OGUNQUIT RIVER WATERSHED

2016 WATER QUALITY MONITORING REPORT

APRIL 2017

PREPARED FOR:
Town of Ogunquit
23 School Street
Ogunquit, ME 03907

PREPARED BY:
FB Environmental Associates
170 West Road, Suite 6
Portsmouth, NH 03801

2016 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 2016, an intense monitoring program was conducted throughout the Ogunquit River watershed. These efforts included:

FBE Scientist Carly Ellis investigating the freshwater section of the Ogunquit River.

- Monitoring 12 locations (some previously identified as "hotspots" of fecal contamination) for fecal indicator bacteria from May through November.
- Collecting samples for a subset of dates and sites to test for specific sources of fecal contamination (e.g., humans, dogs, and gulls) using mitochondrial DNA analyses.
- Investigating the freshwater section of the Ogunquit River (west of Route 1 from OR-06) to identify potential upstream sources of fecal contamination.

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 throughout the watershed, as all sites exceeded the State water quality criteria, whether for geomean or single sample or both.**
- **Two sites (north of Littlefield's Village and the Village Highlands neighborhood) showed high bacteria** during both wet weather (stormwater and/or groundwater sources) and dry weather (groundwater sources likely from septic or sewer).
- **Sites located along the downstream portion of Leavitt Stream showed high bacteria counts** during wet weather across all seasons.
- **Hotspots of bacteria in the freshwater section of the Ogunquit River were found in the more densely populated area of the watershed (i.e., closer to Route 1).**
- DNA analyses indicate that **dog waste is a consistent contributor to fecal contamination** in Leavitt Stream (a tributary to the Ogunquit River), both at the outlet and slightly upstream at a site behind the Leavitt Theater.
- DNA analyses also indicate that **bird waste is a widespread contributor** to fecal contamination.

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BACKGROUND

The Ogunquit River estuary (Class SB) is listed in the Maine Department of Environmental Protection (MEDEP)'s Draft 2014 Integrated Water Quality Monitoring and Assessment Report (MEDEP, 2014) as impaired under Category 5-B-1: Estuarine and Marine Waters Impaired for Bacteria Only (fecal pollutants) – TMDL Required. 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. Thus, the Ogunquit River is also listed on the MEDEP Nonpoint Source Priority Watersheds List of Impaired Marine Waters and Threatened Streams.

Investigative and monitoring work over the last 20 years have been conducted in the Ogunquit River watershed and at the beaches by many different groups, including Maine Healthy Beaches, the MEDEP, the Ogunquit Sewer District, the Ogunquit Conservation Commission, and FB Environmental Associates (FBE). Elevated fecal indicator bacteria (Enterococci) levels have been found throughout the watershed and at the beaches, with particularly high counts or "hotspots" found along Leavitt Stream, a tributary to the Ogunquit River (FBE, 2013). High bacteria counts led to 10 swimming advisories over the course of seven summers (2010-2016) at Ogunquit and Riverside Beaches.

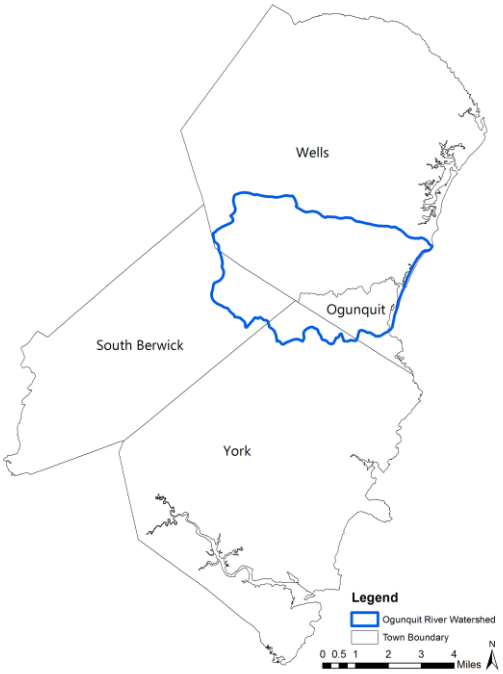
To minimize beach advisories and remediate impairments to the river, the Town of Ogunquit has collaborated with these groups to support an ongoing monitoring program. The goals of this monitoring program are to:

1) **Help identify and bracket sources of high bacteria levels in the Ogunquit River watershed.**

2) **Maintain a baseline of fecal indicator bacteria data for hotspot sites to assess trajectory of changes because of remediation efforts.**

In 2016, the Town of Ogunquit, the Ogunquit Conservation Commission, and FBE worked 1) to maintain the annual watershed monitoring program for tracking success of

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.

remediation work funded through a MEDEP/USEPA Section 319 Watershed Assistance Grant for Phase II (with approved QAPP; FBE, 2016) and 2) to expand monitoring efforts beyond baseline monitoring, which was funded through a Maine Coastal Communities Grant. The following report summarizes results from the 2016 monitoring program.

WATERSHED MONITORING

FBE conducted bacteria sampling at 12 sites throughout the Ogunquit River watershed on 14 days from May through November 2016 (Figure 1): two wet and two dry weather events in spring (May – June), three wet and three dry weather events in summer (July – September), and two wet and two dry weather events in fall (October – November)[1]. Sampling sites were selected from priority "hotspot" sites identified by 2012-2015 bacteria sampling and canine detection efforts (FBE, 2012, 2013, 2014, 2015), as well as sampling sites from Maine Healthy Beaches. A back-up site (OR-04) was sampled in 2016 when OG-pipe was not flowing; OG-pipe could only be sampled on two occasions. Sampling of tidal sites occurred within ± one hour of low tide. Bacteria collection was conducted in accordance with methods outlined in the QAPP (FBE, 2016). A more detailed discussion of QAPP deviations is discussed in Appendix B. Dissolved oxygen, temperature, and salinity data were also collected during sampling events at each location using an YSI ProODO meter and a refractometer.

