

2020 WATER QUALITY MONITORING REPORT FOR
OGUNQUIT RIVER

FOR THE TOWN OF OGUNQUIT

December 2020

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2020 REPORT SUMMARY

The Ogunquit River estuary is listed as impaired due to elevated fecal indicator bacteria (Enterococci). The cause of this impairment is largely attributed to sources of nonpoint source pollution (e.g., stormwater runoff, malfunctioning septic systems, leaky sewer lines, etc.) in the watershed. The Town of Ogunquit and its partners have been working to remediate this impairment and monitor any changes in water quality in the estuary and near Riverside Beach.

In 2020, the baseline annual monitoring program was continued throughout the Ogunquit River watershed. These efforts included monitoring six locations (some previously identified as “hotspots” of fecal contamination) for fecal indicator bacteria from June through October. This monitoring effort yielded several important results that will help direct management actions within the watershed and reduce fecal contamination in the Ogunquit River.

- Fecal contamination was evident at all sampling sites at least once during the sampling season. All sites exceeded the Maine Healthy Beaches water quality threshold for Enterococci, either for single sample or geometric mean or both. Riverside Beach continued to experience contamination advisories, consistent with previous years.
- During large rain events, elevated fecal indicator bacteria continued to occur at OG-Pipe, a stormwater overflow conveyance from catch basins in the Main Beach parking lot and adjacent roadway to the Ogunquit River at Riverside Beach. The retrofitted catch basins are designed to treat all stormwater runoff from their drainage area (a portion of the parking lot) in rain events up to 1”. Two catch basins in the parking lot are still tied directly to OG-Pipe. Installation of another enhanced dry well and specialized bacteria filter cartridges are planned for the Maine DEP/USEPA 319 Watershed Assistance Grant Phase III project.
- Continued monitoring downstream of the Lower Lot stormwater retrofit at site OR-13 is needed to measure water quality benefits. Leavitt Stream continues to be an area of concern with elevated fecal indicator bacteria levels especially following rain events.
- Fecal source tracking efforts focused on groundwater entering the unnamed tributary between Littlefield Village and the Great Works Regional Land Trust property, following up on the prior year’s investigations in the same location. As in 2019, secondary indicators of contamination were found on both sides of the tributary, and unlike in 2019, elevated Enterococci counts were found on both banks in 2020.



Site OR-18 along an unnamed tributary leading into the Ogunquit River.

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The 2020 annual monitoring and fecal source tracking project was funded by the Town of Ogunquit in order to continue the long-term monitoring of the Ogunquit River’s water quality and to measure progress and prioritize actions for the ongoing Ogunquit River Restoration Project, in partnership with the Maine Department of Environmental Protection.

Cover photo: Ogunquit River downstream from Beach Street bridge. Photos below: OR-13 at low tide (top left); FBE staff measuring pH (top right); beach activity at OG-04 (bottom left); OR-06 looking upstream (bottom right).



BACKGROUND

The Ogunquit River estuary (Class SB) is listed in the Maine Department of Environmental Protection (Maine DEP)'s 2016 Integrated Water Quality Monitoring and Assessment Report (Maine DEP, 2016) as impaired under Category 5-B-1: Estuarine and Marine Waters Impaired for Bacteria Only (fecal pollutants) – TMDL Required. This impairment is largely attributed to nonpoint source pollution in the form of stormwater runoff, with possible contributions from malfunctioning septic systems and leaky sewer lines. The Ogunquit River is also listed on the Maine DEP Nonpoint Source Priority Watersheds List of Impaired Marine Waters and Threatened Streams.

Investigative and monitoring work over the last twenty years has been conducted in the Ogunquit River watershed and at the beaches by many different groups, including Maine Healthy Beaches, Maine DEP, the Ogunquit Sewer District, the Ogunquit Conservation Commission, and FB Environmental Associates (FBE). As shown by annual monitoring reports prepared by FBE since 2012, elevated fecal indicator bacteria (Enterococci) levels have been found at sampling sites throughout the lower tributaries and the estuary, with “hot spots” – locations where frequent high fecal indicator bacteria counts are observed – found along Leavitt Stream and the unnamed tributary north of Littlefield Village. In addition, high fecal indicator bacteria counts have led to frequent contamination advisories at local beaches. In 2020 there were three separate contamination advisories spanning 21 days at Riverside Beach, reflecting a statewide trend of above average fecal indicator bacteria counts and resulting beach closures.

To minimize beach advisories and remediate impairments to the river, the Town of Ogunquit has collaborated with the aforementioned organizations to support an annual monitoring program. The goals of this monitoring program are to:

- 1) **Help identify and bracket sources of high fecal indicator bacteria levels in the Ogunquit River watershed.**
- 2) **Maintain a baseline of fecal indicator bacteria data for hotspot sites to assess trajectory of changes in response to remediation efforts.**

In 2020, the Town of Ogunquit, the Ogunquit Conservation Commission, and FBE worked to maintain the annual watershed monitoring program for tracking success of remediation work funded through previous Maine DEP/US Environmental Protection Agency (USEPA) Section 319 Watershed Assistance Grants. In 2019, the town was awarded another Section 319 Watershed Assistance Grant for Phase III. This report summarizes results from the 2020 monitoring program in support of Phase III of the Ogunquit River Watershed Restoration Project.

Enterococci bacteria are present in the intestinal tracts of warm-blooded animals and are used to indicate the presence of fecal contamination in waterbodies. Each gram of human feces contains approximately 12 billion bacteria, many associated with human health issues. Wastes from other warm-blooded animals, including pets, farm animals, and wildlife may also contribute bacteria and associated disease vectors to waterbodies. High concentrations of fecal indicator bacteria in waterbodies can lead to posted advisories at swimming beaches and closure of shellfish beds. These bacteria are used to signal human health risks, such as gastrointestinal, respiratory, eye, ear, nose, throat, and skin infections transmissible to humans through the consumption of contaminated fish and shellfish, skin contact, and/or ingestion of water.



The Ogunquit River watershed spans 13,267 acres across four Maine towns: Wells, Ogunquit, South Berwick, and York.

