Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in the New Salt Rd. Tributary, Goosefare Brook, Maine, 2012-2013

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APPENDICES

Executive Summary

The Goosefare Brook forms the border between the towns of Saco to the south and Old Orchard Beach (OOB) to the north and both are designated "MS4" communities. Since 2010, MHB has supported enhanced monitoring and pollution source tracking efforts, held Stakeholder Workshops, and more to address impaired water quality in the Saco and Old Orchard Beach tributaries feeding the brook. In 2011 and 2012, US EPA expanded the pollution source tracking toolbox to include analysis of pharmaceutical and personal care products. The Ocean Park Conservation Society also contracted with Canine Detection services to "sniff out" human sources in 2012. Over the past two years, MHB efforts have focused primarily on Old Orchard's New Salt Rd. Tributary (NSRT) while Maine DEP's efforts have focused on the tributaries feeding the Saco branch.

In 2013, MHB supported 170 Enterococci and 140 optical brightener samples at 17 sites stratified throughout the NSRT watershed. Enterococci values ranged from 5 MPN to 9999 MPN/100mls with a combined geometric[1] mean of 157 MPN for all sites, and the optical brightener values ranged from 0 to 155 μg/l with a combined mean of 89 μg/l for all sites in the NSRT. Results were analyzed to determine how each site deviated from the NSRT-wide Enterococci geometric mean and the mean optical brightener value. Nine sites located primarily within the GFB-01 and GFB-05 series exhibited positive deviations from the Enterococci geometric mean and 7 sites (largely within the GFB-05 series only) demonstrated positive deviations from the optical brightener mean. The pollution source-tracking tools applied in the NSRT were combined into a risk factor matrix, highlighting priority areas needing further investigation.

Saco and Old Orchard have conducted property surveys to identify malfunctioning septic systems as well as Illicit Discharge Detection and Elimination studies of sewer and stormwater infrastructure. This has led to the removal of numerous grey and black water discharges throughout the watershed as well as upgrades and expansion of sewer and stormwater infrastructure. Additionally, Saco and Old Orchard Beach worked together to acquire 319 funds to support a watershed management plan in 2014. Recommendations include continuing investigations to ensure the integrity of wastewater disposal (septics, sewer) and to expand and upgrade infrastructure throughout the watershed. Other recommendations to protect public health and improve water quality are also provided.

Acknowledgements

Written and compiled by Keri Kaczor, and Meagan Sims, Maine Healthy Beaches Program; UMaine Cooperative Extension. Reviewed by Bill Robertson-OOB Public Works and John Bird-Ocean Park Conservation Society. Special thanks to the dedicated volunteers who helped collect samples: Bill Bell and Trish Caruthers, as well as Maine DEP, US EPA, OOB, and Saco for their support.

[1] A geometric mean represents the typical value of a set of numbers. It is calculated using the product of a set of values rather than using their sum as when calculating an arithmetic mean (average).

Background

The Goosefare Brook demarcates the beach and town boundary between Saco and OOB. Just above the mouth, the brook splits into two branches, one draining primarily from Saco and the other from OOB (Figure 1). Progressing upland in the watershed (land area draining to the brook), the two sections of the brook continue to branch into a network of tributaries. The Goosefare Brook watershed is approximately 9.83mi^2 and is shared by the towns of Saco (approximately 4,000 acres) and OOB (approximately 1,000 acres). Municipal and private sewer services the majority of the Goosefare Brook watershed.

Consistently elevated bacteria levels documented through routine monitoring of 2 sites (GFB-01, Saco-00) located just above the mouth where the brook splits into two major sections, prompted the need to expand the monitoring efforts further upland in Goosefare Brook and associated tributaries. Since 2010, MHB has supported enhanced monitoring and pollution source tracking efforts to address impaired water quality in the brook and associated tributaries. Additionally, a 5.54-mile segment of the GFB and several upstream tributaries are listed on ME-DEP's 303(d) list of urban impaired waters for bacteria.

MHB partnered with ME-DEP and US EPA to expand the number of sites and parameters monitored as part of a larger pollution assessment study of Goosefare Brook. Results indicated widespread bacterial contamination throughout Goosefare Brook and a high likelihood of human-sourced fecal contamination, especially in Saco's Bear Brook (Appendix A). In response, MHB planned and facilitated meetings with representatives from Saco and OOB, ME-DEP and US EPA to share data and develop remediation strategies in 2011 (Appendix A). In 2012 and 2013, ME DEP focused on the areas feeding the Saco tributary (Appendix B) and MHB concentrated on the OOB branch termed the New Salt Rd. Tributary (NSRT) for the purpose of this report.

Project Methods

In an effort to pinpoint human sources contributing to bacterial pollution, MHB utilized the pollution source tracking toolbox approach including enhanced monitoring of multiple parameters. Typically, as the number of parameters that exceed a threshold (or detectable) limit increases, so does the confidence that human sources are impacting water quality. Although wildlife, pet and waterfowl waste can contribute to impaired water quality, it is recommended to target human sources first.

Enterococci and Optical Brighteners

Enterococci bacteria indicate the presence of fecal contamination from warm-blooded animals and the possible presence of disease-causing microorganisms. However, fecal indicator bacteria like Enterococci do not differentiate the source(s) of bacterial pollution. The safety thresholds used by MHB are those US EPA recommends for recreational water contact.

Optical brighteners are commonly used in commercial/retail products such as clothing detergents, dishwashing agents, and personal care products to brighten the whiteness of materials. These products are typically flushed down the drain; therefore, when optical

brightener concentrations are coupled with elevated fecal bacteria levels, this can be indicative of human-sourced fecal contamination. Typically, levels above 100 µg/l can be considered a "red-flag" for human impacts. For the NSRT watershed, the 100µg/l threshold may not be a good metric for indication of point-source pollution due to humic interference. Humic substances (tannins and other dissolved organic compounds) can cause interference and result in elevated OB readings. As a result, there will always be a "background level" contribution to OB readings in systems like the NSRT that have tea colored waters, an indicator of humic content.
MHB monitored two sites located at the two branches near the outlet of Goosefare Brook (Saco-00 and GFB-01) for bacteria and optical brightener (OB) levels on a weekly basis throughout the summers of 2012 and 2013. These samples were collected during both flood and ebbing tidal conditions. Additionally, 6 enhanced monitoring events were conducted in 2012 and 10 events in 2013 in the NSRT during ebb tide conditions, approaching low tide to assure downstream flow and decreased dilution with seawater. Fifteen monitoring stations were stratified throughout the NSRT sub-watershed in 2012 and 17 stations were monitored in 2013 targeting specific areas keeping in mind ease of accessibility and avoidance of private property (Figure 1, Figure 6).

Based on 2012 results, enhanced monitoring in 2013 targeted priority areas in addition to monitoring sites established during the 2012 season. One of these priority areas included the region where the brook goes underground (in a closed box culvert parallel to Rt. 9) between sites GFB-01-0 (Randall Ave.) and GFB-01-1 (Ancona Ave.). This catch basin (site GFB-01-2) was sampled three times during 2013 with the assistance of OOB Public Works. In addition, three sites (GFB-05-4, GFB-05-5, and GFB-05-6) were established to rule out bacteria contributions from regions beyond those sites already sampled and to isolate the potential source of contamination. Similarly, site (GFB-04-0B) was established in 2013 to isolate the potential source of contamination between sites GFB-04-0 and GFB-04 (Figure 6, Appendix D).

Deviation from Mean Values
Another potentially useful approach to identifying "hot-spots" of contamination is by examining how levels for each site deviate from the mean of all sites. In areas like the NSRT where all sites have elevated bacteria levels and OB results are likely impacted by humic interference, examining deviations from the mean may help pull a meaningful signal from the variability as well as help identify the most problematic sites within the system. Additionally, sites with positive deviations for both Enterococci and OB levels are likely impacted by human sources.

Pharmaceutical and Personal Care Products (PPCP)
With the help of US EPA, the source tracking toolbox was expanded to include analysis of 7 PPCPs in 2012. The presence of these compounds can be indicative of human sourced fecal contamination. In 2012, US-EPA analyzed PPCPs at 11 of the 15 locations within the NSRT sub-watershed for 4 of the 6 enhanced monitoring dates (Table 1). US EPA did not provide PPCP support in 2013.

Table 1. Description of PPCPs monitored at selected stations within the NSRT in 2012.

