Combined Work/Quality Assurance Project plan for Water Quality Monitoring and Combined Sewer Overflow Receiving Water Monitoring in Boston harbor and Its Tributary Rivers, 2000

Massachusetts Water Resources Authority

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Combined Work/Quality Assurance Project Plan

for

Water Quality Monitoring
and
Combined Sewer Overflow Receiving Water Monitoring
in Boston Harbor
and Its Tributary Rivers
2000

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Water Quality Monitoring in Boston Harbor And Its Tributary Rivers: 2000

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July 1, 1997

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1.0. PROJECT DESCRIPTION

1.1 Objectives and Scope

MWRA's treatment plants at Deer Island and Nut Island are or have historically been major sources of suspended solids, nutrients and bacteria to Boston Harbor. MWRA's Boston Harbor Project, nearing completion, includes new facilities for sludge treatment, construction of a new primary and secondary treatment plant at Deer Island, and an extended outfall/diffuser system in Massachusetts Bay. The objective of the project is to better treat and reduce the inputs of pollutants to Boston Harbor, to in turn improve the environmental health of the Harbor and make it safer for human use.

A second major source of pollution to the Harbor and also to its tributary rivers is combined sewer overflows (CSOs). Over the next decade, most of these CSOs will be eliminated by small scale projects and major construction efforts by MWRA and the CSO communities (MWRA 1994). The numbers of CSO's providing treatment to the discharges will be increased, and the level of treatment at the these facilities will be improved.

The main objective of water quality monitoring in Boston Harbor and its tributary rivers is to track the environmental effects of these pollution abatement projects, measuring environmental changes before and after the projects are implemented. The water quality monitoring described in this project plan complements other long-term studies in the Harbor, including:

- studies of EPA priority pollutants/toxic chemicals in effluent (Butler, Hasegawa, and McGrath 1995)
- sediment fauna and penetration of dissolved oxygen (Blake and Hilbig 1995, Blake et al. 1998, Kropp and Boyle 1998, Kropp et al. 2000),

- health of lobster and flounder populations (Mitchell, Butler, and McGrath 1995, Lefkowitz and Moore 1998, Lefkowitz et al. 2000),
- "mussel watch" studies (Downey et al. 1995),
- studies of sediment metabolism and benthic nutrient fluxes (Tucker et al. 2000),
- beach water-quality monitoring (Rex, Coughlin and DiPietro 1997),
- pathogenic virus monitoring (Cibik and Margolin 1995, Tilton et al. 1998),
- and modelling of Harbor circulation (McGillivary and Adams 1995a, 1995b, 1995c, Signell 1992).

The water quality monitoring covered by this Project Plan falls into 3 projects:

1. Harbor-wide Water Quality Monitoring (BHWQM and other sub-projects);
2. Combined Sewer Overflow Receiving Water Monitoring (CSO-RWM); and
3. Wastewater Treatment Plant Outfall Monitoring (TP-OUT).

The database codes for these projects are listed in Appendix Table A-1. The database codes for the various parameters monitored in each of the projects are listed in Appendix Table A-2.

1.1.1 Harbor-wide Water Quality Monitoring (BHWQM)

MWRA began its Harbor-wide water quality monitoring in 1993 (Taylor 2001 in prep). This program gathers data to document present conditions Harbor-wide, and in rivers tributary to the Harbor, including the Charles, the Mystic and the Neponset. The purpose is to measure water quality changes as improved primary treatment, secondary treatment, and the new Massachusetts Bay outfall become operational. Because Boston Harbor receives some of the highest loadings of total nitrogen and phosphorus of any bay or estuary in the United States (Nixon et al.1996, Kelly 1997), this project focuses on

measuring the eutrophication status of the Harbor. Sites are intended to be "representative" of different geographic areas of the Harbor and the rivers, and sampling is year-round and random with respect to weather.

1.1.2 Combined Sewer Overflow Receiving Water Monitoring (CSO-RWM)

MWRA began its CSO receiving water monitoring program in 1989 (Rex 1989, 1991 and 1993). Data are gathered to measure the effect of CSOs on the Harbor and rivers, in order to satisfy MWRA's NPDES permit requirements, to relate bacteria counts in the water to rainfall, and to measure changes in water quality over time as CSO remediation plans are effected. This monitoring focuses on the areas affected by CSOs: the Inner Harbor, the North and South regions of Dorchester Bay, and the Charles, Mystic, and Neponset Rivers.

The most damaging effect of untreated CSOs is pollution of the receiving waters with the disease-causing microorganisms found in sewage that contaminate shellfish beds and recreational waters (Leo et al. 1994). Therefore, the CSO monitoring program focuses on measuring bacterial pollution in the water column, with intensive monitoring of *Enterococcus* and fecal coliform bacteria as indicators. Sampling stations are located in all CSO receiving waters, with locations both near to and distant from CSO outfalls. Samples are collected during both wet and dry weather.

1.1.3 Wastewater Treatment Plant Outfall Monitoring (TP-OUT)

Monitoring of the Deer Island and Nut Island wastewater treatment plant outfalls in the Harbor has been ongoing since 1995 (Taylor 2000). This monitoring was designed to: (1) provide feedback to facility operations to determine if the plants are operating as permitted, and (2) measure changes in water quality as new treatment facilities become operational - including the upgrades to new primary treatment (1995), secondary treatment (1996), transfer of flows from the South System to the North System, and flow transfer to the new Massachusetts Bay outfall.

The monitoring in 2000 focused on the immediate vicinity of the Deer Island outfalls and the areas around Deer Island that computer models predicted would be most affected by the discharges from Deer Island. The monitoring at the former Nut Island outfalls was cut back in 2000 from that conducted in 1999 (for 1999 monitoring see Rex and Taylor 1999), because the discharges through these outfalls were ended in mid-1998. One station, 082, was maintained to provide continued monitoring of water quality at one of the former outfalls.

2.2 Data Usage

Data from the Harbor-wide water quality monitoring (BHWQM) are presented monthly and quarterly in MWRA's report on performance measures, in the annual State of the Harbor report (Pawlowski et al. 1995, Rex and Connor 1996, Rex 2000), and on MWRA's web site (http://www/mwra/state/ma/us). The data have been used to track the impact of the South System transfer on Harbor water quality (Taylor et al. 1999, Taylor 2000), and will be used to track Harbor recovery following completion of the Boston Harbor Project. Beyond these local uses, the data are of general scientific interest as an invaluable record of the effects of a major pollution abatement effort in an important urban estuary.

Data from the CSO receiving water monitoring (CSO-RWM) are provided to state and federal regulatory agencies, and the Boston Water and Sewer Commission (BWSC 1995, 1996) as part of required monitoring to measure the effects of these wet-weather discharges on the receiving waters. These data will also used by MWRA to track the progress of CSO remediation efforts, and to detect sources of sewerage pollution.

Past CSO-RWM data have been used in CSO Facilities Planning efforts (Leo et al. 1994) particularly in calibrating models predicting bacteria counts in the Harbor. Data have also been used in 1999 and will be used in 2000, to meet the requirements for the Final Variance for CSO discharges to the Alewife/Upper Mystic Basin, which is now part of

the MWRA NPDES permit. The data have also been subjected by MWRA to statistical analyses (Gong et al. 1996, 1998) to determine if the relationship between rainfall and bacteria pollution in the Harbor and rivers is changing as a result of pollution abatement projects.

Data from Harbor outfall monitoring (TP-OUT) are used to provide feedback to plant operations personnel on the effects of Deer Island treatment plant activities, and also to track water quality changes in the areas expected to be most directly affected by operation of the Harbor outfalls. The discharges of wastewater from the Deer Island outfalls are expected end fall 2000. Monitoring will continue at the outfalls, to provide information to plant operations personnel on the effects of the ending of Deer Island discharges to the Harbor.

1.3 Rationale and Design

The Harbor and river monitoring described here are complemented by other MWRA monitoring projects in the Harbor which have been subsumed under MWRA's Harbor and Outfall Monitoring contracts with ENSR Consulting and Engineering and Battelle Ocean Sciences. Those projects include studies of Boston Harbor's benthos (Hilbig et al. 1996), sediment toxic chemicals (Durell et al. 1991, Leo et al. 1993), fish and shellfish (Mitchell and Moore 1997), effluent quality (Butler et al. 1997), and anthropogenic virus monitoring (Margolin and Mounce 1996, Margolin and Beauchesne 1997). The water quality sampling described in this plan in the Harbor and the rivers is relatively intensive in terms of spatial and temporal coverage; samples are collected weekly to several times per week, depending on the project. This intensive sampling reflects the fact that water quality in the Harbor and the rivers is highly geographically variable, and liable to rapid changes depending on weather and the functioning of the sewerage infrastructure.

