Appendix G3

Reverse Osmosis Concentrate Ocean Discharge Compliance Assessment

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LOS ANGELES COUNTY SANITATION DISTRICTS
Converting Waste Into Resources

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Memorandum

Date: October 18, 2022

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Subject: **Pure Water Southern California RO Concentrate Ocean Discharge Compliance Assessment**

Introduction

The purpose of this memorandum is to confirm that the ocean disposal of reverse osmosis (RO) concentrate from the proposed Pure Water Southern California advanced water treatment facility at the Joint Water Pollution Control Plant meets current regulatory requirements applicable to its discharge and is not expected to generate concerns for water quality. This memo presents monitoring results for RO concentrate to date that demonstrate compliance with these regulatory requirements and show no toxicity for blends of RO concentrate and secondary effluent tested. Based on this testing, RO concentrate discharge is not expected to be toxic to marine aquatic life or cause harm to biological communities. This memo also describes work to evaluate certain constituents of emerging concern (CECs) in the RO concentrate and assess any potential impacts of these CECs on aquatic life. Additional monitoring data for the discharge of RO concentrate continue to be collected and analyzed, including any cumulative effects associated with concentrate conveyed directly to the JWPCP outfall tunnels by others, and this memo will be updated after completion of these ongoing and future studies.

Background

Joint Water Pollution Control Plant Outfalls

JWPCP currently provides secondary wastewater treatment for a dry weather flow capacity of up to 400 MGD. Currently, after treatment at JWPCP, chlorinated secondary effluent travels six miles through underground tunnels to an outfall manifold from which it is discharged to the Pacific Ocean at White Point off the Palos Verdes Peninsula. The outfall manifold at White Point consists of four outfalls (Discharge Points 001 through 004), as shown in Figure 1. Discharge Points 001 and 002 are routinely used, whereas Discharge Point 003 is used to provide hydraulic relief during heavy wet weather events, and Discharge Point 004 serves as a standby outfall to provide additional hydraulic relief during the heaviest storms.

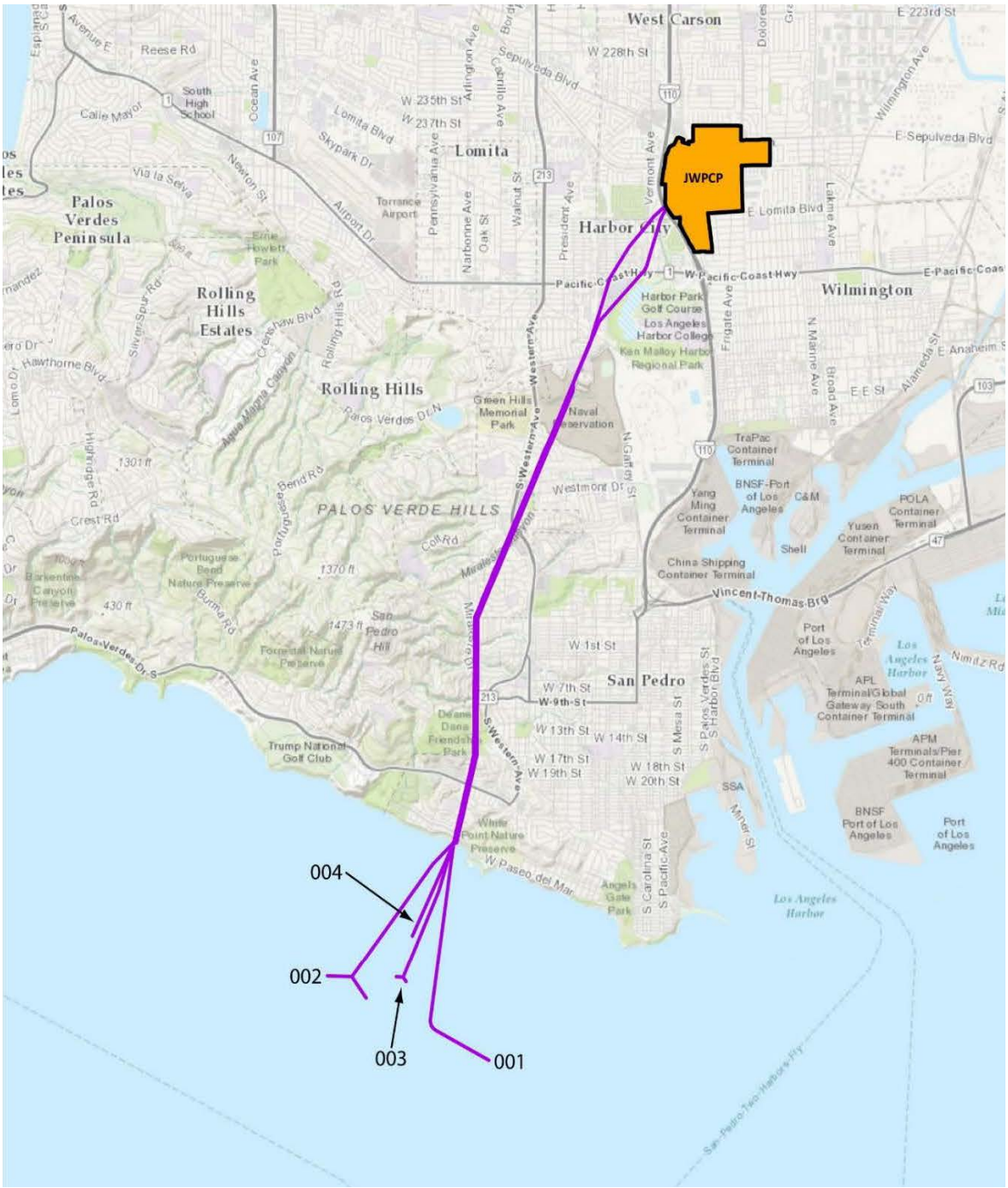

Figure 1. JWPCP Location and Ocean Outfalls

Ocean Discharge and Applicable Regulatory Requirements

Discharge of secondary-treated effluent from JWPCP is permitted under the Federal Clean Water Act via a National Pollutant Discharge Elimination System (NPDES) permit, Los Angeles Regional Water Quality Control Board (Regional Board) Order No. R4-2017-0180 (Los Angeles Regional Water Quality Control Board 2017). The JWPCP NPDES permit specifies discharge prohibitions and specifications, effluent limitations, performance goals, receiving water limitations, and monitoring and reporting requirements. Order No. R4-2017-0180 expires on October 31, 2022 and a report of waste discharge (ROWD) was submitted on May 4, 2022. Based on correspondence with the Regional Board, the new permit is expected to be adopted in May 2023.