PPCP	Description
Atenolol	Control high blood pressure
Acetaminophen	Pain killer
Cotinine	Metabolite of nicotine
1,7-Dimethylxanthine	Metabolite of caffeine
Caffeine	Stimulant
Carbamazepine	Control seizures
Metoprolol	Control high blood pressure

Canine Detection Services
A separate study funded by the Ocean Park Conservation Society and conducted by FB Environmental Associates in partnership with Canine Detection services, collected Enterococci data and employed 2 sewage-sniffing dogs at 14 of the 15 locations throughout the NSRT watershed in 2012. The canines are trained to alert their trainers to the presence of human sources at distinct locations or in water sample collected from suspect areas (Appendix C). The Canines were not part of the study in 2013.

Risk Factor Matrix
MHB combined and assessed the results of the various parameters utilized in the pollution source tracking toolbox to highlight areas needing further investigations. As the number of parameters that exceed a threshold (or detectable) limit increased, so does the confidence that these areas are impacted by human sources.

Results/Discussion

2012

Enterococci and Optical Brighteners
All sites exceeded the US EPA-recommended Enterococci geometric mean safety threshold of 35 MPN/100ml (Figure 11.). Variability in the data set was large and single sample values ranged from 10-2755 MPN/100ml. Enterococci geometric mean levels also showed variability between monitoring stations and the average Enterococci value (geometric mean) for all NSRT sites was 196 MPN/100ml.

Optical brightener results mirrored those of Enterococci with regards to the overall elevated nature of the values. The variability of OB concentrations was considerably lower than the Enterococci data with levels ranging from 22-169 µg/l and a mean of 93µg/l. Mean OB concentration, like Enterococci, also showed variability between monitoring stations (Figure 12) with six sites exceeding 100 µg/l, the value Maine Healthy Beaches typically considers as a lower threshold for OB results with the potential for human wastewater contamination.

Pearson Product Moment correlations for the watershed as a whole for 2012 (R^2=0.1797, p< 0.0000) revealed a significant but weak relationship between Enterococci and OB concentrations suggestive of human sources impacting water quality in the NSRT.

Deviation from Mean Values

In 2012, 10 sites exhibited positive deviations from the NSRT-wide geometric mean value of 196 MPN/100 ml. These sites included those within all three major series (GFB-01, GFB-04, GFB-05) (Figure 2, Figure 4, Table 5). Eight sites (primarily within the GFB-01 and GFB-05 series) demonstrated positive deviations from the optical brightener mean value of 93 µg/l (Figure 3, Figure 5, Table 5).

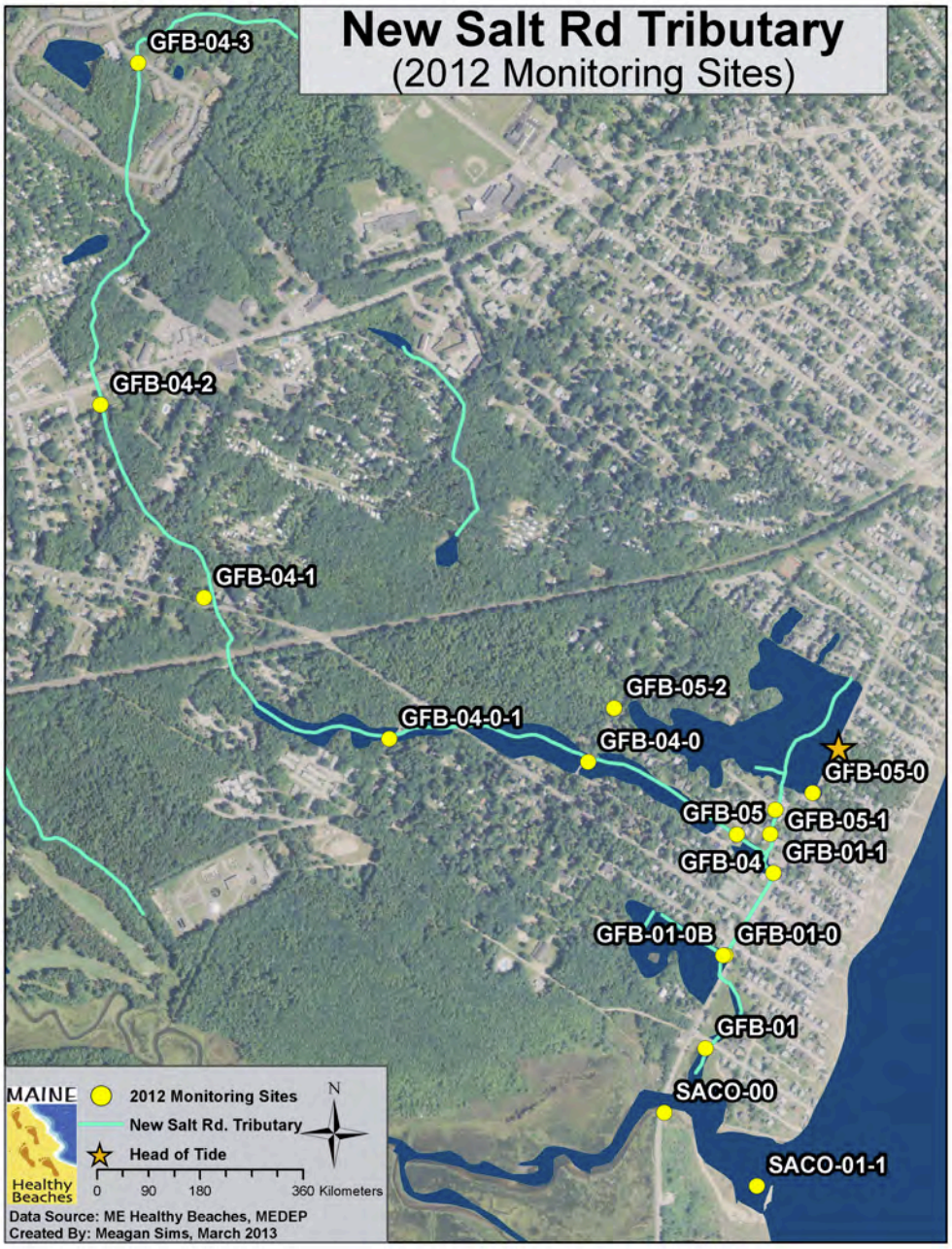

Figure 1. Aerial map of the 15 NSRT monitoring stations in 2012.

