BACTERIA SOURCE TRACKING AND CANINE DETECTION

LONG SANDS BEACH, SHORT SANDS BEACH, AND THE CAPE NEDDICK RIVER

YORK, MAINE

JULY 30, 2013

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1. INTRODUCTION

On July 30, 2013, FB Environmental (FBE) and Environmental Canine Services (ECS) collaborated with the Town of York, ME to conduct targeted bacteria source tracking at Long Sands Beach, Short Sands Beach, and the Cape Neddick River. Scott and Karen Reynolds of ECS, along with canines Sable and Logan, pioneered the canine detection method of identifying pollution sources in the upper Midwest and California. Canine detection is recognized by EPA Region 5 as an effective, quality-controlled tool able to rapidly detect human-source wastewater in the environment. FBE coordinated with ECS to conduct this second working visit to New England.

The primary purpose of this testing was to help identify the potential "hotspots" of bacterial pollution to York's beaches. Weather conditions leading up to this sample event were hot, dry and sunny, with no rain the prior two days. The dogs alerted to the presence of human wastewater at nine of 15 locations throughout York. Many of these locations also exceeded the water quality standard for enterococci bacteria.

2. BACTERIA SAMPLING

2.1 BACTERIA IN 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 consumption of contaminated fish and shellfish, skin contact, and/or ingestion of water.

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. Enterococci bacteria are used by the State of Maine to assess the designated uses for salt waterbodies and to determine the need for beach closings and advisories. For this effort, enterococci sampling was conducted in addition to the canine detection efforts even though most sampling locations were from freshwater. Enterococci were chosen as the indicator organism to determine each site's contribution to water quality at the beaches. The canines can detect human-source wastewater at relatively low concentrations, so the conventional bacteria test provide an idea of the severity of pollution.

2.2 BACTERIA SOURCE TRACKING METHODS

Identifying the sources of bacteria to a waterbody is often difficult, as many sources are diffuse, may change over time, and can depend on weather conditions. Methods to track sources of bacteria include:

1. **Bacteria Sampling**: Regular water quality sampling of a waterbody at established sampling locations can provide general information about the sources of bacteria. For instance, high bacteria

levels during wet weather may indicate that stormwater runoff is a primary source of bacteria, while dry weather sampling may indicate the presence of an illicit discharge.

2. **Bracket Sampling**: Bracket sampling is used to locate the sources of bacteria entering a storm drain system or tributary by sampling upgradient and downgradient of potential sources to "bracket" (or isolate) pollutant source locations. This type of testing can guide remediation efforts as it may reveal an isolated bacteria source or that elevated bacteria levels are spread throughout the storm drain system or watershed.
3. **Mapping and Watershed Investigation**: Once areas of high bacterial pollution have been identified, creating a map of the watershed draining to a storm drain outfall or waterbody can provide additional information about sources of bacteria in the watershed. Through this method, the location of bacteria sources such as sewer lines, agricultural operations, and septic systems can be assessed and their potential contribution to the waterbody can be evaluated.
4. **Microbial Source Tracking**: Microbial Source Tracking refers to a broad range of genetic tests aimed at identifying specific sources of bacteria. These methods can often indicate the source species of animal. A highly specialized laboratory is required, cost per sample is high, and more time is required for this method. Some methods remain experimental.
5. **Canine Detection**: Environmental Canine Services (ECS) has trained dogs to identify human sources of bacteria (human sewage) through scent in a storm drain system or waterbody. This cost-efficient method provides a rapid screening method for illicit discharge detection.