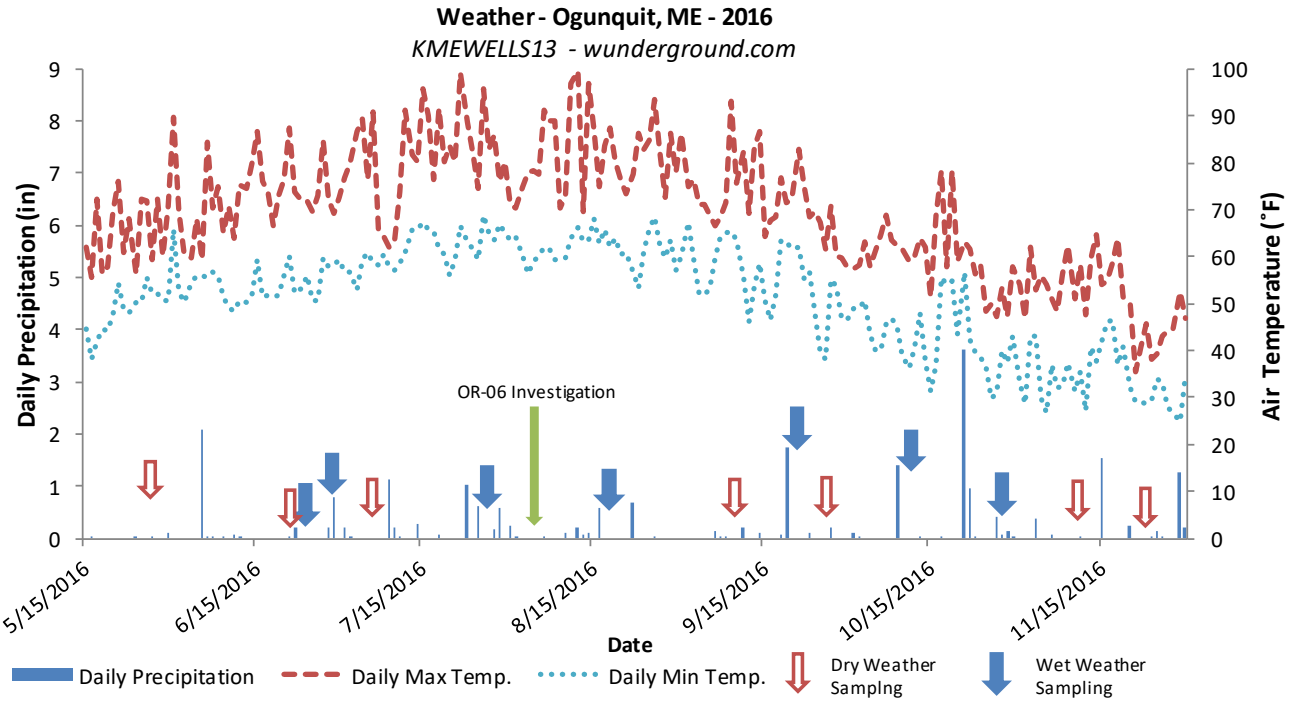


FIGURE 1. Daily high and low air temperature and precipitation data from May – November 2016 with sampling dates indicated by arrows. Data was retrieved from Weather Underground for Ogunquit, ME (KMEWELLS13).

[1] Conditions were considered "wet" if the area experienced >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, although larger precipitation events were sampled when possible. Dry weather conditions were those times that precipitation was less than 0.1" for each day over 72 hours.

All bacteria samples were analyzed for Enterococci at Nelson Analytical Laboratory in Kennebunk, Maine. Enterococci are used as an indicator of the presence of fecal material in brackish/marine waters by Maine Healthy Beaches. In Maine, the State water quality criteria for Enterococci is 104 mpn/100mL for a single grab sample and 35 mpn/100mL for the geometric mean of multiple samples[2]. Though the Ogunquit River is freshwater west of Route 1, the brackish/marine water quality criteria were used to assess the impact of the Ogunquit River on beach advisories in Ogunquit.

DID YOU KNOW?

High bacteria counts during dry weather events indicate that fecal contamination is likely from groundwater sources (e.g., malfunctioning septic systems or leaky sewer pipes). High bacteria counts during wet weather events indicate that fecal contamination is likely 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 leachfields.

RESULTS

- Fecal contamination was evident throughout the watershed, as all sites exceeded the State water quality criteria, whether for geomean or single sample or both (Figure 2, Table 1). See Appendix A, Table A1 for full results.
- Due to drought conditions throughout southern Maine in 2016, several sites could not be sampled during the summer months (OR-Jothams and OR-MeadowLn). **OG-pipe** could only be sampled on two wet weather events, but bacteria counts exceeded 1,000 mpn/100mL on both occasions (Table 1). These high counts could be from regrowth or other sources aside from human, dog, or bird.
- Two sites showed consistently high bacteria during both wet and dry weather events.
  - → **OR-18** (north of Littlefield's Village)
  - → **OR-15-1** (Village Highlands neighborhood)
- Other sites located along the downstream portion of Leavitt Stream (**OR-15**, **OR-16**, **OR-Theater**, and **OR-13**) also showed high bacteria counts during wet weather in all seasons (except OR-13 in fall).
- In fall, bacteria counts dropped during dry weather, but continued to be high during wet weather across all sites.

TOP, site OG-pipe. BOTTOM, site OR-18.

