Summary of marine debris observations at MWRA's Deer Island Treatment Plant effluent discharge site in Massachusetts Bay: 2000-2012

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SUMMARY OF MARINE DEBRIS OBSERVATIONS AT MWRA'S DEER ISLAND TREATMENT PLANT EFFLUENT DISCHARGE SITE IN MASSACHUSETTS BAY 2000-2012

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1.0 Introduction

Marine debris has been an ongoing issue in the Gulf of Maine (Hoagland and Kite-Powell 1997). An early environmental concern related to the Massachusetts Water Resources Authority (MWRA)'s use of an effluent outfall to discharge to Massachusetts Bay was that the aesthetics of the marine environment would be protected, and that the discharge would not contain "floatable" material (particularly plastics and petroleum oil and grease) that could be an aesthetic nuisance or harm marine life. MWRA monitored floatables in the effluent from Deer Island Treatment Plant (DITP) from 2002-2010 (Rex *et al.* 2008, Rex and Tyler 2011), and has been monitoring marine debris in the waters of Massachusetts Bay since 2000 through the present (2012). This report presents the results of MWRA's marine debris monitoring program from ambient waters at the discharge site.

2.0 Background

Early in the planning of the effluent outfall monitoring program, before DITP was built, two Contingency Plan thresholds aiming to measure effluent floatables were developed, shown in Table 1 (MWRA 1997 November).

Table 1. 1997 Contingency Plan thresholds

PARAMETER TYPE/LOCATION	PARAMETER	CAUTION LEVEL	WARNING LEVEL
Effluent	Floatables	None	5 gallons/day in final collections device
	Oil and grease (petroleum)	None	15 mg/L weekly

However, as the new DITP began to come online in the late 1990s, it became clear that it was not logistically feasible to measure floatables in the "final collection devices" which were inaccessible tip tubes in the secondary clarifiers. In 2000, MWRA requested Outfall Monitoring Science Advisory Panel and regulatory review of the floatables Contingency Plan threshold. As a result of that review, revised floatables requirements were included in the first revision of the Contingency Plan (MWRA 2001). The revised plan deleted the trigger parameters and thresholds for floatables (the threshold for oil and grease as petroleum hydrocarbons remains), but required MWRA to "make regular observations of wastewater during treatment to determine whether floatables are removed as expected and whether oil and grease discharges are within the limits established by the NPDES permit." MWRA developed a sampling device to measure floatables in the final effluent at DITP and has also been monitoring oil and grease, and petroleum hydrocarbons in the final effluent.

In addition to effluent sampling, MWRA incorporated sampling for marine debris at the outfall site in Massachusetts Bay, using a net, during nearfield water column monitoring surveys. This sampling began in 2000 before the outfall came online, and included an area directly over the outfall as well as a control site northwest of the outfall.

MWRA first presented results of effluent floatables sampling to OMSAP and the regulatory agencies in 2003 (MWRA 2003, OMSAP briefing). In 2008, MWRA provided a comprehensive summary of the results of monitoring for floatables in effluent and ambient waters from 2000-2007 (Rex *et al* 2008). In 2010, regulatory agencies approved MWRA's request to end the effluent floatables sampling requirement, based on data showing that floatables amounts from 2006 through 2009 were very low in the effluent (MWRA Ambient Monitoring Plan Revision 2, Report 2010-04). However, the revised Ambient Monitoring Plan

(AMP) still includes several marine debris monitoring activities in ambient waters: visual monitoring at the outfall site during routine water column surveys, two wet weather net tow surveys annually subsequent to blending events at DITP, and analysis of fat particles collected in the net tows for PCBs, pesticides, PAHs, and mercury. The AMP (MWRA 2010, page 34) also includes a provision that MWRA may request elimination of the net tow requirement after two years:

> The purpose of floatables monitoring is to ensure that MWRA discharges continue to meet water quality criteria for aesthetics. During the nine annually conducted water column surveys, monitoring staff will note the presence or absence of visible floating material in the water in the nearfield in its survey reports. In addition, MWRA will carry out two wet weather net tow surveys annually, subsequent to blending events at DITP. [5] Acceptable net tows will be carried out after storms where the duration of blending was more than 3 hours.[6] Net tows will be conducted within 24 hours of the ending of the blending events.[7] The net tows will be carried out as described in previous water column work plans. The plans include a transect over the outfall and a control transect. The contents of the net will be photographed and observations shall be tabulated as presence/absence data for paper, plastic and/or fat particles in order to be able to compare to previous net tow surveys. A summary of the results of the visual observational surveys and the net tows will be included in the annual water column monitoring report. In addition, MWRA will carry out chemical analyses for PCBs, PAHs, pesticides, and mercury on samples of the fat particles which are collected in the net tows.

[5] After two years of wet-weather floatables monitoring (4 tows), MWRA will analyze and report on the data to determine if it is comparable to previous observations. MWRA may submit a written request, along with the data analysis report, to EPA and DEP requesting an elimination of the net tows. In order to be considered acceptable data for the consideration of elimination of the net tow requirement, tows must be conducted within 24 hours of the end of a blending event of at least 3 hours in duration.

[6] Between July 2006 and December 2009, the 50th percentile for duration of blending events was 3 hours, the mean duration was 6.48 hours, and the 75th percentile was 5.8 hours.

[7] If MWRA finds that it is logistically infeasible, due to weather conditions, to conduct net tows within 24 hours of blending events, it may request that this time limit be reevaluated.

This report presents the results of marine debris observations since the outfall came online, 2000-2012, including fat particle chemistry results for 2011 and 2012.

3.0 Methods

Details of how surveys were conducted, sample collection and analysis methods, and QA/QC are given in the Quality Assurance Project Plans for Water Column Monitoring (Libby *et al.* 2011 and Leo *et al.* 2011).

Marine debris monitoring took place during the following surveys (MWRA 1997, 2004, 2010):

- 17 surveys per year from 2000-2003 for net tows
- 12 surveys per year from 2004-2010 for net tows
- 9 surveys per year in 2011 and 2012 for visual observations
- 2 surveys per year in 2011 and 2012 for net tows following blending events at DITP.

3.1 Ambient Marine Debris Tows in Massachusetts Bay

Surface net tows were used to sample for plastics and other floatable objects beginning in 2000, before the outfall came online. A Neuston net (1 x 2 meter with 500-µm mesh, Figure 1) was towed at two locations to capture any floating debris. The first tow, the control site, began 0.5 miles along heading 300º from station N01. The tow was conducted at a heading of 060º for 10 minutes at 2 knots. The second tow was conducted in the vicinity of the outfall over the diffuser (Station N21), also for 10 minutes at 2 knots. The tow started to the south of the outfall and was conducted at a heading of 45º for 10 minutes at 2 knots, crossing the diffuser line on the transect. Table 2 shows the coordinates for the sampling stations, and Figure 2 shows the locations on a map.

Figure 1. Net used for debris sampling.

Table 2. Locations for net tows for floating debris in Massachusetts Bay

STATION	LATITUDE (°N)	LONGITUDE (ºW)	WATER DEPTH (M)	STATION TYPE
N01	42.419	70.865	31.2	Control
N21	42.388	70.785	34.8	Outfall Diffuser

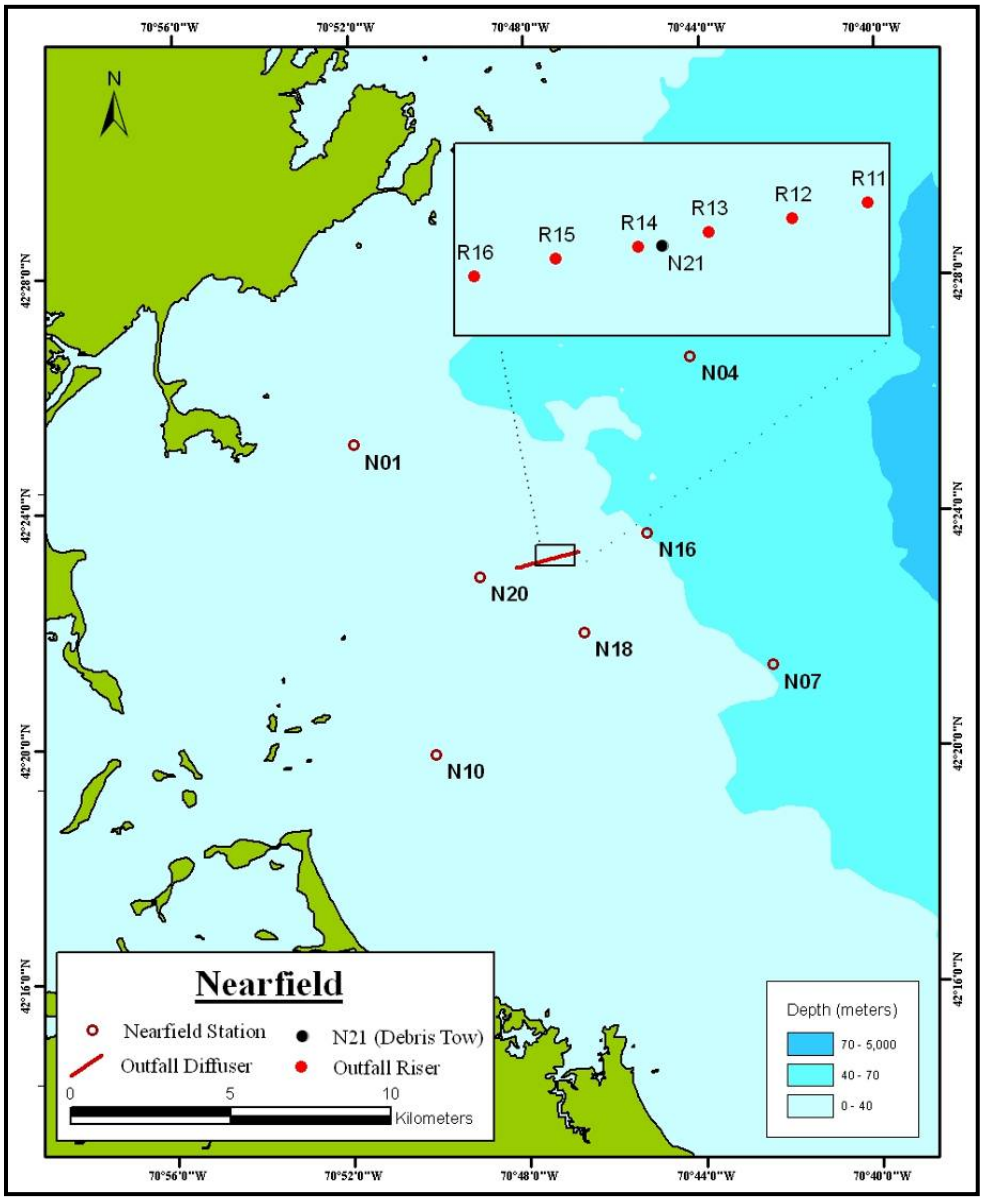

Figure 2. Map of sampling locations for marine debris tows in Massachusetts Bay (station N01 is the control, station N21 at the outfall is shown in inset, near Riser 14).

After the net tow was completed, the sample was emptied into a white dissection basin (with a black stripe on the bottom for contrast) for a visual, qualitative inspection. Types and relative amounts of anthropogenic and natural debris were documented in the survey log. The observations of anthropogenic material were tabulated indicating the presence or absence and relative amounts of plastics, paper, and fat particles. Each sample was digitally photographed with the date, time, and survey ID, along with a ruler for visual scale. If macro algae obscured the contents, they were removed and a second set of photos taken.

Visible fat particles were separated and placed in a labeled sample jar, stored on ice, and delivered to the laboratory for analysis. At the laboratory, all fat particle samples were received frozen and were kept frozen until being thawed and manually homogenized prior to chemical analysis.

3.2 Visual Monitoring, Scans of Sea Surface

On routine water column surveys, while on station (especially at N21) the sea surface in the vicinity of the boat was scanned by eye for the presence of any anthropogenic debris (e.g. paper, plastics, and floating bits of fat) especially those potentially associated with wastewater (e.g. tampon applicators). Any notable observations were reported in the survey summary and survey report.

3.3 Chemical Analysis of Fat Particles

Prior to aliquoting for laboratory analysis the frozen wet-weather fat samples were thawed and immediately processed at the DITP Central Laboratory. Sub-sample aliquots of each homogenized sample were taken for chemical analysis. One portion was tested for pesticide, PCB, and PAH compounds using a procedure based on the laboratory's routine procedure for aqueous and solid samples. One portion was tested for total mercury using MWRA's routine procedure for solid samples. The remaining portion was tested for Total and Volatile Solids using the routine gravimetric procedure. The procedures are summarized below.