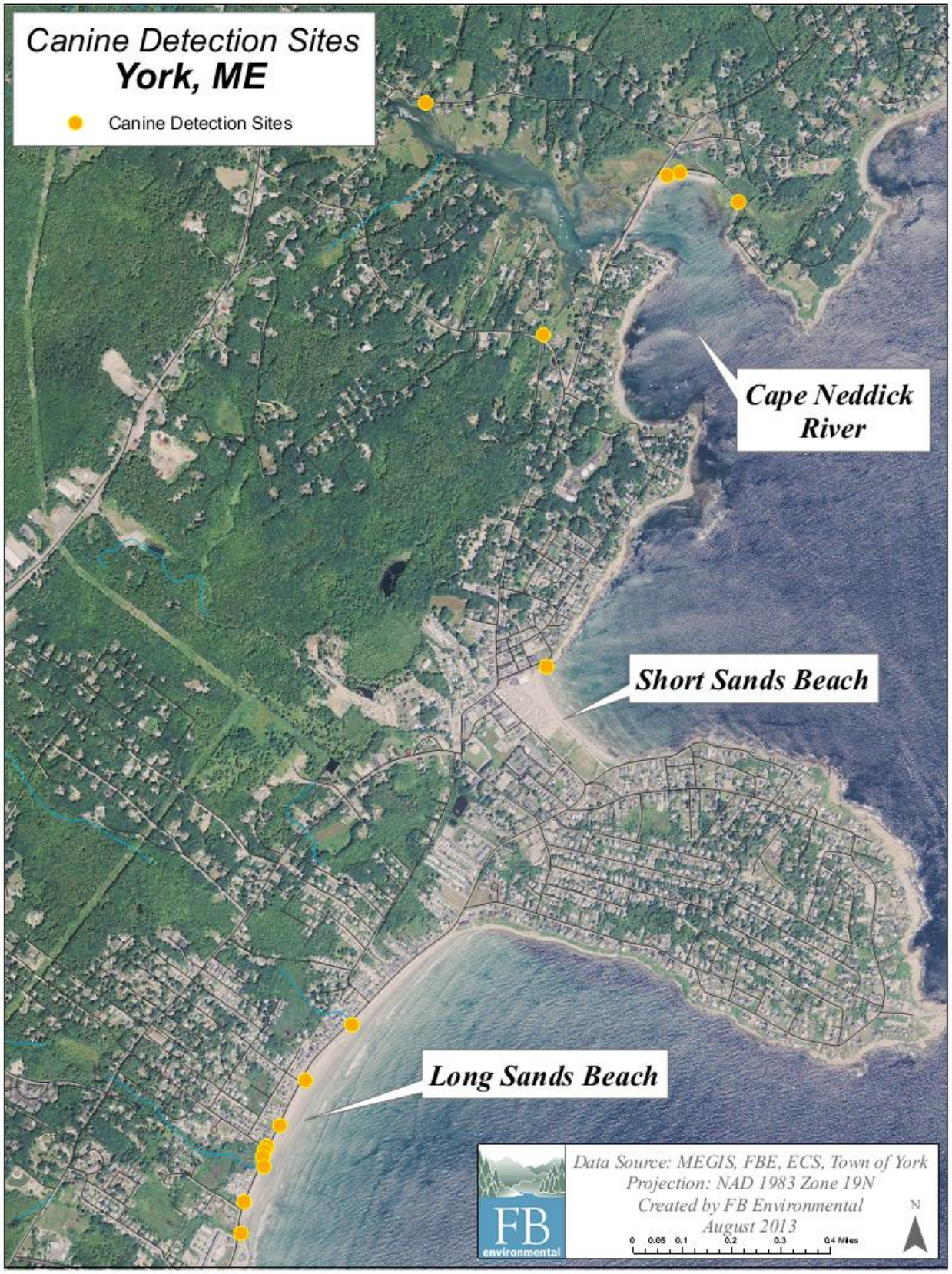
Each of the above methods has its merits, and they are most effective when used in a coordinated, watershed-based, iterative approach to detecting sources of bacteria to waterbodies.

