

Memorandum

To	Robert Lowell, MA DCR	Page	1
CC	Thomas Valton, MA DCR		
Subject	2016 Stacey Brook Illicit Discharge Survey		
From	Paula Winchell, AECOM		
Date	February 13, 2017		

This memorandum provides findings from the Illicit Discharge bacterial and pharmaceutical surveys conducted along Stacey Brook in Lynn and Swampscott, Massachusetts (MA). On December 5, 2016 AECOM completed a survey of the discharges at Red Rock Beach (from both the Lynn and Swampscott sides) as well as at Stacey Brook. The field findings and lab results from the 2016 survey are outlined herein.

Stacey Brook Illicit Discharge Bacteria and Pharmaceutical/Personal Care Product Sampling

AECOM conducted sampling of flowing water found in three features which included Stacey Brook as well as the divided discharges from Lynn and Swampscott at Red Rock Beach (Figure 1). The AECOM team scheduled field investigation activities at times with less than a tenth of an inch of rain in the preceding 48 hours to ensure observed flows were the result of non-stormwater discharges, and went at a period of low tide so the system was not flooded with seawater. The investigations and sampling occurred during a light snow and rain event, but all samples were obtained prior to the point at which 0.10" of precipitation had fallen. Precipitation for December 5th measured at Red Rock Park in Lynn reached a total of 0.1-inch at 11:43 (SB-01 collected at 10:00, SB-02 at 10:20 and SB-03 at 11:35), with another 0.03-inch by 15:14 for a daily total of 0.13-inch. All samples that were collected were tested for *Escherichia coli* (*E.coli*), and *Enterococcus* by Alpha Analytical in Westborough, MA, and were tested for pharmaceuticals (EPA Method 1694 - caffeine, 1,7-DMX, acetaminophen, carbamazepine, primidone, atenolol, cotinine, urobilin, azithromycin) by ALS in Kelso, Washington. A summary of the sampling results is found below.

Bacteria Results

Dry weather flow was detected at all three of the features investigated. Each collected sample was laboratory tested for *E.coli*, and *Enterococcus* at Alpha Analytical.

Bacteria levels, as *Enterococcus*, exceeded the Massachusetts Department of Public Health Standard from 105 CMR 445.010 of 104 colonies per 100ml at all three sampling locations, and exceeded the Standard for *E.coli* of 235 colonies per 100ml at all three locations. The results of the study are outlined in Table 1 below and shown on the associated figure (Figure 1) attached.

Table 1. Bacteria Results from the Dry Weather Survey at Stacey Brook and Red Rock Beach

Sample Location	Date	Specific Conductivity (S/cm)	<i>E. Coli</i> (MPN/100ml)	<i>Enterococcus</i> (MPN/100ml)
SB-01 – Lynn Side	12/5/2016	937	1300	200
SB-02 – Swampscott Side	12/5/2016	1828	7900	1300
SB-03 – Stacey Brook at Grates	12/5/2016	2375	6000	1900

Pharmaceutical Testing Results

Samples from all three features were also tested for the presence of pharmaceutical and personal care products (EPA Method 1694 - caffeine, 1,7-Dimethylxanthine, acetaminophen, carbamazepine, primidone, atenolol, cotinine, urobilin, and azithromycin) by ALS in order to determine that the discharges include substances that would indicate the presence of human waste. High bacterial counts could be attributed to animal waste, but the presence of pharmaceuticals in any of the samples would indicate that human waste is getting into the stormwater system. The results of the pharmacological testing are outlined in Table 2 below, and are shown on the associated figure (Figure 1) attached.

