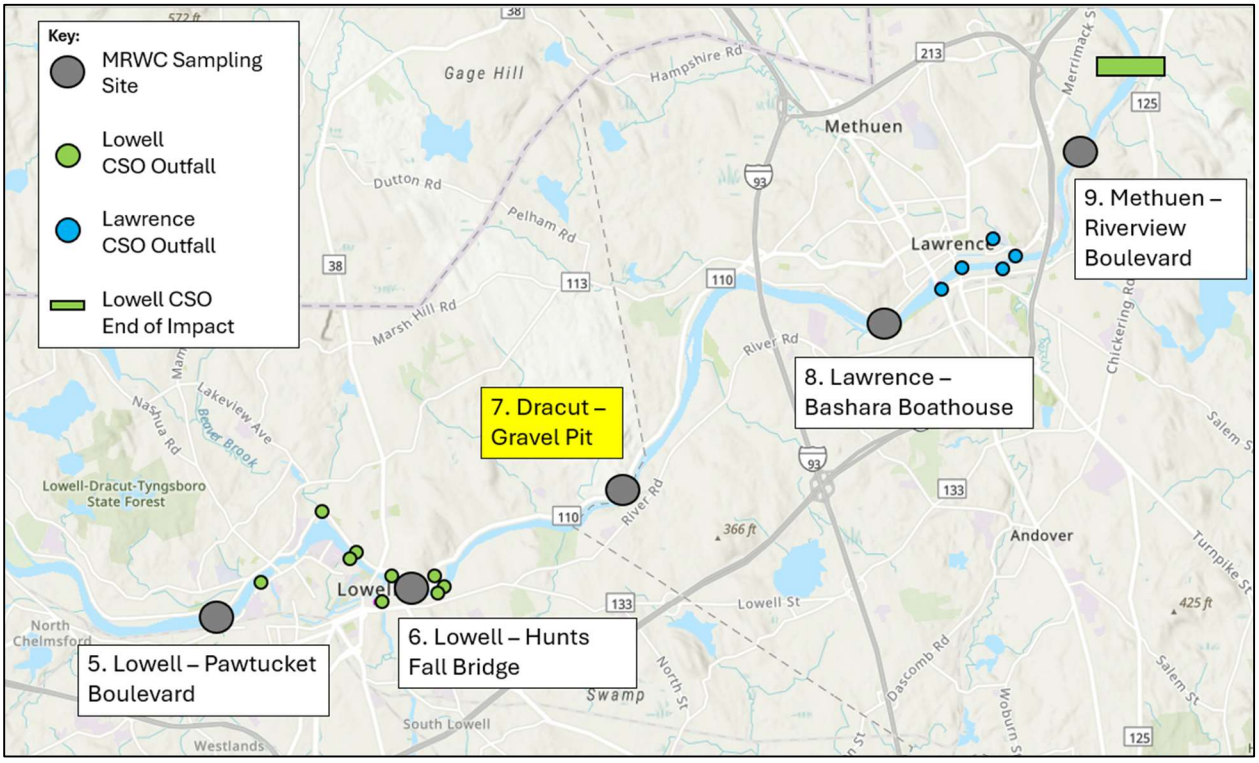


Figure 40: MRWC Dracut – Gravel Pit sampling site, Lowell CSO outfalls, and Lawrence CSO outfalls

Greater Region: Lowell, Massachusetts

Monitoring Site: Dracut - Gravel Pit

(river mile 34)

Water Quality Results

Table 25. 2024 and 2025 bacteria results for the Dracut – Gravel Pit site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	6% Unsafe	7% Unsafe
CSO Events	100% Unsafe	100% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline bacteria samples and unsafe CSO events were relatively similar to 2024. For both years, there was only one elevated baseline result. In 2024, the unsafe baseline reading of 774 CFU/100 ML (3x the safety limit) was recorded on August 21st. In 2025, the unsafe baseline reading of 727 CFU/100 mL (3x the safety limit) was recorded on July 29th.

For the CSO events, the 2025 unsafe bacteria levels were significantly higher than the 2024 unsafe bacteria levels. It's also noteworthy that in 2025 a larger number of CSOs were sampled after versus 2024, further validating the previous results of 100% unsafe readings during CSOs at this site.

As with the upstream Lowell Hunt Falls Bridge site, the limited high readings during baseline sampling are encouraging for recreational use outside of the immediate 2-3 days following rain events.

This site has a much higher percentage of unsafe CSO events (100% unsafe) compared to the upstream Lowell Hunts Falls Bridge site (50% unsafe). This could be because it is downstream of all Lowell CSO outfalls and impacted by a higher volume of Lowell CSO discharges.

The Dracut Gravel pit higher unsafe CSO percentage could also be due to the fact that the Lowell Hunts Falls Bridge site is closer to the Lowell CSO outfalls. Given this proximity and the fact that samples can be taken 14-38 hours after a Lowell CSO begins, bacteria could potentially flow past the Lowell Hunts Falls Bridge site before the first day of testing.

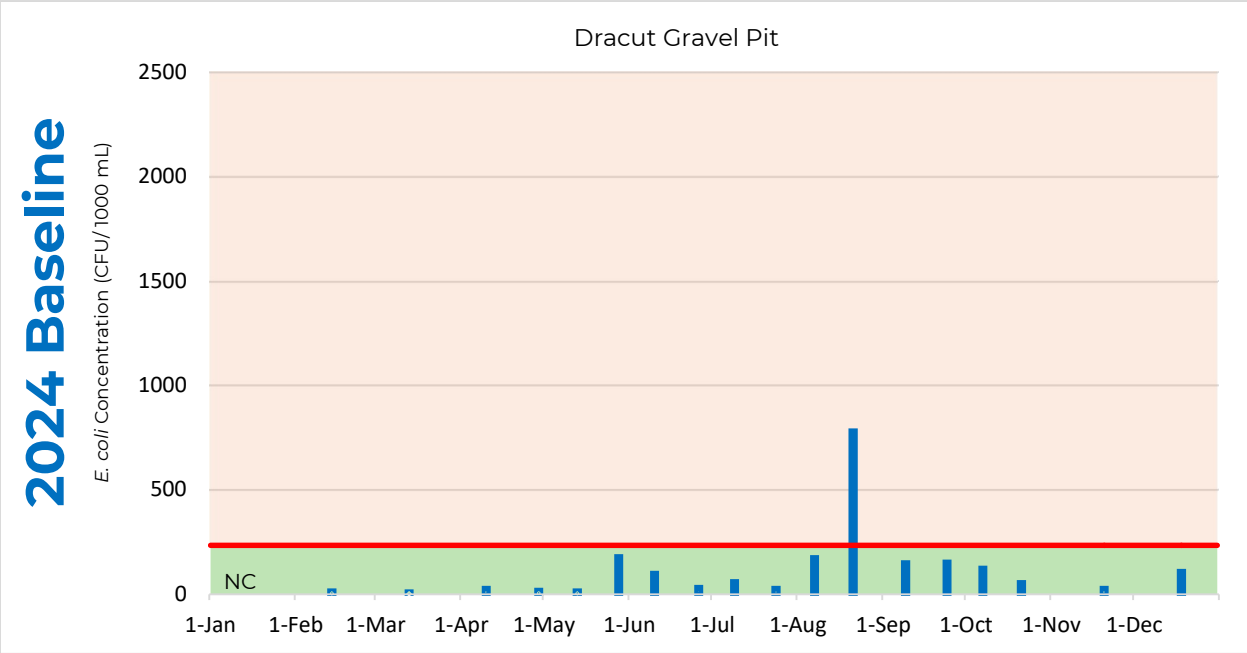


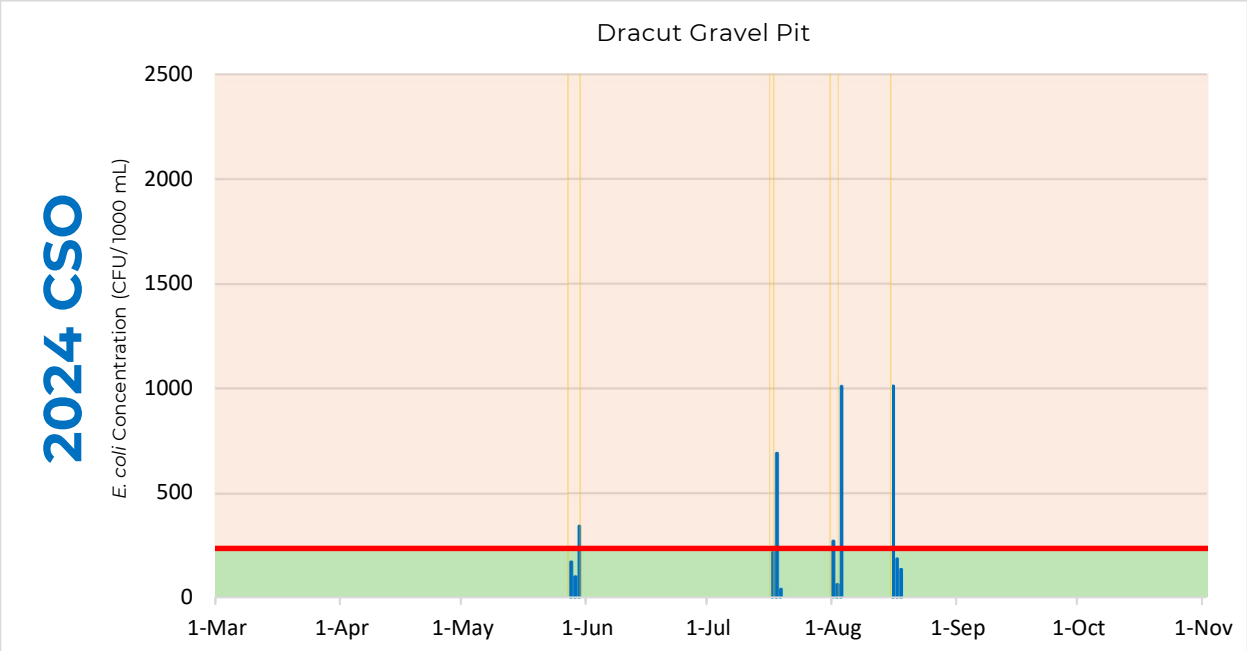
Figure 41: Dracut – Gravel Pit sampling site

Greater Region: Lowell, Massachusetts

Monitoring Site: Dracut - Gravel Pit

2024 Results





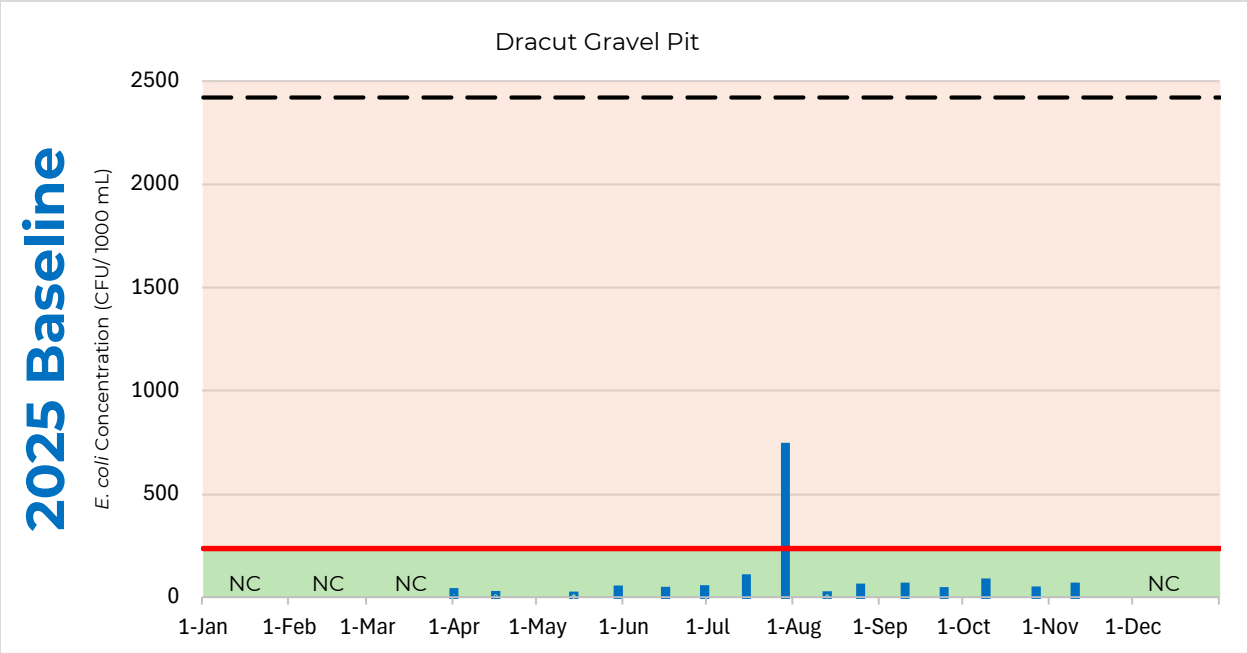
Safe | Unsafe | Bacteria | Date of Lowell CSO | Safety Limit

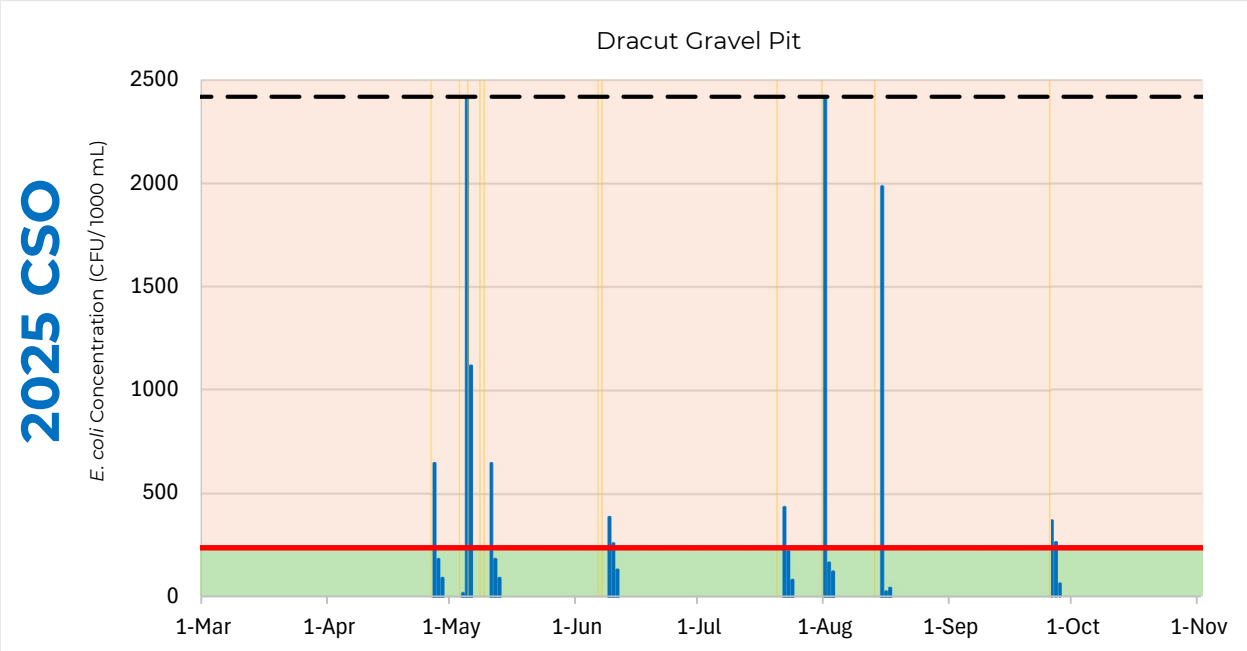
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Lowell, Massachusetts

Monitoring Site: Dracut - Gravel Pit

2025 Results





Safe | Unsafe | Bacteria | Date of Lowell CSO | Detection Limit | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Lawrence, Massachusetts

Monitoring Site: Lawrence - Bashara Boathouse

(river mile 29)

Known CSO Infrastructure

- The Bashara Boathouse site is located 7.8 miles downstream of the closest Lowell CSO outfall.
- Lowell reports 9 CSO outfalls, 8 of which were activated at least once in 2025.
- Greater Lowell contributed the second largest volume of CSOs to the Merrimack in 2025 (110 million gallons). Over the past decade, Greater Lowell discharged an average of 297 million gallons of CSOs per year.
- Lowell is working on its Centralville Area Sewer Separation Project. Construction began in March 2026 and will add 7+ miles of new drainpipes, separating the sewer and stormwater infrastructure for 400 acres.
- The Bashara Boathouse site is a mile upstream of the Essex Dam and it is at a significant bend of the river, both of which contribute to hydraulic complexities at this site and could be leading to a pooling-effect that could impact bacteria levels. Large flocks of Canada geese also frequent this site and could be contributors to the bacteria level. There are two stormwater outfalls right at the Boathouse (on the Boathouse side).
- Although the Greater Lawrence Sanitary District reports 5 CSO outfalls, they are all downstream of this Lawrence site and do not impact it.

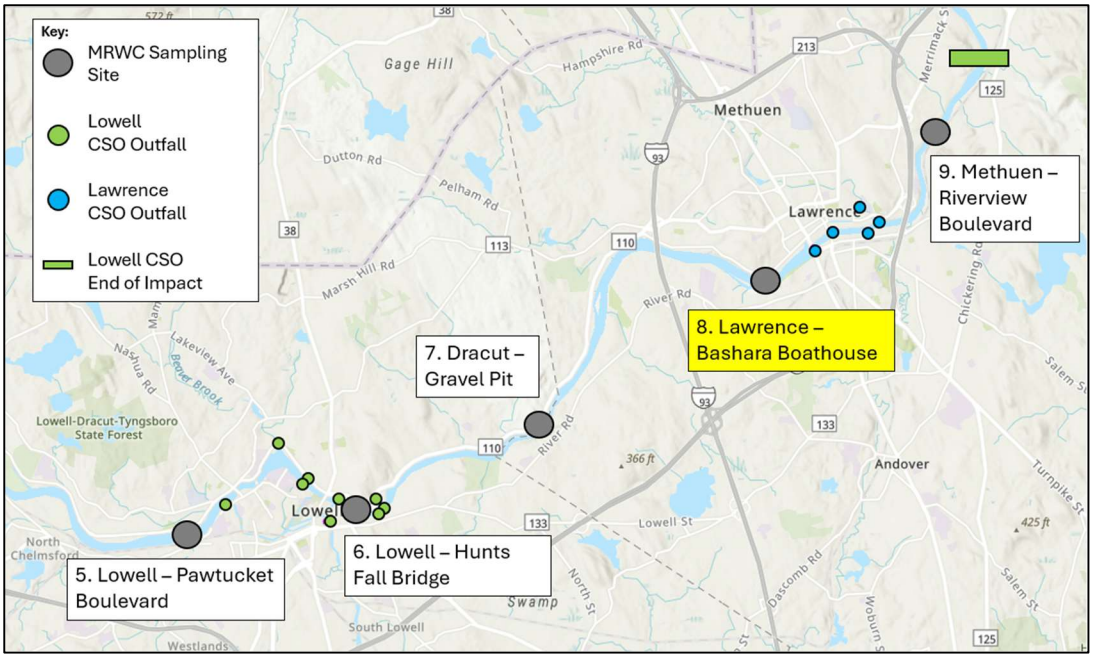


Figure 42: MRWC Lawrence - Bashara Boathouse sampling site, Lowell CSO outfalls, and Lawrence CSO outfalls

Greater Region: Lawrence, Massachusetts

Monitoring Site: Lawrence - Bashara Boathouse

(river mile 29)

Water Quality Results

Table 26. 2024 and 2025 bacteria results for the Lawrence – Bashara Boathouse site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	39% Unsafe	19% Unsafe
CSO Events	50% Unsafe	63% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline samples decreased and the unsafe CSO events increased from 2024. Being a recreational spot for youth in the Merrimack Valley, this site's percentage of dangerous readings is of concern.

The baseline results for this site (19% unsafe) are higher than the upstream Dracut Gravel Pit site (7% unsafe) and the downstream Methuen Riverview Boulevard site (6% unsafe). However, the CSO event results for this site (63% unsafe) are lower than the upstream Dracut Gravel Pit site (100% unsafe) and the downstream Methuen Riverview Boulevard site (100% unsafe).

Further analysis is needed to determine the bacteria sources causing the high percentage of unsafe samples.