1.3.1 Boston Harbor Water Quality Monitoring (BHWQM)

This program focuses on eutrophication (nutrient enrichment) parameters. Boston Harbor receives estimated total N and P loadings from combined terrestrial sources of 130 g/m^2y plus atmospheric sources of 20 g/m^2y (Alber and Chan 1994)—high compared to other bays and estuaries in the US. The wastewater discharges from the MWRA Deer Island facility, contribute most of the N (90%) and P (95%). These discharges are sufficient to cause symptoms of eutrophication in the Harbor, including elevated concentrations of dissolved inorganic nitrogen and chlorophyll *a* in the water column, and low dissolved oxygen concentrations in the Harbor bottom-waters (Adams et al. 1992, Hydroqual 1995). Other symptoms of eutrophication of Boston Harbor include the almost complete demise of its seagrass beds earlier in the century (P. Colarusso, USEPA unpublished data), and the occurrence of dense macroalgal mats in the North Harbor in the 1960's (Sawyer, 1965).

Wastewater loadings of nutrient and solids to the Harbor have been decreasing since 1991, when MWRA stopped sludge discharges to the Harbor. From January 1995 through July 1996, a new more efficient primary treatment facility was phased in, and in August 1997 MWRA began phasing in secondary treatment. In summer 1998, the Nut Island (South System) treatment plant was decommissioned, and the flow diverted to Deer Island. In the fall of 2000, the secondary treated effluent from Deer Island is scheduled to be diverted from the Harbor to Massachusetts Bay through a 9.5-mile diffuser/outfall tunnel.

After 2000, the total loading of nutrients to Boston Harbor will decrease to about 10% of the present amount. The water quality monitoring described here will provide data to measure the present state of eutrophication in Boston Harbor, track the recovery of the Harbor, and together with data collected by consultants under the Harbor and Outfall Monitoring (HOM) Contract, information to understand the interactions between Massachusetts Bay and Boston Harbor. Boston Harbor and Massachusetts Bay

have been shown by the HOM contracts to be functionally linked. Therefore, information on the changes in the Harbor will assist in understanding any changes that might occur in Massachusetts Bay following start of operation of the ocean outfall.

Water Quality Monitoring is divided into four sub-projects. These sub-projects are:

(1) *Eutrophication or Nutrient Monitoring (BHWQM).* The purpose of this project is to measure the changing eutrophication status of Boston Harbor. Locations are distributed in the Inner Harbor, Dorchester Bay, Quincy Bay, Hingham/Hull Bay, and near the Deer Island and former Nut Island outfalls. Sampling takes place year round.

(2) *River Water Quality Monitoring (BHWQMR).* The purpose is to measure the eutrophication status of the major rivers tributary to the Harbor—Charles, the Mystic and the Neponset, and to improve the estimates of loadings of nutrients and solids to the Harbor. Sampling takes place year round.

(3) *Continuous Hydrographic Monitoring.* A moored hydrographic instrument array (one surface, one bottom) located in the Inner Harbor near the New England Aquarium, records hourly measurements of temperature, salinity and dissolved oxygen, providing diurnal and seasonal data on stratification and dissolved oxygen levels.

(4) *Biofouling monitoring* (BHFOUL). This project measures the growth of biofouling material on artificial substrates (plastic tiles) deployed at various depths in the water column. The monitoring of biofouling material supplements the water quality monitoring, because in shallow well-flushed systems such as Boston Harbor, biofouling material may be more responsive to the anticipated changes in wastewater inputs than the phytoplankton in the

water column. Deployments are done two times per year, in the months of August through September.

1.3.1.1 Criteria for Selection of Sampling Locations

(1) *Boston Harbor Nutrient monitoring(BHWQM).* Sampling sites for Boston Harbor were chosen to be representative of the Harbor's major embayments: the Inner Harbor, Dorchester Bay, Quincy Bay, and Hingham/Hull Bay. The Broad Sound site reflects the water quality where Massachusetts Bay water exchanges with Boston Harbor water. Two sites are near present wastewater treatment plant outfalls. Locations (Figure 1, Table 1) were chosen to coincide with sites for previous studies done by either New England Aquarium and/or the Massachusetts Department of Environmental Protection, ensuring that present and future data will be able to be compared to past data. Samples are collected at the surface (0.3 m beneath the water surface) and bottom (0.5 m above the bottom) of each location. Hydrographic measurements are conducted at the surface and bottom of each location.

(2) *Tributary Rivers (BHWQMR).* Very few measurements of eutrophication parameters have previously been recorded in the rivers tributary to the Harbor. The locations of each of the BHWQMR stations and the depths sampled at each of the stations are shown in Table 2 and Figure 1. Sites in the Charles, Mystic, and Neponset rivers just upstream of the dams located at the rivers' mouths represent the loads to the Harbor. A site upstream of the Charles lower basin samples the upstream contribution of nutrients to the lower Charles. In 2000, a site (066) was added immediately downstream of Alewife Brook, to assess the contribution of nutrients from Alewife Brook to the Mystic. All sites except for 066, were chosen because they are accessible by foot in winter, when access by boat is limited.

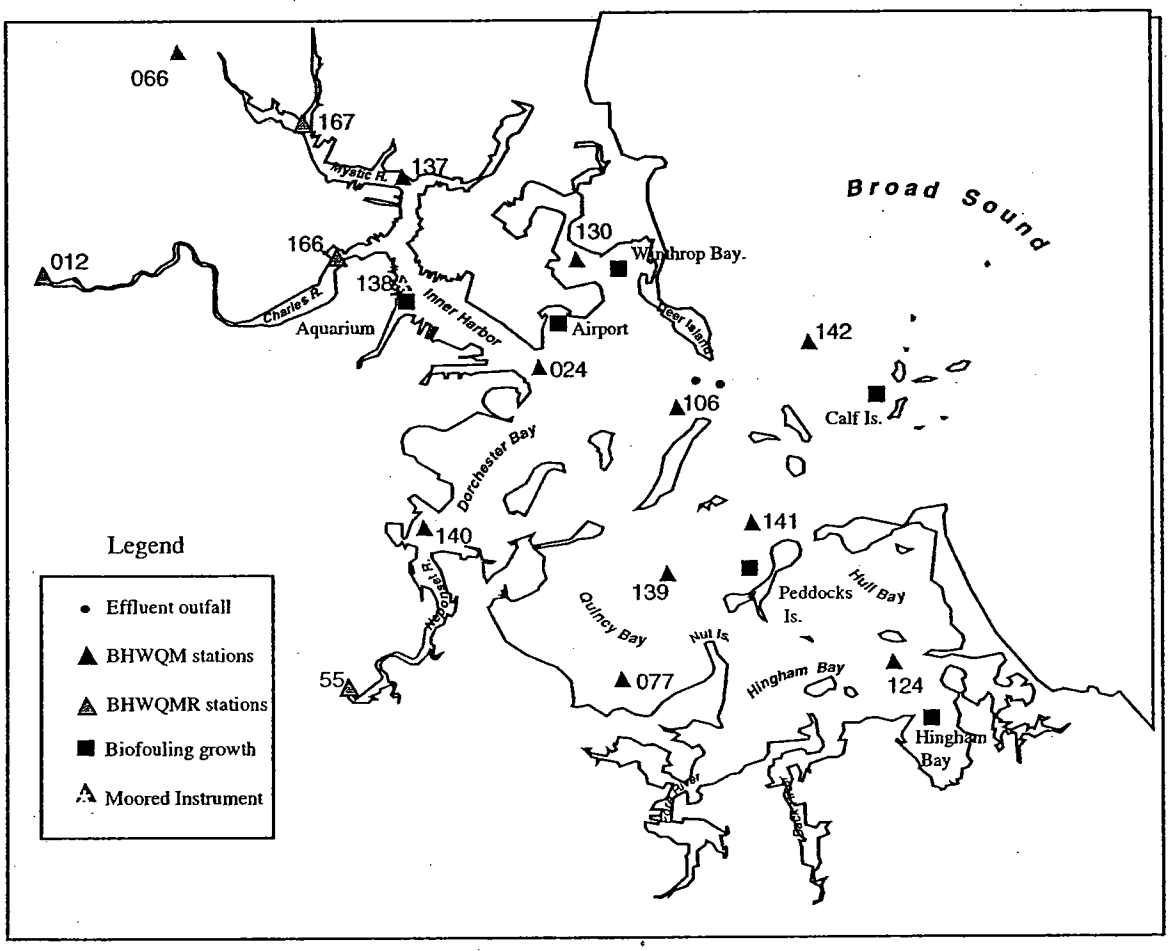

Figure 1. Water Quality monitoring locations in Boston Harbor and Tributary Rivers.

