

2023 SCHOOL HOUSE BROOK MONITORING | MEMORANDUM



TO: Jess Bourne, Town Clerk & Rachel Bizarro, Town Administrator, Town of Bristol, Maine
FROM: Luke Frankel, FB Environmental Associates (FBE)
SUBJECT: 2023 School House Brook Monitoring Memorandum
DATE: November 28, 2023
CC: Forrest Bell, FB Environmental Associates (FBE)

INTRODUCTION AND SUMMARY OF RESULTS

FB Environmental Associates (FBE) has been working with the Town of Bristol and Bristol Shellfish Committee to investigate potential pollution sources in the Pemaquid River, its tributaries, and the Pemaquid River Estuary since 2018. In 2023, the Town of Bristol funded further investigation in the School House Brook Tributary which outlets to School House Cove. The cove is located on the east side of the Pemaquid River Estuary and is closed to shellfishing from May 1 through October 31. **The Bristol Shellfish Committee has identified School House Cove as valuable shellfishing grounds and an important area for water quality restoration and flat re-opening.**

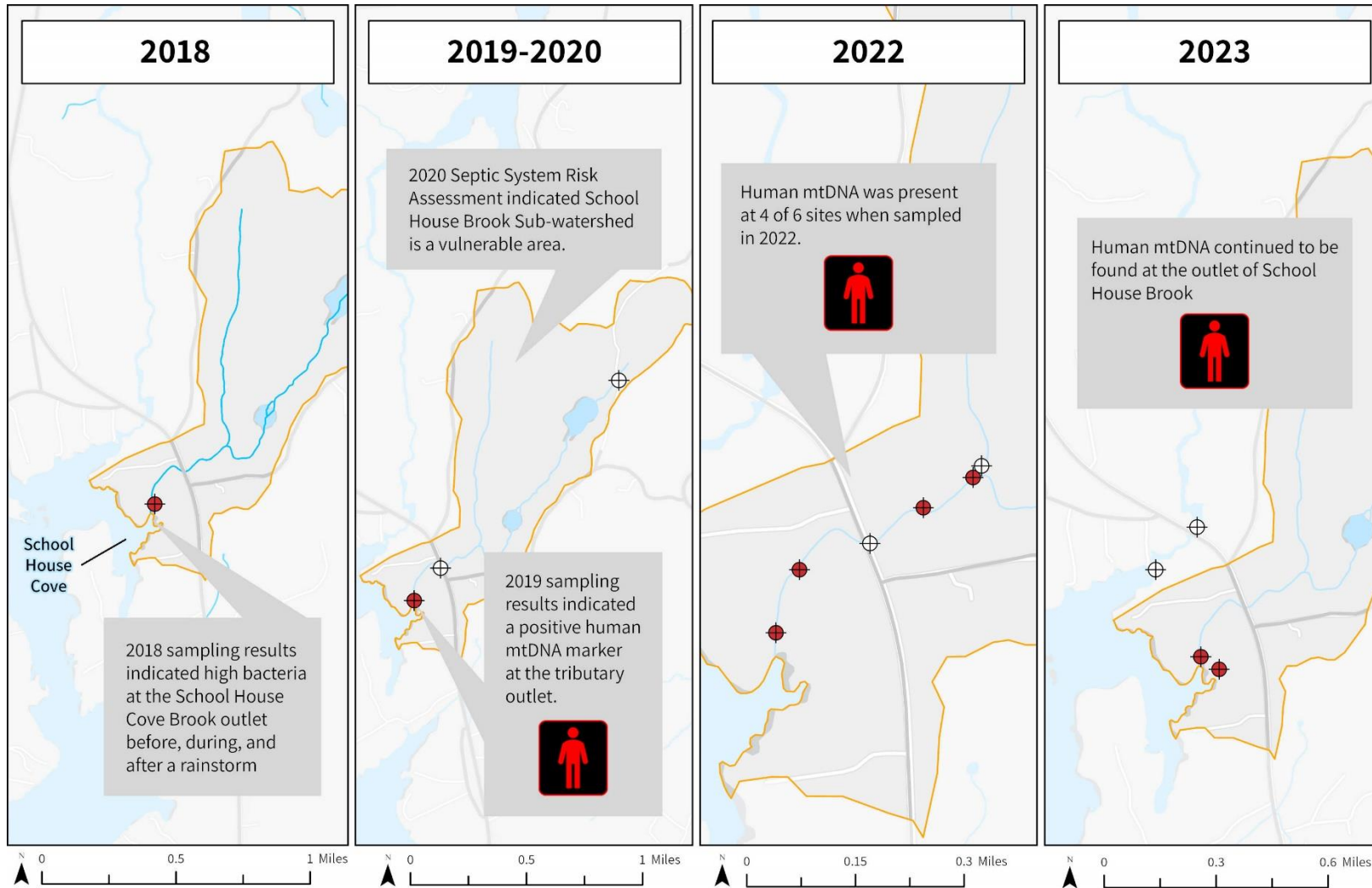
History of Investigative Sampling in the School House Brook Sub-Watershed

