



BACWA
(wastewater utilities)



Water Boards
Regional Water Board
(regulatory)



San Francisco Estuarine Institute
(science)



SAN FRANCISCO
BAYKEEPER.

Non-Govt Organizations
(NGOs)



BACWA Annual Meeting May 15, 2026

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May 15, 2026

NUTRIENT MANAGEMENT in the San Francisco Bay

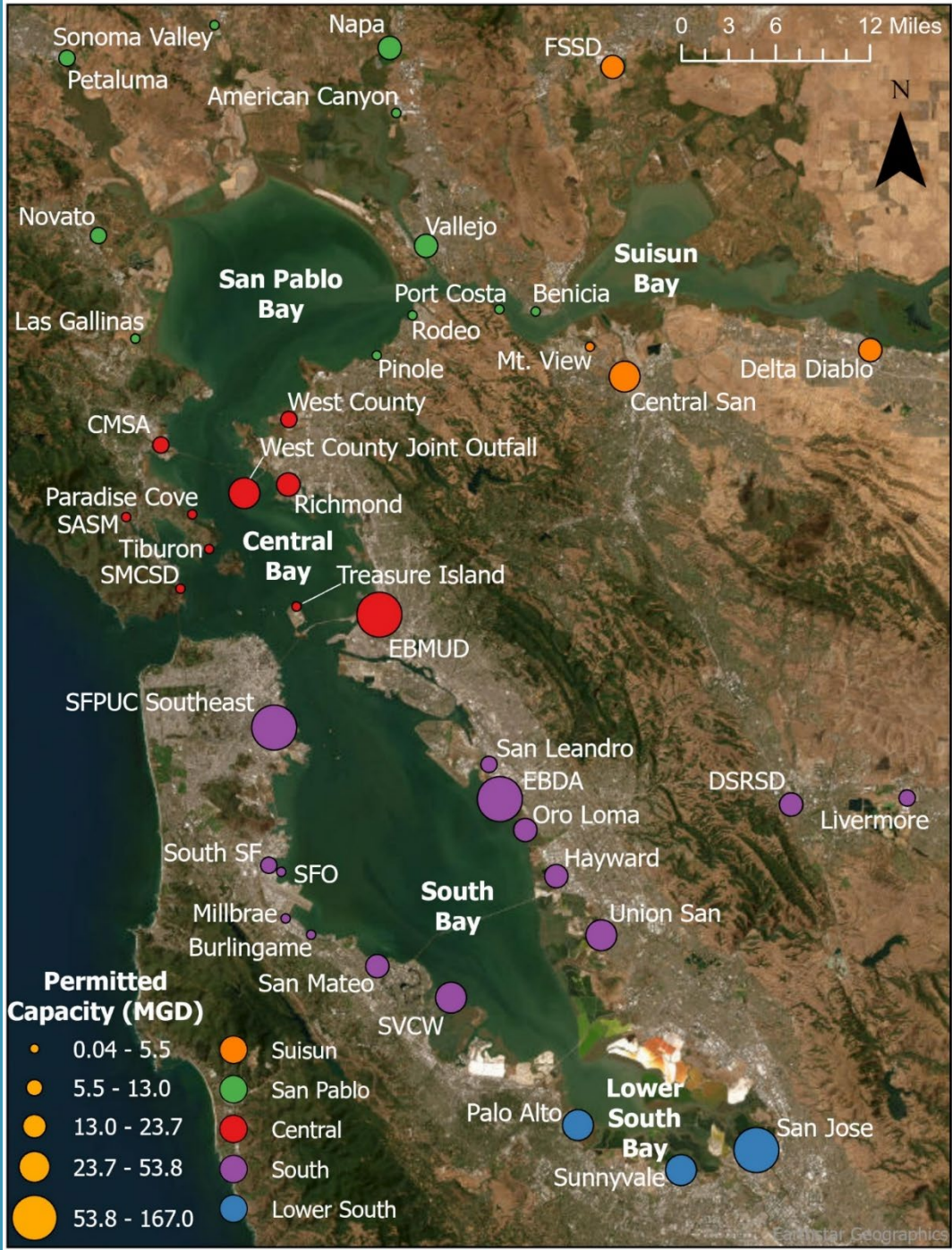


Treatment Opportunities

- 1 How are we doing?
- 2 Progress

Group Annual Report from 4/1/26
(includes trending analysis and baywide projects status):

bacwa.org/wp-content/uploads/2026/03/BACWA-Group-Annual-Report-for-Nutrients-2026-04-01.pdf



Summary of Dry Season Flows and Loads

Constituent	2022	2023	2024	2025	Pre-2025 Average
Flow, mgd	337	381	388	374	373
Ammonia, kg N/d	35,800	32,400	32,400	30,700	35,400
NOx, kg N/d	8,550	10,700	11,200	11,200	11,000
TIN, kg N/d ^(b)	44,400	43,300	43,700	41,604.1	46,500
TP, kg P/d	3,300	3,760	3,650	3,530	3,660

- Flows: strong correlation with extent of wet season precipitation
- Ammonia/TIN: lowest since sampling began in 2012
- Nitrite + Nitrate (NOx): as expected higher levels as POTWs transition to removing ammonia
- Total P: similar to historical values

The 2025 dry season TIN loads are 6.3% less than the 2022 values (i.e., baseline values used in the 3rd Watershed Permit)

Fate of the Nitrogen Loads during the Dry Season (Limited to Plants with ADWF Capacity >10 mgd)