Parameters with effluent limitations in the JWPCP NPDES permit include technology-based parameters for secondary treatment, such as: biochemical oxygen demand (BOD) and total suspended solids (TSS); ammonia; metals; organic compounds (e.g., pesticides); toxicity; and bacteria. Water quality objectives for ocean waters off the coast of California are established in the *Water Quality Control Plan for Ocean Water of California* (Ocean Plan), including numeric criteria that are protective of marine aquatic life and human health.[1] The JWPCP NPDES permit also incorporates wasteload allocations (WLAs) specified in the *Santa Monica Bay Total Maximum Daily Loads for DDTs and PCBs* (SMB TMDL), adopted in 2012 by the United States Environmental Protection Agency (EPA).[2]

In addition to numeric effluent limitations, the JWPCP NPDES permit also contains a number of narrative receiving water limitations based on standards established in the Ocean Plan. These limitations require that effluent discharges must preserve the physical, chemical, and biological quality of the marine environment. In particular, wastewater discharges must not degrade the physical and chemical characteristics of the marine environment, impair biological communities, or impact the safety of seafood. To assess compliance with these standards, the Sanitation Districts employ an extensive ocean monitoring program that includes water quality and sediment assessments, fish and invertebrate monitoring, fish tissue and benthic surveys, and other monitoring programs. The Sanitation Districts also participate in several regional monitoring programs (e.g., Southern California Bight program and Central Region Kelp Survey Consortium) that assist in assessing impacts to the marine environment.

In accordance with its NPDES permit, the JWPCP also has an industrial wastewater pretreatment program that is approved by the EPA and Regional Board. The pretreatment program allows the Sanitation Districts to implement an industrial waste permitting, monitoring, and enforcement program, including the implementation of local discharge limits where necessary. This program assists the JWPCP in reducing concentrations in treated wastewater and complying with effluent discharge requirements. Source control is an integral part of the pretreatment program and is established to protect the wastewater collection system and ensure the quality of treated wastewater discharges. Current projects include source investigations and monitoring, public outreach to industrial users, and developing a chemical inventory that tracks new and existing chemicals and contaminants resulting from new sources or changes to existing sources that may impact the quality of wastewater discharges. The Sanitation Districts will also implement an enhanced source control program that is appropriate for the direct potable reuse (DPR) of treated wastewater. The source control program would comply with the California State Water Resources Control Board (State Board) regulations for DPR, which are expected to be adopted by 2023 and will likely include requirements for enhanced local limits, discharger evaluations, and collection system monitoring practices.

The JWPCP NPDES permit effluent limitations are based on the dilution ratios in Table 1 for each outfall location, calculated according to a model that incorporates electrical conductivity, density, salinity, and total

[1] State Water Resources Control Board and California EPA. 2019. "Water Quality Control Plan for Ocean Waters of California."
[2] USEPA Region 9. 2012. "Santa Monica Bay Total Maximum Daily Loads for DDTs and PCBs".

dissolved solids (TDS).[3] As Discharge Points 003 and 004 are normally only used during wet weather, the 166:1 for Discharge Points 001 and 002 is typically the applicable dilution ratio, which corresponds to an in-stream waste concentration (IWC) of 0.6% for toxicity testing.

Table 1. JWPCP NPDES Permit Dilution Ratios

Discharge Point	Dilution Ratio
001 and 002	166:1
003	150:1
004	115:1

The Sanitation Districts have conducted additional modeling to characterize a variety of flow scenarios, including best estimates of future flows and flows of combined RO concentrate and effluent for future scenarios. Results of the model confirmed that the current dilution ratios are appropriate for future estimated flow scenarios and would be considered conservative.

Current and Future Concentrate Discharge for Ocean Disposal

Groundwater desalination plants and RO plants produce concentrate that could be potentially suitable for direct discharge through the outfall tunnels at JWPCP. In most cases, these concentrates are mixed with wastewater and conveyed through the Sanitation Districts' collection system to the JWPCP for treatment. The West Basin Municipal Water District (West Basin) discharges approximately 0.5 million gallons per day (MGD) of brine directly to JWPCP's outfall tunnels via a brine disposal line; however, West Basin's discharge is permitted separately by the Regional Board and subject to the requirements of the permit. Additional discharges of concentrate directly to the JWPCP outfall tunnels, such as the brine discharges from existing and proposed groundwater desalting projects, would need to be evaluated to assess their ability to meet ocean discharge requirements.

Pure Water Southern California

The Metropolitan Water District (Metropolitan) and the Sanitation Districts are pursuing the Pure Water Southern California (PWSC) program to beneficially reuse up to 150 MGD of treated wastewater from the JWPCP that is currently being discharged to the Pacific Ocean. PWSC will consist of a new advanced water treatment facility (AWTF) at the JWPCP to further purify treated wastewater using RO membrane filtration. The purified product water will be used for groundwater recharge in Los Angeles County and potentially for direct potable reuse. The AWTF will produce up to 26 MGD of RO concentrate (assuming a 15% RO reject rate on a feed flow of 180 MGD) that will be blended with secondary effluent from the JWPCP and discharged via the JWPCP's existing outfalls. The ratio of RO concentrate to secondary effluent that is discharged from the outfalls depends on the size of the AWTF (i.e., amount of product water produced from the AWTF). The ratios that were considered during this analysis are based on expected project implementation phasing and are shown in Table 2.

[3] Steele, Alex. 2016. "Final Report Joint Water Pollution Control Plant Outfalls Initial Dilution Calculation Study".

Table 2. Ratio of RO concentrate to secondary effluent discharged from JWPCP's outfalls according to AWTF project size.

AWTF Product Water (MGD)	Discharge from JWPCP Outfalls	
	RO Concentrate (%)	JWPCP Secondary Effluent (%)
150	32	68
75	8	92
25	2	98
5	0.4	99.6

As part of the PWSC, a 0.5 MGD demonstration facility has been in operation since October 2019. Testing at this facility will allow Metropolitan to demonstrate pathogen removal through membrane bioreactors (MBR), demonstrate the ability of the proposed treatment train to meet groundwater basin water quality objectives, gather data, conduct public outreach, and allow the Sanitation Districts to assess proposed RO concentrate discharge to the ocean. A tertiary MBR phase (nitrification only) was completed in 2021 and a secondary MBR phase operating in nitrification/denitrification mode is scheduled to start in October 2022.

