Savin Hill Cove Water Quality Monitoring Program
for
Morrissey Boulevard Drainage Conduit Project
Executive Summary

Background of Morrissey Boulevard Drainage Conduit Project

Savin Hill Cove is a shallow embayment that is adjacent to the mouth of the Neponset River. It is an exposed tidal flat during periods of low tide and entirely submerged at high tide. During low tide, a low flow channel conveys flow along its northern side and a larger channel, through its center, conveys flows from Patten's Cove. Sediments within the Cove are primarily comprised of organic muck with some limited areas of sandier material.

The Savin Hill Cove Water Quality Monitoring Program (WQMP) was required under the Order of Conditions issued by the Boston Conservation Commission for the Morrissey Boulevard Drainage Conduit (MBDC) Project. The WQMP studies and evaluates water quality and sedimentation/erosion impacts from stormwater discharges into Savin Hill Cove. Design and construction of the MBDC Project were undertaken by the Boston Water and Sewer Commission (BWSC) on behalf of the Massachusetts Water Resources Authority (MWRA).

In compliance with recommendations included in the MWRA 2004 *Supplemental Facilities Plan and Environmental Impact Report on the Long-Term Control Plan for North Dorchester Bay and Reserved Channel* (Supplemental Environmental Impact Report), the MBDC will operate in conjunction with the MWRA's North Dorchester Bay CSO Storage Tunnel (NDBST) Project to improve water quality in North Dorchester Bay. These two projects will provide better management of stormwater runoff and enable the BOS087 Outfall to be closed, diverting stormwater runoff away from recreational beaches on North Dorchester Bay.

As part of the MDBC Project, a diversion structure (Special Manhole D) was constructed in the existing BOS087 system. This structure is located in the parking lot of the State Police Barracks, upstream of where MWRA constructed a sluice gate manhole and pipe connecting the BOS087 system to the NDBST. Special Manhole D includes a weir wall to direct lower flow levels to the NDBST and allow levels above its crest elevation to overflow into the MBDC. The sluice gate

manhole contains a remotely-operated sluice gate to control the flow entering the NDBST from the BOS087 system.

The MBDC Project also included other water quality improvement features. Among them was a rip-rap lined discharge basin at the MBDC's outfall to Savin Hill Cove intended to reduce flow velocity and erosion potential at the outfall. In addition, particle separators were added on all tributary drainage systems along its alignment in order to reduce pollutant loads prior to stormwater entering the MBDC.

Figure ES-1 provides an overview of the MBDC Project showing major project components, areas contributing flow to the MBDC system and the wastewater piping and sluice gate chamber that were installed by MWRA to control flow entering the NDBST from the BOS087 system.

Stormwater flows sampled during the monitoring program can be derived from two separate watersheds depending on how MWRA controls flow entering the NDBST from the existing BOS087 system. The following provides a brief description of the watersheds and identifies when each watershed will contribute stormwater runoff to the MBDC:

- Lower/Morrissey Boulevard Watershed: this watershed encompasses Morrissey Boulevard and the adjacent properties and has historically drained to Savin Hill Cove through a storm drain system (referred to as the Morrissey Boulevard Storm Drain (MBSD)) that is generally located in the median between the northbound and south bound travel lanes. The land use characteristics of this watershed are primarily medium density commercial and institutional, with some freeway. The watershed is unchanged by the MBDC Project; it drained to Savin Hill Cove prior to construction and it continues to drain to the Cove under Post-MBDC Construction conditions.

- Upper/Sydney-Carson Streets Watershed: this watershed includes densely populated and heavily developed areas of Dorchester, as well as residential and roadway areas adjacent to Moakley Park and portions of the Bayside Exposition Center. Prior to constructing the MBDC and NDBST projects, stormwater runoff from this watershed was conveyed by the BOS087 system and discharged to North Dorchester Bay via Outfall BOS087.

Stormwater runoff from the Lower/ Morrissey Boulevard Watershed is tributary to the MBDC and discharges to Savin Hill Cove during all rainfall events. Stormwater runoff from the Upper/ Sydney-Carson Streets Watershed is conveyed by the BOS087 system and will discharge to either the NDBST or the MBDC, depending on the following MWRA operating procedures.

- The NDBST will collect the "first flush", or approximately 1 million gallons, of stormwater runoff generated by the Upper Watershed for all rainfall events up to and including the 1-year storm (2.8 inches of precipitation in 24 hours).