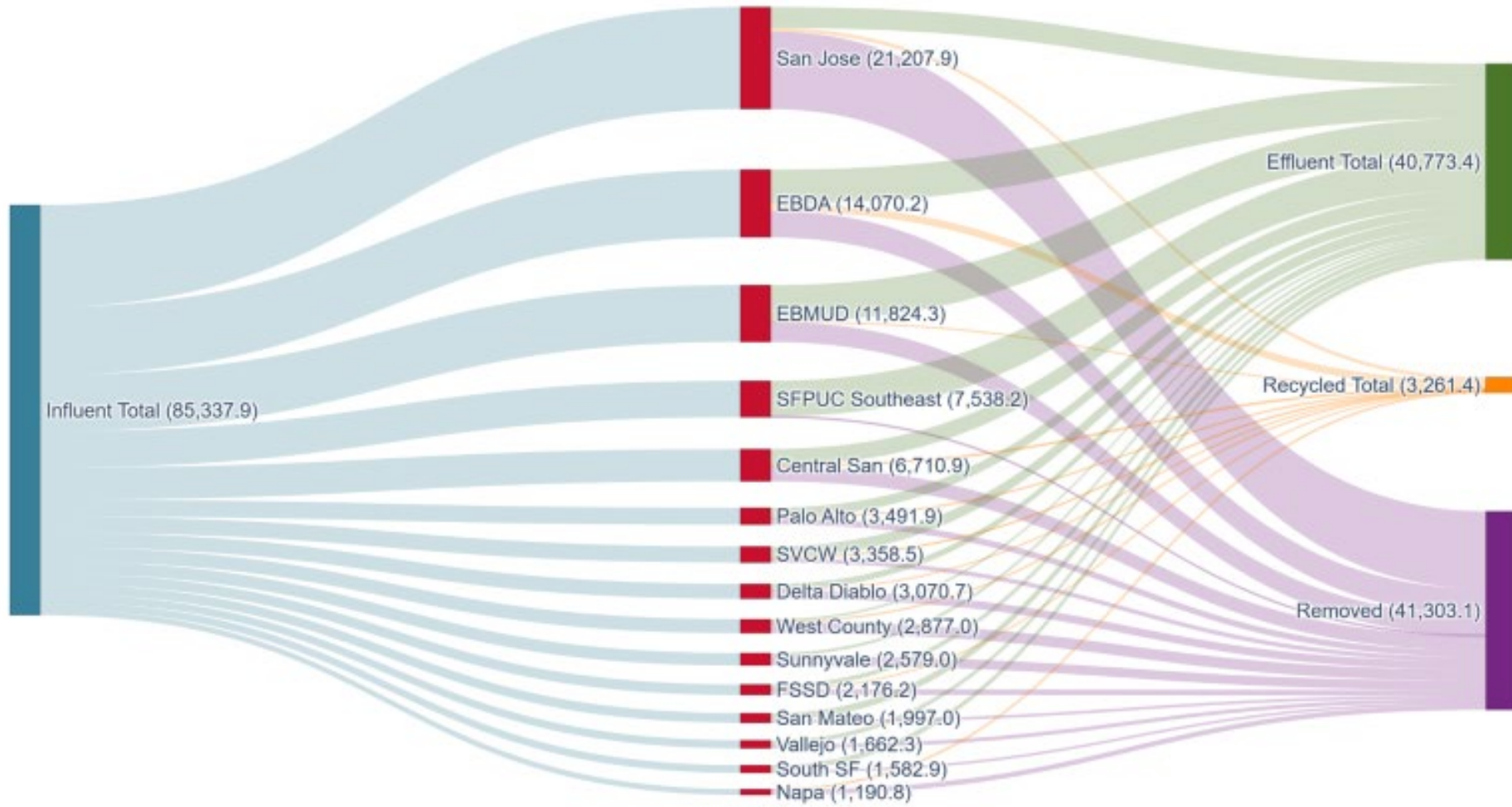
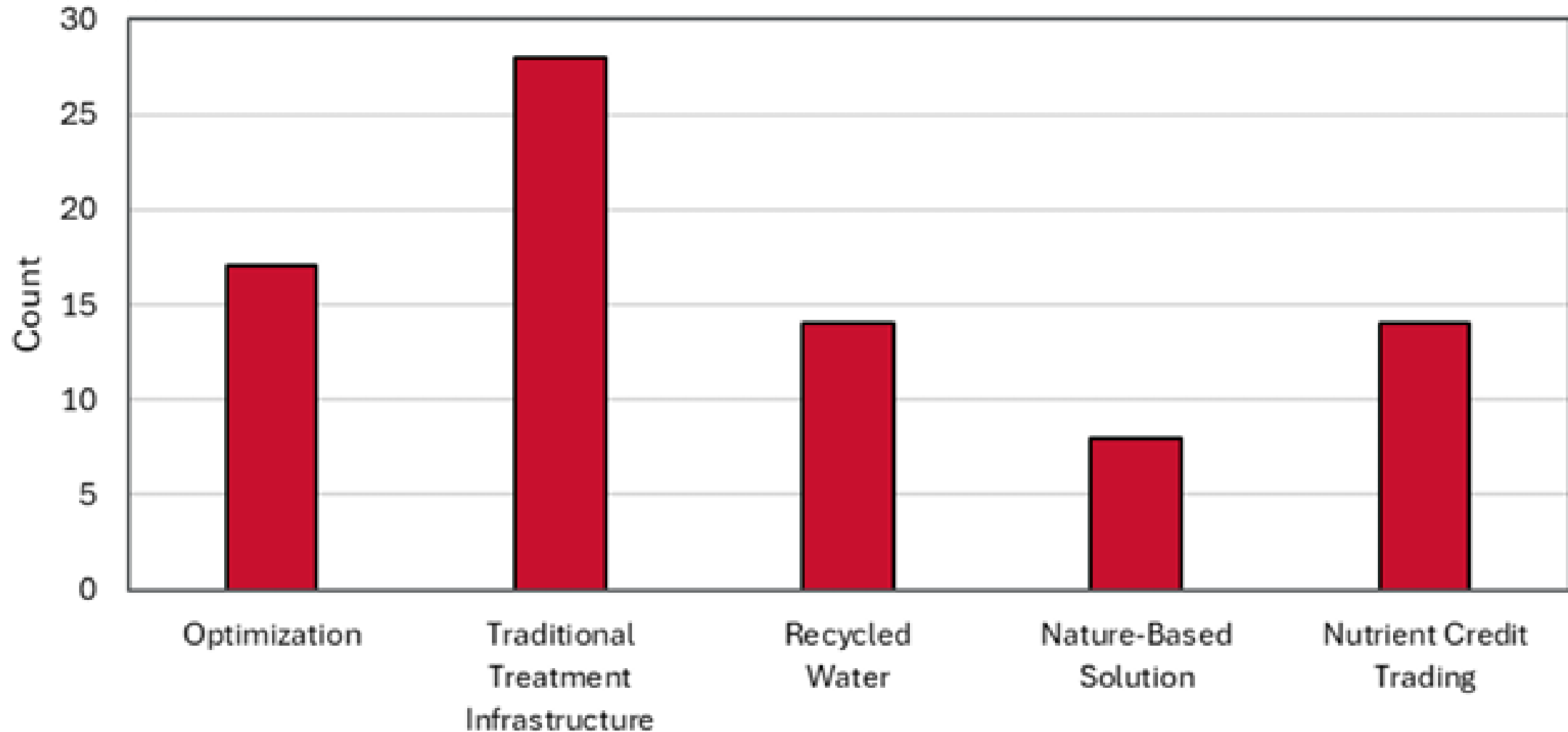


