



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) 788-4899
TTY: (617) 788-4971

December 7, 2022

Todd Borci
EPA Region 1
5 Post Office Square, Suite 100
Mail Code ECAD4-4
Boston MA, 02109-3912

Catherine Coniaris
Department of Environmental Protection
100 Cambridge Street, 9th Fl.
Boston, MA 02114

RE: Massachusetts Water Resources Authority
Permit Number MA 0103284
Contingency Plan Threshold Exceedances: Nearfield and Stellwagen Basin
DO concentration

Dear Mr. Borci and Ms. Coniaris:

The Massachusetts Water Resources Authority (“MWRA”) monitors bottom water dissolved oxygen (“DO”) ¹ concentration and percent saturation in the outfall nearfield and at the Stellwagen Basin station as part of its permit-attached Ambient Monitoring Plan² and Contingency Plan.³ The Contingency Plan states that the bottom water DO concentration, during any survey while the water column is stratified (roughly May through October), is expected to be at least 6.5 mg/L (caution level threshold) or at least 6.0 mg/L (warning level threshold) unless background conditions are lower than these thresholds, in which case the measured concentration is expected to be at least as high as the background concentration. Background concentrations are computed from monitoring during the 1992-2000 baseline period, prior to operation of the Massachusetts Bay outfall. The background DO concentration is 6.05 mg/L for the outfall nearfield and 6.23 mg/L for the Stellwagen Basin station. For DO percent saturation, similarly, for any survey during water column stratification, the caution level threshold is at least 80% and the warning level threshold is at least 75%, unless background conditions are lower. Background DO percent saturation is 65.28% for the nearfield and 67.17% for the Stellwagen Basin station.

On October 18, 2022, MWRA conducted a routine water column monitoring survey. After routine data quality checks, the results were compared to thresholds on December 5, 2022. **The threshold checks for bottom water DO concentration revealed there was a warning level exceedance for the nearfield and a caution level exceedance for the Stellwagen Basin station.** The warning level exceedance occurred for the nearfield because the measured value of 5.85 mg/L is lower than the 6.0 mg/L warning threshold (the 6.05 mg/L background concentration is higher than the warning threshold). The caution level exceedance occurred at the

¹ For an explanation of the DO measurements, see <https://www.mwra.com/harbor/html/thresholds.htm#do>.

² *Ambient Monitoring Plan for the Massachusetts Water Resources Authority Effluent Outfall (Revision 2.1, August 2021)*. Report 2021-08. <https://www.mwra.com/harbor/enquad/pdf/2021-08.pdf>.

³ *Massachusetts Water Resources Authority Contingency Plan Revision 1*. 2001. Report 2001-ms-071. <https://www.mwra.com/harbor/enquad/pdf/2001-ms-71.pdf>. For sections in the Contingency Plan specifically relevant to DO, see pages 23-24 and 26.

Stellwagen Basin station because the measured value of 6.08 mg/L, although higher than the 6.0 mg/L warning level threshold, is lower than both the 6.5 mg/L caution level threshold and the 6.23 mg/L background concentration. For DO percent saturation there were no exceedances.

The exceedances require the regulatory and public notification this letter provides, in accordance with Part I.8.b (Contingency Plan) of the Deer Island Treatment Plant NPDES permit.

Background

Figure 1 shows MWRA monitoring locations in Massachusetts Bay. The outfall nearfield is a group of five stations (N01, N04, N07, N18, and N21) covering a 10 by 12 kilometer (km; 6 by 7.5 mile) area centered on the outfall diffuser. The stations are located at distances between 60 meters (m; N21) and 7.1 km (N04) from the 30 m (100 ft) deep outfall diffuser. Station depths range from 26.6 m (N18) to 50.2 m (N07). For the calculation of the nearfield DO values to compare to the Contingency Plan thresholds, the deepest measurements from each of the five stations are averaged together. Stellwagen Basin is sampled at Station F22, in water 79.7 m deep, located 17.5 km away from the easternmost riser of the outfall diffuser.