In 2017, Maine Department of Environmental Protection (Maine DEP) began sampling the freshwater tributaries of the Pemaquid River to identify possible sources of fecal contamination in the watershed contributing to the impairment of the estuary. As a continuation of this effort, sampling in 2018 by the Town, FBE, and the Maine DEP identified elevated bacteria levels entering the cove from School House Brook during pre-storm, mid-storm, and post-storm sampling across one storm event in June with a cumulative precipitation of 1.86 inches over 24 hours. Further sampling in 2019 on the School House Brook tributary using microbial source tracking at the outlet of School House Brook indicated a positive presence of the human mitochondrial DNA (mtDNA) marker during dry weather conditions. This suggests possible groundwater contamination from septic systems. In addition, the 2021 septic system risk assessment completed by FBE in collaboration with the Town identified areas vulnerable to septic system pollution upstream of the tributary outlet. In 2022, FBE completed bracket sampling at six locations along the lower segment of School House Brook and Pemaquid River to isolate potential sources of pollution. In 2023, FBE completed bracket sampling at four locations in the same vicinity. Refer to Map 1, below for a summary of the history of sampling in School House Brook.

Summary of Results

Between June 2023 and August 2023, FBE performed sampling along the brook twice during wet weather conditions. Samples were analyzed for *Escherichia coli* (*E. coli*) bacteria, fecal coliform, as well as mitochondrial DNA (mtDNA) for poultry, canine, and human markers. **Results indicated that bacteria levels continue to be elevated and the human mtDNA marker continues to be present at the outlet of School House Brook. Two sites in the stream had notably elevated bacteria and had a positive presence of the human mtDNA marker (SB-1 and SB-2, Map 2).** The two sites in the freshwater portion of the Pemaquid River (PR-1 and PR-2, Map 2) did not have any hits for the human mtDNA marker; however, site PR-1 was positive for the poultry mtDNA marker on 6/27/2023 and site PR-2 had elevated fecal coliform bacteria on 6/27/2023, suggesting that other sources of bacteria exist upstream of those sites. The reoccurring presence of the human mtDNA marker at the outlet of School House Brook indicates that a likely source of the elevated bacteria levels is from septic system leakage or waste. **We recommend the Town follow up with assistance from the Code Enforcement Officer to inspect the vicinity for potential malfunctioning or failing septic systems.**

The following memorandum provides the sampling methodology, sampling results, discussion, and recommendations.



School House Brook Monitoring 2018-2023

- Sample Point - elevated bacteria
- ⊕ Sample Point - bacteria not elevated
- School House Brook Drainage
- Road
- Waterbody
- Tributary

Data: Town of Bristol,
NHD, FBE.
Coordinate System: NAD
1983 UTM Zone 19N.
Created by M. Kosalek (FBE)
November 2023

FB
environmental

Map 1. Historical sampling results on School House Brook and 2023 bracket sampling locations. 2023 locations were chosen to isolate sources of pollution from School House Brook and the Pemaquid River.

METHODOLOGY

Bracket Sampling

Table 1. Precipitation prior to sampling events. Data from KMEBRIST8 station, sourced via wunderground.com. Weather events are considered 'wet' with >0.25" of rain within prior 24hrs.

Sample Date	Hours Prior To Sampling	Cumulative Precipitation (in)	Dry or Wet
6/27/2023	24hrs	0.79	Wet
	48hrs	0.79	
8/8/2023	24hrs	0.25	Wet
	48hrs	0.25	



School House Brook outlets to School House Cove, in the eastern side of the Pemaquid River Estuary.

Scientists from FBE completed surface water bracket sampling on 6/27/2023 and 8/8/2023. Bracket sampling is a technique that assists in pinpointing sources of bacteria entering a tributary. This is completed through sampling upgradient and downgradient of potential sources to isolate pollutant source locations. Based on prior sampling results, FBE identified four sampling locations on the School House Brook (SB) tributary and the Pemaquid River Estuary (PR): (SB-1) just upstream of the outlet to School House Cove where a small wooden bridge crosses the brook, (SB-2) just upstream of the Route 130 road crossing, (PR-1) underneath the road bridge upstream of the Lower Pemaquid River, and (PR-2) at the base of the Pemaquid River where the river flows out into the estuary (Map 2).