Figure 3-9. Dry Season Influent (TN), Effluent (TIN), and Recycled Water (TIN) Loads (kg N/d)

Note: limited to POTWs with ADWF permitted capacity of >10 mgd.

Status Update: Distribution of Project Types



Note: Sum of these projects is greater than the number of plants as various plants have a portfolio of solutions

Perspective on Status and Timeline (Limited to those that Provided such Detail)

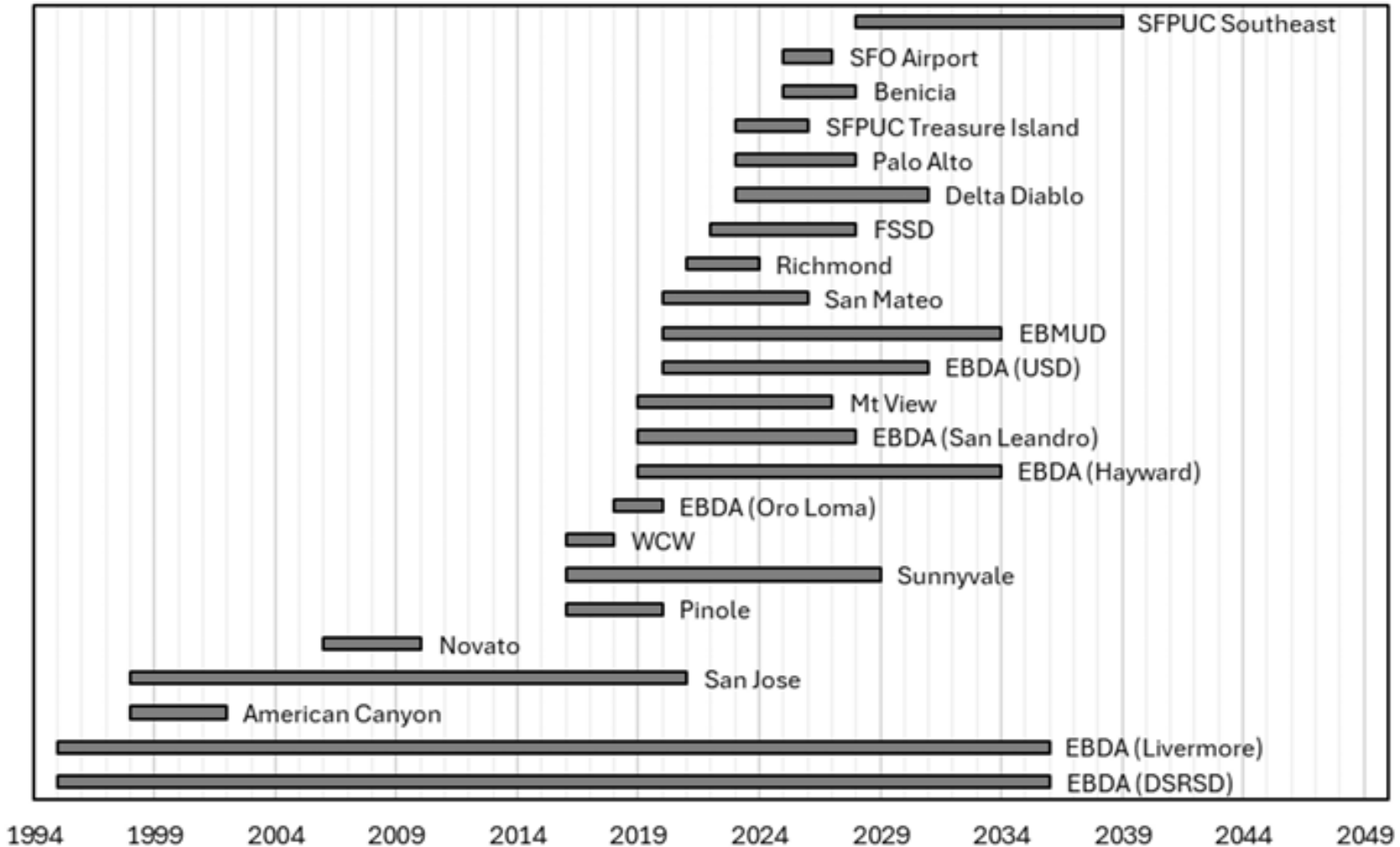


Figure 4. Estimated Timelines for Completed, In-Progress, and Planned Projects

DRAFT: Plant Status Summary





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Bay Area Clean Water Agencies Water Quality Trading Program Development

Chris Thomas, Policy Specialist

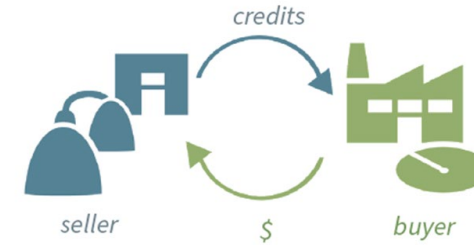
May 2026



What is Water Quality Trading?

- A voluntary, market-based Clean Water Act compliance strategy.
- Allows a permitted discharger to purchase compliance credits created by another source.
- Can result in better economic and ecological outcomes than may be achieved independently.

WQT enables coordination and collaboration among WWTPs that can benefit communities and ratepayers.



How Does Trading Work?

- WWTPs that reduce pollutant loads below their effluent limit can sell those excess reductions (i.e., credits)
- Credits measured in same units and time period as the permit (*TIN kg/day in the dry season*)
- Credit trades verified using existing monitoring and reporting
- San Francisco Bay Program will be governed by a “Trading Framework” that will provide certainty about requirements, mechanics

Types of Trading Programs

Point-to-Point Source

- Buy/sell unused effluent limits
- Co-fund treatment plant upgrades

Nonpoint-to-Point Source

- Implement projects that reduce nutrient loading to watershed (i.e., wetlands, ag practices, eel grass, etc.)

WQT Programs in the United States

Supported by EPA Federal policies (2003, 2009, 2019, 2020)

Upheld by federal courts & endorsed by the State Water Board

Active trading programs in Connecticut, Virginia, Maryland, Wisconsin, California, and Oregon

Case Study: Long Island Sound, CT

Participants: 79+ POTWs

Trading Mechanism: Credit Exchange managed by DEP using standard rates set by Nutrient Credit Advisory Board