- For rainfall events greater than the 1-year storm, the MWRA will use the sluice gate to control flows entering the NDBST from the Upper Watershed. The volume of flow from the Upper Watershed allowed to enter the NDBST will be determined by MWRA on a storm-by-storm basis. In the event of an extreme storm, the MWRA may choose to close the sluice gate. Flow from the Upper Watershed that is prohibited from entering the NDBST is diverted to the MBDC system at Special Manhole D, and then conveyed to Savin Hill Cove. Under these conditions the MBDC will convey flow from both the Lower and Upper Watersheds

Overview of Water Quality Monitoring Program

The WQMP involves collecting and analyzing water quality and sedimentation data through several stages of the MBDC and NDBST project. The program consists of two main components:

1. Water Quality sampling to measure potential changes in stormwater quality entering Savin Hill Cove

2. Semi-annual bathymetric surveying to measure potential changes in cove sedimentation or erosion.

The WQMP is implemented in accordance with a Work Plan (provided in Section 2 of this three-ring binder). Table ES-1, provides an overview of the WQMP schedule.

The Baseline Conditions Report (Section 3 of this three-ring binder) presents the results of water quality sampling and bathymetric surveys conducted during 2005, 2006, and 2007, prior to the start of MBDC construction. These results established the basis to which future sampling and survey results are compared. Water quality sampling was not conducted during the construction of the MBDC because the sampling equipment could not be installed until after construction was completed. However, semi-annual bathymetric surveys were performed during construction and are provided in the annual monitoring reports for 2008 and 2009. Following completion of the MBDC and installation of water quality sampling equipment, sampling of stormwater flows commenced in fall 2010. The NDBST became fully operational in spring 2011.

Stormwater sampling and analyses will be conducted through the spring of 2013 in accordance with the requirement that sampling extend for 2 years beyond completion of the NDBST. It is also required to sample at least one 5-year or greater storm during this time period. Bathymetric

surveying will also continue until the spring of 2013 such that data is gathered for the 2-year period after completion of the NDBST.

Table ES-1. Summary of WQMP Phases

PERIOD	YEARS	MONITORING	REPORT
Pre-MBDC Construction	2005 - 2007	Water Quality Sampling and Bathymetric Survey	Baseline Conditions 2005-2007(Section 3)
During MBDC Construction	2008 and 2009	Bathymetric Survey	2008 and 2009 Annual Monitoring Reports (Sections 4 & 5)
Post- MBDC Construction	Fall 2010 to Spring 2011	Water Quality Sampling & Bathymetric Survey	2010 & 2011 Annual Monitoring Report (Sections 6 & 7)
Post- NDBST Construction	Spring 2011 to Spring 2013	Water Quality Sampling & Bathymetric Survey	2010 – 2013 Annual Monitoring Reports (Sections 7, 8 & 9)
Construction of MBDC Discharge Basin	Pre-Construction & MBDC Construction	Water Quality Sampling	(Section 11 – Pre-Construction) (Section 12 – Construction)

In accordance with the Water Quality Certification issued by the Massachusetts Department of Environmental Protection, a supplemental water quality monitoring program was developed to conduct in-cove sampling prior to and during construction of the discharge basin to evaluate impacts to Savin Hill Cove. A Work Plan detailing the procedures that were followed to collect the samples is provided in Section 10 (of this three-ring binder). A summary of pre-construction sampling results is provided in Section 11 and a summary of results for sampling during construction is provided in Section 12.

PRE-CONSTRUCTION MONITORING

Baseline Conditions (Section 3)

Pre-Construction Water Quality Sampling (2005-2006) & Bathymetric Surveys (2007)

Overview

Pre-construction water quality sampling was conducted to characterize stormwater conveyed by the existing 60" Morrissey Boulevard Storm Drain (MBSD) and the existing 96" x 96" BOS087 system. Sampling was conducted by the Horsely Witten Group, Inc. (HW) at two locations:

1. at a manhole for the existing 60" MBSD (approximately 600 feet upstream of the old MBSD outfall to Savin Hill Cove) to characterize stormwater runoff contributory to Savin Hill Cove from the Lower Watershed; and.
2. at a manhole at the intersection of Sydney and Carson Streets to characterize stormwater runoff contributory to the BOS087 system from the Upper Watershed

Samples were laboratory tested for the following constituents:

- fecal coliform bacteria (FC),
- total suspended solids (TSS), and
- salinity.