[2] mpn = most probable number of viable organisms

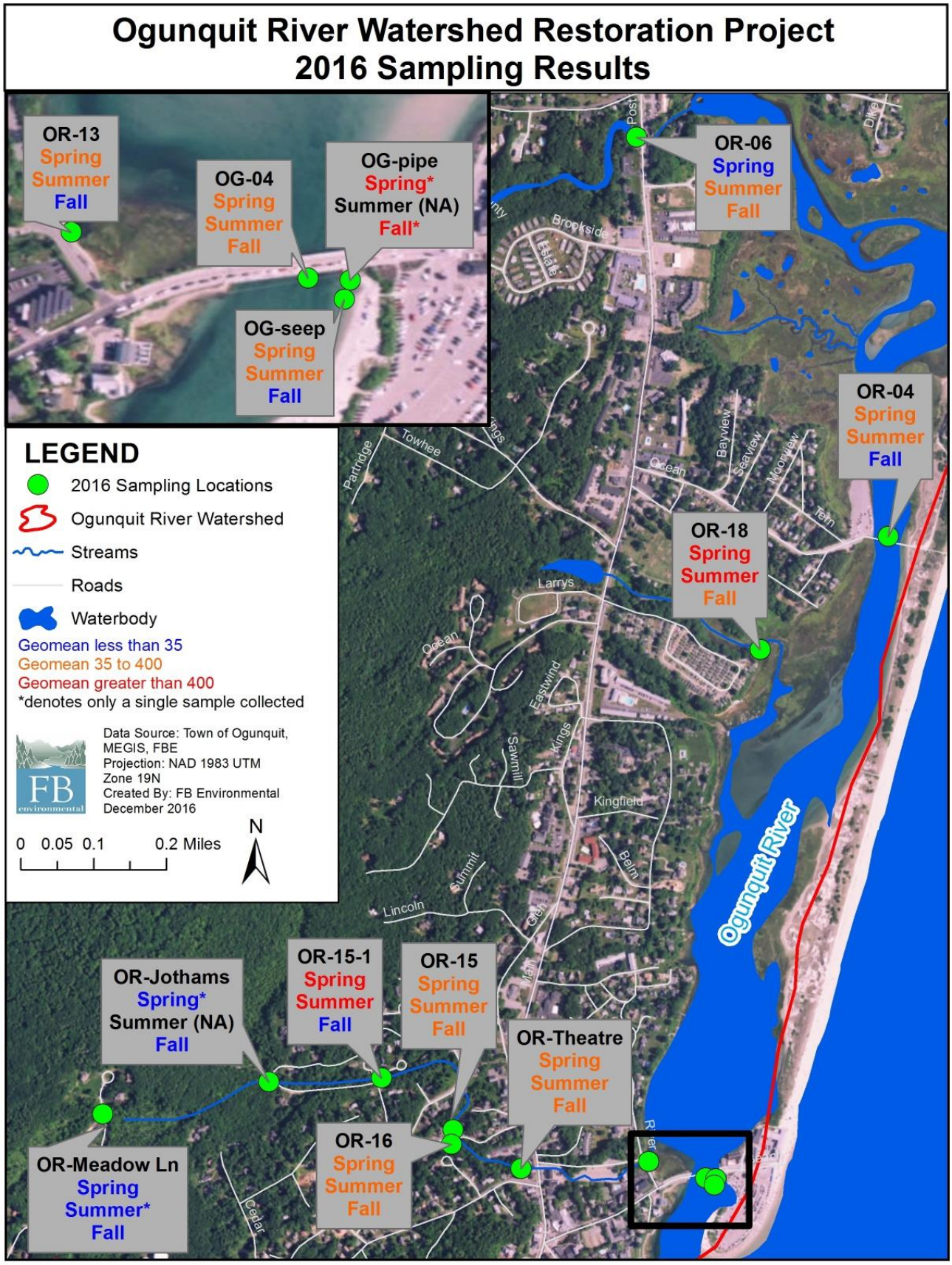


FIGURE 2. Ogunquit River monitoring results for 2016. Callout boxes indicate whether the geometric mean (geomean) for each season meets or exceeds the EPA criterion of 35 mpn/100 mL for Enterococci.

TABLE 1. Enterococci (mpn/100mL) results for sampling locations within the Ogunquit River watershed in 2016. For individual samples <10 mpn/100mL, a value of 5 mpn/100mL (half the detectable limit) was used in calculating the geometric mean. Sites are ordered from upstream to downstream. See Appendix A, Table A1 for full results.

		Spring			Summer			Fall		
Site	Location	All	Dry	Wet	All	Dry	Wet	All	Dry	Wet
OR-06	Main Stem	34	19	58	125	54	291	91	10	823
OR-04	Main Stem	113	183	70	102	19	559	29	10	87
OR-18	Tributary to Main St.	460	420	504	410	132	1,273	238	20	2,803
OR-MeadowLn	Leavitt Stream	26	14	49	52*	--	52*	15	<10	122
OR-Jothams	Leavitt Stream	<10*	<10*	--	--	--	--	23	<10	473*
OR-15-1	Leavitt Stream	419	261	671	447	170	1,176	30	<10	177
OR-15	Leavitt Stream	87	69	109	385	254	584	83	10	686
OR-16	Tributary to Leav.Str.	46	12	169	249	80	769	106	10	1,122
OR-Theater	Leavitt Stream	101	47	219	228	99	525	71	<10	996
OR-13	Leavitt Stream	125	62	250	199	45	871	19	<10	76
OG-04	Main Stem	79	136	46	76	15	375	40	20	79
OG-pipe	Riverside Beach	1,660*	--	1,660*	--	--	--	2,380*	--	2,380*
OG-seep	Riverside Beach	99	153	64	140	65	299	<10	<10	<10

Gray cells indicate an exceedance of MEDEP water quality criteria for Enterococci; 104 mpn/100mL for single sample and 35 mpn/100mL for geomean.

**result is for a single sampling event*

- Water temperatures dropped off significantly during fall sampling, when most sites averaged less than 10 °C (Appendix A, Table A2). Two sites experienced persistent low dissolved oxygen (**OR-15-1** and **OR-MeadowLn**), likely due to low flow conditions. OR-Jothams could only be sampled a few times during the season and notable amounts of algae and aquatic plants covered the rocks at this site throughout the season.

Algae and aquatic plants at OR-Jothams.

DNA SOURCE TRACKING

To supplement traditional bacteria source tracking methods, mitochondrial DNA analyses were performed on samples from eight sites on six occasions: one wet weather and one dry weather event in each of the three seasons. DNA analysis allows for identification of potential source species (e.g., human, dog, or wildlife) of fecal contamination. Samples were tested for human, dog, and bird DNA biomarkers by John Bucci at the University of New Hampshire Fecal DNA Analysis Laboratory.