Driver: Nitrogen TMDL: 65% reduction in nutrient loading from baseline levels by 2014
General Permit: Implements the TMDL and creates framework for permittees

Options:

- Technological solutions for facility to achieve individual compliance with General Permit
- Purchase excess pollution reductions from another facility to achieve joint compliance

With trading program: \$300 – 400 million saved by not forcing all municipalities to upgrade at once



Case Study: Chesapeake Bay Exchange, VA

Buyer: 130+ Wastewater Treatment Plants

Seller: Other Point Sources or the Exchange

Exchanges: Virginia Nutrient Credit Exchange Association or directly between sources

Driver: Chesapeake Bay TMDL: Mandates tributary specific nutrient reductions

Virginia General Permit: Implements WLAs and guides trading activities

Compliance Options:

- Upgrade facility for individual compliance
- Purchase credits on the Exchange
- Independent trades between sources
- Bubble WLAs for multiple facilities in close proximity and under same ownership



Why Consider Water Quality Trading?

COST SAVINGS.

Meet aggregate load targets without every facility independently building treatment.



COST SAVINGS



COLLABORATION

COLLABORATION.

Watershed-wide coordination and shared solutions.

FLEXIBILITY.

Purchase credits or co-fund treatment upgrades rather than pursuing a full capital project.



FLEXIBILITY



**ENVIRONMENTAL
BENEFIT**

ENVIRONMENTAL BENEFIT.

Safeguards ensure water quality improvements.

Perspectives Shared with The Freshwater Trust

- Strong support for trading as an **efficient** and **flexible** compliance alternative
- **Minimize risk** and **maximize** certainty for participants
- **Bay-wide** trading program based on aggregate limits
- **Effective, equitable outcomes** for ratepayers
- Fosters **coordination** and **collaboration** to meet Bay's nutrient reduction goals



WQT in San Francisco Bay

- Facilities planning capital upgrades can evaluate whether over-treating could generate revenue through credit sales.
- Facilities facing difficult or expensive upgrades can evaluate whether buying credits is a more cost-effective option.
- WQT preserves future flexibility, even for those unsure if they will buy or sell credits.