ANNUAL BASELINE WATER QUALITY MONITORING

METHODS

FBE conducted sampling at six sites throughout the Ogunquit River watershed on six dates (three wet and three dry weather events¹) from July through October 2020 (Figure 1). Sample sites were selected from priority “hot spot” sites identified by 2012-2019 water quality sampling and canine detection efforts (FBE, 2012, 2013, 2014, 2015, 2017, 2018, 2019, 2020a). A seventh site (OG-Pipe) draining stormwater from the Main Beach parking lot was also sampled whenever flow was present (sampled once on 9/30/2020). All sampling of tidal sites (OG-04, OR-13, and OR-18) occurred within ± 2 hours of low tide. All fecal indicator bacteria samples were analyzed for Enterococci bacteria using the Enterolert method² at Nelson Analytical Laboratory in Kennebunk, Maine. Temperature, dissolved oxygen, salinity, specific conductivity, and pH data were also collected at each site using a YSI ProSolo and ExStik® II pH meter. Data collection was conducted in accordance with methods outlined in the 2020 Quality Assurance Project Plan (QAPP) (FBE, 2020b). A more detailed discussion of any QAPP deviations is discussed in Appendix B.

Enterococci are used as an indicator of the presence of fecal material in brackish/marine waters by Maine Healthy Beaches, which applies USEPA water quality threshold of 104 mpn/100mL for a single sample maximum (a.k.a., the “instantaneous” threshold) and 35 mpn/100mL for the geometric mean of multiple samples³. Though the Ogunquit River is freshwater west of Route 1, the brackish/marine water quality threshold were used for both freshwater and brackish/marine sites to assess the impact of the Ogunquit River on beach advisories in Ogunquit.

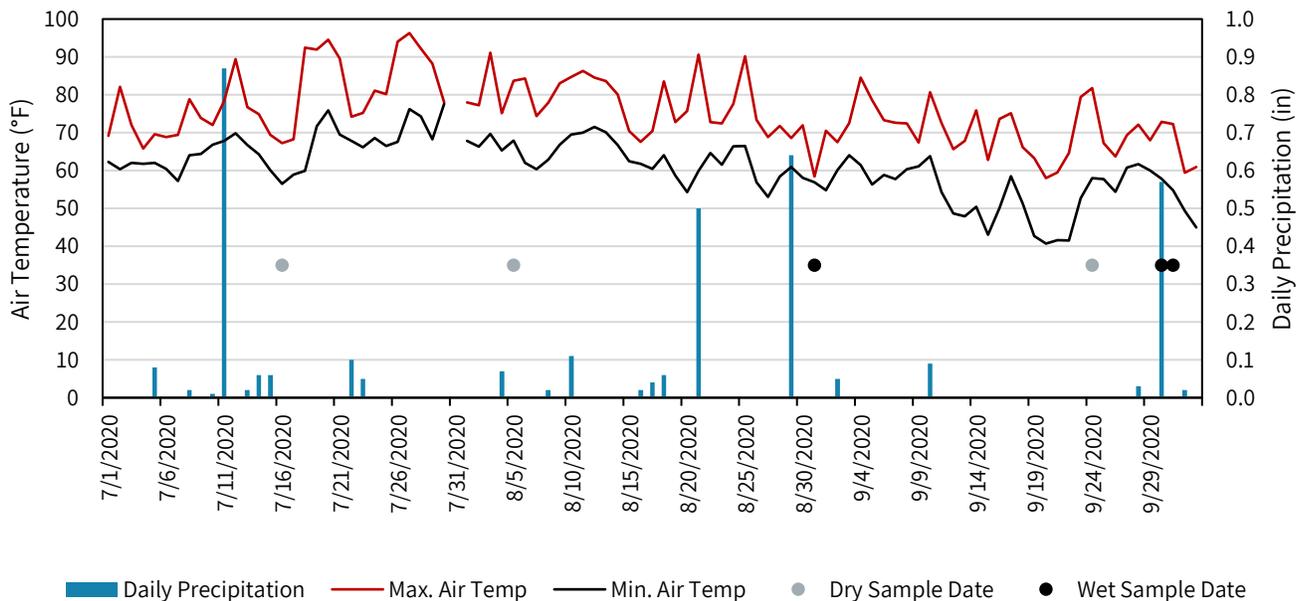


FIGURE 1. Daily high and low air temperature (red and black lines, respectively) and precipitation data (blue bars) from July – October 2020 with wet and dry weather sample dates indicated by black and gray points, respectively. Data were retrieved from the Ogunquit Sewer District weather station.

¹Conditions were considered “wet” if nearby weather stations recorded any of the following: >0.1” of precipitation in the prior 24 hours; or >0.25” in the prior 48 hours; or >2.0” in the prior 96 hours. Larger precipitation events were sampled when possible. Dry weather conditions were defined as periods when precipitation was less than 0.1” for each day within 72 hours.

²ASTM D6503-19, Standard Test Method for Enterococci in Water Using Enterolert, ASTM International, West Conshohocken, PA, 2019, www.astm.org.

³mpn = most probable number of viable organisms

RESULTS

Fecal contamination was evident at all sample sites, including the Ogunquit River main stem, freshwater tributaries, and the estuary. Every site exceeded the Maine Healthy Beaches *Enterococci* threshold of 104 mpn/100mL at least once during the season, and several sites exceeded the threshold for the entire season as measured by geometric mean (Table 1, Figures 2-4; see Appendix A, Table A1 for full results).

Only one site, the Ogunquit River estuary at the Beach Street bridge (**OR-04**), had fecal indicator bacteria counts that met the Maine Healthy Beaches geometric mean threshold for dry weather, wet weather, and all-weather sampling. This site did, however, exceed the instantaneous fecal indicator threshold for two sampling events (one dry weather and one wet weather). All other sites exceeded the geometric mean threshold for dry, wet, and across all sampling events.

In 2020, site **OR-18**, situated on the unnamed tributary north of Littlefield Village just before it empties into the estuary, showed elevated fecal indicator bacteria counts during both wet and dry weather. Instantaneous thresholds were exceeded on all but one sampling day. This pattern is consistent with results from previous sampling years. Dry weather exceedances can sometimes indicate that groundwater sourced from adjacent land is a source of fecal contamination. In 2019 and again in 2020, FBE assessed this possible contamination vector by using targeted groundwater sampling (see Targeted Fecal Source Tracking section below).

Leavitt Stream continued to be targeted for surface water sampling in 2020. In previous years, genetic source tracking tests in this area had identified wildlife, human, and dog waste as potential sources of fecal contamination (FBE, 2013). Additionally, the neighborhoods surrounding the Leavitt Stream west of Route 1 are largely serviced by private septic systems. Remediation efforts in this area include two bioretention systems installed in the Lower Lot parking lot in 2016, part of the Maine DEP/USEPA 319 Watershed Assistance Grant Phase I project.