Southern California Salinity Coalition Study

In November 2020, the Sanitation Districts and Water Replenishment District of Southern California (WRD) partnered on a study, partially funded under the Southern California Salinity Coalition (SCSC) Applied Research Program, to determine if concentrates from regional desalter facilities combined with PWSC can be discharged to the ocean outfall without receiving any further treatment. The study includes review of existing water quality data from WRD's Robert W. Goldsworthy Desalter (Goldsworthy) and West Basin's Juanita Millender-McDonald Carson Regional Water Recycling Plant, along with data from PWSC's demonstration facility. The Sanitation Districts will develop a sampling plan to analyze any constituents that are part of the discharge requirements but missing from existing data, coordinate with WRD to collect water quality samples, and conduct the laboratory analysis and toxicity testing. To date, the Sanitation Districts have reviewed existing data and started an initial phase of data collection and analysis from WRD and West Basin's facilities. RO concentrate from PWSC's demonstration facility during Year 2 secondary MBR testing will be blended at appropriate ratios with WRD and/or West Basin's concentrate and JWPCP's secondary effluent to complete this analysis. The proportions of concentrates that are blended and tested during the study will be determined based on the facilities that are anticipated to be discharging to JWPCP's outfalls at the time of testing. The study can be adjusted to accommodate a change in anticipated discharge volumes.

PWSC Demonstration Facility RO Concentrate Compliance Assessment - Completed and Future testing

As mentioned above, RO Concentrate Compliance Assessment testing was completed during tertiary MBR ("Year 1") demonstration facility testing and similar monitoring will be implemented in the upcoming secondary MBR ("Year 2") demo testing in October 2022. The parameters in the following Tables 3 to 7, along with nitrate (as nitrogen), organic nitrogen, total organic carbon, total phosphorus, conductivity, salinity, and TDS, were sampled and analyzed as part of the Year 1 testing.

Chemical Parameters

The JWPCP NPDES permit contains technology-based effluent limitations for BOD, TSS, pH, oil and grease, settleable solids, and turbidity. These limitations are derived from standards for secondary wastewater treatment plants specified in the Clean Water Act (BOD, TSS, and pH) and the Ocean Plan (oil and grease, TSS, settleable solids, turbidity, and pH). In order to evaluate future compliance with the technology-based effluent limitations, these parameters were monitored weekly during baseline testing. The list of parameters, frequency, and monitoring locations for technology-based parameters are summarized in Table 3.

Table 3. Compliance Assessment Monitoring for Technology-based Parameters

Parameter	**Monitoring Frequency during Baseline Phase**
BOD	Weekly
Oil and grease	
pH	
Settleable solids	
TSS	
Turbidity	

The JWPCP NPDES permit contains effluent limitations and/or monitoring requirements for certain parameters to protect the quality of the receiving water. The water quality-based effluent limitations are derived from the Ocean Plan, which specifies numerical criteria that are protective of marine aquatic life and human health. These water quality-based parameters with effluent limitations were monitored three times during baseline testing for compliance assessment. Some parameters were monitored more frequently to satisfy other objectives of pilot testing. The list of these parameters is summarized in Table 4.

Additionally, four other water quality-based parameters that do not have effluent limits but are required to be monitored under the JWPCP NPDES permit, were tested in the RO concentrate. These parameters include nitrate (as nitrogen), organic nitrogen, total organic carbon, and total phosphorus. These constituents were used for operational control of the demonstration facility during Year 1 as well as for evaluating the ability of RO concentrate discharge to comply with potential future nutrient requirements for ocean discharge. Conductivity, salinity, and total dissolved solids were also monitored in the RO concentrate. The concentrations of these constituents are used as input into a model that calculates dilution ratios for discharge.

Table 4. Compliance Assessment Monitoring for Water Quality-based Parameters

Water Quality-based Parameters	
Arsenic	Bis(2-Chloroisopropyl)ether
Cadmium	Bis(2-Ethylhexyl)phthalate
Hexavalent Chromium	Carbon tetrachloride
Copper	Total chlordanes[6]
Lead	Chlorobenzene
Mercury	Dibromochloromethane
Nickel	Chloroform
Selenium	Trivalent chromium
Silver	Total DDTs[7]
Zinc	Total 1,2&1,3-dichlorobenzenes
Cyanide, Total	Bromodichloromethane
Ammonia as Nitrogen	Methylene chloride
Non-chlorinated Phenolic Compounds[1]	Dieldrin
Chlorinated Phenolics[2]	Diethyl phthalate
Endosulfan[3]	Dimethyl phthalate
Endrin	Di-n-butyl phthalate
HCH[4]	Ethylbenzene
Radionuclides[5]	Fluoranthene
1,1,1-trichloroethane	Total halomethanes[8]
1,1,2,2-tetrachloroethane	Heptachlor
1,1,2-trichloroethane	Heptachlor epoxide (Isomer B)
1,1-dichloroethene	Hexachlorobenzene
1,2-dichloroethane	Hexachlorobutadiene
1,2-diphenylhydrazine	Hexachlorocyclopentadiene
1,3-dichloropropene	Hexachloroethane
1,4-dichlorobenzene	Isophorone
2,4,6-trichlorophenol	Nitrobenzene
2,4-dinitrophenol	N-nitrosodimethylamine
2,4-dinitrotoluene	N-nitrosodi-n-propylamine
3,3'-dichlorobenzidine	N-nitrosodiphenylamine
4,6-dinitro-2-methylphenol	Total PAHs[9]
Acrolein	Total PCBs[10]
Acrylonitrile	TCDD equivalents
Aldrin	Tetrachloroethene
Antimony	Thallium
Benzene	Toluene
Benzidine	Toxaphene
Beryllium	Tributyltin (TBT)
Bis(2-Chloroethoxy)methane	Trichloroethene
Bis(2-Chloroethyl)ether	Vinyl chloride

1. 2,4-dimethylphenol, 2,4-dinitrophenol, 2-methyl-4,6-dinitrophenol, 2-nitrophenol, and 4-nitrophenol.
2. 2,4,6-Trichlorophenol, 2,4-dichlorophenol, 2-chlorophenol, 4-chloro-3-methylphenol, and petachlorophenol.
3. Sum of endosulfan I, endosulfan II and endosulfan sulfate.
4. Sum of alpha, beta, gamma (lindane) and delta isomers of hexachlorohexane (HCH/BHC).
5. Gross alpha and beta radioactivity, radium 226+228, strontium, tritium, and uranium.
6. Sum of alpha and gamma chlordane, alpha and gamma chlordane, alpha and gamma nonachlor, and oxychlordane.
7. Sum of 4,4'-DDT, 2,4'-DDT, 4,4'-DDE, 2,4'-DDE, 4,4'-DDD, and 2,4'-DDD.
8. Sum of bromoform, bromomethane (methyl bromide), and chloromethane (methyl chloride).
9. Sum of acenapthene, anthracene, benzo(a) anthracene, benzo(a) pyrene, benzo(b) fluoranthene, benzo(g,h,i) perylene, benzo(k) fluoranthene, chrysene, dibenzo(a,h) anthracene, fluorene, indeno(1,2,3-cd) pyrene, phenanthrene, and pyrene.
10. Sum of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260.
    Note: The Ocean Plan also contains objectives for chlorine residual, however chlorine residual was not recommended for monitoring in the Test Plan during Year 1.