100% of eligible facilities are interested in a WQT program

Source: GAR 2026 & Interviews

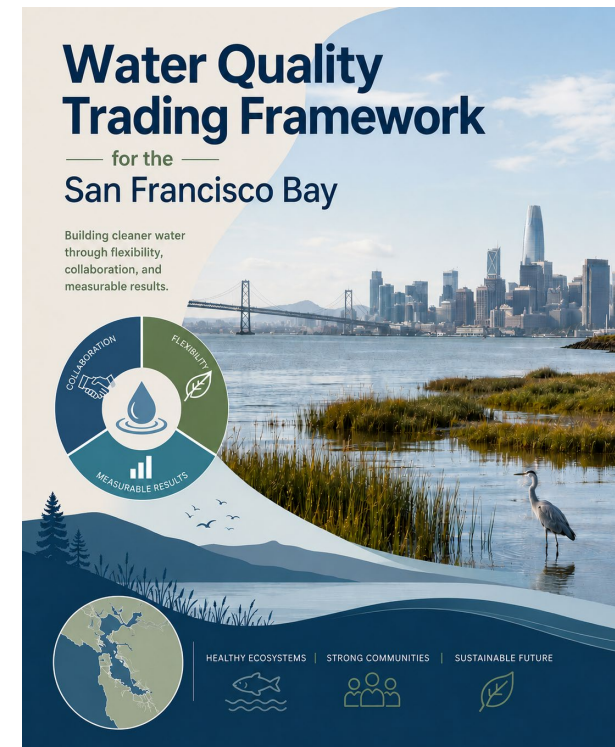


2026 Workplan

1. Outreach to BACWA Members, Experts & Stakeholders
2. Evaluation of Credit Supply, Demand, Timing & Costs
3. Scientific Basis & Watershed Modeling
4. Evaluate Regulatory & Jurisdictional Constraints
5. Draft Trading Framework

Goal: Proposed *Draft Water Quality Trading Framework* in late 2026

Next Step: *Workshop on August 31st*



Trading Overview Two-Pager



San Francisco Bay Water Quality Trading Program: Designing a Program for Wastewater Treatment Plants

In recent years, the San Francisco Bay has experienced an increased frequency and severity of harmful algal blooms (HABs). In July 2024, the Regional Water Quality Control Board adopted the Nutrient Watershed Permit (Nutrient Permit), establishing nitrogen discharge limits for wastewater treatment plants (WWTPs) across the San Francisco Bay. The Nutrient Permit is intended to reduce the potential for HABs by requiring a 40% reduction in total inorganic nitrogen (TIN) loading from WWTPs by 2034. Satisfying the Nutrient Permit's final limits will require costly facility upgrades—estimated at approximately \$11 billion. In response, many dischargers have expressed interest in water quality trading as a compliance option to help reduce financial and operational burdens while achieving water quality improvements.

What Is Water Quality Trading?

Water quality trading (WQT) is a voluntary, market-based compliance strategy authorized under the Clean Water Act. It allows a regulated discharger to purchase credits from another source, frequently resulting in better economic and ecological outcomes than may be achieved with each discharger acting alone.

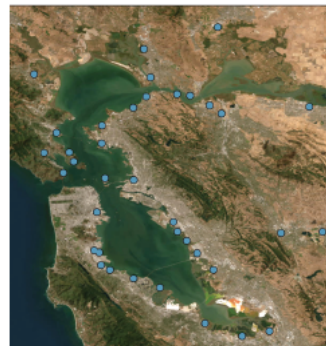
San Francisco Bay Context

In San Francisco Bay, the diversity of WWTP circumstances reflects the diversity of the Bay itself. Some facilities can reduce nitrogen loads below their permit limit more efficiently than others due to available space, existing infrastructure, or economies of scale. Facility changes are paid for from a variety of sources, including bonds, customer rate increases, loans, and grants. By allowing the Bay's regulated dischargers to look beyond an individual facility to consider nutrient reduction opportunities throughout the watershed, participants in a trading program can pursue the most efficient and cost-effective compliance strategies while reducing nutrient loading to the Bay. WQT enables collaboration between WWTPs that can ultimately benefit communities and ratepayers.

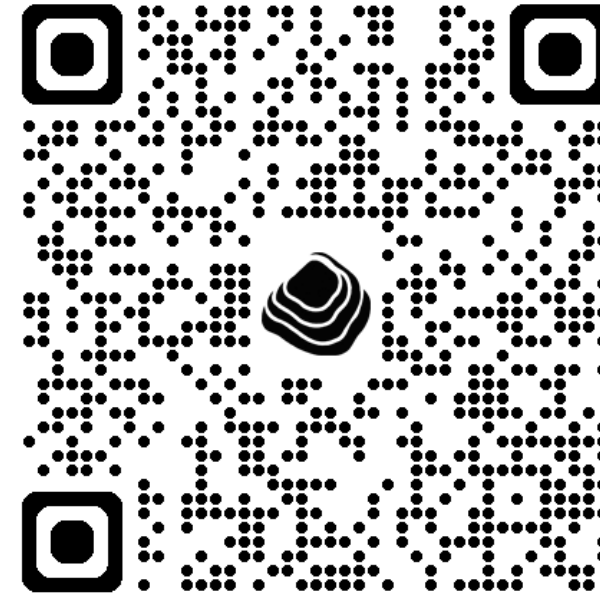
EXAMPLE CREDIT TRADE



A watershed-wide program to reduce nutrients in the San Francisco Bay could include voluntary trades between wastewater treatment plants. One regulated discharger with high permit compliance costs can purchase credits from another discharger that can achieve nutrient reductions more cost effectively.



Relevant San Francisco Bay WWTPs



We Need You!

It is important to engage to make sure your perspectives are considered.