The results of this stormwater quality sampling established the baseline conditions to which future sampling results are to be compared.

Pre-MBDC Construction bathymetric surveys were conducted on November 27, 2007 to establish the baseline topography in Savin Hill Cove along the northern low flow channel, the larger channel from Patten's Cove channel and in the adjacent tidal flat downstream of the proposed MBDC outfall.

Water Quality Sampling Results

Stormwater runoff from four storms of varying intensity was sampled during this period. Table ES-2 summarizes the sampling results at each location for each storm event, and averaged for all four storms to establish the baseline water quality parameters. Water quality results are presented in Event Mean Concentrations (EMC's), which are a flow-weighted method for characterizing pollutant concentrations across an entire storm into a single, composite result when multiple

samples are taken at various time periods. EMC's allow for pollutant comparisons to be made between storm events with highly variable rainfall and flow characteristics and limited water quality data.

Table ES-2. Summary of Baseline Water Quality Sampling Results

Morrissey Boulevard Site (Lower Watershed)				**Sydney/Carson Streets Site (Upper Watershed)**		
	EMC's				**EMC's**	
Date	**FC (CFU/ 100 mL)**	**TSS (mg/L)**		**Date**	**FC (CFU/ 100 mL)**	**TSS (mg/L)**
11/09/05	1,280	54		11/09/05	29,946	109
11/30/05	5	78		11/30/05	10,228	58
1/18/06	249	570		1/18/06	26,357	222
5/13/06	1,336	38		5/13/06	155,924	331
Avg. all storms	**717**	**185**		**Avg. all storms**	**55,614**	**180**

FC = fecal coliform
CFU = Colony Forming Units
TSS = total suspended solids

In general, FC and TSS concentrations for each of the sites were consistent with expectations. As can be seen from the data presented in Table ES-2, there was a wide range of FC concentrations between the two sites as well as between samples collected at each site. That variability is consistent with stormwater sampling results that have been reported in a number of industry studies. These studies have shown that mean FC concentrations have been measured on the order of 7,200 CFU/100mL – 19,000 CFU/100mL in stormwater runoff attributable to commercial developments; similar to land use characteristics of the Lower/ Morrissey Boulevard Watershed. Industry studies also show mean concentrations for commercial areas are typically lower than high-density urban neighborhoods with low traffic roadways, driveways and residential lawns (15,000 CFU/100mL – 22,000 CFU/100mL).

Industry studies also report that there can be extreme variability in FC concentrations, even for samples collected during different storms at the same sampling location. This variability is due to a number of factors that affect microbe concentrations: including population density, age of development, and percent of residential development. Other factors that may influence concentrations of a particular sample from a specific time are the depth of precipitation, rainfall intensity and length of the antecedent dry period. Of the studies catalogued within a national database by the Center for Watershed Protection, all exhibited a fairly wide range of

concentrations, with the extreme range for one study having a low of less than 50 CFU/100mL up to high exceeding 500,000 CFU/100mL.

Data compiled in a database by the Nationwide Urban Runoff Program (NURP) demonstrate that median TSS concentrations for different land uses fall within a narrow range of 69 mg/l (commercial) to 101 mg/l (residential), with an overall median value of 100 mg/l. Other recent data (from the National Stormwater Quality Database (NSQD)) reported median TSS concentrations within a similarly narrow range of 43 mg/l (commercial) to 99 mg/l (freeway), with an overall median value of 58 mg/l.

As shown in Table ES-2, TSS concentrations were found to be moderately higher than those reported in the national databases. However, it is important to note that TSS concentrations within stormwater samples are influenced by a variety of factors such as rainfall depth and intensity associated with each storm, antecedent dry period, land use characteristics, snow and ice control practices, and street sweeping schedules.

The entire compilation of collected Baseline Conditions sampling data is presented in the October 2006 *Savin Hill Cove Stormwater Pollutant Loading Assessment Report* prepared by HW.

Bathymetric Survey Results

Bathymetric monitoring was conducted on November 27, 2007 to establish the baseline bathymetry in Savin Hill Cove along the northern low flow channel, the larger channel from Patten's Cove channel and in the adjacent tidal flat downstream of the proposed MBDC outfall. The completed survey results are presented in the May 2008 *Savin Hill Cove 2007 Water Quality Monitoring Program – Baseline Conditions Report,* prepared by HW. Survey results in the Baseline Conditions Report are presented as a series of figures to which subsequent survey data can be visually compared. These figures include plan view contour maps of the measured bathymetry, four topographic transects across the cove, and sub-bottom stratigraphy along the same four transects.