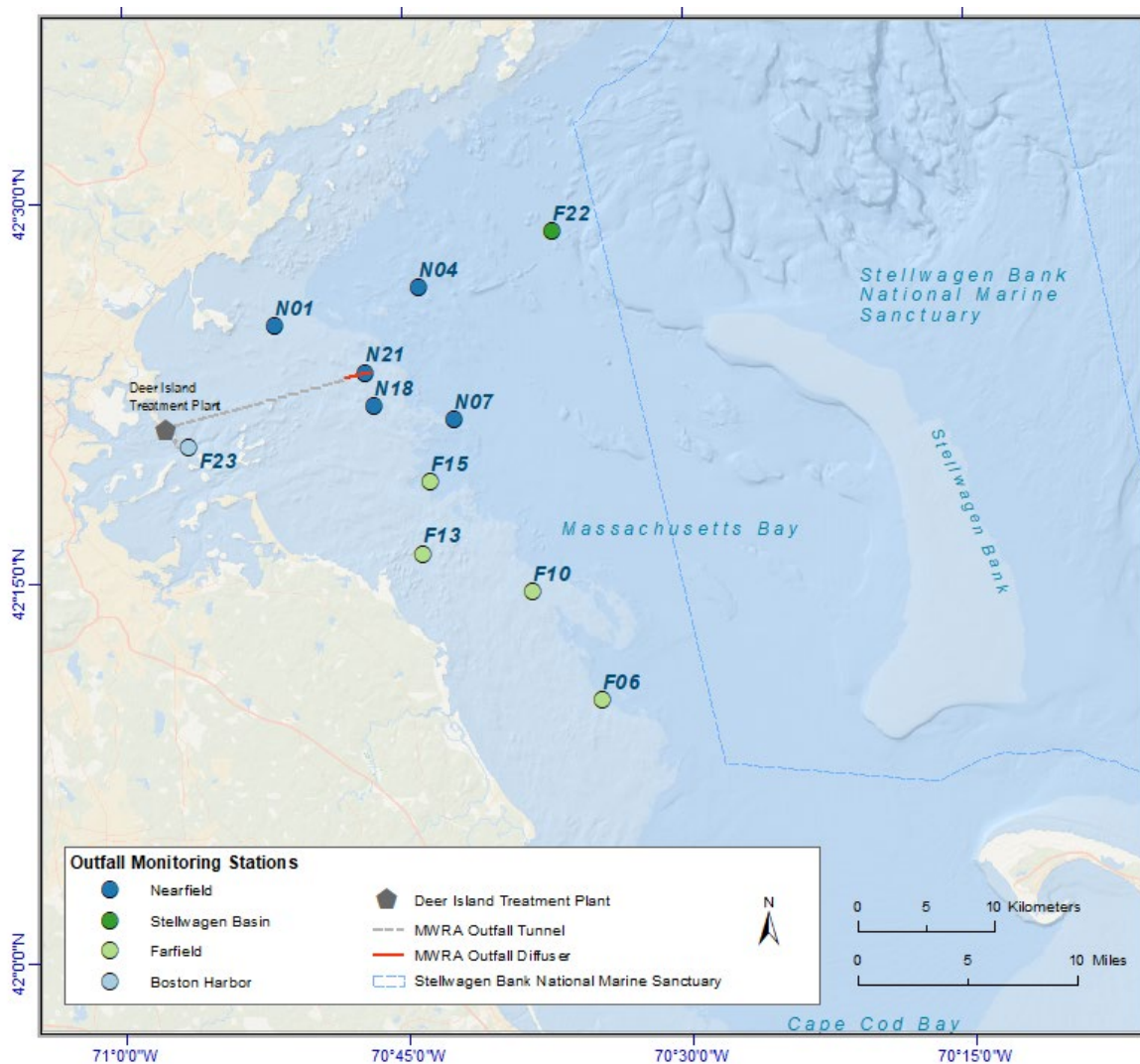


Figure 1. Map of outfall, nearfield, Stellwagen Basin, farfield, and harbor monitoring stations.

The farfield stations (F06, F10, F13, and F15) south of the nearfield are farther from the outfall and not part of Contingency Plan thresholds. However, they often can provide useful context for nearfield and Stellwagen Basin conditions. Farfield stations range from 9 km (F15) to 29 km (F06) from the outfall, with depths ranging from 25.2 m (F13) to 38.3 m (F15). Station F23 at the mouth of Boston Harbor, 25.4 m deep and 12 km from the outfall, also gives useful context.