The WLAs in the SMB TMDL are incorporated into the JWPCP NPDES permit as effluent limitations for total DDTs (dichloro-diphenyl-trichloroethane isomers) and PCBs (polychlorinated biphenyl compounds). Total DDTs and total PCBs as Aroclors were monitored three times during baseline testing. In addition, samples were collected and analyzed using low-level methods (EPA method 1668 for PCB congeners and EPA method 1699 for DDTs), for which method detection levels are lower than the TMDL-based NPDES permit limits, twice during the baseline phase.

Table 5. Compliance Assessment Monitoring for TMDL Parameters

Parameter	Number of Samples During Baseline Phase
Total DDTs[1]	3
Total DDTs (low level)	2
Total PCBs as Congeners[2] (low level)	2
Total PCBs as Aroclors[3]	3

1. Sum of 4,4'-DDT, 2,4'-DDT, 4,4'-DDE, 2,4'-DDE, 4,4'-DDD, and 2,4'-DDD.
2. Sum of PCB-18, 28, 37, 44, 49, 52, 66, 70, 74, 77, 81, 87, 99, 101, 105, 110, 114, 118, 119, 123, 126, 128, 138, 149, 151, 153, 156, 157, 158, 167, 168, 169, 170, 177, 180, 183, 187, 189, 194, 201, and 206. Number of samples increased to 3 for Year 2 sMBR testing.
3. Sum of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260.

Microbiological Parameters

To evaluate compliance with the JWPCP NPDES and Ocean Plan receiving water microbiology objectives, and to determine if the RO concentrate will require disinfection prior to ocean discharge, testing for select indicator microorganisms (i.e., total/fecal coliform bacteria, *Enterococcus* spp., and male-specific coliphage) and pathogens (i.e., *Giardia*, *Cryptosporidium*, and culturable enteric viruses) was also performed during baseline testing. Bacteria and bacterial viruses (i.e., male-specific and somatic coliphage) were tested eight times (once/week during the first two months), and the pathogens, *Giardia*, *Cryptosporidium*, and enteric viruses were tested four times (once every other week). The microorganisms tested are listed in Table 6.

Table 6. Compliance Assessment Monitoring for Microbiological Parameters

Parameter Type	Microorganism
Bacteria	Total/Fecal Coliforms
Bacteria	Enterococcus
Bacterial Virus	Male-Specific Coliphage
Parasites	Giardia/Cryptosporidium
Virus	Culturable Human Enteric Viruses (A549 cell culture)

Toxicity Parameters

To evaluate compliance with the JWPCP NPDES toxicity discharge limits, acute and chronic toxicity testing was performed on both the RO concentrate and mixtures of the RO concentrate and JWPCP secondary effluent. The RO concentrate and secondary effluent ratios used are shown in Table 2, while the organisms tested are listed in Table 7. The objective was to assess the potential for elicitation of toxicity at the IWC of 0.6% for the JWPCP discharge. *M. beryllina* was used for chronic toxicity testing when *A. affinis* was unavailable or when valid test or quality control data could not be acquired using *A. affinis*. In addition to the acute toxicity data acquired using *A. bahia*, survival (acute) data from both of the fish chronic tests were measured at 96 hours (the acute endpoint), to provide acute toxicity information.

Table 7. Compliance Assessment Monitoring for Toxicity Parameters

Toxicity Test Type	Species Tested
Acute	Mysid Shrimp (*Americamysis bahia*)
Chronic	Topsmelt (*Atherinops affinis*)
	Red Abalone (*Haliotis rufescens*)
	Giant Kelp (*Macrocystis pyrifera*)
	Inland Silverside (*Menidia beryllina*)

Constituents of Emerging Concern (CECs)

CECs were also monitored during baseline testing for tracking purposes and to generate data that could be used to evaluate compliance with potential future regulatory requirements for these chemicals. Monitoring for CECs and a discussion of the results are presented in the section entitled "Constituents of Emerging Concern" below.[4]

[4] Concentration data for certain CECs were collected at the Sanitation Districts' laboratory. These data may have been collected using research analytical methods and should be used for informational and research purposes only.

Year 1 (Tertiary MBR) RO Concentrate Compliance Assessment Results

Chemical Parameters

All technology-based, water quality-based, and TMDL-based parameter results were within the applicable Ocean Plan, TMDL or other NPDES permit limits when the dilution ratio in the JWPCP NPDES permit was applied. Tables 8 through 11 show the monitoring results for these parameters along with their respective limits. Table 12 shows the monitoring results for water quality-based parameters that currently do not have numeric discharge limits but were monitored for operational control and/or for assessing potential compliance with future nutrient limitations for discharge.

Table 8. Demonstration Facility RO Concentrate Technology-Based Parameters

Parameter	Units	Median	Max	NPDES Permit Limits				
				Avg monthly	Avg weekly	Max daily	Instant. Min	Instant. Max
BOD	mg/L	2.0	6	30	45			
Oil and Grease	mg/L	ND	4.3	15	22.5	45		75
pH	pH units	7.4	7.6				6	9
Settleable Solids	mL/L	ND	0.1	0.5	0.75	1.5		3
Total Suspended Solids	mg/L	ND	4.4	30	45			
Turbidity	NTU	ND	0.7	75	100			225

ND = non-detect. In accordance with JWPCP NPDES permit (Order R4-2017-0180), when a non-detected value is included in the dataset, a median value is calculated in place of an average. When the calculated median is an ND, the ND could represent multiple potential detection limits. The detection limit is therefore not shown.