3.3.1 **Gravimetric Analysis of Total and Volatile Solids (**adapted from MWRA SOP 1094.2). A 0.4-2.0 g portion of each sample was placed in a pre-weighed dish and dried to constant weight in an oven at 103^{o}C to 105^{o}C. The remaining residue is the total solids. Volatile solids require further drying at 550^{o} C. The decrease in weight represents the volatile solids. Percentages of total and volatile solids are calculated accordingly.

3.3.2 **Cold Vapor Atomic Absorption Spectrometric Analysis of Mercury in Solid Samples (adapted from MWRA SOPs 1027.1 and 1049.2).** A 0.2 g portion of each sample was prepared by leaching with hot acid in a water bath, then oxidizing with potassium permanganate. The digested sample with all forms of mercury was oxidized to the inorganic form in line with a reducing agent ($SnCl_2$) to form elemental mercury vapor. Argon was used to carry the mercury vapor from a liquid-gas separator through a drying tube for water vapor removal. The dry vapor then enters an optical cell. A mercury source, powered by a constant current power supply, delivers a stable source of emission at 254 nm. Absorbance by the mercury cold vapor is measured using a solid state detector.

3.3.3 **Selected Ion Monitoring (SIM) Gas Chromatography – Mass Spectrometry Analysis of Pesticides, Polychlorinated Biphenyls, and Polycyclic Aromatic Hydrocarbons in Solid Samples (adapted from MWRA SOPs 1073.0, 1173.3, and 1030.3).** MWRA's routine procedures for aqueous and solid samples were adapted for the fat particle samples. A 0.4 to 1.1 g portion of each sample was spiked with both Pesticide/PCB and PAH surrogate compounds, dissolved in methylene chloride, and dried with anhydrous sodium sulfate. The extract was then cleaned up using a silica gel cartridge, and concentrated by nitrogen evaporation to 1.0 mL. The methylene chloride sample extract was analyzed by GC/MS in both the full scan and Selected Ion Monitoring (SIM) modes. Two SIM runs were performed; one analysis to determine the PCB congener compounds and one analysis for the pesticide compounds. The target analytes were identified by their characteristic primary and secondary (confirmation) ions, and by their retention times as compared to the analytical standards. Quantitation was performed using the internal standard technique. A third SIM GC/MS run was conducted for PAH compounds. Target compounds were identified by their characteristic primary and secondary ions and by their retention times. Quantitation was performed using the internal standard technique. In addition to the individual target PAH compounds, the concentrations of substituted PAH homologues were determined using the response factors of the parent PAH compound.

3.4 Data Management

Management of field data is described in the Quality Assurance Project Plan for water column monitoring (Libby *et al.* 2011). Laboratory data management, quality assurance, audit, and corrective action procedures are documented in the MWRA Department of Laboratory Services (DLS) Quality Assurance Management Plan (QAMP) (MWRA 2008). The Review, Validation, and Approval processes described in the QAMP are employed to ensure conformity with DLS and with client data quality requirements.

4.0 Results

4.1 Net Tows

Net tows for marine debris were collected during every water column survey (except one when the net became unusable) after the outfall came on-line (September, 2000-2010).[1] Then, four net tow samples in the vicinity of the outfall were collected following blending events at DITP on March 8, 2011; March 17, 2011; May 10, 2012; and July 19, 2012.

From September 2000 through July 2012 there were 136 marine debris surveys completed, including 135 net tow samples collected at the "control" or reference site (N01) and 134 net tow samples collected at the outfall site (N21). Debris of all types was found at both locations, however debris was found more frequently at the outfall site (69%) than at the control site (40%). The biggest difference between the two locations was in the prevalence of fat particles: 49% of outfall site net tows captured fat particles compared to 5% at the control site (Figure 3).

Other types of debris were found at similar frequencies between the two locations. Sightings of sewage-related floatables of concern were rare; over the 12 years of monitoring there were five. One tampon applicator and one tampon were seen at the control site on two different surveys. One condom, two condoms, and one tampon applicator were seen at the outfall site on three different surveys.

[1] Pre-discharge period and discharge period results through 2007 were reported in 2008 (Rex *et al*. 2008).

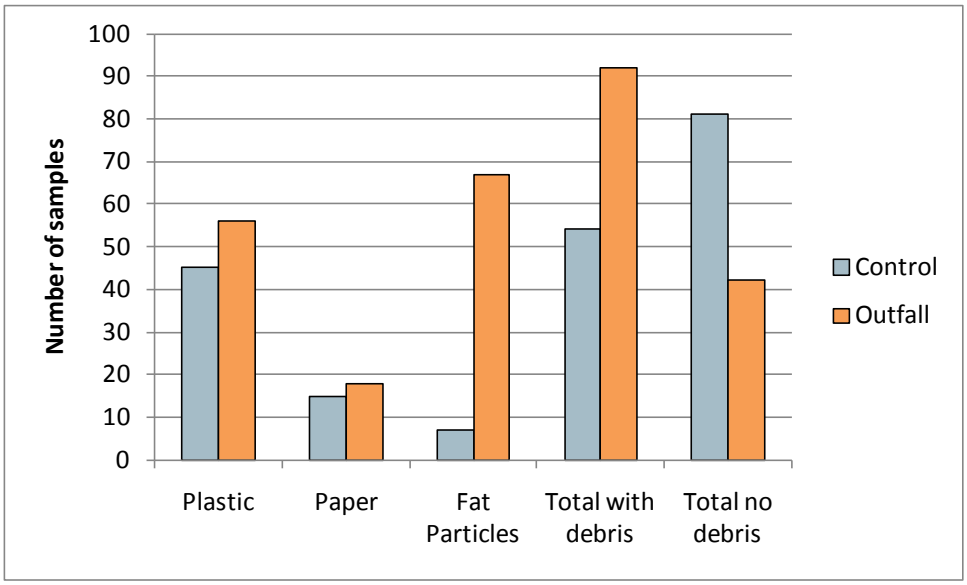

Figure 3. Number of net tow samples, 2000-2012, with different types of marine debris; control vs. outfall site. Different types of debris were sometimes present in the same sample. "Plastic" includes plastic and latex-like material; "Paper" includes paper, cellophane, string, and fabric.

Table 3 shows all the observations of presence or absence of floatables in net tows after the outfall came on-line. Detailed observations of the post-blending net tows are included in survey reports (see Appendix, Survey Reports).

Table 3 Results of net tow observations at the control site and the outfall site 2000-2012. "1" indicates observed, "0" indicates none observed, "ND" means no data.

Survey ID	Sample collection date	Control site (station N01)				Outfall site (station N21)				Items of concern
		Debris total	Plastic, latex	Paper, cellophane, string	Fat particles	Debris total	Plastic, latex	Paper, cellophane, string, fabric	Fat particles	
WN00D	9/22/2000	0	0	0	0	0	0	0	0	
WF00E	10/5/2000	0	0	0	0	0	0	0	0	
WN00F	10/24/2000	0	0	0	0	0	0	0	0	
WN00G	11/29/2000	0	0	0	0	1	1	1	0	
WN00H	12/21/2000	1	1	0	0	1	1	0	0	
WF011	2/9/2001	0	0	0	0	0	0	0	0	
WF012	3/1/2001	0	0	0	0	0	0	0	0	
WN013	3/26/2001	0	0	0	0	1	0	0	1	
WF014	4/4/2001	0	0	0	0	0	0	0	0	
WN015	4/26/2001	0	0	0	0	0	0	0	0	
WN016	5/18/2001	0	0	0	0	0	0	0	0	
WF017	6/25/2001	0	0	0	0	0	0	0	0	
WN018	7/12/2001	0	0	0	0	0	0	0	0	
WN019	7/25/2001	0	0	0	0	1	1	0	0	
WN01A	8/9/2001	0	0	0	0	0	0	0	0	

Survey ID	Sample collection date	Control site (station N01)				Outfall site (station N21)				Items of concern
		Debris total	Plastic, latex	Paper, cellophane, string	Fat particles	Debris total	Plastic, latex	Paper, cellophane, string, fabric	Fat particles	
WF01B	8/29/2001	0	0	0	0	1	1	0	0	
WN01C	9/17/2001	1	1	0	0	1	1	0	0	
WN01D	10/9/2001	0	0	0	0	0	0	0	0	
WF01E	10/20/2001	0	0	0	0	0	0	0	0	
WN01F	10/29/2001	0	0	0	0	1	1	0	0	
WN01G	12/7/2001	1	1	0	0	0	0	0	0	
WN01H	12/19/2001	0	0	0	0	0	0	0	0	
WF021	2/8/2002	0	0	0	0	0	0	0	0	
WF022	2/28/2002	0	0	0	0	1	1	0	0	
WN023	3/25/2002	0	0	0	0	0	0	0	0	
WF024	4/12/2002	1	1	0	0	0	0	0	0	
WN025	5/1/2002	0	0	0	0	1	1	1	0	
WN026	5/22/2002	0	0	0	0	0	0	0	0	
WF027	6/18/2002	0	0	0	0	1	0	1	1	
WN028	7/12/2002	0	0	0	0	1	0	0	1	
WN029	7/25/2002	ND	ND	ND	ND	1	0	1	0	
WN02A	8/9/2002	0	0	0	0	0	0	0	0	
WF02B	8/22/2002	1	1	0	1	1	1	0	1	
WN02C	9/13/2002	1	0	1	0	1	0	0	1	
WN02D	9/25/2002	1	1	1	1	ND	ND	ND	ND	
WF02E	10/10/2002	0	0	0	0	1	1	0	0	
WN02F	11/4/2002	0	0	0	0	1	0	0	0	
WN02G	11/20/2002	0	0	0	0	0	0	0	0	
WN02H	12/11/2002	0	0	0	0	0	0	0	0	
WN031	2/6/2003	0	0	0	0	0	0	0	0	
WN032	3/4/2003	0	0	0	0	0	0	0	0	
WN033	3/20/2003	0	0	0	0	0	0	0	0	
WN034	4/3/2003	0	0	0	0	0	0	0	0	
WN035	4/23/2003	0	0	0	0	0	0	0	0	
WN036	5/15/2003	0	0	0	0	0	0	0	0	
WN037	6/18/2003	0	0	0	0	1	1	0	1	
WN03A	8/4/2003	1	0	0	1	1	1	0	1	
WF03B	8/20/2003	0	0	0	0	1	1	0	1	
WN03C	9/10/2003	0	0	0	0	0	0	0	0	
WN03D	9/25/2003	1	1	0	0	1	1	0	0	
WN03F	10/31/2003	0	0	0	0	1	1	0	0	
WN03G	11/18/2003	0	0	0	0	1	0	0	1	
WN041	2/3/2004	1	1	0	0	0	0	0	0	
WN042	2/25/2004	0	0	0	0	0	0	0	0	
WN043	3/23/2004	0	0	0	0	0	0	0	0	
WN044	4/8/2004	0	0	0	0	1	0	0	1	
WN046	5/14/2004	1	1	0	0	1	0	0	1	
WN047	6/17/2004	0	0	0	0	1	0	1	1	
WN049	7/20/2004	1	1	0	1	0	0	0	0	
WF04B	8/17/2004	1	0	0	1	1	1	0	1	