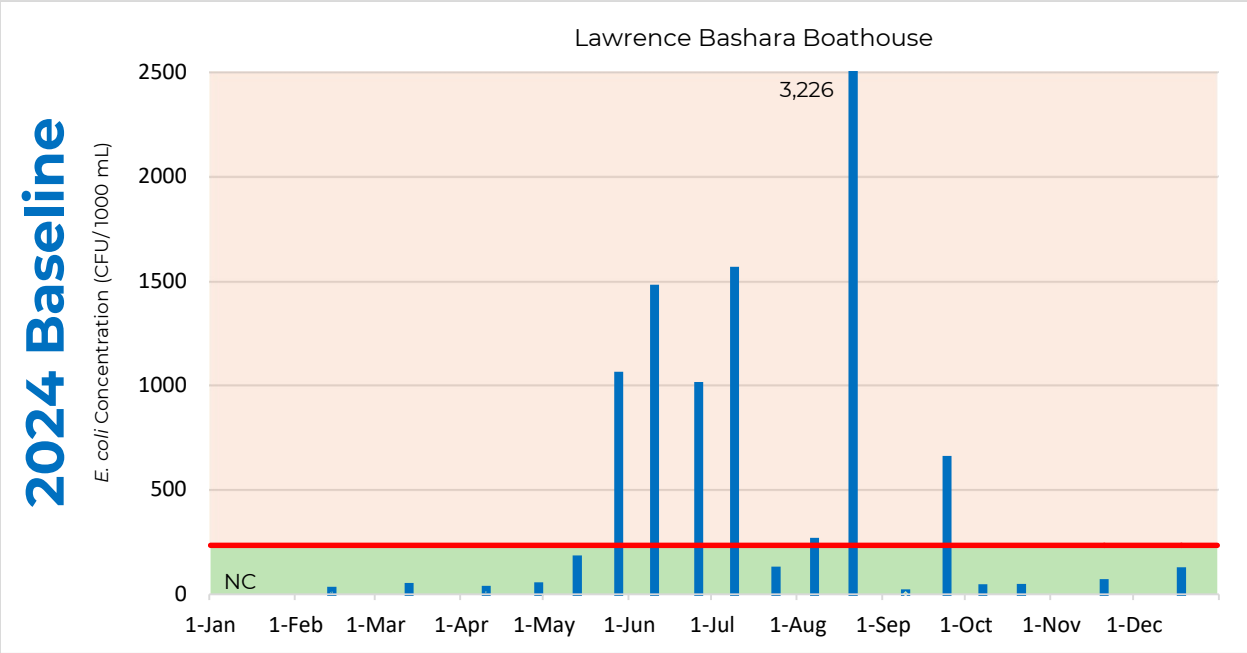


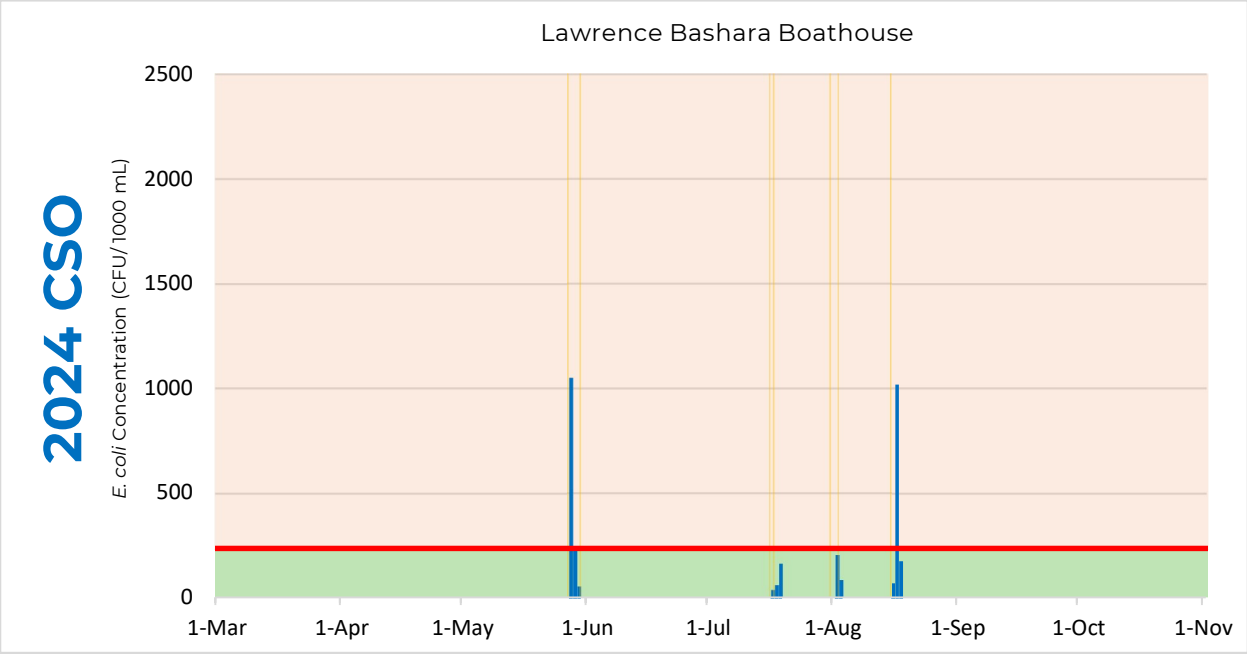
Figure 43: Lawrence – Bashara Boathouse sampling site

Greater Region: Lawrence, Massachusetts

Monitoring Site: Lawrence - Bashara Boathouse

2024 Results





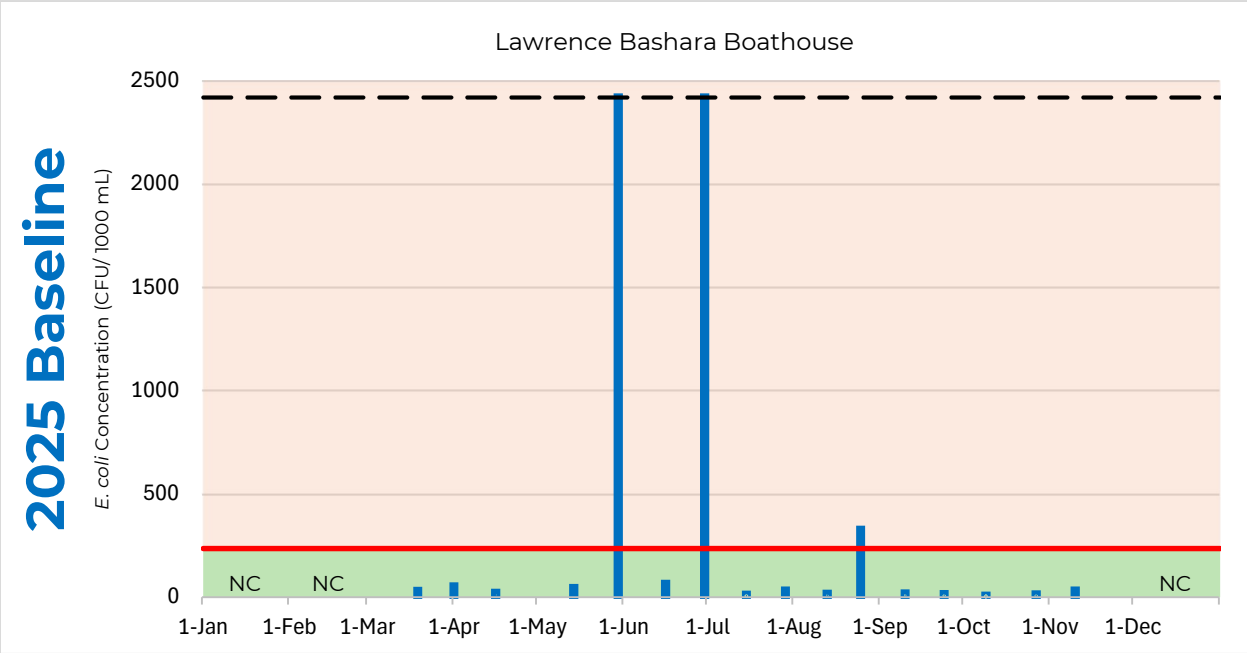
Safe | Unsafe | Bacteria | Date of Lowell CSO | Safety Limit

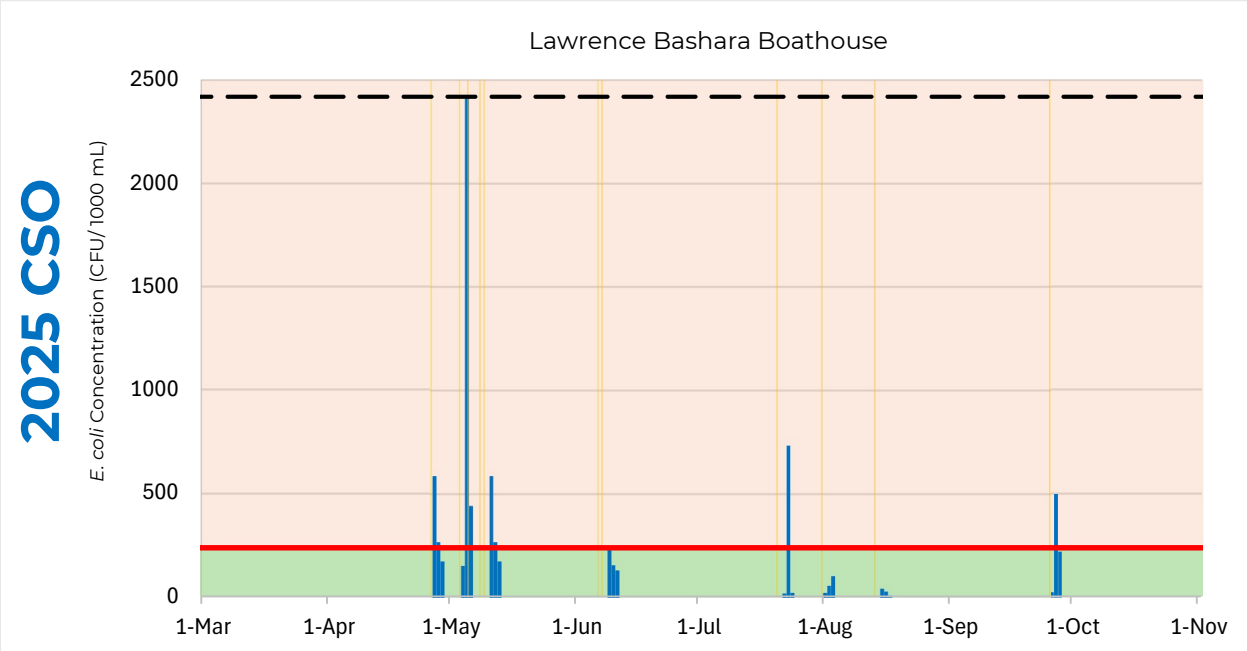
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).
The high August baseline measurement in 2024 was analyzed by the EPA and diluted to be read above MRWCs detection limit.

Greater Region: Lawrence, Massachusetts

Monitoring Site: Lawrence - Bashara Boathouse

2025 Results





Safe | Unsafe | Bacteria | Date of Lowell CSO | Detection Limit | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Lawrence, Massachusetts

Monitoring Site: Methuen - Riverview Boulevard

(river mile 26.2)

Known CSO Infrastructure

- The Methuen Riverview Boulevard site is located downstream of all Lowell CSO outfalls and Lawrence CSO outfalls.
- Lowell reports 9 CSO outfalls, 8 of which were activated at least once in 2025.
    - Lowell contributed the second largest volume of CSOs to the Merrimack in 2025 (110 million gallons). Over the past decade, Greater Lowell discharged an average of 297 million gallons of CSOs per year.
    - Lowell is working on its Centralville Area Sewer Separation Project. Construction began in March 2026 and will add 7+ miles of new drainpipes, separating the sewer and stormwater infrastructure for 400 acres.
- The Greater Lawrence Sanitary District (GLSD) reports 5 CSO outfalls, 3 of which were activated at least once in 2025.
    - GLSD contributed the second lowest volume of CSOs to Merrimack in 2025 (11 million gallons). Over the past decade, GLSD discharged an average of 60 million gallons per year.
    - Lawrence is working on a Green Lawrence-Blue Merrimack Stormwater Resilience Master Plan to address aging infrastructure and reduce the impact of CSOs.

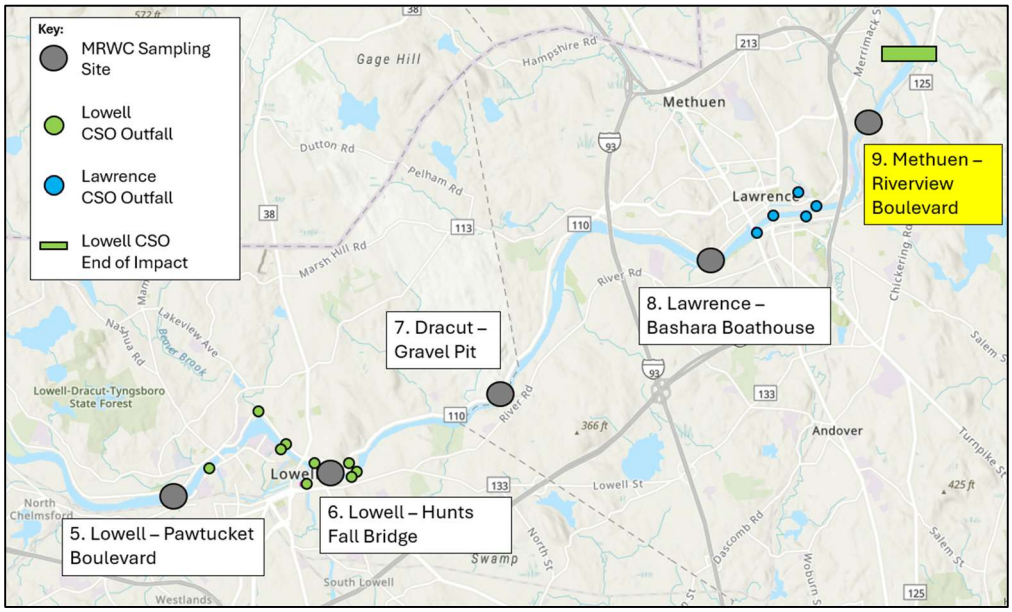


Figure 44: MRWC Methuen – Riverview Boulevard sampling site, Lowell CSO outfalls, and Lawrence CSO outfalls

Greater Region: Lawrence, Massachusetts

Monitoring Site: Methuen - Riverview Boulevard

(river mile 26.2)

Water Quality Results

Table 27. 2024 and 2025 bacteria results for the Methuen – Riverview Boulevard site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	31% Unsafe	6% Unsafe
CSO Events	100% Unsafe	100% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline samples decreased and the percentage of unsafe CSOs stayed the same from 2024.

The baseline results (6% unsafe) are lower than both the upstream Lawrence - Bashara Boathouse site (19% unsafe) and the downstream Haverhill Lincoln Ave Bridge site (13% unsafe).

While the Methuen Riverview Boulevard site is 100% unsafe after CSO events, the upstream Lawrence Bashara boathouse site is only 63% unsafe after CSO events although both sites are primarily impacted by the same Lowell CSOs. MRWC is launching a wet weather hotspot investigation to explore the consistent elevated bacteria levels at this site after CSO events.

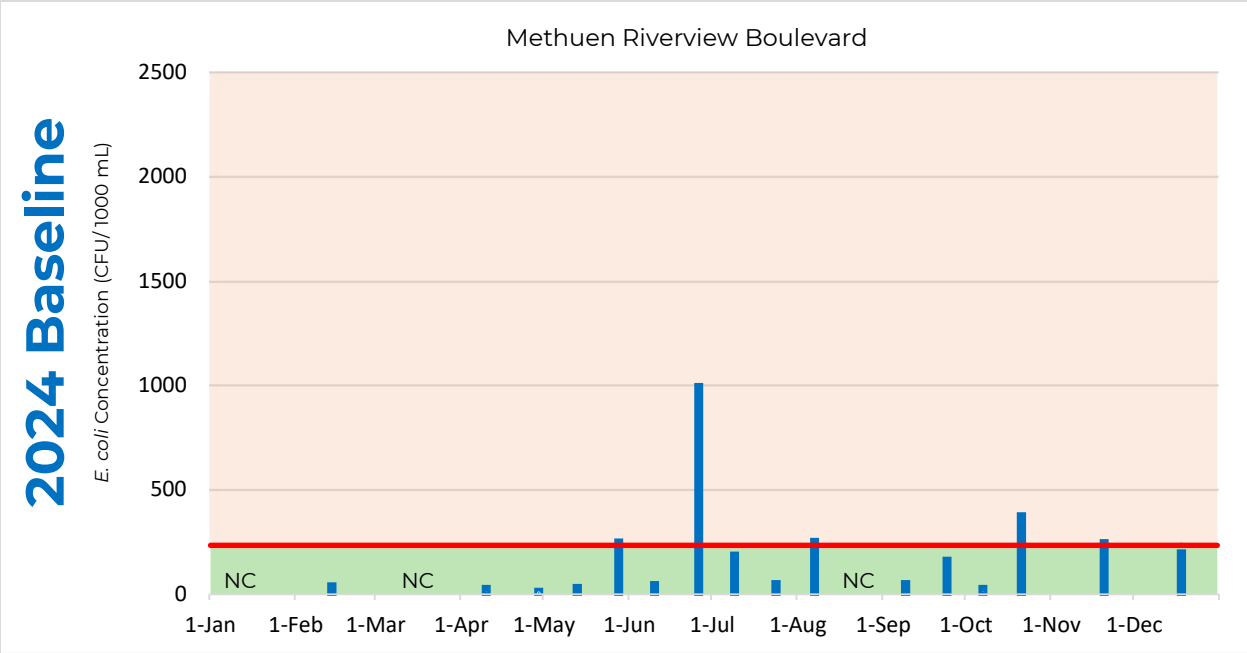


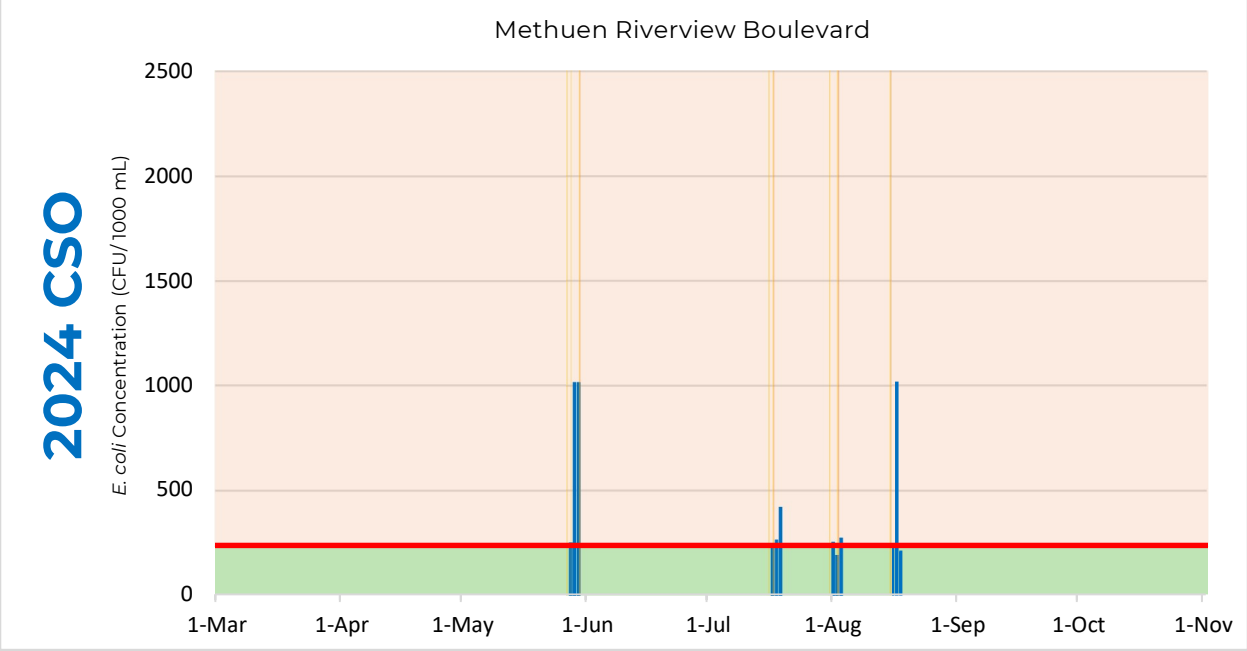
Figure 45: Methuen - Riverview Boulevard sampling site