In past MWRA studies, regional factors have been identified as having a larger influence on DO levels in Massachusetts Bay than the outfall (emphasis added below):

On a regional scale, circulation in the bays is often affected by the larger pattern of water flow in the Gulf of Maine. The western Maine coastal current usually flows southwestward along the coast of Maine and New Hampshire and depending on prevailing oceanographic and meteorological conditions may enter Massachusetts Bay south of Cape Ann (Geyer et al. 1992). Optimal conditions for inflow usually occur during the spring when winds out of the northeast bring significant freshwater inflow from the gulf into the bays and transport generally follows a counterclockwise path along the coast to Cape Cod Bay. Inflow from the gulf is the major source of nutrients to the bay. *The inflow also helps to flush the bay, and gives the bay its water quality characteristics including dissolved oxygen levels and plankton communities (including nuisance blooms such as Alexandrium)...*

Furthermore, modeling and statistical analyses indicate that bottom water DO levels in Massachusetts Bay are highly correlated with conditions along the bay/Gulf of Maine boundary and that *regional processes and advection are the primary factors governing bottom water DO concentrations in the bay* (HydroQual 2001, Geyer et al. 2002, Jiang et al. 2007).⁴

For water column parameters other than nitrogen, such as chlorophyll or dissolved oxygen, MWRA monitoring has shown no outfall influence, even in the nearfield close to the outfall. For nitrogen the outfall influence extends as far as 20 km away on an infrequent basis, and persistently less than 10 km away.

Exceedances

Table 1 shows October 18 survey bottom water DO results for both the nearfield and Stellwagen Basin station, with the Contingency Plan thresholds (caution, warning, and background).

LOCATION	PARAMETER	TEST LEVEL	THRESHOLD VALUE	BACKGROUND VALUE	UNIT	TEST RESULT	EXCEEDANCE Y/N
Nearfield	bottom dissolved oxygen	CAUTION	6.5	6.05	mg/L	5.85	Y
		WARNING	6				Warning
Nearfield	bottom DO % saturation	CAUTION	80	65.28	%	66.7	N
		WARNING	75				
Stellwagen Basin	bottom dissolved oxygen	CAUTION	6.5	6.23	mg/L	6.08	Y
		WARNING	6				Caution
Stellwagen Basin	bottom DO % saturation	CAUTION	80	67.17	%	67.7	N
		WARNING	75				

Table 1. Bottom water DO results from the October survey, with Contingency Plan thresholds.

⁴ *Ambient Monitoring Plan for the Massachusetts Water Resources Authority Effluent Outfall (Revision 2.1, August 2021)*. Report 2021-08. <https://www.mwra.com/harbor/enquad/pdf/2021-08.pdf>. See pages 24 and 40-41 for specific information on DO monitoring.

For DO concentration there was a warning level exceedance in the nearfield and a caution level exceedance at the Stellwagen Basin station. Unlike for previous surveys with DO exceedances in 2021 and 2022, there were no exceedances of the percent saturation thresholds.

Discussion

In the 1990s pre-outfall monitoring phase, excursions of DO percent saturation below the level later defined as the caution level were not unusual at both the nearfield and Stellwagen Basin – they occurred in seven of the eight years before the outfall went online.⁵ In addition, in October 2000 there were caution level exceedances for DO percent saturation at both the nearfield and the Stellwagen Basin station. Following 2000, no further exceedances occurred until 2021. Over the past two years a number of exceedances of DO thresholds have occurred (Table 2).

	Nearfield				Stellwagen Basin			
	Concentration		Percent saturation		Concentration		Percent Saturation	
	Caution	Warning	Caution	Warning	Caution	Warning	Caution	Warning
Sep 2021								X
Nov 2021						X		X
Aug 2022								X
Sep 2022		X			X			X
Oct 2022		X			X			

Table 2. Surveys with bottom oxygen exceedances during 2021 and 2022.

As with previous 2021 and 2022 exceedances, MWRA believes the current exceedances may be due to region-wide processes not related to the outfall, based on sampling from other locations in Massachusetts Bay more distant from the outfall (see Figure 1).

Figure 2 shows October 18 survey vertical profile DO results at a station representative of the nearfield (N21), the Stellwagen Basin station (F22), and a station representative of the farfield (F13). Results from the downcast (as the instrument travels down through the water column) are in green. They can be compared to historical results from the same time of year: the dark blue line is the mean of the results from the previous three years, and the shaded blue and gray areas are the interquartile range and the minimum and maximum results, respectively, from the 21-year period 2000-2021. Also shown are orange triangles with upcast results (as the instrument returns to the surface) at the five depths where water samples were collected for other parameters. Values from the deepest of these five depths are used for the threshold tests.

