



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

October 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
1 Winter Street
Boston, MA 02108

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

Dear Mr. Borci and Ms. Coniaris:

The Massachusetts Water Resources Authority (“MWRA”) monitors bottom water dissolved oxygen (“DO”) concentration and percent saturation in the outfall nearfield and Stellwagen Basin¹ 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. Background conditions are computed from monitoring during the baseline period 1992-2000, prior to when operation of the outfall in Massachusetts Bay began. When testing against the caution and warning level thresholds, if background conditions are lower than the thresholds, the measured values must be above the background conditions. Similarly, for DO percent saturation, during any survey while the water column is stratified, the caution level threshold is at least 80% and the warning level threshold is at least 75%, unless background conditions are lower.

On September 20, MWRA conducted a routine water column monitoring survey. After routine data quality checks, the results were compared to thresholds on October 3. **The threshold checks revealed that there was a warning level exceedance for the nearfield bottom water DO concentration, a warning level exceedance for Stellwagen basin bottom water DO percent saturation, and a caution level exceedance for the Stellwagen basin bottom water DO concentration.** The bottom water DO concentrations for the nearfield and Stellwagen Basin were 5.85 mg/L and 6.1 mg/L, respectively. The Contingency Plan thresholds are 6.5 mg/L for the caution level and 6.0 mg/L for the warning level. The bottom water DO percent saturation at

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 was 65.4%. The Contingency Plan warning threshold level is 75% and the calculated background condition value is 67.17%. MWRA believes that these exceedances may be due to region-wide processes not related to the outfall.

These exceedances require the regulatory and public notification provided by this letter, 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 between 60 meters (m; 197 feet; Station N21) and 7.1 km (4.4 miles; Station N04) from the outfall diffuser. Depths range from 26.6 m (87.2 ft; N18) to 50.2 m (164.7 ft; 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 (261.5 ft) deep, located 17.5 km (10.9 miles) away from the easternmost riser of the 30 m (100 ft) deep outfall diffuser.

The farfield stations (F06, F10, F13, and F15) to the south of the nearfield are more distant from the outfall and are not part of any Contingency Plan thresholds. However, they often can provide useful context for data collected in the nearfield or Stellwagen Basin. The farfield stations range from 9 km (5.6 miles; F15) to 29 km (18 miles; F06) from the outfall. Depths range from 25.2 m (82.7 ft; F13) to 38.3 m (125.7 ft; F15).

Station F23 is at the mouth of Boston Harbor 12 km (7.5 miles) from the outfall and often displays quite different physical characteristics from all the other stations. It is also one of the shallowest locations at 25.4 m (83.3 ft).

