Semiannual water column monitoring report

July - December 2002

Massachusetts Water Resources Authority

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SEMIANNUAL WATER COLUMN MONITORING REPORT

July – December 2002

Submitted to

Massachusetts Water Resources Authority
Environmental Quality Department
100 First Avenue
Charleston Navy Yard
Boston, MA 02129
(617) 242-6000

prepared by

P. Scott Libby[1]
Alex D. Mansfield[1]
Aimee A. Keller[2]
Jeff T. Turner[3]
David G. Borkman[2]
Candace A. Oviatt[2]
Claudia J. Mongin[1]

[1] Battelle Duxbury Operations
Duxbury, MA 02332

[2] University of Rhode Island Graduate School of Oceanography
Narragansett, RI 02882

[3] University of Massachusetts at Dartmouth
North Dartmouth, MA 02747

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EXECUTIVE SUMMARY

The Massachusetts Water Resources Authority (MWRA) has collected water quality data in Massachusetts and Cape Cod Bays for the Harbor and Outfall Monitoring (HOM) Program since 1992. This monitoring is in support of the HOM Program mission to assess the potential environmental effects of the relocation of effluent discharge from Boston Harbor to Massachusetts Bay, which occurred on September 6, 2000. The data from 1992 through September 1, 2000 were collected to establish baseline water quality conditions. The current outfall monitoring is expected to provide the means to detect significant departure from that baseline. The surveys have been designed to evaluate water quality on both a high-frequency basis for a limited area in the vicinity of the outfall site (nearfield) and a low-frequency basis over an extended area throughout Boston Harbor, Massachusetts Bay, and Cape Cod Bay (farfield). This semi-annual report summarizes water column monitoring results for the ten surveys conducted from July to December 2002.

Over the course of the HOM program, a general trend in water quality events has emerged from the data collected in Massachusetts and Cape Cod Bays. The trends are evident even though the timing and year-to-year manifestations of these events are variable. The summer is generally a period of strong stratification, depleted surface water nutrients, and a relatively stable mixed-assemblage phytoplankton community dominated by microflagellates. In the fall, stratification breaks down supplying nutrients to surface waters and often resulting in the development of a fall phytoplankton bloom. The lowest dissolved oxygen concentrations are usually observed in the nearfield bottom water in October prior to the fall overturn of the water column. By late fall or early winter, the water column is usually well mixed and has returned to winter conditions.

These trends were generally adhered to in 2002 although the major fall bloom started in August which is earlier than usual. The water column remained stratified throughout the bays until October when the nearshore areas of Massachusetts Bay and Cape Cod Bay had become well mixed. The water column remained weakly stratified at the deeper nearfield, offshore, and boundary stations. By early November the water column had become well mixed throughout the nearfield. The biological highlights during this time period included an early fall bloom of centric diatoms and a minor late fall bloom that failed to achieve elevated phytoplankton abundances. The early fall bloom in August and September was evident as peak chlorophyll concentrations, production rates and phytoplankton abundances. The early occurrence of the bloom may have been associated with the decimation of zooplankton populations by ctenophore (*Mnemiopsis leidyi*) predation. The late fall bloom was apparent in the chlorophyll and production data, but did not result in a large increase in phytoplankton abundance likely due to light limitation (well mixed water column and decreasing light availability).

The primary physical characteristic of this period was the overturn of the water column and the return to winter conditions. Regionally, seasonal stratification had deteriorated at the coastal stations and had begun to weaken at the offshore stations by the October survey. In the nearfield, the pycnocline had weakened by early October, but the water column was not well mixed until early November. In August, an upwelling signature of cooler, more nutrient rich waters was observed at coastal and nearfield stations. The entrainment of nutrients into these nearshore waters may have enhanced productivity during the early fall bloom.

The general trend in nutrient concentrations during the 2002 July to December period was similar to previous baseline monitoring years. Nutrients were depleted in the surface waters during the summer due to biological utilization and increased in concentration with weakening stratification and increased mixing. Additional nutrients were also supplied to nearshore coastal and nearfield waters via upwelling. The increase in nutrients due to mixing appeared to be offset somewhat in November due to elevated rates of production and nutrient utilization. By December, nutrient concentrations had returned to elevated winter levels. Ammonium continued to be a clear indicator of the effluent plume

in the nearfield. Elevated NH_4 concentrations were measured at a few offshore and boundary stations in October. This occurrence is being examined in more detail given the importance of understanding the reason contributing factors. It is extremely unlikely that they are related to the outfall due to the distances involved.