3. BACTERIA SAMPLING IN YORK

3.1 SAMPLING LOCATIONS

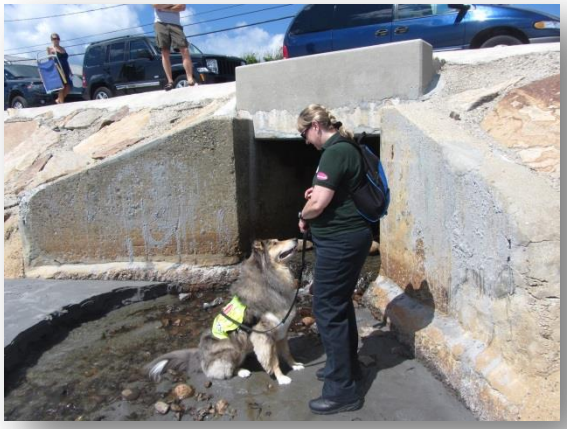
On July 30, 2013, Steve Burns and Leslie Hinz from the Town of York, Emily DiFranco and Laura Diemer from FB Environmental Associates (FBE), and Scott and Karen Reynolds from Environmental Canine Services (ECS) sampled tributaries and outfalls discharging to Long Sands Beach, Short Sands Beach, and the Cape Neddick River (Figure 1).

Figure 1: Sampling locations in York, Maine on July 30, 2013



3.2 SAMPLING METHODS

At all sampling locations, each dog was brought to the catch basin, outfall, or tributary in turn. Sable, indicated the presence of human wastewater by barking, while Logan indicated by sitting down. All in-field responses were recorded on field sheets. In locations that were inaccessible to the dogs, samples were collected using plastic buckets with lids. All buckets were triple-rinsed at the collection site. Buckets were presented on site to Sable and Logan and responses were recorded on field sheets. Buckets were handled with gloves upon opening and removed from the area after analysis. At many locations, bacteria samples were collected in Whirl-pak bags for analysis at Nelson Analytical Laboratory in Kennebunk, ME. Samples were transported to the laboratory on ice and were analyzed for enterococci bacteria. Sampling was conducted under low tide conditions.



Sable (left) and Logan (right) show their positive alert signals

4. BACTERIA AND CANINE DETECTION RESULTS, DISCUSSION, AND NEXT STEPS

Enterococci bacteria are important indicators of potential fecal contamination, and correspond with an increased likelihood of human illness from mammalian fecal contamination. As a basis for comparison, Maine's saltwater water quality standard (WQS) for bathing beaches for enterococci is 104 colonies/100 mL for instantaneous samples. Weather in the two days prior to sampling had been warm, dry, and sunny. Sunlight and heat both lead to higher die-off of bacteria in streams, while dry weather reduces the transport of most bacteria

The beach at the Cape Neddick River, York, Maine

sources to streams. All sampling was conducted under low tide conditions.

4.1 CAPE NEDDICK RIVER

The Cape Neddick River was investigated by Scott and Karen Reynolds and dogs Sable and Logan from Environmental Canine Services, Steve Burns and Leslie Hinz from the Town of York, and Emily DiFranco and Laura Diemer from FB Environmental. The field team investigated established sampling locations along the river and walked the shoreline along the outlet of the River.