⁵ November 10, 2000 letter to DEP and EPA regarding Contingency Plan exceedances of DO.
<https://www.mwra.com/harbor/pdf/ax111000.pdf>

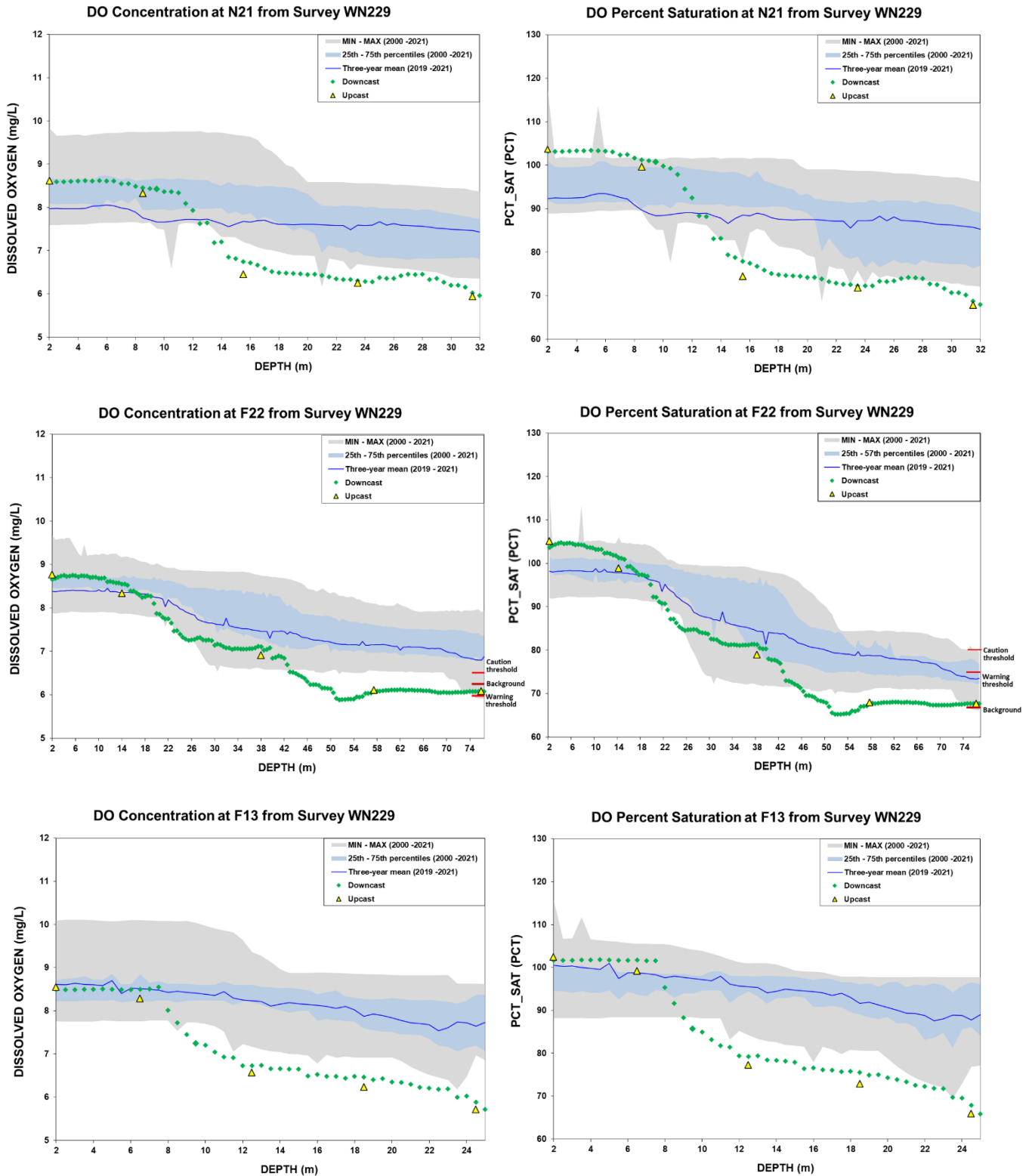


Figure 2. October 18 survey vertical profiles of DO concentration (left column) and percent saturation (right column) measurements from the nearfield (N21), Stellwagen Basin (F22), and farfield (F13). Contingency Plan thresholds and background conditions are labeled on the F22 panels; they are not shown on the N21 panels as the nearfield thresholds are an average across five nearfield stations.