Table 2. Pharmaceutical Results from the Dry Weather Survey at Stacey Brook and Red Rock Beach

Sample Location	Date	Caffeine (ng/L)	1,7-Dimethylxanthine (ng/L)	Acetaminophen (ng/L)	Carbamazepine (ng/L)	Primidone (ng/L)	Atenolol (ng/L)	Cotinine (ng/L)	Urobilin (ng/L)	Azithromycin (ng/L)
SB-01 – Lynn Side	12/5/16	140	ND	110	6.5	ND	ND	ND	ND	ND
SB-02 – Swampscott Side	12/5/16	2000	420	1800	5.2	ND	ND	ND	830	ND
SB-03 – Stacey Brook at Grates	12/5/16	2300	240	660	5.1	ND	ND	74	260	ND

ND = Not detected

The LC/MS/MS method EPA 1694 used by the laboratory is highly selective and eliminates most interferences, while improving the signal to noise ratio and sensitivity. This method was developed for use in Clean Water Act programs to quantify pharmaceuticals and personal care products in water, soil, sediments, and biosolids. Each of the detected target analytes was quantified by true

isotope dilution technique, meaning an isotopically labeled standard was added to the sample before extraction and then the calculated concentration is corrected for the recovery of the labeled analog.

There were minor Quality Control (QC) issues in the lab report, such as the holding time exceedance for just azithromycin and urobilin, low cotinine-d3 labeled standard recovery (3%), an LCS/LSCD caffeine RPD exceedance, and acetaminophen and urobilin LCS/LSCD recovery exceedances. None of these QC issues seriously impact the qualitative identification of the detected target analytes, which is the most important part of our intended data use. If validated, some of the results would be qualified as estimated concentrations based on the QC criteria exceedances, but none of the data would be rejected.

The lab results show the presence of the following pharmaceuticals:

- Acetaminophen, which is an antipyretic medication used to treat pain and fever. Acetaminophen has been found to be well correlated with *E. coli* and *Enterococcal* contamination of wastewater treatment plant effluent (Glassmeyer *et al.*, 2005);
- Caffeine, which is a trimethyl xanthine compound, and the primary stimulant found in coffee and tea. Detections of caffeine in wastewater and contaminated groundwater have been used as tracers of human sewage contamination and found to be highly correlated with fecal coliform contamination (Wu *et al.*, 2008; Petra, 2012);
- 1,7-Dimethylxanthine, also called paraxanthine, this compound is not produced by plants but only observed in nature as a metabolite of caffeine and theobromine (another xanthene alkaloid found in coffee, tea, and chocolate). After ingestion of caffeinated foods, paraxanthine is the primary product excreted by humans and a known indicator of human sewage (Glassmeyer *et al.* 2005);
- Carbamazepine, a tricyclic dibenzazepine medication used primarily in the treatment of epilepsy, neuropathic pain, schizophrenia, and bipolar disorder. Carbamazepine is a pharmaceutical compound that has no natural source, but is very stable when released in the environment and can persist up to 10 years in subsurface groundwater. Due to this chemical stability it is one of the most commonly detected human sewage related contaminants of groundwater and surface water (Sui *et al.*, 2015, Glassmeyer *et al.*, 2005, Standley *et al.*, 2008, and Fram and Belitz, 2011). Pharmacokinetic studies indicate about 5-percent of the ingested drug is excreted unchanged. It has been detected in wastewater effluent and sewage sludge, as well as groundwater and drinking water contaminated by sewage (Heberer, 2001);
- Cotinine, An alkaloid found in tobacco and the primary human metabolite of nicotine. Cotinine is used as a biomarker for exposure to tobacco smoke, and has been detected in 92.5% of wastewater treatment plant effluent samples analyzed as part of an EPA study (Glassmeyer *et al.*, 2005). Cotinine, like caffeine, is regarded as a significant potential indicator of sewage and human fecal contamination; and
- Urobilin, which is the chemical primarily responsible for the yellow color of urine.

With the exception of urobilin which is likely to be excreted by many animals, it is unlikely that all of these other substances found in the samples came from animal waste. The most likely source of these pharmaceuticals is human waste.

Recommendations

The dry weather results suggest that discharges from Lynn and Swampscott may be affecting bacterial levels at the outfalls at Red Rock Beach since both flows were found to contain bacterial

levels which exceed Massachusetts Department of Public Health (MA DPH) standards. Additionally, the presence of pharmaceuticals in all three of the samples indicates that human waste, not just animal waste, is entering the Massachusetts Department of Conservation and Recreation (MA DCR) stormwater system from both the Lynn and Swampscott sides of the outfall. AECOM recommends that MA DCR, and if necessary the cities of Lynn and Swampscott, perform further evaluations of these systems during dry-weather to determine the sources of these wastes.

References

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