PARSONS CREEK WATERSHED
WATER QUALITY REPORT

December 2021

PREPARED FOR

Town of Rye
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Rye, NH 03862

PREPARED BY

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TRACKING FECAL CONTAMINATION

Current Tools and Challenges

STATEWIDE FECAL CONTAMINATION ISSUE

Surface waters near developed areas are impacted by fecal contamination from polluted stormwater runoff, malfunctioning septic systems, pet, livestock, and wildlife waste, leaky sewer lines, and other aging infrastructure on residential, municipal, and commercial properties. The State of New Hampshire lists over 300 river and estuarine segments as impaired for fecal indicator bacteria (FIB). These impaired waterbodies are particularly concentrated in the populated Seacoast Region. This fecal contamination generates a significant threat to water quality, public health, and the local economy.

Order addressed in report	HUC8 ID	Watershed name	# of impaired assessment units
1	01040002	Lower Androscoggin River	3
2	01060002	Saco River	18
3	01060003	Salmon Falls - Piscataqua Rivers	122
4	01070001	Pemigewasset River	17
5	01070002	Winnipesaukee River	23
6	01070003	Contoocook River	16
7	01070004	Nashua River	6
8	01070006	Merrimack River	81
9	01080101	Upper Connecticut River	16
10	01080103	Connecticut River - Johns River to Waits River	7
11	01080104	Connecticut River - Waits River to White River	3
12	01080106	Connecticut River - White River to Bellows	24
13	01080107	Connecticut River - Bellows Falls to Vernon	8
14	01080201	Connecticut River - Ashuelot River-Vernon Dam to Millers River	21
15	0100000	Coastal Impaired Segments	14
	TOTAL		379

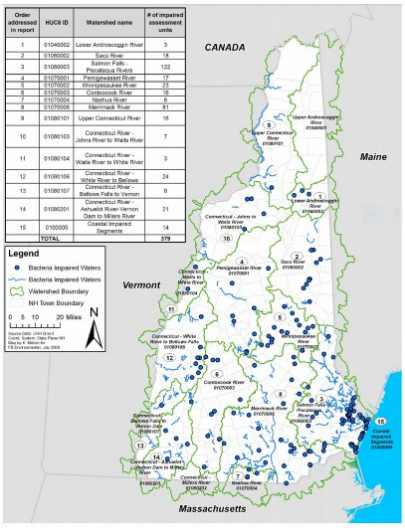
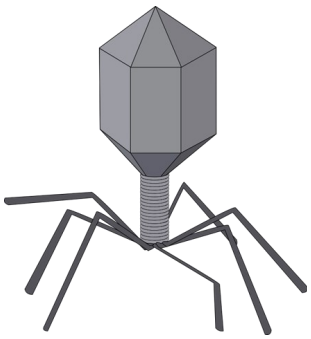


Figure 1-1: Map of Bacteria Impaired Waters in New Hampshire, by HUC 8 Watershed.

TRACKING FECAL SOURCES IS DIFFICULT

Monitoring, tracking, and managing pathogens in fecal matter is extremely difficult, particularly when fecal indicators (e.g., *E.coli,* Enterococci, or fecal coliform) are also highly variable to track and measure. Bacteria and viral pathogens react differently in the natural environment, so that external factors (temperature, sunlight, proliferation, etc.) may influence the concentration of FIB, but not the viral pathogens of interest for protecting public health. In addition, laboratory analysis of FIB can be highly variable due to the biological nature of the bacteria. For instance, laboratory and field duplicates can vary up to 200% or more, particularly at lower concentrations. As such, bacteria results should not be interpreted as absolute numbers, but as a rough estimate of concentration.



To aid with fecal source tracking, other parameters can be used as "co-indicators" to help determine if the source of the bacteria is from human waste. Nutrients (nitrate-nitrite and phosphate) can indicate the presence of human sewage in extremely high concentrations (>100 ppb for nitrate-nitrite and >1000 ppb for phosphate). If surface waters present elevated FIB counts and extremely high nutrient concentrations, then it is likely that the fecal contamination is from illicit discharges of human waste rather than other sources like stormwater runoff or animal waste.

Designed by L. Diemer, FBE
Graphic credit: OpenClipArt

BEACH MONITORING

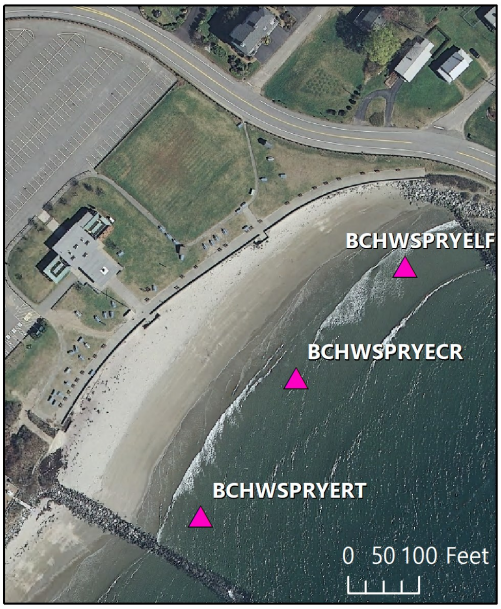
Wallis Sands State Beach and Wallis Beach, Rye, NH

