MASSACHUSETTS WATER RESOURCES AUTHORITY
Charlestown Navy Yard
100 First Avenue, Building 39
Boston, MA 02129

Frederick A. Laskey
Executive Director

Telephone: (617) 242-6000
FAX: (617) 788-4889
TTY: (617) 788-4971

September 5, 2014

Ms. Susan Studlien
Office of Environmental Stewardship
U.S. EPA Region I
5 Post Office Square, Suite 100
Mail code OES04-5
Boston, MA 02109-3912

Mr. David Ferris
Division of Wastewater Management
Department of Environmental Protection
1 Winter Street
Boston, MA 02108

Re: Massachusetts Water Resources Authority, Permit Number MA0103284
Notification Pursuant to Part I.8. Contingency Plan: *Phaeocystis*

Dear Ms. Studlien and Mr. Ferris:

One of the nuisance algae that the Massachusetts Water Resources Authority ("MWRA") monitors in its outfall ambient monitoring program is *Phaeocystis pouchetii*. Reporting on seasonal abundances of *Phaeocystis* in the outfall nearfield area is part of the Contingency Plan.[1] MWRA has received *Phaeocystis* results from samples collected through June 14, 2014.

All eight samples collected in the nearfield on May 9, 2014 contained *Phaeocystis*, with the highest abundances found in samples collected at depth, indicating a senescent bloom with colonies settling out of the water column. Two of the eight samples collected in the nearfield on June 14, 2014, both collected at depth, contained low abundances of *Phaeocystis*, an apparent remnant of the 2014 bloom.

This observation corresponds to a calculated nearfield mean abundance of *Phaeocystis* in the May survey of about 1,600,000 cells/L, and in the June survey of about 5,500 cells/L. Results from the July and August surveys, which are included in the Contingency Plan summer seasonal threshold, will not be available until early October. However, even if *Phaeocystis* is not found in any samples from July and August, abundances observed in samples from the May and June surveys will result in a seasonal summer mean, which is calculated from average counts from May 1 to August 31, of 395,000 cells per liter (as displayed in the table below). This is above the Caution Level threshold of 357 cells/L, which triggers a notification under the Contingency Plan. This letter constitutes the notification for the threshold exceedance.

1 *Massachusetts Water Resources Authority Contingency Plan Revision 1*. 2001. Report 2001-ms-071. http://www.mwra.state.ma.us/harbor/enquad/trlist.html.

Parameter	Specific Parameter	Baseline	Caution Level Threshold	Warning Level Threshold	2014 Results
Phaeocystis pouchetii	Winter/spring	470,000 cells/L	2,020,000 cells/L	None	27,800 cells/L
	Summer	**79 cells/L**	**357 cells/L**		**≥395,000 cells/L*** **Caution Level Exceedance**

* Assumes *Phaeocystis* is absent from all samples collected in July and August, 2014.

No adverse aesthetic or other impacts were observed from this year's *Phaeocystis* bloom. Figure 1 shows that the temporal pattern of the bloom was relatively atypical, with the organism first detected in February, and not peaking in abundance until the May survey (most blooms observed previously peaked in March or April). Abundance dropped to much lower levels by mid-June. Figure 2 shows the winter-spring seasonal means, and Figure 3 shows the summer seasonal means, plotted against the corresponding thresholds. There is no obvious association between the 2014 bloom and MWRA's outfall, as the bloom appeared to be region-wide. In March, samples from station F02 in Cape Cod Bay and F29 north of Race Point had abundances of *Phaeocystis* of about 3 million cells per liter, more than ten times higher than samples collected that month anywhere in Massachusetts Bay. During the May survey, counts above 1 million cells/L were found in subsurface samples from nearly all stations in Massachusetts Bay, including those distant from the outfall.