The upstream-most site along Leavitt Stream, **OR-15-1**, exceeded the fecal indicator bacteria geometric mean threshold during wet, dry, and all-weather sampling. Instantaneous thresholds were exceeded during each wet weather sampling event but not during dry weather events (note no sample was collected on 9/24/2020 as there was no standing water present). Downstream sites **OR-Theatre** and **OR-13** also exceeded geometric mean thresholds across sampling conditions. At both sites, the instantaneous bacteria threshold was exceeded on all wet weather sampling days and for one dry weather sample (8/5/2020). While there was no consistent upstream to downstream pattern evident, *Enterococci* counts were generally higher following rain events throughout the Leavitt Stream sites especially on 9/30/2020 when *Enterococci* counts ranged from 4,080-10,100 mpn/100mL. *Enterococci* levels and threshold exceedances at Leavitt Stream sites are consistent with previous years suggesting persistent fecal sources that are likely mobilized during rain events.

DID YOU KNOW?

High fecal indicator bacteria during dry weather indicate that fecal contamination is likely derived from groundwater sources (e.g., malfunctioning septic systems or leaky sewer pipes). High fecal indicator bacteria during wet weather indicate that fecal contamination is likely derived from stormwater (e.g., dog or wildlife waste picked up in runoff); however, large storm events can also raise the water table to intercept malfunctioning septic systems and flush out pollutants from leach fields.



Dry weather conditions led to low water levels at several sampling sites in 2020. OR-15-1 had no standing water present on September 24th.

The upstream-most sampling location along the main stem of the Ogunquit River, **OR-06**, also exceeded the Enterococci geometric mean for wet, dry, and all-weather sampling and showed instantaneous exceedances during two dry weather sampling events and two wet weather sampling events. These results indicate bacteria sources are likely present higher up in the watershed and carried downstream.

OG-Pipe was actively flowing on 9/30/2020 during a large rain event and therefore only sampled once in 2020 (total rainfall for the day was 0.57" but at least 0.14" had fallen prior to sampling). This pipe is the overflow outlet from the Main Beach parking lot and receives some Beach Street stormwater drainage in significant storms. The instantaneous threshold exceedance of 4,360 mpn/100mL indicates accumulation of fecal sources on these nearby impervious surfaces despite the remediation efforts aimed at treating stormwater runoff. As part of the Maine DEP/USEPA 319 Watershed Assistance Grant Phase II project, an enhanced dry well and specialized bacteria filter cartridges were installed in two catch basins at the lower end of the parking lot in



Outflow from OG-Pipe caused significant erosion during the Sep 30th rain event.

early 2018. The retrofitted catch basins are designed to infiltrate all stormwater runoff from their drainage area (a portion of the parking lot) in rain events up to 1", with any larger precipitation events directed to overflow. The high fecal indicator bacteria counts measured at the outfall (OG-Pipe) in 2018 (n=1), 2019 (n=1), and 2020 (n=1) are likely the result of overflow from larger storms or of pollutants picked up in the stormwater runoff from the roadway. Installation of another enhanced dry well and specialized bacteria filter cartridges are planned for the upcoming Maine DEP/USEPA 319 Watershed Assistance Grant Phase III project.

Seasonal water temperatures ranged from 13.5°C (at OR-06) to 22.7°C (OG-04) with an average of 17.8°C across all sites (Appendix A, Table A2). Several sites experienced persistent low dissolved oxygen (DO) throughout the summer of 2020. Average DO was less than 8.0 ppm at the following sites: OR-06, OR-15-1, OR-Theatre, OR-13, OG-04. Low flow conditions were evident over the course of the sampling season, as rainfall was extremely low, which likely contributed to these results. Salinity and specific conductivity were tightly correlated, indicating that specific conductivity was largely driven by saline, tidal waters (and not excess ionic nutrients from human activities).

Contamination advisories occurred at Riverside Beach (near **OG-04**) on three separate occasions for a total of 21 days in the summer of 2020 (Figure 2). Maine Healthy Beaches Program data indicates that the Town of Ogunquit issued a contamination advisory alerting the public that fecal indicator bacteria levels in the water were possibly unsafe and contact was not advised from 6/24-7/2/2020, 7/9-7/10/2020, and 7/22-7/31/2020. Days under contamination advisory in 2020 (n =21) increased by 31% over 2019 (n = 16), but there were no rainfall advisories or beach closures issued in 2020.

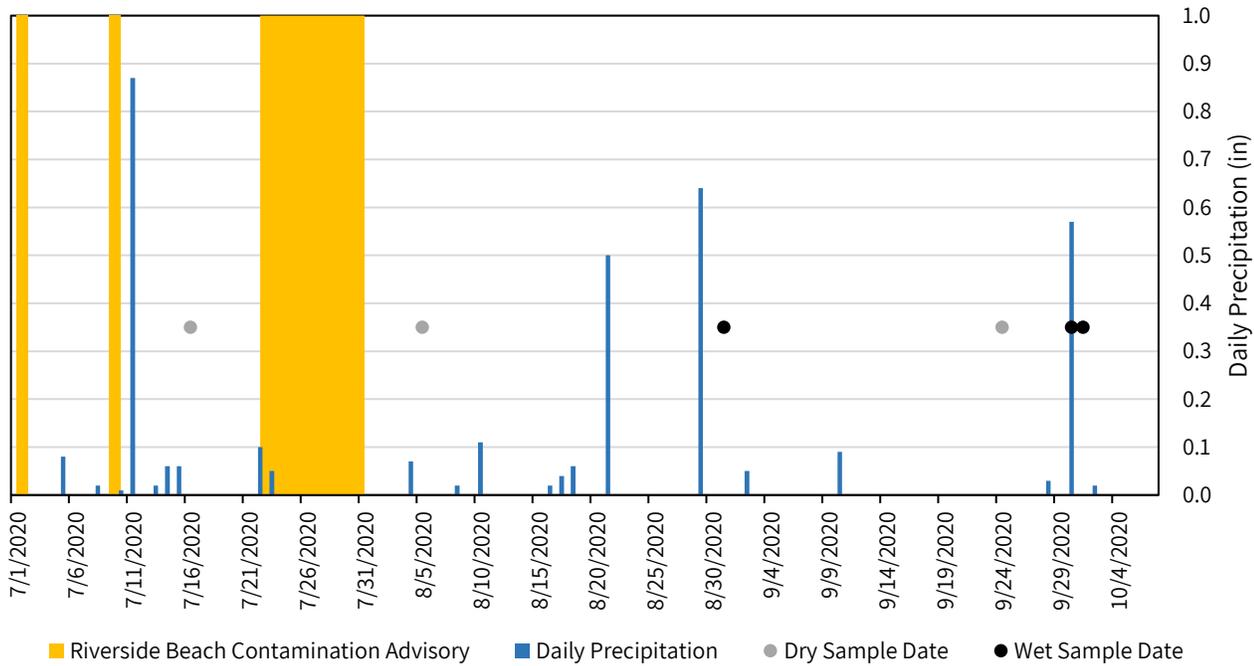


FIGURE 2. Contamination advisories at Riverside Beach in Ogunquit (near OG-04). Advisory dates are shaded in yellow. There were no Rainfall Advisories or Beach Closures issued in 2020. The amount of daily precipitation is represented with blue bars. Data shown from 7/1/2020- 10/4/2020 with dry and wet weather sampling dates marked with grey or black points, respectively. Beach status data were retrieved from the Maine Healthy Beaches Program website; precipitation data were retrieved from the Ogunquit Sewer District from their rooftop weather station.