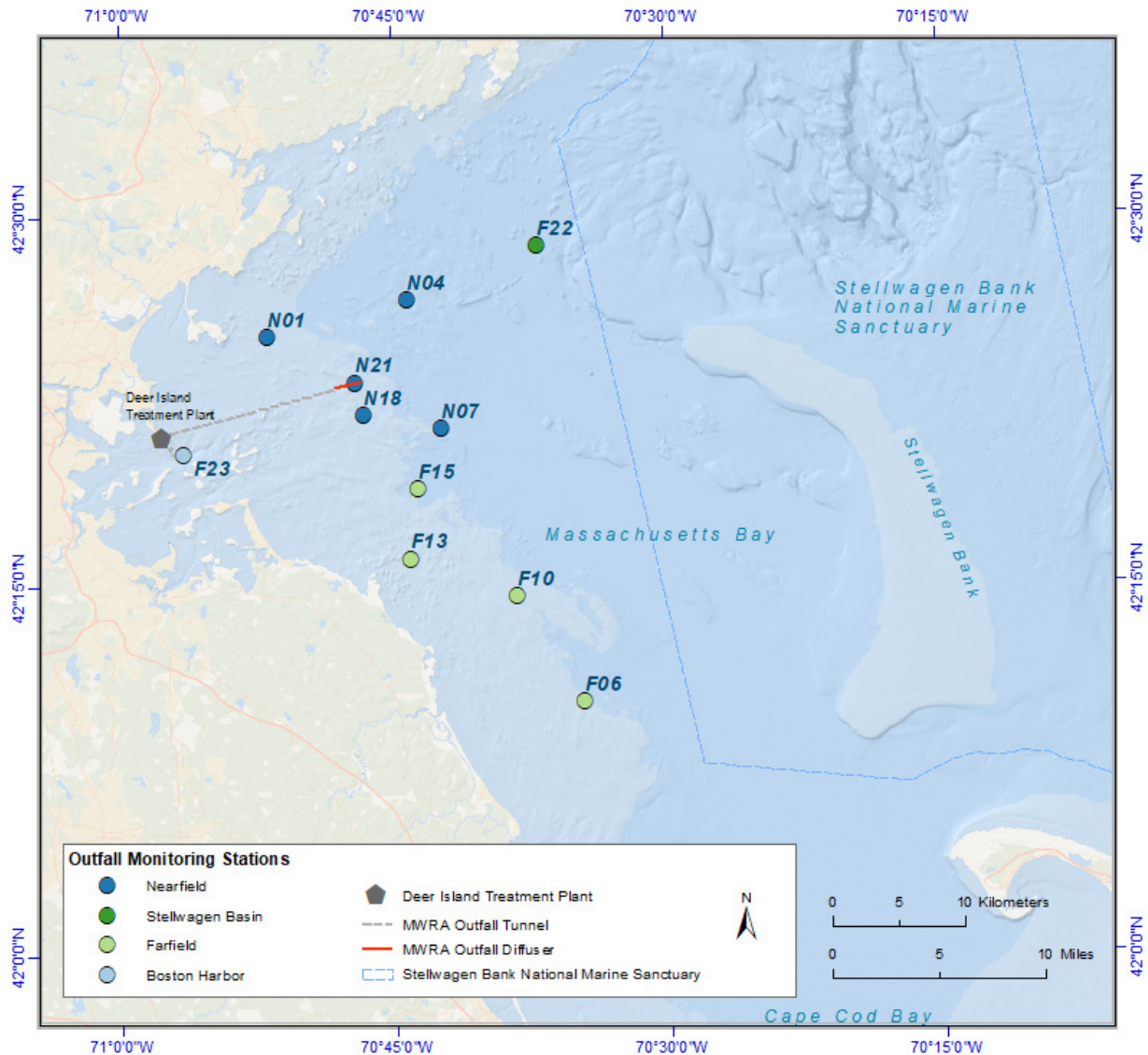


Figure 1. Map of outfall, nearfield, Stellwagen Basin, farfield, and harbor monitoring stations.

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 (12 miles) away on an infrequent basis, and persistently less than 10 km (6 miles) away.

Exceedances

Table 1 shows bottom water DO data from the September 30 survey and the Contingency Plan thresholds (caution, warning, and background). Results are shown for both the nearfield and Stellwagen Basin. In the nearfield, there was an exceedance of the warning threshold for DO concentration; there was no exceedance for percent DO saturation. At the Stellwagen Basin station, there was an exceedance of the caution level threshold for DO concentration and an exceedance of the warning level threshold for percent DO saturation.

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
		WARNING	6				
Nearfield	bottom DO % saturation	CAUTION	80	65.28	%	66.6	N
		WARNING	75				
Stellwagen Basin	bottom dissolved oxygen	CAUTION	6.5	6.23	mg/L	6.1	Y Caution
		WARNING	6				
Stellwagen Basin	bottom DO % saturation	CAUTION	80	67.17	%	65.4	Y Warning
		WARNING	75				

Table 1. Bottom water DO results from September 30 survey, with Contingency Plan thresholds

Figure 2 shows the vertical profiles for DO concentration and percent saturation results at a station representative of the nearfield (Station N21), Stellwagen Basin (Station F22), and a station representative of the farfield (Station F10) from the September 20 survey. The results from the downcast (as the instrument travels down through the water column) are in green, and the upcast results (as the instrument returns to the surface) are the orange triangles. The dark blue line is the mean of the results from the previous three years during the same time of year as the current results. The shaded blue and gray areas are: (a) the interquartile range of the results from 2000-2021; and (b) the minimum and maximum results from 2000-2021, respectively – both from the same time of the year as the survey results.