Table 1. Sampling Locations for Harbor-wide Water Quality Monitoring in Boston Harbor (BHWQM)

Site No.	Description	Latitude (N)	Longitude (W)	Depth Sampled S= Surface B=Bottom
130	Winthrop Bay	42° 21.80	70° 59.4	S+B
137	Mouth of Mystic River	42° 23.20	71° 03.80	S+B
138	Inner Harbor, mouth of Fort Point Channel	42° 21.59	71° 02.82	S+B
024	Mouth of Inner Harbor	42° 20.59	71° 00.48	S+B
140	Southern Dorchester Bay, mouth of Neponset River	42° 18.35	71° 02.43	S+B
139	Hangman's Island (Quincy Bay, near Nut Island discharges)	42° 17.20	70° 58.10	S+B
124	Hingham Bay	42° 16.36	70° 53.86	S+B
141	Peddock's Island (Nantasket Roads)	42° 18.30	70° 55.85	S+B
142	President Roads (Broad Sound)	42° 20.35	70° 55.89	S+B
077	Quincy Bay	42° 16.51	70° 59.31	S+B
106	Long Island (near Deer Island discharges)	42° 20.00	70° 57.60	S+B

Table 2. Sampling Locations for Tributary monitoring (BHWQMR)

Site No.	Description	Latitude (N)	Longitude (W)	Depth Sampled S= Surface B=Bottom
012	Charles River at Watertown Dam	42° 21.51.35	71° 11.26.99	S
166	Charles River at Science Museum	42° 22 02.59	71° 04 12.28	S
167	Mystic River at Earhart Dam	42° 23 41.16	71° 04 28.24	S
066	Mystic River below Alewife Brook	42° 25.03	71° 0.7.87	S
055	Neponset River at Lower Mills Dam	42° 16 18.35	71° 04 07.78	S

Table 3. Sampling Locations for Biofouling Monitoring (BHFOUL)

Site	Lat.	Long.
Aquarium	42° 21.57	71° 02.88
Airport	42° 20.75	70° 59.94
Calf Island	42° 20.21	70° 53.98
Winthrop	42° 21.28	70° 58.37
Peddocks Island	42° 17.94	70° 56.39
Hingham Bay	42° 16.67	70° 53.96

(3) *Continuous Hydrographic Monitoring.* Because the Inner Harbor is seasonally stratified, some of the Harbor's worst dissolved oxygen measurements have historically been recorded there. Changes in the Inner Harbor can be related to nuisance algal blooms, or major storms. A hydrographic instrument is moored near the New England Aquarium (Figure 1), where it is relatively sheltered from ship traffic. This location is also near MWRA's "mussel watch" site. The instrument provides continuous water quality measurements.

(4) *Biofouling monitoring.* Deployment sites are located in each of the major embayments of Boston Harbor (Figure1), including areas where seagrass historically was found (Airport), the area where seagrass still persists (Hingham Bay), an area previously affected by sewage discharges (Peddocks Island), the Inner Harbor (Aquarium) and outside Boston Harbor (Calf Island) to compare the Harbor to Massachusetts Bay. A station was added in Winthrop Bay in 2000, to examine the impacts of the ending of discharges to the region from Deer Island, scheduled for fall 2000. Sampling locations are given in Table 3.

1.3.1.2 Sampling Locations

The sampling locations for the BHWQM and BHWQMR projects, and for the continuous hydrographic measurements are shown in Figure 1 and Tables 1 and 2, respectively. The station locations for BHFOUL are shown in Table 3.

1.3.1.3 Sample Collection and Parameters Measured

The Harbor water quality monitoring stations (BHWQM, BHFOUL) and the continuous mooring are accessed by motorboat; all except one of the river water quality sites are accessed by foot. A Kemmerer sampler is used to collect water samples; the water is then dispensed into the appropriate sample containers.

A summary of the frequency of sampling, the numbers of sites sampled per survey, and the planned number of samples per project is provided in Table 4.

1. *Harbor (BHWQM).* The parameters monitored at each of the BHWQM stations are summarized in Table 5. The sample bottles employed, method of preservation, analytical methods employed and the holding times for each of the parameters monitored as part of BHWQM are summarized in Table 6.

2. *Tributaries.* The parameters monitored at each of the BHWQMR stations are summarized in Table 5. The field measurements and analytical methods employed are summarized in Tables 7 and 8, respectively.

3. *Continuous hydrographic measurements.* A moored instrument array is maintained by the MWRA off of the New England Aquarium, to generate continuous hydrographic measurements. Two stand-alone YSI 6000 units are deployed, one 0.5 m below the surface, and the other 0.5 m above the sediment surface. The units measure dissolved oxygen, temperature, conductivity, salinity and depth. Measurements are recorded hourly on the hour. The data are downloaded in the laboratory, and stored in the EM & MS data base.

4. *Biouling material (BHFOUL).* Rates of accumulation of biofouling material are measured on arrays deployed in the water column. The parameters measured as part of BHFOUL are listed in Table 9. Each array consists of 7 plastic plates (sections of polyethylene cutting board) that are attached to 5/8 inch braided nylon line and anchored to the bottom with

Table 4. Frequency and Number of Samples Collected for Harbor Water Quality Monitoring

Project	Survey Frequency	Sites per Survey	Planned Samples per Project, 2000
Harbor Water Quality (BHWQM)	Bi-weekly Nov through Apr; weekly May through Oct. 31 surveys total	11 Sites, 2 samples/site (Samples collected at surface and bottom)	682
River Water Quality (BHWQMR)	Weekly until frozen	5 sites	260
Inner Harbor Mooring Hydrographic	Measurements recorded hourly	1 (surface +bottom)	Not applicable
Biofouling material	2 3-week long deployments in summer	6 locations, 7 depths	72

Table 5. Monitoring Parameters for Boston Harbor Water Quality Monitoring (BHWQM and BHWQMR): Field Measurements

Parameter	Instrument	Units
Temperature	Hydrolab DataSonde 4 Series Water Quality meter	°C
Dissolved Oxygen		mg/L, % saturation
Salinity		ppt
Specific conductance		millisiemens/cm
Turbidity		NTUs
pH		pH units
Photosythetically Active Radiation	Licor 1000 logger Spherical PAR sensor Model LI-193 SB	µmol/sec/m^2
Transmissivity	Wet Labs C-Star Transmissometer	percent transmittance
Secchi depth	8" oceanographic all-white secchi disk	m

Table 6. Monitoring Parameters for Boston Harbor Water Quality Monitoring: Laboratory Analyses

Parameter LIMS TEST CODE	Sample Container	Preservation	Analysis Method	Holding time	Units
Fecal coliform FCOLSWMFL	Sterile 250-ml LDPE bottle	Cooler <10°C	SM 9222D	6 hours	#/100 ml
Enterococcus ECOCAQMFL and ECZ4AQMFL (as of 9/00)			SM 9320C-mEnt Agar EPA1600 – mEi Agar (as of 9/00)		
Total Suspended Solids TSS-SWGRV	1-L translucent LDPE bottles	Filtered in field	EPA 160.2	7 days	mg/L
Particulate Nitrogen PN—TSCHN	1-L amber wide-mouth HDPE bottle	Cooler <10°C	Lambert, 1986	6 hours	µmol/L
Total Dissolved Nitrogen TDN-SWAAN			Valderama, 1981 (Mar. Chem. 10)		
Nitrate/Nitrite NO32SWAAN			EPA 353.2		
Ammonium NH3—SWAAN			EPA 350.2		
Particulate Phosphorous PP--SWOXA	1-L amber wide-mouth HDPE bottle		Solarzano, 1980		
Total dissolved Phosphorous TDP-SWAAN			Valderama, 1981 (Mar. Chem. 10)		
Orthophosphate PO4—SWAAN			EPA 365.1		
Particulate Organic Carbon PC—SWCHN			Lambert, 1986		
Chlorophyll *a* CHLASWFLU	1-L amber wide-mouth HDPE bottle	Cooler <10°C	Modified EPA 445.0	6 hours	µg/L
Phaeophytin PHAESWFLU					