MBDC CONSTRUCTION PERIOD MONITORING

2008 and 2009 Annual Reports – Sections 4 and 5

Bathymetric Surveys (2008 and 2009)

Overview

Water quality sampling was not conducted during the construction of the MBDC because the sampling equipment could not be installed until after construction was completed. Also, during this time-frame the MBDC system collected and conveyed stormwater runoff from the Lower/ Morrissey Boulevard Watershed. Because the MBDC system did not receive flow from the Upper/Sydney-Carson Streets Watershed, the quality of stormwater conveyed by the MBDC during this period was not meaningfully different from pre-construction conditions.

Bathymetric surveys were completed in June and November of 2008 and again in June and November of 2009.

Bathymetric Survey Results

Some variability in cove bottom bathymetry was observed over the four rounds of bathymetric surveying that were performed. Cove bottom elevations varied by several tenths of a foot during this time period and no clear correlation could be established between geographic locations of sedimentation changes to known processes that accounted for observed variability. Rather, seasonal or storm-related marine processes likely represent the primary contributors to the observed variability, as well as the inherent accuracy of the survey techniques. Similarly, no significant changes in sedimentation patterns were observed that could reasonably be attributed to changes in stormwater management practices.

The completed survey results are presented in the *Savin Hill Cove Water Quality Monitoring Program – 2008 and 2009 Annual Reports*, dated June 2009 and April 2010, respectively, and prepared by HW.

POST – MBDC CONSTRUCTION MONITORING

2010 & 2011 Annual Reports – Sections 6 & 7

Water Quality Sampling & Bathymetric Surveys (Fall 2010 through Winter 2011)

Overview

With the construction of Special Manhole A in December of 2009, the MBDC Project was substantially complete. Since that time, stormwater runoff from within the MBDC watershed has been flowing through the conveyance system and discharging at the new outfall to Savin Hill Cove. Construction of ancillary project components and installation of the stormwater sampling equipment was completed in September of 2010. Post-MBDC Construction-period water quality sampling began shortly thereafter, in October, 2010, and continued through March, 2011. Bathymetric surveys were completed on May 17, 2010 and on October 21, 2010.

Water Quality Sampling Results

Six Post-MBDC Construction conditions rainfall events and one dry weather event were sampled by HW and analyzed by MA DEP certified laboratories between October 1, 2010 and March 30, 2011. Water quality results for the four rainfall events sampled to establish Baseline Conditions, and the six Post-MBDC Construction conditions events sampled are presented as EMCs in Tables ES-3A and ES-3B, respectively. Detailed discussion of the 2010 sampling program can be found in the *Savin Hill Cove Water Quality Monitoring Program – 2010 Annual Report,* dated February 2011, prepared by HW. Detailed discussion of the 2011 sampling program can be found in the *Savin Hill Cove Water Quality Monitoring Program – 2011 Annual Report,* dated March 2012, also prepared by HW.

Table ES-3A. Baseline Water Quality Sampling Results and Rainfall Characteristics – Morrissey Boulevard Site (Lower Watershed)

Date	Storm Total (inches)	Ante-cedent Period (Days)	Storm Duration (Hours)	Peak Hour Precip. (in)	Measured Peak Flow (MGD)	Event Mean Concentration		
						Fecal Coliform (CFU/100 ml)	TSS (mg/l)	BOD (mg/l)
11/09/05	0.64	1	12.50	0.26	1.94	1,280	54	-
11/30/05	0.79	5	13.25	0.19	1.45	5	78	-
01/18/06	0.22	2	16.25	0.06	4.98	249	570	-
05/12/06	7.36	1	70.50	0.60	1.67	1,336	38	-
Average						**717**	**185**	

TSS = Total Suspended Solids
BOD = Biological Oxygen Demand

Table ES-3B. Post-MBDC Construction Water Quality Sampling Results and Rainfall Characteristics