Table 9. Demonstration Facility RO Concentrate Ammonia Results

Date	Ammonia result (mg/L)
7/22/2020	2.39
7/29/2020	2.13
8/5/2020	2.34
8/12/2020	2.68
8/19/2020	2.59
8/26/2020	2.73
9/2/2020	2.89
9/9/2020	3.27
9/16/2020	3.30
9/23/2020	2.65
9/30/2020	2.76
10/7/2020	2.79
10/12/2020	2.98
10/22/2020	2.81
10/28/2020	2.52
11/4/2020	2.24
Average	2.69
Max	3.30
Objective	0.6
Objective with 166:1 dilution	99.6

Table 10. Demonstration Facility RO Concentrate Results for Water Quality-Based Parameters with NPDES Effluent Limits

Parameter	Sample Date (2020) and Result						Ocean Plan	
	8/4-5	8/13	9/1-2	10/6-7	10/20	10/28	Objective[1]	Objective with 166:1 dilution[2]
Arsenic (ug/L)	7.78		8.65	8.47			8	1328
Cadmium (ug/L)	<0.20		<0.20	0.089J			1	166
Hexavalent Chromium (ug/L)		0.33	0.42	0.95			2	332
Copper (ug/L)	1.42		1.8	2.99			3	498
Lead (ug/L)	0.07J		0.06J	0.14J			2	332
Mercury (ug/L)	<0.04		<0.04	<0.04			0.04	6.64
Nickel (ug/L)	22.3		24.5	30.7			5	830
Selenium (ug/L)	14		16.6	13.4			15	2490
Silver (ug/L)	<0.20		<0.20	<0.20			0.7	116.2
Zinc (ug/L)	19.5		24.5	25.1			20	3320
Cyanide, Total (ug/L)	8.18		9.6	5.52			1	166

Parameter	Sample Date (2020) and Result						Ocean Plan	
	8/4-5	8/13	9/1-2	10/6-7	10/20	10/28	Objective[1]	Objective with 166:1 dilution[2]
Non-chlorinated Phenolic Compounds (ug/L)	ND		ND	ND			30	4980
Chlorinated Phenolics (ug/L)	2.8		ND	3.3			1	166
Endosulfan (ug/L)	ND		ND	ND			0.009	1.494
Endrin (ug/L)	0.01		<0.01	<0.01			0.002	0.332
HCH (ug/L)	ND		ND	ND			0.004	0.664
Gross Alpha Radioactivity (pCi/L)	4.74		-7.73	15.2			Footnote 3	-
Gross Beta Radioactivity (pCi/L)	60.9		94.3	66.6				
Radium 226+228 (pCi/L)	0.7		0.13	0.26				
Strontium-90 (pCi/L)	0.499		0.202	0.305				
Tritium (pCi/L)	143		67.6	79.7				
Total Uranium (pCi/L)	4.3		7.32	5.57				
1,1,1-Trichloroethane (ug/L)	<0.50		<0.50	<0.50			540000	89640000
1,1,2,2-Tetrachloroethane (ug/L)	<0.50		<0.50	<0.50			2.3	381.8
1,1,2-Trichloroethane (ug/L)	<0.50		<0.50	<0.50			9.4	1560.4
1,1-Dichloroethene (ug/L)	<0.50		<0.50	<0.50			0.9	149.4
1,2-Dichloroethane (ug/L)	<0.50		<0.50	<0.50			28	4648
1,2-Diphenylhydrazine (ug/L)	<2.0		<20.0	<2.0			0.16	26.56
1,3-Dichloropropene (Total) (ug/L)	ND		ND	ND			8.9	1477.4
1,4-Dichlorobenzene (ug/L)	<0.50		<0.50	<0.50			18	2988
2,4,6-Trichlorophenol (ug/L)	2.8		<20.0	3.3			0.29	48.14
2,4-Dinitrophenol (ug/L)	<10.0		<100	<10.0			4	664
2,4-Dinitrotoluene (ug/L)	<2.0		<20.0	<2.0			2.6	431.6
3,3'-Dichlorobenzidine (ug/L)	<2.0		<20.0	<2.0			0.0081	1.3446
2,4,6-Trichlorophenol (ug/L)	2.8		<20.0	3.3			0.29	48.14
Acrolein (ug/L)	0.94J		<2.0	<2.0			220	36520
Acrylonitrile (ug/L)	<2.0		<2.0	<2.0			0.1	16.6
Aldrin (ug/L)	<0.005		<0.005	<0.005			0.000022	0.003652
Antimony (ug/L)	6.01		7.6	7.02			1200	199200
Benzene (ug/L)	<0.50		<0.50	<0.50			5.9	979.4
Benzidine (ug/L)	<10.0		<100	<10.0			0.000069	0.011454
Beryllium (ug/L)	<0.25		<0.25	<0.25			0.033	5.478
Bis(2-Chloroethoxy)methane (ug/L)	<2.0		<20.0	<2.0			4.4	730.4
Bis(2-Chloroethyl)ether (ug/L)	<2.0		<20.0	<2.0			0.045	7.47
bis(2-Chloroisopropyl)ether (ug/L)	<2.0		<20.0	<2.0			1200	199200

