STATE OF CALIFORNIA
REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION

STAFF SUMMARY REPORT: Thomas Mumley
MEETING DATE: May 10, 2023

ITEM: 7

San Francisco Bay Nutrient Management Strategy – Update on the state of the science and management actions

DISCUSSION:

This item is an update on our San Francisco Bay Nutrient Management Strategy. It will include a presentation by Thomas Mumley, Assistant Executive Officer, which will cover the basis and goals of the Strategy, including the associated Nutrient Watershed NPDES Permit issued to all wastewater dischargers to the Bay. Dr. David Senn, Senior Scientist at the San Francisco Estuary Institute (SFEI), Co-Director of the Institute's Clean Water Program, and Lead Scientist for the Nutrient Management Strategy Science Program will also provide a presentation on the state of nutrient science and what we learned from the harmful algal bloom (HAB) last summer. In addition, Ian Wren, San Francisco staff scientist and member of the Science Program team, will present on Baykeeper efforts during the HAB last summer and the need for nutrient load reductions.

San Francisco Bay is a nutrient-enriched estuary with higher nitrogen and phosphorus concentrations than most estuaries in the world. Too much nitrogen and phosphorous can result in excessive phytoplankton growth, which can be associated with harmful algal blooms (HABs) and low dissolved oxygen. Despite being nutrient rich, the Bay has resisted excessive phytoplankton growth due to its turbidity, which limits light penetration necessary for growth; strong tidal mixing, which limits periods of stratification necessary for phytoplankton to thrive at the Bay's surface; and filter-feeding clams, which graze on phytoplankton. However, increasing phytoplankton levels in the early 2000s were observed by United States Geological Survey (USGS) scientists, in addition to previous observed decreases in sediment concentrations, indicate the Bay's resilience may be weakening.

These observations, in addition to interest in reviewing and updating water quality objectives applicable to nutrients, gave us cause to establish a Nutrient Management Strategy in 2012 including a Nutrient Science Program to answer the following two major management questions:

- Do nutrient loads result in adverse impacts now or under future scenarios?
- What management actions will prevent or mitigate current or future impacts?

Also, since nitrogen has the biggest influence on phytoplankton growth in the Bay, and the Region's municipal wastewater treatment plants account for about 65 percent of the Bay's total nitrogen loading and those loads increase with population growth, the municipal wastewater agencies have proactively collaborated with us and the scientific community to generate the scientific understanding necessary to inform nutrient management strategies to avoid Bay impairment.

In 2014, the Board issued the first Nutrient Watershed Permit to provide a consistent approach for regulating the more than 40 municipal wastewater treatment plants that discharge to the Bay. That permit required municipal dischargers to (1) monitor their effluent to characterize nutrient discharge concentrations and loads; (2) evaluate opportunities to reduce nutrient discharges through treatment plant optimization and upgrades; and (3) financially support ($880 thousand per year) the

Nutrient Science Program to conduct nutrient monitoring in the receiving water, modeling, and special studies to characterize the Bay's response to current and future nutrient loads.

A not surprising, but head-turning finding of the nutrient treatment evaluations is that the cumulative costs of treatment plant upgrades could exceed $10 billion for the region. We also know that nutrient treatment upgrades require more energy and increase greenhouse gas emissions, so if we are to invest in upgrading our treatment plants, we want to ensure the adequacy of scientific basis of the need and include consideration of management actions that provide multiple benefits. Accordingly, when the Nutrient Watershed Permit was reissued by the Board in 2019, it included a requirement to evaluate opportunities to reduce nutrient discharges through recycling of treated wastewater and through wetlands systems and other green solutions. It also called for increased support ($2.2 million per year) for the Nutrient Science Program.

Although neither the first nor second Nutrient Watershed Permit included effluent limits for nutrients, the second Nutrient Watershed Permit included load targets to set the stage for the Board to consider nutrient load caps or reductions in the next permit. The targets provided encouragement for early planning of nutrient reduction strategies that may be necessary to achieve potential future nutrient load caps. Further, the current loads recognized in the Permit provided a baseline to account for implementation of nutrient reduction actions during the permit term.

The Nutrient Science Program led by Dr. Senn is conducted by a team of scientists at SFEI in collaboration with USGS, the Regional Water Board, and others. The Program has five focus areas to inform answers to the management questions noted above. These include the following: nutrient loads transport and transformations; phytoplankton production and dissolved-oxygen depression; harmful algae and algal toxins; and coastal ocean impacts. The fifth area is consideration of these focus areas in future scenarios. The science tools used to inform the focus-area considerations include monitoring, modeling, and special studies. The monitoring includes the continuation of the decades-long monitoring of nutrients by USGS along the spine of the Bay, the deployment of moored fixed-station, continuous monitoring devices in shallow water areas and in Lower South Bay sloughs, and monitoring in transects between deep and shallow areas of the Bay. Modeling includes development and validation of a comprehensive three-dimensional model of nutrient fate and transport in the Bay. Special studies, in addition to monitoring, are informing model development and validation and understanding of nutrient transformation processes in the Bay. The combination of monitoring, modeling, and special studies will allow us to associate nutrients with the probability of adverse impacts such as depressed dissolved oxygen or harmful algal blooms. Information on the Nutrient Science Program is available at [Status/Progress Tracking (sfei.org)].

There are many key Nutrient Science Program findings and accomplishments. These include improved understanding of the roll nutrients play in open Bay habitats including confirmation that dissolved oxygen concentrations in open-Bay habitats (deep subtidal) meet or exceed current standards most of the time, and although substantial phytoplankton blooms do occur seasonally, they tend to be short-lived. In Lower South Bay slough and creek habitats, particularly those exchanging water with managed restored former salt ponds, elevated phytoplankton biomass and low dissolved oxygen are frequently observed. However, fish abundance and diversity in these slough/pond habitats are high relative to margin habitats elsewhere in the Bay. HAB-forming phytoplankton species are commonly detected throughout the Bay and multiple HAB-toxins (e.g., domoic acid, microcystins, and saxitoxin) occur in water and biota. Data analysis and early modeling indicate that substantial positive nutrient transformations (e.g., nitrification) and losses (denitrification) occur within the Bay. Major advances in modeling capabilities also include simulation of nutrient transport, phytoplankton blooms, and oxygen cycling. The Nutrient Science Program findings provide a working base to start evaluation of nutrient load management and reduction scenarios relative to probability of adverse impacts.

The major HAB and associated fish kills from last summer have been a game changer. It was a profound example of the potential consequences of the Bay's nutrient rich waters. Nutrients did not cause the HAB, but they certainly enabled it and affected its spread. Some heretofore unique conditions such as multiyear drought conditions coupled with multiple days of sun with no fog and no or little wind in August allowed the bloom to form, promulgate, and spread and continue for weeks, while being fed by the nutrient rich waters until those nutrients were used up. Fortunately, our ongoing monitoring presence on the Bay allowed us to quickly mobilize and conduct extensive monitoring during the HAB event.

The HAB event has also caused us to enhance and expedite our evaluation of nutrient management options and nutrient load reduction requirements for Board consideration with the reissuance of the third Nutrient Watershed Permit next year. We will not present and discuss possible options as part of this Board item, but we will do so at a future Board meeting.