Survey ID	Sample collection date	Control site (station N01)				Outfall site (station N21)				Items of concern
		Debris total	Plastic, latex	Paper, cellophane, string	Fat particles	Debris total	Plastic, latex	Paper, cellophane, string, fabric	Fat particles	
WN04C	9/1/2004	1	1	1	0	1	1	0	1	
WN04D	9/27/2004	1	1	0	0	1	1	0	1	
WN04E	10/18/2004	0	0	0	0	1	1	0	1	
WF04F	11/17/2004	1	1	0	0	1	0	0	1	
WN051	2/2/2005	0	0	0	0	0	0	0	0	
WN053	3/17/2005	0	0	0	0	0	0	0	0	
WF054	4/6/2005	0	0	0	0	1	1	0	1	
WN056	5/13/2005	0	0	0	0	1	0	0	1	
WF057	6/17/2005	0	0	0	0	1	1	0	1	
WN05C	9/2/2005	1	1	0	0	1	1	0	0	
WN05D	9/28/2005	0	0	0	0	1	1	0	1	
WF05E	10/20/2005	0	0	0	0	0	0	0	0	
WN05F	11/14/2005	0	0	0	0	1	0	1	1	
WF061	2/10/2006	0	0	0	0	1	0	0	1	
WF062	3/1/2006	1	1	0	0	1	0	0	1	
WN063	3/22/2006	1	1	0	0	1	0	0	1	
WF064	4/12/2006	1	1	0	0	1	0	0	1	
WN066	5/17/2006	0	0	0	0	1	1	0	1	
WN069	7/19/2006	0	0	0	0	1	1	0	1	
WF06B	8/22/2006	0	0	0	0	1	0	0	1	
WN06C	9/5/2006	0	0	0	0	1	1	0	1	
WN06D	10/3/2006	0	0	0	0	0	0	0	0	
WF06B	10/31/2006	0	0	0	0	1	0	0	1	
WN06F	11/18/2006	1	1	0	0	1	1	0	1	
WF071	2/11/2007	0	0	0	0	0	0	0	0	
WF072	2/27/2007	0	0	0	0	1	0	0	1	
WN073	3/21/2007	0	0	0	0	1	0	0	1	
WF074	4/24/2007	0	0	0	0	1	0	0	1	
WN076	5/23/2007	1	1	0	0	1	1	0	1	
WF077	6/19/2007	1	1	0	0	1	1	0	0	
WN079	7/24/2007	0	0	0	0	1	1	0	0	
WF07B	8/22/2006	1	1	0	0	1	0	0	0	
WN07C	9/4/2007	1	1	0	0	1	1	0	1	
WN07D	10/2/2007	1	0	0	0	1	1	0	1	
WF07E	10/30/2007	0	0	0	0	1	1	0	0	
WN07F	11/13/2007	1	1	0	0	0	0	0	0	
WF081	2/25/2008	1	0	1	0	1	0	0	1	
WF082	3/6/2008	0	0	0	0	1	0	0	1	
WF083	3/24/2008	0	0	0	0	1	0	0	1	
WN084	4/11/2008	1	1	0	0	1	0	1	1	
WN086	5/21/2008	1	1	0	0	0	0	0	0	
WF087	6/13/2008	1	1	0	0	1	1	0	1	
WN089	7/22/2008	1	1	0	0	1	1	1	1	
WF08B	8/19/2008	0	0	0	0	1	1	1	0	
WN08C	9/2/2008	1	0	1	0	1	1	1	1	

Survey ID	Sample collection date	Control site (station N01)				Outfall site (station N21)				Items of concern
		Debris total	Plastic, latex	Paper, cellophane, string	Fat particles	Debris total	Plastic, latex	Paper, cellophane, string, fabric	Fat particles	
WN08D	9/30/2008	1	1	0	0	ND	ND	ND	ND	
WF08E	10/27/2008	1	1	0	0	1	1	1	1	
WN08F	11/21/2008	0	0	0	0	1	0	1	1	
WF091	2/11/2009	1	1	1	0	1	0	0	1	
WF092	2/26/2009	0	0	0	0	1	0	0	1	
WN093	3/18/2009	0	0	0	0	1	0	0	1	
WF094	4/9/2009	0	0	0	0	1	0	0	1	
WN096	5/12/2009	0	0	0	0	1	1	1	0	1 condom outfall site
WF097	6/17/2009	1	1	0	0	1	0	0	1	
WN099	7/21/2009	1	1	1	0	0	0	0	0	
WN09B	8/18/2009	0	0	0	0	1	1	0	0	
WN09C	9/1/2009	0	0	0	0	1	1	0	1	
WN09D	9/30/2009	1	0	1	0	1	1	0	1	
WF09E	10/22/2009	1	1	1	0	1	0	0	1	
WN09F	11/10/2009	1	1	0	0	1	0	1	1	
WF101	2/3/2010	0	0	0	0	1	0	0	1	
WF102	2/23/2010	0	0	0	0	1	1	0	1	
WN103	3/19/2010	1	1	0	0	1	1	0	1	
WF104	4/7/2010	0	0	0	0	1	1	1	1	
WN106	5/11/2010	1	1	0	0	1	1	0	0	
WF107	6/15/2010	1	1	1	1	0	0	0	0	
WN109	7/20/2010	1	1	1	0	1	1	0	1	Tampon applicator control site
WF10B	8/10/2010	1	1	1	1	1	1	0	0	
WN10C	8/30/2010	1	0	1	0	1	1	1	1	Tampon control site
WN10D	9/29/2010	1	1	1	0	1	1	1	1	
WF10E	10/18/2010	1	1	0	0	1	1	0	0	
WN10F	11/15/2010	1	1	0	0	1	1	0	0	
MD111	3/8/2111	1	1	0	0	1	1	0	1	
MD112	3/17/2011	1	1	0	0	1	1	0	1	2 condoms outfall site
MD121	5/10/2012	1	1	0	0	1	1	0	1	
MD122	7/19/2012	1	0	1	0	1	1	1	1	1 tampon applicator outfall site
	Present Total	54	45	15	7	92	56	18	67	
	Absent Total	81	90	120	128	42	78	116	67	

4.2 Visual Monitoring, Scans of Sea Surface (2011 and 2012).

A total of 18 routine water column surveys were done in 2011 and 2012. Observers on the sampling vessel scanned the ocean surface by eye to look for the presence of a plume, marine debris, sewage-related floatables (e.g. toilet paper, tampon applicators, condoms) and fat particles, particularly at station N21 located at the outfall.

Fat particles were visible at the outfall site during 5/18 surveys (28%) (Table 4). No observations of paper, plastic or sewage-related floatables were recorded. A surfacing plume was seen during both March surveys, but not during the other 16 surveys. Eight of the surveys took place five or fewer days after a blending event at DITP, however there appears to be no association with prior blending and presence of visible fat particles: fat particles were observed after two of the eight blending events, and were also seen during three surveys when previous blending had not occurred.

Table 4 Results of visual observations during routine water column surveys, 2011 and 2012 at station N21 near the outfall diffuser line. If any blending at DITP occurred within five days prior to the survey, the date is noted.

Survey ID	Survey Date	Visible plume	Fat particles visible	Paper	Plastic	Prior blending
WN111	Feb 1, 2011	0	0	0	0	No
WN112	Mar 15, 2011	Yes	Yes	0	0	Mar 11
WN113	Apr 7, 2011	0	Yes	0	0	Apr 4
WN114	May 20, 2011	0	0	0	0	No
WN115	Jun 16, 2011	0	0	0	0	Jun 12
WN116	Jul 19, 2011	0	0	0	0	No
WN117	Aug 18, 2011	0	0	0	0	Aug 15
WN118	Sep 12, 2011	0	0	0	0	Sep 8
WN119	Oct 18, 2011	0	0	0	0	Oct 14
WN121	Feb 6, 2012	0	0	0	0	No
WN122	Mar 20, 2012	Yes	Yes	0	0	No
WN123	Apr 10, 2012	0	0	0	0	No
WN124	May 15, 2012	0	0	0	0	May 10
WN125	Jun 19, 2012	0	0	0	0	No
WN126	Jul 26, 2012	0	Yes	0	0	No
WN127	Aug 21, 2012	0	0	0	0	No
WN128	Sep 6, 2012	0	0	0	0	Sep 5
WN129	Oct 23, 2012	0	Yes	0	0	No

4.3 Fat Particle Chemistry Analysis Results

In addition to particles collected by four net tows, three “grab” samples were collected—one on March 17, 2011 and two on May 10, 2012. The “grab” samples were bits of fat floating within 300 meters of the tow line and fished out of the water by the sampling crew by means of a stainless steel sieve. These three “grab” samples were placed in separate bottles and analyzed separately from the net samples. Thus, there were a total of seven fat particle samples analyzed for chemistry.

4.3.1 **Total and Volatile Solids.** Table 5 shows total and volatile solids results. The samples were approximately half superficial moisture. The solid matter was predominantly volatile, which is indicative of organic material. (No volatile solids data are available for the net tows in 2011 due to laboratory error.)

Table 5. Total and volatile solids in ambient fat particle samples 2011-2012.

	3/8/11	3/17/11		5/10/12			7/19/12
	net tow	net tow	"grab"	net tow	"grab 1"	"grab 2"	net tow
Total Solids % moisture	44.1	47.9	48	51.8	46.7	49.5	39.4
Volatile Solids % of TS	N/A	N/A	93.4	93.5	94.0	89.4	89.4

4.3.2 **Mercury.** Table 6 shows the mercury concentrations in the fat particles. Mercury ranged from below 0.0034 to 0.09 mg/kg wet-weight. The samples had mercury concentrations below 0.07 mg/kg on a dry-weight basis. The grab samples were similar to the net tow samples.

EPA's current ambient water quality criterion for mercury, expressed as methylmercury in fish tissue, is 0.3 mg/kg wet-weight (based on levels of human consumption of fish). It is unclear how this criterion would relate to the fat particles, but the measured levels are much lower than the criterion.

Table 6. Mercury in ambient fat particle samples 2011-2012.

		3/8/11	3/17/11		5/10/12			7/19/12
	Units	net tow	net tow	"grab"	net tow	"grab 1"	"grab 2"	net tow
Mercury (Hg)	mg/kg dry weight	0.0613	0.0433	0.196	0.0358	0.0385	0.0676	<0.0086
	mg/kg wet weight	0.0270	0.0207	0.0941	0.0185	0.0180	0.0335	<0.0034

4.3.3 **Pesticides.** Table 7 shows the pesticide results. The nominal reporting limit for pesticides is based on the lowest calibration standard, the available sample size, and the final extract volume. The reporting limits ranged from 4 to 56 µg/kg dry-weight. Several pesticides were detected below the nominal reporting limit based on sufficient instrument response at the expected GC retention time and mass spectrometer masses.

The pesticide surrogate recoveries were good, ranging from 50.8 to 119%. DDTs and chlordanes were detected in the net tows and grab sample in 2011.

In 2012, no pesticides were detected in either net tow sample; for the two grab samples, detected pesticides were alpha-Chlordane, gamma-Chlordane, and trans-Nonachlor. The pesticide concentrations were roughly comparable for both years.

Table 7. Pesticide results from ambient fat particle samples 2011-2012.

	Pesticides (µg/kg dry weight)						
	3/8/11	3/17/11		5/10/12			7/19/12
	net tow	net tow	"grab"	net tow	"grab 1"	"grab 2"	net tow
2,4'-DDD	16.7	22	8.59	<5.01	<4.80	<4.73	<13.0
2,4'-DDE	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
2,4'-DDT	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
4,4'-DDD	38.2	<8.38	22.5	<5.01	<4.80	<4.73	<13.0
4,4'-DDE	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
4,4'-DDT	37.1	41	<10.3	<5.01	<4.80	<4.73	<13.0
Aldrin	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
alpha-Chlordane	14.6	15.4	7.14	<5.01	23.2	5.2	<13.0
cis-Nonachlor	1.67	1.74	<10.3	<5.01	<4.80	<4.73	<13.0
DDMU	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
Dieldrin	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
Endrin	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
gamma-BHC	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
gamma-Chlordane	13.9	15	6.55	<5.01	59.1	5.27	<13.0
Heptachlor	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
Heptachlor epoxide	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
Hexachloroben-zene	1.46	1.19	1.25	<5.01	<4.80	<4.73	<13.0
Mirex	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
Oxychlordane	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
trans-Nonachlor	6.53	7.02	3.83	<5.01	12.8	2.84	<13.0
Total Chlordane	21.1	22.4	11	<5.01	<4.80	<4.73	<13.0
Total DDT	92	63	31.1	<5.01	<4.80	<4.73	<13.0
% recovery							
C13-4,4'-DDT (S)	116	101	94.7	76.7	65.3	61.7	67.4
C13-gamma-BHC (S)	95.6	113	90.6	56.0	94.1	119.0	93.0

NOTE: (S) denotes a surrogate compound added for quality control. Results are not surrogate-corrected.

4.3.4 **PCB Congeners.** Table 8 shows the results for PCB congeners. The nominal reporting limit for PCB congeners is based on the lowest calibration standard, the available sample size, and the final extract volume. The reporting limits ranged from 4 to 56 µg/kg dry-weight. Several PCBs were detected below the nominal reporting limit based on sufficient instrument response at the expected GC retention time and mass spectrometer masses. The PCB surrogate recoveries were good, ranging from 54 to 140%. PCB congener concentrations were roughly comparable between both years. In 2012, no PCB congeners were

detected in three of the samples: both of the net tows and "grab 1". "Grab 2" had detected concentrations of nine PCB congeners. The 2011 and 2012 PCB congener concentrations were roughly comparable.