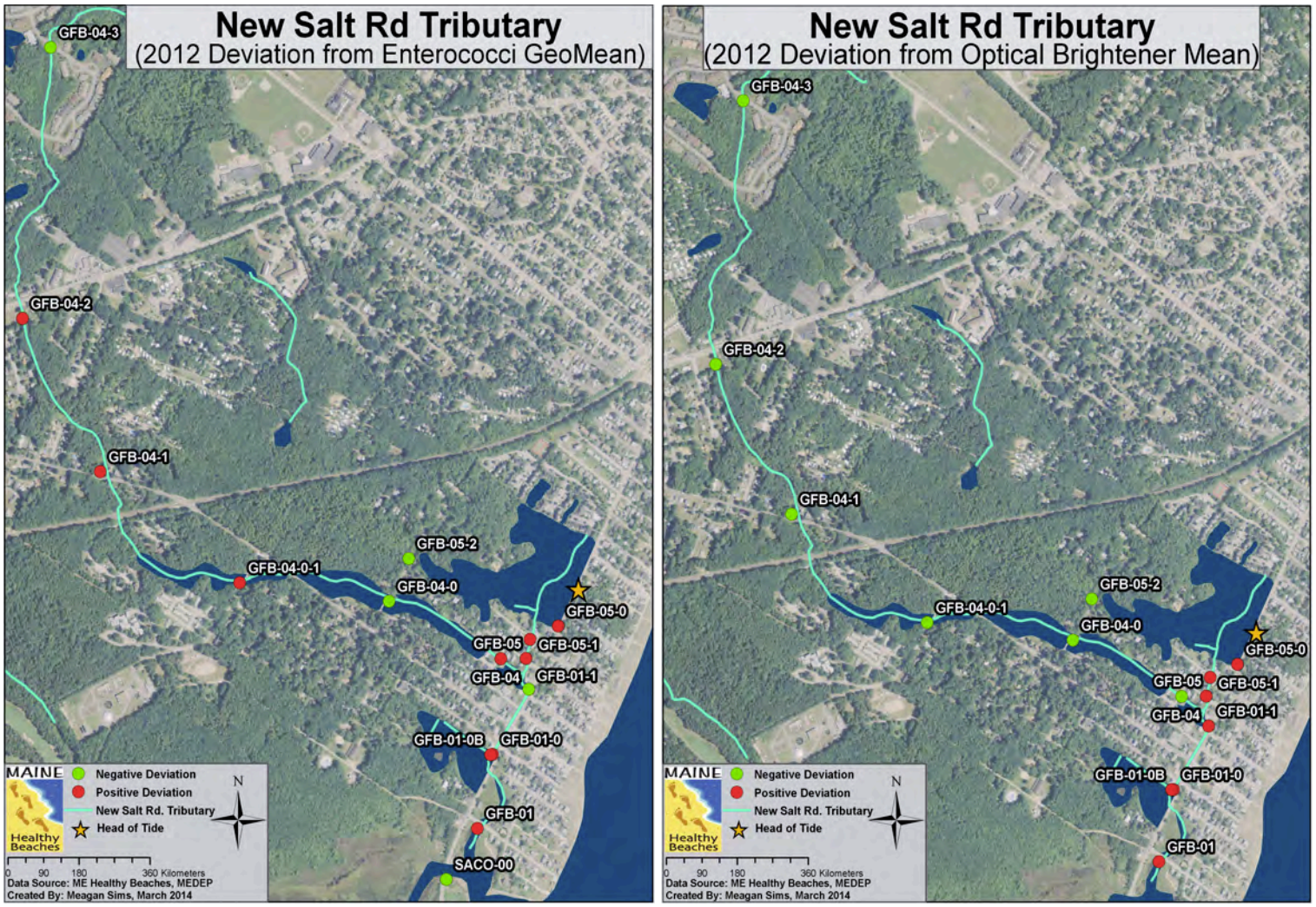

Figure 2 and 3. 2012 deviation from watershed-wide Enterococci geomean and mean optical brightener concentrations. Negative deviations represents sites with a geomean Enterococci and OB value less than the watershed geomean and average. Positive deviations represents sites with a geomean Enterococci and OB value greater than the watershed geomean and average

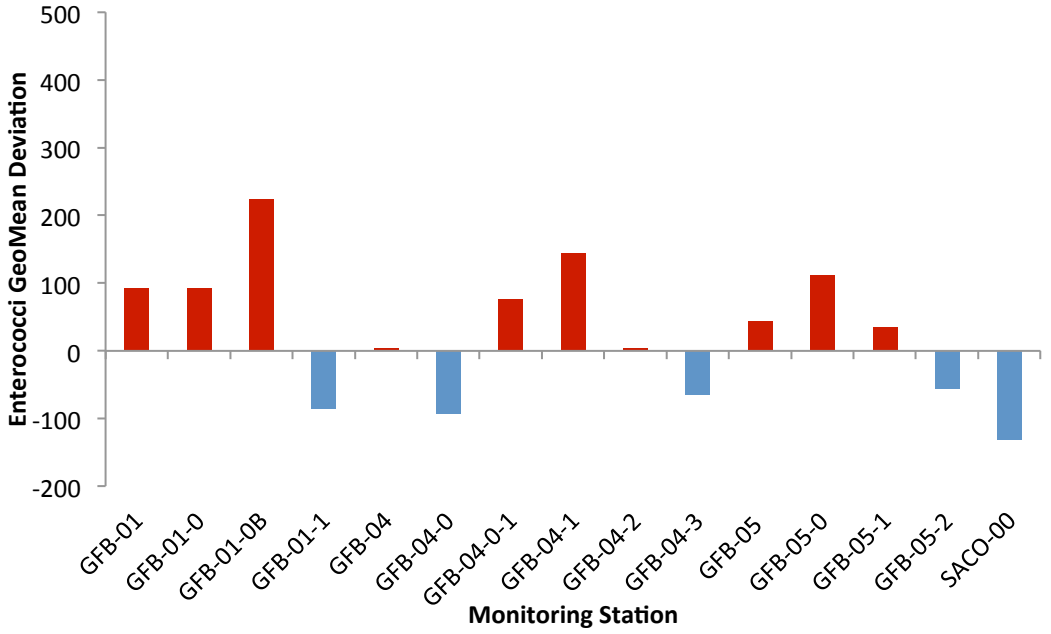

Figure 4. Deviations from the 2012 season-wide Enterococci geometric mean for all NSRT sites. Bars above the X-axis indicate monitoring locations where Enterococci values were greater than the average value and bars below X-axis represent those that were lower than the average value.

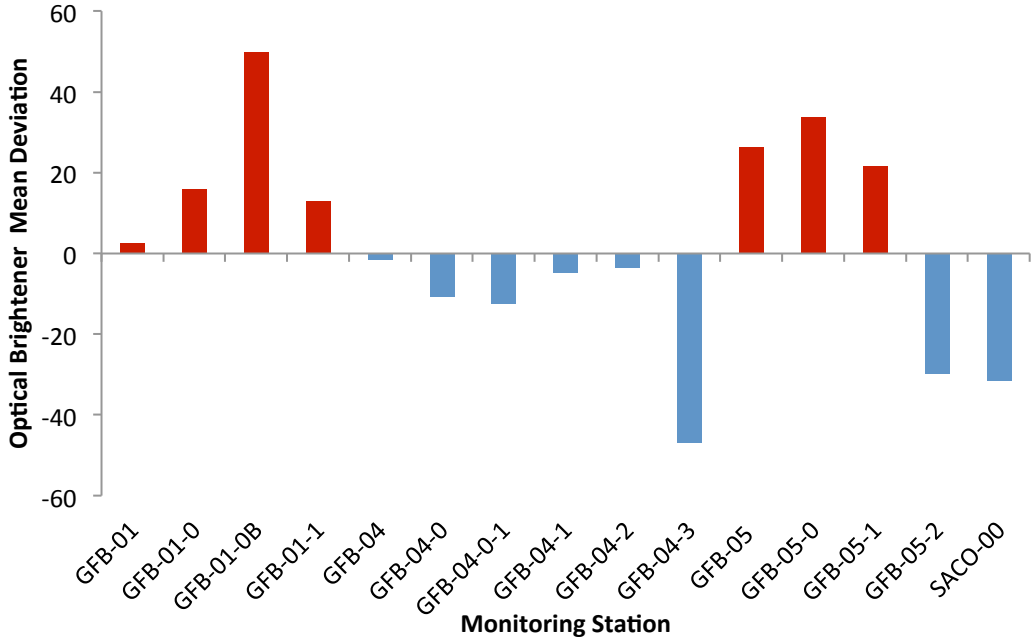

Figure 5. Deviations from the 2012 season-wide mean OB value for all NSRT sites. Bars above the X-axis indicate monitoring locations where OB values were greater than the average value for all sites in the NSRT sub-watershed and bars below X-axis represent those that were lower than the average value.

Pharmaceutical and Personal Care Products

PPCP results indicated that all 11 sites monitored had detectable limits of 1,7-dimethylxanthine, caffeine and cotinine (Table 2). These results are likely due to human sources in the NSRT watershed as 1,7-dimethylxanthine (caffeine metabolite) and cotinine (nicotine metabolite) pass through the human body.

As all sites monitored for PPCPs had detectable limits for the same 3 compounds, monitoring sites (GFB-04-0-1, GFB-05-0, and GFB-05-1) with 4 or more detectable limits out of the 7 PPCP compounds tested were considered to "stand out" in this context. The presence of multiple compounds is likely a "red flag" prompting the need for further investigation into potential illicit discharges in the areas surrounding those monitoring locations. In general, as the number of PPCP compounds with detectable limits increases, so does the likelihood of human sources of pollution are impacting water quality at or near the monitoring site. Further monitoring is recommended to increase the sample size.

Table 2. 2012 mean concentration (n=4) of pharmaceutical compounds (ng/l) for 11 monitoring stations within the New Salt Road Tributary sub-watershed. Rows highlighted in red indicate ≥ 4/7 pharmaceutical compounds present at or above the assay detection limit.

MONITORING STATION	1,7-DIMETHYLXANTHINE	ACETAMINOPHEN	ATENOLOL	CAFFEINE	CARBAMAZEPINE	COTININE	METOPROLOL
GFB-01	2.60	-	-	21.97	-	1.90	-
GFB-01-0	2.30	-	-	7.50	-	3.10	-
GFB-01-1	3.80	-	-	16.75	-	1.55	-
GFB-01-B	1.80	-	-	9.70	-	3.60	-
GFB-04-0	3.80	-	-	15.00	-	4.25	-
GFB-04-0-1	4.30	19.00	-	16.00	-	1.50	-
GFB-04-2	10.60	-	-	18.48	-	2.13	-
GFB-04-3	4.70	-	-	36.00	-	0.76	-
GFB-05-0	3.47	7.35	-	23.43	-	6.70	1.00
GFB-05-1	2.90	2.60	-	23.00	-	5.70	-
GFB-05-2	9.20	-	-	21.40	-	1.33	-

Canine Detection Study

All the sites monitored during the canine detection event, excluding Saco-00, exceeded the US EPA-recommended single sample threshold of 61 MPN/100mls for freshwater sites and 104 MPN/100mls for tidally influenced sites. Human sewage was detected by one dog at GFB-04-0-1, by the other dog at GFB-05-1, and both dogs alerted for human sewage at GFB-01(Appendix C).