Chlorophyll, production and phytoplankton abundance peaked during the early fall bloom that was observed from August through September. There was a steady increase in nearfield chlorophyll concentrations over this time period peaking in late September. Phytoplankton abundance peaked in early August at >5 x 10^6 cells L^{-1} in the nearfield and was dominated by centric diatoms. The nearfield mean abundance for centric diatoms ranged from 1.3 to 2.6 x 10^6 cells L^{-1} during the August to September bloom. The diatom bloom was dominated by *Dactyliosolen fragilissimus, Leptocylindrus danicus,* and *Skeletonema costatum*. The early fall bloom was also evident in nearshore areas of Massachusetts and Cape Cod Bay during the late August survey when maximum levels of chlorophyll, production and phytoplankton abundance were observed throughout the bays for this time period. The highest values were measured in Boston Harbor with area mean total phytoplankton and centric diatom abundance reaching more than 8 and 6 x 10^6 cells L^{-1}, respectively. The major centric diatom bloom was constrained to the harbor, coastal, and nearfield waters with a minor diatom bloom evident in Cape Cod Bay. Total phytoplankton and diatom abundances at the offshore and boundary stations were relatively low.

The fall bloom usually occurs in October in Massachusetts Bay as had been observed during most of the previous years, although the timing of the bloom as defined by peaks in biomass, production, or phytoplankton is not always consistent. The early occurrence of the fall bloom in 2002 may have been due to predation by ctenophores (*Mnemiopsis leidyi*), which were observed in high numbers from late August through November. There was a sharp decline in nearfield zooplankton abundance from early to late August. Although very low, the nearfield zooplankton abundance was high in comparison to harbor and some coastal stations where abundance ranged from only 200 to 3,000 animals m^{-3}. These very low abundances suggest that grazing pressure on phytoplankton was minimal and conducive to a bloom. These conditions may have been further enhanced by the input of additional nutrients into the nearshore waters via the outfall and upwelling, which may have entrained both nutrient rich bottom waters and the effluent plume into the upper water column.

By October, zooplankton abundances were among the lowest ever recorded for the MWRA program. During this period, the highest area mean abundance was only ~5,000 animals m^{-3} (boundary stations). Mean zooplankton abundance in Boston Harbor was only 100 animals m^{-3}.

Even though grazing pressure had likely been further reduced by October, the fall diatom bloom had terminated in the nearfield between the late September and October surveys. A late fall bloom was, however, apparent in the chlorophyll and production data in November, but did not result in a large increase in phytoplankton abundance. There was a slight increase in total phytoplankton abundance from October to November that was primarily due to an increase in diatoms. The increase in diatoms was concomitant with elevated chlorophyll concentrations and production rates, but did not result in a substantial late fall bloom as the water column had become well mixed and the phytoplankton were likely light limited.

There were no threshold exceedances during the July – December 2002 period for chlorophyll, dissolved oxygen, or nuisance phytoplankton species. The 2002 nearfield survey mean bottom water minima for DO concentration and %saturation (6.43 mgL^{-1} and 71.25%) were below the caution (and warning for %saturation) threshold values but above the background values (5.75 mgL^{-1} and 64.31%). Mean DO %saturation in the nearfield bottom water also dropped below the caution threshold during both September surveys. The survey mean bottom water minima for Stellwagen Basin stations was higher than in the nearfield, but as in the nearfield the minima DO %saturation (75.13%) was below

the caution threshold. As the nearfield DO concentration and %saturation minima and Stellwagen DO %saturation minima were above established background threshold values, there was no threshold exceedance for dissolved oxygen. The summer (May to August) *Phaeocystis* threshold (334 cells L^{-1}) was exceeded (1,490 cells L^{-1}), but this was due to the persistence of the April bloom rather than any summer event that may suggest a problem. Relatively low abundances persisted in the nearfield into early May, but *Phaeocystis* was not observed from again from mid May through the end of 2002.

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