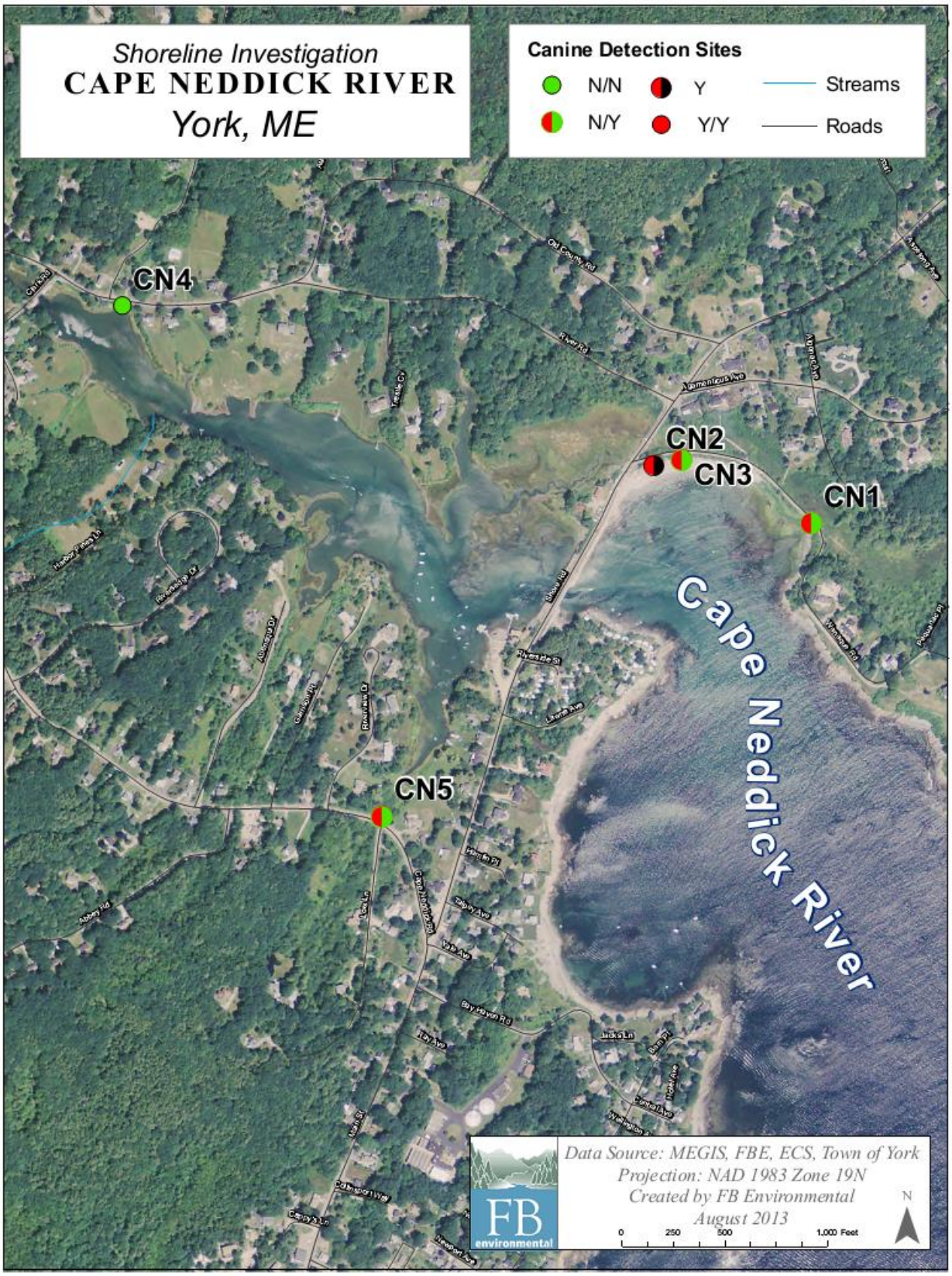
4.1.1 Cape Neddick River Results

As shown in Figure 2, five locations in and near the Cape Neddick River were assessed for the presence of human wastewater using canine detection. Canine response at four of the five sampling locations was positive for human wastewater (indicated by one dog). In addition to canine detection, water quality samples were taken at CN1, CN4, and CN5. All samples exceeded the water quality standard (Table 1).

Table 1: Sampling results from bacteria source tracking and canine detection on July 30, 2013 at the Cape Neddick River in York, ME

Site Name	Description	Enterococci (colonies/100 mL)	Dog Response (Sable/Logan)	Comments
CN1	Culvert to River	2755	No/Yes	White "sewage fungus present" toilet paper present in marsh
CN2	Right side of house from beach	--	No/Yes	
CN3	To the right of house	--	No/Yes	
CN4	River Road	1483	No/No	
CN5	Lois Lane and 1A	287	No/Yes	
Gray cells indicate an exceedance of the water quality standard (104 colonies/100mL). Blue cells indicate a positive response via canine detection from one dog only.				

Figure 2: Sampling locations on the Cape Neddick River in York, ME (July 30, 2013). Colored dots indicate canine response from Sable and Logan, respectively.