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.

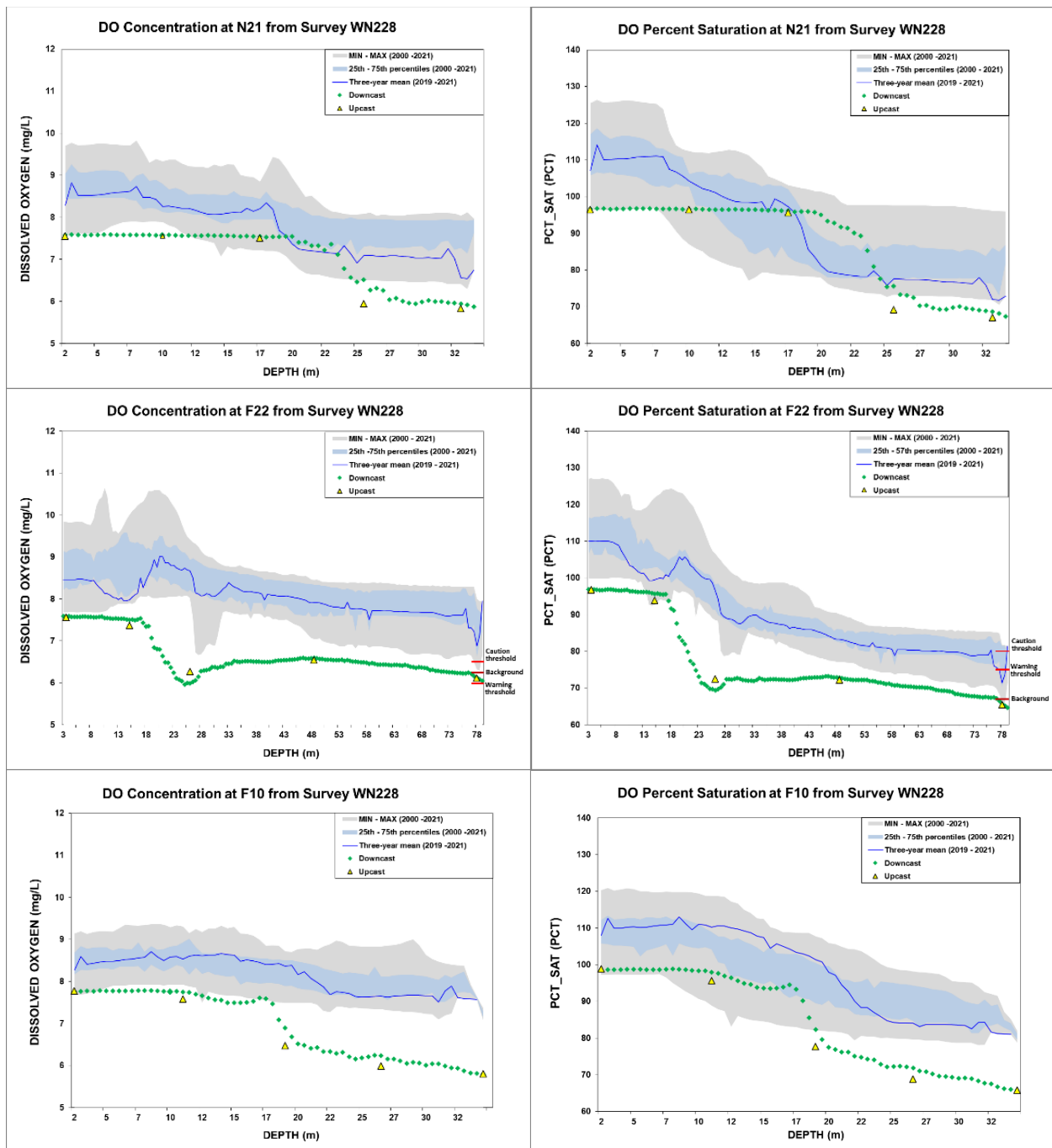


Figure 2. Vertical profiles of DO concentration (left column) and percent saturation (right column) measurements from the nearfield (N21), Stellwagen Basin (F22), and farfield (F10) on the September 20 survey. Reference lines for Contingency Plan thresholds and background conditions are included on the F22 panels. They are not included for the N21 panels as the nearfield thresholds are an average across five nearfield stations.

Discussion

Previously in October 2000 there was a caution level exceedance in the nearfield of bottom water DO percent saturation. In Stellwagen Basin, there was a caution level threshold exceedance for bottom water DO percent saturation in October 2000 and warning level exceedances in

September 2021, November 2021, and August 2022. There were no nearfield exceedances in September 2021, November 2021, or August 2022. Excursions of percent saturation below the caution level were not unusual in the pre-outfall phase of monitoring in both the nearfield and Stellwagen Basin – they occurred in seven of the eight years before the outfall went online.⁵ The DO concentrations at both locations in 2000, September 2021, and August 2022 met the threshold values. Stellwagen Basin DO concentrations in November 2021, however, were below the warning level. The nearfield met the DO concentration threshold in November 2021.

As with the previous DO threshold exceedances, MWRA believes this set of exceedances may be due to region-wide processes not related to the outfall. In addition to the nearfield and Stellwagen Basin locations, MWRA samples other locations in Massachusetts Bay more distant from the outfall (the farfield; see Figure 1). On the September 20 survey, low DO levels were observed across the region, at all stations (Figures 3 and 4). The lowest bottom water DO concentration was 5.0 mg/L at Station F13, northeast of Cohasset and Scituate. The average bottom water DO concentration and percent saturation across the farfield was 5.7 mg/L and 65%, respectively. These numbers are comparable to the nearfield results (Table 1), pointing to a region-wide cause of low DO, rather than the outfall.