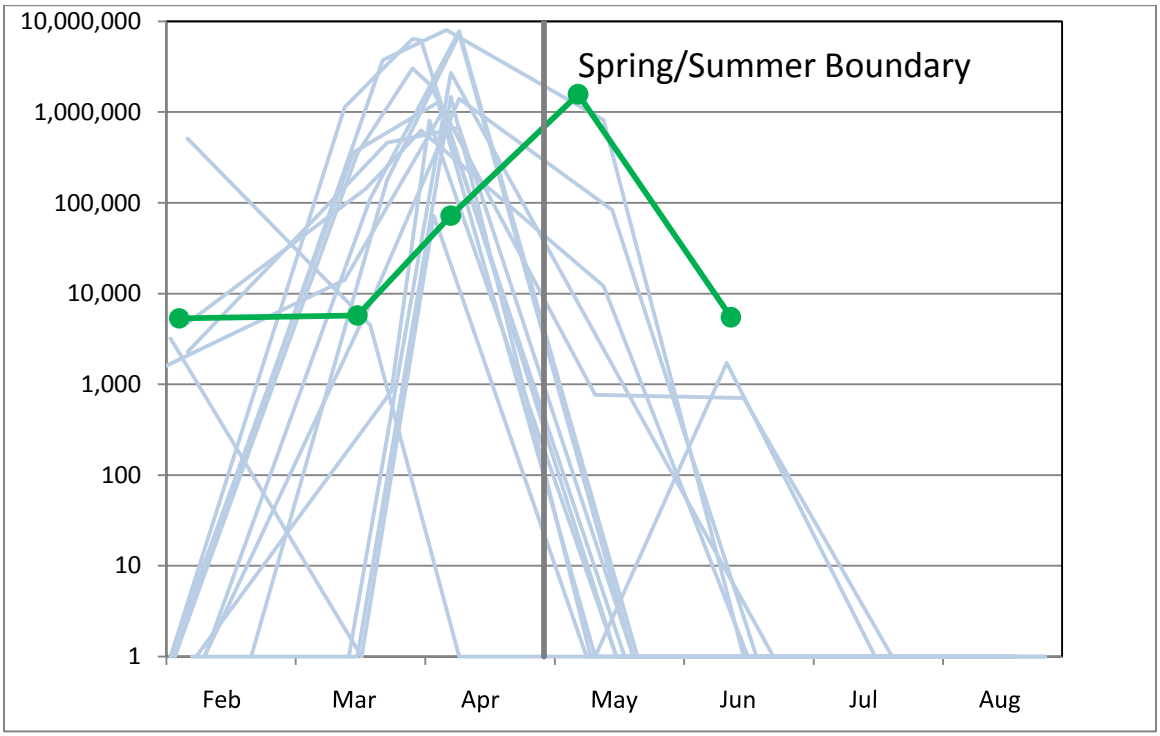

Figure 1. Patterns of survey mean *Phaeocystis* abundances (cells/liter) in the nearfield, 1992-2013 (light blue lines) and 2014 (green symbols and line)