Date	Storm Total (inches)	Ante-cedent Period (Days)	Storm Duration (Hours)	Peak Hour Precip. (in)	Measured Peak Flow (MGD)	Event Mean Concentration		
						Fecal Coliform (CFU/100 ml)	TSS (mg/l)	BOD (mg/l)
10/01/10	0.45	7	10.80	0.16	1.059	20,865	62	40
11/04/10	0.84	6	9.00	0.26	1.670	14	57	5
12/01/10	0.28	3	8.50	0.08	4.056	90	86	2
12/12/10	1.13	0	17.00	0.18	11.107	158	89	8
2/28/11	0.55	0.6	9.5	0.19	3.377	78	85	3.3
3/11/11	0.48	3.7	14.3	0.23	19.485	120	153	9.3
Average with 10/01/10 Sample						**3,554**	**89**	**11.27**
Average w/o 10/01/10 Sample						**82**	**81**	**5.52**

TSS = Total Suspended Solids
BOD = Biological Oxygen Demand

Fecal Coliform Concentrations

As can be seen from the data presented in Tables ES-3A and ES-3B, there was a range of FC concentrations for both Baseline and Post-MBDC Construction conditions sampling. However, these results are not atypical and are, in fact, consistent with stormwater sampling results that have been reported in a number of industry studies for urban watersheds. Given the wide variability of fecal coliform concentrations that are typically observed during sampling of urban stormwater runoff, the range of results for both Baseline and Post -MBDC Construction conditions can viewed as being relatively narrow. With the exception of the October 1, 2010 sample, all Baseline and Post -MBDC Construction conditions samples indicate FC concentrations at or below what might be expected for an urban watershed.

Because the NDBST was not on-line during the Post-MBDC Construction sampling period, there was no contribution of stormwater runoff to the MBDC from the BOS087 system and consequently no contribution of stormwater from the more urbanized Upper Watershed. Therefore, fecal coliform concentrations measured during the Baseline Conditions sampling period (Morrissey Boulevard Site) and Post-MBDC Construction sampling period are generally lower than observed during the Baseline Conditions sampling from the Sydney/Carson Streets Watershed, and can be considered typical for commercial developments along Morrissey Boulevard.

Total Suspended Solids Concentrations

As can be seen from Tables ES-3A and ES-3B, the TSS concentrations measured in stormwater samples collected during both Baseline and Post-MBDC Construction sampling periods are well within the ranges reported in NURP (69 mg/l to 101 mg/l) and NSQD (43 mg/l to 99 mg/l) national databases, particularly given the commercial and freeway land use characteristics of the Lower/ Morrissey Boulevard watershed.

Investigation of Potential Tidal Influence on Sampling Site

Although FC concentrations measured during both Baseline and Post-MBDC Construction conditions sampling fall within a narrow range and are consistent with other studies, the Post-MBDC Construction samples have concentrations that are slightly lower than the Baseline Conditions samples. Because of these results, and because data from flow monitoring equipment showed water level and flow fluctuations at Special Manhole A that suggested tidal influences, there was a suspicion the tide gate immediately downstream of the sampling location may not have been seating properly, allowing seawater into the sampling location.

Further investigations and analyses to evaluate the influence of salt water occurred during the spring of 2011, and were reported in an April 29, 2011 Memorandum. Salinity measurements taken during the spring 2011 sampling events confirmed significant tidal influence on the sampling site. As a result, on July 20, 2011, the sampling intake tube inside Special Manhole A was reconfigured to hang from a swing arm/float mechanism such that samples are always collected near the top of the water column where lower density, fresh, stormwater would most likely reside. Some debris was also noted and cleared that may have partially impeded sealing of the tide gates. New debris will likely continue to impede gate sealing from time to time.

Sampling since July 20, 2011 has consistently revealed significantly lower salinity concentrations indicating the minimization, although not elimination, of tidal influence on the sampling site. Measured fecal coliform concentrations also increased noticeably after July 20, 2011 and for the remainder of the summer monitoring period.

Bathymetric Survey Results

For the Post-MBDC Construction survey rounds in 2010, the MBDC did not carry stormwater flows that were significantly different from Pre-MBDC Construction conditions. Similar to what was discussed for 2008 and 2009 surveys, some variability in cove bottom bathymetry was observed between the various rounds of bathymetric surveying that were performed. No clear correlation exists between geographic locations of sedimentation changes to known processes that would account for observed variability. In general, the overall elevation of the Savin Hill Cove bottom measured during all subsequent surveys was slightly higher, to varying extents, than it was at the time of the November, 2007 Baseline Conditions survey. The observed, increased elevation has not been spatially nor temporally constant across the surveyed area, but the cove bottom along each of the four survey transects is, in general, between approximately 0.0 and 0.2 feet higher.