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

BOTTOM DISSOLVED OXYGEN: CONCENTRATION

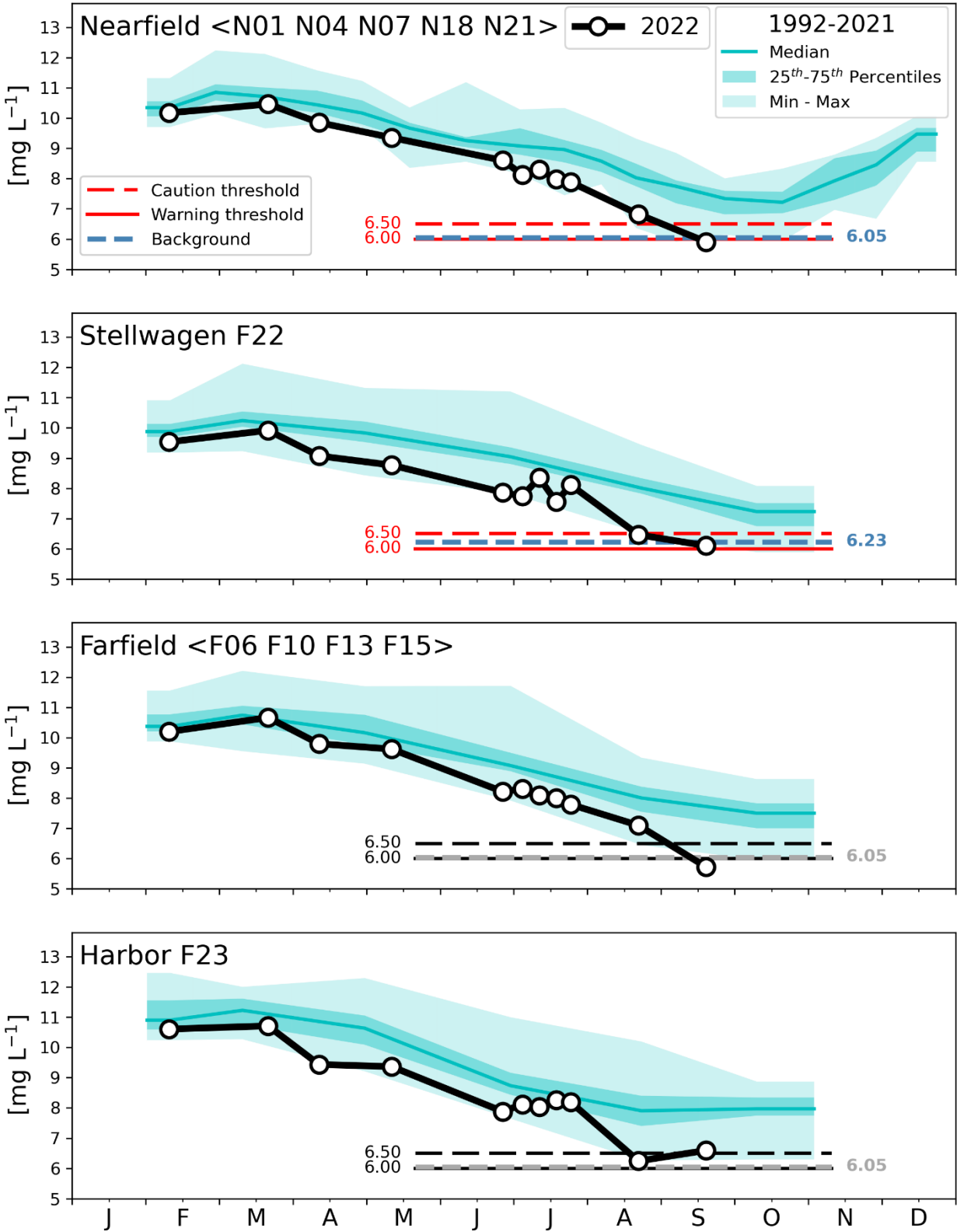


Figure 3. 2022 DO concentration seasonal progression results compared to 1992-2021 historical results in the nearfield, Stellwagen Basin, the farfield, and the mouth of Boston Harbor. Contingency Plan thresholds and background levels used to determine exceedances are shown in color on the panels for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