BAY AREA CLEAN WATER ASSOCIATION ·
ANNUAL MEETING 2026

Nutrient Management Strategy

An overview and current trajectory

Ian Wren

San Francisco Estuary Institute

SFEI

Photo · Adobe Stock

Where we're going in the next fifteen minutes

01 What is the NMS?

02 BACWA's role — the funding partnership behind the science

03 2022: the turning point

04 The 2024 Permit and the NMS

05 Where we're going next

What is the Nutrient Management Strategy?

A collaborative science program, established in 2014, that gives the region a rigorous basis for managing nutrient impacts in San Francisco Bay.

- Housed at SFEI; co-managed with the SF Bay Regional Water Quality Control Board
- **15-member Steering Committee** — dischargers, regulators, environmental groups, scientists
- **Mission:** develop the scientific basis for managing nutrient impacts in the Bay
- **Funded** primarily through the SF Bay Nutrient Watershed Permit, plus EPA and NOAA grants



R/V Turning Tide, USGS · NMS field operations

BACWA: foundational partner from day one

2014 – 2019 · FIRST PERMIT CYCLE

\$880K

Total BACWA contribution that funded the founding NMS science program.

2019 – TODAY · 2ND & 3RD CYCLES

\$2.2M/yr

Annual investment through the SF Bay Nutrient Watershed Permit, supplemented by EPA and NOAA grants.

+ \$550K/yr via the Regional Monitoring Program — supports ship-based and moored sensor work.

Without BACWA, there is no monitoring program, no model, and no scientific basis for the 2024 Permit.

Since the 2022 Bloom, federal funding has increased the program to

~\$6 million per year

SFEI

Why nutrients matter in San Francisco Bay

- Largest estuary on the Pacific Coast — **1,600 km²** , watershed of 8 million people
- Among the most nutrient-enriched estuaries on Earth — **90th percentile globally for nitrogen**
- Historically resilient — high turbidity, strong tidal mixing, and filter-feeding clams kept algae in check
- That resilience is **weakening**



SFEI

Photo · Adobe Stock

sfei.org/programs/cw/nutrients

Standing on the shoulders of giants

USGS began monitoring SF Bay water quality in 1969 — one of the longest continuous estuarine datasets in the world.

- Carried forward for decades by the late **Dr. Jim Cloern**, whose conceptual frameworks still anchor how we understand the Bay.
- Every trend we discuss today rests on that record.



USGS field operations

The first eight years: building the foundation

FOUNDATIONAL SCIENCE — CHARACTERIZING CHRONIC CONDITIONS

- Moored sensor network grew from **2 stations (2013) to 12 (2019)**
- Built the **SF Bay Biogeochemical Model**
- Established molecular HAB detection
- Central Bay primary production grew **2–3× since the early 1990s** — the first sign resilience was weakening

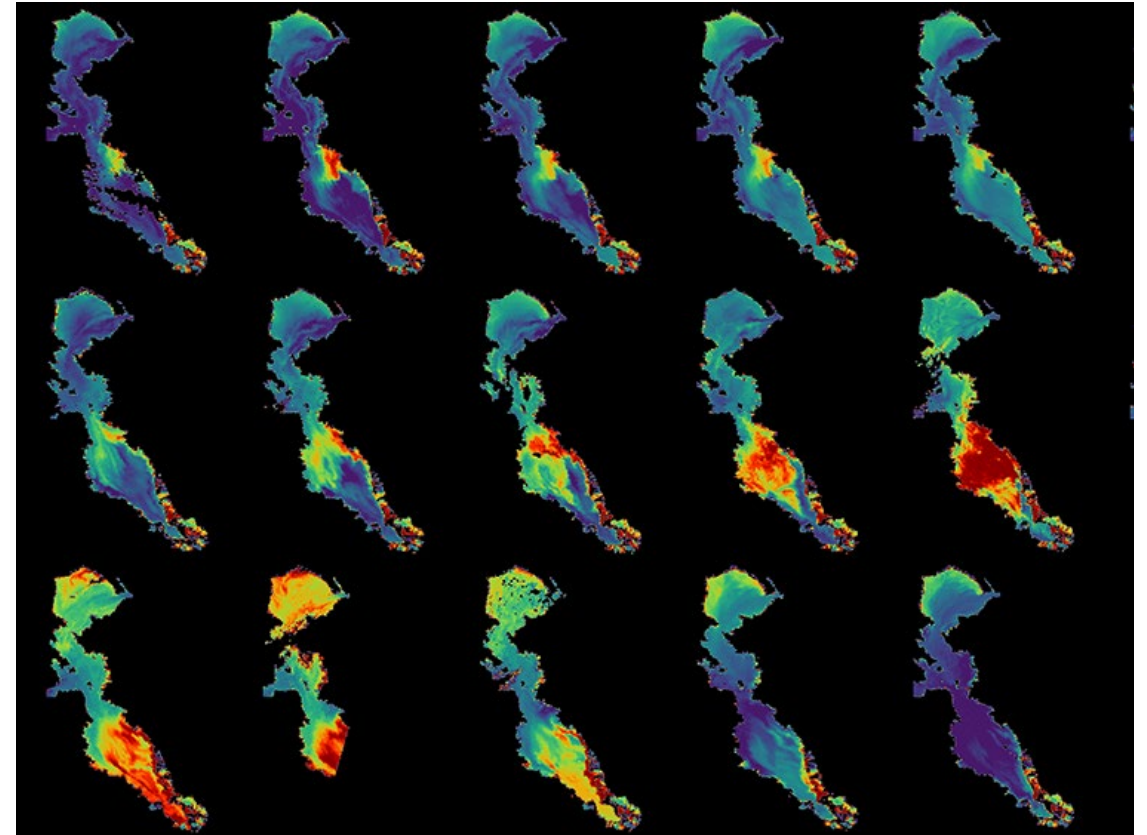


Peterson cruise · 2019 · SFEI

August 2022: the turning point

Heterosigma akashiwo bloomed across the lower Bay from July through September 2022.