TABLE 1. Summary of Enterococci (mpn/100mL) results for sampling locations within the Ogunquit River watershed in 2020. For individual samples <10 mpn/100mL, a value of 5 mpn/100mL (half the detectable limit) was used in calculating the geomean. Sites are ordered from upstream to downstream. Red text indicates an exceedance of the Maine Healthy Beaches Enterococci water quality threshold of 35 mpn/100mL for the geomean of multiple samples or 104 mpn/100mL for a single sample (applied to OG-Pipe). No samples were collected from OG-Seep in 2020.

Site	Location	<i>n</i>	Enterococci Dry Weather Geomean (mpn/100mL)	Enterococci Wet Weather Geomean (mpn/100mL)	Enterococci All Data Geomean (mpn/100mL)
OR-06	Main Stem	6	115	279	180
OR-18	Tributary to Main Stem	6	362	2,224	897
OR-15-1	Leavitt Stream	5	74	2,781	651
OR-Theatre	Leavitt Stream	6	86	1,361	343
OR-13	Leavitt Stream	6	89	654	241
OG-04	Main Stem	6	16	29	22
OG-Pipe	Stormwater Pipe to Main Stem	1	-	4,360	4,360
OG-Seep	Beach Seep to Main Stem	0	-	-	-

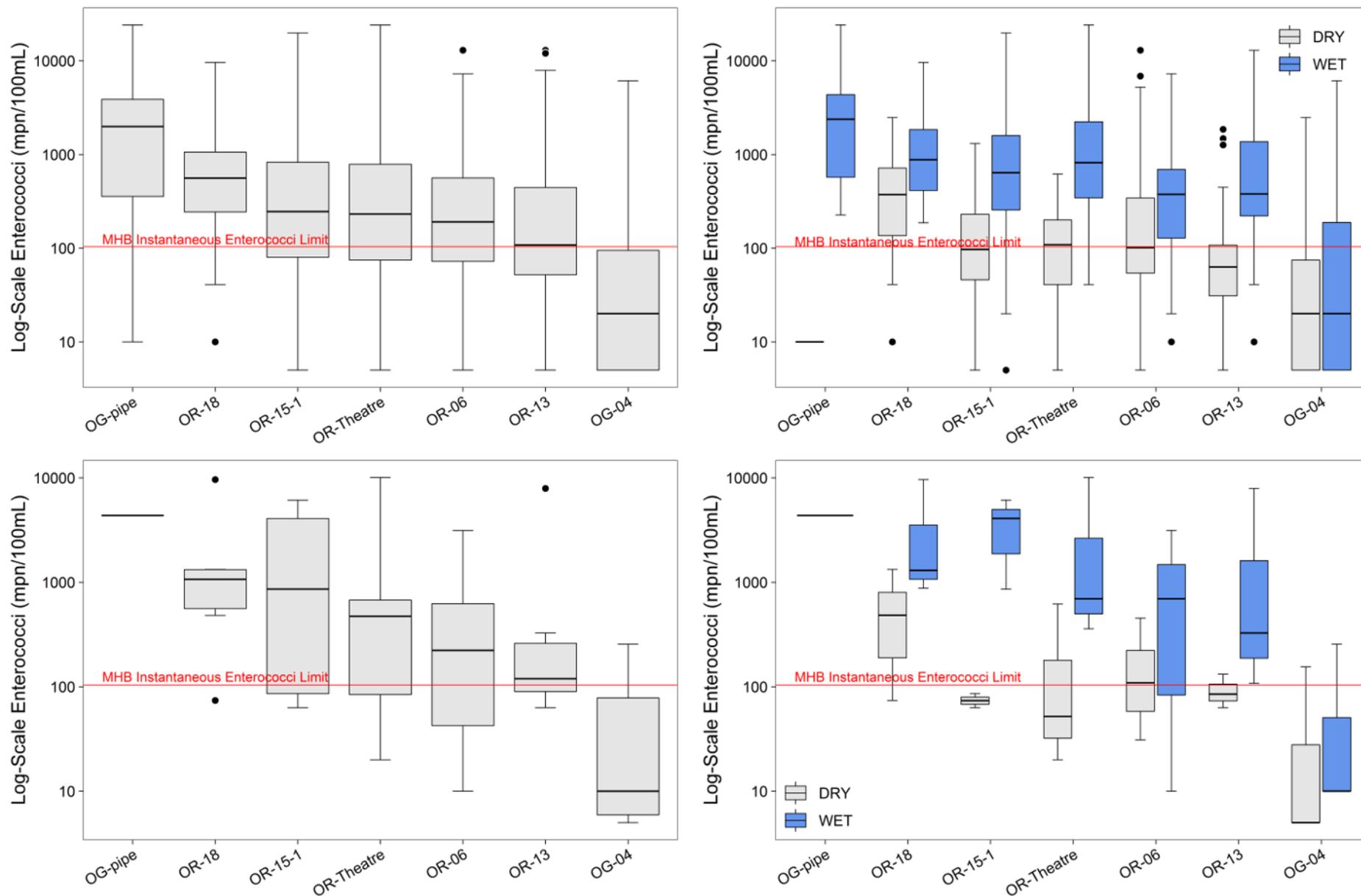


FIGURE 3. Distribution of Enterococci results for all sampling years (2003-2020; top) and 2020 results (bottom) for seven sites in the Ogunquit River watershed (left) and separated by antecedent weather condition (right). Sites are ordered from highest to lowest median value according to all sampling years (2003-2020) distribution (top left). The red line represents the Maine Healthy Beaches instantaneous Enterococci threshold of 104 mpn/100mL.