Greater Region: Lawrence, Massachusetts

Monitoring Site: Methuen – Riverview Boulevard

2024 Results





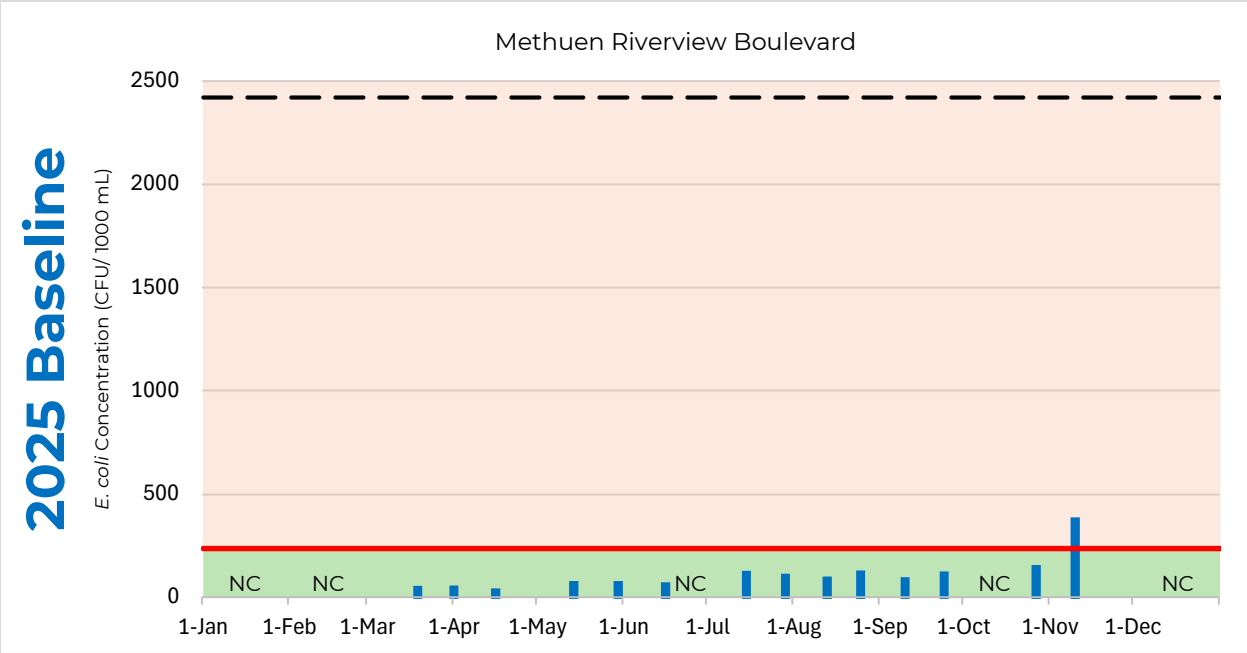
Safe | Unsafe | Bacteria | Date of Lowell CSO | Date of Lawrence CSO | Safety Limit

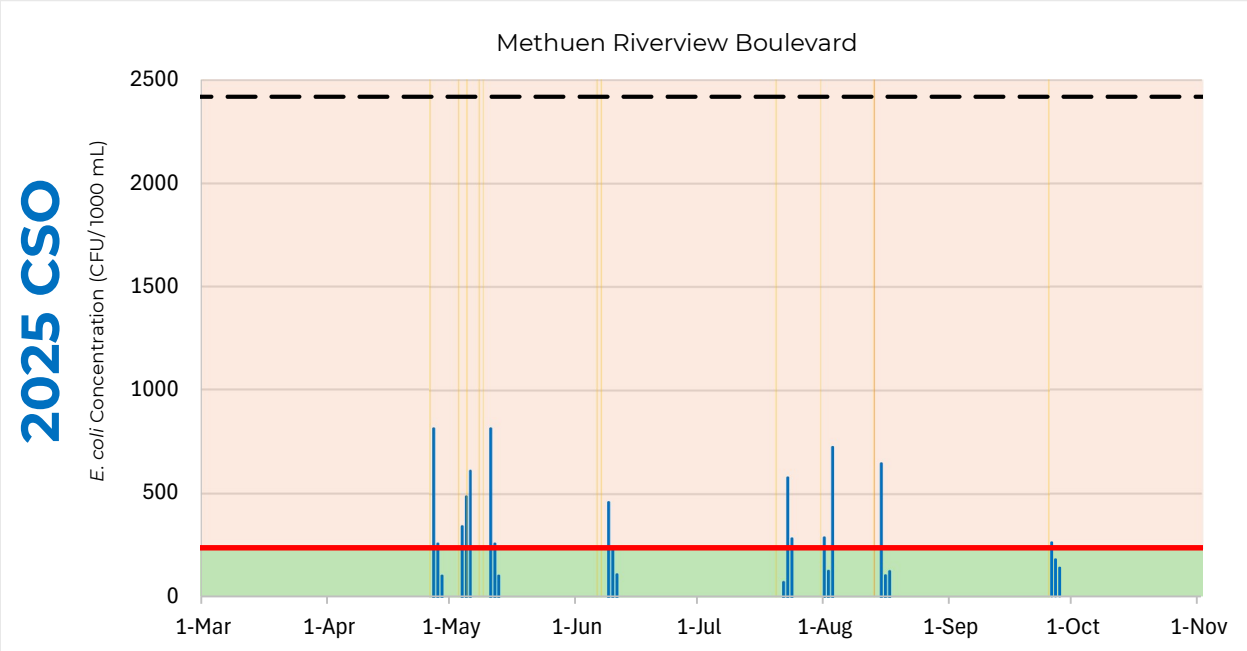
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Lawrence, Massachusetts

Monitoring Site: Methuen – Riverview Boulevard

2025 Results





Safe | Unsafe | Bacteria | Date of Lowell CSO | Date of Lawrence CSO | Detection Limit | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Haverhill, Massachusetts

Monitoring Site: Haverhill - Lincoln Ave Bridge

(river mile 16.2)

Known CSO Infrastructure

- The Haverhill Lincoln Avenue Bridge site is located 11 miles downstream of all Lawrence CSO outfalls and 2.1 miles downstream of all Haverhill CSOs
- The Greater Lawrence Sanitary District (GLSD) reports 5 CSO outfalls, 3 of which were activated at least once in 2025.
    - GLSD contributed the second lowest volume of CSOs to the Merrimack in 2025 (11 million gallons). Over the past decade, GLSD discharged an average of 60 million gallons per year.
    - Lawrence is working on a Green Lawrence-Blue Merrimack Stormwater Resilience Master Plan to address aging infrastructure and reduce the impact of CSOs.
- Haverhill reports 13 CSO outfalls, 10 of which were activated at least once in 2025.
    - Haverhill contributed the lowest CSO volume in 2025 (3 million gallons). Over the past decade, Haverhill discharged an average of 34 million gallons per year.
    - Haverhill is currently working on its Locke Street Area Sewer Separation project to further reduce the impact of CSOs.

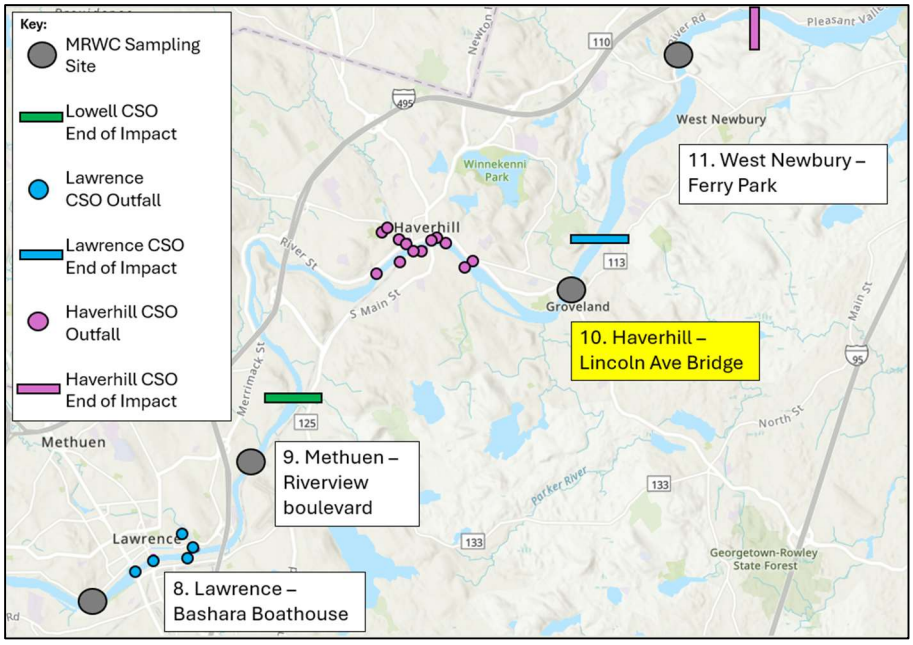


Figure 46: MRWC Haverhill – Lincoln Ave Bridge sampling site, Lawrence CSO outfalls, and Haverhill CSO outfalls

Greater Region: Haverhill, Massachusetts Monitoring Site: Haverhill - Lincoln Ave Bridge
(river mile 16.2)

Water Quality Results

Table 28. 2024 and 2025 bacteria results for the Haverhill – Lincoln Ave Bridge site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	16% Unsafe	13% Unsafe
CSO Events	50% Unsafe	60% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline samples decreased while the unsafe CSO events increased from 2024.

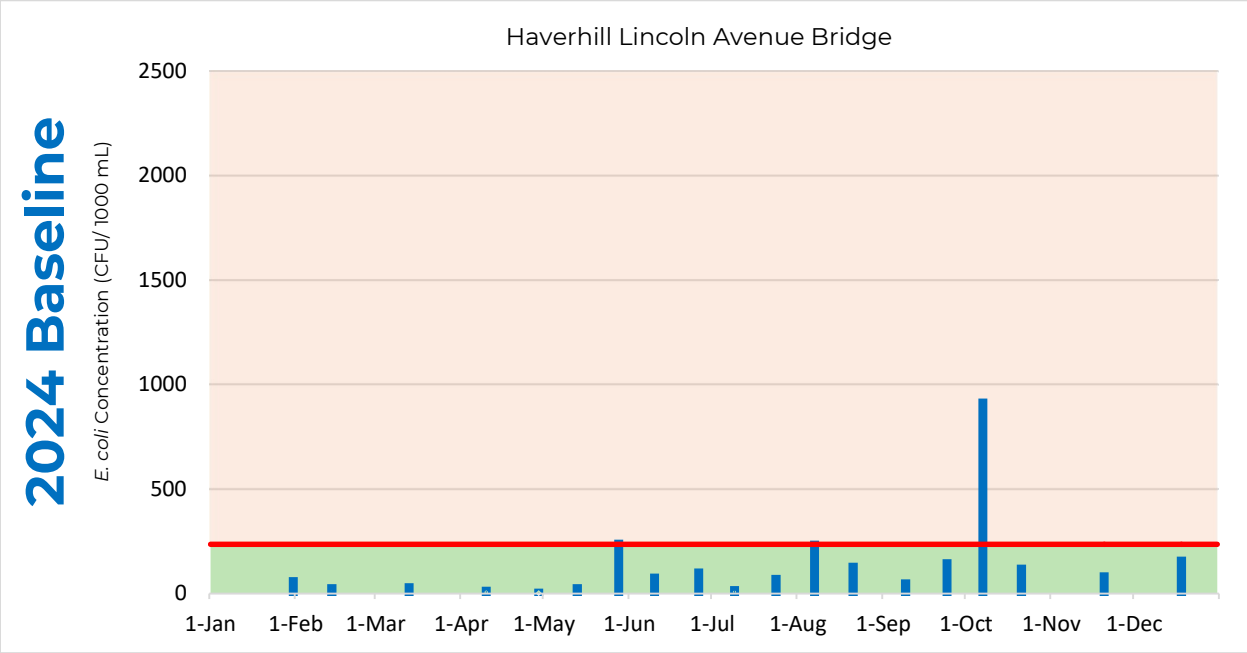
The baseline results for this site (13% unsafe) are higher than both the upstream Methuen Riverview Boulevard site (6% unsafe) and the downstream West Newbury Ferry Park site (0% unsafe).

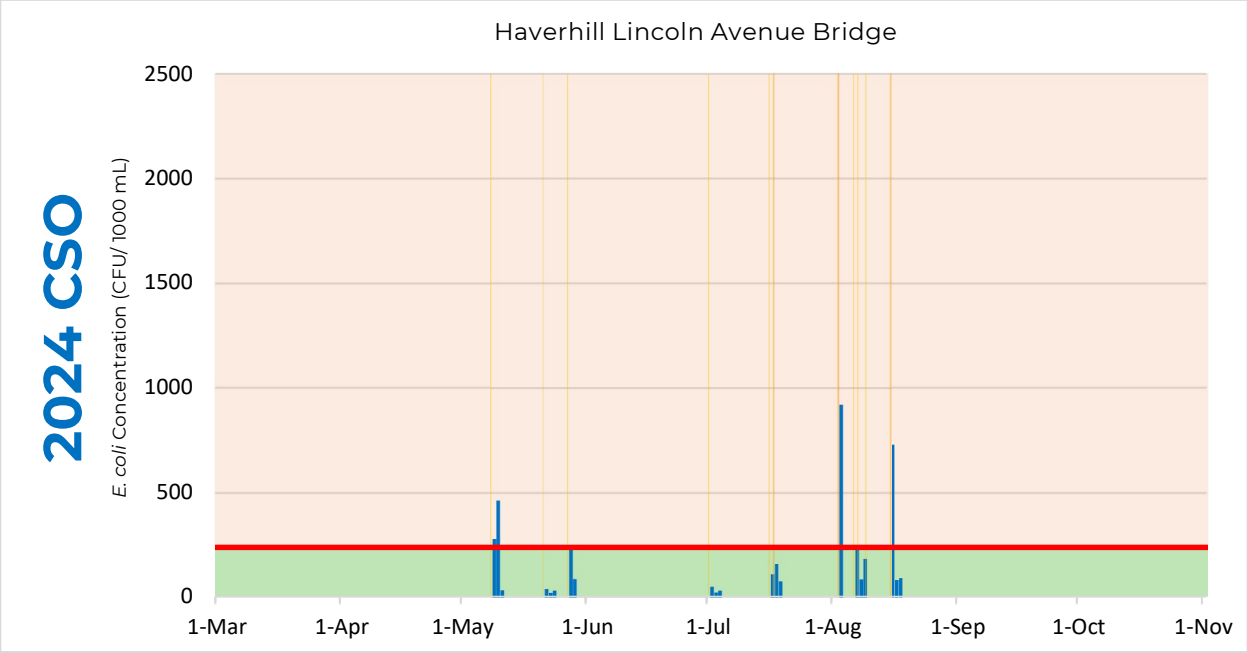
The CSO results for this site (60% unsafe) are lower than both the upstream Methuen Riverview Boulevard site (100% unsafe) and the downstream West Newbury Ferry Park site (80% unsafe).



Figure 47: Haverhill - Lincoln Ave Bridge sampling site (Photo credits to MVPC)

Greater Region: Haverhill, Massachusetts
Monitoring Site: Haverhill - Lincoln Avenue Bridge
2024 Results



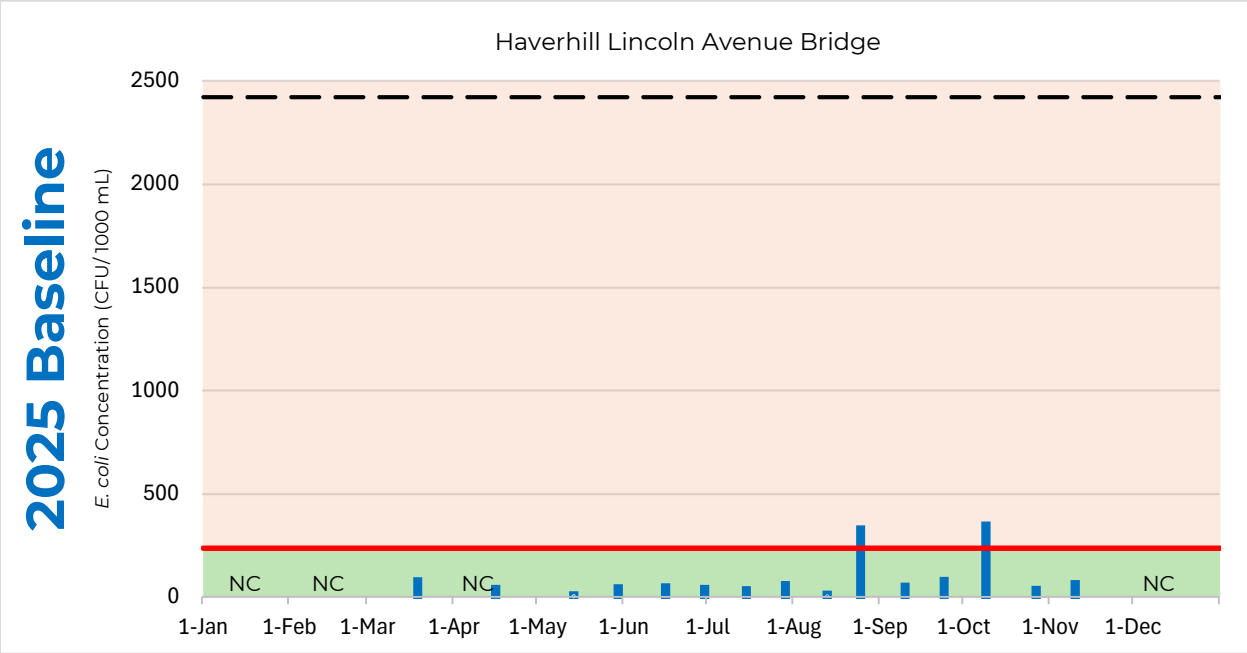


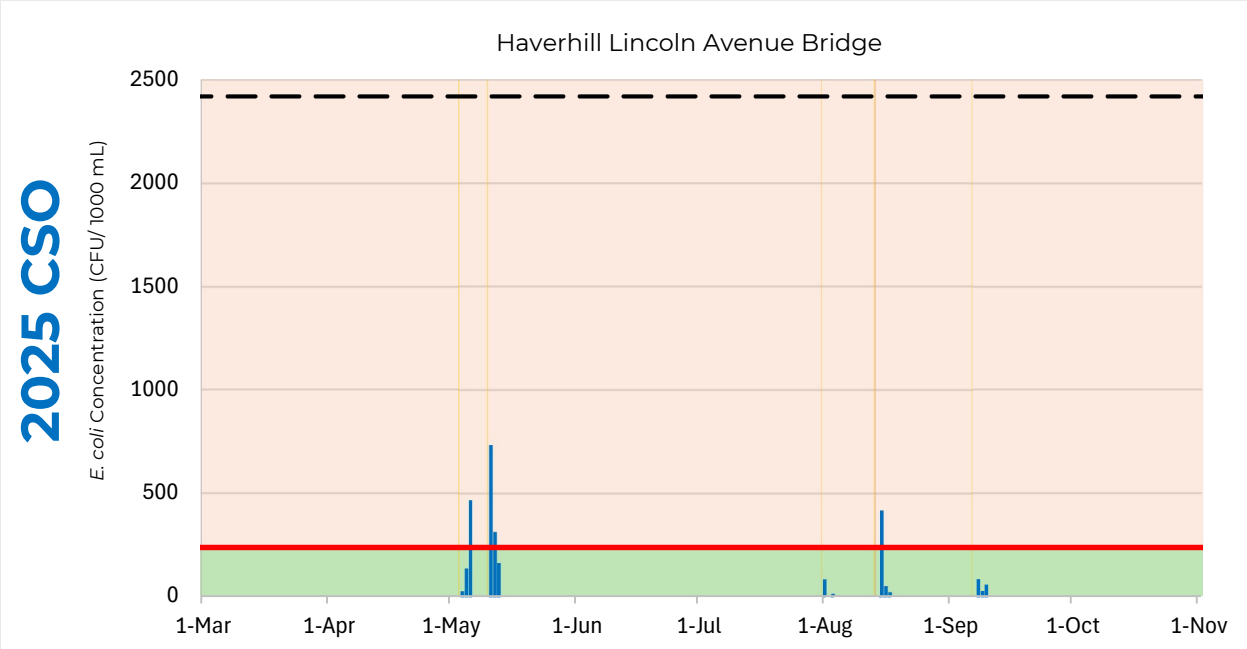
Safe | Unsafe | Bacteria | Date of Haverhill CSO | Date of Lawrence CSO | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Haverhill, Massachusetts Monitoring Site: Haverhill - Lincoln Avenue Bridge

2025 Results





Safe | Unsafe | Bacteria | Date of Haverhill CSO | Date of Lawrence CSO | Detection Limit | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Haverhill, Massachusetts
Monitoring Site: West Newbury - Ferry Park
(river mile 12.4)

Known CSO Infrastructure

- The Ferry Park site is located 5.9 miles downstream of all Haverhill CSO outfalls.
- Haverhill reports 13 CSO outfalls, 10 of which were activated at least once during 2025.
- Haverhill contributed the lowest CSO volume in 2025 (3 million gallons). Over the past decade, Haverhill discharged an average of 34 million gallons per year.
- Haverhill is currently working on its Locke Street Area Sewer Separation project to further reduce the impact of CSOs.
- Ferry Park has a large presence of waterfowl, which could be influencing fecal coliform levels and agricultural land is close upstream which could be contributing to bacteria either from fertilizer and/or farm animal waste. The site itself is located at a significant bend in the river which could be leading to a pooling-effect and possibly impacting bacteria levels.