Risk Factor Matrix

Factors include whether or not Enterococci (geometric mean) results exceeded the US EPA-recommended safety threshold of 35 MPN/100ml, if OB (mean) levels surpassed the "red-flag" threshold (100 µg/l) for human influence, if there was a positive deviation from the Enterococci (ENT) mean for all NSRT sites, if there was a positive deviation from the optical brightener

(OB) mean, if there was 4 or more detectable limits out of the 7 PPCP compounds tested, and if the canine detection results were positive.

Table 3. 2012 Pollution Source Tracking Toolbox, Risk Factor Matrix. Y = Yes, N= No.

MONITORING STATION	ENT ≥ 35 MPN/100ml	OB ≥100 µg/l	+ Dev. from ENT Mean	+ Dev. from OB Mean	≥4 PPCPs ng/l	+ Canine Det.
GFB-01	**Y**	N	**Y**	**Y**	N	**Y**
GFB-01-0	**Y**	**Y**	**Y**	**Y**	N	N
GFB-01-0B	**Y**	**Y**	**Y**	**Y**	N	-
GFB-01-1	Y	Y	N	Y	N	N
GFB-04	Y	N	Y	Y	-	N
GFB-04-0	Y	N	N	N	N	N
GFB-04-0-1	**Y**	N	**Y**	N	**Y**	**Y**
GFB-04-1	Y	N	Y	N	-	N
GFB-04-2	Y	N	Y	N	N	N
GFB-04-3	Y	N	N	N	N	N
GFB-05	**Y**	**Y**	**Y**	**Y**	-	N
GFB-05-0	**Y**	**Y**	**Y**	**Y**	**Y**	N
GFB-05-1	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
GFB-05-2	Y	N	N	N	N	N

Monitoring stations with ≥ 4 "Y" values are highlighted as priority sites with the potential for point sources of human associated fecal pollution within the New Salt road Tributary sub-watershed for 2012. The highlighted sites necessitate further investigation into potential sources of human fecal contamination, however, it should be noted that the matrix is merely an indicator of the likelihood of human-sourced fecal contamination and is not a definitive or conclusive indicator that illicit source(s) are present.

2013

Enterococci and Optical Brighteners

In 2013, 15 out of 17 sites exceeded the US EPA-recommended Enterococci geometric mean safety threshold of 35 MPN/100ml (Figure 13). As in 2012, the data was quite variable with single sample values ranging from 5-9999 MPN/100 ml. Enterococci geometric mean values varied substantially between monitoring locations and the average Enterococci geometric mean for all NSRT sites in 2013 was 157 MPN/100ml (Table 6).

Optical brightener concentrations demonstrated lower variability compared to Enterococci as they did in 2012. The single sample optical brightener concentrations for 2013 ranged from 0-155 µg/l. Overall, four sites exhibited elevated optical brightener concentrations above the 100 µg/l threshold considered by MHB to indicate the potential for human wastewater contamination (Figure 14, Table 6).

Pearson Product Moment correlations for the watershed as a whole in 2013 (R^2=0.0093, p= 0.2578), and combining data from 2012 and 2013 (R^2=0.0512, p= 0.0007) revealed no significant relationship between Enterococci and optical brightener values (Figure 17). These results suggest primarily non-point sources of contamination impacting the NSRT as a whole. However, small sample sizes and humic interference may have confounded these results. Examining the deviation from sample means of both Enterococci data and OB data can derive meaningful

information on potential target areas for human contamination nested within the larger water body.

Deviation from Mean Values

Nine sites exhibited positive deviations from the NSRT wide Enterococci geometric mean of 157 MPN/100 ml and were located primarily within the GFB-01 and GFB-05 series (Figure 7, Figure 9, Table B-1). The mean optical brightener value for all NSRT sites was 89 µg/l and 7 sites (largely within the GFB-05 series only) demonstrated positive deviations from the mean (Figure 8, Figure 10, Table 6).

Figure 6. Aerial map of the 17 NSRT monitoring stations in 2013.

Figures 7 and 8.2013 deviation from watershed-wide Enterococci geomean and mean optical brightener concentrations. Negative deviations represents sites with a geomean Enterococci and OB value less than the watershed geomean and average. Positive deviations represents sites with a geomean Enterococci and OB value greater than the watershed geomean and average

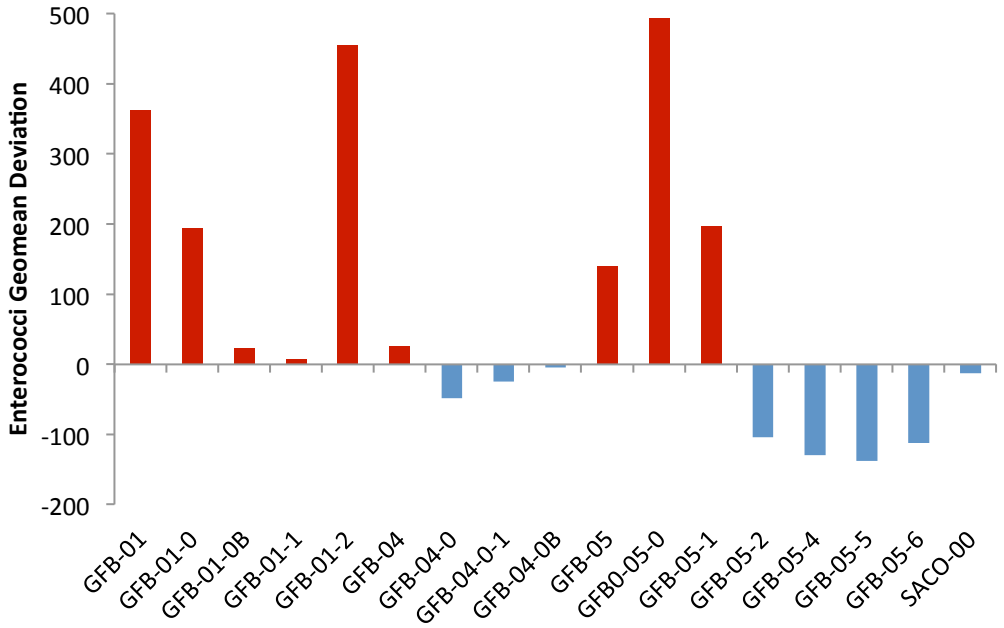

Figure 9. Deviations from the 2013 season-wide Enterococci geometric mean for all NSRT sites. Bars above the X-axis indicate monitoring locations where Enterococci values were greater than the average value and bars below X-axis represent those that were lower than the average value.

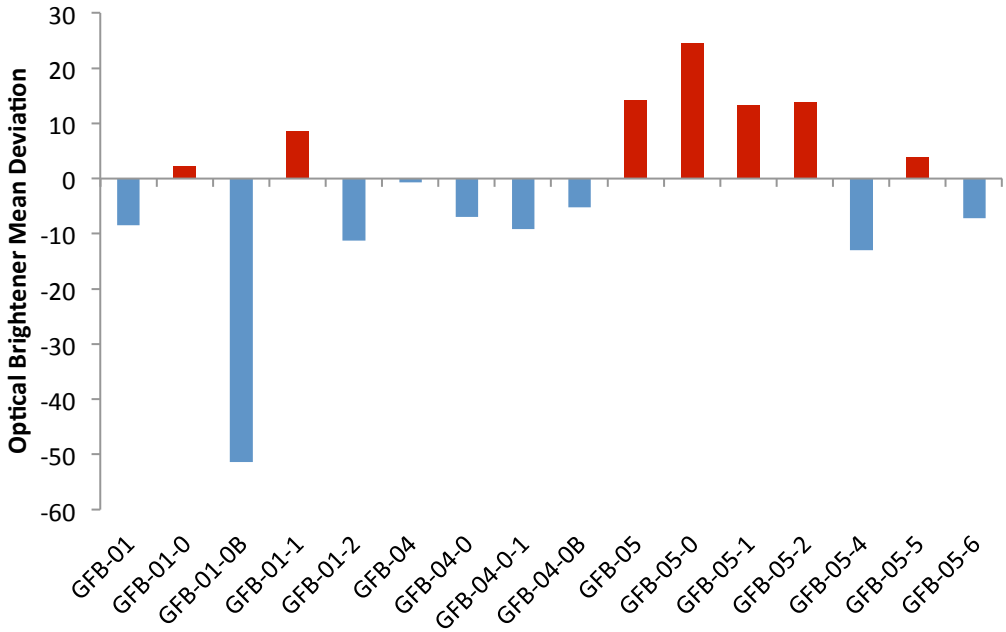

Figure 10. Deviations from the 2013 season-wide mean optical brightener value for all NSRT sites. Bars above the X-axis indicate monitoring locations where OB values were greater than the average value for all sites in the NSRT sub-watershed and bars below X-axis represent those that were lower than the average value.