Table 7. Monitoring Parameters for Tributary River Water Quality Monitoring (BHWQMR): Field Measurements

Parameter	Instrument	Units
Temperature	YSI 3800 water quality meter	°C
Dissolved Oxygen		mg/L, % saturation
Salinity		ppt
Conductivity		millisiemens/cm
Turbidity		NTU
pH		pH std. units

Table 8. Monitoring Parameters for Tributary River Water Quality Monitoring (BHWQMR): Laboratory Analyses

Parameter	Sample Container	Preservation	Analysis Method	Holding Time	Units
Fecal coliform FCOLSWMFL	Sterile 250-ml LDPE bottle	Cooler <10°C	SM 9222D	6 hours	#/100 ml
Enterococcus ECOCAQMFL and EC24AQNFL (as of 9/00)			SM 9320C and EPA1600 (as of 9/00)		
Total suspended solids TSS-SWGRV	1-L wide-mouth translucent LDPE bottles		EPA 160.2	7 days	mg/L
Total Nitrogen TN—SWAAN	1-L amber wide-mouth HDPE bottle	Cooler <10°C	Valderama, 1981 unfiltered	6 hours	µmol/L
Nitrate/Nitrite NO32SWAAN			EPA 365.1		
Ammonium NH3—SWAAN			EPA 350.2		
Total Phosphorus TP—SWAAN	1-L amber wide-mouth HDPE bottle	Cooler <10°C	Valderama, 1981 Unfiltered	6 hours	µmol/L
Orthophosphate PO4SWAAN			EPA 365.1		
Chlorophyll *a* CHLASWFLU	1-L amber wide-mouth HDPE bottle	Cooler <10°C	Modified EPA 445.0	6 hours	µg/L
Phaeophytin PHAESWFLU					

Table 9. Monitoring Parameters for Biofouling Monitoring (BHFOUL)

Parameter LIMS TEST CODE	Preservation	Analysis method	Holding time	Units
Total solids TS—TSGRV	Dry 60 °C	Lavery, 1993	6 month	mg/a/d (milligrams dry wt/100cm^2/day)

30-lb train track sections. The plates (12.5 x 12.5 x 1.25cm) are deployed at fixed depths in the water column, at 0.5, 1.5, 2.0, 3.0, 4.0, 5.0 and 6.0 meters.

Arrays are deployed in August and September, for a total of two separate deployments per location per year. Deployments are three weeks in duration. Arrays are retrieved on the 21st day, the plates are removed in the field and returned to the laboratory. At the lab, non-plant organisms are removed, the plate surfaces are scraped, and the scrapings dried in a laboratory oven, cooled in a dessiccator and weighed using an analytical balance. Rates of accumulation of total solids for each plate are calculated as follows:

Rate of accumulation = (milligrams of dried material/# of days deployed)/(surface area of plate).

The final units for total solids are milligrams/100cm^2/day (although this appears in the database as mg/a/d.).

1.3.2 Combined Sewer Overflow Receiving Water Monitoring (CSORWM)

1.3.2.1 Criteria for Selection of Sampling Locations

There are 60 active CSO's in the greater Boston area which are hydraulically connected to the MWRA wastewater system. The receiving waters of all the CSOs in the sewerage system tributary to MWRA treatment plants are included in this study, regardless of the municipal ownership of the CSOs. The sampling area includes tributary rivers (Figures 2, 3 and 5), the Inner Harbor (Figure 4), and Dorchester Bay (Figure 5). Locations for monitoring were chosen upstream and downstream of CSOs in rivers with directional

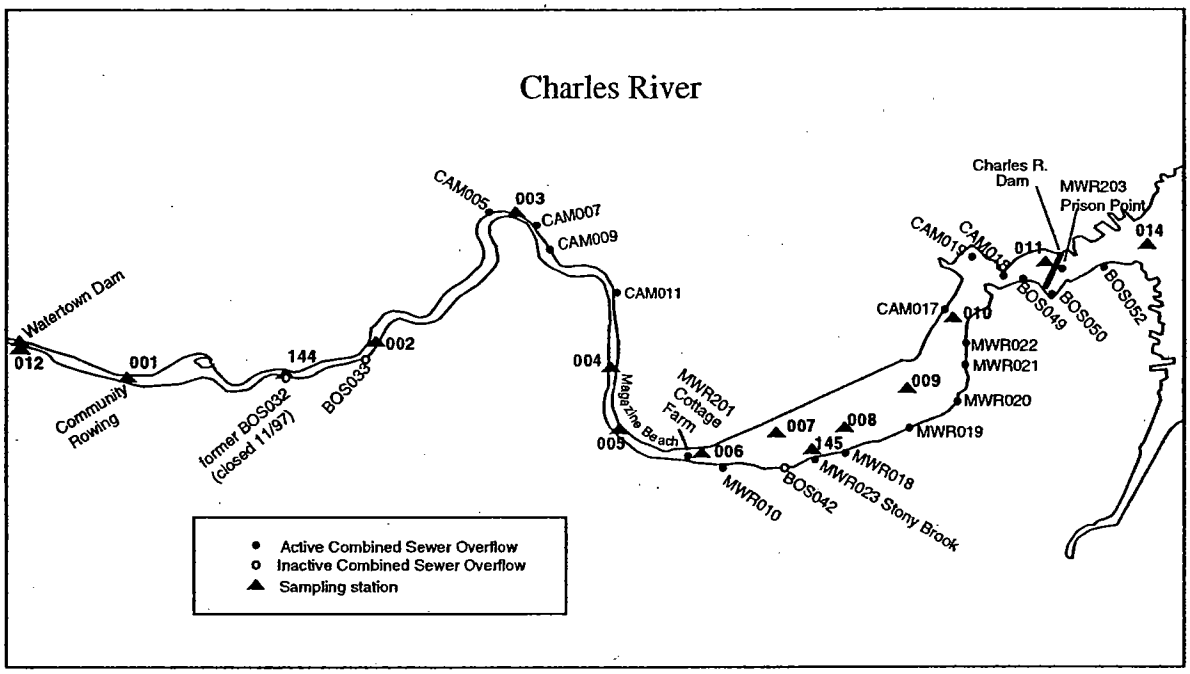

Figure 2. CSO Receiving Water monitoring locations in the Charles River 2000

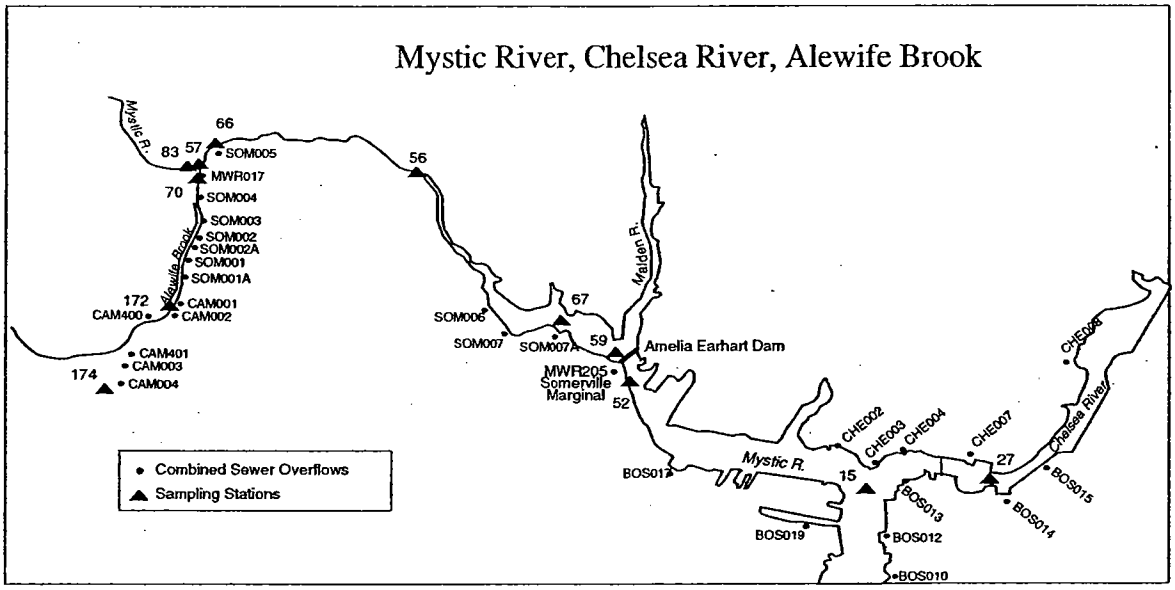

Figure 3. CSO Receiving Water monitoring locations in the Mystic River, Chelsea River and Alewife Brook, 2000