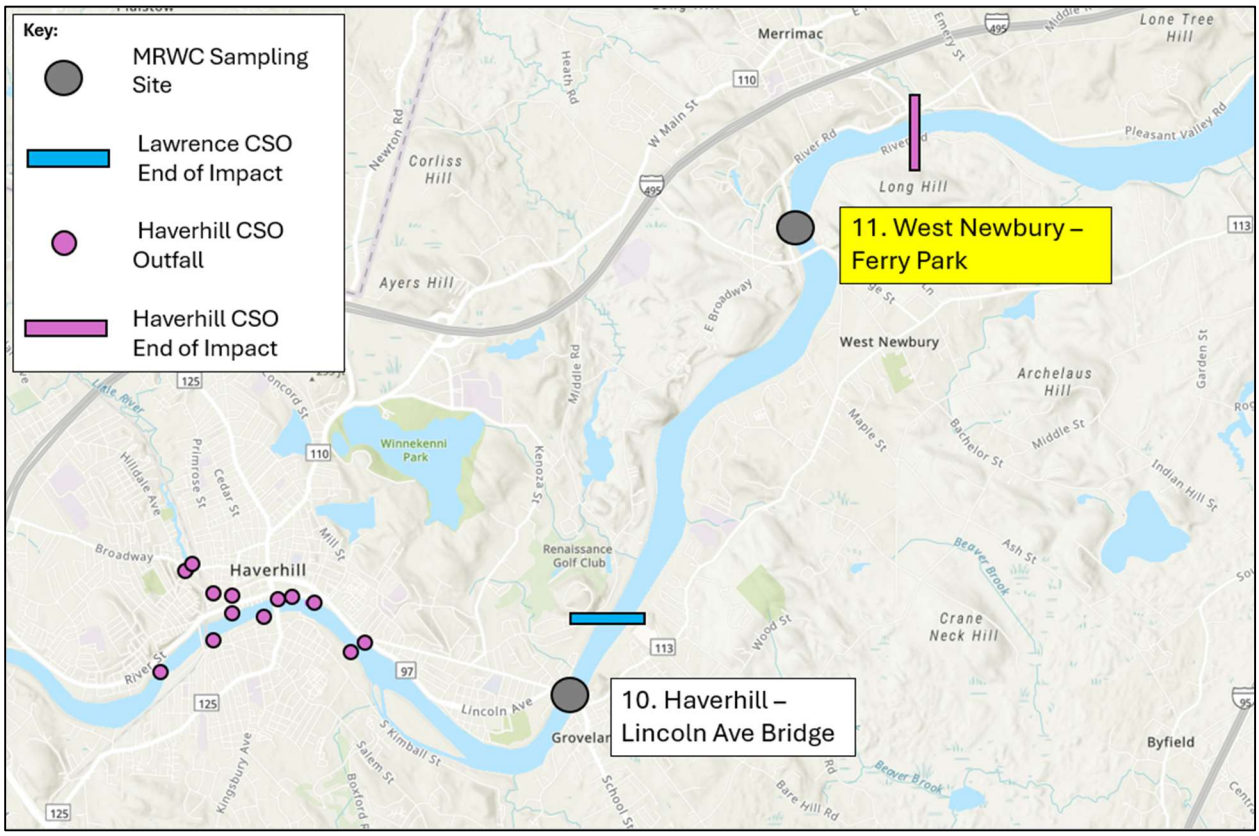


Figure 48: MRWC West Newbury – Ferry Park sampling site, Lawrence CSO outfalls, and Haverhill CSO outfalls

Greater Region: Haverhill, Massachusetts Monitoring Site: West Newbury - Ferry Park
(river mile 12.4)

Water Quality Results

Table 29. 2024 and 2025 bacteria results for the West Newbury – Ferry Park site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	25% Unsafe	0% Unsafe
CSO Events	50% Unsafe	80% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline samples decreased and the unsafe CSO events increased from 2024.

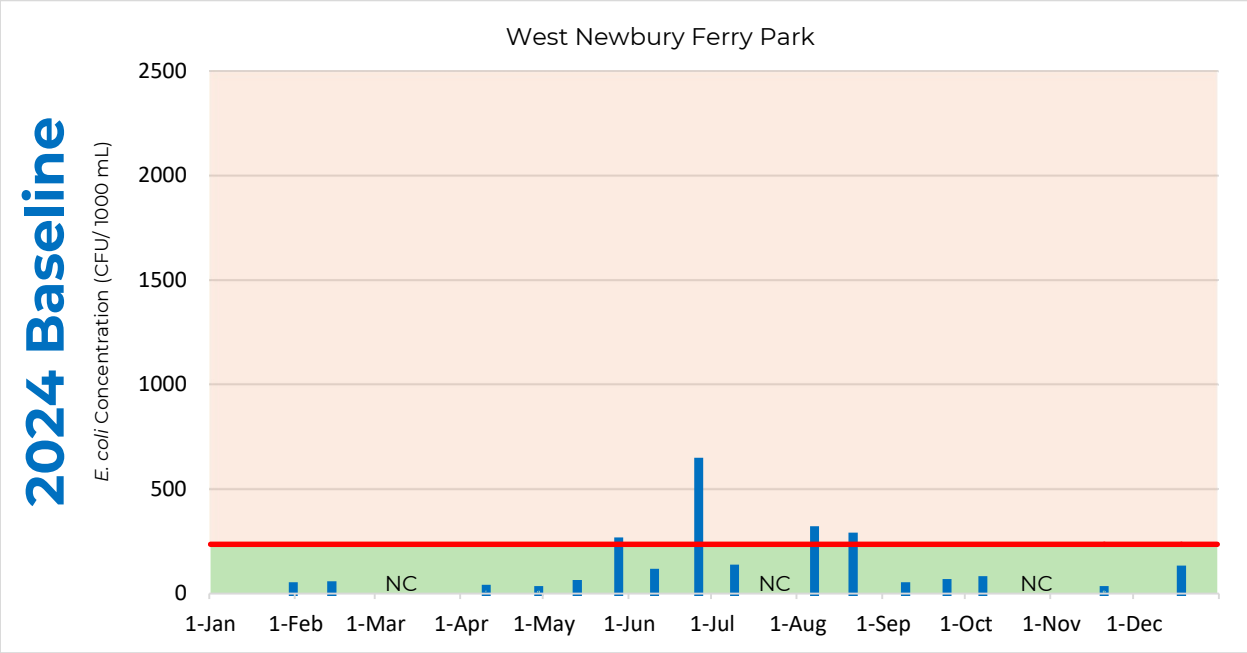
The baseline results for this site (0% unsafe) are lower than both the upstream Haverhill Lincoln Ave Bridge site (13% unsafe) and the downstream Amesbury Deer Island site (38% unsafe).

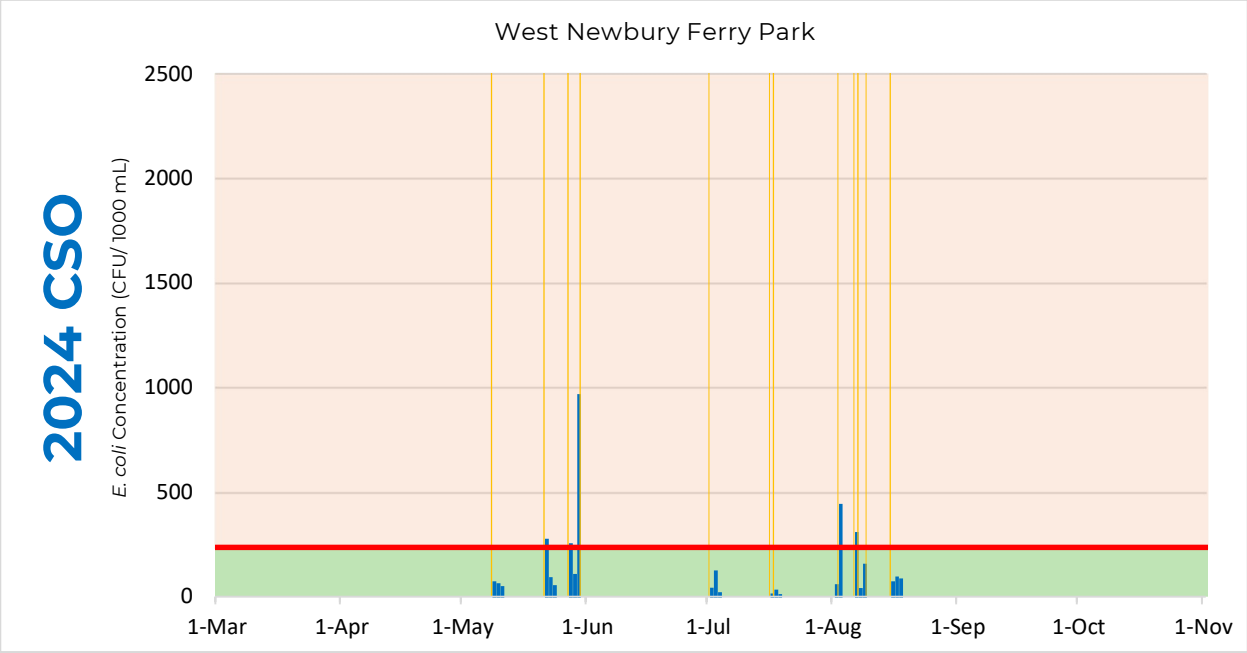
The CSO results for this site (80% unsafe) are higher than the upstream Haverhill Lincoln Ave Bridge site (60% unsafe). This higher unsafe CSO percentage could be due to the fact that the Haverhill Lincoln Ave Bridge site is closer to the Haverhill CSO outfalls. Given this proximity and the fact that samples can be taken 14-38 hours after a Haverhill CSO begins, bacteria could potentially flow past the Haverhill Lincoln Ave Bridge site before the first day of testing.



Figure 49: West Newbury -Ferry Park sampling site

Greater Region: Haverhill, Massachusetts
Monitoring Site: West Newbury - Ferry Park
2024 Results

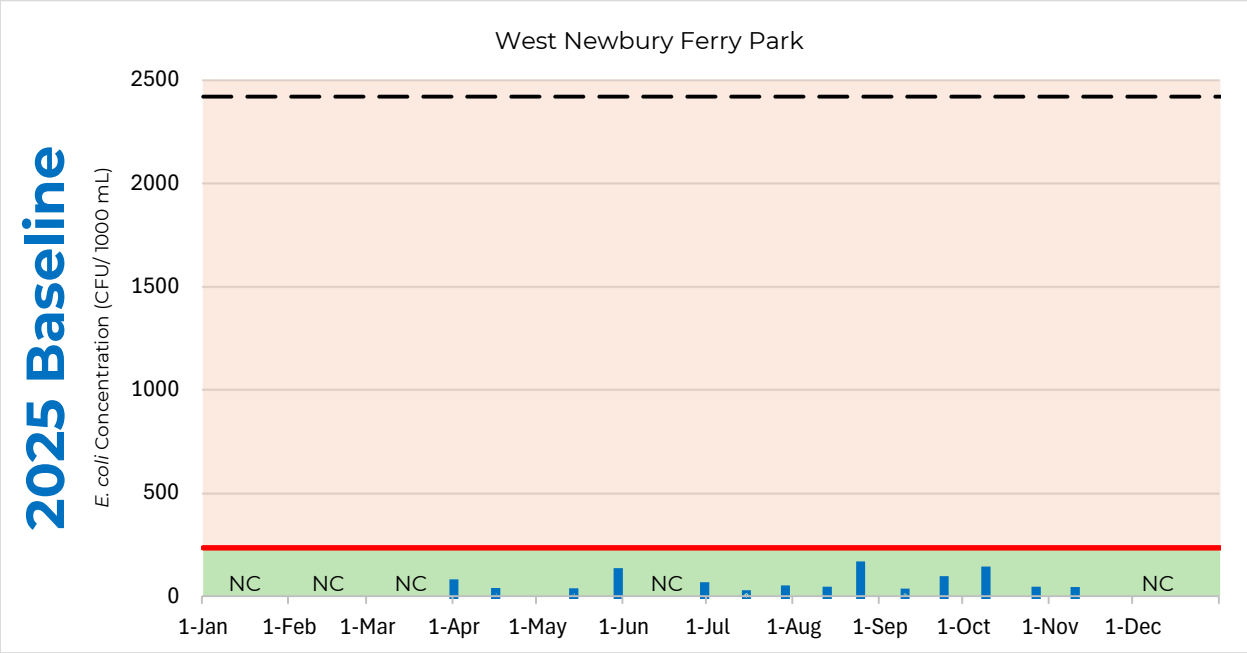


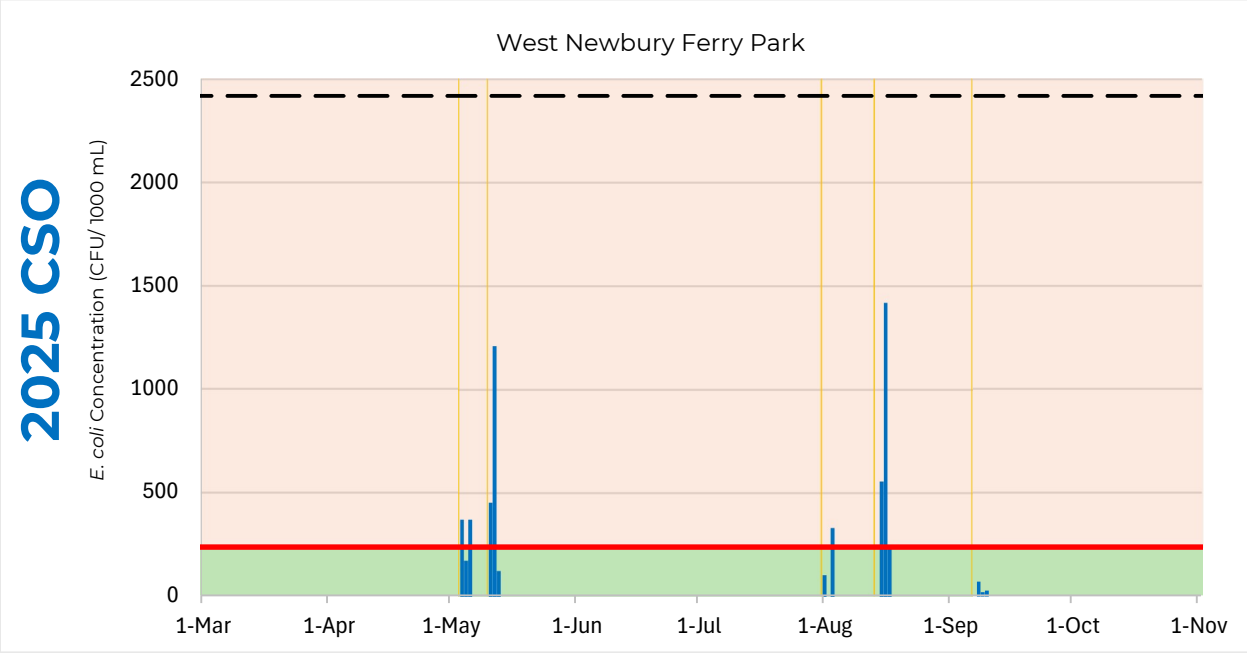


Safe | Unsafe | Bacteria | Date of Haverhill CSO | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Greater Region: Haverhill, Massachusetts
Monitoring Site: West Newbury - Ferry Park
2025 Results





Safe Unsafe Bacteria Date of Haverhill CSO Detection Limit Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Region: Coastal Massachusetts

Monitoring Site: Amesbury – Deer Island

(river mile 5.7)

Known CSO Infrastructure

- There are no combined sewer outfalls within the coastal region. The closest CSOs are in Haverhill. Engineering studies[33] and MRWC 2024 and 2025 data suggest no meaningful bacteria impact from CSOs to this site.
- Although CSOs are not a leading contributor to high bacteria levels at this site, high bacteria levels can occur after rain events due to stormwater runoff.

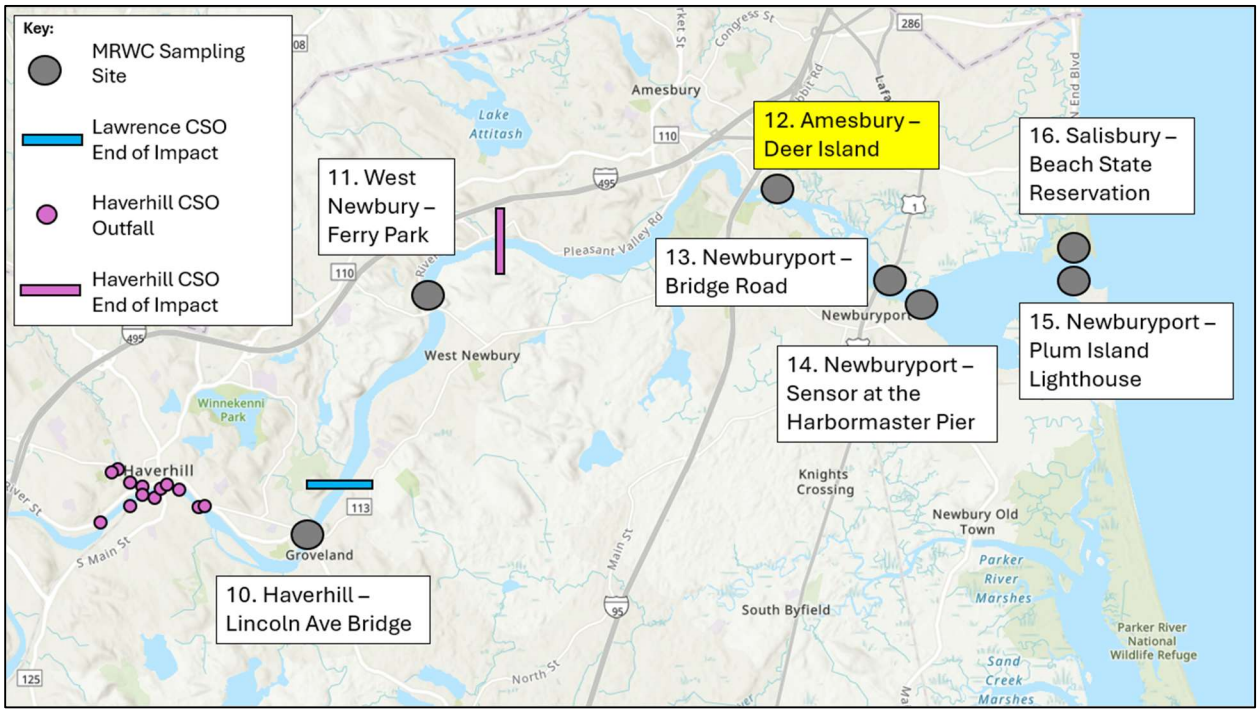


Figure 50: MRWC Amesbury – Deer Island sampling site and Haverhill CSO outfalls

Region: Coastal Massachusetts

Monitoring Site: Amesbury – Deer Island

(river mile 5.7)

Water Quality Results

Table 30. 2024 and 2025 bacteria results for the Amesbury – Deer Island site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	13% Unsafe	38% Unsafe
Heavy Rain Events	25% Unsafe	56% Unsafe

Site Analysis: In 2025, the percentage of both unsafe baseline samples and unsafe heavy rain events increased from 2024. MRWC used the occurrence of a Haverhill CSO as an indicator of a heavy rain event in the region.

All sites in the coastal region experienced high bacteria results July through October in 2025, significantly higher and more frequently than 2024. Overall, the percentage of unsafe Baseline and Heavy Rain event results at the Amesbury Deer Island site were relatively similar to the downstream Newburyport Bridge Road site and lower than the farther downstream Newburyport Plum Island Lighthouse and Salisbury Beach State Reservation sites. This could suggest that high bacteria levels are localized to the mouth of the river and not this far upstream. MRWC is funded to design and initiate a more in-depth study of bacteria in Newburyport Harbor in 2026/2027.