Risk Factor Matrix

Monitoring stations with ≥ 3 are highlighted as priority sites with the potential for point sources of human associated fecal pollution within the New Salt road Tributary sub-watershed as fewer parameters were examined in 2013.

Table 4. 2013 Pollution Source Tracking Toolbox, Risk Factor Matrix. Y = Yes, N= No.

MONITORING STATION	ENT ≥ 35 MPN/100ml	OB ≥100 µg/l	+ Dev. from ENT Mean	+ Dev. from OB Mean
GFB-01	Y	N	Y	N
GFB-01-0	**Y**	N	**Y**	**Y**
GFB-01-0B	Y	N	Y	N
GFB-01-1	**Y**	N	**Y**	**Y**
GFB-01-2	Y	N	Y	N
GFB-04	Y	N	Y	N
GFB-04-0	Y	N	N	N
GFB-04-0-1	Y	N	N	N
GFB-04-0B	Y	N	N	N
GFB-05	**Y**	**Y**	**Y**	**Y**
GFB-05-0	**Y**	**Y**	**Y**	**Y**
GFB-05-1	**Y**	**Y**	**Y**	**Y**
GFB-05-2	N	Y	N	Y
GFB-05-4	N	N	N	N
GFB-05-5	N	N	N	Y
GFB-05-6	Y	N	N	N

Comparing data collected for both 2012 and 2013, four common sites (GFB-01-0, GFB-05, GFB-05-0, GFB-05-1) demonstrated positive deviations from the mean for both Enterococci *and* OB values (Tables 3 and 4). Three of those 4 sites also demonstrated Enterococci (geometric mean) and OB (mean) levels above the safety threshold for both years (Figures 15 and 16, Table 7). This suggests the potential for point sources of human fecal contamination in close proximity to these locations.

The highlighted sites necessitate further investigation into potential sources of human fecal contamination, however, it should be noted that the matrix is merely an indicator of the likelihood of human-sourced fecal contamination and is not a definitive or conclusive indicator that illicit source(s) are present. Additionally, stormwater drains directly to the NSRT sub-watershed at no fewer than 20 locations. Polluted stormwater carrying human, pet, and wildlife waste from diffuse sources throughout the watershed is likely having a substantial impact on NSRT water quality.

Impaired water quality in the NSRT is likely a combination of point and non-point sources. Potential point sources include leaky sewers, cross-connections between sewer and stormwater infrastructure, and malfunctioning septic systems. Non-point pollution includes polluted runoff from various diffuse sources including humans, pets, and wildlife. In addition to these sources, there are also several low-lying and marshy areas within the study area that may allow for regrowth of Enterococci in the environment.

Local Actions to Improve Water Quality

Saco and OOB have implemented Illicit Discharge Detection and Elimination (IDDE) studies using video surveys as well as smoke and dye testing to identify illicit cross connections between the sewer and storm drainage networks and damaged sewer lines (some are clay, some asbestos). Both towns have created and updated GIS layers of sewer and storm water networks to assist with source-tracking efforts. Additionally, both towns have made infrastructure improvements by replacing sewer lines, storm water catch basins, etc. Upgrades are costly and must be spread out over time.

In 2012, OOB Public Works conducted IDDE studies using cameras to explore the sewer line running between the Transfer Station on Rt. 9 and New Salt Rd near the tide gate and found no problems. They also ensured all homes within this vicinity were tied to the sewer and not on private septic. Additionally, OOB upgraded nearly 8,000 ft. of sewer lines (159 connections and 35 structures) as well as over 10,000 ft. of stormwater water drainage (95 structures) since 2010.

In 2013, OOB Public Works continued IDDE techniques, particularly camera work and dye testing. In Ocean Park, approximately 10,000 ft. of sewer lines (existing sewer lines and an existing drainage box culvert) were explored with cameras. OOB upgraded approximately 2500 feet of sewer pipe, 10 sewer manholes, 45-50 house connections, approximately 2100 feet of drain pipe, 20 structures (drain manholes and catch basins) and four flapper valves into Jordan Marsh. OOB Public Works also performed dye tests for 51 properties located in close proximity to the Goosefare Brook. As a result, one failed system located at the mouth of the Brook was detected and Old Orchard Beach Codes Enforcement will take steps to address the malfunctioning in the spring of 2014.

In 2013, Saco expended approximately $48,000 on infrastructure improvements, televised over 12,000 ft. of sewer and storm drain lines, and dye tested15 properties with subsurface wastewater disposal. In addition, 760 linear feet of sewer lines were replaced within the Bear Brook Watershed, a tributary of the Goosefare Brook. As part of this work, one malfunction was detected in which the sewer and stormwater flow were running to the same line. The malfunction was resolved by the construction of a new sewer main beside the existing stormwater line.

As part of a joint effort between the towns of Saco and Old Orchard Beach, a proposal was submitted to the Maine Department of Environmental Protection to obtain a supplemental 319 grant to develop a Goosefare Brook Watershed Management Plan. This grant was awarded the towns and work will begin during the spring of 2014. Additionally, as part of MS4 requirements, both towns submitted a Stormwater Program Management Plan detailing best management practices planned to reduce the discharge of pollutants, protect water quality, and meet requirements set forth by the Clean Water Act. Additionally, Old Orchard Beach has a bi-annual tax credit for property owners that pump-out their septic systems. The Ocean Park Conservation Society has also posted signage at the mouth of Goosefare Brook alerting the public to the possible risk of water contact at this location.

As part of MS4 requirements, both towns plan to continue IDDE studies to ensure the integrity of storm and sewer infrastructure and OOB Public Works plans to continue dye testing homes in close proximity to the brook. Utilizing 319 grant funding, a steering committee will be formed to

provide guidance throughout the grant execution process, information on the current and past condition of the Goosefare Brook Watershed will be compiled, monitoring will be conducted focusing on a suite of watershed health characteristics, a focus will be placed on stormwater retrofit and watershed restoration planning, and public outreach and involvement will be emphasized

Recommendations

Target Human Sources
It is recommended that the town continue local efforts to expand and improve sewer and stormwater infrastructure as well as conduct investigations of suspect areas to rule out sources of human sewage (e.g. faulty sewer lines, cross connections between sewer and stormwater, malfunctioning septic systems), particularly in the vicinity of the priority sites indicated in Tables 3 and 4. For example, one priority area is where the brook runs beneath a residential area between sites GFB-05-1 (Oceana Ave.) and GFB-05-0 (Rt.9 near Casco Ave.) (Figure 18). It is notable that site GFB-05-1, where the brook crosses Oceana Ave., is the only site that showed positive results for all of the source tracking tools considered in the 2012 study. Also, it is recommended that investigations continue at GFB-01-2 where the brook goes underground (in a closed box culvert parallel to Rt. 9) between sites GFB-01-0 (Randall Ave.) and GFB-01-1 (Ancona Ave). It may also be worthwhile to recheck the area near the tide gate to ensure a tight system. Investigating properties and monitoring is necessary along tributary (runs parallel to Oceana Ave.) between sites GFB-05-02 (Free St.) and GFB-05-0 (Oceana Ave) and in the drainage north along Rt. 9.

In addition to IDDE investigations, continued monitoring of multiple parameters (toolbox approach) is needed to further explore the source(s) of pollution and to verify sites are clean following remediation work. Monitoring should include more intense stratification of sites near known priority areas to increase the chances of isolating contamination sources. On a broad scale, it is recommended the town incorporate water quality assessment and investigation of these sites into their MS4 Permit/Plan that requires the town to develop and implement a stormwater management program.

Signage
Recreational water contact occurs in the mouth of GFB including swimming and people jumping off of the Rt. 9 Bridge. It is recommended that Saco and OOB post permanent signage at the bridge and on both banks of the river mouth alerting the public to the potential hazards of swimming at this location until bacteria levels are consistently within acceptable limits.

Precautionary Rainfall Advisories
Due to the history of impaired water quality in the brook and its impact on adjacent coastal beaches, it is recommended that local beach managers from both towns post a precautionary rainfall advisory when local precipitation levels are greater than one inch within 24hrs. The advisory should be kept in place for at least 24hrs after the rainfall ceases to allow flushing of the system.