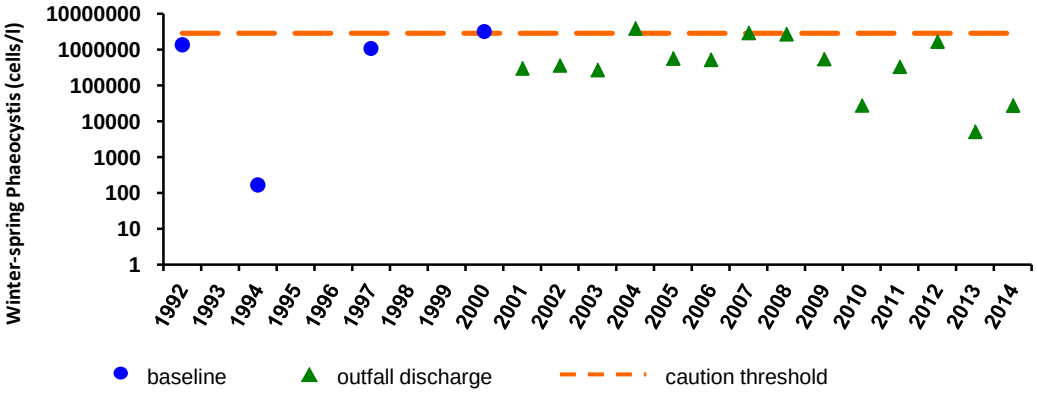

Figure 2. Winter-spring nearfield seasonal mean *Phaeocystis* counts 1992-2014

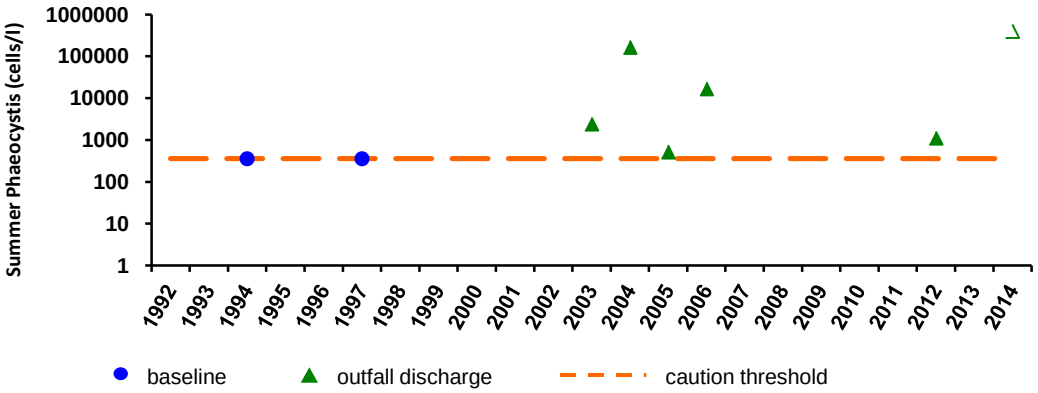

Figure 3. Summer nearfield seasonal mean *Phaeocystis* counts 1992-2014 (note logarithmic scale). The open triangle for Summer 2014 indicates the provisional mean assumes zero abundances for July and August samples.

Phaeocystis was only rarely observed after May 1 in baseline years during which it bloomed, which accounts for the extremely low May-August threshold of 357 cells per liter. However, cells were observed in May or June samples every year from 2002[2] through 2006, again in 2012, and this year (2014).

MWRA evaluated possible causes for the apparent increased occurrence of *Phaeocystis* in summer samples in the water column annual report for 2004[3], and has continued its evaluation of the blooms of *Phaeocystis* in Massachusetts Bay since then. The termination of *Phaeocystis* blooms appears to be related to how quickly the surface waters warm in spring. Research reviewed in the 2004 report suggested that *Phaeocystis pouchetii* could not grow in nutrient enriched cultures when water temperatures are higher than 14ºC. If the water warms up relatively early, in late April or early May, few or no *Phaeocystis* cells are observed in MWRA's May or June surveys. When warming is delayed until late May or into June, and there is a winter/spring *Phaeocystis* bloom, appreciable numbers of *Phaeocystis* are often seen later than May 1. More recent evaluations by MWRA's project team that will be discussed at the September 23, 2014 meeting of the Outfall Monitoring Science Advisory Panel suggest that, in Massachusetts Bay, *Phaeocystis pouchetii* blooms are curtailed when water temperatures exceed about 9.8ºC.

While the evaluation of the atypical *Phaeocystis pouchetii* bloom in 2014 is just beginning, all indications are that the high abundances observed in samples from this May conform to the developing understanding of bloom dynamics in Massachusetts Bay.

The prolonged cold winter of 2013-2014 appears to have resulted in some of the coldest surface water temperatures observed (at the NERACOOS A Buoy south of Cape Ann) from between mid-February and the end of April, 2014 (Figure 4). These conditions could have delayed the development of peak bloom abundance past the mid-April survey (when it is commonly observed). Then, in early May 2014 surface temperatures warmed rapidly to 10ºC and beyond (Figure 4), which may have caused *Phaeocystis* cells to senesce and begin to settle out of the water column. Multiple lines of evidence support this view:

- As previously noted, during the May 2014 survey, *Phaeocystis* abundances were much higher at mid-depth than they were in surface samples, more than 10 times higher at most stations.
- The depth of the chlorophyll maximum in May was observed in the bottom waters in May(except at a shallow station at the mouth of Boston Harbor that was well-mixed and a very deep station south of Cape Ann). This is substantially deeper than normally observed in May.
- The bottom water maxima in chlorophyll were combined with elevated phaeophytin[4] to chlorophyll ratios. This is consistent with the sinking of a senescent bloom.

[2] *Phaeocystis* was observed during a survey on May 1, 2002 and resulted in a threshold exceedance that year, reported at http://www.mwra.state.ma.us/harbor/pdf/20021209amx.pdf. Since the survey during which it was observed was dropped from the Ambient Monitoring plan, its data no longer appear in threshold plots like Figure 3.
[3] See section 3.4.7 and Appendix D of Libby PS, Geyer WR, Keller AA, Mansfield AD, Turner JT, Borkman D, Oviatt CA. 2006. **2004 Annual Water Column Monitoring Report**. Boston: Massachusetts Water Resources Authority. Report 2006-15. 177 p.
[4] Phaeophytin is a chlorophyll breakdown product.