Table 8. PCB congener results from ambient fat particle samples 2011-2012.

	PCBs (µg/kg dry weight)						
	3/8/11	3/17/11		5/10/12			7/19/12
	net tow	net tow	"grab"	net tow	"grab 1"	"grab 2"	net tow
BZ 8 Dichlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 18 Trichlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 28 Trichlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 44 Tetrachlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	13.1	<13.0
BZ 52 Tetrachlorobiphenyl	5.9	3.41	6.83	<5.01	<4.80	26.5	<13.0
BZ 66 Tetrachlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	9.35	<13.0
BZ 77 Tetrachlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 101 Pentachlorobiphenyl	7.62	5.64	12.7	<5.01	<4.80	35.6	<13.0
BZ 105 Pentachlorobiphenyl	<4.23	<8.38	3.64	<5.01	<4.80	9.91	<13.0
BZ 118 Pentachlorobiphenyl	8.36	<8.38	9.76	<5.01	<4.80	25.3	<13.0
BZ 126 Pentachlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 128 Hexachlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 138 Hexachlorobiphenyl	7.92	11.8	9.2	<5.01	<4.80	16.1	<13.0
BZ 153 Hexachlorobiphenyl	7.85	12.6	6.64	<5.01	<4.80	11.8	<13.0
BZ 170 Heptachlorobiphenyl	<4.23	3.83	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 180 Heptachlorobiphenyl	5.1	13.2	1.92	<5.01	<4.80	7.4	<13.0
BZ 187 Heptachlorobiphenyl	2.37	6.55	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 195 Octachlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 206 Nonachlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
BZ 209 Decachlorobiphenyl	<4.23	<8.38	<10.3	<5.01	<4.80	<4.73	<13.0
Total AMP PCBs	45.1	57	50.7	<5.01	<4.80	155	<13.0
% Recovery							
BZ 34 Trichlorobiphenyl (S)	114	79.4	107	55.0	53.6	75.6	73.0
BZ 104 Pentachlorobiphenyl (S)	111	79	104	65.5	54.1	72.1	87.8
BZ 192 Heptachlorobiphenyl (S)	140	102	111	68.4	63.3	64.5	78.5

NOTES: (S) denotes a surrogate compound added for quality control. Results are not surrogate-corrected.
Total AMP PCBs refers to the group of PCBs analyzed in MWRA's Ambient Monitoring Program

4.3.5 **PAHs.** Table 9 shows results for PAHs. The nominal reporting limit for PAHs is based on the lowest calibration standard, the available sample size, and the final extract volume. The reporting limits ranged from 12 to 223 μg/kg dry-weight. The PAH surrogate recoveries were good, ranging from 64 to 97%. Many PAHs were detected above the nominal reporting limit based on sufficient instrument response at the expected GC retention time and mass spectrometer masses. The 2012 and 2011 PAH concentrations were roughly comparable.

Table 9. PAH results from ambient fat particle samples 2011-2012.

	PAHs (μg/kg dry weight)						
	3/8/11	3/17/11		5/10/12			7/19/12
	net tow	net tow	"grab"	net tow	"grab 1"	"grab 2"	net tow
1-Methylnaphthalene	1410	2830	1150	721	1640	1400	2830
1-Methylphenanthrene	244	356	119	121	426	1050	544
2,3,5-Trimethylnaphthylene	1090	1470	600	453	1420	973	2140
2,6-Dimethylnaphthalene	813	1400	619	465	1100	1530	1650
2-Methylnaphthalene	1060	1890	817	501	1190	973	1800
Acenaphthene	356	626	228	131	645	336	557
Acenaphthylene	23.3	40.1	26.9	13.9	62.9	21.4	40.5
Anthracene	67	204	49.9	66.1	366	132	316
Benzo(a)anthracene	141	194	89.3	59.5	366	77.9	259
Benzo(a)pyrene	132	188	97.6	43.1	192	60.9	197
Benzo(b)fluoranthene	165	212	117	62.5	236	83.4	273
Benzo(e)pyrene	<21.2	<41.9	32.1	33.8	111	<11.8	139
Benzo(g,h,i)perylene	65.8	102	56.1	17	44.3	40.9	90.6
Benzo(k)fluoranthene	50.5	59.6	51.3	25.4	82.5	24.3	85.4
Benzothiazole	145	128	270	59.3	36.3	27.3	38
Biphenyl	387	681	247	85.2	223	191	326
C1-Chrysenes	122	<41.9	36.7	45.7	136	29.7	148
C1-Dibenzothiophenes	345	445	145	286	722	306	1240
C1-Fluoranthenes/ Pyrenes	312	477	163	<12.5	<12.0	79.3	381
C1-Fluorenes	660	886	367	317	1170	152	1430
C1-Naphthalenes	1700	3270	1380	875	2030	611	3310
C1-Phenanthrenes/ Anthracenes	1220	1790	588	607	2280	568	2930
C2-Chrysenes	<21.2	<41.9	<25.7	<12.5	<12.0	35.4	<16.2
C2-Dibenzothiophenes	557	719	197	<12.5	<12.0	20	903
C2-Fluoranthenes/ Pyrenes	<21.2	<41.9	<25.7	<12.5	<12.0	66.3	<16.2
C2-Fluorenes	1120	1560	581	386	1500	859	2150
C2-Naphthalenes	4140	6190	2730	1700	4380	874	6600

	PAHs (μg/kg dry weight)						
	3/8/11 net tow	3/17/11		5/10/12			7/19/12 net tow
		net tow	"grab"	net tow	"grab 1"	"grab 2"	
C2-Phenanthrenes/ Anthracenes	1370	1980	738	359	1110	386	2140
C3-Chrysenes	<21.2	<41.9	<25.7	22.4	<12.0	<11.8	<16.2
C3-Dibenzothiophenes	488	552	<25.7	<12.5	<12.0	164	<16.2
C3-Fluoranthenes/ Pyrenes	<21.2	<41.9	<25.7	<12.5	<12.0	<11.8	<16.2
C3-Fluorenes	776	1260	<25.7	228	1420	67.7	1890
C3-Naphthalenes	4520	6120	2320	1560	4640	260	7110
C3-Phenanthrenes/ Anthracenes	1470	1510	613	<12.5	<12.0	72.6	1390
C4-Chrysenes	<21.2	<41.9	<25.7	<12.5	<12.0	38.5	<16.2
C4-Naphthalenes	3080	3750	1450	829	2890	235	4650
C4-Phenanthrenes/ Anthracenes	<21.2	<41.9	<25.7	<12.5	<12.0	21.5	<16.2
Chrysene	182	217	120	70.2	138	96.5	283
Dibenzo(a,h)anthracene	<21.2	<41.9	32.2	<12.5	13.3	8.04	21.9
Dibenzofuran	178	294	161	78.1	291	140	283
Dibenzothiophene	118	181	61.3	55.3	196	178	233
Fluoranthene	486	644	221	191	282	39.6	327
Fluorene	270	560	159	145	596	365	592
Indeno(1,2,3-cd)pyrene	79	103	55.8	<12.5	50.5	4.47	90.3
Naphthalene	704	1100	687	302	1090	435	936
Perylene	19.1	35.9	24.5	<12.5	29.1	4.28	34.5
Phenanthrene	1040	1700	488	482	1750	1510	2070
Pyrene	328	484	199	190	638	14.2	624
% recovery							
Chrysene-d12 (S)	71	65.7	112	87.9	82.2	93.3	96.9
Naphthalene-d8 (S)	72.7	65	90.7	63.5	63.9	64.1	64.4
Phenanthrene-d10 (S)	42.2	55	73.7	71.2	69.8	88.1	81.1

NOTE: (S) denotes a surrogate compound added for quality control. Results are not surrogate-corrected.

5.0 Discussion

5.1 Net Tows

Twelve years of net tow results, comparing the outfall area to a control location, found little marine debris of concern, except several bunches of balloons. Most of the paper, plastic, and related debris was small and inconspicuous, and the amounts and types of debris were similar between both sites, except for fat particles. Debris (except for fat particles) that could be considered sewage-related was rare, only seen 5 times out of 136 surveys, and such items were seen at both outfall and control sites. Two of these occasions at the outfall site were after blending events at DITP (Table 2, March 2011 and July 2012) ; otherwise the four debris tows done after blending events at DITP were similar in results to all the other samples done on routine water column surveys. Much of the debris caught in the tows was described as wind-blown.

5.2 Visual Monitoring, Scans of Sea Surface

Visual scans of the outfall area are likely the best way to evaluate the aesthetic impact of the discharge, which was the primary concern of the Contingency Plan. Marine debris (paper and plastic) was not seen at all during the 18 surveys in 2011-2012, and fat particles were observed in a minority of surveys (28%). The fat particles were seen not because they are obvious, but because the observers had been sensitized to look for them because of the net tow results, which concentrate the particles. There appeared to be no relationship between previous blending events and visible impacts of the discharge. Overall, the aesthetic impact of the discharge is negligible.

5.3 Fat Particle Chemistry

Because the fat particles were much more prevalent at the outfall site than at the control site, and because similar bits of fat were the main degradable material collected in the DITP effluent sampler, it is reasonable to presume that the outfall is the source of the fat particles caught in the net and grab samples. Regulatory agencies requested chemical analyses of the particles to learn if they might be a concentrated source of contaminants to the environment. The chemistry analyses were done on what may be presumed to be "worst-case" conditions, after significant blending events at DITP, when runoff contributions of chemicals are likely to be higher, and when there would be less toxic contaminant removal because of blending.

Based on the results, even under these worst-case conditions, the fat particles do not appear to be a significant environmental contaminant source for pesticides, PCBs, PAHs, or mercury. Previous analysis found that, on average the DITP effluent was found to contain 32 ppb by weight (milligrams per kilogram) floatables with 14% consisting of non-degradable floatables (*e.g.* plastic fruit labels) and 86% degradable floatables (*e.g.* fat particles and plant matter) (Rex and Tyler 2011). Based on a mean daily flow of 380 million gallons from the plant it is estimated that 39 kg of degradable floatables would enter Massachusetts Bay each day from the DITP effluent. To be conservative, the following calculations assume that all the degradable material is in the form of fat particles.

For mercury, the loading based on the highest result for these fat particles in 2012 (0.0676 mg/kg dry) would correspond to about 2.6 milligrams of mercury per day or less. DITP discharges about 10.2 grams of mercury per day (Wu 2012), so the fraction of mercury loading to Massachusetts Bay from these fat

particles is only at most about 0.025% of the total loading. In 2011, the highest result (from a grab sample) was 0.196 mg/kg dry, corresponding to about 7.8 milligrams of mercury per day or about 0.08% of the total loading.

The absolute loadings of the detected pesticides and PCBs are significantly less than for mercury though the proportion of the contribution to the total effluent loading from fat particles is about the same as for mercury. For example, DITP discharges about 1.3 gram/day of alpha-chlordane compared to 0.89 mg/day from fat particles. So, the contribution from fat particles is estimated to be up to 0.07% of the total loading.

For Total AMP PCB's, there was one detect in 2012 at 155 µg/kg dry weight which translates to a load of 6.0 mg per day from the fat particles. DITP discharges about 0.00315 lbs Total AMP PCBs per day, so, the fraction of Total AMP PCBs in effluent that comes from the fat particles is less than 0.4%.

The PAH compounds were observed at higher concentrations than for the pesticides and PCBs. The highest result for a single PAH was 1-Methylnaphthalene at 2,830 µg/kg, which corresponds to a fat particle loading of 0.11 g/day compared to the total effluent loading of 3.9 g/day. So, fat particles are conservatively estimated to comprise 2.8% of the total loading of PAH.

In summary, mercury and certain pesticides, PCBs, and PAHs were detected at low concentrations in wet-weather tow fat particles. Overall even worst case after blending, the fat particles appear to constitute only a small fraction of already-low total DITP effluent contaminant loadings to Massachusetts Bay.

6.0 Conclusions

MWRA successfully developed and implemented methodologies for its unique requirements for monitoring floatable material including a previously-described flow-paced effluent sampler, net tows in ambient waters, and chemical analyses of fat particles captured by the net tows. MWRA has thoroughly characterized the aesthetic and chemical impacts of floating material at the outfall site. It is worth noting that over time, MWRA has implemented upgrades to treatment at DITP that likely have had a cumulative effect of improving the removal of floatables, especially the decrease in blending events and the improvements in 2010 to floatables control in its primary and secondary clarifiers (Table 10).