Parameter	Sample Date (2020) and Result						Ocean Plan	
	8/4-5	8/13	9/1-2	10/6-7	10/20	10/28	Objective[1]	Objective with 166:1 dilution[2]
bis(2-Ethylhexyl)phthalate (ug/L)	<6.0		<3.0		0.83J	<3.0	3.5	581
Bromodichloromethane (ug/L)	1		1.2	0.62			6.2	1029.2
Carbon Tetrachloride (ug/L)	<0.50		<0.50	<0.50			0.9	149.4
Total Chlordanes (ug/L)	ND		ND	ND			0.000023	0.003818
Chlorobenzene (ug/L)	<0.50		<0.50	<0.50			570	94620
Chloroform (ug/L)	8		9.1	6.7			130	21580
Total DDTs (ug/L)[4]			ND	ND			0.00017	0.02822
Dibromochloromethane (ug/L)	0.19J		0.38J	0.14J			8.6	1427.6
Total 1,2&1,3-Dichlorobenzenes (ug/L)	ND		ND	ND			5100	846600
Dieldrin (ug/L)	<0.01		<0.01	<0.01			0.00004	0.00664
Diethyl phthalate (ug/L)	<2.0		<20.0	<2.0			33000	5478000
Dimethyl phthalate (ug/L)	<2.0		<20.0	<2.0			820000	136120000
Di-n-butyl phthalate (ug/L)	<2.0		<20.0	<2.0			3500	581000
Ethylbenzene (ug/L)	<0.50		<0.50	<0.50			4100	680600
Fluoranthene (ug/L)	<0.020		<0.020	<0.020			15	2490
Heptachlor (ug/L)	<0.01		<0.01	<0.01			0.00005	0.0083
Heptachlor epoxide (Isomer B) (ug/L)	<0.01		<0.01	<0.01			0.00002	0.00332
Hexachlorobenzene (ug/L)	<0.20		<0.10		<0.10	<0.10	0.00021	0.03486
Hexachlorobutadiene (ug/L)	<2.0		<20.0	<2.0			14	2324
Hexachlorocyclopentadiene (ug/L)	<2.0		<1.0		<1.0	<1.0	58	9628
Hexachloroethane (ug/L)	<2.0		<20.0	<2.0			2.5	415
Isophorone (ug/L)	<2.0		<20.0	<2.0			730	121180
Methylene Chloride (ug/L)	<0.50		<0.50	<0.50			450	74700
Nitrobenzene (ug/L)	<2.0		<20.0	<2.0			4.9	813.4
N-Nitrosodimethylamine (ug/L)	0.63		0.41		0.93	0.84	7.3	1211.8
N-Nitrosodi-n-propylamine (ug/L)	<0.0020		<0.020		<0.020	<0.020	0.38	63.08
N-Nitrosodiphenylamine (ug/L)	<0.010		<0.10		<0.10	<0.10	2.5	415
Total PAHs (ug/L)	0.03		0.027	ND			0.0088	1.4608
Total Detectable PCBs (ug/L)			ND	ND			0.000019	0.003154
TCDD Equivalents (ug/L)	ND		ND	ND			0.0039	0.6474
Tetrachloroethene (ug/L)	<0.50		<0.50	<0.50			2	332
Thallium (ug/L)	<0.25		<0.25	<0.25			2	332
Toluene (ug/L)	<0.50		<0.50	<0.50			85000	14110000
Total Halomethanes (ug/L)	ND		ND	ND			130	21580

Parameter	Sample Date (2020) and Result						Ocean Plan	
	8/4-5	8/13	9/1-2	10/6-7	10/20	10/28	Objective[1]	Objective with 166:1 dilution[2]
Toxaphene (ug/L)	<0.50		<0.5	<0.5			0.00021	0.03486
Tributyltin (TBT) (ng/L)	<3.0		<3.0	<3.0			0.0014	0.2324
Trichloroethene (ug/L)	<0.50		<0.50	<0.50			27	4482
Trivalent Chromium (ug/L)		2.12	2.9	3.62			190000	31540000
Vinyl Chloride (ug/L)	<0.50		<0.50	<0.50			36	5976

1. Objectives for the protection of marine aquatic life are expressed in 6-month median, daily maximum, and instantaneous maximum concentrations. The 6-month median objectives are used in this table as the most conservative.
2. Uses the dilution ratio in the JWPCP NPDES permit for Discharge Points 001 and 002: 166:1. Discharge Points 003 and 004 are used only during emergency high flows and have dilution ratios of 150:1 and 115:1 respectively. The data presented in this table also do not exceed the Ocean Plan objectives considering the lower dilution scenarios.
3. The water quality objectives for radioactivity in the Ocean Plan states the value is not to exceed limits specified in Title 17, Division 1, Chapter 5, Subchapter 4, Group 3, Article 3, Section 30253 of the California Code of Regulations. This regulation does not establish a numerical limit for radionuclides.
4. Analyzed using EPA method 608.3.
5. ND = non-detect. ND is shown in place of a detection limit when the constituent concentration is calculated and a detection limit is not applicable.

Table 11. Demonstration Facility RO Concentrate Results - SMB TMDL Parameters

Parameter	Analytical Method	Sample Date			Average Monthly Effluent Limit[1]
		8/5/2020	9/2/2020	10/7/2020	
Total DDTs (ug/L)	EPA 608.3	-	ND	ND	0.0158
Total DDTs (low level) (ug/L)	EPA 1699	1.16E-04	1.42E-04	-	
Total PCBs as Congeners (ug/L)	EPA 1668	-	ND	ND	3.50E-04
Total PCBs as Aroclors (ug/L)	EPA 608.3	1.78E-05	2.88E-05	-	

1. The limits in this table are only applicable to Discharge Points 001 and 002.

Table 12. Demonstration Facility RO Concentrate and JWPCP Chlorinated Effluent Results - Water Quality-Based Parameters without NPDES Effluent Limits

Parameter	Units	Chlorinated Effluent			RO Concentrate		
		Median	Max	N	Median	Max	N
Nitrate as Nitrogen	mg/L	0.0905 J	0.246	20	224	275	20
Organic Nitrogen	mg/L	ND	2.68	4	ND	ND	4
Total Organic Carbon	mg/L	12.8	14.8	52	44.4	48.0	4
Total Phosphorus as P	mg/L	0.746	0.847	4	2.56	3.09	4
Salinity	-	1.2	1.2	16	6	6.9	16
Conductivity	µmhos/cm @ 25°C	2,290	2,510	17	10,600	12,000	16
Total Dissolved Solids (TDS)	mg/L	1,380	1,600	17	8,195	12,900	16

N: Number of Samples
J: Detected but not quantified
ND: non-detect

Microbiological Parameters

All microbiological parameter results (total and fecal Coliforms and *Enterococcus*) for the RO concentrate were within NPDES permit limits for receiving waters outside of the initial zone of dilution. Table 13 shows the monitoring results for these parameters along with the NPDES permit limits. The RO concentrate consistently met permit limits for total and fecal coliform and *Enterococcus*, with and without dilution. Therefore, disinfection of RO concentrate would not be required.

Table 13. Demonstration Facility RO Concentrate Results for Microbiological Parameters

	Mean Indicator Concentration for Positive Samples[1, 2, 3]			NPDES Permit Limit for Receiving Waters (to be collected outside initial zone of dilution)	
Microbe	**Pre-Testing**	**Baseline Testing**	**Challenge Test 3**	**30-day Geometric Mean Limits**	**Single Sample Maximum Limits**
Total Coliforms (CFU/L)	1.4E+2 (1.6E+2)	1.9E+1 (2.2E+1)	8.1E+1 (9.3E+1)	10,000	1.0E+5 [4]
Fecal Coliforms (CFU/L)	8.0E+1 (1.5E+2)	N/A	8.3E+0 (1.5E+1)	2000	4000
Enterococcus (CFU/L or MPN/L)	N/A	N/A	5.0E+0 (9.2E+0)	350	1040
Male-Specific Coliphage (PFU/L)	9E-1 (2.2E+0)	2.5E+0 (6.0E+0)	2.2E+1 (5.2E+1)	NA	NA

1. Units are expressed in colony forming units per liter (CFU/L) for total and fecal coliforms, a combination of CFU/L and most probable number per liter (MPN/L) for Enterococcus, and plaque forming units per liter (PFU/L) for male-specific coliphage.
2. Results from samples collected on 9/15/21 were not included in determination of mean concentrations. Samples from 9/15/21 were collected subsequent to an approximately 5 hour lapse in the pre-RO hypochlorite addition. Lack of chlorine addition likely contributed to the elevated indicator concentrations observed on that date.
3. Values in parentheses are recovery adjusted mean concentrations.
4. Total coliform density shall not exceed 1,000/100 mL, if the ratio of fecal-to-total coliform exceeds 0.1.