Figures 3 and 4 show that DO during the October survey was lower than typical not only in the nearfield and at the Stellwagen Basin station, but also in the farfield and at the Boston Harbor station, suggesting a region-wide cause rather than the outfall.

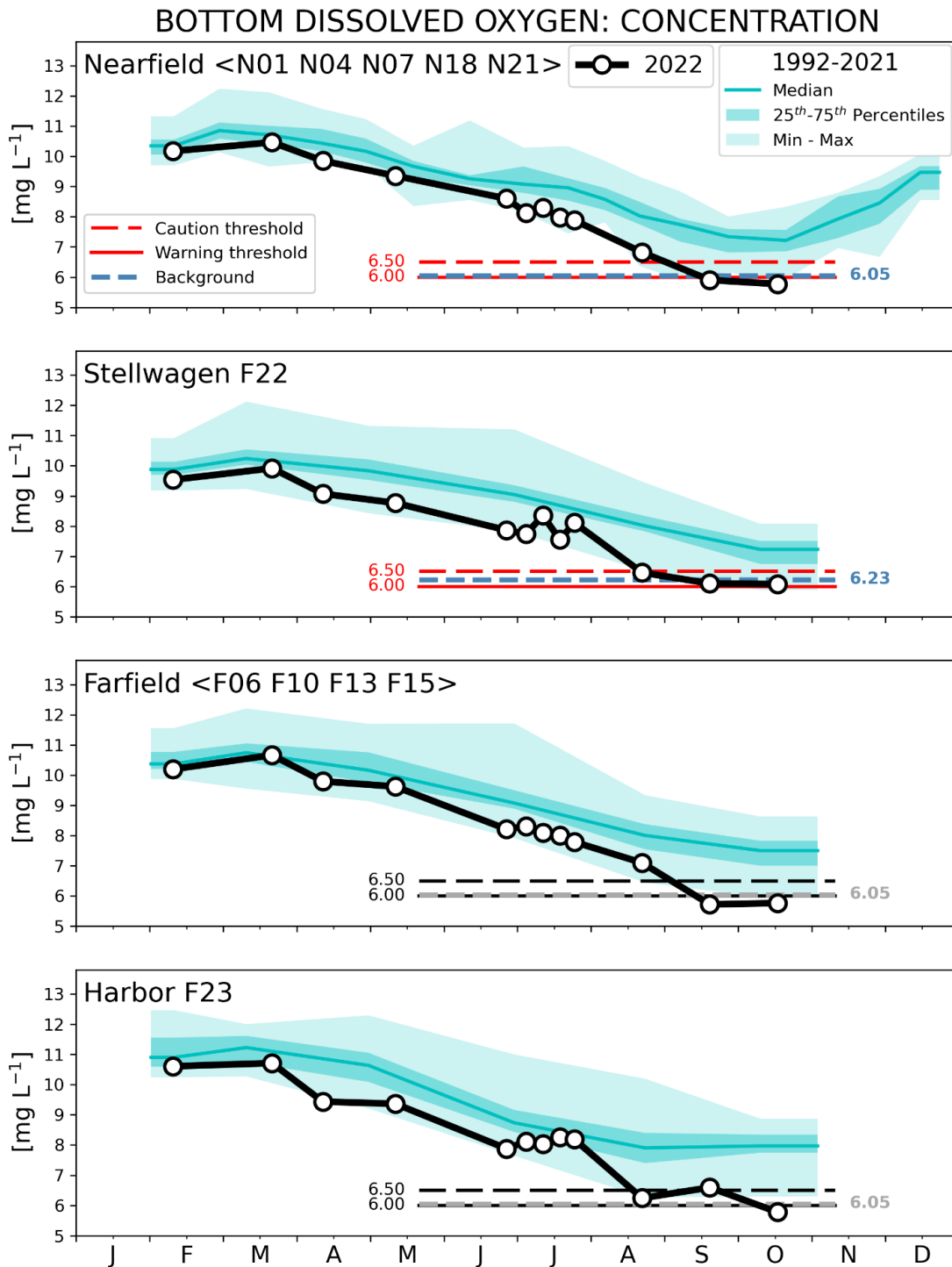


Figure 3. DO concentration 2022 seasonal progression results compared to 1992-2021 historical results in the nearfield, Stellwagen Basin, the farfield, and the mouth of Boston Harbor. Contingency Plan thresholds and background levels used to determine exceedances are shown in color on the panels for nearfield and Stellwagen stations where they apply; they are repeated in black and gray in the other two panels for reference.