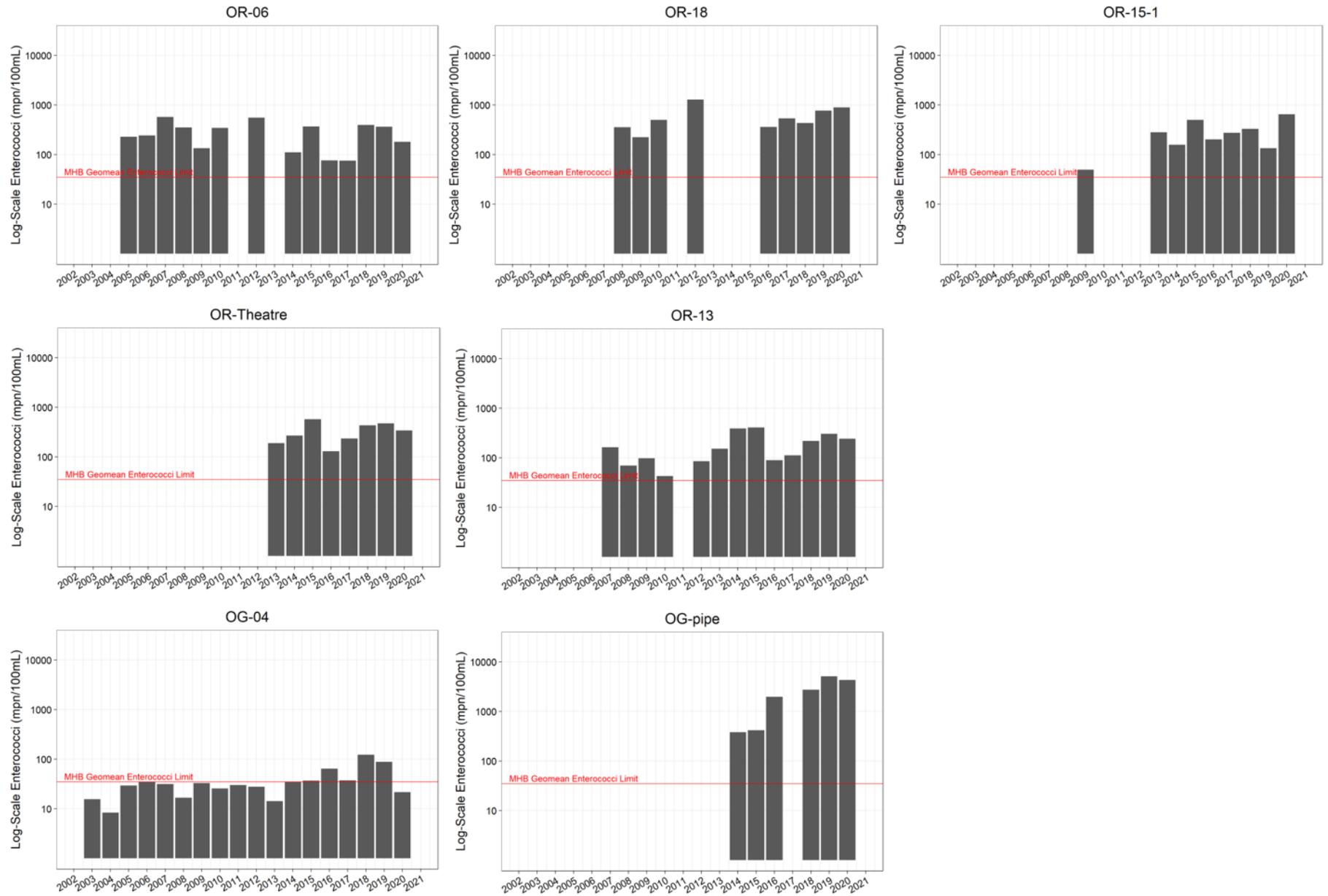


FIGURE 4. Annual Enterococci geomean from 2003-2020 for seven sites in the Ogunquit River watershed. The red line represents the Maine Healthy Beaches geomean threshold of 35 mpn/100mL.