Table 10. Improvements and upgrades to treatment at DITP since the outfall began operation

DATE	IMPROVEMENT
September 6, 2000	New outfall diffuser system online
March, 2001	Upgrade from primary to secondary treatment completed
October, 2004	Upgrades to secondary facilities (clarifiers, oxygen generation)
April 2005	Sludge/filtrate line between Deer Island and Fore River operational Improved removal of TSS etc due to more stable process
January 2012	Improvements to primary and secondary clarifiers completed

MWRA is not aware of any other publicly-owned treatment works which have had such unusual and long-term monitoring requirements for effluent floatables monitoring and debris sampling in ambient waters. MWRA had to develop new methods of monitoring for each phase of these studies, and has carried out the studies for twelve years. MWRA believes it has thoroughly answered the original, aesthetic monitoring questions as well as second-order questions on the chemistry of fat particles, and shown that the impacts are minimal. MWRA believes that it is now appropriate to call the floatables monitoring complete and end this study.

7.0 References

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8.0 Appendix

Survey reports of marine debris tows after blending events at DITP

2011 and 2012

Photographs of net tow results for all ambient floatables samples from the beginning of the study are available on request.

MD111 AND MD112

FLOATABLES SURVEY REPORT

FOR

WATER QUALITY MONITORING
Task 8
MWRA Harbor and Outfall Monitoring Project

Submitted to

MASSACHUSETTS WATER RESOURCES AUTHORITY
Environmental Quality Department
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April 19, 2011

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1. Introduction

Floatables surveys MD111 and MD112 were successfully completed on March 8 and 17, 2011 respectively. The surveys were conducted at two stations located in Massachusetts Bay. This survey represents the continuation of floatables monitoring as part of MWRA's Harbor and Outfall Monitoring Program. The *R/V Aquamonitor*, a 45-foot research vessel owned and operated by Battelle, served as the sampling platform during these surveys. Mobilization efforts for MD111 were conducted while the vessel was docked in Plymouth, Massachusetts. Mobilization efforts for MD112 were conducted while the vessel was docked in Hingham, Massachusetts. Demobilization was conducted following each survey when the boat returned to Hingham, Massachusetts. Mr. Bob Carr captained the vessel for both surveys. Both surface net tows were successfully completed during each survey. The scientific crew was composed of Battelle employees (Table 1). The samples from each survey were transferred to MWRA within 24-48 hours of survey completion.

Table 1. Survey Personnel for Floatables Surveys MD111 and MD112.

	MD111		MD112	
Activity:	Mobilization	Survey/Demob	Mobilization	Survey/Demob
Date:	Mon 3/7	Tues 3/8	Wed 3/16	Tues 3/17
Port:	Plymouth	Plymouth/Hingham	Hingham	Hingham
Battelle Staff				
Chief Scientist	B. Mandeville	B. Mandeville	M. Fitzpatrick	M. Fitzpatrick
Captain	B. Carr	B. Carr	B. Carr	B. Carr
Deck Hand	G. Lescarbeau	G. Lescarbeau		
At-sea Totals	N/A	3	N/A	2

2. Methods

2.1. Sample collection and processing

During each survey, a Neuston net (1 x 2 meter with 0.5mm mesh) was towed at two stations to capture any floating anthropogenic debris. The objective is to collect material floating in the surface water. As configured, the Neuston net samples the upper ~0.5 m of the water as it is submerged about half of its 1 m height (Figure 1). The tows were conducted near the inshore (western) side of the nearfield near station N01 and in the vicinity of the outfall (near station N21) for 10 minutes at 2 knots. The outfall tow was conducted through the visible plume. During MD111, the effluent plume was clearly visible in the vicinity of station N21. For MD112, the effluent plume was not visible upon initial arrival at station N21, but was found directly over the risers to the southwest of station N21. The risers were visible on the NavSam© and GPS chart displays as well as on the echosounder. The beginning and end coordinates, as well as start and stop time of each tow were recorded on the survey log and in NavSam's electronic data files.

After the net tow was completed, the sample was emptied into a white dissection basin for photography, picking out fat particles, and a visual qualitative inspection. The basin had a black stripe along the bottom, to provide contrast. Each sample was digitally photographed with the

survey ID, date, and station, along with a ruler for visual scale. Photographs were taken both with and without the flash to ensure a quality photo has been taken. When macro algae obscured contents, the algae were removed and a second set of photos taken.

If the sample contained visible fat particles, these particles were separated from the debris using stainless steel forceps, a stainless spoon, and a nylon or stainless screen (depending on the number of fat particles and the abundance of other smaller particles). The fat particles were transferred from the basin to a barcode-labeled short wide-mouth amber sample jar with a Teflon-lined lid. The number of fat particles was estimated and noted in the survey log. Any incidental seawater was decanted from the jar before it is frozen. The frozen jar was delivered within 2 to 3 days of collection to MWRA's Department of Laboratory Services (DLS) for later analysis (Libby *et al.* 2011).

With the fat particles removed, the remaining material was identified, described, and documented in the survey log in terms of whether an item was natural, sewage-related (e.g. condoms, tampon applicators, toilet tissue), or typical windblown anthropogenic trash. These materials were then discarded.

2.2. Deviations in Scope for Samples Collected

- During MD111, the fat particles were collected with a plastic spoon, and transferred to a clear wide mouth jar. The seawater was not decanted off. MWRA has deemed this sample acceptable for analysis.
- During MD111, the marks on the dissection pan were not marked. The pan is identical to the one used during MD112.
- During MD112, 3 larger fat particles (about 1 cm in length) were included in a separate sample jar- these 3 particles were not part of the tow, and were observed floating by while processing the initial net tow from near station N21. Instead of using a single 2mm sieve to separate the fat particles from other debris, a stacked sieve was used (2 mm and 500 micron) so that all material captured by the net would be available for transfer to the sample jar.

3. Survey Chronology

Note: All times are recorded in Local Time

Monday, March 7, 2011

~0340	Receive e-mail about >3 hours of blending at DITP.
0807	Receive official notice from MWRA to proceed with mobilization for survey MD111.
1200	*R/V Aquamonitor* is put back in the water for the year and transferred to Plymouth.
1700	Mobilization completed.

Tuesday, March 8, 2011

~0520	Receive the "end of blending notice" and 24-hour survey clock starts.

0753	Perform navigation check.
0809	Depart dock in Plymouth for station N21.
1045	Arrive in the vicinity of the risers to find the plume is visible and easy to locate. Begin rigging the Neuston net for deployment.
1058	Begin towing the net through the visible plume at ~2 kts.
1108	End tow near N21, begin collecting fat particles and depart for N01.
1151	Arrive near N01.
1153	Begin western nearfield tow near N01.
1203	Tow completed. Photograph net and contents and depart for Hingham Shipyard, Hingham Massachusetts.
1315	Arrive at dock in Hingham.
1318	Perform navigation check and begin demobilization.

Wednesday, March 16, 2011

0829	Receive official notice from MWRA to proceed with mobilization for survey MD112 if more than 3 consecutive hours of blending occurs.
1513	Receive e-mail about >3 hours of blending at DITP.
1630	Receive the "end of blending notice" and 24-hour survey clock starts.
1700	Mobilization completed.

Thursday, March 17, 2011

0709	Perform navigation check.
0715	Depart dock in Hingham for station N21.
0819	Arrive in the vicinity of the risers to find the plume is not visible and few particulates are in the water.
	Spend approximately 45 minutes transiting around the area looking for the visible plume- finally see small patches of upwelling (10-15' in diameter) directly over the risers south west of N21. Begin rigging the Neuston net for deployment.
0900	Begin towing the net through small areas of the visible plume parallel to the pipeline at ~2 kts.
0910	End tow near N21, photograph the net and contents, and begin collecting fat particles.
	Spend approximately 30-40 minutes picking the small fat particles from other organic debris. During this time period 3 other larger fat particles are observed floating by. They were collected and transferred to a separate jar.
1015	Depart for N01.
1048	Arrive near N01.
1051	Begin western nearfield tow near N01.
1101	Tow completed. Photograph net and contents and depart for Hingham Shipyard, Hingham Massachusetts.
1233	Arrive at dock in Hingham.
1235	Perform navigation check and begin demobilization.

4. Survey Results

4.1. Overview

During MD111 and MD112, surface net tows were conducted in the vicinity of the risers and a control station in the western nearfield area near N01. The contents of each net tow are documented below in Table 2. Positional data for each net tow is located in Table 3. The survey tracklines are shown in Figures 2, 3 and 4. Photographs of the net contents are shown in Figures 5 through 10.

Table 2. Contents of Marine Debris tows conducted during MD111 and MD112.

Survey / Station	Windblown man-made debris	Sewage related debris	Other items of interest
MD111 / N21	None	Numerous (>25-50) small to medium fat particles	1 piece of latex, which may or may not be sewage related
MD111 / N01	One small piece of a plastic trash bag	None	None
MD112 / N21	One ¾" piece of Styrofoam and some small Styrofoam balls	Numerous (>100) small fat particles 2 condoms were observed in the area, but not captured by the net	The net began to clog with phytoplankton towards the end of the tow. Higher engine rpm was needed to keep the boat traveling around 2kts.
MD1112/ N01	Several small white Styrofoam balls, 5 small pieces of plastic and one small piece of a blue tarp	None	The net was somewhat full of phytoplankton, but not as much as the tow near N21.

Table 3. Listing of positional data for marine debris tows

Event ID	Station ID	Date	Begin Time	Begin Latitude	Begin Longitude	End Time	End Latitude	End Longitude	Distance Traveled (M)
MD111	N21	03/08/11	10:58:13	42.3884667	-70.7814167	11:08:20	42.3871667	-70.7892833	662.79
MD111	N01	03/08/11	11:53:33	42.4221667	-70.8639167	12:03:38	42.41745	-70.8686667	654.26
MD112	N21	03/17/11	9:00:31	42.3853683	-70.797966	9:10:30	42.3868331	-70.7908477	607.58
MD112	Sample of Opportunity*	03/17/11	~9:30	42.38723	-70.7924				
MD112	N01	03/17/11	10:51:33	42.4155006	-70.8677139	11:01:32	42.4195175	-70.8625335	617.41

*sample of opportunity was observed floating alongside the boat about 20 minutes after the N21 debris tow was complete. The position data was retrieved from the boat trackline data record for 9:30 am.

4.2. Marine Mammal Observations

Tuesday, March 8, 2011 from 0809 to 1315
Thursday, March 17, 2011 from 0715 to 1233

No marine mammals were observed on either survey.

5. Problems experienced, actions taken, and recommendations

5.1. Schedule

None.

5.2. Technical

None.

6. References

Libby PS, Fitzpatrick MR, Buhl RL, Lescarbeau GR, Leo WS, Borkman DG, Turner JT. 2011. Quality assurance project plan (QAPP) for water column monitoring 2011-2013: Tasks 4-9 and 12. Boston: Massachusetts Water Resources Authority. Report 2011-02. 72 p.

Figure 1. Deployed Neuston Net.

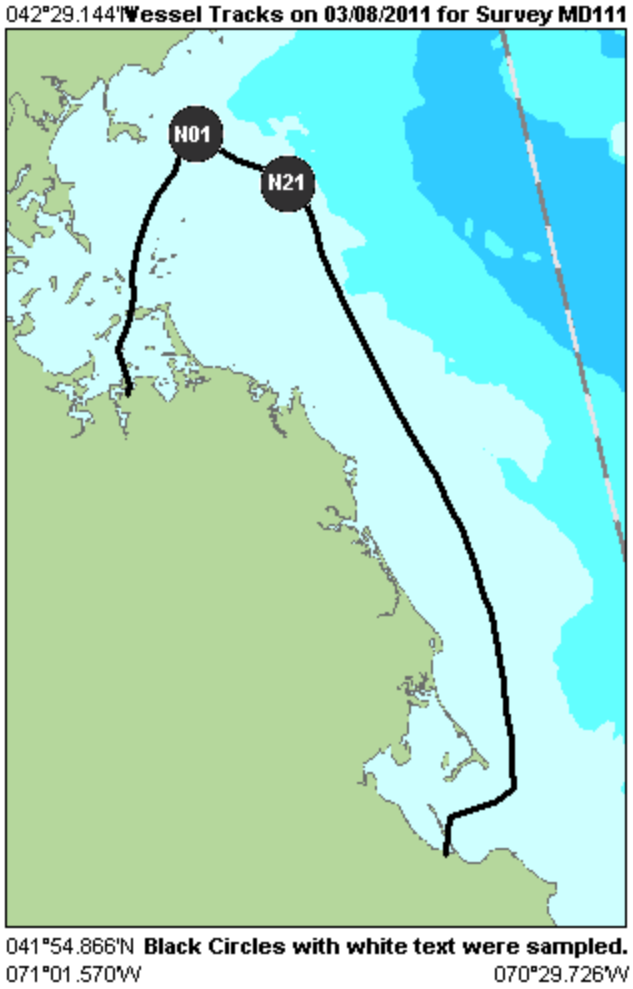

Figure 2. Survey Track for Floatables Survey MD111.