Because bathymetry has varied between monitoring events absent any significant changes in stormwater management, minor differences in observed sedimentation patterns across the surveyed area are unlikely to be related to stormwater management practices. It is possible that those observed sedimentation changes are due to natural marine processes, accuracy of the survey techniques, or a combination of the two. Future observations will help to determine if these same patterns continue to occur. No significant changes in sedimentation patterns have been observed that could reasonably be attributed to changes in stormwater management.

POST – NDBST CONSTRUCTION MONITORING

2011 Annual Report – Section 7

Water Quality Sampling & Bathymetric Surveys (Spring 2011 through Winter 2011)

Overview

The diversion into the MBDC of stormwater derived from outside of the Lower/MBDC Watershed during large storm events began on March 31, 2011. On that date the BOS087 system that conveys stormwater to the NDBST was connected to the MBDC at Special Manhole "D" making the entire MBDC/NDBST system operational (refer to the earlier discussion of operational procedures). Sampling from March 31, 2011 onward is referred to as Post-NDBST Constructions conditions. Post-NDBST Construction bathymetric surveys were completed on May 6, 2011 and on November 29, 2011.

Water Quality Sampling Results

Eight Post-NDBST Construction conditions rainfall events and four dry weather events were sampled by HW and analyzed by MA DEP certified laboratories between March 31, 2011 and December 31, 2011. Water quality results for the four rainfall events sampled to establish Baseline Conditions are presented as EMCs in Tables ES-3C and ES-3D, respectively. Water quality results for the eight Post-NDBST Construction conditions events sampled are presented as EMCs in Table ES-3E. Baseline water quality data from both the Upper and Lower Watersheds are shown because, under Post-NDBST Conditions, runoff from the Upper Watershed can be diverted through the MBDC during larger, more intense rainfall events. Detailed discussion of the 2011 sampling program can be found in the *Savin Hill Cove Water Quality Monitoring Program – 2011 Annual Report,* dated March 2012, prepared by HW. Results for the 2012 sampling period will be reported in the *Savin Hill Cove Water Quality Monitoring Program – 2012 Annual Report,* anticipated to be submitted in March/April 2013.

Table ES-3C. Baseline Water Quality Sampling Results and Rainfall Characteristics - Morrissey Boulevard Site (Lower Watershed)

Date	Storm Total (inches)	Ante-cedent Period (Days)	Storm Duration (Hours)	Peak Hour Precip. (in)	Measured Peak Flow (MGD)	Event Mean Concentration		
						Fecal Coliform (CFU/100 ml)	TSS (mg/l)	BOD (mg/l)
11/09/05	0.64	1	12.50	0.26	1.94	1,280	54	-
11/30/05	0.79	5	13.25	0.19	1.45	5	78	-
01/18/06	0.22	2	16.25	0.06	4.98	249	570	-
05/12/06	7.36	1	70.50	0.60	1.67	1,336	38	-
Average						**717**	**185**	

TSS = Total Suspended Solids
BOD = Biological Oxygen Demand

Table ES-3D. Baseline Water Quality Sampling Results and Rainfall Characteristics – Sydney/Carson Streets Site (Upper Watershed)

Date	Storm Total (inches)	Ante-cedent Period (Days)	Storm Duration (Hours)	Peak Hour Precip. (in)	Measured Peak Flow (MGD)	Event Mean Concentration		
						Fecal Coliform (CFU/100 ml)	TSS (mg/l)	BOD (mg/l)
11/09/05	0.64	1	12.50	0.26	3.35	29,946	109	-
11/30/05	0.79	5	13.25	0.19	2.38	10,228	58	-
01/18/06	0.22	2	16.25	0.06	12.14	26,357	222	-
05/12/06	7.36	1	70.50	0.60	37.88	155,925	331	-
Average						**55,614**	**180**	

TSS = Total Suspended Solids
BOD = Biological Oxygen Demand

Table ES-3E. Post-NDBST Construction Water Quality Sampling Results and Rainfall Characteristics