RESULTS

- DNA from all three of the target species (humans, dogs, and birds) were detected at least once throughout the course of the sampling season (Table 2; Figure 3).
- At **OR-15** (upstream section of Leavitt Stream), **OR-13** (outlet of Leavitt Stream near the Lower Parking Lot), and **OR-Theater** (Leavitt Stream behind the Leavitt Theater), dog DNA was detected in both wet and dry weather in 2016. DNA analysis from 2014 also detected dog DNA at both OR-13 and OR-15, indicating that dog waste is a persistent problem along Leavitt Stream (Table 2).
- Dog waste is a newly-detected source at **OG-pipe**, which was thought to be impacted primarily from seagull waste from the Main Beach parking lot.
- Bird DNA was detected most frequently throughout the watershed (18 instances), in both wet and dry weather. Dog DNA was detected in 13 instances.
- Human DNA was only detected at one site (**OR-Jothams**) during dry weather in spring.
- High bacteria counts measured at **OR-15-1** may be mostly attributed to wildlife.

TABLE 2. Source species detected by mitochondrial DNA analyses and canine detection (human fecal contamination only) from 2012-2016. Sites are ordered from upstream to downstream. Symbols indicate the source species detected: human, dog, or bird. Dashed lines indicate the site was not tested for any indicators (DNA or canine detection) on that date. A red "x" indicates no source species were detected.

				2016 DNA Analyses					
Site	Location	2012-13 Canine Detection Results	2014 DNA Analyses	5/26/2016	6/28/2016	9/9/2016	8/17/2016	11/8/2016	10/28/2016
				Dry	Wet	Dry	Wet	Dry	Wet
OR-04	Main Stem	--	--	🐕	x	x	🐦	🐦	--
OR-18	Trib. To Main Stem	--	--	--	--	--	--	x	--
OR-MeadowLn	Leavitt Stream	--	--	x	x	--	--	🐦	x
OR-Jothams	Leavitt Stream	--	--	🧍	--	--	--	x	x
OR-15-1	Leavitt Stream	x	--	🐦	🐦	🐕🐦	🐦	x	x
OR-15	Leavitt Stream	🧍	🐕🧍	x	🐦	🐕🐦	🐕🐦	x	x
OR-16	Trib. To Leav.Str.	🧍	🐕	🐕	x	x	x	x	x
OR-Theater	Leavitt Stream	x	--	x	🐦	🐕🐦	🐕🐦	🐕	x
OR-13	Leavitt Stream	🧍	🐕	🐕🐦	🐕🐦	🐦	🐕🐦	🐕	x
OG-pipe	Riverside Beach	--	🐦🧍	--	🐕	--	--	--	🐦