4.1.2 Cape Neddick River Discussion

Water quality sample collection at CN1

At one location (CN1), enterococci concentrations were over 20 times the water quality standard (Table 1). White sewage fungus was present at the site and fragments of toilet paper were found in the marsh upstream of the site. Though Sable did not indicate the presence of human wastewater at this site, high bacteria results, the presence of other human indicators such as toilet paper, and Logan's response indicates a potential septic system malfunction in this location. It has been shown in previous studies that some dogs used for canine detection can be overwhelmed by areas with large amounts of human sewage. In these studies, it was shown that many chemicals or substances with strong scent can occasionally temporarily deaden or wash out a canine's ability to scent. In a 2011 study by the Water Environment Research Foundation (WERF), Sable showed this limitation in some field trials while Logan did not.

At other locations throughout the watershed, Logan alerted to the presence of human wastewater while Sable did not. As described above, Sable has been shown to have upper detection limit limitations. In the same WERF study, it was shown that Logan is more sensitive to low levels of human wastewater than Sable. In these cases of a positive alert by Logan only, and if bacteria counts were relatively low, and if other indicators of human wastewater were not present, it is likely that the actual amount of human wastewater present at the time of detection was also relatively low. However, human sources should still be included as potential sources of bacteria in follow-up investigations.

House on the beach at Cape Neddick River by Sites CN2 and CN3

At the two beach locations (CN2 and CN3), Logan indicated the presence of human wastewater near a house located directly on the beach. Though no wet seeps were found and Sable did not indicate human wastewater at these locations, it is possible that previous septic failures have occurred at this site. Maintenance records for this system should be investigated.

At the two upstream locations (CN4 and CN5), water quality samples exceeded the water quality standard (Table 1). At CN4, bacteria concentrations were more than ten times the water quality standard. However, human wastewater was not detected at this

site indicating that other sources, such as wildlife or pet waste may be contributing to bacteria in this portion of the Cape Neddick River.

4.1.3 Recommended Next Steps for the Cape Neddick River

1. Contact the Maine Department of Environmental Protection about a potential septic system failure upstream of CN1;

2. Investigate the septic system history for the house at Sites CN2 and CN3. A dye test may be necessary to determine malfunction;

3. Continue to conduct regular sampling on the main stem of the Cape Neddick River and its tributaries in an effort to bracket sources of bacteria;

4. Examine the pattern of wet weather vs. dry weather bacteria counts, conducting additional sampling as needed. High counts in wet weather can indicate a connection to surface hydrology (street runoff, pet or wildlife waste, pipes or systems subject to overflow from rain) while high counts in dry weather suggest a source fed by a domestic water supply (leaking sewer pipes or septic systems); and

5. Investigate areas throughout the Cape Neddick River watershed for areas of concentrated pet waste and where wildlife congregates (such as birds).

4.2 LONG SANDS BEACH

Long Sands Beach was investigated by Scott and Karen Reynolds and dogs Sable and Logan from Environmental Canine Services, Steve Burns and Leslie Hinz from the Town of York, and Emily DiFranco and Laura Diemer from FB Environmental. The field team investigated the shoreline and all outfalls draining to the beach

Long Sands Beach, York, Maine

4.2.1 Long Sands Beach Canine Detection Results

As shown in Figure 3, nine locations on Long Sands Beach were assessed for the presence of human wastewater using canine detection. Four of the nine sites were positive for human wastewater (indicated by at least one dog), with two of these sites receiving positive responses from both dogs. In addition to canine detection, three sampling locations (LS2, LS7, and LS8) were also sampled for enterococci bacteria. All of these sites exceeded Maine's bacteria standard for bathing beaches and LS7 and LS8 tested positive for human wastewater (Table 2).

Figure 3: Sampling locations on Long Sands Beach in York, ME (July 30, 2013). Colored dots indicate canine response from Sable and Logan, respectively.