Date	Storm Total (inches)	Ante-cedent Period (Days)	Storm Duration (Hours)	Peak Hour Precip. (in)	Measured Peak Flow (MGD)	Event Mean Concentration		
						Fecal Coliform (CFU/100 ml)	TSS (mg/l)	BOD (mg/l)
4/1/11	0.97	9.4	35.3	0.08	13.376	32	153	6.3
4/13/11	1.35	6.9	40.0	0.25	20.018	22	85	4.7
6/1/11	0.62	8.6	2.8	0.58	90.405	18	96	4.9
8/27/11	1.69	1.0	28.8	0.24	3.741	9,911	41	42.7
9/23/11	1.22	3.0	21.3	0.25	2.592	5,361	62	3.1
10/13/11	1.32	7.6	23.3	0.33	2.979	1,324	54	3.3
10/19/11	2.12	4.0	31.8	0.24	5.200	1,111	24	4.3
11/23/11	1.73	3.8	19.8	0.24	3.686	114	36	2.3
Average						**2,237**	**69**	**8.95**

TSS = Total Suspended Solids
BOD = Biological Oxygen Demand

Fecal Coliform Concentrations

As can be seen from the data presented in Tables ES-3C, ES-3D, and ES-3E, there was a range of FC concentrations for Baseline and Post-NDBST-Construction conditions sampling. As was also the case and previously discussed for Post-MBDC Construction conditions, these results are not atypical and are, in fact, consistent with stormwater sampling results that have been reported in a number of industry studies for urban watersheds. Observed FC concentrations have been at or below what might be expected for an urban watershed.

In the Post-NDBST Construction period, under specific conditions during larger storm events, runoff generated from the more urban Upper Watershed can be diverted down the MBDC and can contribute to higher measured fecal coliform concentrations at the sampling site. Under such conditions, water quality sampled during Post-NDBST Construction conditions is reflective of both the commercial land use characteristic of the Lower Watershed, and the high density residential land use typical of the Upper Watershed.

An example of how stormwater runoff from the Upper Watershed may influence fecal coliform concentrations at the sampling location is demonstrated by the water quality sampling conducted during the August 27, 2011 storm. During this rainfall event, which is associated with Hurricane Irene, stormwater runoff form the Upper Watershed was diverted to the MBDC for approximately 12 hours. As can be seen from Table ES-3E, samples collected during this event were found to have the highest fecal coliform EMC measurements of those rainfall events included in the sampling program.

Although the data appear to show that diverting stormwater runoff from the Upper Watershed will tend to increase fecal coliform concentrations, care should be taken when drawing conclusions using data from a single storm. As has been noted, fecal coliform concentrations are notoriously variable and can be affected by a variety of factors. For example, the next highest fecal coliform EMC was measured from samples collected during the September 23, 2011 rainfall event during which no flow from the Upper Watershed was diverted to the MBDC.

Total Suspended Solids Concentrations

As can be seen from Tables ES-3C and ES-3D, the TSS concentrations measured in stormwater samples collected during Baseline Conditions and Post-NDBST Construction sampling periods are well within the ranges reported in NURP (69 mg/l to 101 mg/l) and NSQD (43 mg/l to 99 mg/l) national databases, particularly given the commercial and freeway land use characteristics of the Lower/ Morrissey Boulevard watershed.

