Responses to Review#3

We have carefully reviewed the comments and questions provided by the reviewer. Most of the inquiries are directly related to the two reports, and we find them to be constructive and valuable.

We have conducted dye-tracking modeling experiments for the New Bedford and Fairhaven outfalls for 2021, incorporating improved forcing conditions and refined coastal geometry, particularly in the Fairhaven Bridge area and along the coast. Additionally, we have included the WWTP discharge from the Dartmouth outfall in our analysis. We will ensure that the reviewer's detailed comments and suggestions are taken into account as we prepare the revised report.

In this response, we will address only the major comments.

<u>Comments on "Estimation of the Sewage Water Dilution from Wastewater Treatment Plants in New Bedford and Fairhaven, Massachusetts"</u>

Comments*: The validation of the Mass Coastal FVCOM model results is limited, although the parent model, NECOFS, has been extensively validated. In Section 4, the model's tidal amplitude and phase were successfully validated against observations from 18 tidal gauges. However, the evaluation could be strengthened by incorporating validation of additional physical parameters, such as current speeds, water temperature, and salinity. Furthermore, the external validation section (file: USCG_Annual_Report_2024_model_validation_section.pdf) focuses exclusively on the NECOFS results from 2017. Conducting a comprehensive validation of the Mass Coastal FVCOM model results for 2021, with a broader range of features, would enhance the assessment of its performance and improve reliability.*

Response: We acknowledge the reviewer's observation regarding the limitations in validation. The challenge arises from the lack of comprehensive data around the WWTP outfalls in Massachusetts. We have provided a link to our work on water quality assessment in Boston Harbor/Mass Bay, conducted under contract by MWRA, which utilized the same physical model as that used for the New Bedford and Fairhaven outfalls. Each year, a detailed validation of water currents, temperature, salinity, and stratification was conducted in Mass Bay, accounting for the impacts of the outfall from Boston Harbor. Our comparisons with observational data demonstrate that the model effectively reproduces the spatiotemporal variability of key physical variables relevant to water quality.

In contrast to our current dye-tracking model, the work conducted for MWRA incorporated a water quality model named UG-RCA, which underwent validation through comparison with observations. The data for this comparison included temperature, salinity, dissolved oxygen, chlorophyll-a, nitrate, ammonium, phosphate, silicate, dissolved organic matter, and particulate organic matter. Data were sourced from the MWRA monitoring program, which comprised seven "near-field" stations near the MWRA outfall, 27 "far-field" stations in Mass Bay and Cape Cod Bay, and 19 "harbor" stations in Boston Harbor, with varying sampling frequencies. Water samples were collected at five standard depths at all near- and far-field stations, except for certain shallow far-field stations sampling only three depths. Nutrients, organic substances, and dissolved oxygen were analyzed based on protocols developed by Libby et al. (2003, 2004). Additionally, primary productivity was measured at stations close to the MWRA outfall. The data were either downloaded from http://www.wmra.state.ma.us/ harbor/enquad/trlist.html or provided directly by MWRA.

The validation experiments conducted in Boston Harbor/Mass Bay illustrate the capability of both physical and water quality models to reproduce the water quality conditions resulting from wastewater inputs at the outfall. We can conduct similar measurements around individual WWTP outfalls, such as those in Boston Harbor; however, this requires sufficient personnel support to conduct such measurements. The WWTP dye-tracking model experiment is currently constrained by limited funding, which restricts our capacity to conduct parallel assessments.

It is also important to note that our model configuration is informed by insights gained from our previous dye experiments. We have conducted extensive tests to evaluate the convergence of the tracer model through comparisons with dye releases, highlighting the sensitivity of spatiotemporal variability of the diluted tracer to model resolution. At a regional scale, such as Georges Bank, convergence can be achieved with model resolutions approaching 100 meters, as detailed in our published work. In our research on predicting the initial spread of radionuclides from the Fukushima Dai-ichi Nuclear Power Plant, we determined that a model resolution of approximately 5 meters is necessary to accurately represent the plant's infrastructure and to align with observational data.

The WWTP model has also been successfully utilized by FVCOM users in other states, where configurations around 100 meters have effectively reproduced WWTP effluent dilution. For the Massachusetts coast, the resolution of 3-4 meters employed in our WWTP model is sufficient to achieve convergence of the dye tracer from the outfall.

We hope to secure funding to conduct a dye experiment at the New Bedford and Fairhaven outfalls, or at least at one of these locations. Such an experiment would provide us with valuable data for robust model validation.

Comments on "Modeling Assessment of Spreading of the Scituate Waste Water Treatment Plant in the North-South Rivers, Massachusetts"

Comments: *However, I have some concerns on the experiment setup and result presentation. (1) Why was the model applied to a climatologically seasonal case but not for an exact year or for an exact period? The current application disables direct model validation weakening the conclusion. Model validation of one-year simulation (for example, 2020, when the shellfish bed was closed) may be needed. (2) It seems that the result sections (3–4) were not organized by topics, i.e., effects of tides, effects of wind. I listed all the detailed comments as followed.*

Response: We appreciate the reviewer's concerns regarding the experiment setup and presentation of results. In 2020, there was significant public concern about the impact of the shellfishing bed closure in the North River, MA, on the state's shellfish industry. In response, the Division of Marine Fisheries (DMF) reached out to us to estimate the area affected by the WWTP effluents from the North River outfall.

Our primary objectives were to assess the influence area under both climatological mean conditions and extreme weather conditions for each season. The climatological mean scenarios represent averaged conditions, while the extreme weather scenarios signify the worst-case conditions. This is why we applied the model across multiple years under climatological conditions. The dilution maps generated from these simulations serve as references for the DMF in their analysis, and some areas have since been reopened based on the DMF's final analysis, which integrated our model data with other observational data.

When we applied the model to the New Bedford and Fairhaven outfalls, we shifted our approach to running the model for a specific year. Additionally, we are considering rerunning the model for the North River outfall over several years in the future, which would enable us to examine both short-term and long-term variability of the WWTP effluents. However, this will depend on securing the necessary funding.

We believe that a resolution of 3 to 4 meters is sufficient to capture the dispersion of the passive tracer over the wetland-tidal creek-estuarine-shelf complex. We agree that further validation through observational data should be conducted to confirm our findings. For additional context, we refer you to our explanations regarding convergence experiments, which compared dye concentrations over Georges Bank, as well as observations of radionuclides from the Fukushima Dai-ichi Nuclear Power Plant along the Japanese coast.