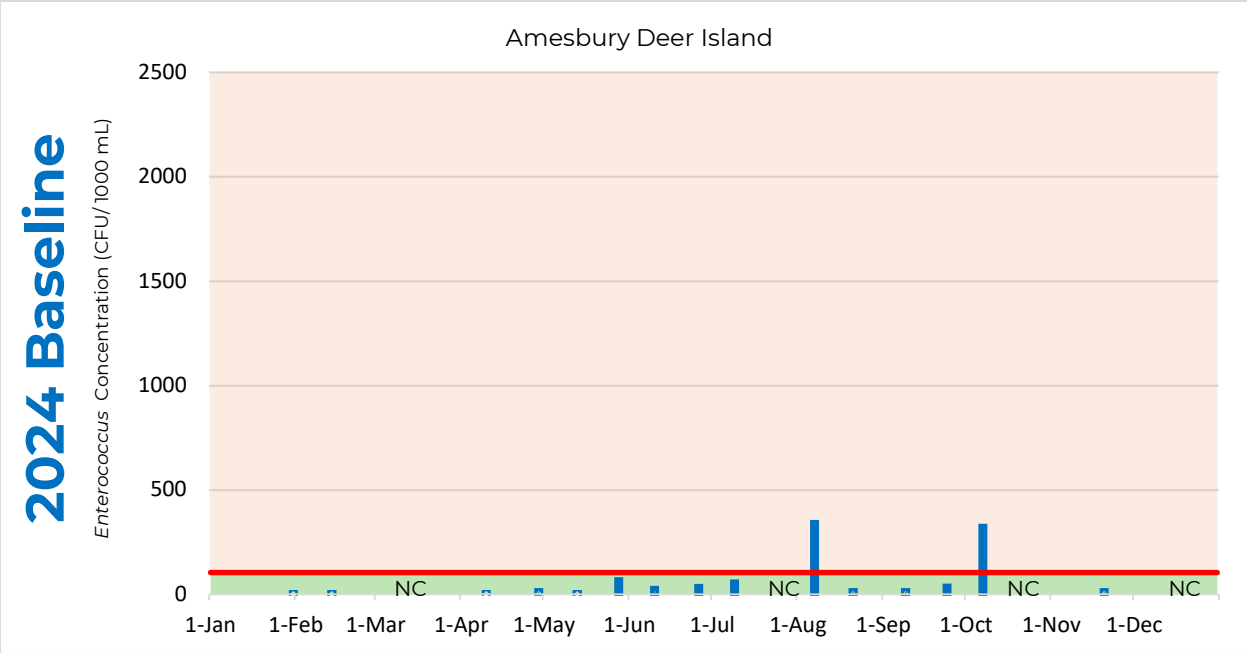


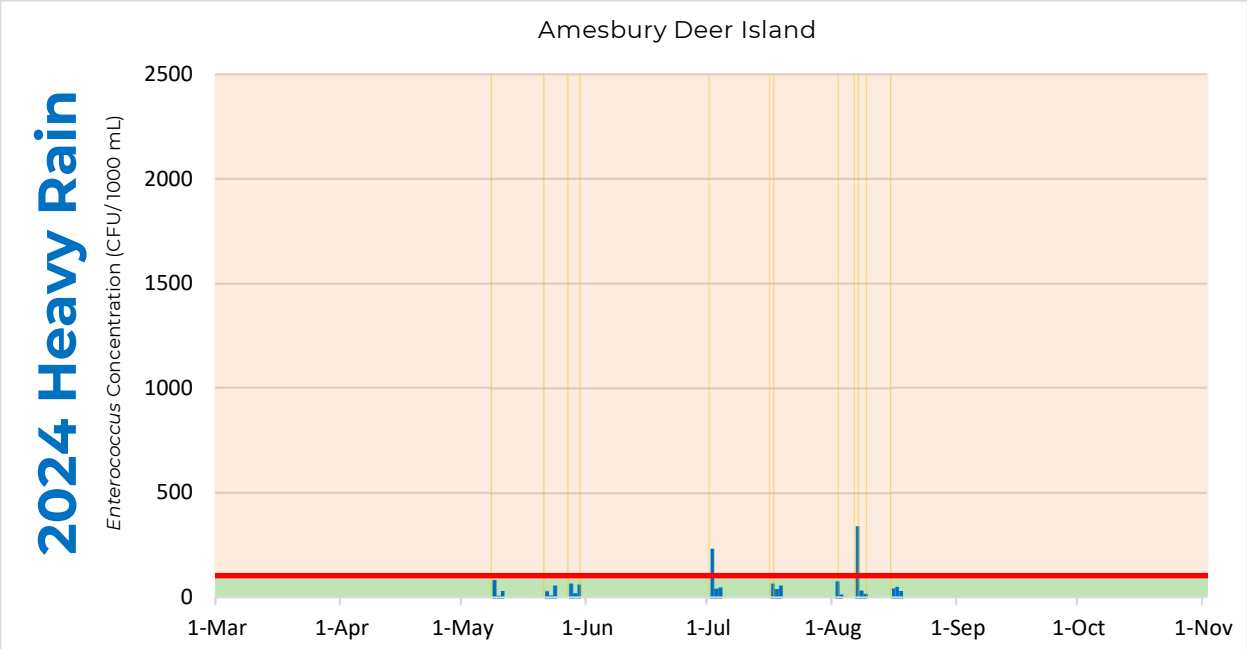
Figure 51: Amesbury – Deer Island sampling site

Region: Coastal Massachusetts

Monitoring Site: Amesbury – Deer Island

2024 Results





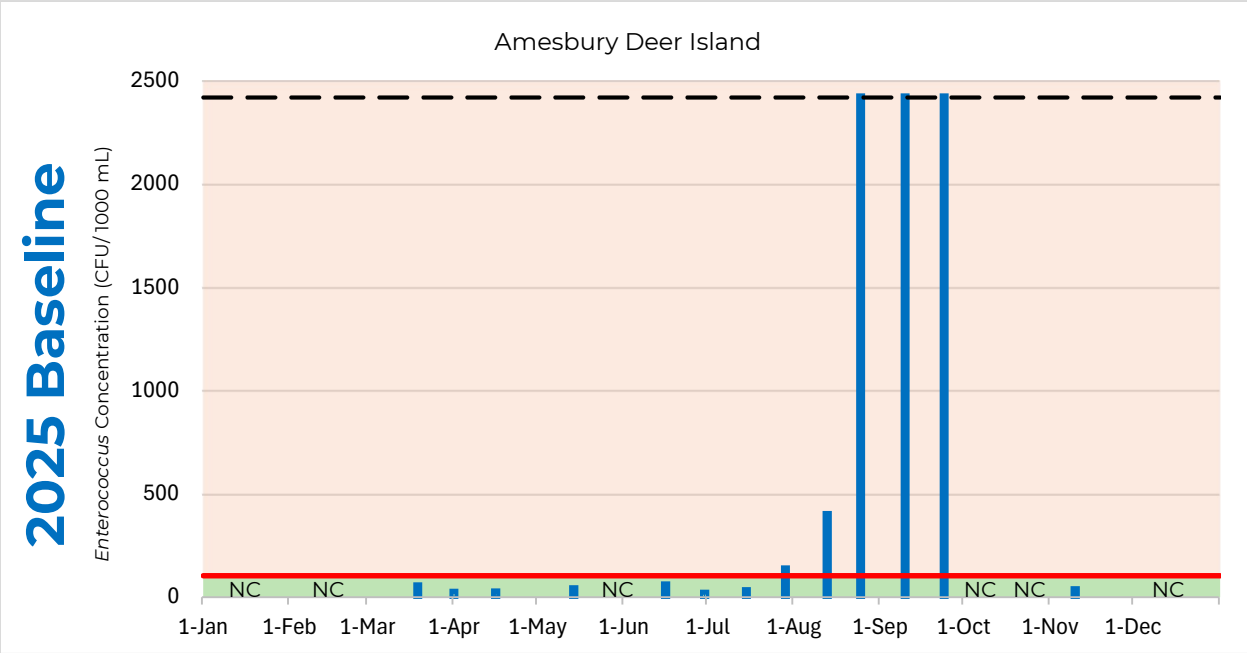
Safe | Unsafe | Bacteria | Date of Haverhill Heavy Rain Event | Safety Limit

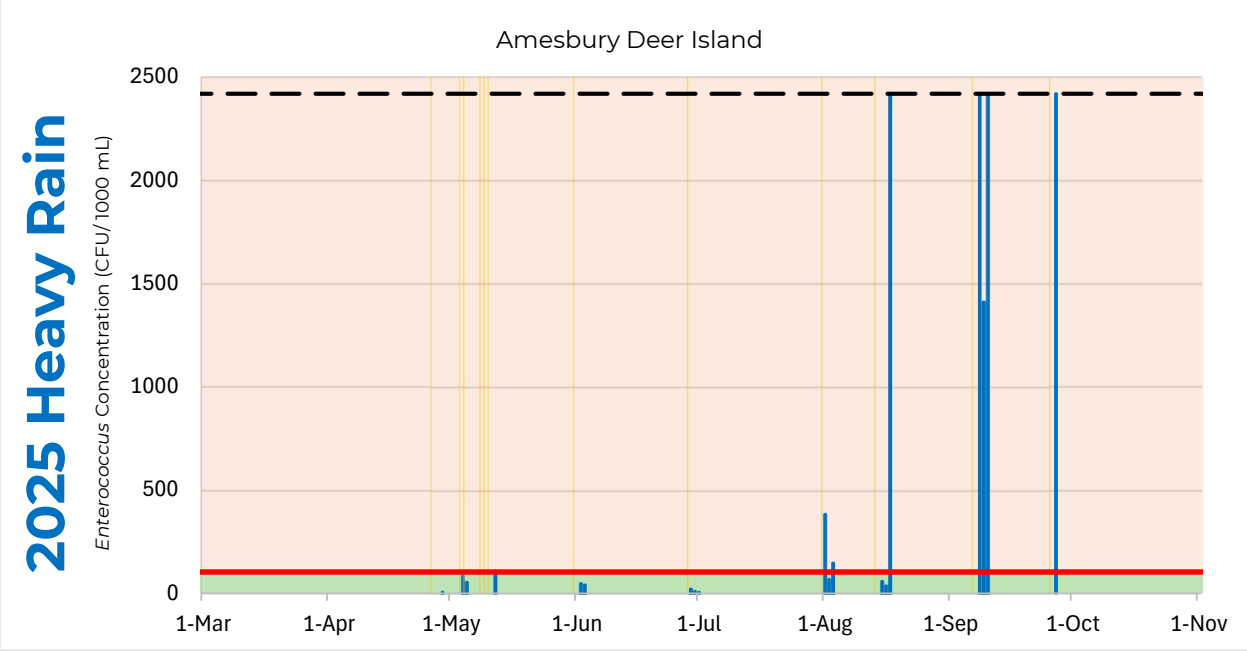
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Region: Coastal Massachusetts

Monitoring Site: Amesbury – Deer Island

2025 Results





Safe Unsafe Bacteria Date of Haverhill Heavy Rain Event Detection Limit Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Region: Coastal Massachusetts

Monitoring Site: Newburyport – Bridge Road

(river mile 3.5)

Known CSO Infrastructure

- There are no combined sewer outfalls within the coastal region. The closest CSOs are in Haverhill. Engineering studies[33] and MRWC 2024 and 2025 data suggest no meaningful bacteria impact from CSOs to this site.
- Although CSOs are not a leading contributor to high bacteria levels at this site, high bacteria levels can occur after rain events due to stormwater runoff.

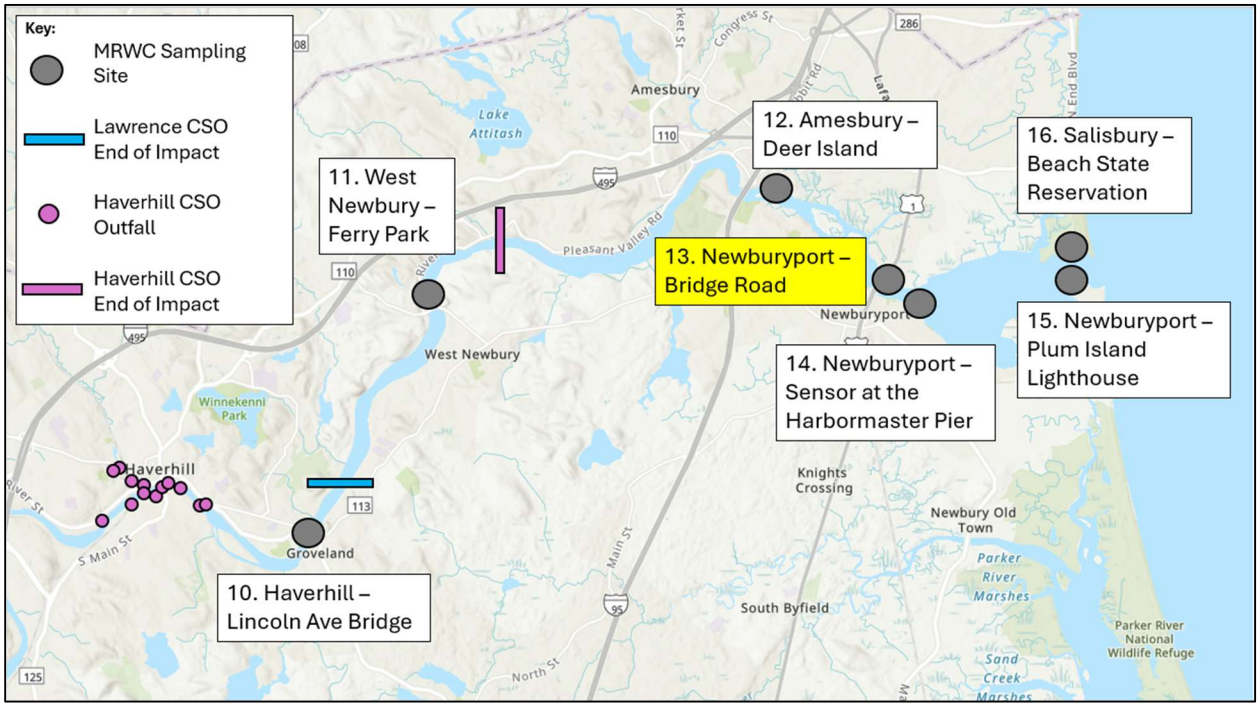


Figure 52: MRWC Newburyport – Bridge Road sampling site and Haverhill CSO outfalls

Region: Coastal Massachusetts

Monitoring Site: Newburyport – Bridge Road

(river mile 3.5)

Water Quality Results

Table 31. 2024 and 2025 bacteria results for the Newburyport – Bridge Road site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	13% Unsafe	31% Unsafe
Heavy Rain Events	31% Unsafe	78% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline samples and unsafe heavy rain events increased from 2024. MRWC used the occurrence of a Haverhill CSO as an indicator of a heavy rain event in the region.

All sites in the coastal region experienced high bacteria results July through October in 2025, significantly higher and more frequently than 2024. Overall, the percentage of unsafe Baseline and Heavy Rain event results at the Newburyport Bridge Road site were similar to the upstream Amesbury Deer Island site and lower than the downstream Newburyport Plum Island Lighthouse and Salisbury Beach State Reservation sites. This could suggest that high bacteria levels are localized to the mouth of the river and not this far upstream. MRWC is funded to design and initiate a more in-depth study of bacteria in Newburyport Harbor in 2026/2027.

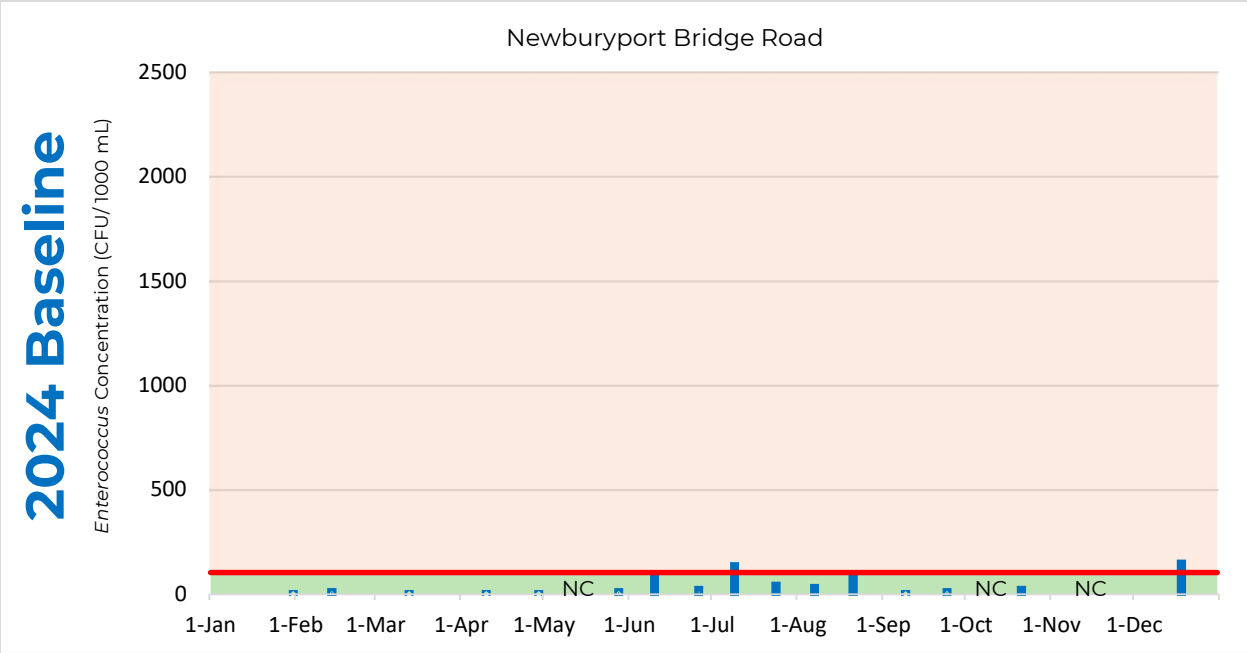


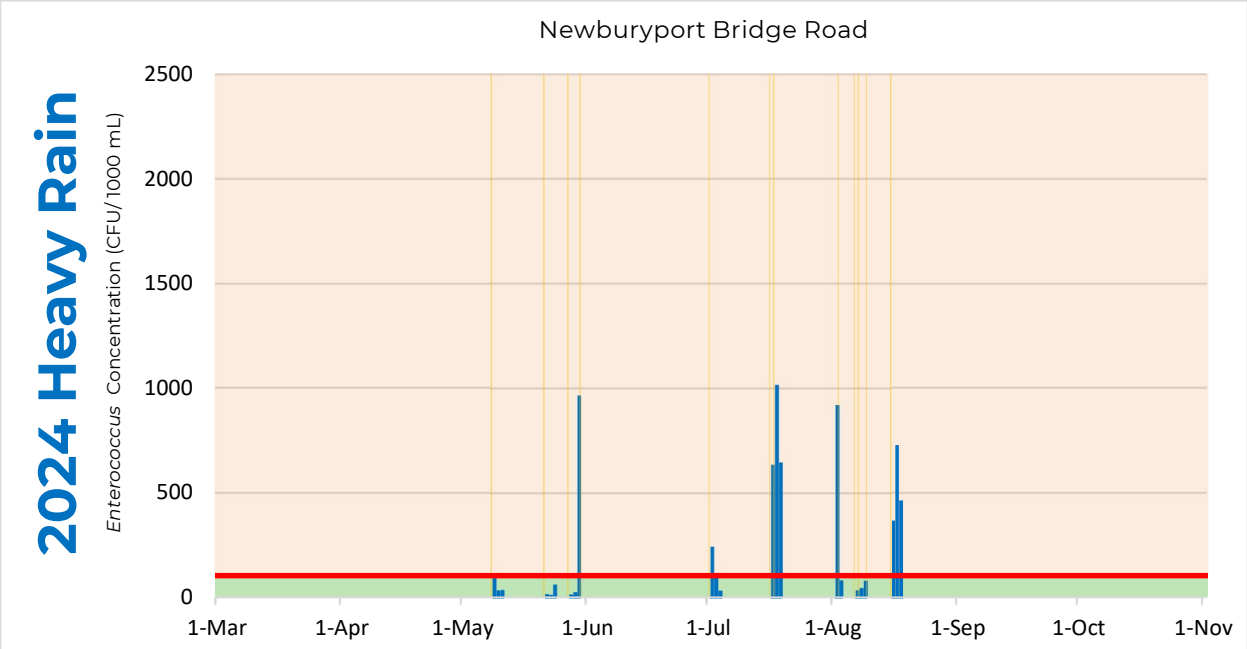
Figure 53: Newburyport – Bridge Road sampling site

Region: Coastal Massachusetts

Monitoring Site: Newburyport – Bridge Road

2024 Results





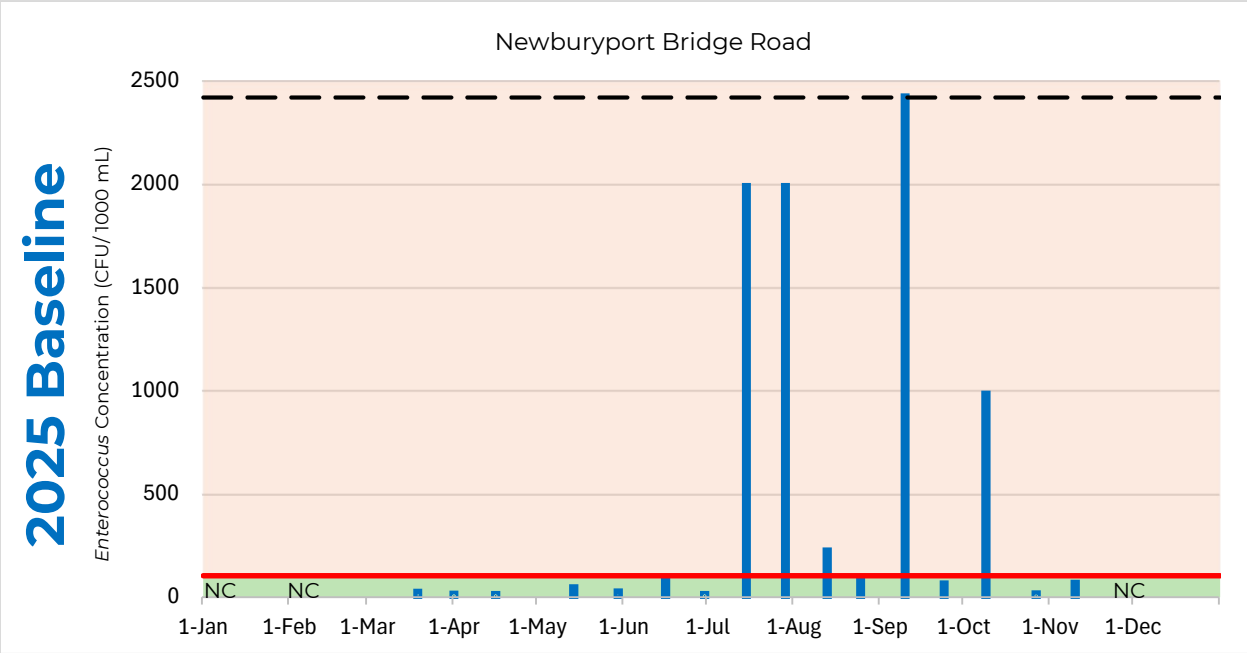
Safe | Unsafe | Bacteria | Date of Haverhill Heavy Rain Event | Safety Limit