Promote Best Practices

The towns are also encouraged to follow low impact development practices throughout the watershed such as reducing impervious surfaces to allow rainwater to naturally percolate into the ground, preserving and recreating natural landscapes to treat polluted runoff, restoring vegetative buffers (sections of vegetation adjacent to bodies of water used to minimize runoff effects), etc. Also, it is suggested that the towns continue to work with partners (e.g. MHB, OOB Conservation Society) on outreach and education campaigns such as septic system maintenance, responsible pet waste management, and storm drain stenciling (e.g. no dumping, drains to ocean).

Disclaimer

This report has been compiled to the best of the Maine Healthy Beaches Program's knowledge. Please submit and comments or additions to the program www.mainehealthybeaches.org

Supporting Figures

2012 Monitoring Data

Table 5. 2012 data summary for Goosefare Brook watershed monitoring including the mean Enterococci concentration, geometric mean Enterococci concentration, mean optical brightener concentration and the sample size at each site for Enterococci and optical brightener samples.

Site	Mean ENTERO	GeoMean ENTERO	Mean OB	Sample Size ENTERO	Sample Size OB
GFB-01	597.4	288.7	95.9	18	18
GFB-01-0	334.0	288.6	109.2	5	6
GFB-01-0B	509.5	419.9	143.0	2	2
GFB-01-1	239.6	111.1	106.2	5	6
GFB-04	292.8	200.2	91.7	5	6
GFB-04-0	226.0	103.8	82.6	5	6
GFB-04-0-1	462.6	272.7	80.7	5	5
GFB-04-1	494.5	339.6	88.4	4	5
GFB-04-2	282.0	199.7	89.5	4	5
GFB-04-3	158.5	131.9	46.3	4	5
GFB-05	271.0	239.9	119.5	5	6
GFB-05-0	337.2	307.6	127.0	5	6
GFB-05-1	253.2	230.8	114.9	5	6
GFB-05-2	182.6	140.1	63.5	5	6
SACO-00	248.6	64.7	61.8	21	18
Total	**339**	**196**	**93**	**98**	**106**

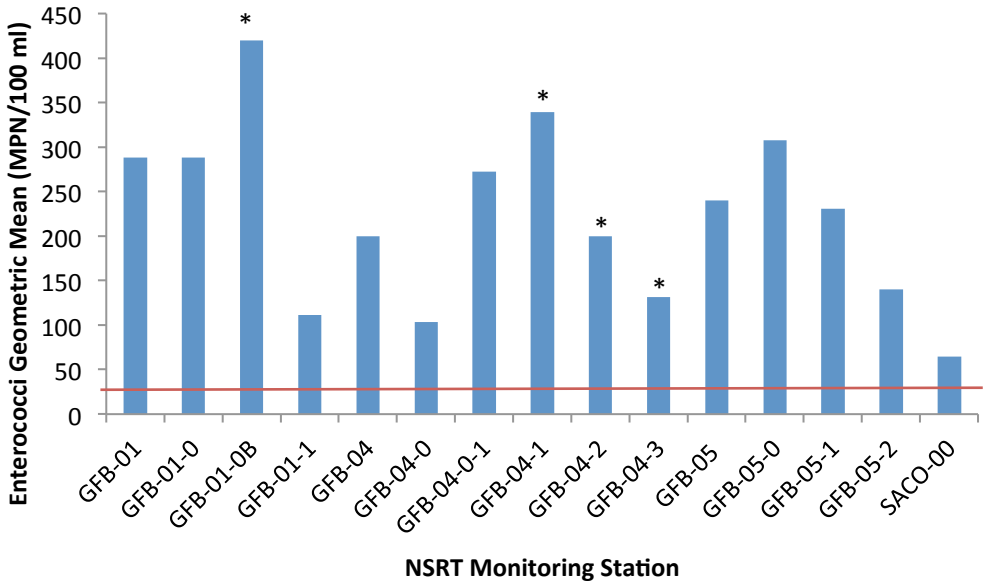

Figure 11. The 2012 geometric mean Enterococci (MPN/100ml) values by monitoring station in the NSRT as indicated by blue bars. Red solid line indicates safety level of 35 MPN/100ml. Asterisks indicate values based on 5 or fewer samples.

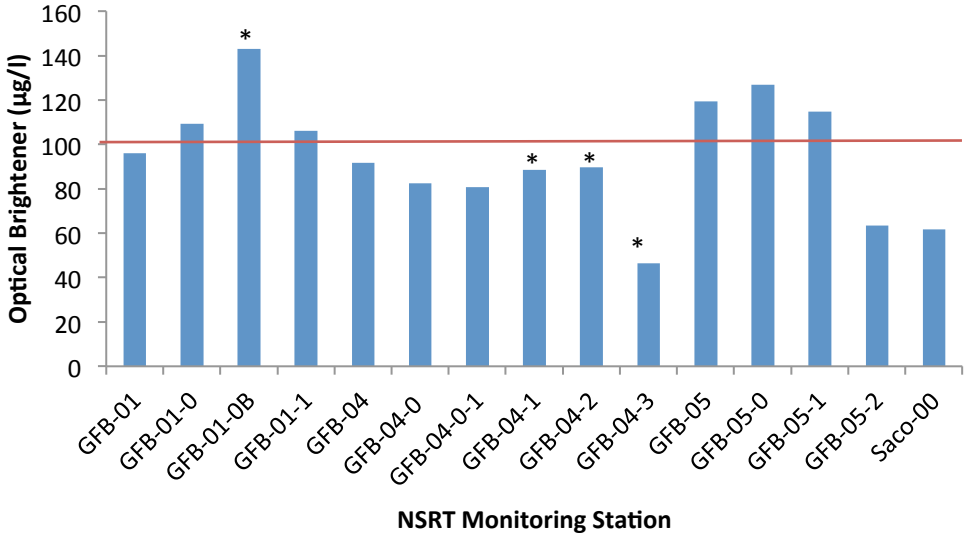

Figure 12. The 2012 New Salt Road Tributary mean optical brightener (µg/l) concentrations by monitoring station. Red solid line indicates optical brightener lower threshold (100 µg/l) indicating the potential for human wastewater contamination. Asterisks indicate values based on 5 or fewer samples.

2013 Monitoring Data

Table 6. 2013 data summary for Goosefare Brook watershed monitoring including the mean Enterococci concentration, geometric mean Enterococci concentration, mean optical brightener concentration and the sample size at each site for Enterococci and optical brightener samples.

Site	Mean ENTERO	GeoMean ENTERO	Mean OB	Sample Size ENTERO	Sample Size OB
GFB-01	1355.8	518.9	80.4	25	10
GFB-01-0	449.0	350.7	91.1	10	10
GFB-01-0B	181.0	179.5	37.6	2	3
GFB-01-1	213.2	163.9	97.5	10	10
GFB-04	207.9	183.3	88.1	9	9
GFB-04-0	132.9	108.9	81.9	9	9
GFB-04-0-1	196.5	132.7	79.8	8	9
GFB-05	315.6	297.2	103.2	10	10
GFB-05-0	729.9	650.1	113.4	9	9
GFB-05-1	381.9	354.2	102.2	10	10
GFB-05-2	89.8	52.8	102.8	9	9
SACO-00	1189.9	144.7	-	15	-
GFB-01-2	658.3	611.4	77.6	3	3
GFB-04-0B	181.1	152.5	83.7	9	9
GFB-05-4	37.7	27.1	75.9	10	10
GFB-05-5	25.7	19.4	92.8	10	5
GFB-05-6	74.7	44.6	81.7	9	6
Total	**487**	**157**	**89**	**167**	**131**

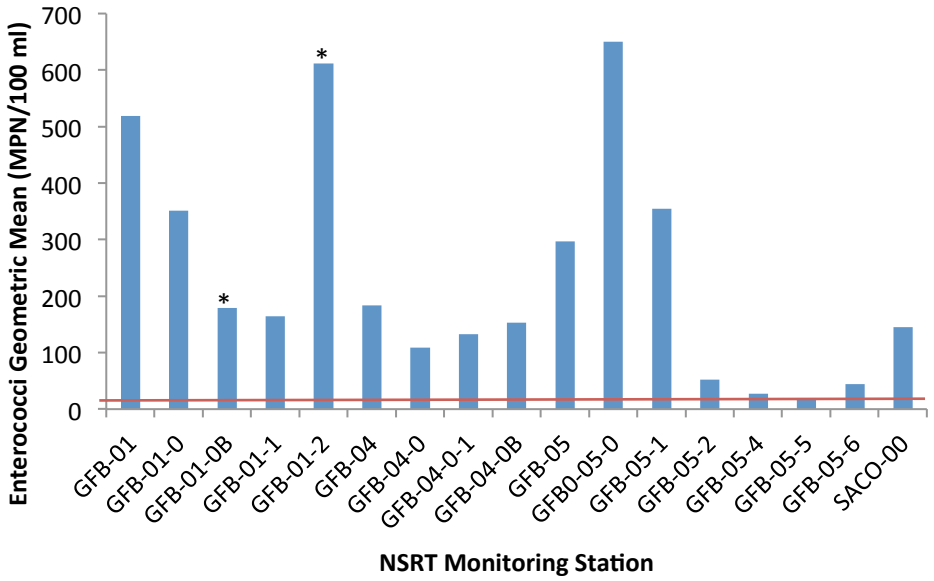

Figure 13. The 2013 geometric mean Enterococci (MPN/100ml) values by monitoring station in the NSRT as indicated by blue bars. Red solid line indicates safety level of 35 MPN/100ml. Asterisks indicate values based on 5 or fewer samples.