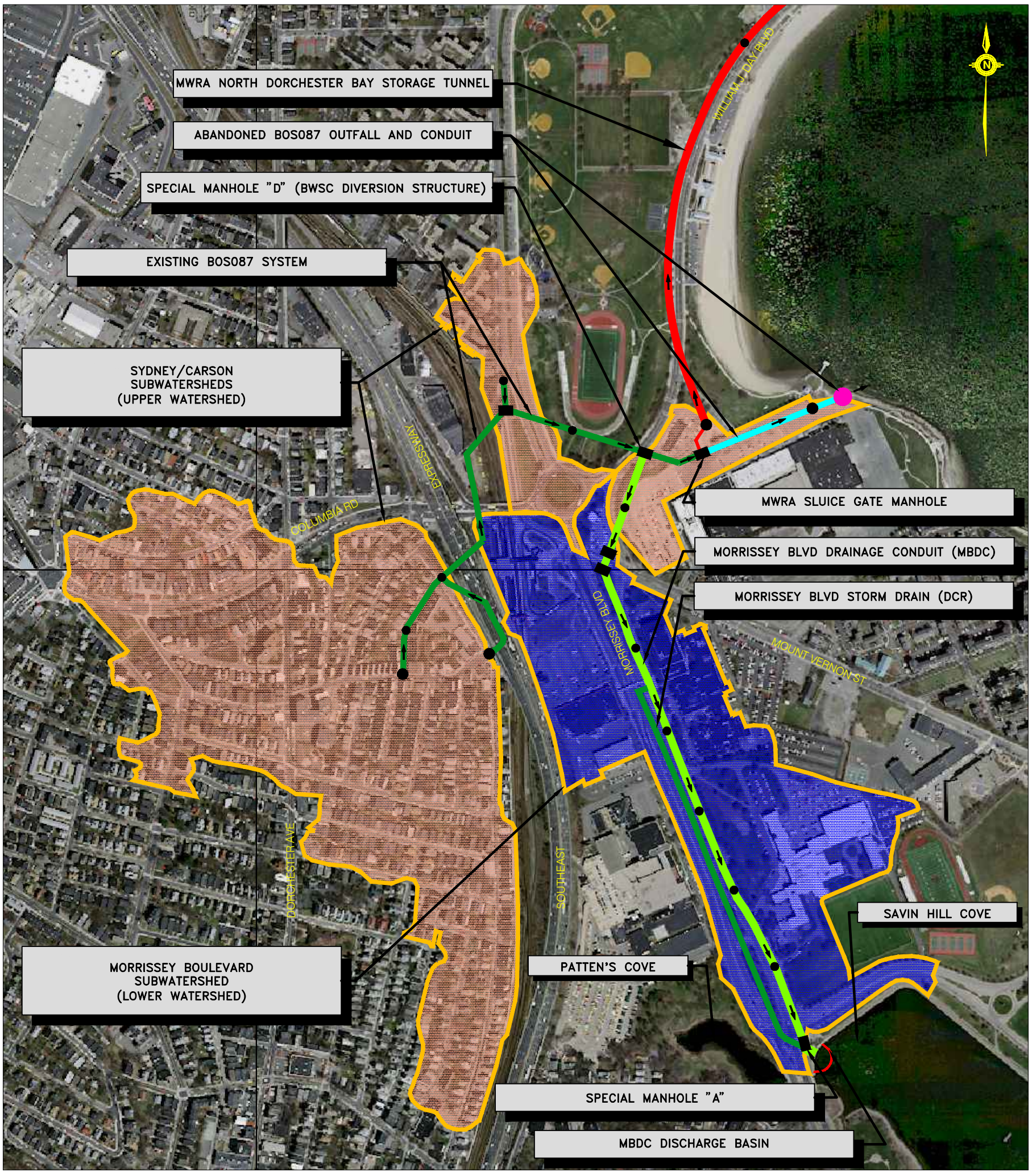
The number of rainfall events that have been sampled are relatively small in number; four events for Baseline Conditions, six events for the Post-MBDC Construction period, and eight events for the Post-NDBST Construction period. As the monitoring program continues and samples are collected for a broader range of rainfall events, it is anticipated the data will provide a better understanding of FC and TSS loading variability by rainfall event and season, and a more refined assessment of potential impacts to Savin Hill Cove. These additional data will be reported in the annual reports prepared for the 2012 and 2013 sampling periods.

Bathymetric Survey Results

For all but the two most recent survey rounds in 2011, the MBDC did not carry stormwater flows that were significantly different from Pre-MBDC Construction conditions. In general, the overall elevation of the Savin Hill Cove bottom measured during all surveys was slightly higher, to varying extents, than it was at the time of the November, 2007 Baseline Conditions survey. The observed, increased elevation has not been spatially nor temporally constant across the surveyed area, but the cove bottom along each of the four survey transects is, in general, between

approximately 0.0 and 0.2 feet higher near the center of the cove, and up to three feet higher at the northern ends of Transects 1 and 4 during the May 2011 survey.

Because bathymetry has varied between monitoring events absent any significant changes in stormwater management, minor differences in observed sedimentation patterns across the surveyed area are unlikely to be related to stormwater management practices. It is possible that those observed sedimentation changes are due to natural marine processes, accuracy of the survey techniques, or a combination of the two. Future observations will help to determine if these same patterns continue to occur. No significant changes in sedimentation patterns have been observed that could reasonably be attributed to changes in stormwater management.



BOSTON WATER AND SEWER COMMISSION
MORRISSEY BOULEVARD DRAINAGE CONDUIT PROJECT
BWSC CONTRACT NO. 02-309-017
WATER QUALITY MONITORING PROGRAM OVERVIEW PLAN

FST ENGINEERS

SCALE: 1" = 600'

Figure ES-1
July 2012

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