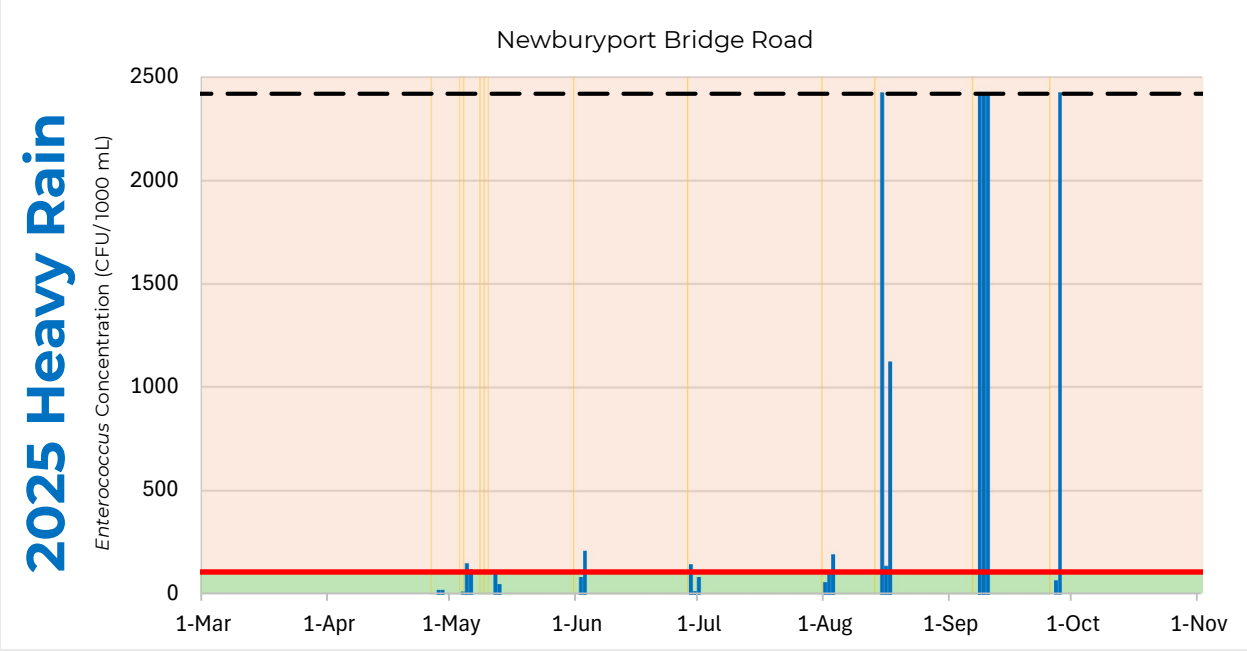
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Region: Coastal Massachusetts

Monitoring Site: Newburyport – Bridge Road

2025 Results





Safe | Unsafe | Bacteria | Date of Haverhill Heavy Rain Event | Detection Limit | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Region: Coastal Massachusetts

Sensor Monitoring Site: Newburyport Harbormaster Pier

(river mile 3.3)

Known CSO Infrastructure

- There are no combined sewer outfalls within the coastal region. The closest CSOs are in Haverhill. Engineering studies[33] and MRWC 2024 and 2025 data suggest no meaningful bacteria impact from CSOs to this site.
- Although CSOs are not a leading contributor to high bacteria levels at this site, high bacteria levels can occur after rain events due to stormwater runoff.

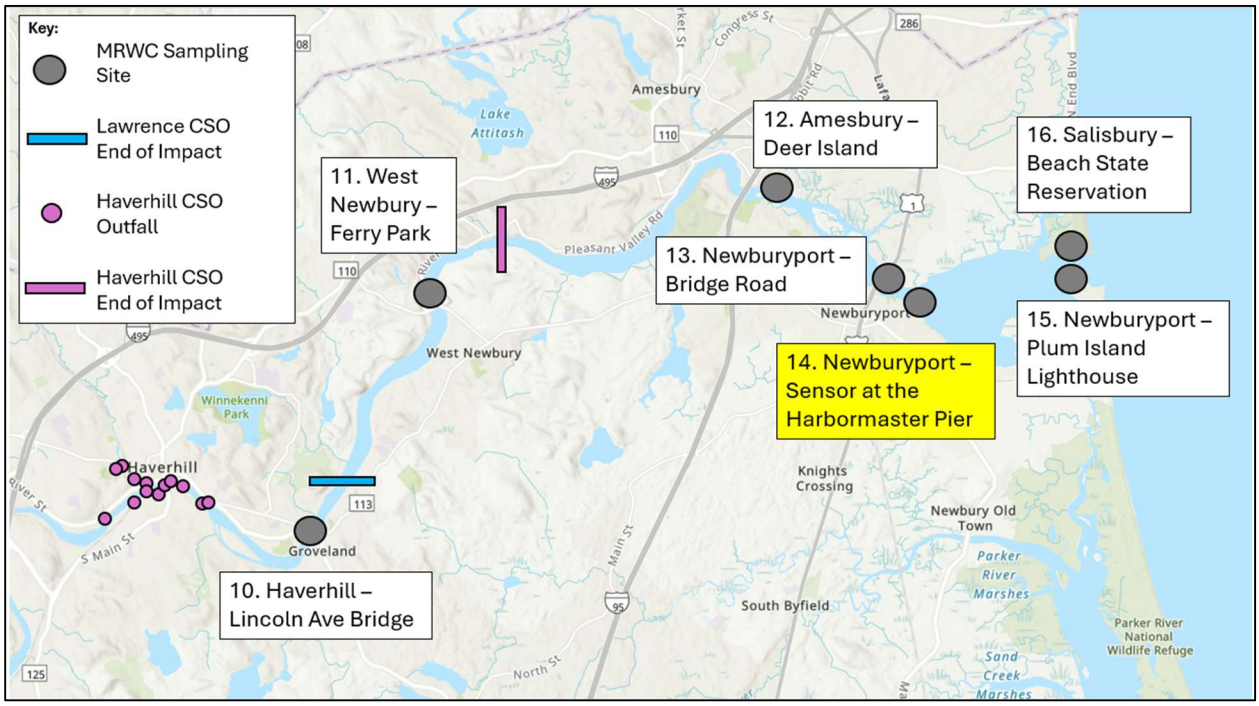


Figure 54: MRWC Newburyport Harbormaster Pier Sensor sampling site and Haverhill CSO outfalls

Region: Coastal Massachusetts

Sensor Monitoring Site: Newburyport Harbormaster Pier

(river mile 3.3)

Water Quality Results

Table 32. 2024 and 2025 bacteria results for the Newburyport - Harbormaster Pier Sensor site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline (Friday) Bacteria Samples	41% Unsafe	29% Unsafe
Heavy Rain Events	86% Unsafe	67% Unsafe

Site Analysis: In 2025, the percentage of unsafe Baseline samples and unsafe heavy rain events decreased from 2024. MRWC used the occurrence of a Haverhill CSO as an indicator of a heavy rain event in the region.

The percentage of unsafe results for this site are lower than the upstream Newburyport – Bridge Road site and downstream Newburyport Plum Island Lighthouse site. Since this site records bacteria levels using a sensor instead of a grab sample, it is difficult to make a direct comparison with the other sites.

Although the percentage of unsafe samples decreased for the sensor from 2024 to 2025, there were still some alarmingly high readings in 2025. According to state regulations, unsafe conditions exist when *E. coli* levels exceed 235 CFU/100 mL. For 2025 Baseline Friday tests, the highest readings were 11, 794 CFUs/100 mL (50X the safety limit) and 4,017 (17X the safety limit). For 2025 heavy rain event testing, the highest readings were 5,151 CFU/100 mL (22X the safety limit) and 4,292 CFU/100 mL (18X the safety limit). Additionally, MRWC conducted two multi-day trials of consecutive daily testing and documented 47% unsafe readings in both wet and dry weather in 2025. These results seem to underscore the existence of a concerning unknown and intermittent source of bacterial contamination in the vicinity. MRWC is funded to design and initiate a more in-depth study of bacteria in Newburyport Harbor in 2026/2027.

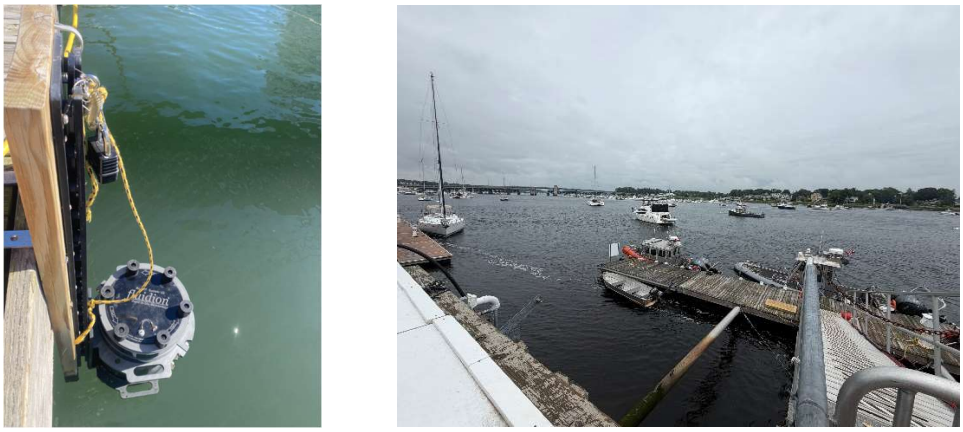
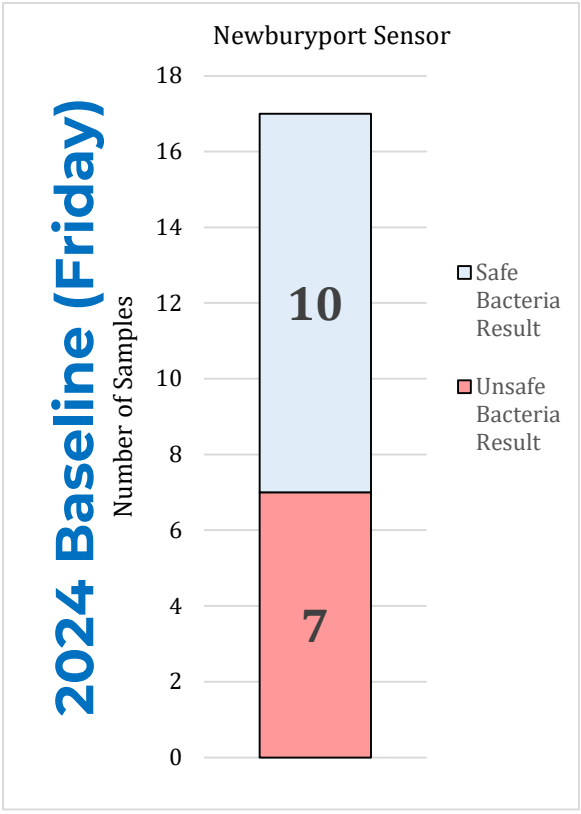


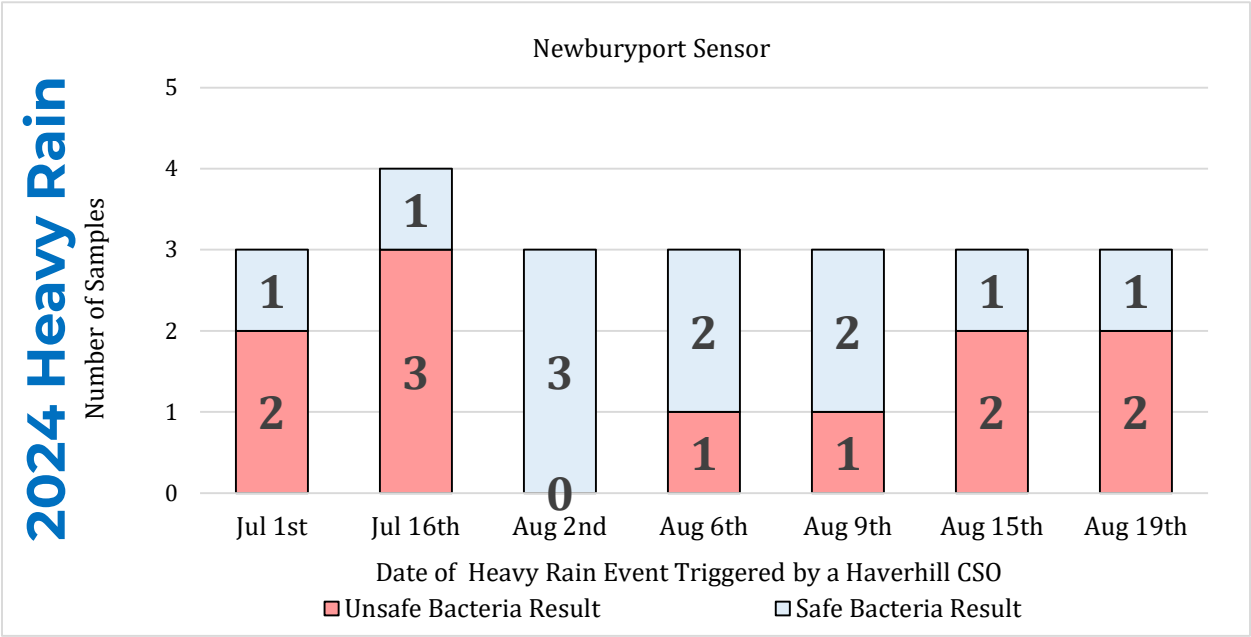
Figure 55: Newburyport – Harbormaster Pier Sensor and location

Region: Coastal Massachusetts

Monitoring Site: Newburyport Sensor

2024 Results

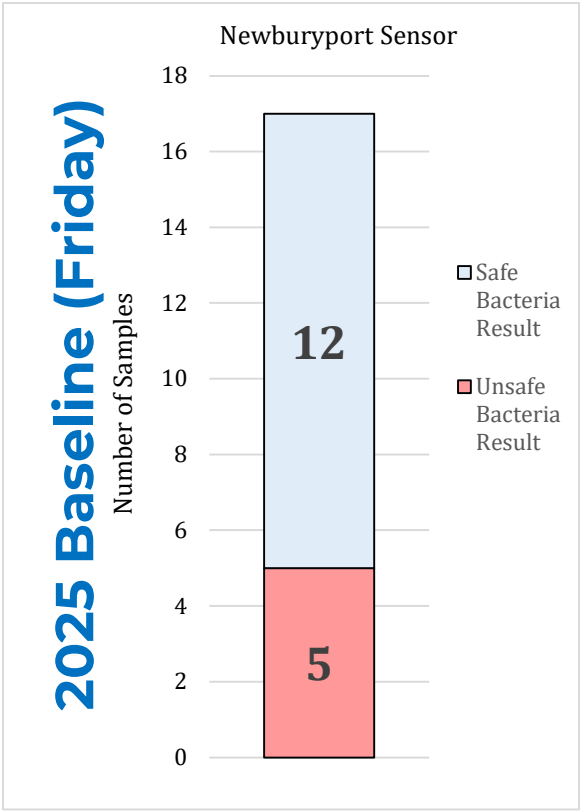


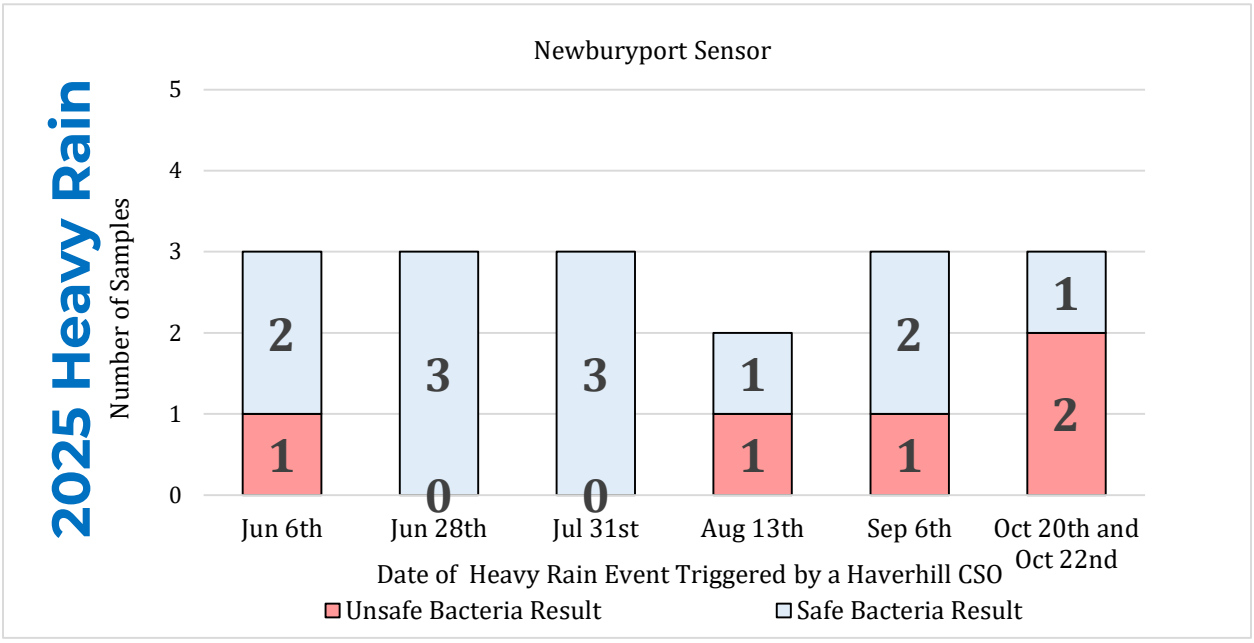


Region: Coastal Massachusetts

Monitoring Site: Newburyport Sensor

2025 Results





Region: Coastal Massachusetts
Monitoring Site: Newburyport Sensor
2024 Results

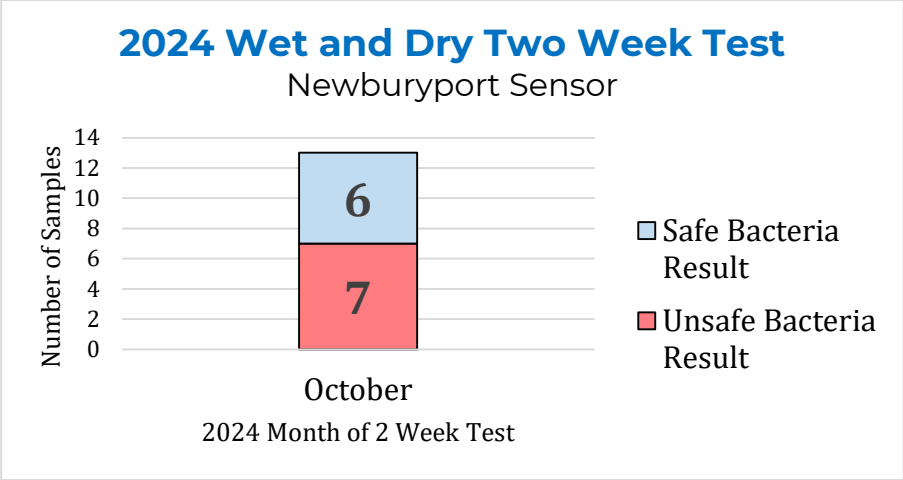


Table 33. 2024 wet and dry two-week bacteria test for the Newburyport sensor

Week	2024 Date	Test Day	Result	Total rain on the date of the Sensor Test (Inches)			
				Haverhill Marginal Pumping Station Rain Gauge	Haverhill WWTP Rain Gauge	NOAA Haverhill Rain Gauge	NOAA Newburyport Rain Gauge
1	Oct 21st	1	Unsafe	0.00	0.00	0.00	0.00
1	Oct 22nd	2	Safe	0.00	0.00	0.00	0.00
1	Oct 23rd	3	Unsafe	0.00	0.00	0.00	0.00
1	Oct 24th	4	Not Collected	0.00	0.00	0.00	0.00
1	Oct 25th	5	Unsafe	0.00	0.00	0.00	0.00
1	Oct 26th	6	Unsafe	0.00	0.00	0.00	0.00
1	Oct 27th	7	Unsafe	0.00	0.00	0.00	0.00
2	Oct 28th	8	Safe	0.00	0.00	0.00	0.01
2	Oct 29th	9	Safe	0.00	0.01	0.00	0.00
2	Oct 30th	10	Safe	0.12	0.29	0.28	0.34
2	Oct 31st	11	Safe	0.00	0.00	0.02	0.00
2	Nov 1st	12	Safe	0.00	0.00	0.00	0.00
2	Nov 2nd	13	Unsafe	0.00	0.00	0.00	0.00
2	Nov 3rd	14	Unsafe	0.00	0.00	0.00	0.00