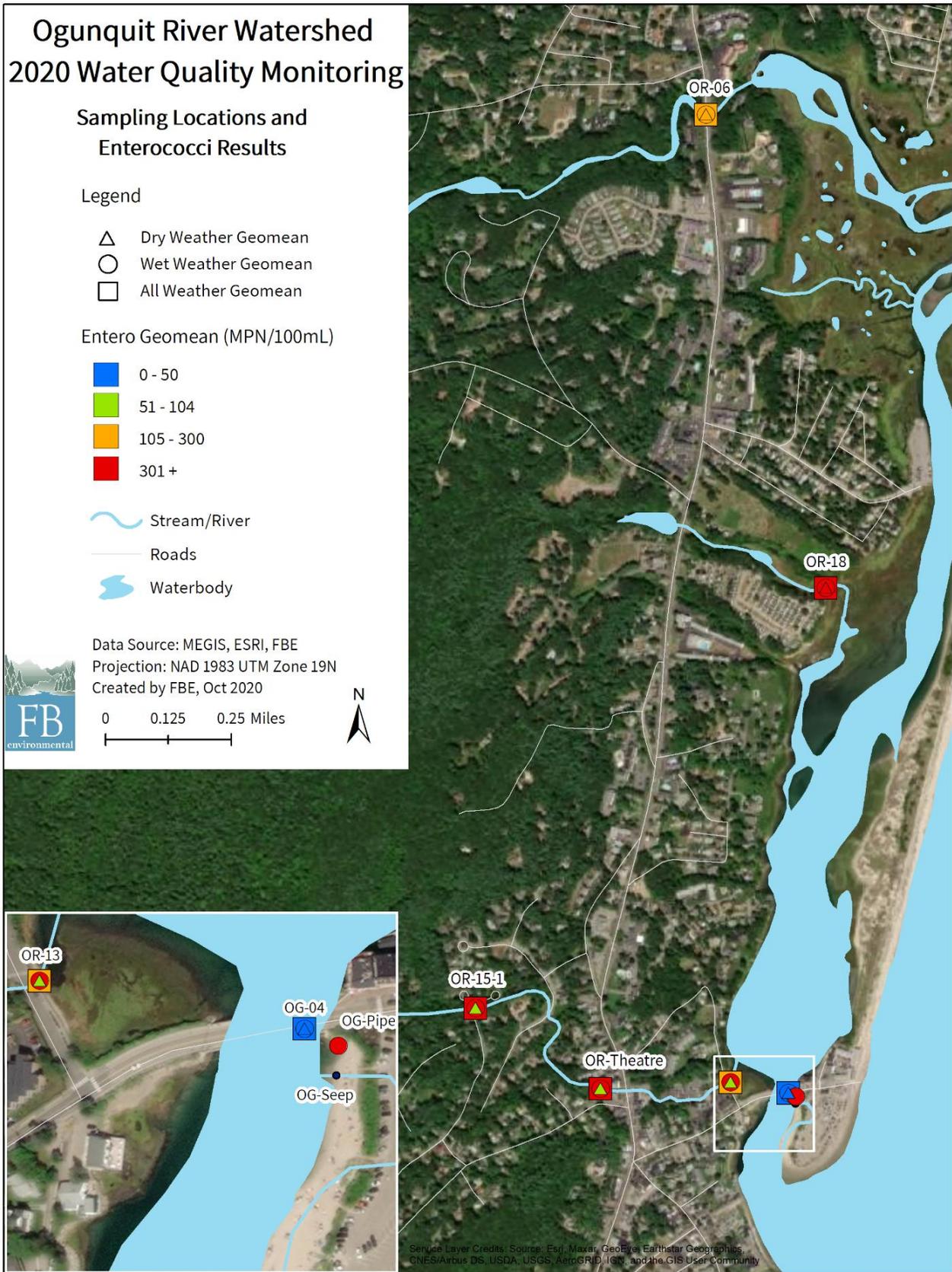


FIGURE 5. Ogunquit River watershed monitoring results for 2020. For each sampling site, overlaid symbols show Enterococci counts as the geomean of dry weather samples (triangles), wet weather samples (circles), and all (wet and dry) samples (squares). Note: OG-Pipe was only sampled during one wet weather sampling event.

TARGETED FECAL SOURCE TRACKING

SITE SELECTION

In previous years, intensive sampling along the unnamed tributary north of Littlefield Village showed that fecal contamination increases moving downstream along the reach, suggesting that contamination at **OR-18** is not caused by sources upstream of Route 1. Along the southern edge of the tributary lies Littlefield Village, which is serviced by sewer that conveys wastewater to the Ogunquit Sewer District facility. Generally, the risk associated with sewer infrastructure is that wastewater may leak from pipes, pump stations, etc. due to undersized infrastructure, blockages, or excessive infiltration of groundwater or rainwater into pipes, exceeding system capacity. The Great Works Regional Land Trust facility is located north of the unnamed tributary and is serviced by an on-site wastewater disposal system (septic system). In general, the risk associated with septic systems is malfunction due to improper maintenance, leach field erosion, or excessively wet conditions. Inspection and maintenance by a qualified professional can prevent any such problems. In spring 2020, Great Works Regional Land Trust communicated to FBE that their records show proper maintenance and inspection has been carried out over the lifetime of the current system.

METHODS

Groundwater sampling was conducted along the unnamed tributary between surface water sites OR-18 (downstream) and OR-18-1 (Figure 6). On 10/1/2020, following a rain event (0.57 inches in <24 hours), FBE personnel collected 12 groundwater samples along the streambank or marsh fringe and 3 surface water samples. Sampling locations were the same as 2019 except for OR-GW-03-1 which was added when groundwater could not successfully be extracted from OR-GW-12. Samples were analyzed for Enterococci, ammonia, nitrate-nitrite, orthophosphate, and optical brighteners (except for OR-GW-03-1, which was analyzed for Enterococci only). These additional parameters are commonly used as indicators of wastewater contamination, and when found co-occurring with elevated Enterococci counts can indicate a possible wastewater source. Surface water sampling followed methods previously mentioned for the annual baseline water quality monitoring. Groundwater samples were extracted 1-2 feet below the marsh surface using a 36-inch MHE PushPoint ¼” diameter field investigation sampler, equipped with syringe assembly. The syringe and sampler were each rinsed three times with distilled water after each site.



Sampling equipment used for groundwater extraction.

Optical brighteners are fluorescent whitening agents found in many soaps, detergents, and other personal care products, and their detection can be used as an indicator of the presence of wastewater. A fluorometer was used to detect the presence or absence of optical brighteners in each sample at the end of the sampling day. This procedure first measures the amount of light emitted from a water sample. Each sample was run in triplicates to ensure accurate results. After the initial fluorometer reading, if elevated, the samples are incubated under a UV light and then read again using the fluorometer. The measurement recorded shows the amount of emitted light which degraded as a result of the UV light incubation because optical brighteners rapidly degrade under these conditions. If there was an intermediate level of decrease (between the definitive thresholds for “presence” or “absence” of optical brighteners) in the fluorescence of the sample, then the samples are placed under the UV light again for a second incubation.

RESULTS

South Side

Of the nine groundwater sites tested on the south side of the tributary, one location, **OR-GW-08**, showed elevated Enterococci (3,610 mpn/100mL) and nitrate-nitrite (0.159 mg N/L). Two other sites also showed elevated nitrate-nitrite (≥ 0.1 mg N/L), with one high value of more than 1.2 mg N/L at **OR-GW-07**. Elevated ammonia results (≥ 0.5 ppm) were widely distributed at five sites along the southern bank (see Appendix A, Table A3 for all targeted fecal source tracking results). No optical brighteners were detected.

North Side

Two of three testing sites on the north side resulted in elevated Enterococci counts: **OR-GW-01** (1,970 mpn/100 mL) and **OR-GW-03-01** (5,340 mpn/100 mL). OR-GW-01 also showed elevated ammonia (1 ppm). No optical brighteners were detected.

Surface Water

OR-18, the surface water site at the outlet of the tributary and routinely sampled in the watershed monitoring program, showed elevated Enterococci levels at 1,110 mpn/100 mL, consistent with results from baseline water quality monitoring in 2020 and prior years. Upstream surface water samples (**OR-18-2** and **OR-18-1**) did not exceed fecal indicator bacteria thresholds, but other wastewater indicators were elevated. Nitrate-nitrite was elevated above background conditions at **OR-18-2** (0.118 mg N/L). **OR-18-1** had elevated ammonia (0.5 ppm) and nitrate-nitrite (0.113 mg N/L) and tested positive for optical brighteners, which confirms a greywater contamination source upstream.

Discussion

Groundwater on both sides of the tributary showed possible evidence of wastewater contamination, with elevated levels of Enterococci, ammonia, and nitrate-nitrite present at sites along both banks but no obvious spatial patterns were noted. Proximity to potential wastewater sources did not appear to explain any of the spatial variation in levels of fecal indicator bacteria and other indicators, as groundwater sites with high and low Enterococci counts were equally close to buildings and septic disposal fields. Location along the tributary (i.e., upstream vs. downstream) likewise appears not to be a factor in determining where elevated levels were found.