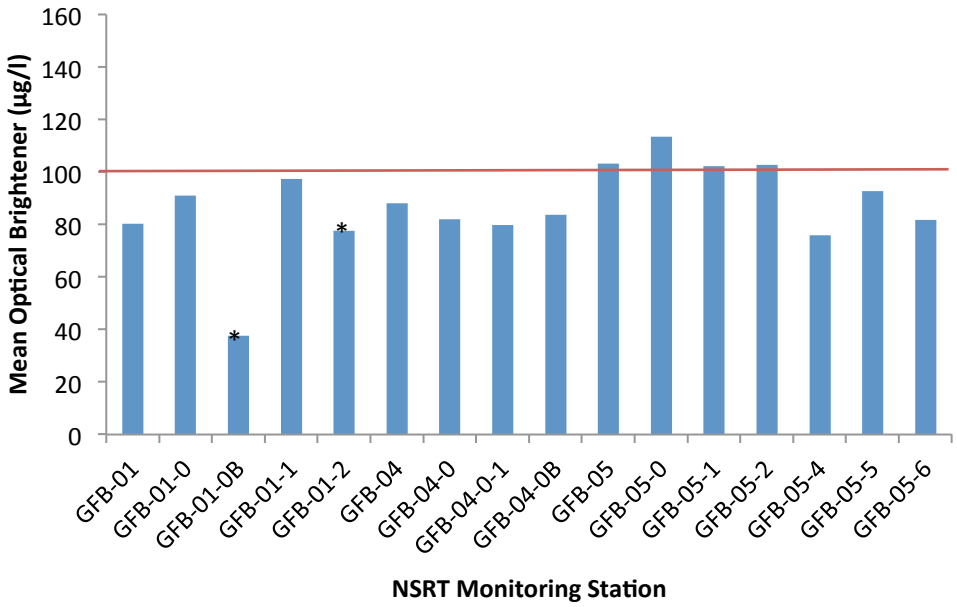

Figure 14. The 2013 New Salt Road Tributary mean optical brightener (µg/l) concentrations by monitoring station. Red solid line indicates optical brightener lower threshold (100 µg/l) indicating the potential for human wastewater contamination. Asterisks indicate values based on 5 or fewer samples.

2012 & 2013 Monitoring Data

Table 7. 2012-2013 data summary for Goosefare Brook watershed monitoring including the mean Enterococci concentration, geometric mean Enterococci concentration, mean optical brightener concentration and the sample size at each site for Enterococci and optical brightener samples.

Site	Year	Mean ENTERO	GeoMean ENTERO	Mean OB	Sample Size
GFB-01	2012 & 2013	1009.6	397.0	88.0	46
GFB-01-0	2012 & 2013	410.7	328.7	98.0	15
GFB-01-0B	2012 & 2013	345.3	274.6	99.7	4
GFB-01-1	2012 & 2013	222.0	144.0	101.4	15
GFB-04	2012 & 2013	238.2	189.2	90.2	14
GFB-04-0	2012 & 2013	166.1	107.1	83.3	14
GFB-04-0-1	2012 & 2013	286.1	170.5	81.0	13
GFB-04-1	2012	494.5	339.6	88.4	5
GFB-04-2	2012	282.0	199.7	89.5	5
GFB-04-3	2012	158.5	131.9	46.3	5
GFB-05	2012 & 2013	300.7	276.7	109.8	15
GFB-05-0	2012 & 2013	589.6	497.6	119.0	14
GFB-05-1	2012 & 2013	339.0	307.1	107.6	15
GFB-05-2	2012 & 2013	122.9	74.8	89.9	14
SACO-00	2012 & 2013	663.9	92.3	61.3	34
GFB-01-2	2013	658.3	611.4	77.6	3
GFB-04-0B	2013	181.1	152.5	83.7	9
GFB-05-4	2013	37.7	27.1	75.9	10
GFB-05-5	2013	25.7	19.4	92.8	9
GFB-05-6	2013	74.7	44.6	81.7	9
Total		**301**	**158**	**91**	**268**

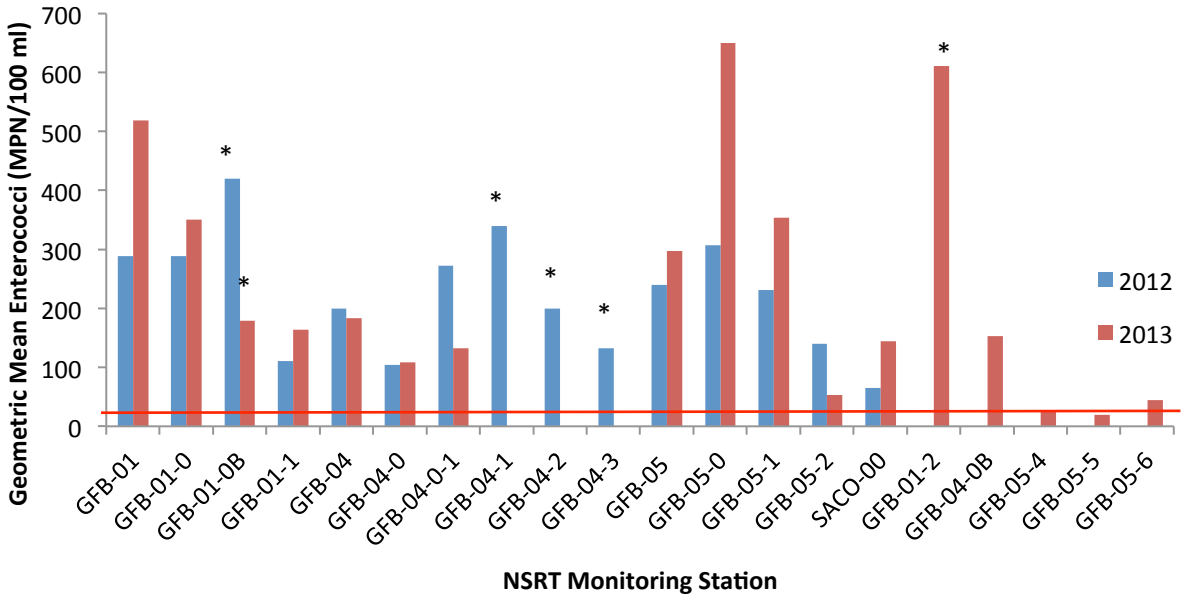

Figure 15. The 2012-2013 geometric mean Enterococci (MPN/100ml) values by monitoring station in the NSRT as indicated by blue bars (2012) and red bars (2013). Red solid line indicates safety level of 35 MPN/100ml. Asterisks indicate values based on 5 or fewer samples.

