San Pablo Reservoir
Hypolimnetic Oxygenation System Project



East Bay Municipal Utility District (EBMUD) is currently constructing a hypolimnetic oxygenation system (HOS) in San Pablo Reservoir. The system is comprised of an underwater speece cone system, an aboveground liquid oxygen (LOX) cryogenic storage system, and vaporizers, which convert LOX into gaseous oxygen. The speece cone assembly combines anoxic lake bottom water with O_2 and injects the oxygenated stream into the reservoir, eliminating reductive environments that release unwanted nutrients and metals into the reservoir. Project benefits are discussed below.

Improve Reservoir Water Quality

The Project will add dissolved oxygen to the reservoir bottom waters. Oxygen improves water quality by reducing dissolved iron, manganese, methylmercury, and mitigating harmful algae blooms (HABs). By oxygenating the reservoir bottom, undesirable nutrients and metals are oxidized, precipitated, and sequestered in the reservoir bottom sediments. This results in improved raw water and treated water quality at two EBMUD drinking water treatment plants (WTPs): Sobrante WTP and San Pablo WTP.

Improve Water Treatment Plant Production by Oxidizing Metals

The San Pablo Reservoir bottom has a significant "muck" or sediment layer rich in metals (iron and manganese) and nutrients (phosphorous and nitrogen). Metals can adsorb onto filters and cause issues at the WTPs by shortening filter runs or increasing turbidity due to desorption. Treatment of this raw water also requires high chlorine use, which can increase disinfection-by-products (DBPs) formation. This project will oxidize these metals in the reservoir and promote settling, thereby reducing their concentrations at the WTPs intakes and impacts.

Reduce Taste and Odor Production

Nutrients stored in the reservoir bottom can participate in a cycle that encourages algae growth in the reservoir. By oxidizing the bottom of the reservoir, this cycle is inhibited, reducing algae growth. These improvements help decrease nuisance compounds like Methylisoborneol (MIB) and Geosmin which create an earthy-musty odor. Reducing these compounds in the reservoir also reduces ozone usage at Sobrante WTP.

Improve Fish Health

Methylmercury is a toxic contaminant originating from air pollution that bioaccumulates in reservoir food webs. This project will help reduce methylmercury by inhibiting its release from the reservoir bottom sediments. The HOS system will therefore help reduce the bioaccumulation of methylmercury in fish and other species in the reservoir.

Construction Challenges

Underwater construction is challenging. Work requires the mobilization of construction barges and specialized divers to construct the submerged portions of the HOS. EBMUD's underwater contractor is preparing an underwater construction plan to stay ahead and prepare for these upcoming challenges.



Figure 1. Speece cone skid with intake screen and submersible pump



Figure 2. Diffuser box, which serves as the outlet for the oxygenated water



Figure 3. Construction barge with crane lowering temporary frame for the speece cone anchorage

Project Facts at a Glance

Scope of Work

- Install a 11,000 gallon liquid oxygen (LOX) storage system
- Install a 5-ton/Day Speece Cone and Diffuser
- Install 2,000-linear feet of HDPE pipeline

Cost and Schedule

- Construction Bid: $8.7M
- September 2023 status: 70% completed
- Active Construction Start: June 2022
- Construction completion: Fall 2023

Design Criteria

- Liquid Oxygen Storage: 11,000 gallons
- Speece Cone Design Capacity: 5 tons/day
- Pump Flow Rate: 4,500 gallons/min
- Maximum Submerged Depth: 150 feet
- Treatment Plants Served: Sobrante and San Pablo
- Communities served: Berkeley, Richmond, El Cerrito, El Sobrante, Hercules Pinole, Crockett, Rodeo and San Pablo.
- Wards: 1, 3, & 4

San Pablo Reservoir

- Earth fill Dam – Constructed 1921
- Storage Capacity: 38,000 acre-feet (125 billion gallons)
- Watershed Area: 24 square miles