NHDES BEACHES PROGRAM

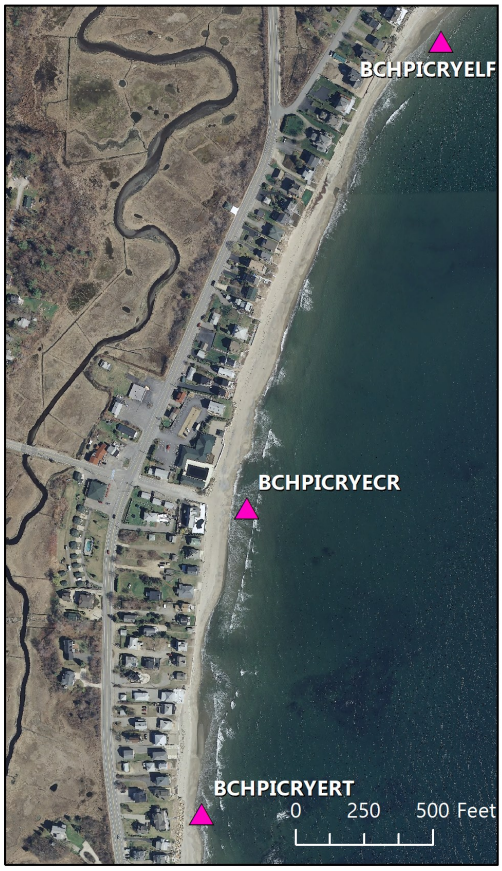
NHDES conducts regular sampling of freshwater and coastal beaches and issues advisories if FIB counts exceed water quality criteria established for the protection of public health. The annual geometric means for the six monitored beach sites were well within acceptable limits for NHDES water quality criteria, but two sites (BCHPICRYELF and BCHPICRYERT) on Wallis Beach showed statistically-significant degrading trends from 1997-2021 and 1998-2021, respectively. Wallis Sands State Beach was issued two advisories in 2021 and one advisory in 2017; Wallis Beach was issued three advisories in 2021 and one advisory in each of the following years: 2020, 2018, 2017, 2014, 2010, 2009, 2008, and 2006. In 2021, FIB counts at Wallis Sands State Beach were elevated (>104 mpn/100mL) twice at BCHWSPRYECR (6/25/21 and 8/23/21) and once at BCHWSPRYERT (6/23/21). At Wallis Beach, FIB counts were elevated six different times at BCHPICRYERT (7/12/21, 7/14/21, 7/26/21, 7/28/21, 7/30/21, 8/16/21)

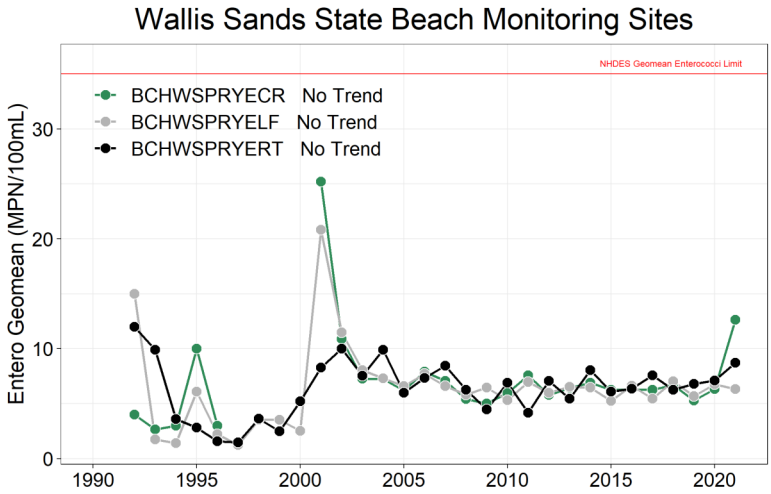
Wallis Beach has shown elevated FIB counts in the swimmable wading zone, particularly at BCHPICRYERT near the outlet of Parsons Creek.

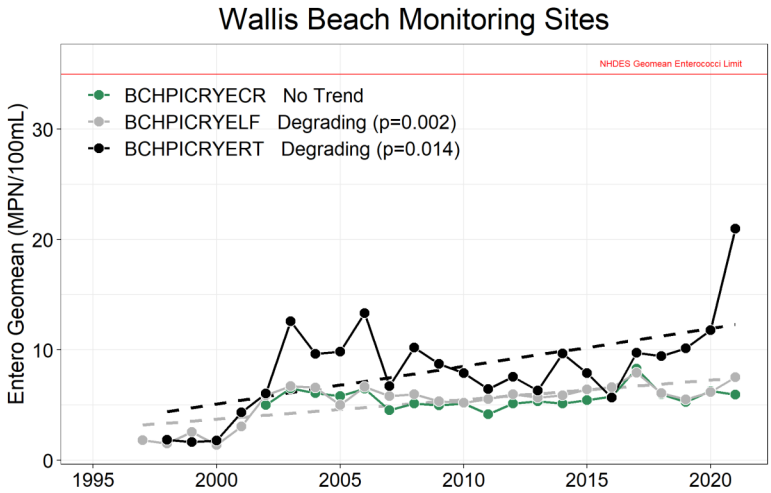
Wallis Sands State Beach



Wallis Beach







WATERSHED MONITORING

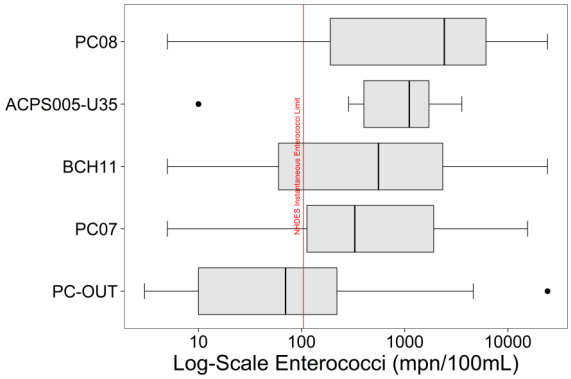
Parsons Creek, Rye, NH

WATERSHED MONITORING (Bacteria)

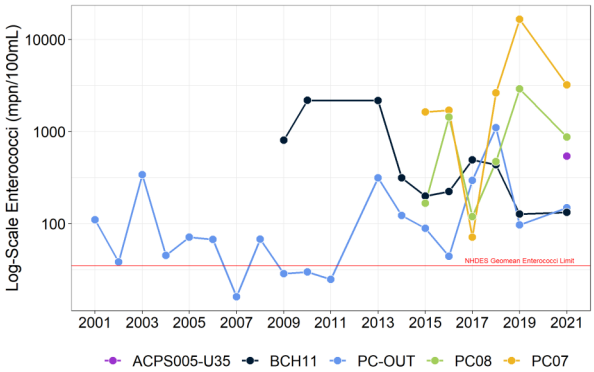
Five sites (ACPS005-U35, PC07, PC08, BCH11, and PC-OUT) within the Parsons Creek watershed were sampled for Enterococci six times at low tide during wet and dry weather conditions from May through September in 2021. These sites have showed historically-elevated levels of Enterococci for multiple years and have been positive for human fecal contamination by either ribotyping or canine detection or both. The Town of Rye has identified several septic systems in failure within the watershed, which may be contributing to elevated levels of Enterococci at these sites.