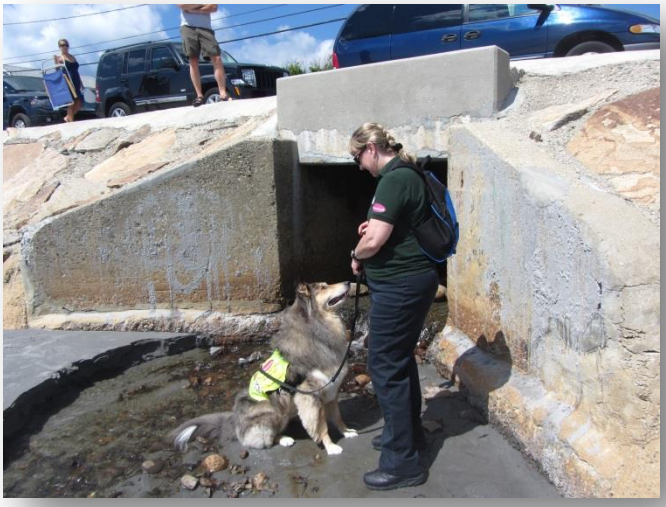
Table 2: Sampling results from bacteria source tracking and canine detection on July 30, 2013 at Long Sands Beach in York, ME

Site Name	Description	Enterococci (colonies/100mL)	Dog Response (Sable/Logan)	Comments
LS2	Stone-covered outfall	521	No/No	
LS1	Outfall by bathhouse	--	No/Yes	Very little flow from outfall
LS3	Catch Basin (CB) on road	--	No/Yes	By parking meter #L62; no inlet pipes; some seepage
LS4	CB on road	--	No/No	By parking meter #L69
LS5	CB on road	--	No/No	CB clogged; by utility pole 101S
LS6	CB on road	--	No/No	
LS7	Outfall draining small stream across street	754	Yes/Yes	Distinct odor from outfall
LS9	CB on road	--	No/No	By parking meter #L96
LS8	Outfall by restaurant	275	Yes/Yes	

Gray cells indicate an exceedance of the water quality standard (104 colonies/100mL).
Purple cells indicate a positive response via canine detection from both dogs.
Blue cells indicate a positive response via canine detection from one dog only.

4.2.2 Long Sands Beach Discussion

The canines alerted to the presence of human wastewater at four locations along Long Sands Beach. As described above, Logan has been shown to have a lower detection limit than Sable. In two instances, Logan alerted to the presence of human wastewater while Sable did not. In these cases, it is likely that the amount of human wastewater present at these locations is negligible.



Logan giving a positive alert at LS7

As shown in Table 2, LS2, LS7, and LS8 exceeded the water quality standard for bathing beaches in Maine. At two locations (LS7 and

LS8), human wastewater was detected. Sources of this wastewater could be from a leaking sewer line or illicit discharges to the stream. Though present, the actual amount of human wastewater at these outfalls is unknown and other sources should be considered. The high bacteria concentrations at these locations, as well as at LS2, could be due to other sources of bacteria including animal waste from the pets and wildlife.

4.2.3 Recommended Next Steps for Long Sands Beach

1. Examine the pattern of wet weather vs. dry weather bacteria counts, conducting additional sampling as needed at Sites LS7 and LS8. High counts in wet weather can indicate a connection to surface hydrology (street runoff, pet or wildlife waste, pipes or systems subject to overflow from rain) while high counts in dry weather suggest a source fed by a domestic water supply (leaking sewer pipes or septic systems);

Sable giving a positive alert at LS8

2. Map the drainage areas to outfalls at Sites LS7 and LS8;
3. Add bacteria sampling locations upstream of these locations in an effort to bracket the sources of bacteria;
4. Conduct an investigation (such as a smoke test) of the sewer line along Long Beach Avenue to ensure there are no leaks in the system; and
5. Walk the watershed upstream of Sites LS2, LS7, and LS8 to determine the extent of pet waste and to identify areas where wildlife (such as birds) may congregate.

4.3 SHORT SANDS BEACH

Short Sands Beach was investigated by Scott and Karen Reynolds and dogs Sable and Logan from Environmental Canine Services, Steve Burns and Leslie Hinz from the Town of York, and Emily DiFranco and Laura Diemer from FB Environmental. The field team investigated one known outfall to the beach.