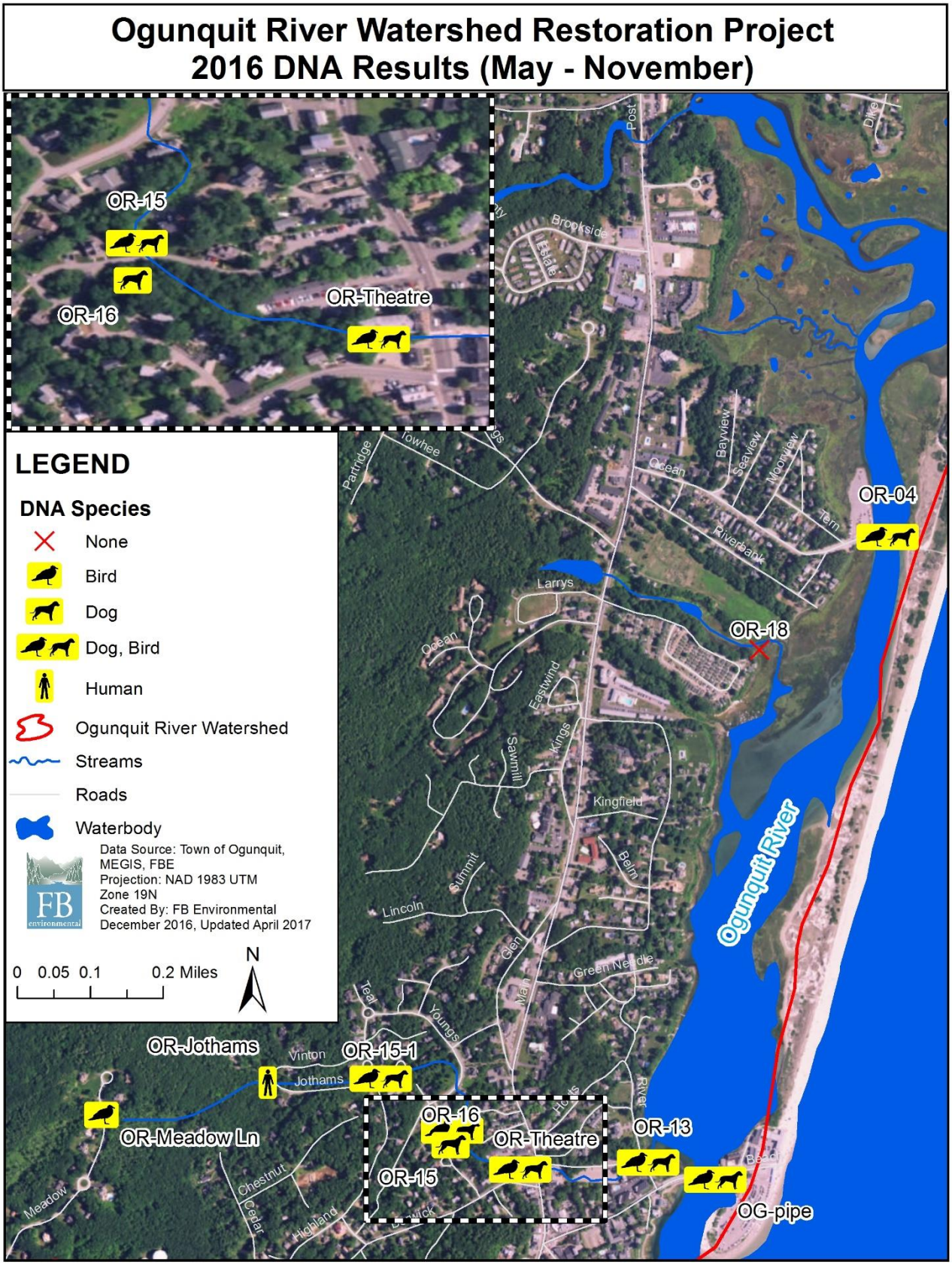


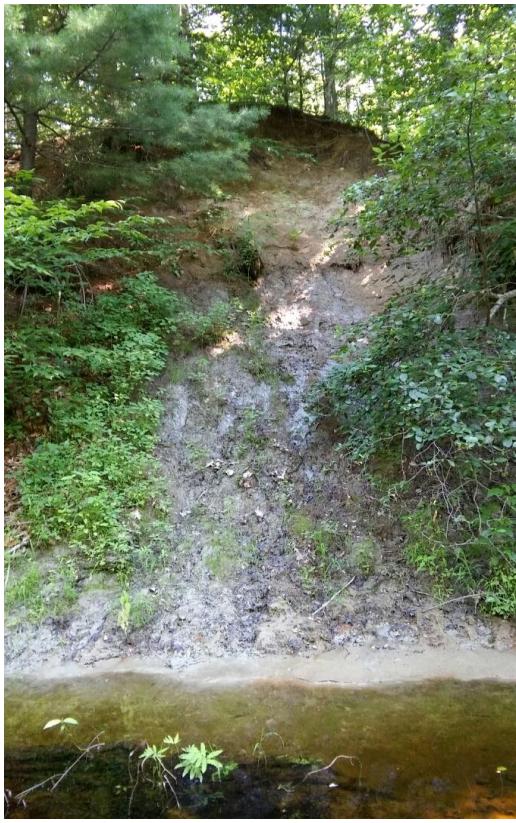
FIGURE 3. Results for species detected by mitochondrial DNA analysis in the Ogunquit River watershed. Species denoted in the map were detected at that site at least once from May through November 2016.

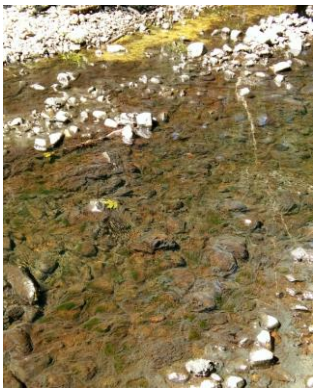
UPSTREAM INVESTIGATION

Much of the recent sampling in the Ogunquit River watershed has focused on areas closest to the estuary and within the Town of Ogunquit, but the watershed covers over 13,000 acres, most of which is in three other towns (Wells, South Berwick, and York). On August 4, 2016, FBE staff investigated the freshwater section of the Ogunquit River and its tributaries within the OR-06 subwatershed (west of Route 1). The investigation began behind the Towne Lyne Motel along Route 1 in Ogunquit and continued upstream on foot to the river's intersection with Captain Thomas Road in Ogunquit. Additional stream crossings throughout the subwatershed in Wells, South Berwick, and York were also sampled. The goal of this investigation was to identify potential sources of fecal contamination or other nonpoint source pollution, such as from homes close to the stream (potential for septic pollution), agricultural impacts, and areas of erosion.

RESULTS

- The investigation identified 26 sites, 9 of which were previously-established sites and 22 of which were sampled for bacteria (Figure 4, Table 3).
- Four sites exceeded the 104 mpn/100mL single-sample criterion (Table 3), two of which were far above the single-sample criterion:
  - → **ORINV-07** (water sluice likely transporting water from a landscaped pond on a hill above the Ogunquit River)
  - → **OR-10** (tributary west of I-95)
- Two areas of erosion were noted:
  - → **ORINV-02** (groundwater seep and landslide)
  - → **OR-06-2** (just upstream from Town Lyne Motel)
- In the first ~0.5 miles, thick brown and green algae were observed at many sites along the river, such as at OR-06-2. Homes are close to the river in some areas and may be a source of excess nutrients and fecal contamination.





TOP, ORINV-2 groundwater seep and erosion. BOTTOM LEFT, thick algae growing on rocks (OR-06-2). BOTTOM RIGHT, ponded area of the river with green algae (upstream of ORINV-03).