The type of potential wastewater source (septic vs. sewer) also appears not to have played a role in determining which indicators of wastewater contamination were found. The north side of the tributary is adjacent to a property served by septic, while the south side is adjacent to a sewer area, yet both sides of the tributary showed the presence of the same group of indicators. The septic system has been shown to be well maintained, but no smoke testing or systematic inspections of the sewer system to Littlefield Village has been done to our knowledge.

Comparing the targeted fecal source tracking efforts in 2019 and 2020, two areas showed persistently elevated indicator parameters: the south side around **OR-GW-07 to -09** and the north side around **OR-GW-03**. These two areas should be further screened for possible fecal contamination sources.

Unnamed Tributary Groundwater Sampling Results

Sampling Locations

Enterococci (mpn/100mL)

- 5 - 104
- 105 - 1000
- 1001 - 5340

Results below RL labeled as 1/2 RL.

OR-18, OR-18-1, and OR-18-2 are surface water samples, not groundwater samples.

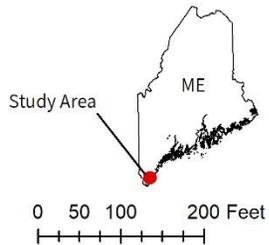


FIGURE 6. Unnamed tributary sampling results for fecal indicator bacteria (Enterococci) collected on 10/1/2020. Green circles mark sites where Enterococci results were below the instantaneous threshold of 104 mpn/100mL. Yellow and red circles indicate sites with results over the threshold. Sites OR-18, OR-18-1, and OR-18-2 are surface water samples, all other sites are groundwater samples.

CONCLUSIONS AND NEXT STEPS

Water quality monitoring in the Ogunquit River watershed continues to show fecal contamination in demonstrated hot spots across weather conditions, and especially during and immediately following rain events. These results suggest that primary sources are likely a combination of wildlife and dog waste (as demonstrated by DNA analyses in previous monitoring years) which are mobilized through stormwater. Combatting these stormwater sources of fecal waste requires a multi-pronged approach of education, outreach, investigation, and implementation of best management practices for stormwater control. In addition, fecal source tracking conducted in 2020 continued to provide valuable information to guide actions in reducing sources of contamination.

RECOMMENDATIONS

- Continue water quality monitoring and sampling for Enterococci at historical sampling sites to document long-term trends in the Ogunquit River watershed and to assess impacts of outreach and remediation efforts conducted under previous and current phases (I-III) of the Maine DEP/USEPA 319 Watershed Assistance Grant.
- Further investigate potential sources of fecal contamination along Leavitt Stream where fecal indicator bacteria are elevated throughout the summer sampling period. Additional source tracking methods are available.
- Considering two years of data showing presence of elevated Enterococci and secondary indicators of fecal contamination for groundwater samples along the Littlefield Village property, follow up with investigations of the sewer infrastructure in that area.
- Further investigate sources of secondary indicators present in upstream surface waters contributing to the unnamed tributary north of Littlefield Village.
- Continue to conduct outreach on river- and beach-friendly home practices to property owners adjacent to the river and its tributaries, especially the Leavitt Stream.
- Install pet waste signage in the Littlefield Village community and where appropriate throughout the Ogunquit River watershed.

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APPENDIX A: Additional Data Tables

TABLE A1. Enterococci (mpn/100mL) results for all sampling locations within the Ogunquit River watershed from July-October 2020. Sites are ordered from upstream to downstream. Red text indicates an exceedance of the Maine Healthy Beaches water quality threshold for Enterococci of 104 mpn/100mL for a single grab sample.

Site	Location	7/16/2020	8/5/2020	8/31/2020	9/24/2020	9/30/2020	10/1/2020
		Dry	Dry	Wet	Dry	Wet	Wet
OR-06	Main Stem	31	109	10	455	3,140	695
OR-18	Tributary to Main Stem	74	1,330	1,300	483	9,610	880
OR-15-1	Leavitt Stream	63	86	860	-	4,080	6,130
OR-Theatre	Leavitt Stream	20	620	359	52	10,100	695
OR-13	Leavitt Stream	63	132	108	85	7,920	327
OG-04	Main Stem	5	155	10	5	256	10
OG-Pipe	Stormwater Pipe to Main Stem	-	-	-	-	4,360	-
OG-Seep	Beach Seep to Main Stem	-	-	-	-	-	-

TABLE A2. Summary of 2020 average water quality data for sampling locations within the Ogunquit River watershed. Sites are ordered from upstream to downstream.

Site	Location	Water Temp (°C)	DO (ppm)	Salinity (ppt)	Spec. Cond. (µS/cm)	pH
OR-06	Main Stem	17.8	6.0	0.1	300	7.1
OR-18	Tributary to Main Stem	19.0	8.3	11.6	19,208	7.3
OR-15-1	Leavitt Stream	17.5	4.1	0.1	232	6.6
OR-Theatre	Leavitt Stream	16.3	5.1	0.2	326	7.0
OR-13	Leavitt Stream	18.1	7.0	5.4	9,379	6.9
OG-04	Main Stem	18.1	7.9	30.0	46,918	7.6
OG-Pipe	Stormwater Pipe to Main Stem	19.9	8.9	0.1	102	-
OG-Seep	Beach Seep to Main Stem	-	-	-	-	-

TABLE A3. Water quality results for targeted fecal source tracking samples collected on 10/1/2020 along the unnamed tributary north of Littlefield Village. Sites are organized by sample type (surface water and groundwater) and ordered upstream to downstream along the north side of the tributary and south side of the tributary (refer to Figure 6). Red text indicates an exceedance of the Maine Healthy Beaches water quality threshold for Enterococci of 104 mpn/100mL for a single grab sample. Values in yellow indicate measurements that are elevated. Water quality criteria do not exist for these parameters for this project, but 0.5 ppm NH₃ (ammonia) is used as an indicator for fecal contamination by the EPA Illicit Discharge Detection and Elimination program, and 0.1 ppm NO₃+NO₂ (nitrate-nitrite) typically indicates background conditions and higher values suggest human-derived fecal sources. PO₄ = orthophosphate. The presence of optical brighteners confirms greywater contamination.