- The depth of the mid-depth phytoplankton samples was deeper than usual in May (except in Boston Harbor) ranging from 19 meters to over 37 meters deep in Massachusetts Bay. These samples were collected near the bottom of the pycnocline at the depth where nitrate levels increased – surface layer nitrate was depleted throughout the bay.
- *Phaeocystis* cells observed in samples from May tended to be smaller (3 to 5 micrometers) compared to what is usually seen (5 to 10 micrometers). This is consistent with stressed (due to nutrient limitation) and/or senescent cells[5].

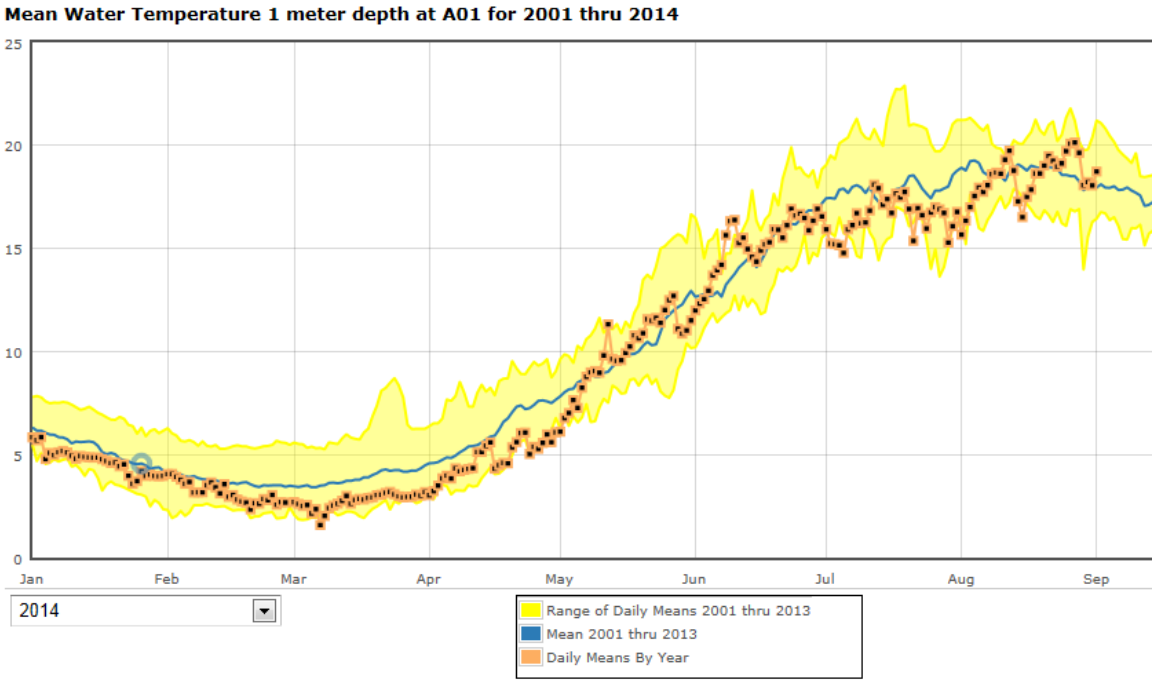

Figure 4. Graph of daily average surface water temperature at NERACOOS Buoy A01. This plot, (generated by the NERACOOS website at www.NERACOOS.org), compares results from 2014 (brown dots and orange line) to the range of observations made in 2001 to 2013 (yellow shading).

As mentioned above, the evaluation of the unusual timing of the *Phaeocystis pouchetii* bloom in 2014 is just beginning. MWRA anticipates discussing this bloom and the developing understanding of *Phaeocystis* blooms in Massachusetts Bay at the September 23, 2014 meeting of the Outfall Monitoring Science Advisory Panel.

[5] Peperzak et al. 2000. Observation of flagellates in colonies of *Phaeocystis globosa* (Prymnesiophyceae); a hypothesis for their position in the life cycle. Journal of Plankton Research. Vol. 22 no. 12 pp. 2181-2203.

If you have questions or need additional information, please feel free to call Dr. Betsy Reilley at (617) 788 - 4940.

Sincerely,

Michael J. Hornbrook
Chief Operating Officer

Cc:

Environmental Protection Agency, Region I
Matthew Liebman
Todd Borci

National Marine Fisheries Service
Daniel Morris

Stellwagen Bank National Marine Sanctuary
Craig MacDonald

MA EOEEA
Kathy Baskin

MA Department of Environmental Protection
Cathy Vakalopoulos

Cape Cod Commission
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