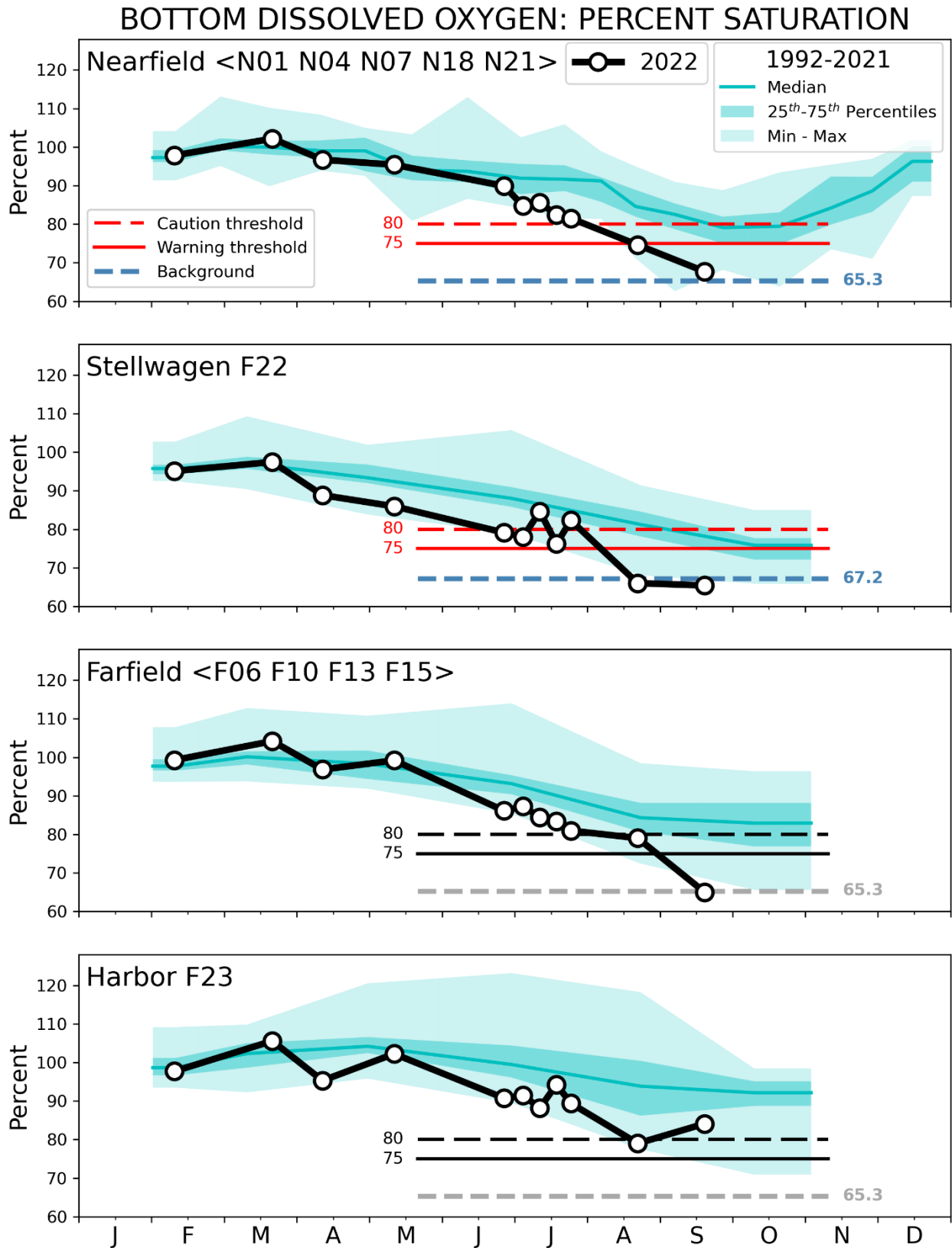


Figure 4. 2022 DO percent saturation seasonal progression results, shown as in Figure 3.

It should be noted that under stratified water column conditions – as existed for this survey – it is normal for DO concentrations 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 stormier weather in the fall. Once that occurs, the water column mixes and surface and bottom DO measurements equalize.

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 outfall discharge. 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. During the period between the September 20 survey and the previous survey on August 23 the average of the effluent cBOD samples was 5.6 mg/L, well below the monthly permit limit. The average effluent cBOD the week preceding the September 20 survey (September 14-20) was 5.1 mg/L, also well below the weekly permit limit. No Deer Island Treatment Plant operational issues were reported between the August and September 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. There is no significant difference between rates of change at the surface or bottom.

Although Figure 5 only presents data from Station F22, similar temperature and DO patterns are seen at all MWRA stations. At most MWRA stations temperatures increases have been 0.4-0.6 degrees Celsius per decade, and oxygen declines have been 0.12-0.25 mg/L DO per decade. Researchers have seen similar results both regionally, nationally, and globally. Higher water temperatures are a factor that contributes to lower DO concentrations.