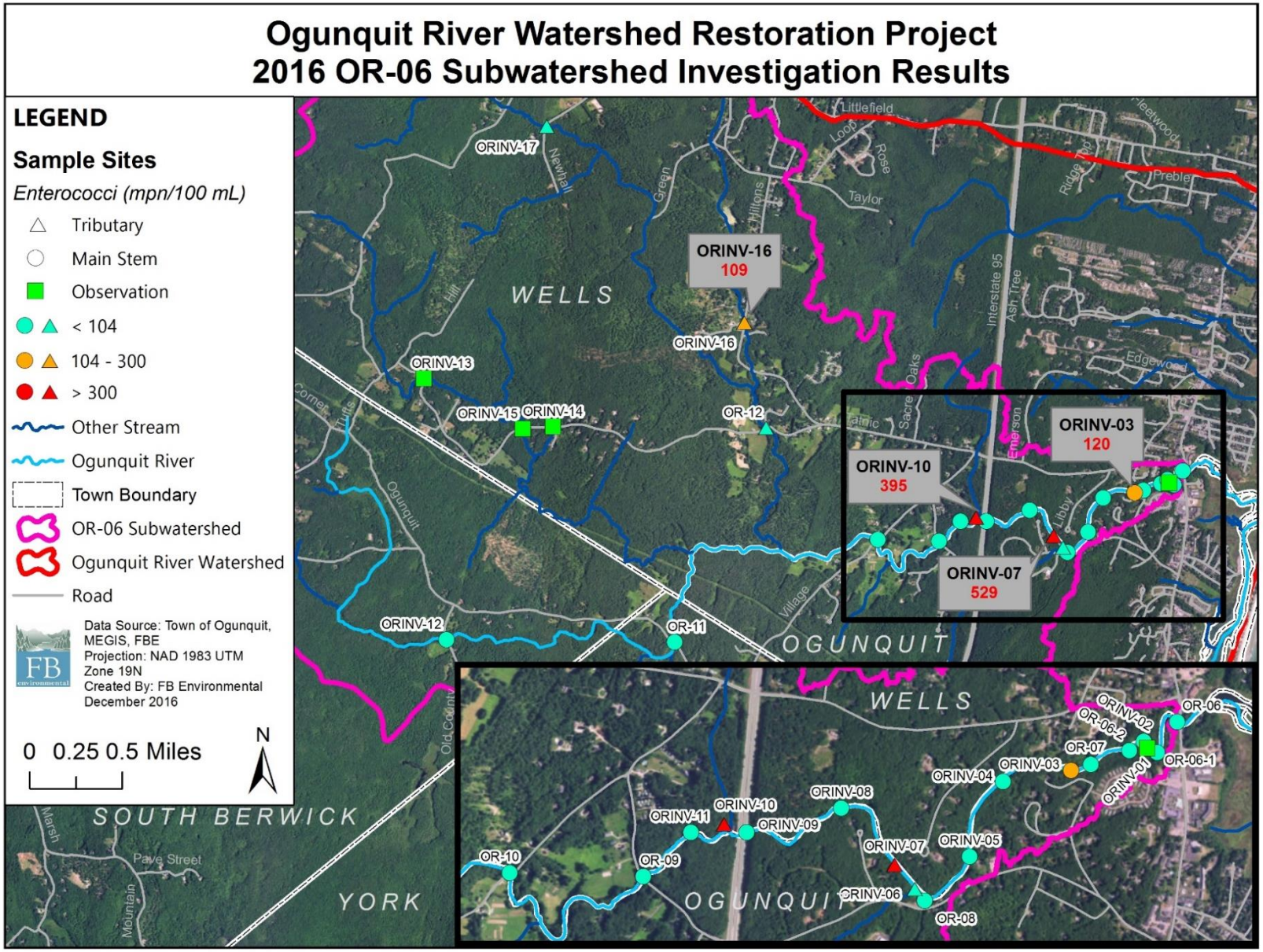


FIGURE 4. Map of OR-06 investigation results. Callout boxes highlight sites that exceeded the single-sample Enterococci criterion. Note: the Ogunquit-Wells border follows the Ogunquit River.

TABLE 3. Results for 26 sites identified during the 2016 OR-06 subwatershed investigation. Historical geomeans are presented if data were available. Sites are ordered from upstream to downstream.

		Historical (2005-2015)					
Site	Town	Enterococci Geomean (mpn/100mL)	Min	Max	Total # Historical Samples	2016 Enterococci (mpn/100mL)	Notes from 2016
ORINV-12	South Berwick					52	Algae-covered pond, large field upstream of this location.
OR-11	Yok	62	10	1,723	11	41	Two culverts at this road crossing.
ORINV-13	Wells					--	Observation only (no flow at road crossing), pond upstream probably low.
ORINV-15	Wells					--	Observation only (no flow), upstream of large horse farm.
ORINV-14	Wells					--	Observation only (no flow), ditch culvert.
ORINV-17	Wells					20	Heavily wooded area.
ORINV-16	Wells					109	Ditchwork being completed nearby.
OR-12	Wells	171	20	2,224	11	20	
OR-10	Ogunquit/Wells	118	10	1,904	14	31	Birds in this area.
OR-09	Ogunquit/Wells	94	10	1,515	12	41	Spotty green algae in the stream.
ORINV-11	Ogunquit/Wells					10	Downstream of campground.
ORINV-10	Wells					395	Tributary from the west side of I-95.
ORINV-09	Ogunquit/Wells					52	Downstream of I-95 crossing
ORINV-08	Ogunquit/Wells					10	Lots of green algae, shaded area.
ORINV-07	Ogunquit					529	Discharge from a sluice into the river, likely from a man-made landscaping pond above.
ORINV-06	Ogunquit					10	Natural oil sheen, small tributary to the river.
OR-08	Ogunquit/Wells	52	<10	2,981	11	<10	Brown water, natural oil sheen.
ORINV-05	Ogunquit/Wells					10	Home close to the river here.
ORINV-04	Ogunquit/Wells					20	Slow moving, pungent water.
ORINV-03	Ogunquit/Wells					120	Convergence of two branches around an island, lots of green algae on the northern branch (Wells' side), northern branch also has minimal buffer to adjacent homes.
OR-07	Ogunquit/Wells	57	<10	1,674	23	31	Brown water.
OR-06-2	Ogunquit/Wells	89	31	253	2	20	Green algae on stream bottom, japanese knotweed present, banks severely eroding.
ORINV-02	Ogunquit/Wells					52	Groundwater seep on eroding bank (Wells side) above sampling site, many deer and racoon prints in the muck.
ORINV-01	Ogunquit/Wells					--	Observation only, very close to ORINV-02. Natural oil sheen and some trash. Trash.
OR-06-1	Ogunquit/Wells	56	20	155	2	41	Brown algae on stream bottom.
OR-06	Ogunquit/Wells	282	31	7,270	52	52	Some foam on surface.

Gray cells indicate an exceedance of ME DEP water quality criterion for Enterococci; 104 mpn/100mL for single sample and 35 mpn/100mL for geomean.