Sample Type	Orientation to Tributary	Site ID	Enterococci (mpn/100mL)	NH ₃ (mg N/L)	NO ₃ +NO ₂ (mg N/L)	PO ₄ (µg P/L)	Optical Brighteners
Surface Water	North	OR-18-2	74	0.25	0.118	14	Negative
	South	OR-18-1	52	0.50	0.113	3	Positive
		OR-18	1,110	1.00	0.130	17	Negative
Groundwater	North	OR-GW-03-1	5,340	-	-	-	-
		OR-GW-03	10	0.25	0.036	30	Negative
		OR-GW-01	1,970	1.00	0.030	27	Negative
	South	OR-GW-11	94	1.00	0.009	8	Negative
		OR-GW-10	41	0.50	0.035	29	Negative
		OR-GW-09	10	1.00	0.102	12	Negative
		OR-GW-08	3,610	0.25	0.159	10	Negative
		OR-GW-07	5	0.25	1.207	6	Negative
		OR-GW-06	20	0.25	0.029	76	Negative
		OR-GW-05	10	1.00	0.003	17	Negative
		OR-GW-04	10	0.25	0.064	9	Negative
OR-GW-02	5	0.50	0.009	45	Negative		

APPENDIX B: QAPP QA/QC Protocol Review

Fecal indicator bacteria samples were collected in 2020 by FBE staff and analyzed by Nelson Analytical Laboratory in accordance with the specific Standard Operating Procedures (SOPs) outlined in the Ogunquit River Watershed-Scale Bacteria Monitoring Quality Assurance Project Plan (QAPP), with any deviations described below (FBE, 2020b). These deviations were minor and did not impact the quality of results.

QUALITY OBJECTIVES AND CRITERIA

Precision and Accuracy/Bias:

Field duplicates for bacteria should attempt to yield a relative percent difference (RPD) of <20%; 4 out of 6 duplicate samples resulted in RPD >20% (Table B1). RPD >20% can be deemed acceptable given the inherent variability of collecting and measuring biological communities. Typically, higher bacteria counts will be less variable than lower bacteria counts of <200 mpn/100mL. As such, 2020 RPDs ranging from 0-62% were acceptable and reflect a consistent field sampling procedure by personnel. One elevated RPD (54%) for high bacteria counts measured at OR-15-1 was flagged but was accepted assuming environmental factors may have changed the fecal count within the parcel of sampled water coming downstream due to the high variability of sources activated during wet weather. Discussions with field personnel immediately following sample collection determined that there were no concerns for sampler-caused contamination.

Laboratory duplicates should also attempt to yield an RPD <20%. In 2020, Nelson Analytical conducted laboratory duplicates once per batch but not once per customer batch. No laboratory duplicate data were provided but discussions with the laboratory manager ensured that all batches met data quality objectives.

TABLE B1. Summary of relative percent difference (RPD) between duplicate field samples. One duplicate field sample was taken on each of the six sampling dates.

Date	Wet/Dry	Sample ID	Enterococci (mpn/100mL)	RPD
7/16/2020	Dry	OR-18	74	0%
		OR-18 Duplicate	74	
8/5/2020	Dry	OG-04	155	22%
		OG-04 Duplicate	121	
8/31/2020	Wet	OR-13	108	62%
		OR-13 Duplicate	41	
9/24/2020	Dry	OR-Theatre	52	44%
		OR-Theatre Duplicate	75	
9/30/2020	Wet	OR-15-1	4080	54%
		OR-15-1 Duplicate	6290	
10/1/2020	Wet	OR-06	695	6%
		OR-06 Duplicate	738	

Data Completeness:

Low-flow conditions prevented collection of grab samples during some sample events. A sample was only collected at OG-Pipe on one sampling day (9/30/2020); on all other sampling days, the site was observed to have no flow. No sample was collected at OR-15-1 on 9/24/2020 due to no flow conditions. Low flow conditions impeded proper YSI ProSolo meter readings at OR-18 on 7/16/2020 and at OR-18 and OR-Theatre on 8/5/2020. The QAPP data completeness guideline of >90% of proposed data was met.

DOCUMENTS AND RECORDS

All COC forms were complete. Written field sheets were not completed. FBE used tablets with Fulcrum field forms to complete in the field.

SAMPLING PROCESS DESIGN

Fecal indicator bacteria samples were collected from tidal sites (OG-04, OR-13, and OR-18) within a window of ±2 hours around dead low tide (Table B2). All samples were delivered to the laboratory well within the 6-hour holding time limit (Table B2).

TABLE B2. Summary of QAPP protocol results for 2020 fecal indicator bacteria sampling.

Date	Precip 24 hrs prior (in)	Precip 48 hrs prior (in)	Precip 96 hrs prior (in)	Time of First Sample	Time of First Tidal Sample	Time of Last Tidal Sample	Time of Low Tide	Time Delivered to Lab	Temp Received (°C)
7/16/2020	0.00	0.06	0.14	13:23	13:23	14:16	14:33	15:49	16.0
8/5/2020	0.00	0.06	0.06	7:17	7:17	8:05	7:14	9:36	14.7
8/31/2020	0.00	0.64	0.64	14:45	15:45	16:36	16:50	17:00	13.8
9/24/2020	0.00	0.00	0.00	9:25	10:30	11:13	11:32	11:48	11.0
9/30/2020	0.57	0.57	0.60	6:03	6:03	6:40	5:04	8:36	13.8
10/1/2020	0.00	0.57	0.60	14:55	16:00	16:26	17:57	16:49	14.9

Date	Time Diff. First Sample	Time Diff. Last Sample	Time Diff. to Lab
7/16/2020	1:10	0:17	2:26
8/5/2020	0:03	0:51	2:19
8/31/2020	1:05	0:14	2:15
9/24/2020	1:02	0:19	2:23
9/30/2020	0:59	1:36	2:33
10/1/2020	1:57	1:31	1:54

SAMPLE HANDLING AND CUSTODY PROCEDURES

Samples should be delivered to the lab at or below 10°C to reduce any potential growth of bacterial communities within the sample after collection. All samples were delivered above 10°C but samples were deemed acceptable because they had decreased greatly in temperature from the initial time of collection (Table B2).

QUALITY CONTROL REQUIREMENTS

One field duplicate sample should be collected for every 10 samples. Out of a total of 42 samples over six sampling dates, 6 field duplicate samples were collected.

NON-DIRECT MEASUREMENTS / DATA ACQUISITION REQUIREMENTS

In 2020, all weather data (daily temperature and precipitation) were obtained from the Ogunquit Sewer District’s weather station, located on the roof of the process building. These data were compared to sources identified in the 2020 QAPP, Weather Underground, but were deemed to be more precise because several rain events were locally isolated and therefore chosen for use in this report.