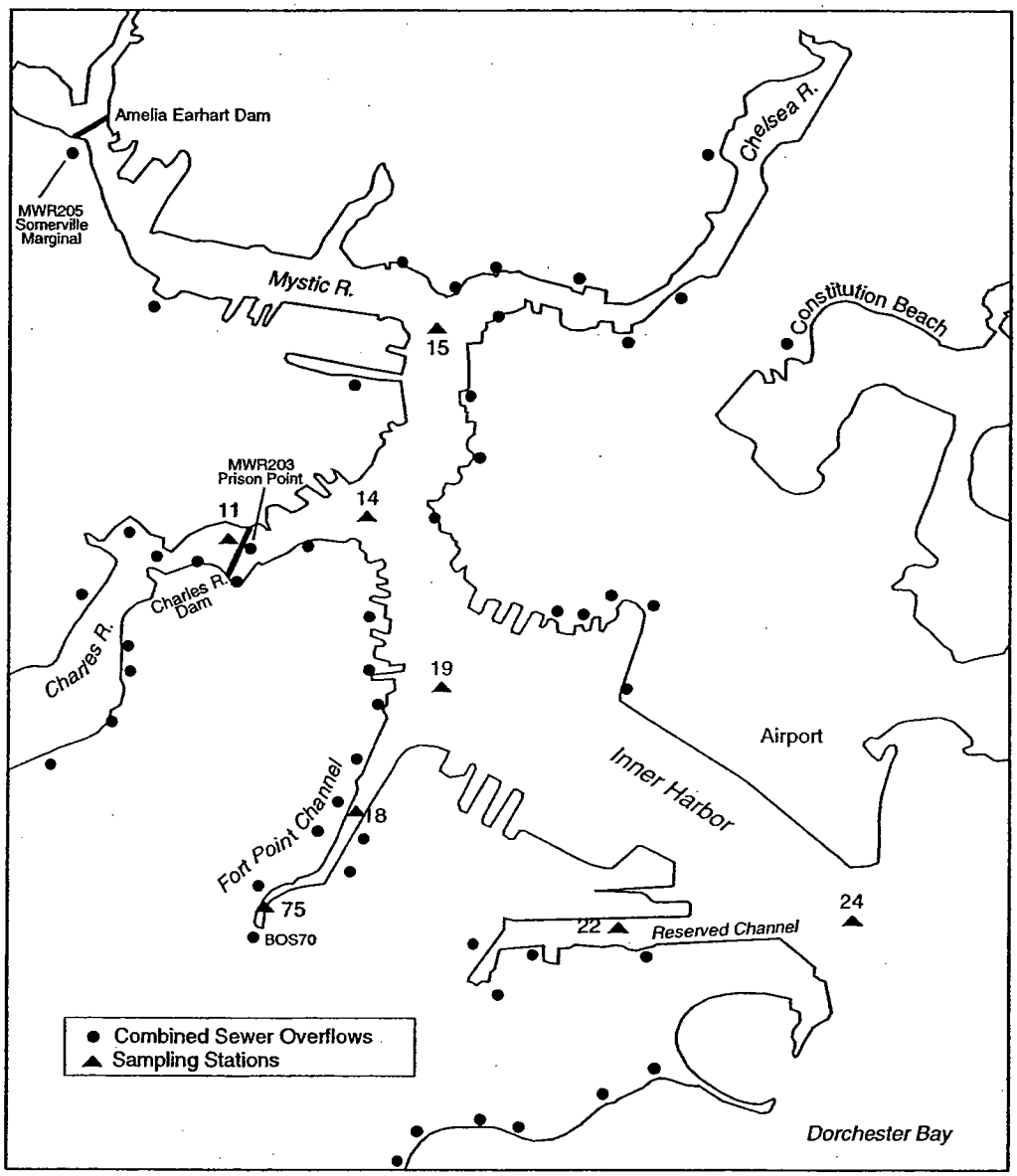

Figure 4. CSO Receiving Water monitoring Stations in the Inner Harbor, 2000.

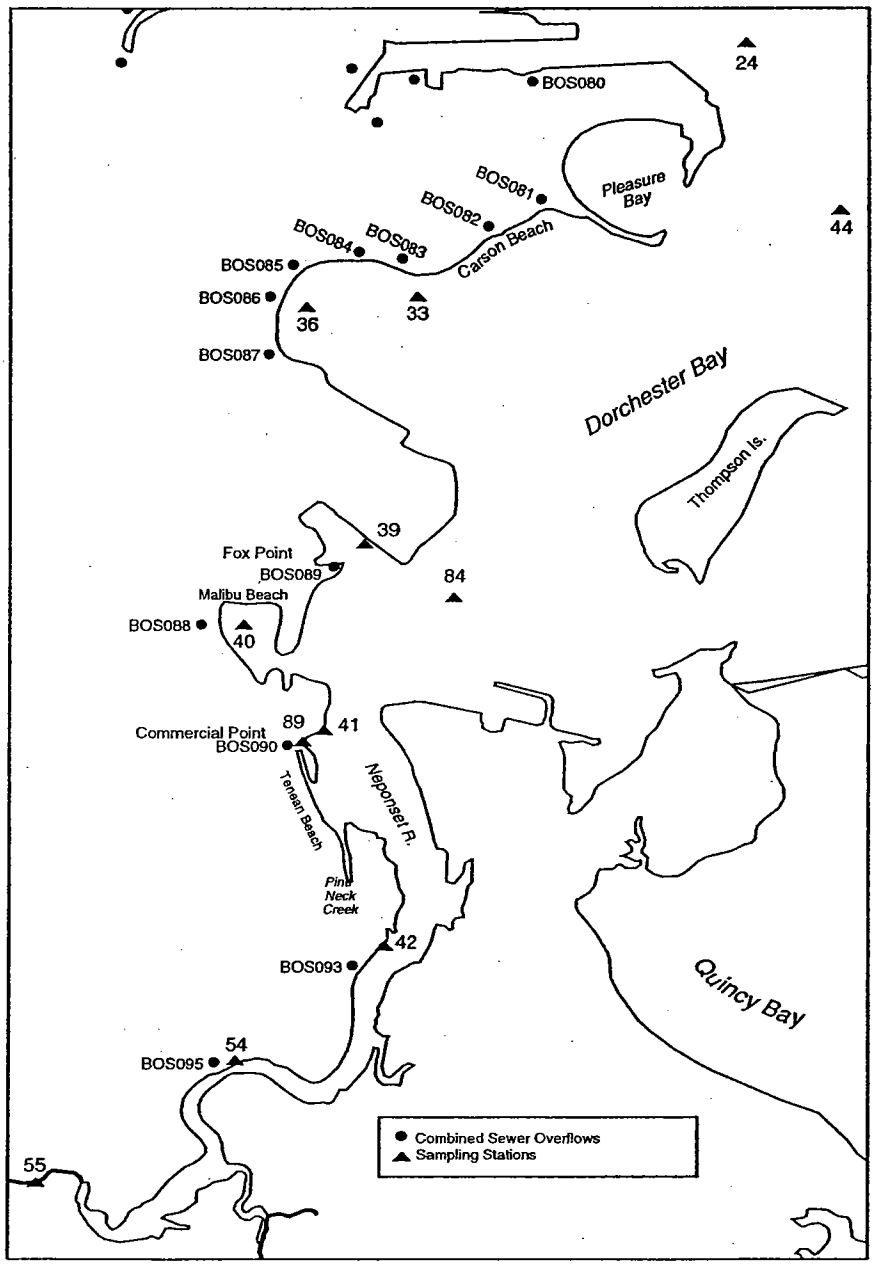

Figure 5. CSO Receiving Water monitoring stations in the Neponset River and Dorchester Bay, 2000

flow. In the marine environment, where tidal currents are strong and the currents reverse direction, locations were selected near CSOs and distant from CSOs.