CONCLUSIONS AND NEXT STEPS

Ogunquit River watershed monitoring in 2016 demonstrated that fecal contamination is persistent in the known "hotspot" areas, particularly during wet weather across all seasons. This suggests that stormwater sources, likely from a combination of wildlife and dog waste (as demonstrated by DNA analyses), may be the dominant source of fecal contamination to the Ogunquit River. Of concern is the Leavitt Stream subwatershed from OR-15-1 to the outlet at OR-13 (covering the Village Highlands neighborhood), as well as OR-18 (Littlefield's Village area), though bacteria were not from human, bird, or dog DNA. It is important to note that 2016 was an extremely dry summer, which restricted the mobilization of bacteria sources from the landscape to waterways. This may explain why human biomarkers were not found at many sites that had historically tested positive for human fecal waste.

RECOMMENDATIONS

- Continue to monitor bacteria levels annually within the Ogunquit River watershed.
- Develop a 'scoop the poop' outreach campaign with a focus on the Leavitt Stream subwatershed and the Main Beach area (draining to OG-pipe). DNA analyses and comments from residents indicate that dog waste is a problem in these areas.
  - → Install pet waste signs noting local fines for improper disposal.
  - → Distribute materials describing the connection between pet waste and water quality to newly-registered dog owners.

    Note: These outreach initiatives are currently being pursued under Phase II of a Section 319 Watershed Assistance Grant from the MEDEP and USEPA.
- Distribute information on proper septic system maintenance for property owners in the Leavitt Stream subwatershed, particularly around OR-Jothams, which may be impacted by a single malfunctioning septic system upstream. Although 2016 DNA analyses did not show human fecal waste as a problem in the watershed, dry summer conditions may have restricted mobilization of deeper groundwater sources where human fecal contamination is more prevalent. Historical DNA analyses have shown human fecal contamination at many sites, particularly in the Leavitt Stream subwatershed.
- Install a stormwater best management practice (BMP) that filters out bacteria and their associated pathogens from stormwater flow through the catchbasins or pipes leading to OG-pipe outlet.

  Note: This is currently being pursued under Phase II of a Section 319 Watershed Assistance Grant from the MEDEP and USEPA.
- Continue to monitor OR-13 for bacteria. A major stormwater best management practice (BMP) is being installed at the Lower Parking Lot as of December 2016 (under Phase I of a Section 319

Watershed Assistance Grant from the MEDEP and USEPA). Monitoring at OR-13 will help determine if the BMP is successful in reducing fecal contamination at this site.

- Resample historical sites above and below Robbie's Pond, which drains to OR-18, a rediscovered hotspot of fecal contamination to the Ogunquit River.
- Investigate the source of thick algae growing above OR-06 and around OR-Jothams by testing for phosphorus (typically the limiting nutrient to growth in freshwater systems) and nitrogen.
- Further investigate potential sources to ORINV-07 and OR-10, which both showed high counts during the dry weather OR-06 subwatershed investigation.
- Provide outreach on river-friendly home practices to property owners adjacent to the river (in both Wells and Ogunquit).

APPENDIX A: Additional Data Tables

TABLE A1. Enterococci (mpn/100mL) results for all sampling locations within the Ogunquit River watershed from May-November 2016. Sites are ordered from upstream to downstream.

	SPRING				SUMMER						FALL			
	5/26/2016	6/22/2016	6/23/2016	6/28/2016	7/7/2016	7/26/2016	8/17/2016	9/9/2016	9/20/2016	9/26/2016	10/11/2016	10/28/2016	11/8/2016	11/22/2016
Site	Dry	Dry	Wet	Wet	Dry	Wet	Wet	Dry	Wet	Dry	Wet	Wet	Dry	Dry
OR-06	<10	74	20	171	94	63	563	41	697	41	2014	336	20	<10
OR-04	41	813	487	10	132	41	2909	10	1467	<10	10	754	10	10
OR-18	173	1019	414	613	934	528	2359	10	1658	246	1211	6490	10	41
OR-MeadowLn	10	20	20	121		52						122	<10	<10
OR-Jothams	<10											473	<10	<10
OR-15-1	52	1314	1043	432	183	299	2909	246	1872	109	30	1040	<10	<10
OR-15	30	158	121	98	414	231	677	3968	1274	10	86	5480	<10	20
OR-16	<10	31	74	388	216	448	762	241	1333	10	52	>24,200	20	<10
OR-Theater	109	20	63	759	20	197	631	336	1162	144	41	24200	<10	<10
OR-13	52	75	62	1010	63	288	2187	20	1050	74	10	576	<10	<10
OG-04	31	594	108	20	148	31	2187	<10	776	<10	10	624	10	41
OG-pipe				1660								2380		
OG-seep	63	373	31	134	459	122	2909	122	75	<10	<10		<10	<10

TABLE A2. Summary of average water quality data from 2016 for sampling locations within the Ogunquit River watershed. Dissolved oxygen (DO) in mg/L has been corrected in all cases where salinity is >10 ppt (using http://water.usgs.gov/software/DOTABLES/). Sites are ordered from upstream to downstream.

	Spring				Summer				Fall			
Site	Temp (°C)	DO (%)	DO (mg/L)	Salinity (ppt)	Temp (°C)	DO (%)	DO (mg/L)	Salinity (ppt)	Temp (°C)	DO (%)	DO (mg/L)	Salinity (ppt)
OR-06	18.2	82.5	7.8	1	19.7	81.3	7.5	0	8.0	96.6	11.5	2
OR-04	15.6	102.4	9.1	31	20.3	91.2	7.5	27	10.4	102.8	10.7	19
OR-18	18.5	102.3	9.1	13	21.6	92.2	7.4	18	9.0	91.9	10.6	8
OR-MeadowLn	16.3	23.7	2.3	1	20.9	27.1	2.4	1	6.2	59.7	7.4	3
OR-Jothams	17.2	89.8	8.7	4	--	--	--	--	6.3	89.9	11.1	2
OR-15-1	15.2	29.9	3.0	1	17.8	31.6	3.0	1	9.2	82.1	9.5	3
OR-15	13.6	85.1	8.8	1	16.2	83.5	8.2	2	9.1	91.3	10.6	5
OR-16	15.1	89.0	9.1	2	17.9	81.2	7.7	1	9.7	91.5	10.5	3
OR-Theater	14.8	70.1	7.1	1	17.5	75.1	7.2	1	8.8	91.3	10.7	2
OR-13	13.0	99.7	10.6	3	18.2	104.9	9.8	5	10.1	100.0	10.9	6
OG-04	12.7	91.2	8.9	34	19.2	88.0	7.6	30	10.1	96.8	10.1	29
OG-pipe	19.9	96.8	8.9	3	--	--	--	--	9.3	100.5	11.6	0
OG-seep	16.1	74.9	6.7	33	20.4	75.5	6.5	27	12.5	78.6	7.5	29