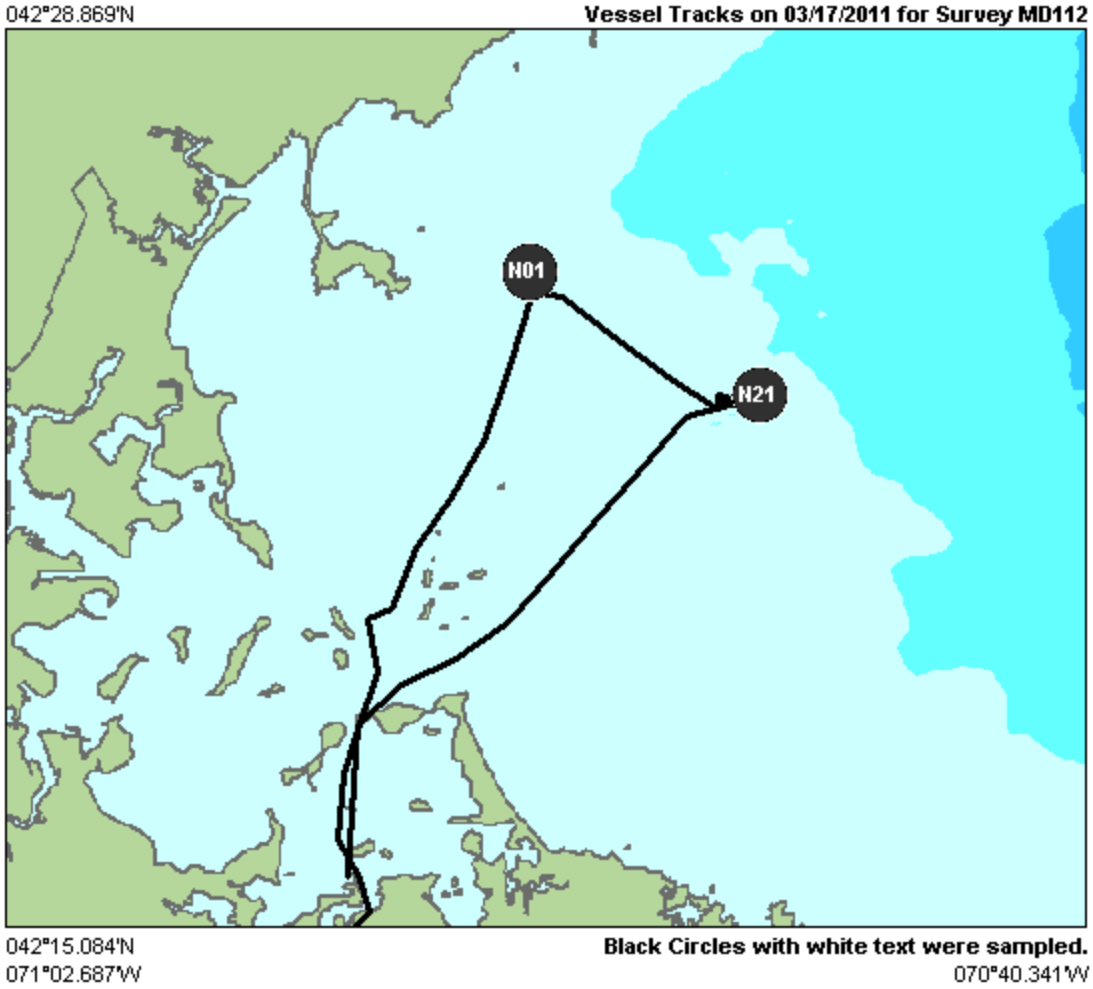

Figure 3. Survey Track for Floatables Survey MD112.

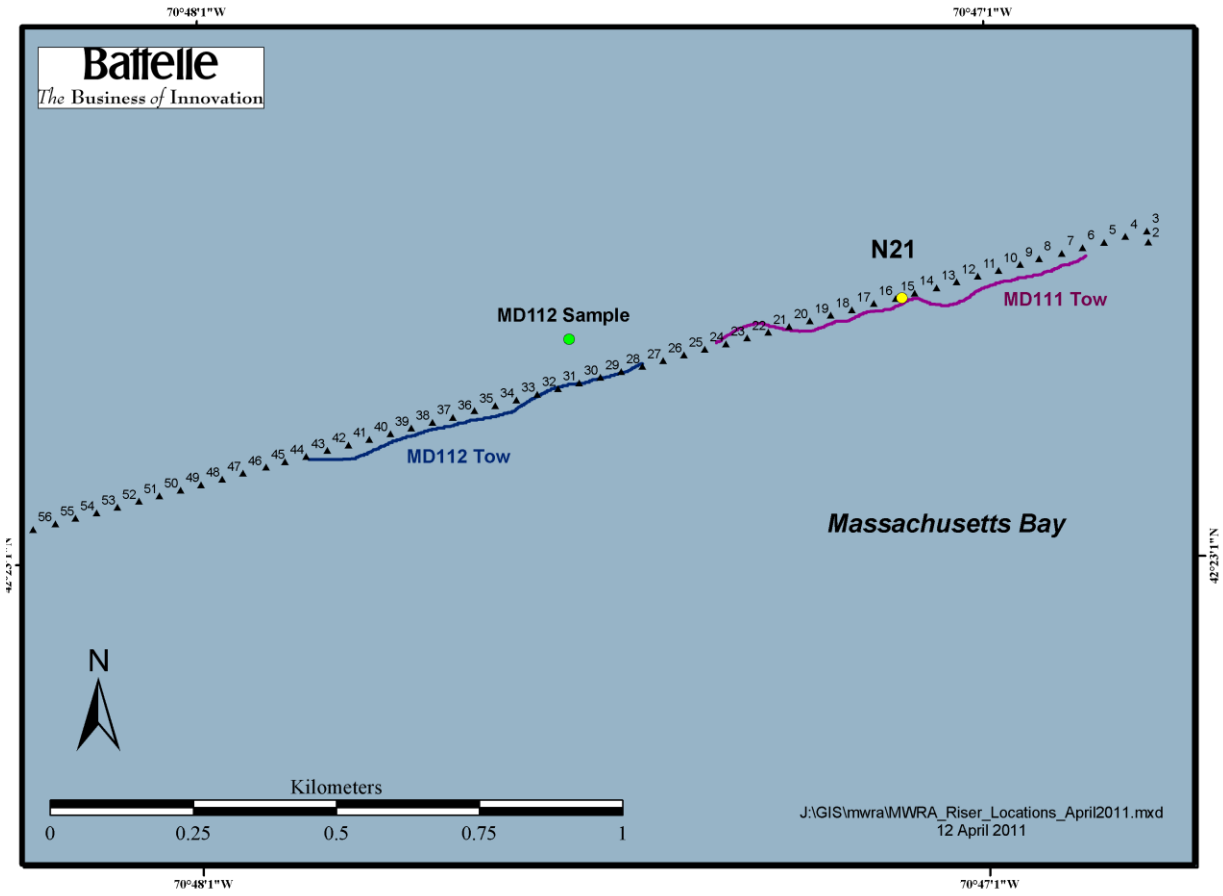

Figure 4. Survey Track for Debris Tows near Station N21 for MD111 and MD112 along with Risers, Station N21, and Sample of Opportunity from MD112.

Figure 5. MD111 Marine Debris Tow from Station N21.

Figure 6. MD111 Marine Debris Tow from Station N01.

Figure 7. MD112 Marine Debris Tow from Station N21.

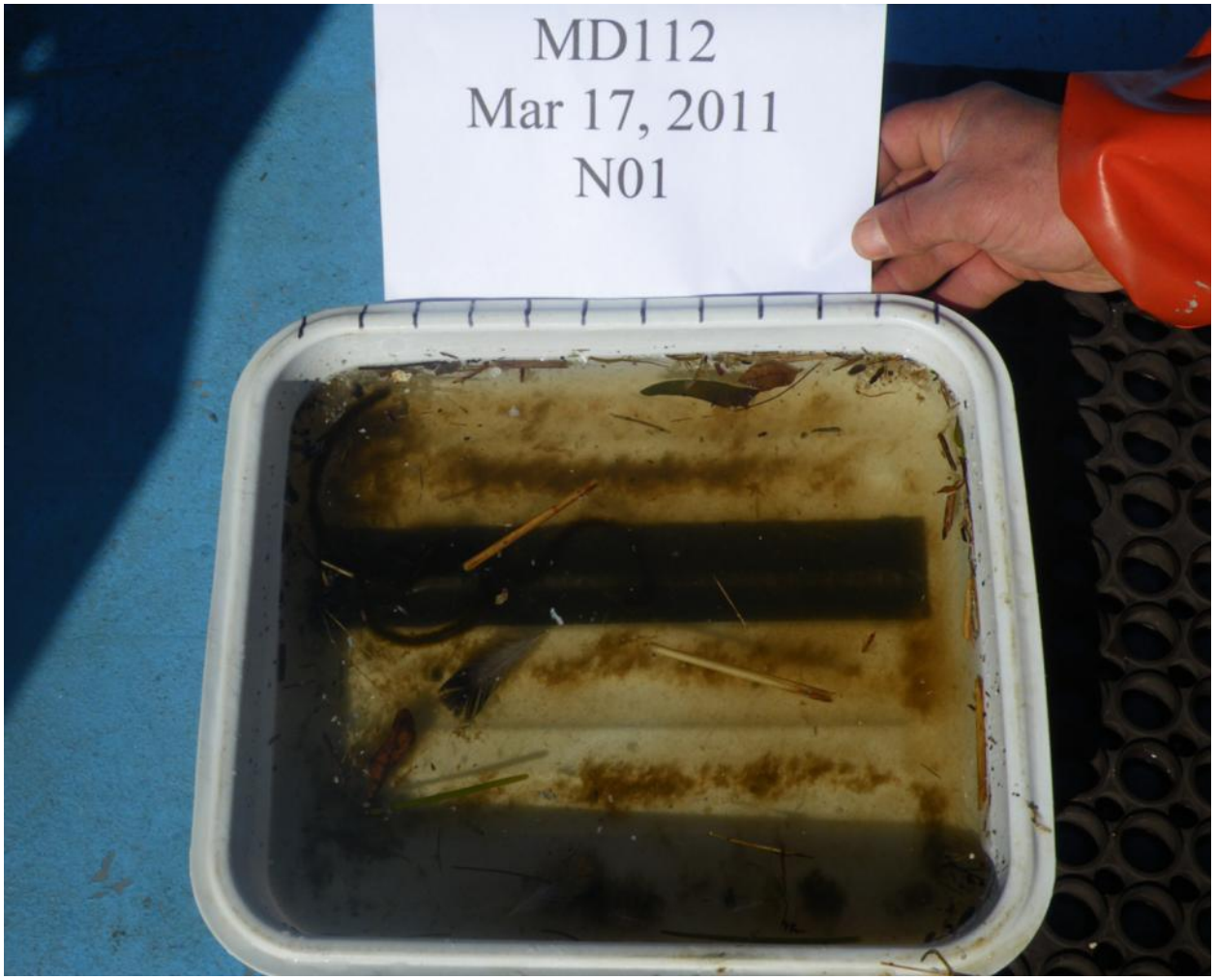

Figure 8. MD112 Marine Debris Tow from Station N01.

Figure 9. MD112 Marine Debris Tow Net from Station N21.

Figure 10. MD112 Marine Debris Tow Net from Station N01.