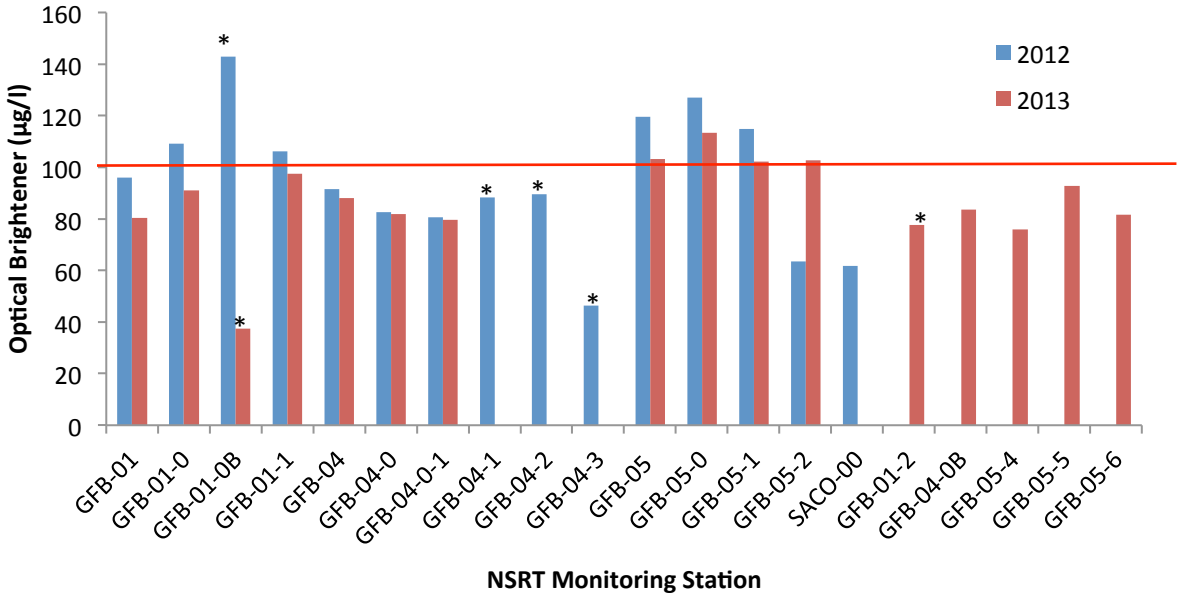

Figure 16. The 2012-2013 mean optical brightener (µg/l) concentration by monitoring station in the NSRT as indicated by blue bars (2012) and red bars (2013). Red solid line indicates optical brightener lower threshold (100 µg/l) indicating the potential for human wastewater contamination. Asterisks indicate values based on 5 or fewer samples.

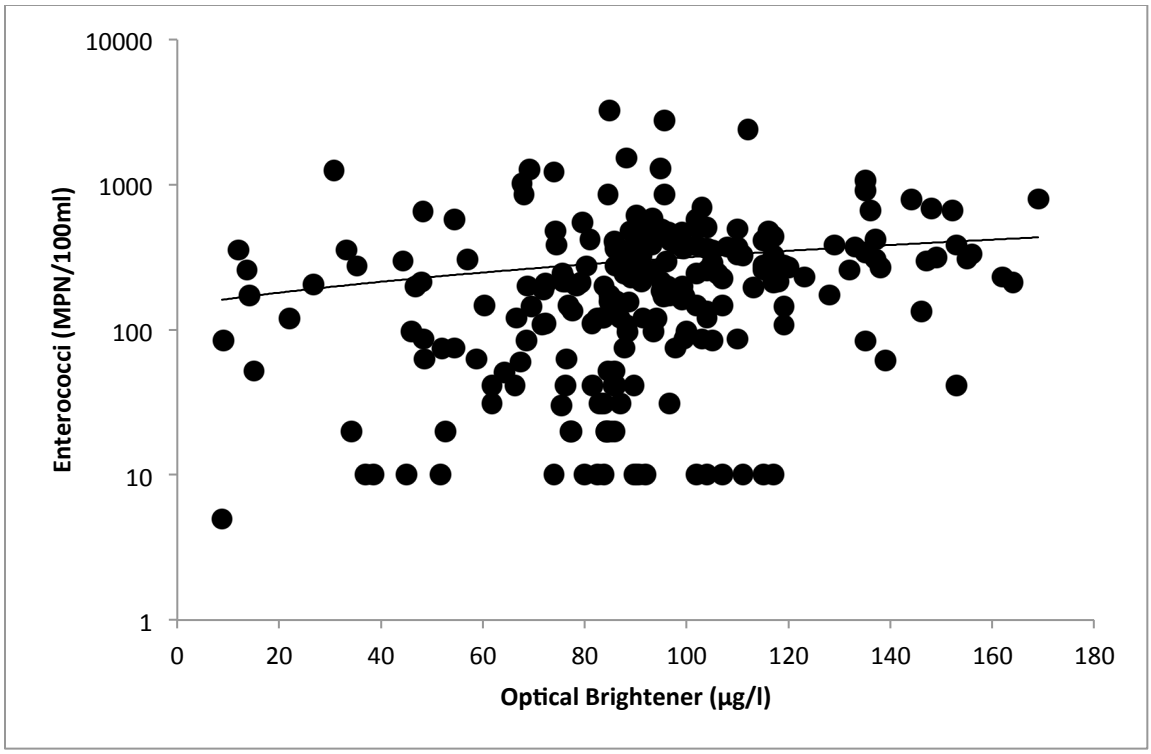

Figure 17. Relationship between Enterococci (MPN/100ml) and optical brightener (µg/l) levels during the 2012 and 2013 seasons for the NSRT.

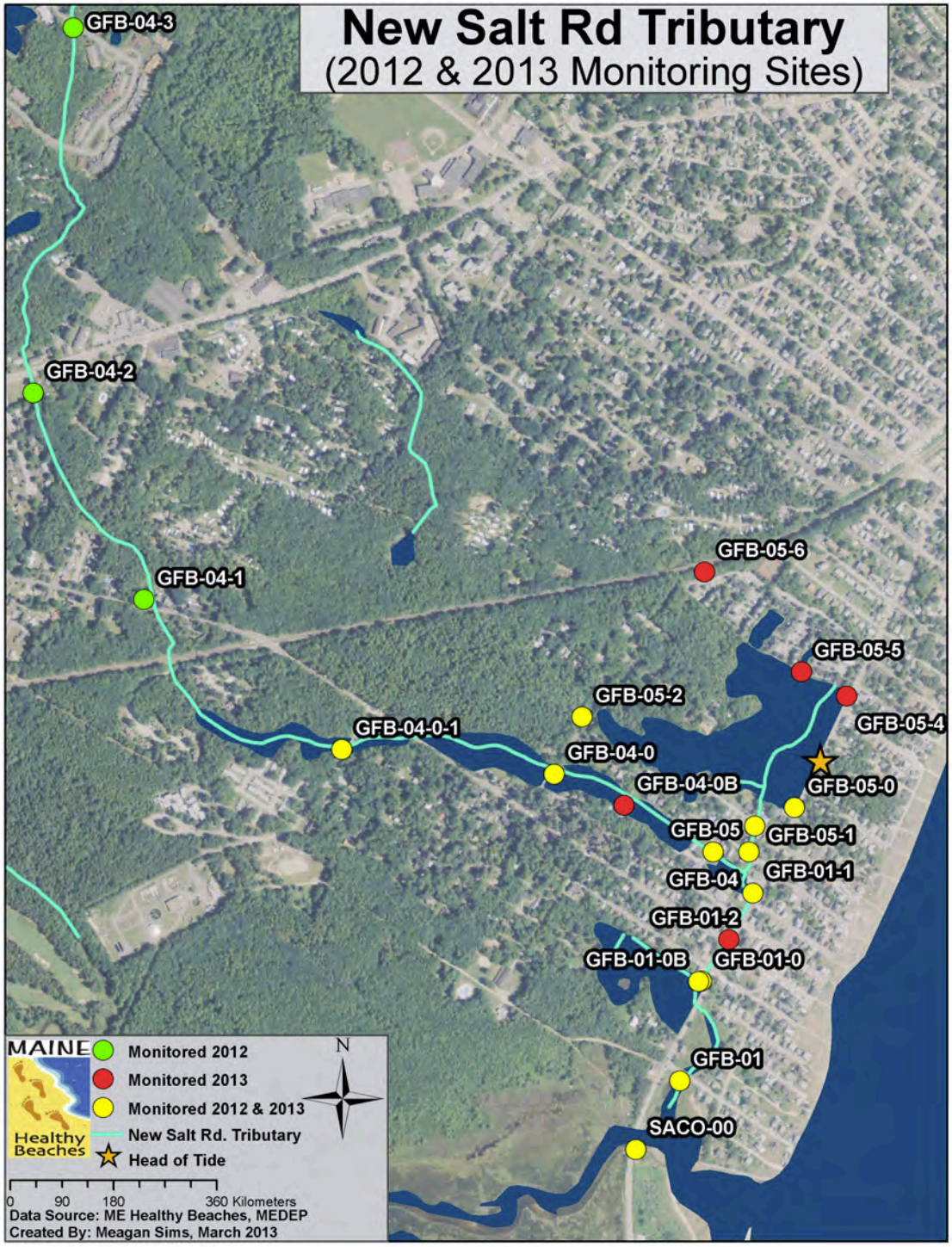

Figure 18. Aerial map of the 17 total NSRT monitoring stations in 2012 and 2013. The NSRT flows through the densely developed, residential neighborhood of Ocean Park and continues northwest for approximately 2 miles.