Toxicity Parameters

Toxicity testing results indicate there were no failures (biological/toxic effects) using the EPA's test of significant toxicity (TST) at the 1% dilution level or higher for each of the combinations of RO concentrate and JWPCP secondary effluent tested. The 1% dilution level is closest to the JWPCP IWC of 0.6%. Tables 14 to 20 below show the toxicity testing results for the blended flows at the 1% sample concentration. Testing demonstrates that toxicity limits would be consistently met, considering blending with JWPCP secondary effluent and dilution of the discharge. The Year 1 Final Report will include the full set of data (over the 1% sample concentration) for each of the combinations.

Table 14: Acute toxicity of RO concentrate/JWPCP secondary effluent mixtures to the Mysid Shrimp (*A. bahia*)

RO Concentrate / JWPCP Secondary Effluent Ratio	Test Initiation Date	Sample Concentration (%)	Mean % Survival	Survival (% Effect)	Survival TST (Pass/Fail)
32% / 68%	8/19/20	Control	100	0	N/A
		1	92.0	8.0	Pass
8% / 92%	10/7/20	Control	100	0	N/A
		1	94.0	6.0	Pass
2% / 98%	9/1/20	Control	100	0	N/A
		1	94.0	6.0	Pass
0.4% / 99.6%	9/9/20	Control	100	0	N/A
		1	100	0.0	Pass

Table 15: Chronic toxicity of RO concentrate/JWPCP secondary effluent mixtures to Topsmelt (*A. affinis*)

RO Concentrate / JWPCP Secondary Effluent Ratio	Test Initiation Date	Sample Concentration (%)	Mean % Survival	Survival (% Effect)	Survival TST (Pass/ Fail)	Mean Biomass (mg)	Biomass (% Effect)	Biomass TST (Pass/ Fail)
0.4% / 99.6%	10/21/20	Control	92.0	0	-	0.96	0	-
		1	88.0	4.4	Pass	1.02	-7.0	Pass

Table 16. Acute toxicity of RO concentrate/JWPCP secondary effluent mixtures to Topsmelt (*A. affinis*). 96-hour acute endpoint data obtained from *A. affinis* chronic test

RO Concentrate/ JWPCP Secondary Effluent Ratio	Test Initiation Date	Sample Concentration (%)	Mean % Survival	Survival (% Effect)	Survival TST (Pass/Fail)
0.4% / 99.6%	10/21/20	Control	100	0	-
		1	100	0.0	Pass

Table 17. Chronic toxicity of RO concentrate/JWPCP secondary effluent mixtures to Inland Silversides (*M. beryllina*)

RO Concentrate/ JWPCP Secondary Effluent Ratio	Test Initiation Date	Sample Concen-tration (%)	Mean % Survival	Survival (% Effect)	Survival TST (Pass/Fail)	Mean Biomass (mg)	Biomass (% Effect)	Biomass TST (Pass/Fail)
32% / 68%	8/19/20	Control	92.0	0	-	1.03	0	-
		1	96.0	-4.4	Pass	1.05	-1.9	Pass
32% / 68%	10/9/20	Control	96.0	0	-	2.25	0	-
		1	96.0	0.0	Pass	2.13	5.0	Pass
8% / 92%	10/9/20	Control	92.5	0	-	2.26	0	-
		1	94.0	-1.6	Pass	2.30	-1.6	Pass
2% / 98%	9/1/20	Control	94.0	0	-	1.71	0	-
		1	100	-6.4	Pass	1.82	-6.2	Pass
0.4% / 99.6%	10/21/20	Control	98.0	0	-	2.36	0	-
		1	98.0	0.0	Pass	2.50	-6.1	Pass

Table 18. Acute toxicity of RO concentrate/JWPCP secondary effluent mixtures to Inland Silversides (*M. beryllina*). 96-hour acute endpoint data obtained from *M. beryllina* chronic tests.

RO Concentrate/ JWPCP Secondary Effluent Ratio	Test Initiation Date	Sample Concen-tration (%)	Mean % Survival	Survival (% Effect)	Survival TST Pass/Fail
32% / 68%	8/19/20	Control	92.0	0	-
		1	96.0	-4.4	Pass
32% / 68%	10/9/20	Control	96.0	0	-
		1	96.0	0.0	Pass
8% / 92%	10/9/20	Control	97.5	0	-
		1	94.0	3.8	Pass
2% / 98%	9/1/20	Control	94.0	0	-
		1	100	-6.4	Pass
0.4% / 99.6%	10/21/20	Control	98.0	0	-
		1	98.0	0.0	Pass

Table 19. Chronic toxicity of RO concentrate/JWPCP secondary effluent mixtures to Red Abalone (*H. rufescens*)

RO Concentrate/ JWPCP Secondary Effluent Ratio	Test Initiation Date	Sample Concentration (%)	Mean Larval Development	Larval Development (% Effect)	Larval Development TST (Pass/Fail)
32% / 68%	8/19/20	Control	94.4	0	-
		1	94.0	0.4	Pass
8% / 92%[1]	8/26/20[1]	Control	82.0	0	-
		1	80.2	2.2	Pass
2% / 98%	9/1/20	Control	93.8	0	-
		1	93.4	0.4	Pass
0.4% / 99.6%	9/9/20	Control	95.8	0	-
		1	97.0	-1.2	Pass

[1]The 8/26/20 concurrent reference toxicant test failed test acceptability criteria for control mean larval development (<80% mean larval development).