Region: Coastal Massachusetts
Monitoring Site: Newburyport Sensor
2025 Results

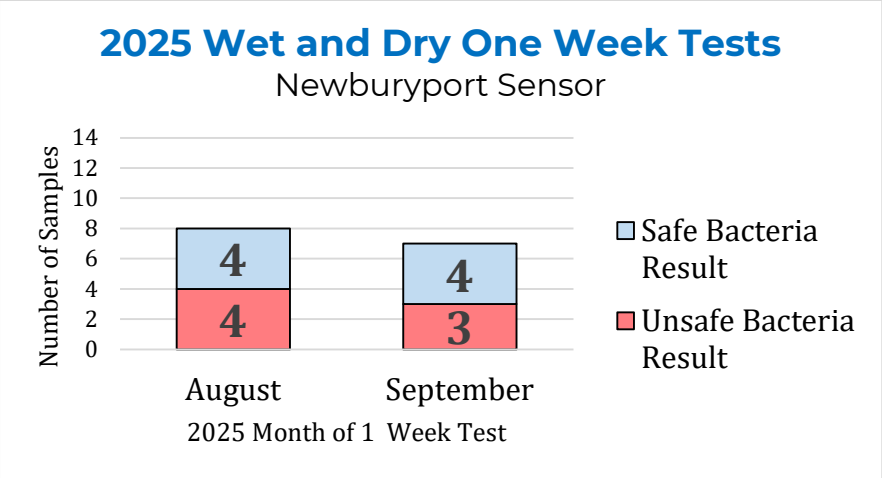


Table 34. 2024 wet and dry one-week bacteria tests for the Newburyport sensor

Week	2025 Date	Test Day	Result	Total rain on the date of the Sensor Test (Inches)			
				Haverhill Marginal Pumping Station Rain Gauge	Haverhill WWTP Rain Gauge	NOAA Haverhill Rain Gauge	NOAA Newburyport Rain Gauge
1	Aug 8th	1	Safe	0.00	0.00	0.00	0.00
1	Aug 9th	2	Unsafe	0.00	0.00	0.00	0.00
1	Aug 10th	3	Unsafe	0.00	0.03	0.00	0.00
1	Aug 11th	4	Safe	0.00	0.02	0.00	0.00
1	Aug 12th	5	Safe	0.00	0.02	0.00	0.00
1	Aug 13th	6	Unsafe	0.05	0.27	0.00	0.00
1	Aug 14th	7	Not Collected	0.08	0.09	0.44	0.23
1	Aug 15th	8	Safe	0.02	0.00	0.00	0.06
1	Aug 16th	9	Unsafe	0.02	0.02	0.00	0.00
2	Sep 4th	1	Safe	0.00	0.00	0.00	0.00
2	Sep 5th	2	Not Collected	0.06	0.09	0.07	0.01
2	Sep 6th	3	Not Collected	0.67	0.5	0.00	0.00
2	Sep 7th	4	Safe	0.54	0.43	0.54	0.91
2	Sep 8th	5	Unsafe	0.00	0.15	0.00	0.57
2	Sep 9th	6	Safe	0.00	0.05	0.00	0.00
2	Sep 10th	7	Safe	0.00	0.04	0.00	0.00
2	Sep 11th	8	Unsafe	0.00	0.00	0.00	0.00
2	Sep 12th	9	Unsafe	0.00	0.00	0.00	0.00

Region: Coastal Massachusetts

Monitoring Site: Newburyport – Plum Island Lighthouse

(river mile 0.7)

Known CSO Infrastructure

- There are no combined sewer outfalls within the coastal region. The closest CSOs are in Haverhill. Engineering studies[33] and MRWC 2024 and 2025 data suggest no meaningful bacteria impact from CSOs to this site.
- Although CSOs are not a leading contributor to high bacteria levels at this site, high bacteria levels can occur after rain events due to stormwater runoff.

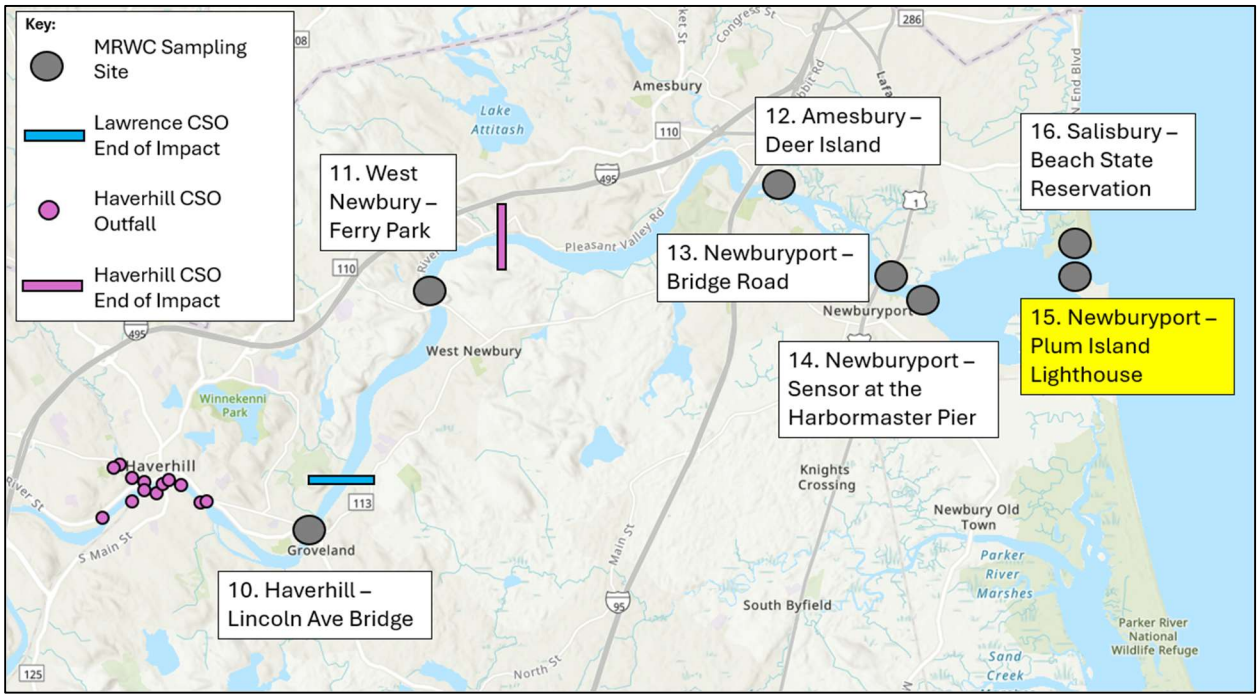


Figure 56: MRWC Newburyport – Plum Island Lighthouse sampling site and Haverhill CSO outfalls

Region: Coastal Massachusetts

Monitoring Site: Newburyport – Plum Island Lighthouse

(river mile 0.7)

Water Quality Results

Table 35. 2024 and 2025 bacteria results for the Newburyport – Plum Island Lighthouse site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	14% Unsafe	63% Unsafe
Heavy Rain Events	75% Unsafe	78% Unsafe

Site Analysis: In 2025, the percentage of both unsafe baseline samples and unsafe heavy rain events increased from 2024. MRWC used the occurrence of a Haverhill CSO as an indicator of a heavy rain event in the region.

All sites in the coastal region experienced high bacteria results July through October in 2025, significantly higher and more frequently than 2024. Overall, the percentage of 2025 unsafe baseline and heavy rain event samples for the Newburyport Plum Island Lighthouse site were higher than the upstream Newburyport Bridge Road site and similar to the cross-river Salisbury Beach State Reservation site. This could suggest high bacteria levels are localized to the mouth of the river. MRWC is funded to design and initiate a more in-depth study of bacteria in Newburyport Harbor in 2026/2027.

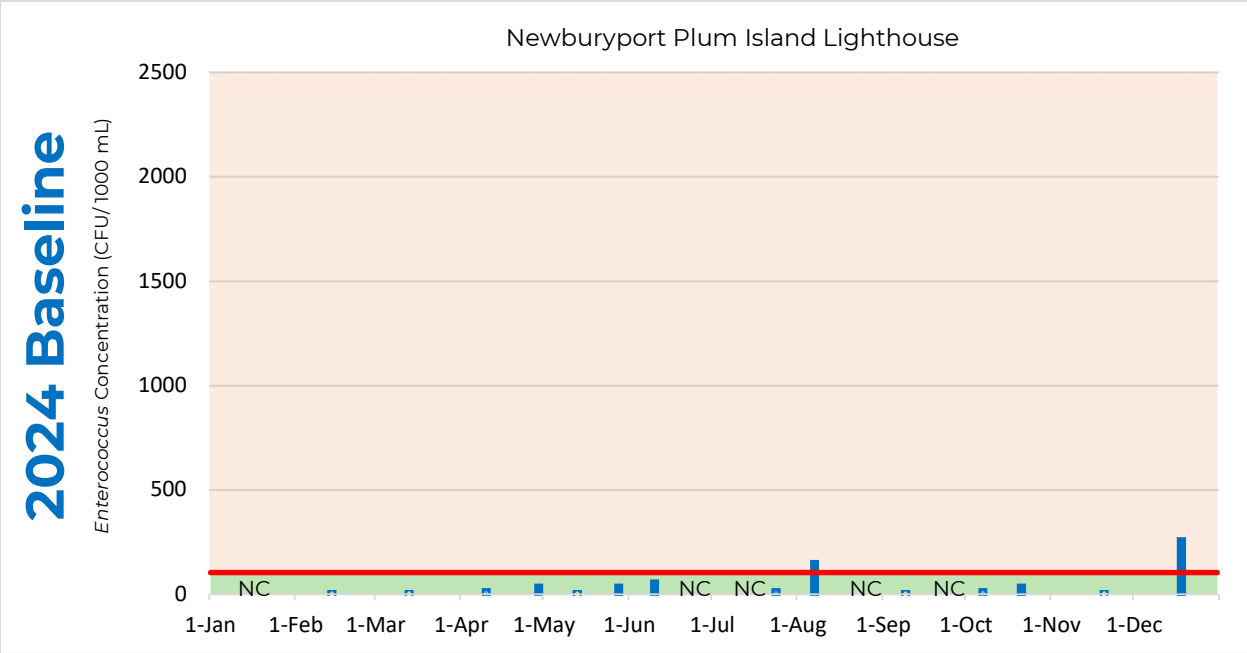


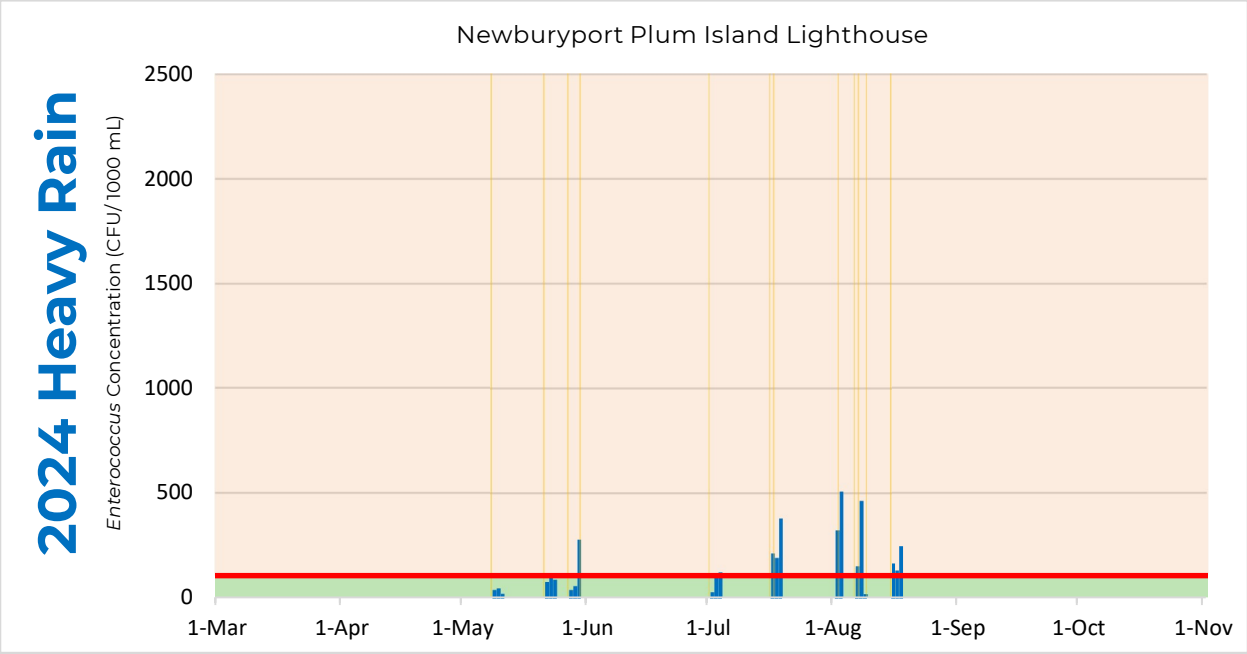
Figure 57: Newburyport - Plum Island Lighthouse sampling site

Region: Coastal Massachusetts

Monitoring Site: Newburyport – Plum Island Lighthouse

2024 Results





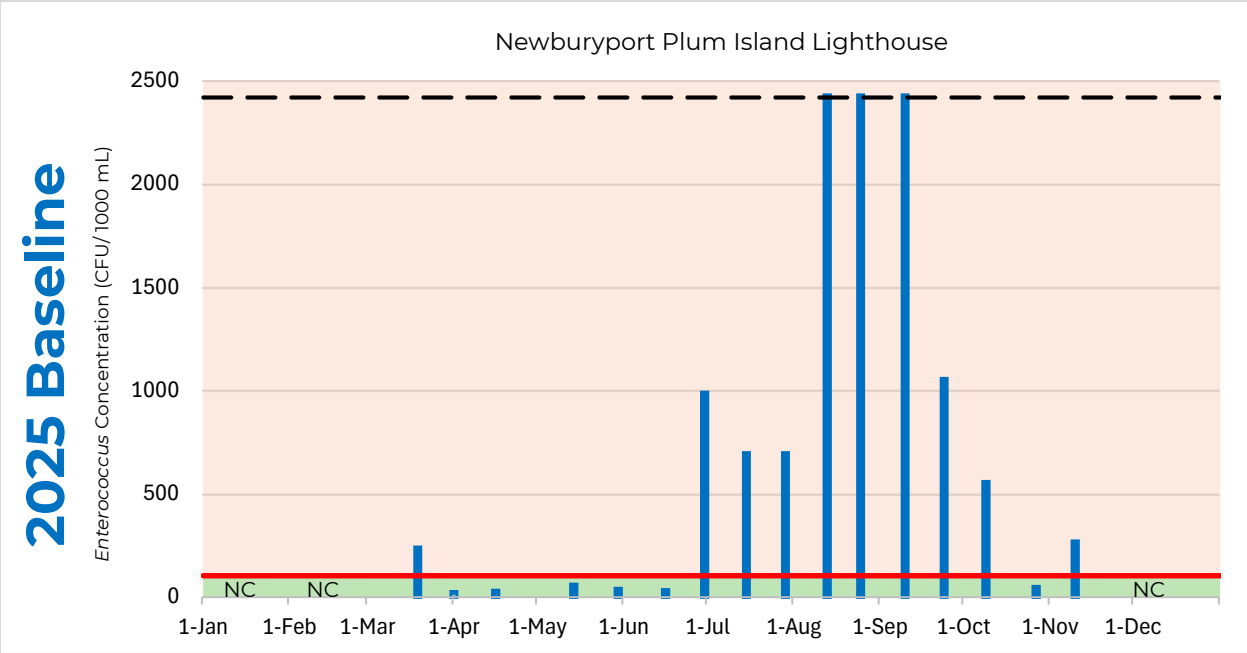
Safe | Unsafe | Bacteria | Date of Haverhill Heavy Rain Event | Safety Limit

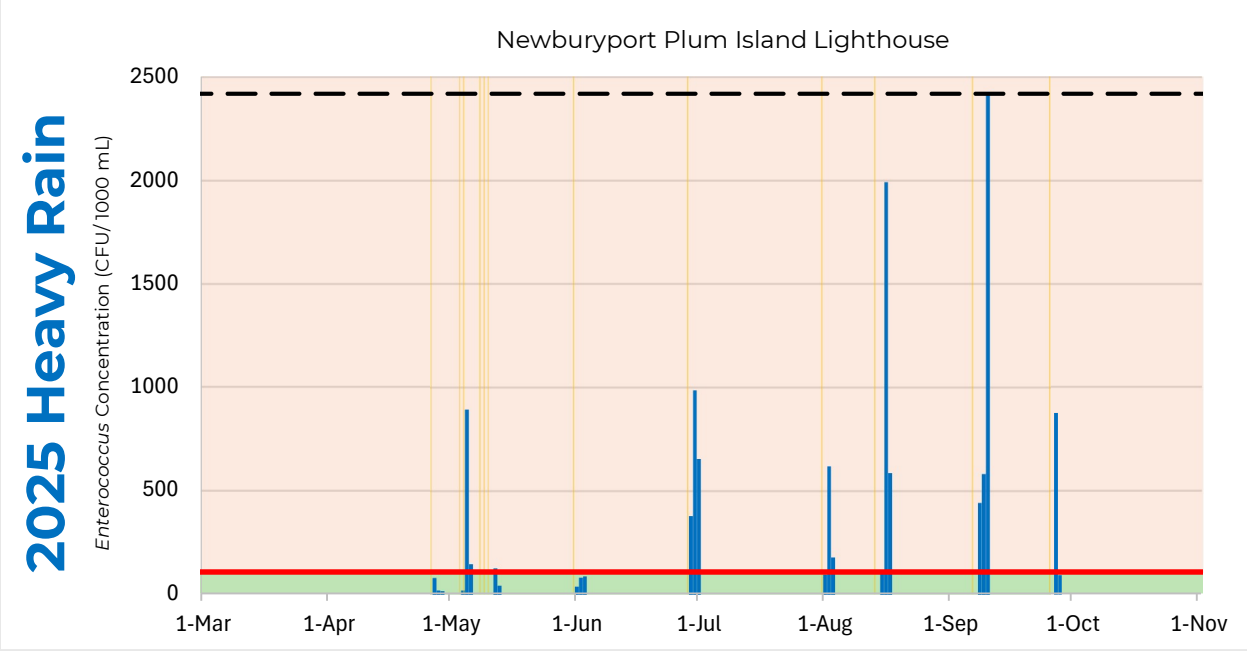
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Region: Coastal Massachusetts

Monitoring Site: Newburyport – Plum Island Lighthouse

2025 Results





Safe | Unsafe | Bacteria | Date of Haverhill Heavy Rain Event | Detection Limit | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Region: Coastal Massachusetts

Monitoring Site: Salisbury Beach State Reservation

(river mile 0.7)

Known CSO Infrastructure

- There are no combined sewer outfalls within the coastal region. The closest CSOs are in Haverhill. Engineering studies[33] and MRWC 2024 and 2025 data suggest no meaningful bacteria impact from CSOs to this site.
- Although CSOs are not a leading contributor to high bacteria levels at this site, high bacteria levels can occur after rain events due to stormwater runoff.