4.3.1 Short Sands Beach Results

As shown in Figure 4, one location on Short Sands Beach was assessed for the presence of human wastewater using canine detection. Canine response at this location was positive for human sewage (indicated by one dog). In addition to canine detection, this SS1 also exceeded Maine's bacteria standard for bathing beaches (Table 3).

Figure 4: Sampling locations on Short Sands Beach in York, ME (July 30, 2013). Colored dots indicate canine response from Sable and Logan, respectively.

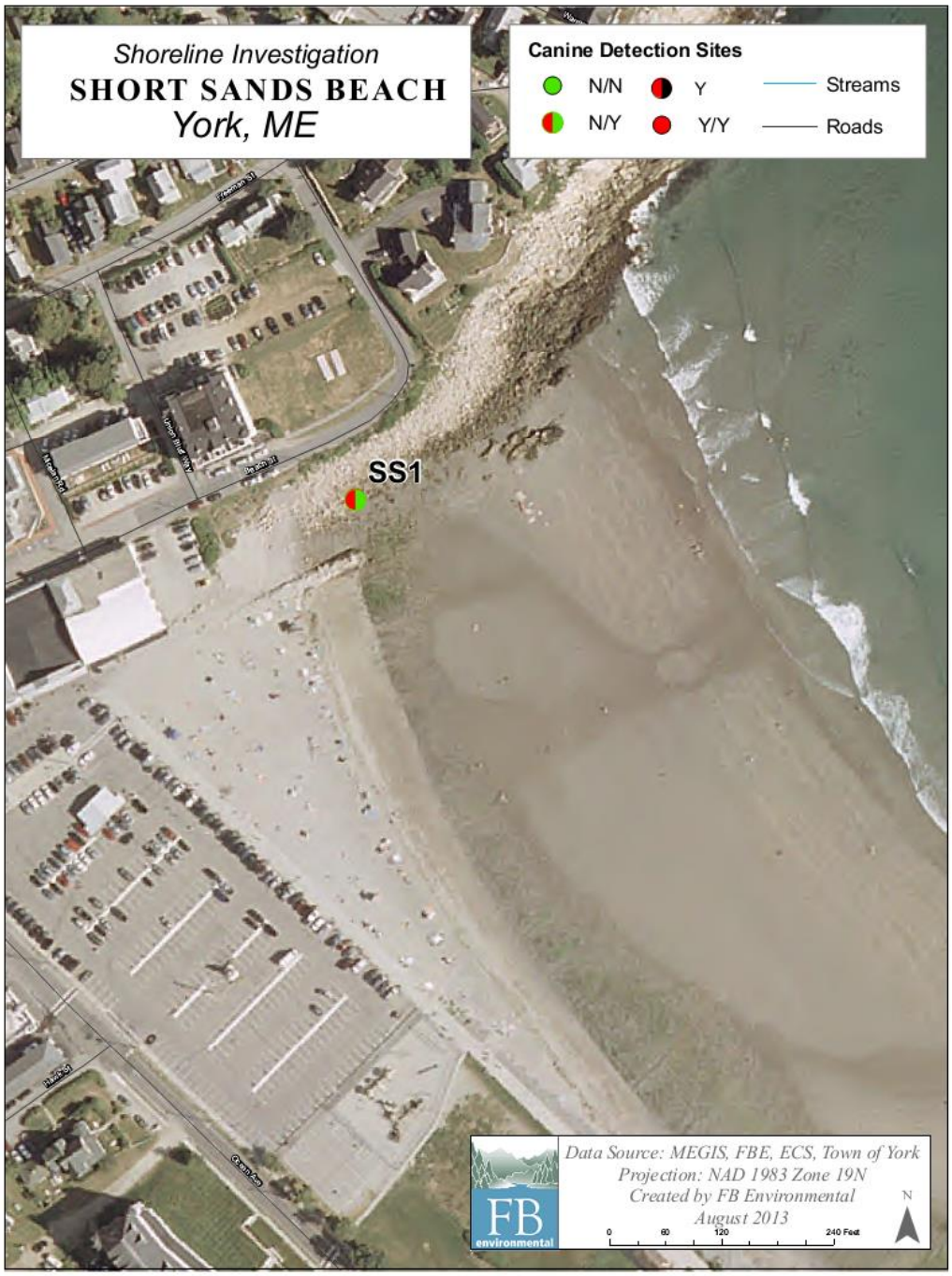


Table 3: Sampling results from bacteria source tracking and canine detection on July 30, 2013 at Short Sands Beach in York, ME