1.3.2.2 Sampling Locations

The monitoring locations for CSO receiving water monitoring are listed in Table 10. The stations were located in one of 5 regions within the Harbor that receive discharges from CSO's.

1.3.2.3 Sample collection and parameters measured

The field measurements conducted at each of the CSORWM stations are shown in Table 11. The laboratory analyses conducted on the samples collected at each of the stations are shown in Table 12. The frequency and planned numbers of samples collected as part of the project are summarized in Table 13.

1.3.3 Wastewater Treatment Plant Harbor Outfall Monitoring (TP-OUT)

The purpose of the TPOUT monitoring is to assess effects of the discharges from Deer Island on the receiving waters closest to the outfalls, and to track the changes at these locations after final transfer of the discharges from Deer Island offshore. In the past, high bacteria counts have been measured in the outfall areas around the Deer Island and Nut Island discharges (Robinson et al. 1990). High bacteria counts in the outfalls have been related to poor disinfection, caused by equipment failures at the old, deteriorating treatment plants.

Two sets of stations are to be monitored off of Deer Island. The one set includes stations 118, 050, 135, 160, and 159, and are to be monitored weekly. The other set that includes Stations 173, 130, 133, 134, 147 and 126, are to be monitored monthly (to characterize background, dry-weather conditions), and then during wet weather events following activation of the two "short" Deer Island outfalls (#004 and #005). Monitoring at the

Table 10. Sampling Locations for CSO Receiving Monitoring (CSORWM) in Charles River region

Site No.	Description (nearest CSO influence)	Latitude (N)	Longitude (W)	Depth Sampled S =Surface B =Bottom
001	Charles River Community Rowing (upstream of CSOs)	42°21.54	71°10.45'	S
002	Downstream of BOS-33	42°21.78	71° 08.79	S
144	Charles River 2 meters off BOS032 (BOS032)	42° 21.60	71° 09.00	S
012	Charles River community rowing, Upstream of CSOs)	42°21.35	71°26.99	S
003	Charles River downstream of CAM005 midstream at hairpin bend in river (CAM005)	42°22.37'	71°07.74'	S
004	Charles River midchannel midway between River St. and Western Ave. Bridges (CAM001)	42°21.70'	71°07.06'	S
005	Charles River Magazine Beach (BOS034)	42°21.27'	71°06.99'	S
006	Charles River 10 meters downstream of BU Bridge (MWR202 Cottage Farm Treatment Facility)	42°21.15'	71°06.51'	S
007	Charles river near MIT Boathouse (MWR010, BOS042)	42°21.33'	71°05.88'	S+B
145	Charles River MWR023 Stony Brook Outfall	42°20.98	71°05.58	S
008	Charles River immediately downstream of Harvard Bridge (MWR023 Stony Brook outfall)	42°21.27'	71°05.37'	S+B
009	Charles River midway between Harvard and Longfellow Bridges midstream (MWR019)	42°21.45'	71°04.93'	S+B
010	Downstream of Longfellow Bridge (MWR022)	42°21.72'	71°04.55'	S+B
011	Between Science Museum Dam and T Drawbridge (BOS049)	42°22.14'	71°03.84'	S+B

Table 10 continued. Sampling Locations for CSO Receiving Monitoring (CSORWM) in Mystic River and Inner Harbor regions

Site no.	Description (nearest CSO influence)	Latitude (N)	Longitude (W)	Depth Sampled S = Surface B = Bottom
070	Alewife Brook near Mystic confluence (MWR017)	42°24.86	71°07.99	S
083	Mystic River upstream of Alewife (Upstream of CSOs)	42°24.92	71°08.10	S
057	Confluence of Mystic River and Alewife Brook	42°24.92	71°07.99	S
056	Mystic R. near Rt. 93 bridge	42°24.88	71°06.25	S
059	Confluence of Mystic and Malden Rivers (SOM007A	42°23.80	71°04.62	S
052	Mystic River/Inner Harbor Somerville Marginal outfall (MWR205)	42°23.63	71°04.55	S+B
067	Mystic, Rt 28 Bridge, Somerville	42° 23.98	71° 05.00	S
015	Inner Harbor Confluence of Mystic and Charles Rivers	42°22.98	71°02.71	S+B
027	Chelsea River/Inner Harbor (BOS014)	42°23.04	71°01.79	S+B
014	Inner Harbor Mouth of Charles River (Prison Point Facility MWR203)	42°22.23	71°03.09	S+B
019	Inner Harbor/Mouth of Fort Point Channel	42°21.54	71°02.69	S+B
018	Inner Harbor Fort Point Channel, Summer St. (multiple CSOs in Channel	42°21.04	71°02.63	S+B
074	Foot bridge downstream side, Alewife T station	42° 23.84	71° 08.66	S
022	Inner Harbor Reserved Channel	42°20.56	71°01.72	S+B
024	Mouth of Inner Harbor Red Buoy #10	42°20.59	71°00.48	S+B
172	Alewife Brook, upstream side of Mass. Ave bridge	42° 24.08	71° 08.17	S
174	Little River/Alewife 415 ft upstream of Rte 2 off-ramp to Alewife T	42° 23.85	71° 08.70	S

Table 10 continued. Sampling Locations for CSO Receiving Monitoring (CSORWM) in North Dorchester Bay and South Dorchester Bay/Neponset River regions.

Site No.	Description (nearest CSO influence)	Latitude (N)	Longitude (W)	Depth Sampled S = Surface B = Bottom
044	Dorchester Bay Green buoy #5	42°19.95	71°00.01	S+B
048	Quincy Bay off Moon Island	42°18.61	70°59.36	S
033	Carson Beach off L-Street Bathhouse	42°19.63	71°02.18	S
036	Carson Beach Bathhouse (BOS086)	42°19.59	71°02.75	S
084	Dorchester Bay, Red buoy #12	42°18.47	71°02.00	S
039	Dorchester Bay UMass dock (near Fox Point BOS089)	42°18.68	71°02.45	S
040	Dorchester Bay Malibu Bay (near BOS088)	42°18.37	71°03.08	S
041	Dorchester Bay Old Yacht Club (Commercial Point BOS090)	42°17.98	71°03.08	S
089	Dorchester Bay Commercial Point, Victory Rd. footbridge (BOS090)	Details	Details	S
042	Neponset River near BOS-093	42°17.13	71°02.36	S
054	Neponset, Granite Ave. Bridge	42°17.13	71°02.36	S
055	Neponset, dam at chocolate factory	42°16.30	71°04.16	S

Table 11. Monitoring Parameters for CSO Receiving (CSORWM) Water Monitoring: Field Measurements

Parameter	Instrument	Units
Temperature	Hydrolab Data Sonde 4 series water quality meter	°C
Dissolved Oxygen		mg/L, % saturation
Salinity		ppt
Conductivity		millisiemens/cm
Turbidity		NTU
pH		pH std. units
Secchi depth	White 10" diam. oceanographic disk	meters
Transmissivity	Wet Labs C-Star transmissometer	Percent transmittance

Table 12. Monitoring Parameters for CSORWM: Laboratory Measurements

Parameter LIMS TEST CODE	Sample Container	Preserva-tion	Analysis Method	Hold-ing Time	Units
Fecal coliform FCOLSWMFL	Sterile 250-ml LDPE bottle	Cooler <10°C	SM 9222D + EPA 1600 as of 9/00	6 hours	#/ 100 ml
Enterococcus ECOCAQMFL + EC24AQFML as of 9/00					

Table 13. Frequency and Number of Samples for CSO Receiving Water Quality (CSORWM)

Study	Survey frequency	Sites per survey	Total samples per study, 2000
CSO Receiving Water Quality (CSORWM)	Each station sampled 2 consecutive days on 3 week rotation – ca 26 collections, with minimum of 20 collections, April through December	43 locations, 10-20 locations/survey	ca. 1120

latter set of sites will cease with opening of the new 9.5-mile outfall, because the 'short' outfalls should not activate again.

1.3.3.1 Criteria for Selection of Sampling Locations

Sampling locations include the outfall discharge locations and areas where computer models (Kossik 1987; Albro 1994; McGillivary and Adams 1994, 1995a, 1995b; Signell 1992, Signell pers. comm. 1994) have predicted Deer Island effluent is dispersed by tidal currents. Generally, strong tidal currents in President Roads carry effluent from the major Deer Island outfalls #001 and #002 northeast to Broad Sound. Effluent discharged from the shorter Deer Island outfalls #004 and #005 has a greater potential to hug the shore of Deer Island and to enter Winthrop Bay. Sites in Winthrop Bay and Wollaston Beach are included because they are sensitive resource areas which could be potentially affected by discharges during particular tide and wind conditions.