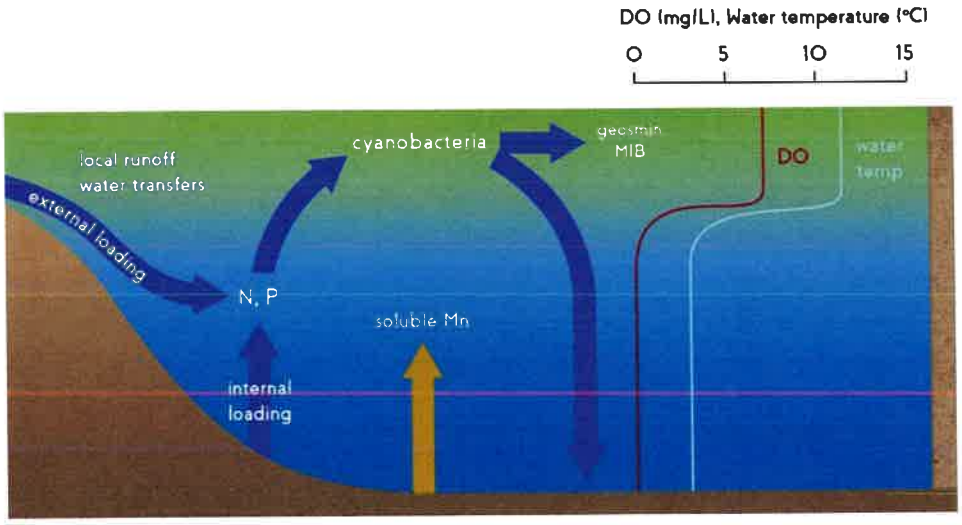


Figure 4. Conceptual model of key factors influencing the production of taste and odor compounds and soluble manganese in San Pablo Reservoir. External and internal loading provide nitrogen and phosphorous to support planktonic algae that (1) produce geosmin and MIB and (2) decay at the reservoir bottom depleting oxygen. Thermal stratification prevents the resupply of oxygen to the bottom waters seasonally causing the release of undesirable compounds, such as soluble manganese.

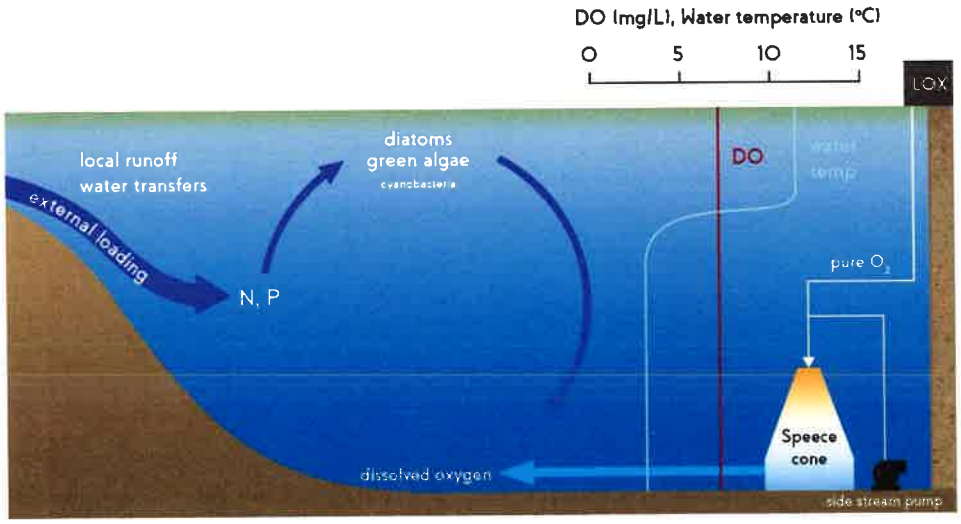


Figure 5. Conceptual model of San Pablo Reservoir after the introduction of an HOS system. Oxygenation of the reservoir bottom reduces the release of nutrients and metals (such as soluble manganese), and reduces harmful algal blooms that produce and release taste and odor compounds into the reservoir.

EBMUD

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