Site Name	Description	Enterococci (colonies/100 mL)	Dog Response (Sable/Logan)	Comments
SS1	Large grated outfall	359	No/Yes	Sniffed outfall structure and used bucket at this location
Gray cells indicate an exceedance of the water quality standard (104 colonies/100mL). **Blue cells indicate a positive response via canine detection from one dog only.**				

4.3.2 Short Sands Beach Discussion

One dog alerted to the presence of human wastewater at the outfall to Short Sands Beach (SS1) while the other did not. As discussed above, it is possible that the amount of human wastewater present at this location may be small. However, the water quality sample at this outfall was over three times the water quality standard for bathing beaches in Maine. Follow-up at this location should include an investigation of both human and non-human sources of bacteria.

Outfall SS1 on Short Sands Beach

4.3.3 Recommended Next Steps for Short Sands Beach

1. Examine the pattern of wet weather vs. dry weather bacteria counts, conducting additional sampling as needed. High counts in wet weather can indicate a connection to surface hydrology (street runoff, pet or wildlife waste, pipes or systems subject to overflow from rain) while high counts in dry weather suggest a source fed by a domestic water supply (leaking sewer pipes or septic systems);
2. Map the drainage areas to SS1;
3. Add bacteria sampling locations upstream of the outfall in an effort to bracket the sources of bacteria;
4. Walk the area to determine the extent of pet waste and to identify areas where wildlife (such as birds) may congregate;

5. PUBLIC OUTREACH

A public outreach event was held at the York Police Department from 2-4 pm on July 30, 2013. Other local organizations were invited to participate in the event. The event included demonstrations from the dogs and a discussion of water quality in York.

Public outreach event in York, Maine, July 30, 2013

Demonstration by Sable at the Outreach Event in York, Maine

Public Outreach Flyer for York, Maine

6. PRESS COVERAGE

Multiple media sources were invited to attend the sampling and outreach event in York, Maine on July 30, 2013. Media coverage included:

- Seacoast Online: July, 24, 2013
  http://www.seacoastonline.com/articles/20130724-NEWS-307240330?cid=sitesearch

Sewer sniffing dogs to visit York

July 24, 2013 2:00 AM

Sewer sniffing dogs to visit York

YORK — The town and FB Environmental of Portland and Portsmouth, N.H., will host Sable and Logan, dogs from Environmental Canine Services of Vermontville, Mich., for a day of bacteria source tracking.

The public is invited to demonstrations planned from 2 to 4 p.m. Tuesday, July 30, in the York Police Department parking lot.

The dogs assist with the detection of human sources of bacteria in water through scent, finding septic system failures, sewage leaks, and illicit connections to storm sewer systems.

Environmental Canine Services trains canines as a rapid screening method to track contaminants in stormwater. Field tests have shown the dogs are approximately 90 percent accurate compared with traditional laboratory water tests, and are a more efficient and cost-effective option for budget-stricken cities and municipalities looking to fix sewer problems and protect areas such as swimming beaches and shellfish beds.

FB Environmental Associates, established in 2001, specializes in directing environmental planning, assessment, monitoring, mapping, and restoration projects for an array of clients. The firm has experience working on water and natural resource projects throughout New England and has worked on numerous bacteria source tracking and mitigation projects.

For information, e-mail Emily DiFranco of FB Environmental at emilyd@fbenvironmental.com or call at (603) 343-6311.

- WCSH Channel 6: Dogs Help Detect Human Waste in Water, July 30, 2013
  http://www.wcsh6.com/news/article/251569/2/Dogs-help-detect-human-waste-in-water