- Peak chlorophyll-a: **>500 µg/L on August 23**
- Cell densities exceeding **1 million per liter**
- Bloom consumed **~1.6 million pounds of nitrogen** — more than was available at the start
- Largest HAB event in the Bay's recorded history



Bay-wide satellite chlorophyll-a, July–September 2022 · RE-SFB algorithm, UCSC / SFEI

947

sturgeon documented dead Bay-wide — the largest fish mortality event in the Bay's recorded history

White sturgeon population dropped from roughly **30,000** to under **6,500** legal-size fish.

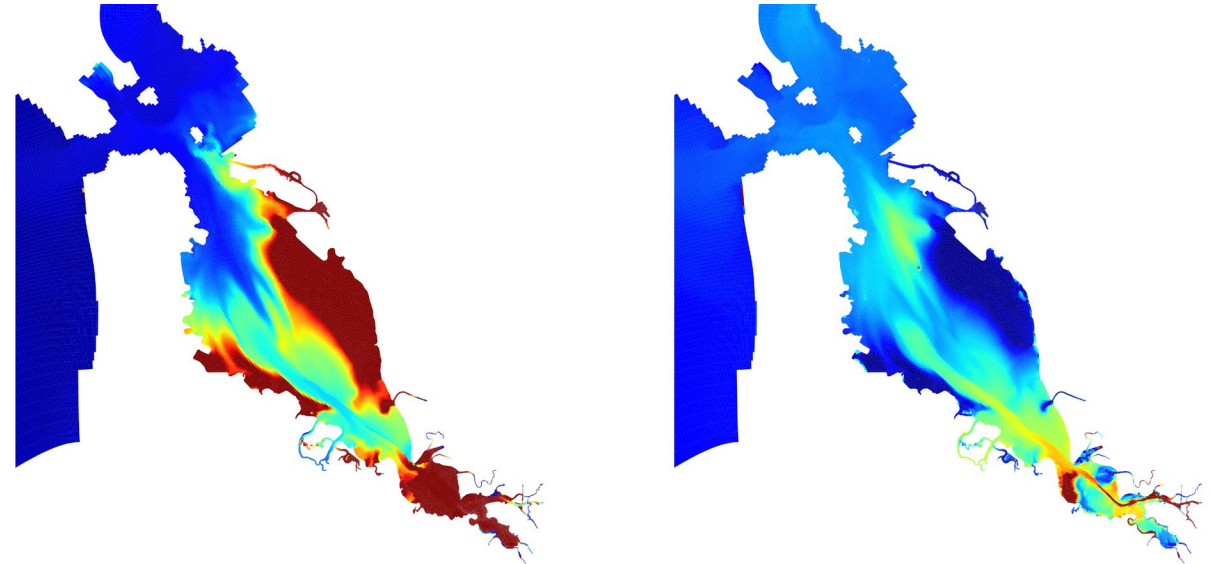
Most died *before* oxygen depleted. The toxicity mechanism remains unresolved.



The 2024 Nutrient Watershed Permit

Third Nutrient Watershed Permit (2024 – 2029) — adopted July 2024

- 40% reduction in dry-season nitrogen loads required
- The biogeochemical model provided the technical basis for the 40% number
- Compliance schedule extends through the permit cycle and beyond



Modeled chlorophyll-a, and dissolved inorganic nitrogen, Spring 2018 · SF Bay Biogeochemical Model

What this means for treatment plants

- POTWs contribute ~90% of dry-season loads in Central and South Bays
- The 40% reduction falls primarily on the agencies in this sub-region
- Substantial capital investment ahead — but the science behind the number is the strongest it could be



A pivot in NMS focus

2022 reoriented the program — from documenting *chronic change* to predicting *acute events*.