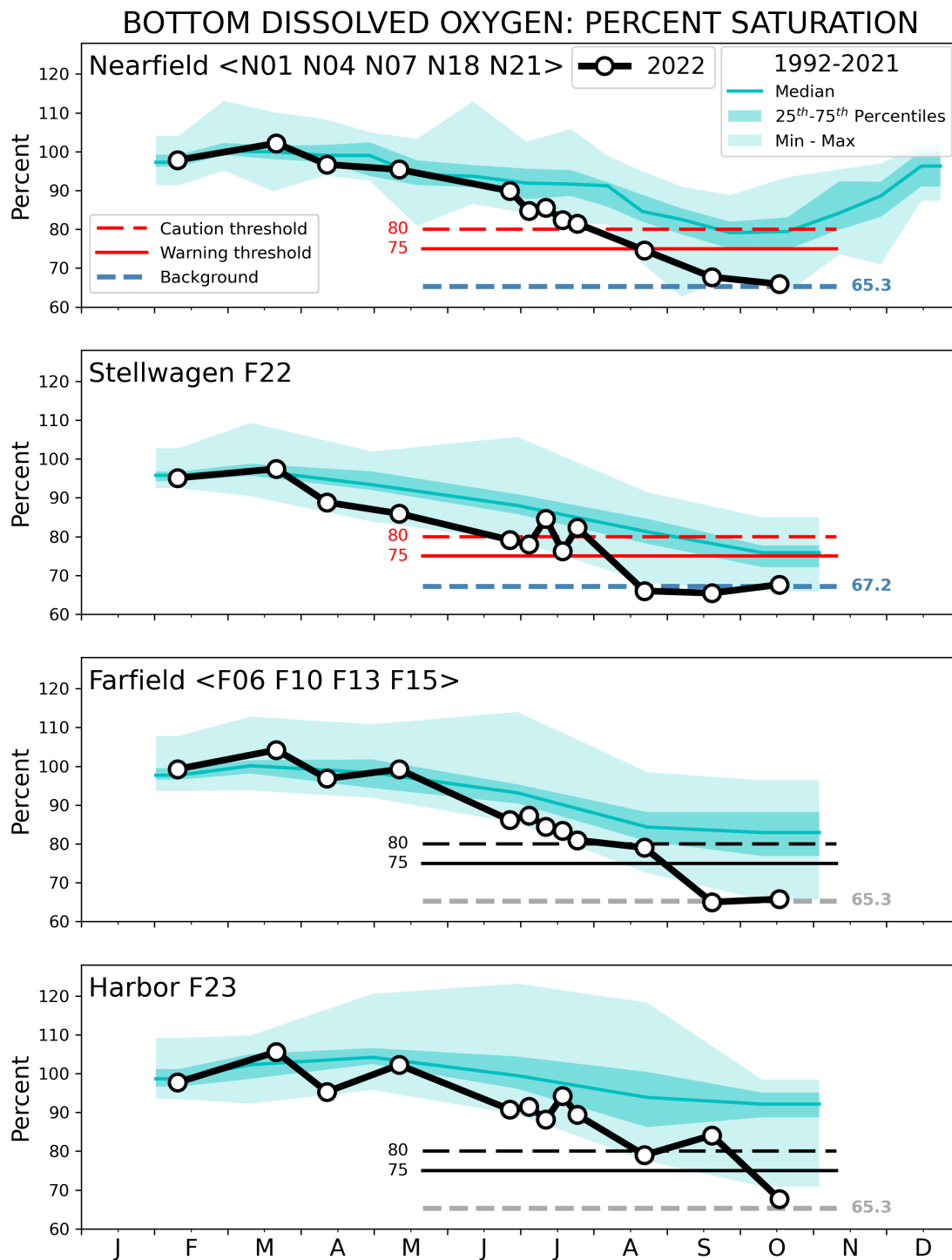


Figure 4. 2022 DO percent saturation seasonal progression results, shown as in Figure 3.

During stratified water column conditions, typically from about May through October, it is normal for DO concentration and percent saturation to decrease in bottom waters over time (Figures 3 and 4). As a result of the stratification, there is no physical mechanism for the water below the thermocline to be reaerated through exchange with the atmosphere, and natural biological consumption processes cause DO there to decline. Stratification naturally breaks down with the onset of colder, stormier weather in the fall. Once that occurs, the water column

mixes and surface and bottom DO measurements equalize. Based on real-time measurements from the buoy off Cape Ann, in 2022 this mixing occurred in mid to late November.