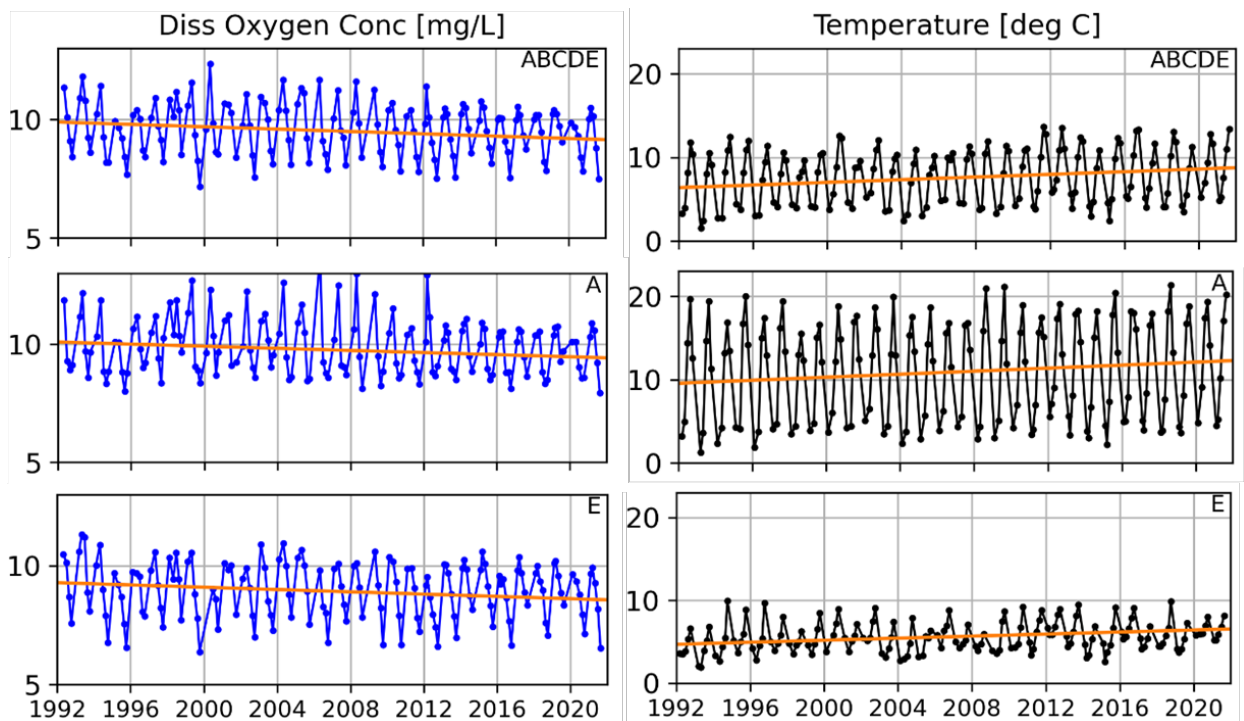


Figure 5. Trends in DO concentration and temperature at Station F22 since 1992. The top panels are averages of readings at all five depths monitored (“ABCDE”). The middle panels are at the surface (“A”), and the bottom panel is the bottom water (“E”).

Relationship to Water Quality Standards

Although bottom water DO concentrations both in the nearfield and at Stellwagen Basin 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 – 6.1 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*. That document stated 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 OMSAP, the Outfall Monitoring Science Advisory Panel) had already noted that “the DO thresholds appear to be overly sensitive.” In February 2000, after the 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

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://neiwpcc.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>

review the issue once the final criteria were issued.⁹ However, while the DO thresholds in the Contingency Plan 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 exceed 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 worth noting that DO percent saturation is not in the current state water quality standards. Percent saturation was removed from EPA’s National Recommended Water Quality Criteria in 2002, and from MA DEP Water Quality Standards in 2006. The CP thresholds applied to MWRA’s monitoring program were established in 2000.

Conclusion

The conclusion of our initial evaluation, based on the information presented here, is that the exceedance is not related to the outfall. It 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 MWRA monitoring data.

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

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>

cc:

Environmental Protection Agency, Region I

Steve Wolf
Alexa Sterling

National Marine Fisheries Service

Christine Vaccaro

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