MD121

FLOATABLES SURVEY REPORT

FOR

WATER QUALITY MONITORING
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MWRA Harbor and Outfall Monitoring Project

Submitted to

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June 6, 2012

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1. Introduction

Floatables survey MD121 was successfully completed on May 10. The survey was conducted at two stations located in Massachusetts Bay. This survey represents the continuation of floatables monitoring as part of MWRA's Harbor and Outfall Monitoring Program. The *R/V Aquamonitor*, a 45-foot research vessel owned and operated by Battelle, served as the sampling platform during the survey. Mobilization efforts for MD121 were conducted while the vessel was docked in Hingham, Massachusetts. Demobilization was conducted following the survey when the boat returned to Quincy, Massachusetts. Mr. Bob Carr captained the vessel for the survey. Both surface net tows were successfully completed during the survey. The scientific crew was composed of Battelle employees (Table 1). The samples from the survey were transferred to MWRA six days after survey completion.

Table 1. Survey Personnel for Floatables Surveys MD121.

	MD121
Activity:	Mobilization/Survey /Demob
Date:	Thurs 5/10
Port:	Plymouth/Hingham
Battelle Staff	
Chief Scientist	M. Fitzpatrick
Captain	B. Carr
NavSam	B. Mandeville
At-sea Totals	3

2. Methods

2.1. Sample collection and processing

During the survey, a Neuston net (1 x 2 meter with 0.5mm mesh) was towed at two stations to capture any floating anthropogenic debris. The objective is to collect material floating in the surface water. As configured, the Neuston net samples the upper ~0.5 m of the water as it is submerged about half of its 1 m height (Figure 1). The tows were conducted near the inshore (western) side of the nearfield near station N01 and in the vicinity of the outfall (near station N21) for 10 minutes at 2 knots. During MD121, the effluent plume was not visible along the diffuser line. The tow was conducted in the vicinity of N21 in an area where small particles were observed by the survey crew. The risers were also visible on the NavSam© and GPS chart displays as well as on the echosounder. The beginning and end coordinates, as well as start and stop time of each tow were recorded on the survey log and in NavSam's electronic data files.

After the net tow was completed, the sample was emptied into a white dissection basin for photography, picking out fat particles, and a visual qualitative inspection. The basin had a black stripe along the bottom, to provide contrast. Each sample was digitally photographed with the survey ID, date, and station, along with a ruler for visual scale. Photographs were taken both with and without the flash to ensure a quality photo has been taken. When macro algae obscured contents, the algae were removed and a second set of photos taken.

If the sample contained visible fat particles, these particles were separated from the debris using stainless steel forceps, a stainless spoon, and a stainless screen. The fat particles were transferred from the basin to a barcode-labeled short wide-mouth amber sample jar with a Teflon-lined lid. The number of fat particles was estimated and noted in the survey log. Any incidental seawater was decanted from the jar before it was frozen. The frozen jar was delivered within six days of collection to MWRA's Department of Laboratory Services (DLS) for later analysis (Libby *et al.* 2011).

With the fat particles removed, the remaining material was identified, described, and documented in the survey log in terms of whether an item was natural, sewage-related (e.g. condoms, tampon applicators, toilet tissue), or typical windblown anthropogenic trash. These materials were then discarded.

2.2. Deviations in Scope for Samples Collected

- During MD121, 2 large fat particles (about 1 inch in length) were included in two separate sample jars- these particles were not part of the tow, and were observed floating near the RV Aquamonitor, while the crew was looking for the visible plume in the vicinity of the diffuser line. These two particles were captured by reaching over the side of the boat with a stainless sieve and were simply scooped up.
- Instead of using a single 2mm sieve to separate the fat particles from other debris, a stacked sieve was used (2 mm and 500 micron) so that all material captured by the net would be available for transfer to the sample jar.

3. Survey Chronology

Note: All times are recorded in Local Time

Thursday, May 10, 2012

0728	Receive e-mail from MWRA authorizing a floatables survey.
0735	Receive Automated e-mail from DITP that secondary blending has occurred for more than 3 hours.
0823	Receive the "end of blending notice" and 24-hour survey clock starts.
0855	Perform navigation check.
~1000	Begin mobilization of *R/V Aquamonitor*
1102	Depart dock in Hingham for station N01.
1209	Arrive near N01. Begin rigging the Neuston net for deployment.
1212	Begin western nearfield tow near N01.
1222	Tow completed. Photograph net and contents and depart for station N21.
~1245	Arrive in the vicinity of the western most risers to find the plume is not visible. Slowly travel across the diffuser line looking for signs of the visible plume.
1258	Observe a large fat particle and collect the first sample of opportunity.
1304	While processing the first sample of opportunity, the crew observes and captures a second large fat particle.
	The crew continues along the diffuser line to towards the North East end of the risers and could not observe the visible plume.

1319	Begin towing the net at ~2 kts near N21 in an area where some small particles were observed.
1330	End tow southwest of N21, begin collecting fat particles and depart Quincy.
1449	Arrive at dock in Quincy.
1450	Perform navigation check and begin demobilization.

4. Survey Results

4.1. Overview

During MD121, surface net tows were conducted in the vicinity of the risers and a control station in the western nearfield area near N01. The contents of each net tow are documented below in Table 2. Positional data for each net tow is located in Table 3. The survey trackline is shown in Figures 2 and 3. Photographs of the net contents are shown in Figures 4 and 5. A photograph of the samples of opportunity is shown in Figure 6.

Table 2. Contents of Marine Debris tows conducted during MD121.

Survey / Station	Windblown man-made debris	Sewage related debris	Other items of interest
MD121 / N21	One pull-top bottle seal like what is used to seal condiment containers	Numerous (>25-50) small to medium fat particles	None
MD121 / N01	Approximately 15 small pieces of plastic	None	None

Table 3. Listing of positional data for marine debris tows

Event ID	Station ID	Date	Begin Time	Begin Longitude	Begin Latitude	End Time	End Longitude	End Latitude	Distance Traveled (M)
MD121	N01	05/10/12	12:12:46	-70.870552	42.418282	12:22:49	-70.863617	42.419399	583.35
MD121	N21	05/10/12	13:19:54	-70.784431	42.387768	13:30:03	-70.792770	42.386101	710.31
MD121	Sample of Opportunity*	05/10/12	12:58:43	-70.795250	42.385780				
MD121	Sample of Opportunity*	05/10/12	13:04:00	-70.796590	42.384820				

*sample of opportunities were observed floating alongside the boat about 20 minutes before the N21 debris tow was started.

4.2. Marine Mammal Observations

Thursday, May 10, 2012 from 1102 to 1449

No marine mammals were observed.

5. Problems experienced, actions taken, and recommendations

5.1. Schedule

None.

5.2. Technical

None.

6. References

Libby PS, Fitzpatrick MR, Buhl RL, Lescarbeau GR, Leo WS, Borkman DG, Turner JT. 2011. Quality assurance project plan (QAPP) for water column monitoring 2011-2013: Tasks 4-9 and 12. Boston: Massachusetts Water Resources Authority. Report 2011-02. 72 p.

Figure 1. Deployed Neuston Net.

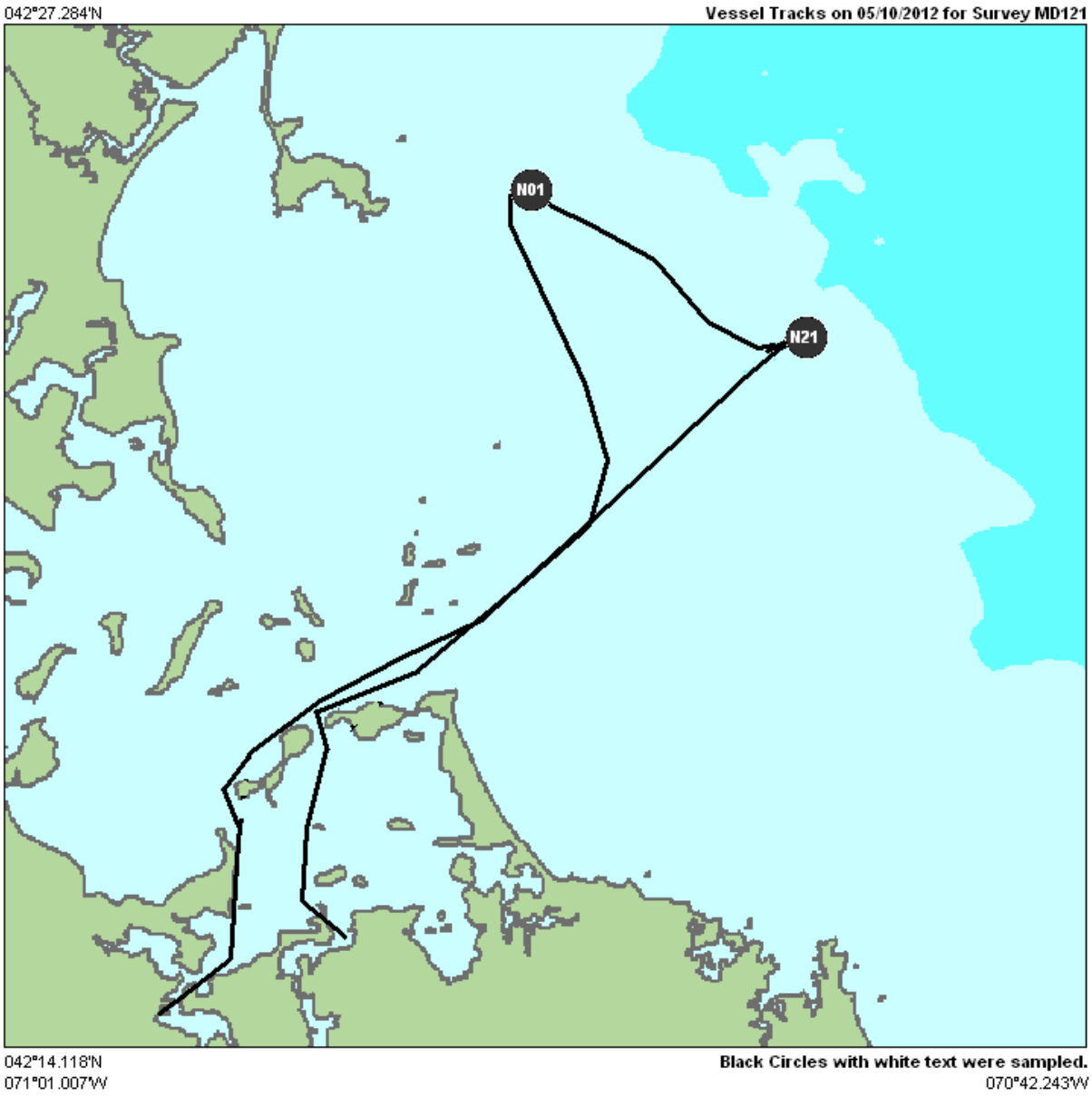

Figure 2. Survey Track for Floatables Survey MD121.

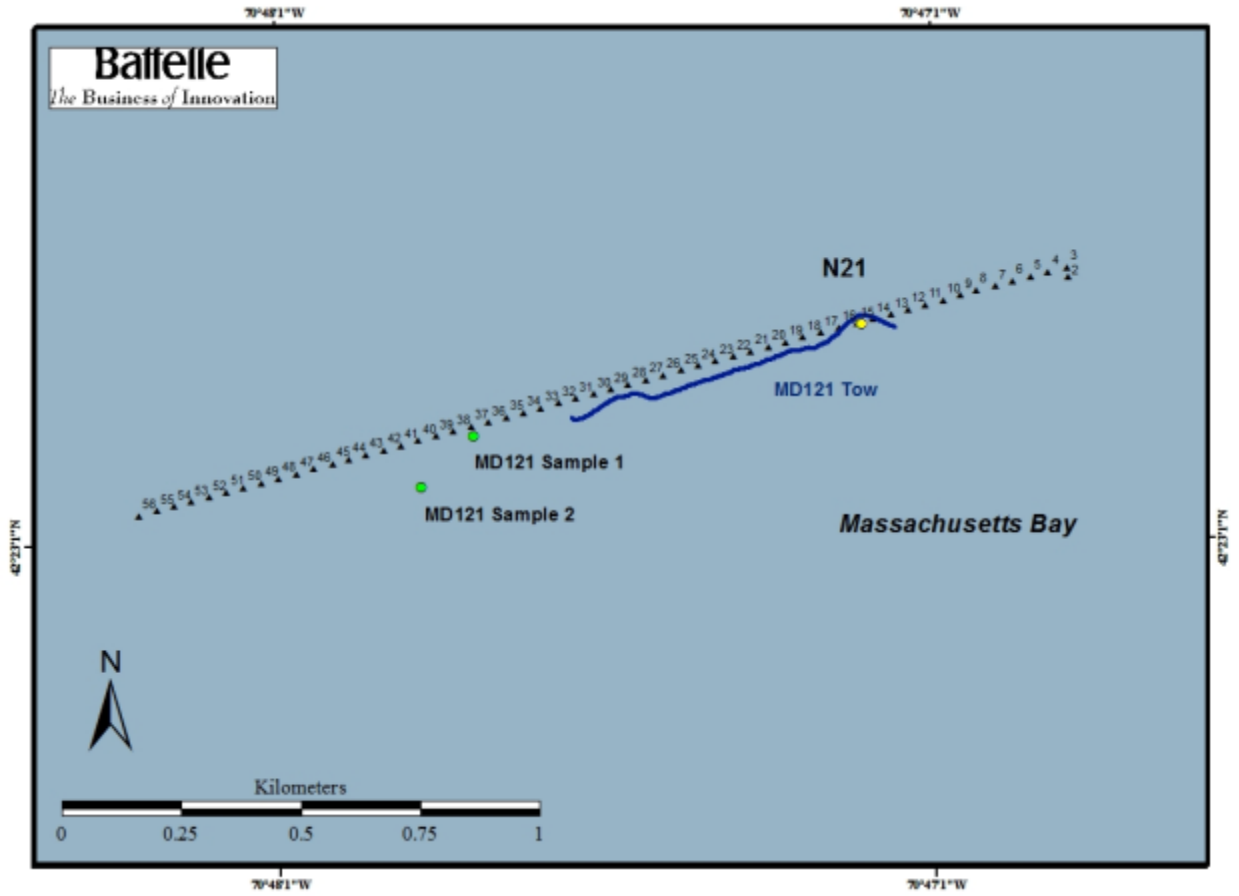

Figure 3. Survey Track for Debris Tow near Station N21 on MD121 along with Risers, Station N21, and Sample of Opportunities.