All sites exceeded the state criterion for geometric mean (35 mpn/100mL) in 2021. All but 6 out of 30 samples (PC-OUT on 5/19/21 and 8/3/21, BCH11 on 5/19/21, 8/3/21, and 9/23/21, and ACPS005-U35 on 5/19/21) surpassed the state criterion for instantaneous level (104 mpn/100mL) in 2021. Duplicate samples were omitted from the data distributions and geometric means for Enterococci. Refer to Appendix A-B for data and Appendix C for methods.

Similar to previous years, FIB counts exceeded state criteria at all five locations in Parsons Creek (ACPS005-U35, PC07, PC08, BCH11, and PC-OUT). FIB counts at PC08 and PC07 remain high. FIB counts at BCH11 may be improving, while FIB counts at PC-OUT may be worsening since around 2011.



All data (2001-2021) distribution for the five sites monitored in 2021. Sites ordered from highest to lowest median value.



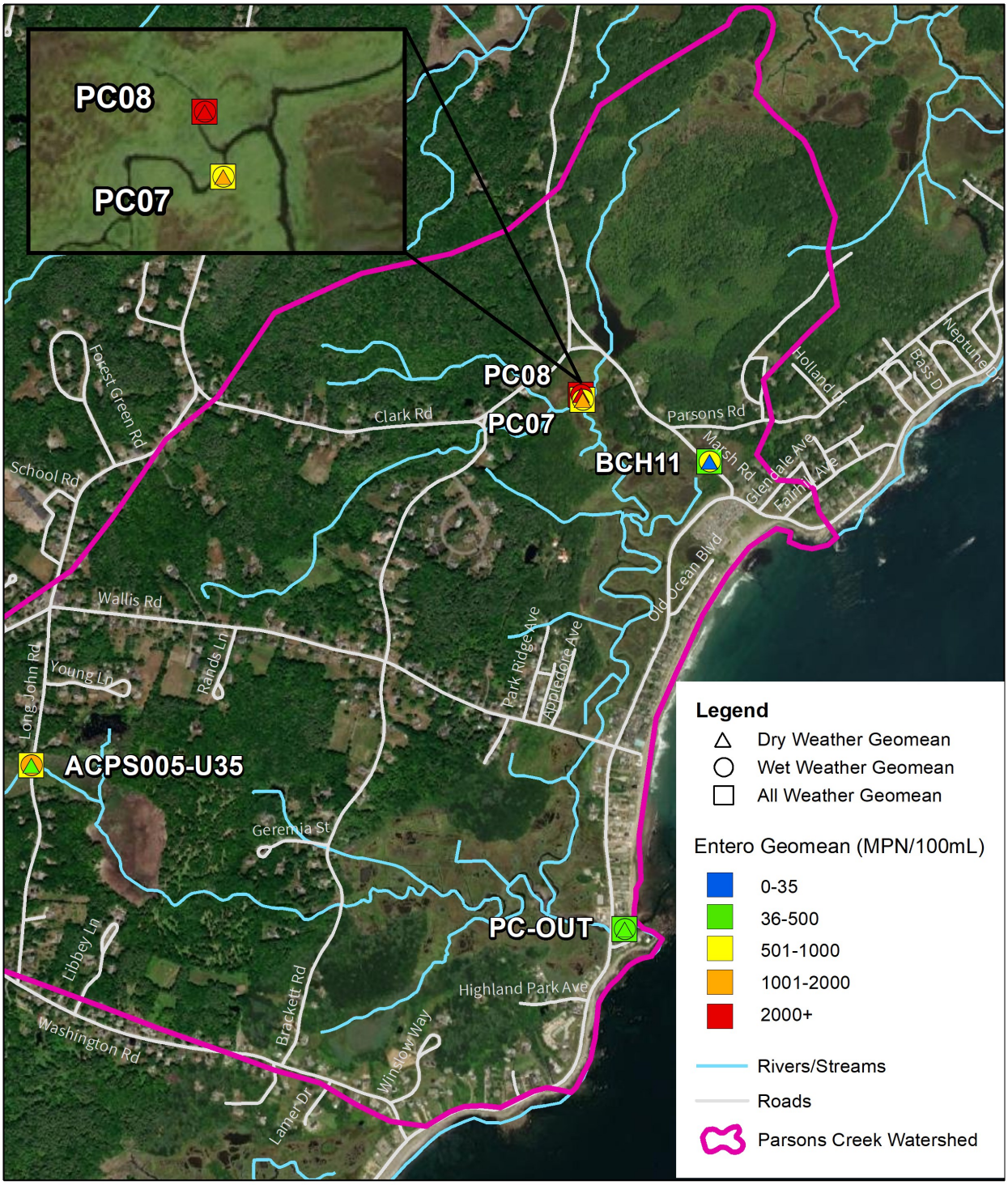
Annual geometric mean from 2001-2021 for the five sites monitored in 2021.

View of the upper east branch of Parsons Creek near PC07 and PC08 on August 3, 2021. Photo Credit: FBE.

View of site ACPS005-U35 on September 23, 2021. Photo Credit: FBE.