1.3.3.2 Sampling Locations

Figure 6 is a map of the monitoring locations for the Harbor treatment plant monitoring (TP-OUT). Sampling locations are listed in Table 14.

1.3.3.3 Sample Collection and Parameters Measured

The sample sites are to be accessed by motorboat; a Kemmerer sampler is used to collect the water samples. Fig. 7 shows the stations to be sampled off of Deer Island and in Winthrop Bay following wet weather activations of outfalls #004 and 005. Details of sampling and analysis are provided in Tables 15, 16 and 17. Wet weather sampling will be shoreline.

2.0 PROJECT FISCAL INFORMATION

This project is funded through MWRA's FY2000 and FY2001 Current Expense Budget.

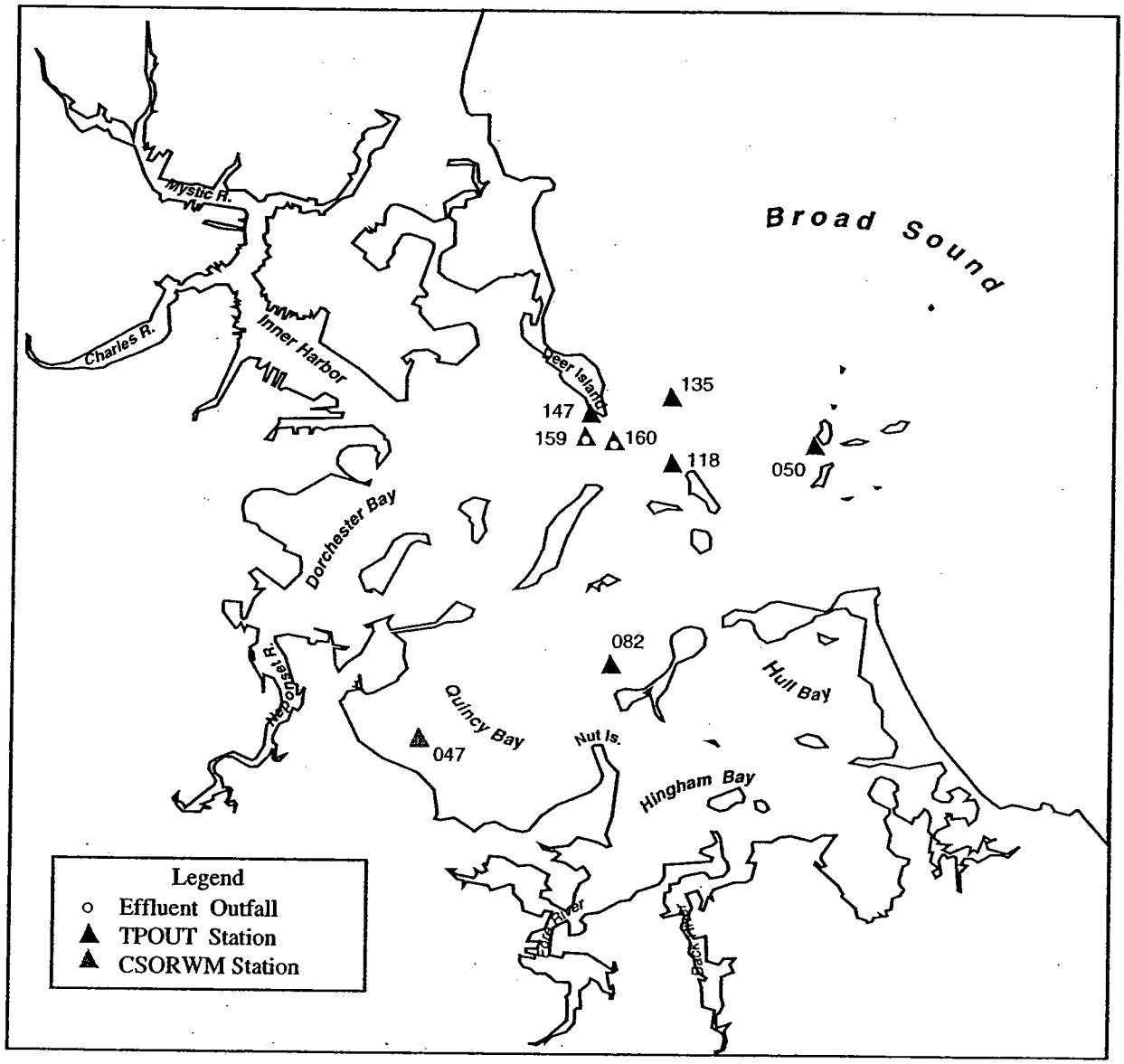

Figure 6. Wastewater Treatment Plant Harbor Outfall (TPOUT) Monitoring Stations, 2000.

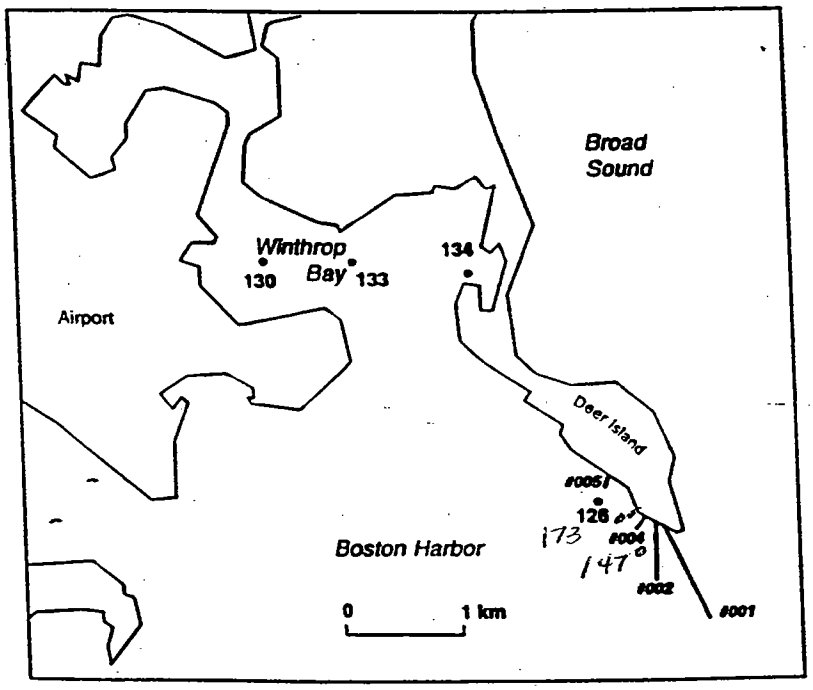

Figure 7. Sampling Locations for Monitoring Deer Island outfall # 004 and #005.

Table 14. Sampling Locations for Wastewater Treatment Plant Harbor Outfall Monitoring (TP-OUT), 2000

Site	Description	Latitude (N)	Longitude (W)	Depth Sampled S = Surface B = Bottom
Former Nut Island Outfall Area				
082	Former Nut Island Outfall #101	42° 17.49	70° 56.95	S
Deer Island Outfall Area				
118	Lovell Island	42° 19.97	71° 56.24	S
050	Calf Island	42° 16.51	71° 59.31	S
135	Boston North Channel	42° 20.61	71° 56.52	S + B
160	Deer Island Outfall #001, off DI light	42° 20.30	71° 57.00	S
159	Deer Island Outfall #002	42° 20.33	71° 57.33	S
Sampling when Deer Island #004 and #005 activate				
147	Deer Island Outfall #004	42° 20.50	71° 57.40	S
130	Winthrop Bay, green can "1"	42° 21.80	70° 59.24	S
133	Cottage Park Yacht Club	42° 21.97	70° 00.77	S
134	"The Basin" green can "3"	42° 21.96	70° 01.45	S
173	End of Deer Island transportation dock	42° 20.96	70° 02.41	S
126	Outfall #005	42° 20.96	70° 02.30	S

Table 15. Monitoring Parameters for Wastewater Treatment Plant Harbor Outfall Monitoring (TP-OUT): Field Measurements 2000

