RMP REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN SAN FRANCISCO BAY
sfei.org/rmp

Plain Language Summary

Benefits of Wastewater Treatment Upgrades for Removing Emerging Contaminants

Wastewater treatment plant upgrades to remove more nitrogen can also help remove under-regulated and under-studied contaminants (known as emerging contaminants). The RMP summarized existing research on how well three types of technologies remove emerging contaminants. RMP scientists screened over 600 papers and reviewed 34 studies in full to compare the technologies.

Contaminant Type & Risk Tier		Conventional Activated Sludge	Biological Nutrient Removal	Membrane Bioreactor
Organophosphate Esters	High	15%	16%	20%
PFAS (Forever Chemicals)	High	42%*	54%*	70%*
Bisphenols	Moderate	70%	61%	70%
Microplastics	Moderate	94%	No Data	85%
Antibiotics	Low	51%	64%	69%
Ethoxylated Surfactants	Low	67%	55%	58%
Personal Care Products	Low	75%	75%	72%
Pharmaceuticals	Low	53%	69%	68%
Other Plastic Additives	Possible	93%	48%	46%

Data from a single study.

Estimated average reduction in concentration for each contaminant type (grouped by current risk in the Bay) and treatment technology. Higher reductions are shaded as darker blue.

Key Points

- **Membrane bioreactors** (MBRs) may remove slightly more emerging contaminants on average (67%) than **other biological nutrient removal technologies** (61%) or **conventional activated sludge** (57%). However, MBR performs worse than the other technologies for several types of contaminants, like some plastic additives.
- Most of the reviewed studies focused on pharmaceuticals, antibiotics, or plastic additives.
- **Few studies exist for** the two groups of **contaminants that are high concerns** in San Francisco Bay. These are PFAS or "forever chemicals" and organophosphate esters (flame retardants and plastic additives).

Implications and Future Directions

Wastewater treatment upgrades from conventional activated sludge to membrane bioreactors and other advanced biological nutrient treatments could be an improvement for removing some emerging contaminants. This is true for antibiotics and pharmaceuticals in particular, which the RMP considers a low concern in the Bay at this time. A key data gap is how wastewater treatment upgrades might affect removal of high-concern contaminants for San Francisco Bay.

Full report: Rudko, N.; Méndez, M.; Sutton, R. 2026. Benefits of Wastewater Nutrient Treatment Upgrades for Removing Contaminants of Emerging Concern: A Systematic Review. SFEI Contribution # 1332. San Francisco Estuary Institute, Richmond, CA.