WATERSHED MONITORING

Parsons Creek, Rye, NH



2021 Bacteria Results
Parsons Creek, Rye, NH

0 0.5 1 Miles

N

Source: New Hampshire GRANIT, FB Environmental, ESRI, Watershed Area from NHDES. Projection: NAD 1983 New Hampshire State Plane FIPS 2800. Created by FB Environmental (L. Frankel), November 2021

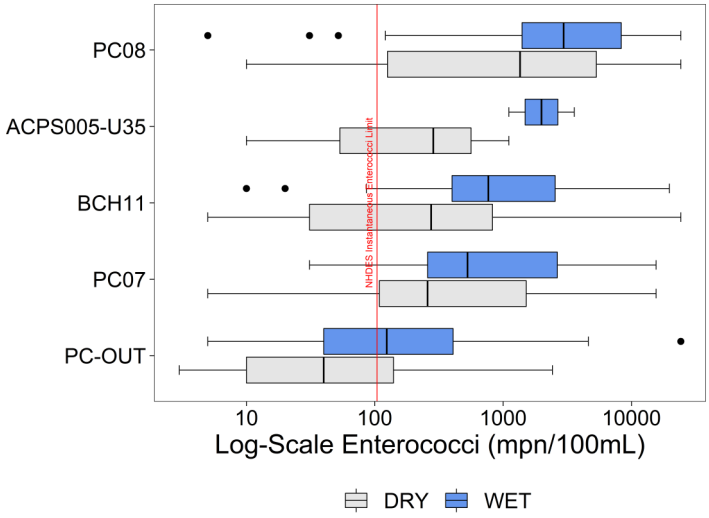
WET/DRY WEATHER ANALYSIS

Parsons Creek, Rye, NH

WET/DRY WEATHER ANALYSIS (Bacteria)

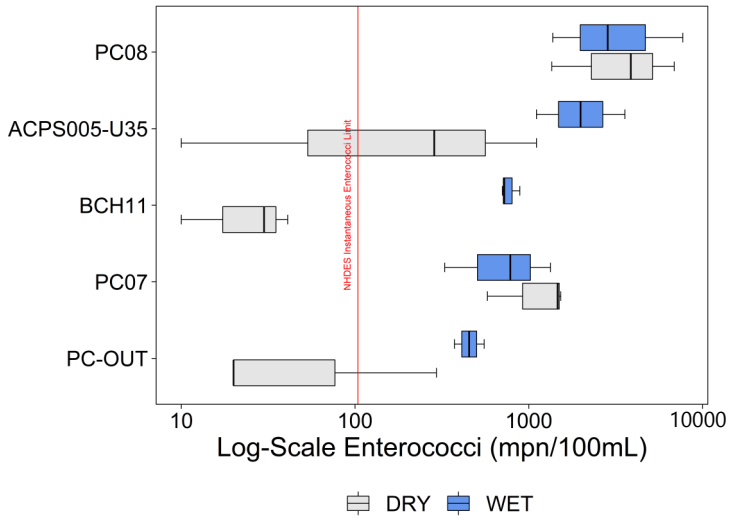
Contrary to historical patterns, dry weather in 2021 generated slightly higher counts of FIB in surface waters compared to wet weather for PC07 and PC08, suggesting that groundwater may be a significant source of fecal contamination in that portion of the watershed. For the remaining three sites (ACPS005-U35, BCH11, and PC-OUT), wet weather produced higher FIB, demonstrating that stormwater runoff is also a source of fecal bacteria to Parsons Creek. All sites exceeded the state criterion for the geometric mean of FIB (35 mpn/100mL) during both dry and wet weather, except for BCH11 which was below the threshold under dry conditions.

Historically and in 2021, FIB counts exceeded state criteria during both wet and dry weather, suggesting that both stormwater runoff and groundwater are significant sources of contamination to Parsons Creek. The low-lying topography and high groundwater table in the watershed make leachfields susceptible to malfunction, which is likely the primary source of fecal contamination in the watershed and at the beaches.



All data (2001-2021) distribution for the five sites monitored in 2021 by weather condition (dry and wet).

BCH11 during wet weather on July 14, 2021 (top) and PC-OUT during dry weather on September 23, 2021 (bottom).
Photo Credit: FBE.



2021 data distribution for the five sites monitored in 2021 by weather condition (dry and wet).

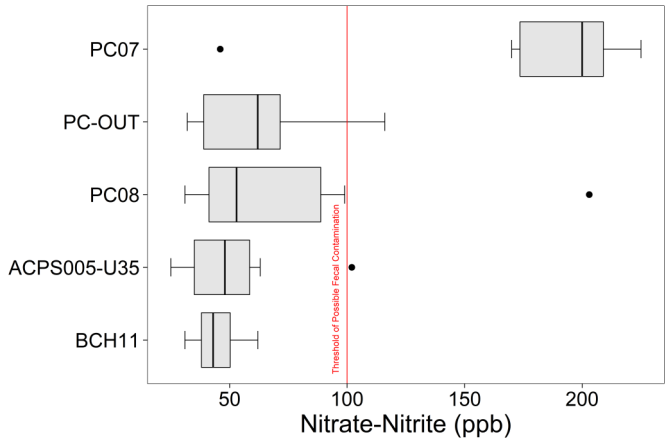
WATERSHED MONITORING (Nutrients)

Five sites (ACPS005-U35, PC07, PC08, BCH11, and PC-OUT) within the Parsons Creek watershed were sampled for nutrient concentrations (nitrate-nitrite and phosphate) six times at low tide during wet and dry weather conditions from May through September in 2021. These sites have been positive for human fecal contamination by either ribotyping or canine detection or both, and the Town of Rye has identified several septic systems in failure within the watershed. Extremely high concentrations of nitrate-nitrite or phosphate would suggest that the dominant source of fecal contamination is from illicit discharges of human waste.

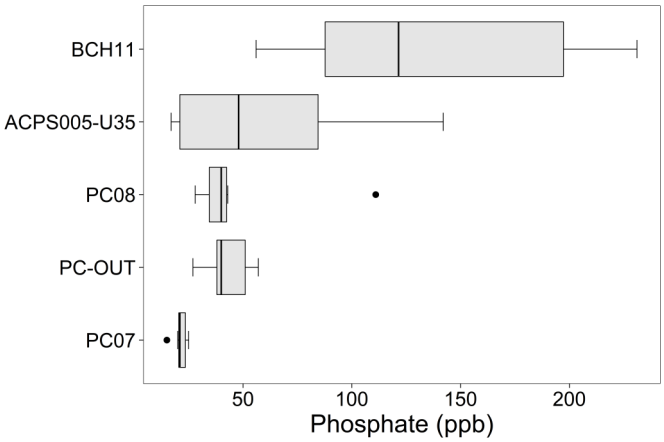
Only one site (PC07) had an average nitrate-nitrite concentration that exceeded the threshold of possible fecal contamination (>100 ppb), however, three other sites had one sample that exceeded the threshold (PC08, ACPS005-U35, and PC-OUT). For phosphate, all five sites had concentrations well below the threshold of possible fecal contamination (> 1000 ppb). Differences in phosphate concentrations between the sites are well explained by oxygen levels, where low oxygen promotes the release of phosphate from the underlying sediments, causing higher phosphate concentrations in surface waters. BCH11 and ACPS005-U35 consistently had lower oxygen concentrations than the other three sites. Duplicate samples were included in the data distributions and averages for nitrate-nitrite and phosphate. Refer to Appendices A-B for data and Appendix C for methods.