Preliminary examination of the nutrient and phytoplankton measurements collected by MWRA in 2022 indicate they are not unusual compared to past years.

Deer Island Treatment Plant Effluent Results

There is also no evidence these exceedances are related to the Deer Island Treatment Plant effluent. The NPDES permit specifies two limits for effluent carbonaceous biochemical oxygen demand (cBOD), a measure of its oxygen depletion potential: a monthly average of 25 mg/L and a weekly average of 40 mg/L. The average cBOD during the one month and one week periods prior to the October 18 survey were 5.5 and 5.3 mg/L respectively, well below permit limits. No treatment plant operational issues were reported between the September and October surveys.

Long-Term Trends in Dissolved Oxygen

As with the previous DO threshold exceedances, MWRA believes these exceedances may be due to long-term, region-wide changes not related to the outfall. Figure 5 shows observed trends at Station F22 since 1992. There are statistically meaningful trends (represented by the orange lines) in temperature (increasing) and DO concentration (decreasing) for vertically averaged observations (five depths spanning the water column) and for surface and bottom measurements independently. The surface and bottom rates of change are not significantly different.

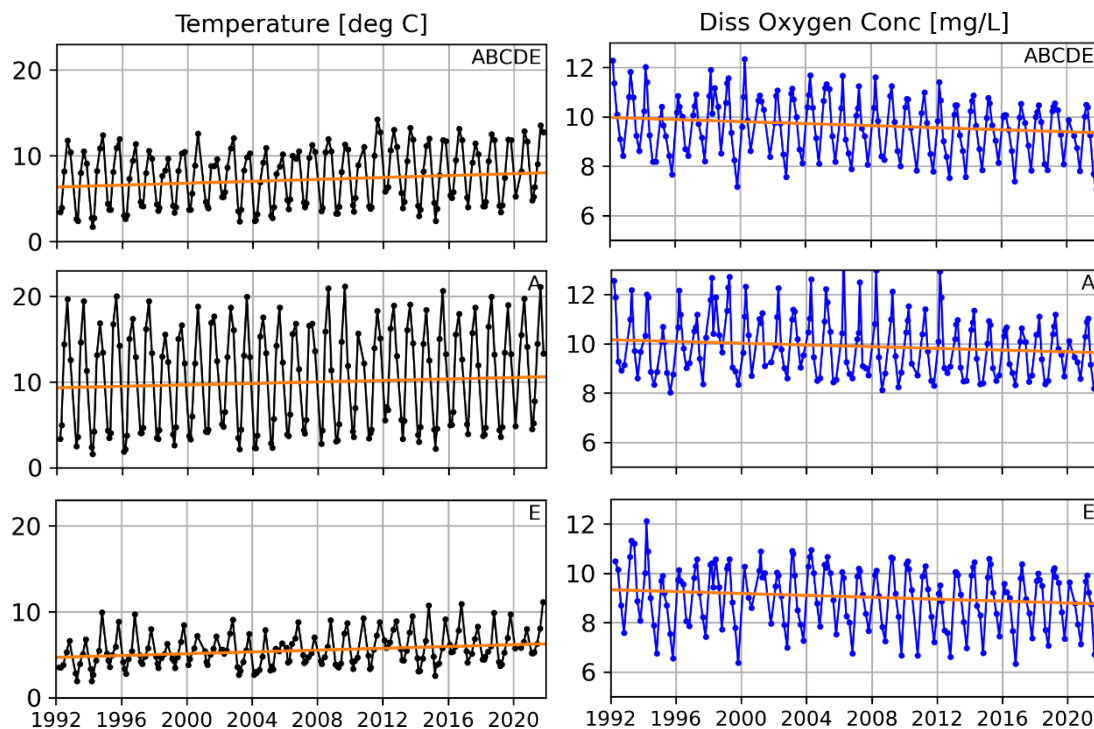


Figure 5. Trends (orange lines) superposed on measured temperature and DO concentration at Station F22 since 1992. Top panels: Averages of all five depths monitored (“ABCDE”). Middle panels: Surface (“A”) measurements. Bottom panels: Bottom water (“E”) measurements.