After the sampling results for the first sampling events were received, FBE analyzed the results and used the remaining funds to complete another round of sampling at the same four sites; SB-1, SB-2, PR-1, and PR-2.

Samples were collected during two wet weather events (targeting >0.25" of rain within the prior 24 hours), even catching a major rainstorm for one of the trips (Table 1).

Parameters included 1) *E. coli*, 2) Fecal Coliform and 3) mitochondrial DNA for human, canine, and poultry presence. Surface water samples were collected and analyzed as follows:

- Field parameters included dissolved oxygen, temperature, salinity, and specific conductance and were recorded using a YSI ProSolo field meter.
- *E. coli* and fecal coliform samples were analyzed at Maine Environmental Laboratory (MEL) in Yarmouth, Maine.
- Mitochondrial DNA for human, canine, and poultry presence samples were analyzed at the University of New Hampshire by Dr. John Bucci.

Using *E. Coli* as a Fecal Indicator Bacteria

Fecal indicator bacteria (such as *Escherichia coli* or *E. coli*, Enterococci, and Fecal Coliform) are used to track a wide variety of potentially harmful pathogens such as viruses and bacteria found in fecal waste that would otherwise be too expensive to monitor comprehensively. High in-stream fecal indicator bacteria levels during dry weather events can point to possible groundwater contamination from septic systems. *E. coli* is the most appropriate indicator bacteria for fecal source tracking in freshwaters and is the Maine DEP standard. *E. coli* was used as a sampling parameter for both sampling events.

Microbial Source Tracking

Elevated fecal indicator bacteria (discussed above) do not alone constitute human waste contamination because fecal indicator bacteria can be sourced from wildlife or proliferate on certain substrates within the environment. Microbial source tracking (MST) is an analytical technique that uses mitochondrial (mtDNA) host-specific markers to determine the source animal of mtDNA found in water samples. The mtDNA analysis was performed at the UNH Microbial Source Identification Laboratory by John Bucci, Ph.D., using molecular biomarkers to assess water quality. If positive, the source of a present sample is detected within the standard microbial source guidelines. If absent, the target biomarker was not detected above the limit of detection and is therefore considered absent. FBE collected samples at all four locations along School House Brook and Pemaquid River for mtDNA analysis for the human, canine, and poultry markers. All three markers were used as a sampling parameter for the two sampling events.

Fecal contamination is one of the most difficult pollutants to remediate. There are a few reasons for this:

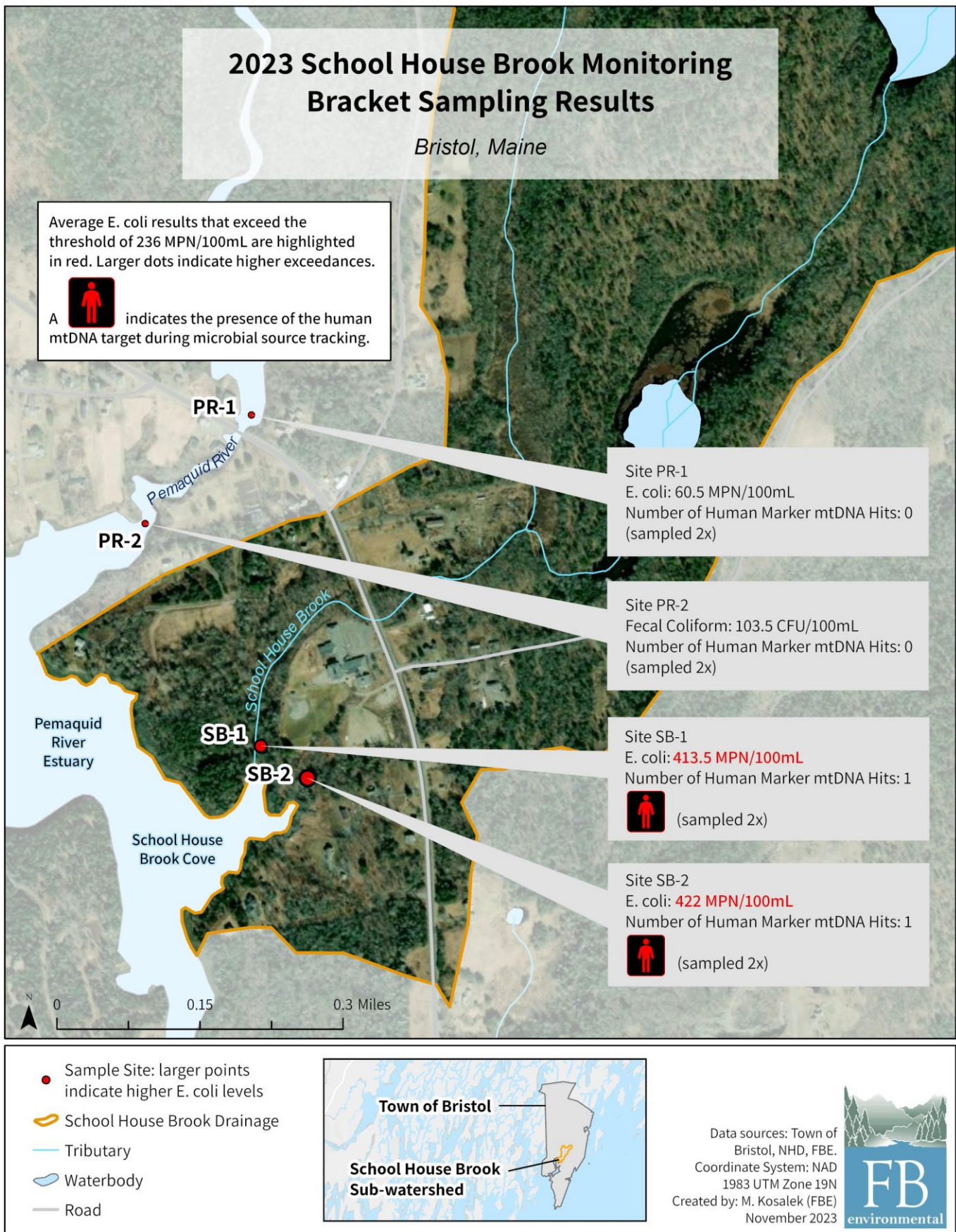
- (1)** It is a nonpoint source pollutant, meaning that it can come from many different locations on the landscape.
- (2)** Human health concerns are caused by potentially harmful pathogens that are present within fecal matter. However, it would be too expensive to track and monitor each pathogen individually. Instead, we use indicator organisms (such as *Escherichia coli* or *E. coli*, Enterococci, and Fecal Coliform). These indicator organisms are chosen based on similarities to pathogens in behavior and transport in the environment.
- (3)** Synchronicity in behavior between fecal indicator bacteria and the pathogens-of-concern for public health risk (e.g., salmonella, campylobacter, rotavirus, giardia, norovirus, hepatitis, etc.) may break down under certain environmental conditions. Therefore, caution must be used when interpreting fecal indicator bacteria data in the context of risk management decisions.
- (4)** Fecal contamination tracking is an evolving science, with new technologies consistently making their way to the market. We do our best to use the tools at our disposal while recognizing their limitations.

RESULTS

Results are displayed in Table 2 and Map 2. Standard water quality metrics – temperature, dissolved oxygen, specific conductance, and flow level – were measured at each site to establish baseline conditions. Baseline levels can be used to help discern future effects on water quality and to inform source tracking. Salinity was measured for all samples to ensure samples were taken in freshwater (above head of tide) because research shows *E. coli* can break down in saltwater. All sites met the Maine DEP recommended threshold for temperature and specific conductance; however **low dissolved oxygen (mg/L) was detected below the state threshold at one of the sites on the Pemaquid River on 8/8/2023**. This is likely in-part due to warm water temperatures, as PR-1 had a temperature of 21.7 °C on 8/8/2023. All sites were above the dissolved oxygen thresholds of 75% both days, though PR-1 was just above the threshold at 76% on 8/8/2023.

The Maine DEP sets a threshold for *E. coli* bacteria for Class A and B waters at 236 MPN/100mL. The Maine DMR sets thresholds for the level of Fecal Coliform allowed in shellfish growing areas. If the analysis result is below 31 CFU/100 mL the area is approved; if the result is between 31-163 CFU/100 mL, the area is restricted; and finally, if the results are above 163 CFU/100 mL, fishing is prohibited. Results in Table 2 are displayed in context of these thresholds. For mtDNA analysis, results are presented as presence/absence. Notable exceedances for each site are summarized by site, downstream to upstream (Map 1).