Average nitrate-nitrite and phosphate concentrations were below the thresholds of possible fecal contamination for all sites except for nitrate-nitrite at PC07. Illicit discharge of human waste is possibly a source of fecal contamination at this site and may also be a contributing source to the other downstream sites.

View of site BCH11 on June 16, 2021 (top) and view of site PC07 on September 23, 2021 (bottom).
Photo Credit: FBE.



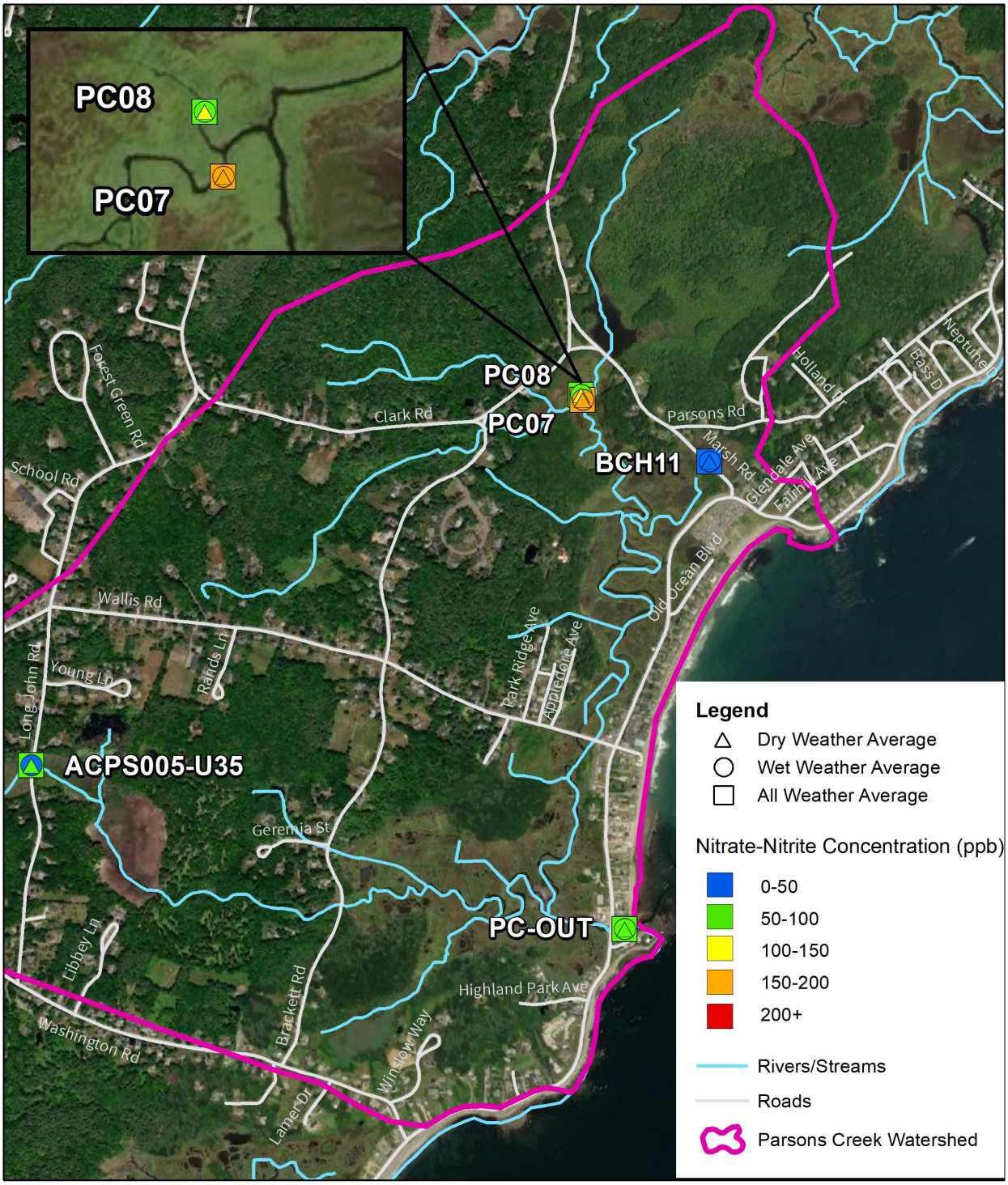
2021 data distribution for nitrate-nitrite. Sites ordered from highest to lowest median value.



2021 data distribution for phosphate. Sites ordered from highest to lowest median value.