Figure 4. MD121 Marine Debris Tow from Station N01.

Figure 5. MD121 Marine Debris Tow from Station N21.

Figure 6. MD121 samples of opportunity.

MD122

FLOATABLES SURVEY REPORT

FOR

WATER QUALITY MONITORING
Task 8
MWRA Harbor and Outfall Monitoring Project

Submitted to

MASSACHUSETTS WATER RESOURCES AUTHORITY
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July 24, 2012

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1. Introduction

Floatables survey MD122 was successfully completed on July 19. The survey was conducted at two stations located in Massachusetts Bay. This survey represents the continuation of floatables monitoring as part of MWRA's Harbor and Outfall Monitoring Program. The *R/V Aquamonitor*, a 45-foot research vessel owned and operated by Battelle, served as the sampling platform during the survey. Mobilization efforts for MD122 were conducted while the vessel was docked in Hingham, Massachusetts. Demobilization was conducted following the survey when the boat returned to Quincy, Massachusetts. Mr. Bob Carr captained the vessel for the survey. Both surface net tows were successfully completed during the survey. The scientific crew was composed of Battelle employees (Table 1). The samples from the survey were transferred to MWRA six days after survey completion.

Table 1. Survey Personnel for Floatables Surveys MD122.

	MD122
Activity:	Mobilization/Survey /Demob
Date:	Thurs 7/19
Port:	Quincy
Battelle Staff	
Chief Scientist	M. Fitzpatrick
Captain	B. Carr
NavSam	B. Mandeville
At-sea Totals	3

2. Methods

2.1. Sample collection and processing

During the survey, a Neuston net (1 x 2 meter with 0.5mm mesh) was towed at two stations to capture any floating anthropogenic debris. The objective is to collect material floating in the surface water. As configured, the Neuston net samples the upper ~0.5 m of the water as it is submerged about half of its 1 m height (Figure 1). The tows were conducted near the inshore (western) side of the nearfield near station N01 and in the vicinity of the outfall (near station N21) for 10 minutes at 2 knots. During MD122, the effluent plume was not visible along the diffuser line. The tow was conducted in the vicinity of N21 in an area where small particles were observed by the survey crew. The risers were also visible on the NavSam© and GPS chart displays as well as on the echosounder. The beginning and end coordinates, as well as start and stop time of each tow were recorded on the survey log and in NavSam's electronic data files.

After the net tow was completed, the sample was emptied into a white dissection basin for photography, picking out fat particles, and a visual qualitative inspection. The basin had a black stripe along the bottom, to provide contrast. Each sample was digitally photographed with the survey ID, date, and station, along with a ruler for visual scale. Photographs were taken both with and without the flash to ensure a quality photo has been taken. When macro algae obscured contents, the algae were removed and a second set of photos taken.

If the sample contained visible fat particles, these particles were separated from the debris using stainless steel forceps, a stainless spoon, and a stainless screen. The fat particles were transferred from the basin to a barcode-labeled short wide-mouth amber sample jar with a Teflon-lined lid. The number of fat particles was estimated and noted in the survey log. Any incidental seawater was decanted from the jar before it was frozen. The frozen jar was delivered the day following collection to MWRA's Department of Laboratory Services (DLS) for later analysis (Libby *et al.* 2011).

With the fat particles removed, the remaining material was identified, described, and documented in the survey log in terms of whether an item was natural, sewage-related (e.g. condoms, tampon applicators, toilet tissue), or typical windblown anthropogenic trash. These materials were then discarded.

2.2. Deviations in Scope for Samples Collected

- Instead of using a single 2mm sieve to separate the fat particles from other debris, a stacked sieve was used (2 mm and 500 micron) so that all material captured by the net would be available for transfer to the sample jar.

3. Survey Chronology

Note: All times are recorded in Local Time

Wednesday, July 18, 2012

2114	Receive Automated e-mail from DITP that secondary blending has occurred for more than 3 hours.
2134	Receive the "end of blending notice" and 24-hour survey clock starts.

Thursday, July 19, 2012

~0730	Begin mobilization of *R/V Aquamonitor.*
0832	Perform navigation check.
0835	Depart dock in Hingham for station N21.
0935	Arrive in the vicinity of the western most risers to find the plume is not visible. Slowly travel across the diffuser line looking for signs of the visible plume. Begin rigging the Neuston net for deployment.
0945	Observe an area north of the diffuser line where small particles are present.
0951	Begin towing the net at ~2 kts approximately 150 meters north of the diffuser line in an area where some small particles were observed.
1001	End the tow approximately 225 meters north of the diffuser line, begin collecting fat particles.
1027	Depart for station N01
1047	Arrive in the vicinity of N01.
1050	Begin western nearfield tow near N01.
1100	Tow completed. Photograph net and contents and depart for Quincy.
1228	Arrive at dock in Quincy.
1233	Perform navigation check and begin demobilization.

4. Survey Results

4.1. Overview

During MD122, surface net tows were conducted in the vicinity of the risers and a control station in the western nearfield area near N01. The contents of each net tow are documented below in Table 2. Positional data for each net tow is located in Table 3. The survey trackline is shown in Figures 2 and 3. Photographs of the net contents are shown in Figures 4, 5, and 6.

Table 2. Contents of Marine Debris tows conducted during MD122.

Survey / Station	Windblown man-made debris	Sewage related debris	Other items of interest
MD122 / N21	2 small pieces of clear cellophane and one small piece of plastic	Numerous (>50) small to medium fat particles Observe one tampon applicator while conducting the tow-it was not captured by the net.	None
MD122 / N01	1 piece of blue paper towel similar to a heavy duty shop towel	None	None

Table 3. Listing of positional data for marine debris tows

Event ID	Station ID	Date	Begin Time	Begin Longitude	Begin Latitude	End Time	End Longitude	End Latitude	Distance Traveled (M)
MD122	N21	07/19/12	9:51:51	-70.796950	42.387180	10:01:56	-70.790000	42.389120	610.88
MD122	N01	07/19/12	10:50:35	-70.867650	42.415870	11:00:38	-70.863460	42.420520	621.70

4.2. Marine Mammal Observations

Thursday, July 19, 2012 from 0835 to 1228

No marine mammals were observed.

5. Problems experienced, actions taken, and recommendations

5.1. Schedule

None.

5.2. Technical

None.

6. References

Libby PS, Fitzpatrick MR, Buhl RL, Lescarbeau GR, Leo WS, Borkman DG, Turner JT. 2011. Quality assurance project plan (QAPP) for water column monitoring 2011-2013: Tasks 4-9 and 12. Boston: Massachusetts Water Resources Authority. Report 2011-02. 72 p.

Figure 1. Deployed Neuston Net.

Figure 2. Survey Track for Floatables Survey MD122.

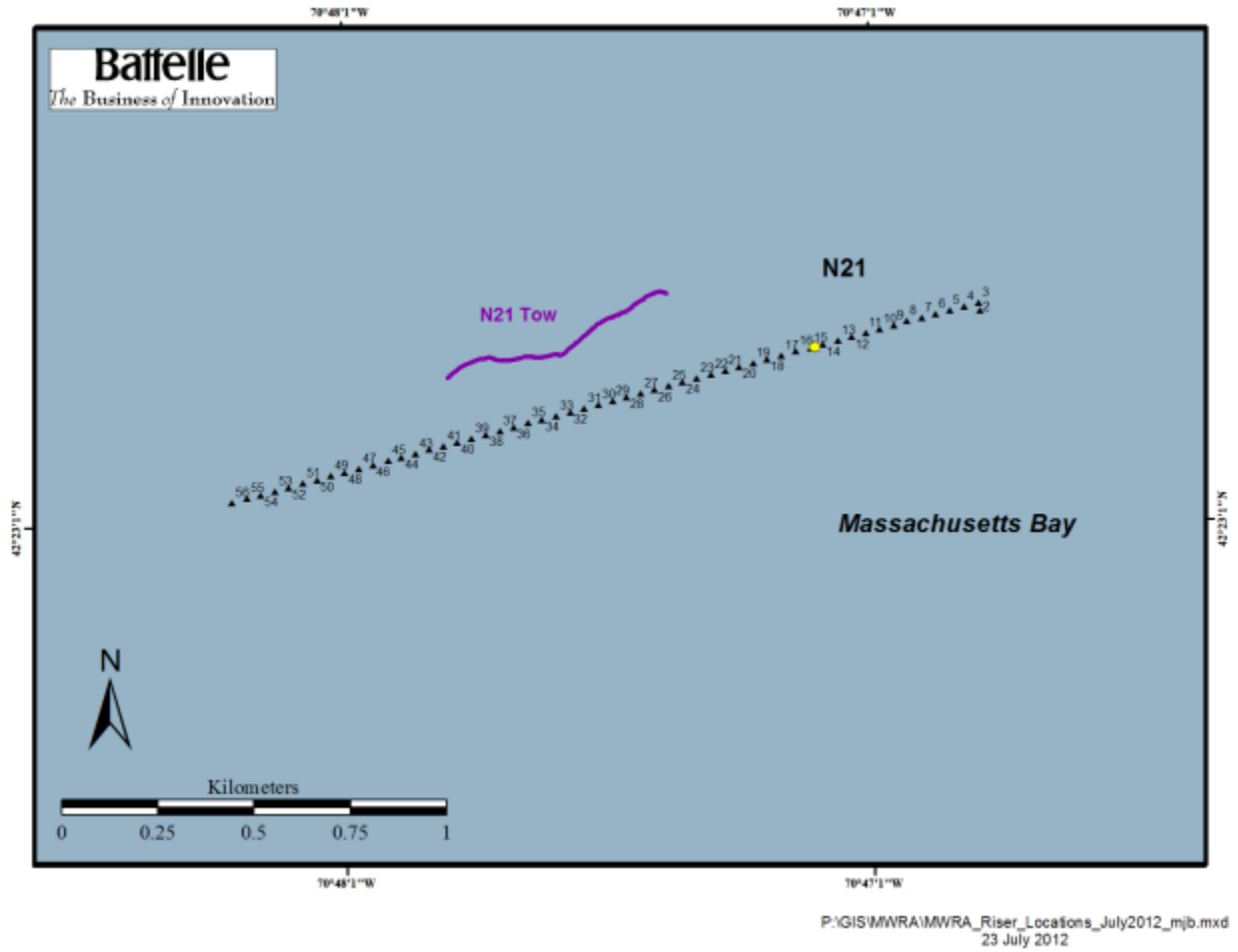

Figure 3. Survey Track for Debris Tow near Station N21 on MD122 along with Risers and Station N21.

Figure 4. MD122 Marine Debris Tow from Station N01.

Figure 5. MD122 Marine Debris Tow from Station N01 with seaweed removed.

Figure 6. MD122 Marine Debris Tow from Station N21.

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