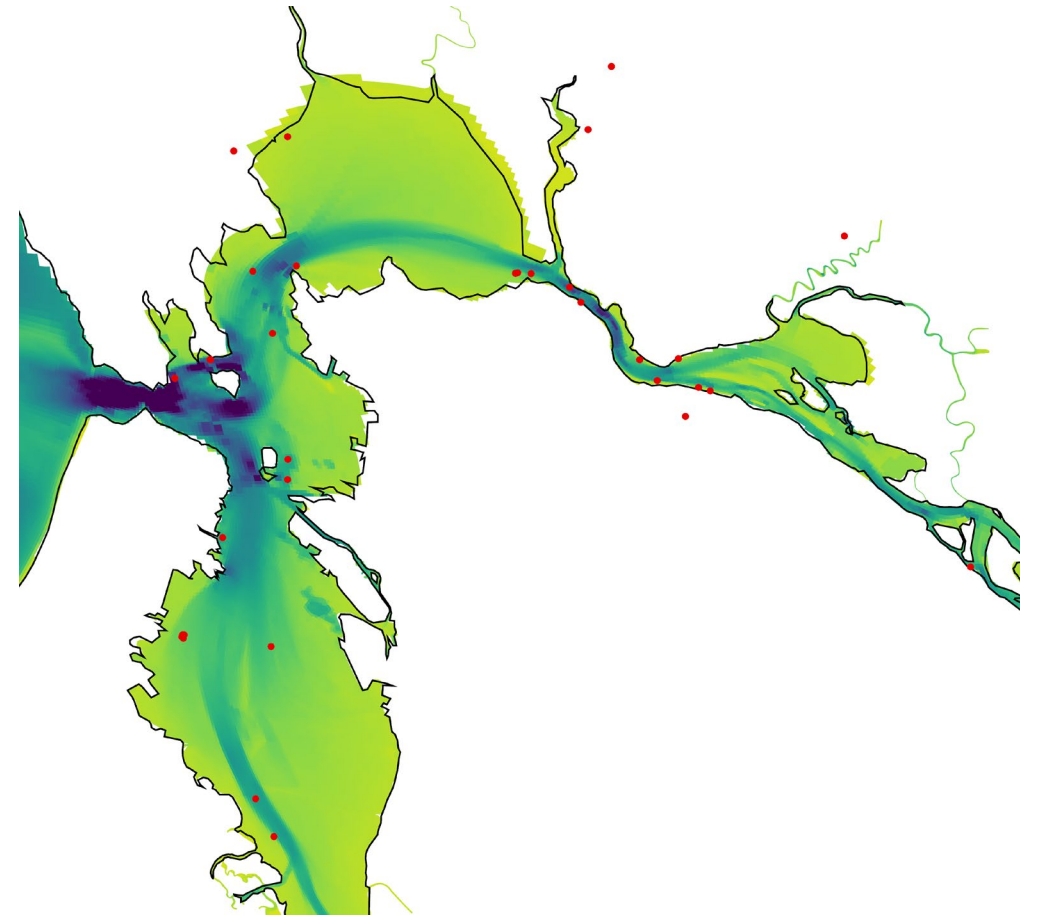
- **2014-2022** (chronic conditions) → **2024 -> ?**
(future scenarios + acute events)
- Monitoring scope expanded substantially after the 2024 Permit
- Modeling now central to permit-relevant decisions
- Analysis of the 2022 bloom prepares us for the *next one*



Moored sensor buoy · SFEI

Modeling steps into a bigger role

- **SF Bay Biogeochemical Model** — coupled hydrodynamic and biogeochemical, ten years in development.
- Set the 40% target; now used to test scenarios environmental and management scenarios
- Future use: load-response curves, regional reduction prioritization, climate scenarios



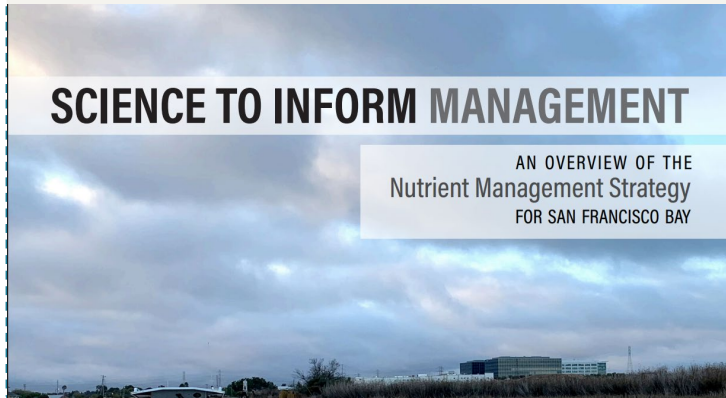
Bay bathymetry and wastewater point sources used in the model

Recent deliverables

OVERVIEW REPORT

Science to Inform Management

Plain-language summary, ~30 pages, for non-specialists.



STATE OF THE SCIENCE

12-year synthesis

Deep technical synthesis of NMS monitoring and modeling.



SCIENCE PLAN

2025 – 2030 roadmap

Where the program is going through the next permit cycle.

Approved May 2025

ALL AVAILABLE AT sfei.org/programs/cw/nutrients

One of the most comprehensive monitoring programs in North America



Moored sensor stations



Ship-based monitoring



Field maintenance

- **15 moored sensor stations** — 15-minute data on chl-a, DO, salinity, temperature, turbidity, pH
- **38 ship-based stations** — monthly to bimonthly nutrient and phytoplankton transects
- **7 high-speed shoal-mapping cruises** per year
- **RE-SFB satellite algorithm** — near-real-time Bay-wide bloom maps
- **\$3M NOAA MERHAB grant** (2023) — expanded HAB monitoring + public dashboard

Science priorities for the next five years

1 Is the 40% reduction protective?

Model refinement and load-response evaluation — ahead of the next permit.

3 Status and trends of key indicators

Sustained baseline tracking — how we'll know whether the permit is working.

2 What caused the 2022 bloom?

And why didn't 2023 spread the same way? HAB mechanism and trigger research.

4 Nature-based solutions

Wetlands, eelgrass, and salt pond management — co-benefits at the margins.

Together, these build the technical foundation for the **2029 Permit reissuance**.

The path forward informs decisions

Science → permit → action →
adaptive feedback.

- Continued partnership: BACWA, the Water Board, scientists, and the public
- Every part of the loop has to stay funded and engaged for it to work
- The next five years will inform continual improvements



SFEI

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sfei.org/programs/cw/nutrients

Thank you.

The NMS exists because BACWA showed up —
and kept showing up — for over a decade.

Ian Wren · San Francisco Estuary Institute

iwren@sfei.org

sfei.org/programs/cw/nutrients



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