WATERSHED MONITORING

Parsons Creek, Rye, NH



2021 Nitrate-Nitrite Results
Parsons Creek, Rye, NH

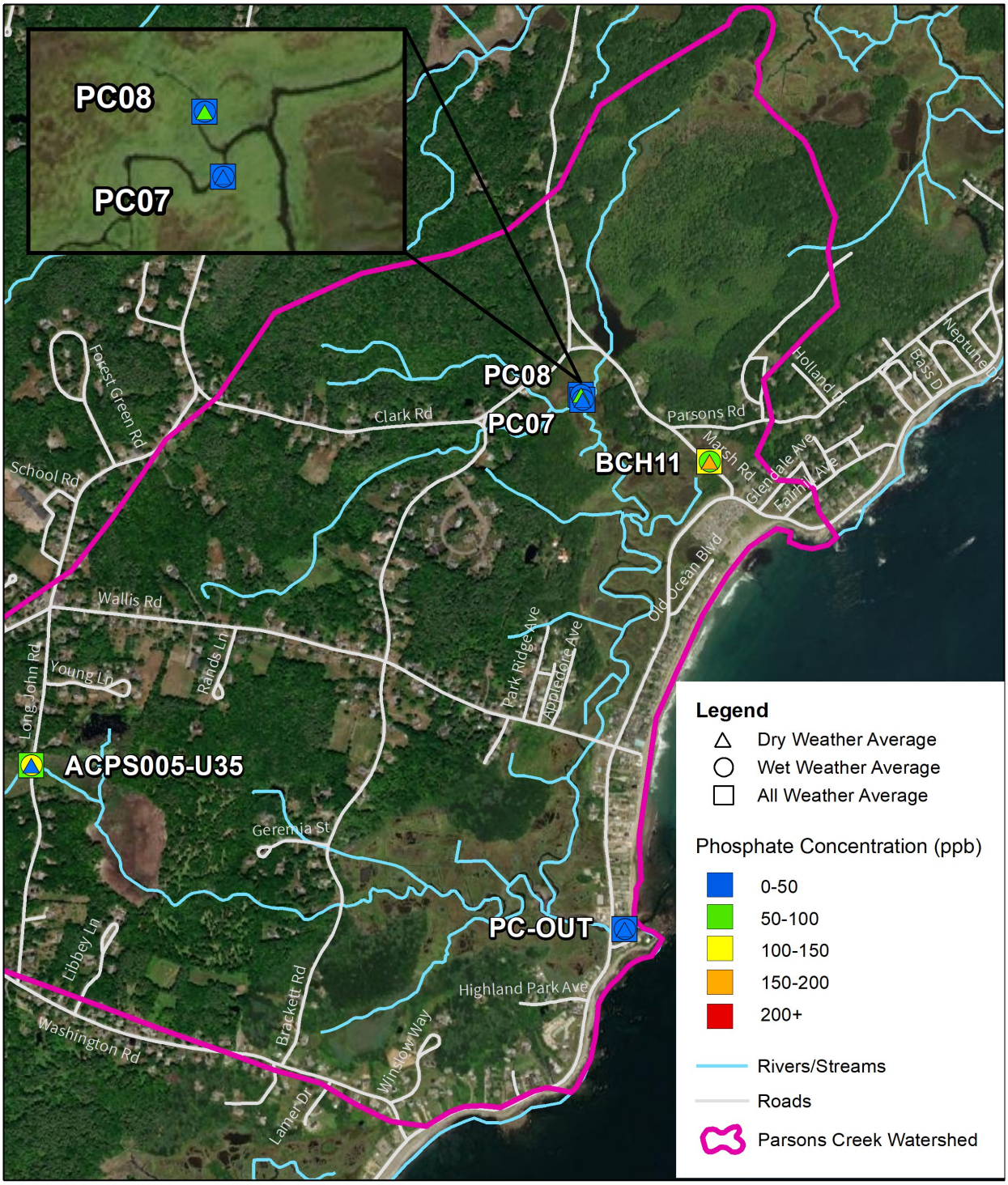
0 0.5 1 Miles

N

Source: New Hampshire GRANIT, FB Environmental, ESRI, Watershed Area from NHDES. Projection: NAD 1983 New Hampshire State Plane FIPS 2800. Created by FB Environmental (L. Frankel), November 2021

WATERSHED MONITORING

Parsons Creek, Rye, NH



2021 Phosphate Results
Parsons Creek, Rye, NH

0 0.5 1 Miles

N

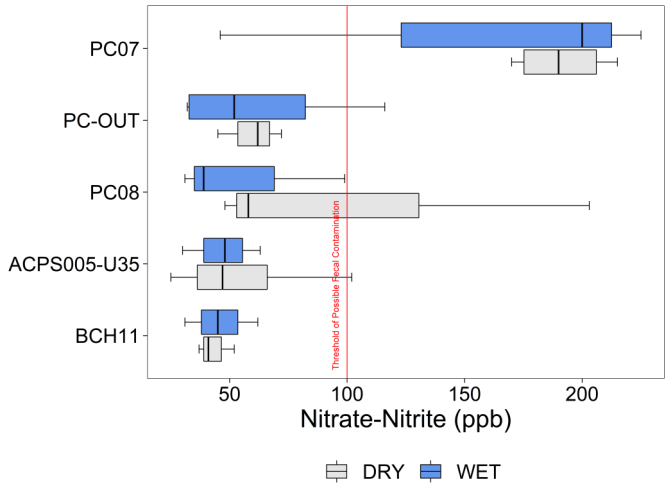
Source: New Hampshire GRANIT, FB Environmental, ESRI, Watershed Area from NHDES. Projection: NAD 1983 New Hampshire State Plane FIPS 2800. Created by FB Environmental (L. Frankel), November 2021

WET/DRY WEATHER ANALYSIS (Nutrients)

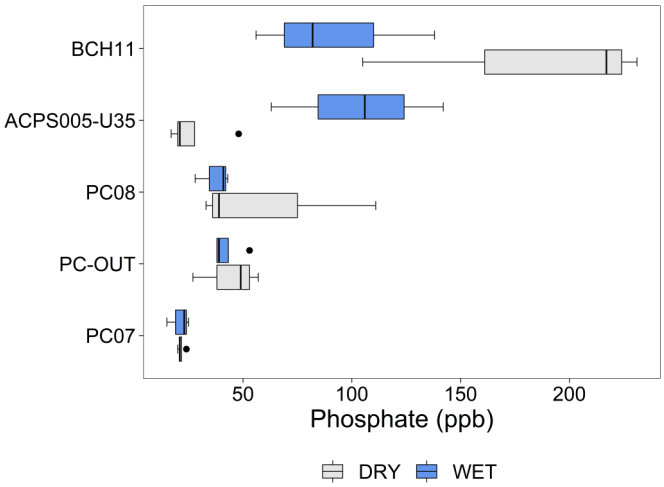
Weather had a significant impact on nutrient concentrations at several of the sites sampled within the Parsons Creek watershed. Nitrate-nitrite concentrations were similar at all sites under dry and wet conditions, though some dilution at PC07 during wet weather and concentration at PC08 during dry weather may have occurred, suggesting groundwater dominant sources of nitrogen. Phosphate concentrations were similar at all sites except at BCH11 and ACP005-U35. Phosphate concentrations were higher under dry conditions at BCH11, suggesting that groundwater is the primary source of phosphate to this site. Phosphate concentrations were higher under wet conditions at ACP005-U35, suggesting that overland flow and stormwater runoff are dominant sources of phosphate to this site.