- Three sites were analyzed for *E. coli*: site SB-1, SB-2, and PR-1. Site SB-1 on 6/27/2023 and site SB-2 on 8/8/2023 exceeded the *E. coli* threshold with elevated bacteria levels over 2.5 times the threshold. The other results for those sites were close to but under the threshold. Site PR-1 had low results compared to the other two sites.
- Site SB-1 and SB-2 both exceeded the *E. coli* threshold and had presence of the human mtDNA target. **Based on these results, the vicinity of SB-1 and SB-2 is considered a hot spot for human waste.**
- Site PR-1 had presence of the poultry mtDNA target on 6/27/2023, however the bacteria at this site remained below the *E. coli* threshold on both sample dates.
- Site PR-2 on 6/27/2023 exceeded the threshold for fecal coliform but did not have presence of any mtDNA targets.



Map 2. Summarized water quality results for 2023 School House Brook water quality bracket sampling.

Table 1. Field and laboratory water quality results for 2023 School House Brook water quality bracket sampling. Results are displayed by site. Exceedances above the threshold or guidance criteria are shown highlighted in **red**.

Site Name	Date	Dissolved Oxygen (mg/L)	Temperature (°C)	Specific Conductance (µS/cm)	Salinity (ppt)	Fecal Coliform (CFU/100 mL)	<i>E. coli</i> (MPN/100 mL)	<i>Canine mtDNA</i> (Present/Absent)	<i>Poultry mtDNA</i> (Present/Absent)	<i>Human mtDNA</i> (Present/Absent)
<i>Threshold:</i>		< 7 mg/L	> 24°C	> 854 µS/cm		> 163 CFU/100 mL	> 236 MPN/100 mL	<i>Present</i>	<i>Present</i>	<i>Present</i>
SB-1	6/27/2023	9.14	17.3	90.6	0.04	-	613	-	-	Present
	8/8/2023	8.33	18.5	70.6	0.03	-	214	-	-	Absent
SB-2	6/27/2023	9.67	15.2	311.7	0.15	-	231	-	-	Absent
	8/8/2023	9.13	16	304.6	0.15	-	613	-	-	Present
PR-1	6/27/2023	7.74	20.8	58.2	0.03	-	101	Absent	Present	Absent
	8/8/2023	6.72	21.7	58.7	0.03	-	20	Absent	Absent	Absent
PR-2	6/27/2023	9.07	21	71.5	0.03	201	-	Absent	Absent	Absent
	8/8/2023	8.41	21.8	83.7	0.04	6	-	Absent	Absent	Absent

"-" indicates site was not tested for that parameter.

DISCUSSION & RECOMMENDATIONS

Ultimately, the results from the 2023 water quality sampling on School House Brook and Pemaquid River found elevated bacteria levels and positive hits for the presence of the human mtDNA marker at two of the sampling sites during wet weather events. **Based on the results, FBE identifies one “hot spot” along School House Brook that had elevated bacteria and hits for the human mtDNA marker.** This hotspot is an important place for the Town to follow up on to remediate the source of bacteria which is likely a malfunctioning septic system.

Hotspot #1: The vicinity of SB-1 and SB-2 is located at the outlet of School House Brook to School House Brook Cove. SB-1 showed elevated bacteria and a human mtDNA hit on sample date 6/27/2023. SB-2 showed elevated bacteria and a human mtDNA hit on sample date 8/8/2023. These sample dates were characterized by wet weather, indicating that fecal sources from the landscape were likely contributing to the high bacteria counts via stormwater runoff in addition to any malfunctioning septic systems. Sampling results at the outlet historically show elevated bacteria levels, further indicating that this site is a hotspot. Ultimately, results indicate that there is likely a source of bacterial pollution in the vicinity of SB-1 and SB-2. This area should be followed up on for opportunities to remediate malfunctioning septic systems.

Recommended Action Items

We recommend the Town of Bristol work with the Code Enforcement Officer and/or a licensed septic system evaluator to follow up at the properties in the vicinity of the identified hotspot. FBE’s specific recommendations are to:

- Connect with the Bristol Consolidated School and identify if they have experienced any signs of a failing septic system. Not all malfunctions or failures will be visible to the property owners, and underground leakages in particular can go undetected. Therefore, we suggest that a septic system evaluation be performed by a certified evaluator to determine if the system is functioning properly.
- Connect with other landowners adjacent to sites SB-1 and SB-2. We recommend approaching the landowners to inquire if they are open to discussing their existing septic system or having a septic system inspection completed. Note that the results of this sampling do indicate that human waste is a likely source of pollution in School House Brook, but it does not indicate which property may be causing this. The [Small Community Grants Program](#), funded through Maine DEP, does provide funding for replacing septic systems if they are polluting a shellfishing area (some income restraints do apply to this funding source).
- Conduct outreach to landowners within the Town of Bristol about proper system maintenance and care. Education can reduce the risk of malfunctioning or failing systems in the future.