Although Figure 5 only presents data from Station F22, similar temperature and DO patterns are seen at all MWRA stations. At most MWRA stations temperature increases have been 0.4 to

0.6 degrees Celsius per decade, and oxygen declines have been 0.12 to 0.25 mg/L DO per decade. Researchers have published comparable results for similar waterbodies regionally, nationally, and globally. High temperatures are a factor contributing to low DO concentrations.

Relationship to Water Quality Standards

Although there were threshold exceedances per the Contingency Plan (CP), aquatic life was not necessarily endangered. CP thresholds were intended to enable detection of changed conditions compared to the 1990s baseline period, not necessarily conditions that are harmful or degraded. The Stellwagen Basin DO concentration – 6.08 mg/L – was a caution level exceedance but still above Massachusetts state water quality standards (6.0 mg/L)⁶ While the nearfield DO concentration of 5.85 mg/L was a warning level exceedance and below state water quality standards, it is still above the marine DO standards for all of the other New England states and New York – which range from 4.8-5 mg/L, in contrast to that of Massachusetts.⁷

The origin of the lower DO standard used in other Northeast states can be found in EPA’s January 2000 document, *Draft Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras*. It states that “If the DO exceeds the chronic protective value for growth (4.8 mg/L), the site meets objectives for protection.” This same phrase appeared in the final version of the criteria issued in November 2000.⁸ In fact, as early as December 1997, the Outfall Monitoring Task Force (the predecessor to the Outfall Monitoring Science Advisory Panel) had already noted that “the DO thresholds appear to be overly sensitive.” In February 2000, after publication of the draft criteria, MWRA proposed changing the warning level threshold from 6.0 mg/L to 4.8 mg/L. OMSAP agreed to review the issue once final criteria were issued.⁹ However, while Contingency Plan DO thresholds were modified to add the “unless background conditions are lower” clause, the 6.0 mg/L warning level threshold remained. Given that the measured levels of DO are higher than the marine DO standards for other northeast states, it seems unlikely at this time that the low DO concentrations in the bottom waters at the nearfield and Stellwagen Basin sites are adversely affecting aquatic life.

It is also of note that DO percent saturation is not in the current state water quality standards. It was removed from EPA’s National Recommended Water Quality Criteria in 2002, and from MA DEP Water Quality Standards in 2006. The CP thresholds were established in 2000.

Conclusion

The conclusion of our initial evaluation, based on the information presented here, is that the exceedances are not related to the outfall. They may be related to widely-recognized regional long-term trends of warming temperatures and declining oxygen concentrations, which are clear from analysis of many independent datasets including the MWRA monitoring program.

⁶ Massachusetts Surface Water Quality Standards, 314 CMR 4.05(4)(a)(1). <https://www.mass.gov/doc/314-cmr-400-surface-water-quality-standards/download>

⁷ NEIWPCC (New England Interstate Water Pollution Control Commission) matrix of state water quality standards. Available at: <https://neiwppcc.org/our-programs/pollution-control/water-quality-standards/wqs-matrix/>

⁸ <https://www.epa.gov/sites/default/files/2018-10/documents/ambient-al-wqc-dissolved-oxygen-cape-code.pdf>

⁹ Attachment C of the November 10, 2000 letter to DEP and EPA regarding Contingency Plan exceedances of DO. <https://www.mwra.com/harbor/pdf/ax111000.pdf>

MWRA will provide raw monitoring data upon request. If you have any questions regarding this matter, please email Betsy Reilley at betsy.reilley@mwra.com.

Sincerely,

Carolyn M. Fiore
Deputy Chief Operating Officer

cc:

Environmental Protection Agency, Region I

Steve Wolf
Alexa Sterling

National Marine Fisheries Service

Christine Vaccaro
Meagan Riley

Stellwagen Bank National Marine Sanctuary

Peter DeCola

US Food and Drug Administration

David Lamoureux

**MA Executive Office of Energy and
Environmental Affairs**

Vandana M. Rao

MA Division of Marine Fisheries

Jeff Kennedy
Terry O'Neil

MA Dept of Public Health

Michael Moore

Cape Cod Commission

Timothy Pasakarnis

Outfall Monitoring Science Advisory Panel

Robert Beardsley
Peter Burn
Virginia Edgcomb
Loretta Fernandez
Robert Kenney
Mark Patterson
Judith Pederson
Jeffrey Rosen
Juliet Simpson
Juanita Urban-Rich

Public Interest Advisory Committee

Bruce Berman

Hyannis Library

Antonia Stephens

MWRA Library

Karen Graham