In general, nutrients are sourced from both stormwater runoff and groundwater to Parsons Creek with diverging responses to wet and dry weather conditions at several sites, indicating that sources of contamination varies throughout the Parsons Creek watershed. However, generally higher concentrations of nutrients were sampled during dry weather conditions, suggesting that groundwater may be the primary source of contamination to Parsons Creek.

ACPS005-U35 during wet weather on July 14, 2021.
Photo Credit: FBE.



2021 data distribution for nitrate-nitrite by weather condition (dry and wet). Sites ordered from highest to lowest median value.



2021 data distribution for phosphate by weather condition (dry and wet). Sites ordered from highest to lowest median value.

SUMMARY

Snapshot of Results

Overall, the Town of Rye, the NHDES Beaches Program, the NHDES Watershed Assistance Section, the NH Shellfish Program, FB Environmental Associates, the Jackson Laboratory, and Environmental Canine Services have done a considerable amount of work to track sources of fecal contamination in both surface water and groundwater within the Parsons Creek watershed and along the beach. This work has generated a long-term dataset for analysis and interpretation for determining next steps in dealing with this issue. A summary of results is provided below.

Beach Monitoring Results

- ⇒ Both Wallis Sands State Beach and Wallis Beach were issued more advisories in 2021 than any previous year, with two issued at Wallis Sands State Beach and three issued at Wallis Beach.
- ⇒ Two sites on Wallis Beach (BCHPICRYELF and BCHPICRYERT) showed statistically-significant degrading trends over time, with BCHPICRYERT near the outlet of Parsons Creek showing record high FIB counts in 2021.
- ⇒ Historical results have shown the critical connection between Parsons Creek water quality and protection of public health at the beach.

Watershed Monitoring Results

- ⇒ In 2021, all sites sampled within the Parsons Creek watershed had FIB counts that exceeded the state criterion for the geometric mean. Historical investigations by human waste tracking canines showed that human fecal contamination is a diffuse problem throughout the watershed due to the area's low-lying topography and high groundwater table that likely intercept leachfields on a regular basis during storm events and/or spring tides. Even if a high water table is not the issue, sandy soils would allow for fast percolation rates of contaminated leachfield water to groundwater and ultimately surface waters without adequate treatment of pathogens.
- ⇒ As part of the new health regulation, several septic systems near or contributing to the area around these hotspot sites have been found to be malfunctioning and possibly contributing to human fecal contamination in Parsons Creek.
- ⇒ Average nitrate-nitrite and phosphate concentrations in 2021 were below the general guideline for possible fecal contamination at all sites except for nitrate-nitrite at PC07. Illicit discharge of human waste is possibly a source of fecal contamination at this site and may be a source to other downstream sites.

Wet/Dry Weather Analysis

- ⇒ Historically and in 2021, FIB counts exceeded state criteria during both wet and dry weather, suggesting that both stormwater runoff and groundwater are significant sources of fecal contamination to Parsons Creek and the beach.
- ⇒ Results showed that nutrients are sourced from both stormwater runoff and groundwater to Parsons Creek with diverging responses to wet and dry weather conditions at several sites, indicating that sources of contamination varies throughout the Parsons Creek watershed. However, generally higher concentrations of nutrients were sampled during dry weather conditions, suggesting that groundwater may be the primary source of contamination to Parsons Creek.

NEXT STEPS

Recommendations and Priorities

Address groundwater sources of fecal contamination

- ⇒ Update the septic system database on a regular basis.
- ⇒ Continue to enforce the septic system health regulation that requires pump-outs every 3 years.
- ⇒ Continue evaluation of individual properties for septic system functioning near hotspots.
- ⇒ Consider incorporating stricter guidelines for septic system replacement or installation to town ordinances.
- ⇒ Consider a town sewer system to connect homes in low-lying areas along the marsh and beach.

Address surface runoff sources of fecal contamination

- ⇒ Continue to locate candidate sites for BMP implementation to address stormwater runoff.
- ⇒ Continue to secure funding that implements these candidate BMP sites.
- ⇒ Continue to track and monitor existing BMP conditions and fix or improve sites, as necessary.
- ⇒ Maintain installed pet waste signs.

Enhance public outreach program

- ⇒ Post and maintain advisories at the beach.
- ⇒ Continue to distribute educational materials and reports to the public via the town's website.
- ⇒ Continue to educate homeowners on proper disposal of pet waste and maintenance of septic systems.
- ⇒ Reinstitute regular meetings of the Parsons Creek Water Quality Committee.

Continue monitoring program

- ⇒ Continue water quality sampling throughout the Parsons Creek watershed under varying weather conditions to track changes in FIB over time, especially as failing septic systems are replaced.
- ⇒ Expand the sampling program by including other co-indicators in addition to inorganic nutrients. Co-indicators such as optical brighteners and microbial DNA source tracking methods like PhyloChip® provide additional information that can be used to better pinpoint human sources of fecal contamination.
- ⇒ Complete a groundwater testing study of the marsh area draining to BCH11.
- ⇒ Retest the area around the large marsh pool to determine whether the elevated fecal indicator levels are from wildlife or possibly remnant from a failing septic system that was recently replaced on a property draining to the large marsh pool.
- ⇒ Consider updating the 2011 Parsons Creek Watershed Management Plan.