APPENDIX B: QAPP QA/QC Protocol Review

In 2016, the Ogunquit River Watershed-Scale Bacteria Monitoring Quality Assurance Project Plan (QAPP) was updated by FBE in cooperation with the MEDEP (FBE, 2016). Bacteria samples were collected in 2016 by FBE staff and analyzed by Nelson Analytical Laboratory in accordance with the specific Standard Operating Procedures (SOPs) outlined in the QAPP, unless mentioned below. These deviations were minor and did not impact the quality of bacteria results. Please note that the following review only applies to summer samples per the QAPP (July – September 2016); however, QAPP procedures were followed throughout the entire sampling season from May to November 2016.

1) A salinity reading was not recorded at site OR-Theater on 8/17/2016.
2) Field duplicates for bacteria should attempt to yield a relative percent difference (RPD) of <20%; 4 out of 8 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, 2016 RPDs ranging from 0-67% were acceptable and reflect a consistent field sampling procedure by personnel.

TABLE B1. Summary of relative percent difference (RPD) between two duplicate field samples.

Date	Wet/Dry	Sample ID	Enterococci (mpn/100mL)	RPD (±%)
7/7/2016	Dry	OG-04	148	*29%*
7/7/2016	Dry	OG-04-DUP	110	
7/26/2016	Wet	OR-13	288	*1%*
7/26/2016	Wet	OR-13-DUP	285	
7/26/2016	Wet	OR-15	231	*6%*
7/26/2016	Wet	OR-15-DUP	218	
8/17/2016	Wet	OG-04	2187	*27%*
8/17/2016	Wet	OG-04 - DUP	1670	
9/9/2016	Dry	OG-04	<10*	*-67%*
9/9/2016	Dry	OG-04 - DUP	10	
9/20/2016	Wet	OR-04	1467	*27%*
9/20/2016	Wet	OR-04-DUP	1119	
9/20/2016	Wet	OR-06	697	*10%*
9/20/2016	Wet	OR-06-DUP	631	
9/26/2016	Dry	OR-13	74	*16%*
9/26/2016	Dry	OR-13-DUP	63	

**RPD calculations assessed as 5 mpn/100mL for values <10*

3) Laboratory duplicates should also attempt to yield an RPD <20%; laboratory duplicates for 2016 bacteria sampling in Ogunquit yielded RPDs ranging from 0-67% (Table B2). This also reflects a generally consistent laboratory analysis procedure by laboratory staff with greater RPDs generally associated

with lower bacteria counts and vice versa. This is to be expected when measuring biological communities and the data are acceptable.

TABLE B2. Summary of relative percent difference (RPD) between field sample and laboratory duplicate results.

Date	Sample ID	Field Sample *Entero* (mpn/100mL)	Lab Duplicate *Entero* (mpn/100mL)	RPD (±%)
7/7/2016	OR-13	63	52	*19%*
7/7/2016	OR-06	94	119	*-23%*
7/26/2016	OR-13	288	336	*-15%*
7/26/2016	OR-06	63	63	*0%*
8/17/2016	OG-seep	2909	2909	*0%*
9/9/2016	OR-13	20	10	*67%*
9/20/2016	OR-13	1050	1450	*-32%*
9/20/2016	OR-06-DUP	631	637	*-1%*
9/26/2016	OR-13	74	63	*16%*

4) Bacteria samples were collected from tidal sites (OG-04, OG-pipe, OG-seep, OR-04, OR-13, and OR-18) within a rough window of ±1 hour around dead low tide, (Table B3). All bacteria samples were delivered to the laboratory well within the 6-hour holding time limit (Table B3).
5) All samples were collected within the designated timeframe of July 1 – October 1, 2016.
6) Bacteria samples were delivered to the laboratory at or below 12.5 °C, which is slightly above the recommended <10°C sample temperature (Table B3). However, this is reasonable since the water temperatures throughout most the sampling period were relatively high (12.2 to 27.5°C) and may not have had enough time to cool down to 10°C between field collection and laboratory delivery (typically about 2 hours). Personal communication with laboratory staff confirmed that this was not a concern for sample quality.
7) All field sheets and COC forms were complete.

TABLE B3. Summary of QAPP protocol results for 2016 bacteria sampling.

Date	Precip 24 hrs prior (in)	Precip 48 hrs prior (in)	Precip 96 hrs prior (in)	Time of First Sample	Time of Last Sample	Time of Low Tide	Time Delivered to Lab	Temp Received (°C)
7/7/2016	0.00	0.00	0.00	7:32	8:13	8:06	9:42	9.5
7/26/2016	0.63	0.63	1.67	9:55	10:46	10:42	12:25	11.0
8/17/2016	0.57	0.57	0.76	4:48	5:37	4:57	7:40	7.5
9/9/2016	0.01	0.03	0.18	10:20	12:00	11:16	14:35	6.0
9/20/2016	1.73	1.80	1.80	7:27	8:14	8:15	9:44	12.5
9/26/2016	0.00	0.00	0.09	13:30	14:24	14:08	16:08	7.5

Date	Time Diff. First Sample (hh:mm)	Time Diff. Last Sample (hh:mm)	Time Diff. to Lab (hh:mm)
7/26/2016	0:47	0:04	2:30
8/17/2016	0:09	0:40	2:52
9/9/2016	0:56	0:44	4:15
9/20/2016	0:48	0:01	2:17
9/26/2016	0:38	0:16	2:38

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