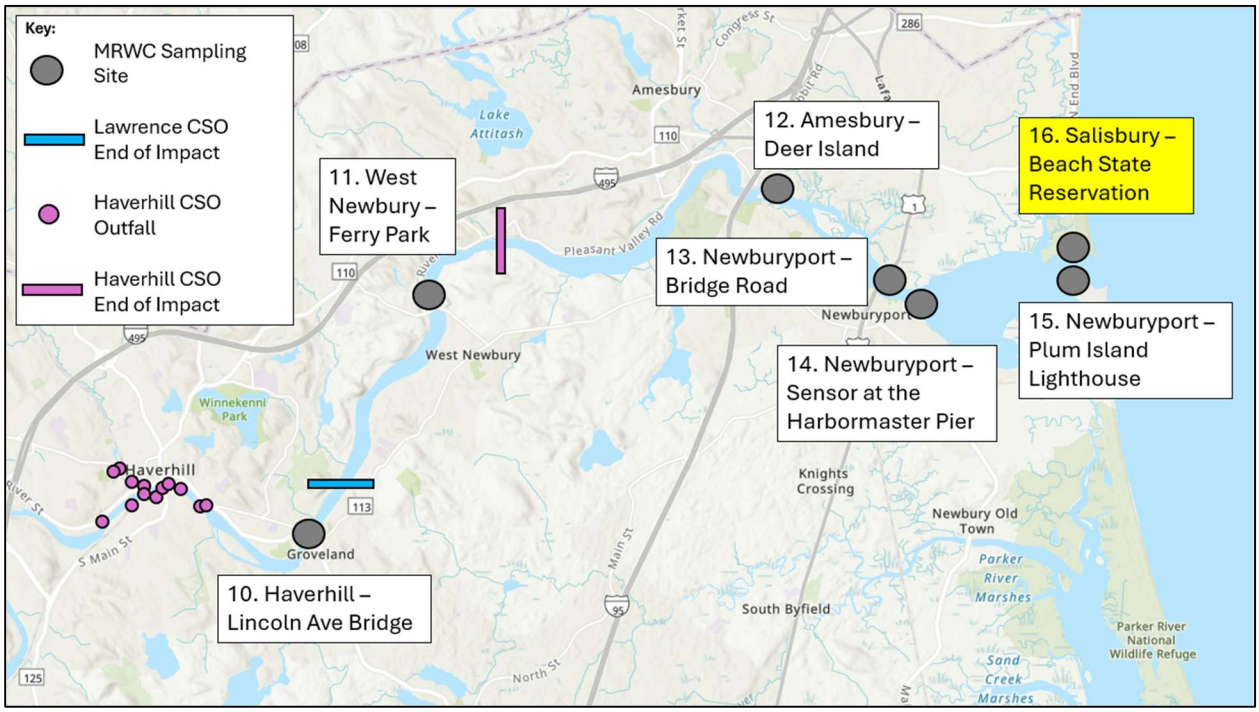


Figure 58: MRWC Salisbury Beach State Reservation sampling site and Haverhill CSO outfalls

Region: Coastal Massachusetts

Monitoring Site: Salisbury Beach State Reservation

(river mile 0.7)

Water Quality Results

Table 36. 2024 and 2025 bacteria results for the Salisbury Beach State Reservation site. The higher percentage of unsafe results between 2024 vs 2025 is highlighted in orange

	2024	2025
Baseline Bacteria Samples	29% Unsafe	56% Unsafe
Heavy Rain Events	88% Unsafe	78% Unsafe

Site Analysis: In 2025, the percentage of unsafe baseline samples increased, and unsafe heavy rain events decreased from 2024. MRWC used the occurrence of a Haverhill CSO as an indicator of a heavy rain event in the region.

All sites in the coastal region experienced high bacteria results July through October in 2025, significantly higher and more frequently than 2024. Overall, the percentage of 2025 unsafe Baseline and heavy rain event samples for the Salisbury Beach State Reservation site were higher than the upstream Newburyport Bridge Road site and similar to the cross-river Newburyport Plum Island Lighthouse site. This could suggest high bacteria levels are localized to the mouth of the river. MRWC is funded to design and initiate a more in-depth study of bacteria in Newburyport Harbor in 2026/2027.

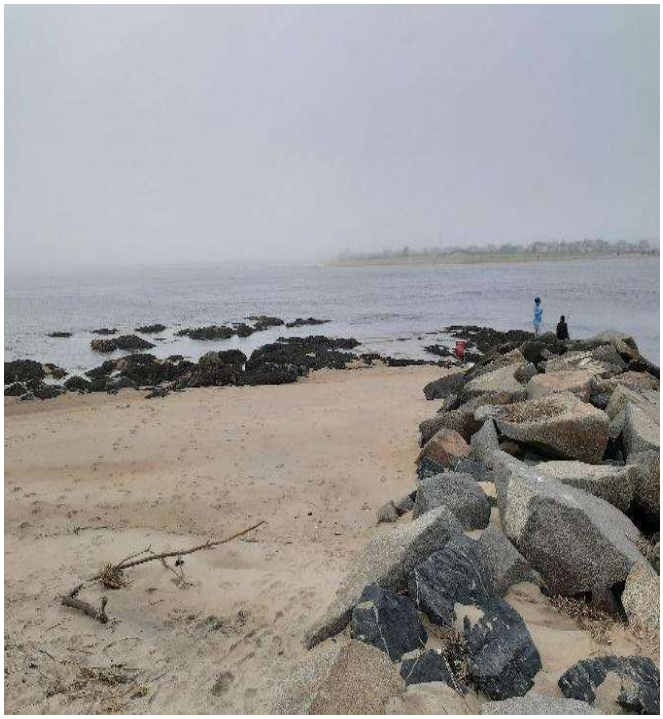
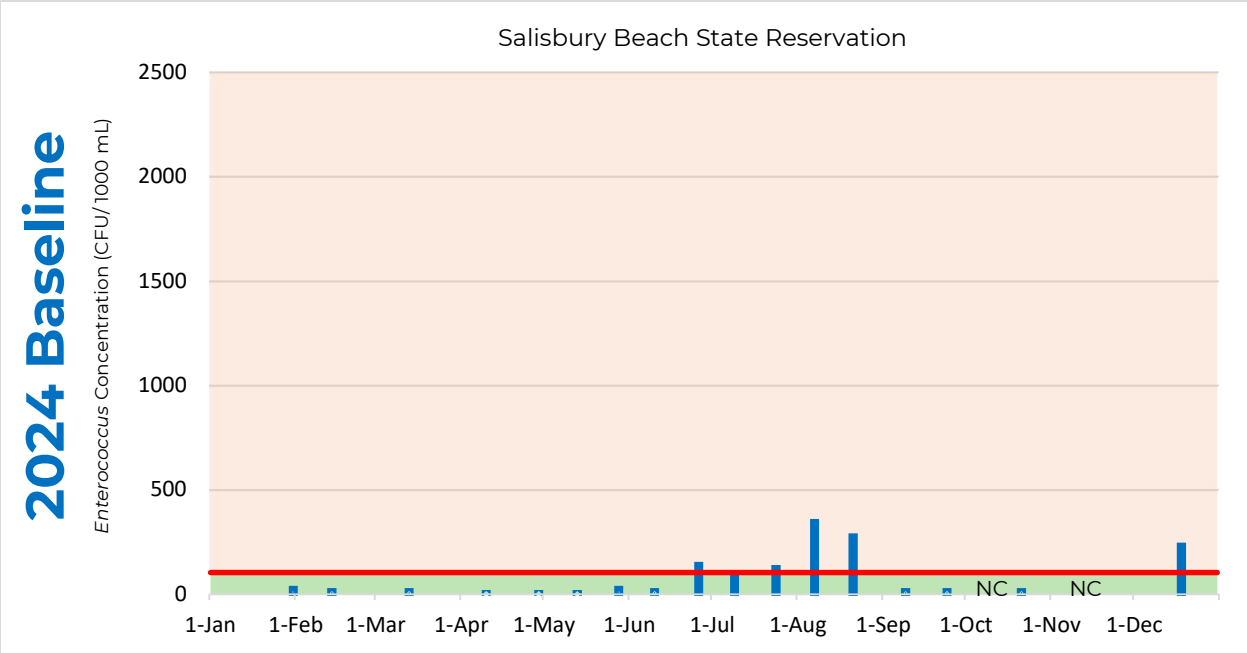


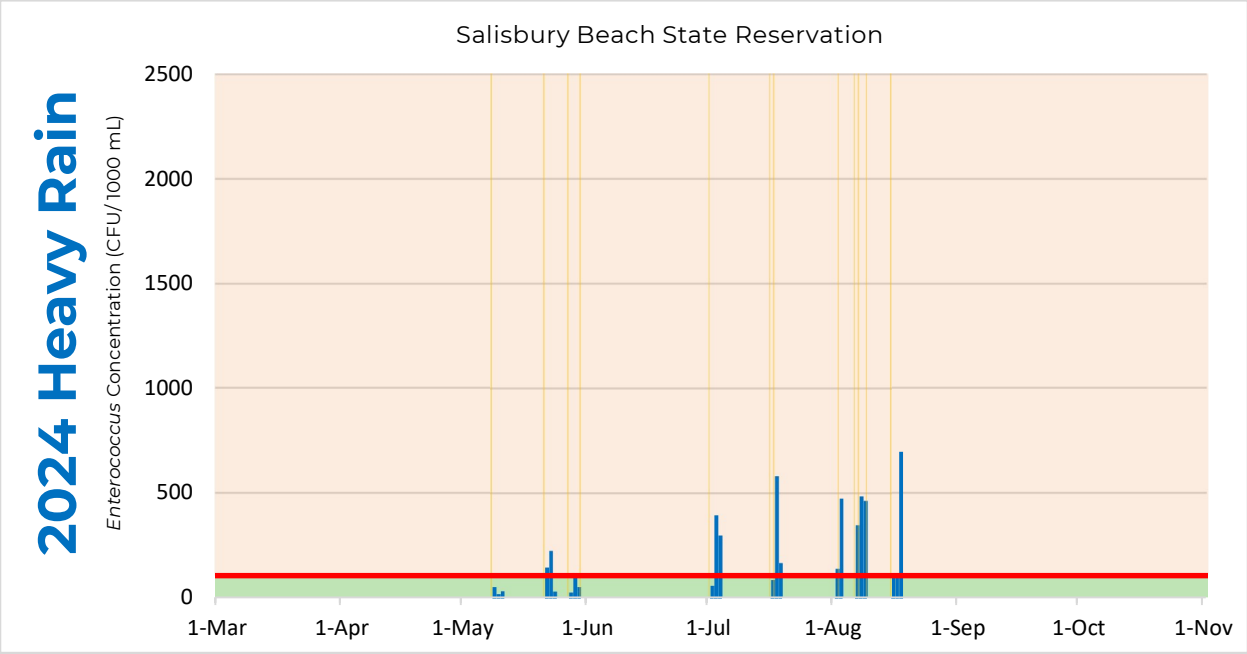
Figure 59: Salisbury Beach State Reservation sampling site

Region: Coastal Massachusetts

Monitoring Site: Salisbury Beach State Reservation

2024 Results





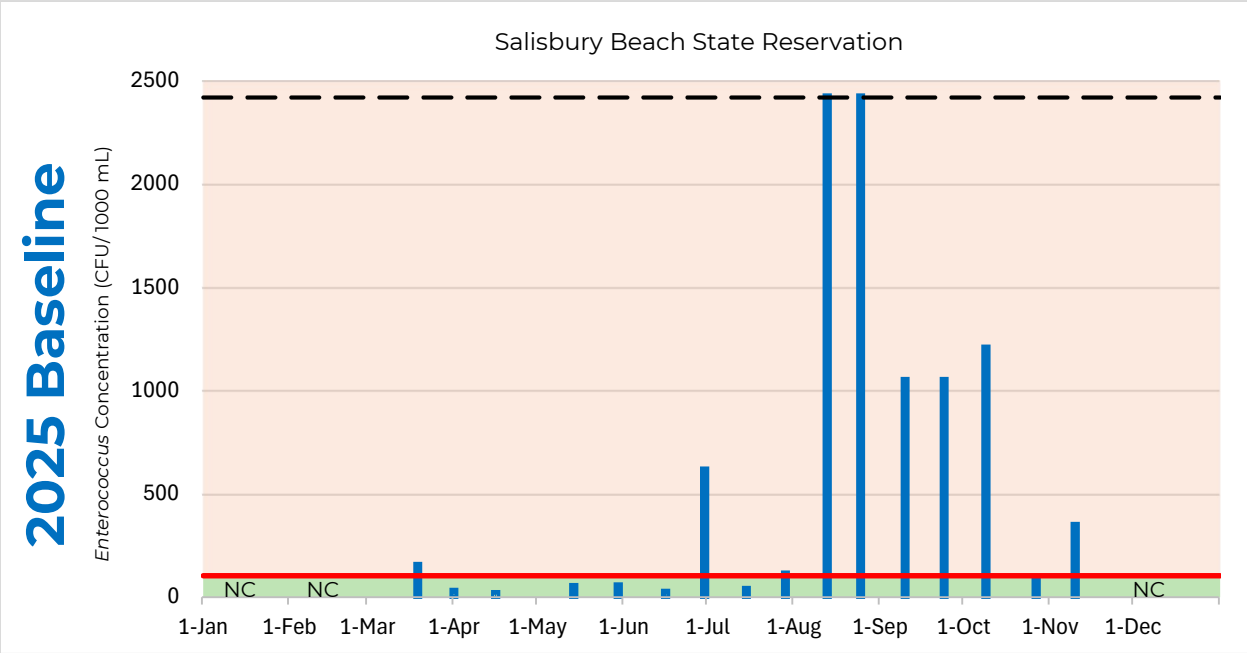
Safe | Unsafe | Bacteria | Date of Haverhill Heavy Rain Event | Safety Limit

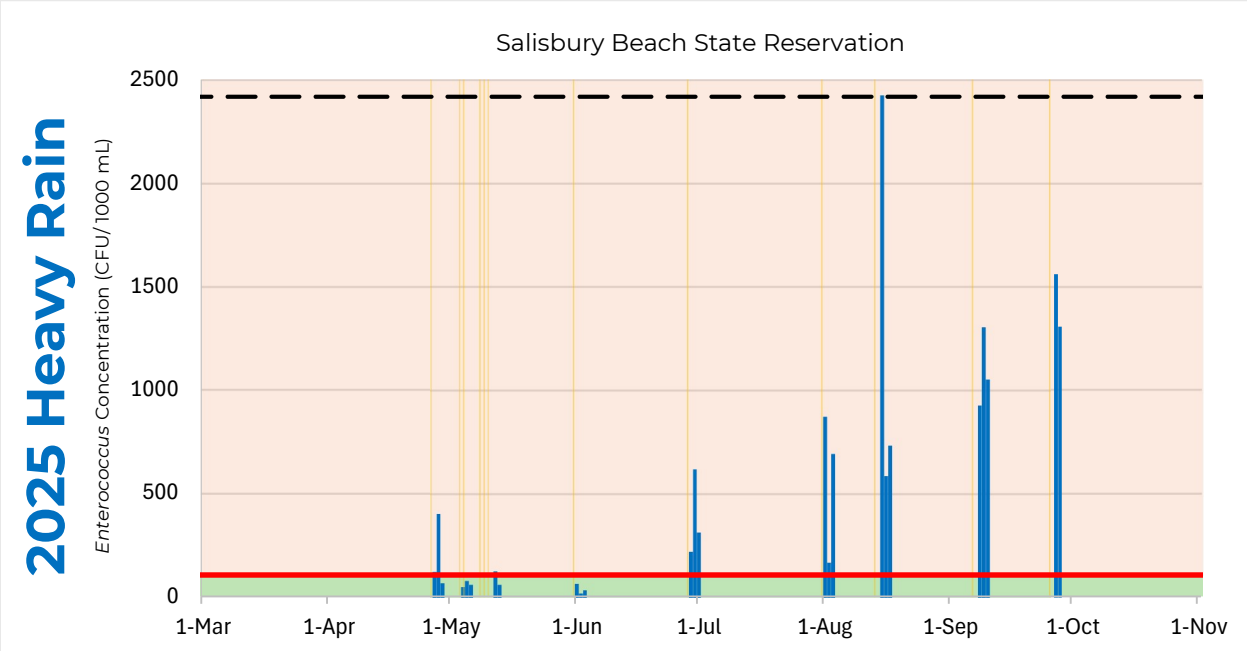
Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

Region: Coastal Massachusetts

Monitoring Site: Salisbury Beach State Reservation

2025 Results





Safe | Unsafe | Bacteria | Date of Haverhill Heavy Rain Event | Detection Limit | Safety Limit

Winter months with no data reflect canceled test dates for volunteer safety. All missed sites are denoted as Not Collected (NC).

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DATA QUALIFICATIONS AND LIMITATIONS

Quality assurance. As is normal in a data collection project, a limited number of questionable data points have been recorded by staff and volunteers, specifically with the Hach handheld Pocket Pro+ Multi 2 Testers due to machine error, user error, or other external issues. Quality Assurance of all Hach Pro data has been completed as of the release of this report.

QAPP. MRWC's previous Quality Assurance Project Plan (QAPP) ended in April 2025. Monitoring procedures throughout the rest of 2025 followed the prior QAPP. While QAPPs are not necessarily needed to conduct a monitoring program, it does provide more legitimacy to data.

New testing sites. MRWC initiated two new testing sites in Nashua, NH in 2025. Data collected from these sites are the first data sets MRWC has collected for Nashua in recent years. As such, it is difficult to draw hard conclusions for what is "normal" for the Merrimack River in Nashua.

Newburyport Plum Island Lighthouse (NPIL) data. During secondary QA analysis of the Baseline data, constant high Specific Conductance readings occurred in the testing area of Plum Island Lighthouse (Newburyport), regularly reading above what would be normal for even ocean water during the mid to late summer. MRWC found that when these abnormally high conductivity readings occurred, bacteria levels were also extremely elevated. Despite both sets of data points being statistical outliers that would otherwise be removed; both analysis procedures produced high reading and were conducted on totally separate machines. This leads MRWC to believe these readings are likely correct and related. The other parameters measured in this time range (pH, temperature, total dissolved solids, and salinity) were also regarded as potential outliers.

Winter data gaps. Data collection in the winter proved difficult due to various factors. MRWC prioritizes volunteer safety from environmental conditions including extreme cold, snowstorms, the river freezing over, docks being pulled for the season, and no available daylight during sampling windows. Due to sampling days being pre-determined to avoid bias, canceled days could not be rescheduled resulting in winter gaps in data.

Limited capacity. Funding for MRWC's water quality work is extremely limited. Though each dollar was stretched through the incredible work of the water quality volunteers, MRWC does not have the capacity to test frequently enough for a comprehensive assessment. Specifically, in the CSO/Heavy Rain Event testing program, testing had to be limited to one round of 3-day testing per week. If a CSO/heavy rain event occurred on Monday, another round of tests would not be initiated until the following Monday. Thus, separate CSO/heavy rain events that occurred later in the 7-day period were missed.

Assumptions and sampling bias. By only sampling on the three days following a CSO/ heavy rain event, the testing protocol suffered sampling bias by not capturing control samples during 3-day dry periods.

DATA QUALIFICATIONS AND LIMITATIONS

Delayed start to CSO/Heavy Rain Event testing. The time from when a significant CSO/heavy rain event occurred to the time of sample collection ranged from 14 to 38 hours. This is due to the variety of times a CSO/heavy rain event might occur, the time it takes to assess whether the duration is enough to be classified as "significant", and the time required to organize a group of volunteers to go out and test. Thus, when results are reported for "day one", "day two", and "day three" after a CSO/heavy rain event, the actual time passed before sampling is variable for each event. Additionally, the immediate impact of the CSO/heavy rain event may have been lost due to the delay (unless a pre-scheduled baseline test day happened to fall in the immediate hours following a CSO/heavy rain event).

Limitations in available CSO data. The available CSO data bears some limitations that should be considered when comparing CSO discharges with water quality. Manchester's CSO data is only available as cumulative annual amounts for each outfall, thus monthly and daily discharge amounts in Manchester are unknown. Additionally, several outfalls in other communities are not metered, so the exact volume and duration are estimated by environmental conditions (such as rainfall).

***Enterococcus* and *E. coli* consistency.** As noted throughout this report, *Enterococcus* is a more reliable indicator of fecal contamination in brackish water than *E. coli*. As such, all of the manually tested sites in brackish water (from Deer Island to the mouth of the river) were tested for *Enterococcus*, while the sites upstream were tested for *E coli*. The sensor pilot program in Newburyport Harbor did not follow this rule and, though it is in a brackish site, it tested for *E coli* due to restrictions of the sensor (and it's *Enterococcus* cartridges) and due to the ability to program the sensor to automatically sample at low tide when upstream freshwater would be the dominant water at the site. As such, the sensor data is not comingled with the baseline or CSO/heavy rain event data and is presented separately.

Outstanding Questions. There is more work to be done to better understand the correlations between CSOs/heavy rain events and bacteria levels. More data analysis is needed for a nuanced understanding of CSO events – not just if one happened upstream, but how large it was, how intense it was, how long it lasted, how far away it was from the sampling site, and if these factors correlate to bacteria levels.

Future Research. In 2026, MRWC will be altering our CSO/heavy rain event protocol to test daily at sampling sites for 10-day periods to gain a better understanding of conditions in both wet and dry weather and to better capture the immediate impact of CSOs. Additionally, MRWC is initiating a Hot Spot Investigation Program that will work to identify the source of high bacteria levels not related to CSOs.

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