APPENDIX A

2021 Watershed Monitoring Data

Date	Dry/Wet	Site ID	Water Temp (°C)	DO (ppm)	Specific-Conductivity (µS/cm)	Salinity (ppt)	pH	Enterococci (mpn/100mL)	Nitrate-Nitrite (ppb)	Phosphate (ppb)
5/19/2021	Dry	ACPS005-U35	17.7	*0.78*	375	0.18	6.81	10	40	17
5/19/2021	Dry	BCH11	15.5	*1.15*	15,675	9.19	6.72	10	41	217
5/19/2021	Dry	PC07	21.8	7.82	4,439	2.37	6.85	*1,529*	*203*	24
5/19/2021	Dry	PC08	22.1	5.27	4,142	2.20	6.70	*1,357*	*203*	33
5/19/2021	Dry	PC-OUT	17.3	6.42	32,905	20.65	7.36	20	45	57
6/16/2021	Wet	ACPS005-U35	17.3	*0.32*	355	0.17	6.36	*1,989*	30	106
6/16/2021	Wet	BCH11	18.2	*0.22*	23,403	14.20	6.79	*723*	31	138
6/16/2021	Wet	PC07	22.1	10.47	11,447	6.53	6.93	*1,333*	46	25
6/16/2021	Wet	PC08	24.0	*1.84*	22,228	13.38	6.68	*7,701*	31	43
6/16/2021	Wet	PC-OUT	19.0	6.57	37,622	23.92	6.80	*373*	33	40
7/14/2021	Wet	ACPS005-U35	18.3	*0.26*	238	0.11	6.48	*3,578*	48	142
7/14/2021	Wet	BCH11	20.0	*0.15*	18,615	11.70	6.89	*889*	45	56
7/14/2021	Wet	PC07	17.3	6.94	1,010	0.50	6.90	*328*	*200*	15
7/14/2021	Wet	PC08	18.3	*4.08*	1,844	0.94	6.61	*1,374*	39	28
7/14/2021	Wet	PC-OUT	18.6	*3.72*	127	7.37	7.02	*554*	*116*	38
8/3/2021	Dry	ACPS005-U35	17.7	*0.14*	331	0.16	6.34	*1,107*	*102*	48
8/3/2021	Dry	BCH11	21.7	*0.08*	16,882	9.98	6.44	41	52	105
8/3/2021	Dry	PC07	21.4	17.40	2,790	1.45	7.79	*1,467*	*177*	21
8/3/2021	Dry	PC08	23.2	*1.82*	6,443	3.52	6.68	*6,867*	48	39
8/3/2021	Dry	PC-OUT	24.0	6.86	20,370	12.17	7.08	20	72	49
8/25/2021	Wet	ACPS005-U35	22.7	*1.25*	277	0.13	6.02	*1,107*	63	63
8/25/2021	Wet	BCH11	23.0	*0.10*	18,998	11.29	6.73	*705*	62	82
8/25/2021	Wet	PC07	21.1	5.74	2,755	1.43	6.69	*784*	*225*	23
8/25/2021	Wet	PC08	23.7	*1.31*	6,566	3.59	6.56	*2,851*	99	41
8/25/2021	Wet	PC-OUT	21.8	*2.90*	26,725	16.39	6.91	*454*	71	53
9/23/2021	Dry	ACPS005-U35	17.7	*0.19*	309	0.15	5.87	*286*	54	21
9/23/2021	Dry	BCH11	19.4	*0.10*	25,959	15.91	6.55	30	37	231
9/23/2021	Dry	PC07	18.5	5.71	7,877	4.38	6.78	*578*	*215*	20
9/23/2021	Dry	PC08	19.2	*0.08*	16,396	9.64	6.67	*3,873*	58	111
9/23/2021	Dry	PC-OUT	18.4	*4.83*	37,120	23.56	7.19	*294*	62	27

Italicized red text indicates exceedance of the state criterion threshold or natural background guideline for individual samples (DO = 5 ppm; Enterococci = 104 mpn/100mL; Nitrate-Nitrite = 100 ppb; Phosphate = 1000 ppb).

APPENDIX B

2021 Watershed Monitoring Data QA/QC

Date	Dry/Wet	Site ID	Rep	Enterococci (mpn/100mL)	Enterococci RPD	Nitrate-Nitrite (ppb)	Nitrate-Nitrite RPD	Phosphate (ppb)	Phosphate RPD
6/16/2021	Wet	PC-OUT	1	373	7%	33	3%	40	6%
6/16/2021	Wet	PC-OUT	2	402		32		38	
8/3/2021	Dry	PC07	1	1,467	19%	177	4%	21	2%
8/3/2021	Dry	PC07	2	1,211		170		21	
9/23/2021	Dry	ACPS005-U35	1	286	25%	*54*	*76%*	21	1%
9/23/2021	Dry	ACPS005-U35	2	367		*25*		21	

Italicized red text indicates nitrate-nitrite and phosphate samples that were flagged for elevated field duplicates. These values are flagged if the Relative Percent Difference (RPD) is greater than 20%, the Relative Standard Deviation (RSD) is greater than 30%, and the values are greater than five times the detection limit. Since there is only one pair of duplicate samples that were flagged, the data were included as there is no systematic bias present.

APPENDIX C

Summary of Methods

SAMPLING PROTOCOL

Baseline bacteria sampling was performed as documented in the *NHDES Generic Beach Program Quality Assurance Project Plan* dated April 3, 2012, RFA # 06193, Section B2.0. Bacteria samples were collected in labeled whirlpak bags and stored on ice in a cooler for transport to Absolute Resource Associates Laboratory in Portsmouth, NH for analysis of Enterococci. Water samples for nutrients were field filtered using a 0.45 μm Millipore filter and stored on ice in a cooler for transport to the UNH Water Quality Analysis Laboratory for analysis of nitrate-nitrite and phosphate. Water quality parameters (temperature, dissolved oxygen, specific conductivity, salinity, and pH) were collected in the field using calibrated instruments: YSI ProSolo and Oakton pHTestr® 30. Three duplicate samples were collected and generally fell within the acceptable difference (see Appendix B).

WET/DRY WEATHER CLASSIFICATION

Wet weather was determined as: >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. Conditions were considered dry weather when precipitation was <0.1" for each day within 72 hours.

STATISTICAL METHODS

A Mann-Kendall trend analysis was performed for beach sites with at least 10 years of data. The Mann-Kendall Trend Test is a non-parametric statistical test that determines if the central value (median) of a dataset has changed over time. A non-parametric test is appropriate here because it does not make assumptions about the normality or variability of the dataset; variation seen year-to-year or within seasons will not influence the results of non-parametric analysis the way that parametric tests can be influenced.

DATA INTERPRETATION – WATER QUALITY STANDARDS

The NHDES Consolidated Assessment Listing Methodology (CALM) describes the process and water quality standards used to assess the state's waters. This information is used to help interpret Parsons Creek water quality results and relate it to state criteria. https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/r-wd-20-20.pdf