Parameter	Instrument	Units
Temperature	See Table 4	°C
Dissolved Oxygen		mg/L, % saturation
Salinity		Ppt
Conductivity		Millisiemens/cm
Turbidity		NTU
pH		PH std units
Photosynthetically Active Radiation	Licor 1000 logger Spherical PAR sensor Model LI-193 SB	Pmol/sec/m^2
Secchi depth	White 8" diam. Oceanographic disk	meters
Transmissivity	Wet Lab C-Star transmissometer	Percent transmittance

Table 16. Monitoring Parameters for Wastewater Treatment Plant Harbor Outfall Monitoring (TP-OUT): Laboratory Measurements 2000

Parameter LIMS TEST CODE	Sample Container	Preservation	Analysis Method	Holding Time	Units
Fecal coliform[1] FCOLSWMFL	Sterile 250 –ml LDPE bottle	Cooler <10°C	SM 9222D	6 hours	#/100 ml
Enterococcus[1] ECOCAQMFL or EC24AQFML post 9/00			SM 9320C + EPA 1600 after 9/00		
Residual chlorine[3]	LPDE bottle	None	330.5 EPA-600/4-79-690	5 min	mg/l
Total Suspended Solids[2] TSS-SWGRV	1-L translucent LDPE bottles.	Filtered on boat	EPA 160.2	7 days	mg/l
Nitrate/Nitrite[2] N032SWAAN			EPA 353.2		
Ammonium[2] NHS—SWAAN			EPA 350.2		
Orthophosphate[2] PO4--SWAAN			EPA 365.1		

[1]Tests done for all stations in Table 14
[2]Tests done only at stations 082 and 160
[3]Test done only at 160, 159, 147 and 173

Table 17. Frequency and Number of Samples for Wastewater Treatment Plant Harbor Outfall Monitoring (TP-OUT)

Study	Survey frequency	Sites per survey	Total samples per project, 1998
Wastewater Treatment Plant Harbor Outfall Monitoring	Weekly May through Oct, and 1x/2 weeks through remainder of year, 31 surveys per year	6 (Surface samples only)	186
Wet Weather	When short outfalls #004 and #005 activate	6	Dependent on activations

The schedule for the CSORWM for 2000 is as follows. One or two of 5 areas will be sampled for 2 successive days every 3 weeks. Areas will be sampled on a rotating schedule, with a full rotation lasting 3 weeks. Each region to be sampled a minimum of 20 days during year.

Table 19. Sampling schedule for CSORWM, 2000

Week	Area	Sampling stations
2	Charles River (12 regular stations + 1 wet weather station)	001S, 002S, 003S, 004S, 005S, 006S, 007S+B, 008S+B, 009S+B, 010S+B, 011S+B, 144S (wet only), 145S
3	Mystic River (11 regular + 1 wet weather)	083S, 070S, 057S (not in winter), 056S, 067S, 059S, 052S+B, 172S, 174S, 069S (wet weather), 074S, (074 'optional' status)
3	Inner Harbor (7 stations)	024S+B, 022S+B, 018S+B, 019S+B, 014S+B, 015S+B, 027S+B
1	South Dorchester Bay/ Neponset River (7 stations)	084S+B, 039S+B, 040S, 041S, 042S+B, 054S, 089S
1	North Dorchester Bay (5 stations)	033S, 036S, 038S+B, 044S+B, 048S+B

3.0 SCHEDULE

The week to week schedule proposed for 2000 is summarized in Table 18.

Table 18. Sampling Schedule, 2000

Week	BHWQMR	BHWQM	TP-OUT DI	TP-OUT NI	CSO-RW
1/2 – 1/8	√	√			
1/9 – 1/15	√		√	√	052S 144S
1/16 – 1/22	√	√			052S
1/23 – 1/29					
1/30 – 2/5	√	√	√	√	052S
2/6 – 2/12	√	√			052S
2/13 – 2/19	√		√	√	052S
2/20 – 2/26	√	√			
2/27 – 3/ 4	√		√	√	052S
3/5 – 3/11	√	√			
3/12 – 3/18	√		√	√	
3/19 – 3/25	√	√			

Table 18 cont.

Week	BHWQMR	BHWQM	**TP-OUT DI & 082**	CSO-RW
3/26 – 4/1	√		√	NDB & SDB (052S)
4/2 – 4/8	√	√		CR
4/9 – 4/15	√		√ (full DI&NI)	MYS & IH (2x 069)
4/16 – 4/22	√	√	√ (082 only)	NDB & SDB
4/23 – 4/29	√		√ (DI only)	CR
4/30 – 5/6	√	√	√	MYS & IH (1x 069)
5/7 – 5/13	√	√	√	NDB & SDB
5/14 – 5/20	√	√	√	CR
5/21 – 5/27	√	√	√	MYS & IH
5/28 – 6/3	√	√	√	NDB & SDB
6/4 – 6/10	√	√	√	CR (2x 144, 022&024S/B)
6/11 – 6/17	√	√	√	MYS & IH
6/18 – 6/24	√	√	√	NDB & SDB
6/25 – 7/1	√	√	√	CR (2x 144)
7/2 – 7/8	√	√	√	MYS & IH
7/9 – 7/15	√	√	√	NDB & SDB
7/16 – 7/22	√	√	√	CR (1x 144)
7/23 – 7/29	√	√	√	MYS & IH
7/30 – 8/5	√	√	√	NDB & SDB
8/6 – 8/12	√	√	√	CR
8/13 – 8/19	√	√	√	MYS & IH
8/20 – 8/26				
8/27 – 9/2				

The schedule for the CSORWM for 2000 is as follows. One or two of 5 areas will be sampled for 2 successive days every 3 weeks. Areas will be sampled on a rotating schedule, with a full rotation lasting 3 weeks. Each region to be sampled a minimum of 20 days during year.

Table 19. Sampling schedule for CSORWM, 2000

Week	Area	Sampling stations
2	Charles River (12 regular stations + 1 wet weather station)	001S, 002S, 003S, 004S, 005S, 006S, 007S+B, 008S+B, 009S+B, 010S+B, 011S+B, 144S (wet only), 145S
3	Mystic River (11 regular + 1 wet weather)	083S, 070S, 057S (not in winter), 056S, 067S, 059S, 052S+B, 172S, 174S, 069S (wet weather), 074S, (074 'optional' status)
3	Inner Harbor (7 stations)	024S+B, 022S+B, 018S+B, 019S+B, 014S+B, 015S+B, 027S+B
1	South Dorchester Bay/ Neponset River (7 stations)	084S+B, 039S+B, 040S, 041S, 042S+B, 054S, 089S
1	North Dorchester Bay (5 stations)	033S, 036S, 038S+B, 044S+B, 048S+B

20.0 APPENDIX

Table A-1. List of Projects, and Corresponding LIMS and EM&MS project codes

Project	LIMS code	EM & MS code
Harbor-wide Water Quality	BHWQM	BHWQM
Harbor Tributary Water Quality	BHWQMR	BHWQM
CSO Receiving Water Monitoring	CSO-RW	CSORWM
Wastewater Treatment Plant Outfall Monitoring	TP-OUT	TP-OUT
Biofouling monitoring	BHFOUL	Data not in EM&MS

Table A-2. List of variables monitored, and of parameter/test codes in the EM&MS and LIMS data bases

Variable	LIMS code	EM & MS code
Temperature	Not in data base	TEMP
Dissolved oxygen conc.	Not in data base	DISS_OXYGEN
Dissolved oxygen percent saturation	Not in data base	PCT_SAT
Salinity	Not in data base	SAL
Specific conductance	Not in data base	SPCOND
Turbidity	Not in data base	TURB
pH	Not in data base	pH
Photosynthetically active radiation	Not in data base	LIGHT
Transmissivity	Not in data base	TRANS
Secchi depth	SECIAQFLD	SECCHI_DEPTH
Fecal coliform	FCOLSWMFL	FCOL
Enterococcus	ECOCAQMFL or after 9/00 EC24AQMFL	ECOC
Total suspended solids	TSS-SWGRV	TSS
Particulate nitrogen	PN--SWCHN	PON
Total dissolved nitrogen	TDN-SWAAN	TDN
Nitrate + nitrite	NO32SWAAN	NO3+NO2
Ammonium	NH3-SWAAN	NH4
Particulate phosphorus	PP--SWOXA	PARTP
Total dissolved phosphorus	TDP-SWAAN	TDP
Orthophosphate	PO4-SWAAN	OPHOS
Particulate organic carbon	PC--SWCHN	POC
Chlorophyll *a*	CHLASWFLU	CHLA
Phaeophytin	PHAEOSWFLU	PHAE

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