Table 20. Chronic toxicity of RO concentrate/JWPCP secondary effluent mixtures to Giant Kelp (*M. pyrifera*)

RO Concentrate / JWPCP Secondary Effluent Ratio	Test Initiation Date	Sample Concen-tration (%)	Mean % Germin-ation	Germin-ation (% Effect)	Germin-ation TST (Pass/Fail)	Mean Tube Length (µm)	Mean Tube Length (% Effect)	Mean Tube Length TST (Pass/Fail)
32% / 68%	8/19/20	Control	96.2	0	-	14.6	0	-
		1	98.0	-1.9	Pass	13.8	5.0	Pass
32% / 68%	10/7/20	Control	78.6	0	-	14.6	0	-
		1	78.0	0.8	Pass	15.6	-6.8	Pass
8% / 92%	8/26/20	Control	73.6	0	-	15.8	0	-
		1	69.4	5.7	Pass	17.2	-9.2	Pass
2% / 98%	9/1/20	Control	86.6	0	-	16.0	0	-
		1	89.6	-3.5	Pass	16.0	0.0	Pass
0.4% / 99.6%	9/9/20	Control	81.8	0	-	16.9	0	-
		1	84.2	-2.9	Pass	15.8	6.2	Pass

Constituents of Emerging Concern

Constituents of emerging concern, or CECs, include a wide variety of organic chemicals which are generally not regulated. CECs include substances such as pharmaceuticals, pesticides, commercial products, and flame retardants. Many of these chemicals are sometimes present in wastewater or the environment in trace amounts that were previously not detectable by available analytical methods, however recent advances in techniques for analyses of these chemicals has allowed detection at low levels. This has led to efforts to investigate potential impacts to human and environmental health from these chemicals.

To prioritize efforts to address CECs, the State Board has convened two Science Advisory Panels charged with developing recommendations for monitoring strategies for CECs, with one panel focused on CECs in recycled water and one focused on CECs in aquatic ecosystems. The Science Advisory Panel for Constituents of Emerging Concern in California's Aquatic Ecosystems was initially convened in 2009 by the Southern California Coastal Water Research Project (SCCWRP) at the request of the State Board and published recommendations in a 2012 report entitled *Monitoring Strategies for Chemicals of Emerging Concern (CECs) in California's Aquatic Ecosystems* (Ecosystems CEC Panel Report). The panel was reconvened in 2020 to update the recommendations in the 2012 report and is scheduled to publish its final report in fall 2022. The State Board convened a separate Science Advisory Panel, also facilitated by SCCWRP, to develop monitoring strategies for CECs in recycled water. This panel initially published recommendations in a 2010 report. The panel was reconvened in 2017 and published an updated report in 2018 entitled *Monitoring Strategies for Constituents of Emerging Concern in Recycled Water*. The recommendations in this report were incorporated as monitoring requirements for indirect potable reuse projects into the most recent update to the State Board's *Water Quality Control Policy for Recycled Water* (Recycled Water Policy), which became effective in 2019. Both Science Advisory Panels developed monitoring recommendations based on a risk-based framework to screen and prioritize CECs. Findings included lists of CECs recommended for monitoring in various scenarios and Monitoring Trigger Levels (MTLs), which if exceeded would trigger response actions ranging from collecting confirmation samples, increasing frequency of monitoring, notification of regulators, and investigations into the source(s) or cause(s) of elevated levels of the compound in question. Monitoring recommendations and MTLs were developed based on available data on occurrence and concentrations of CECs in recycled water or aquatic ecosystems/discharges to aquatic ecosystems compared to available toxicological information for applicable beneficial uses gathered from literature.

Relevant Findings from Ecosystems CEC Panel Report

The Ecosystems CEC Panel Report evaluated stormwater and wastewater treatment plant effluent discharges to inland surface waters (freshwater), estuaries, and the ocean. CEC monitoring data reviewed included aqueous concentrations in discharges as well as aqueous, sediment and tissue concentrations in receiving waters. Data were compared to toxicology data from literature in order to select CECs posing the greatest potential risk to aquatic life depending on the type of waterbody. For the selected CECs, MTLs were derived by applying safety factors to toxic threshold[5] concentrations from literature to address uncertainties based on the panel's professional judgement. The panel did not specifically evaluate discharges of RO concentrate; as such, the most relevant findings from the Ecosystems CEC Panel Report are those pertaining to discharge of treated wastewater to the ocean.

For treated wastewater discharges to the ocean, the panel's risk-based framework did not identify any CECs recommended for monitoring based on water quality data, i.e., the occurrence data reviewed did not exceed literature-based values that would impact aquatic life for aqueous concentrations of CECs. The panel noted that the analysis informing their recommendations assumed 1,000:1 dilution ratio for ocean wastewater discharges, but that even if the dilution ratio was decreased to 100:1, only a single compound would be identified based on the panel's framework: bifenthrin. As bifenthrin was not an official monitoring recommendation for ocean discharges, an MTL was not provided in the report. The panel did identify five compounds recommended for monitoring based on

[5] For example, lowest observable effect concentrations (LOECs) or no observable effect concentrations (NOECs) from available studies of survival, growth and reproduction of aquatic organisms.

concentrations in sediment: bis(2)-ethylhexyl phthalate, p-nonylphenol, PBDE-47, PBDE-99 and butyl benzyl phthalate and presented MTLs for sediment samples for comparison to monitoring data.

For other wastewater discharge scenarios, the panel recommended monitoring of several CECs for wastewater discharges to inland surface water and estuaries, with a total of 16 CECs recommended for monitoring by the panel. Depending on the specific compound, recommendations were made based on water, sediment or tissue data, or a combination of several matrices.

PFAS

Per- and polyfluoroalkyl substances (PFAS) are a class of synthetic chemicals found in a wide variety of consumer products and industrial sources. PFAS are persistent in the environment and are associated with various negative human health impacts. PFAS encompass a long list of chemicals, however perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) in particular have been the focus of efforts to regulate PFAS concentrations in water. Both the EPA and State Board are in the process of developing drinking water maximum contaminant levels (MCLs) for PFOS and PFOA, and the State Board has established drinking water notification levels for PFOS, PFOA, perfluorobutane sulfonate (PFBS) and perfluorohexane sulfonate (PFHxS).

In April 2022, the EPA issued draft aquatic life ambient water quality criteria for PFOA and PFOS, establishing draft freshwater acute (1-hour average) and chronic (4-day average) water column criteria as well as aquatic life tissue criteria. For marine waters, acute water column benchmarks (listed in Table 23) were established in lieu of criteria due to insufficient toxicity data for a diverse array of marine species. According to supporting documentation for the development of the criteria/benchmarks, “Both the freshwater criteria and estuarine/marine benchmarks are draft recommendations for states/authorized tribes to consider as protective values in their state/tribal water quality protection programs.” The EPA is expected to issue ambient water quality criteria for the protection of human health (via fish consumption and drinking water) for PFOA and PFOS as well, and these values may be significantly lower than the aquatic life criteria. However, the human health criteria are not expected to be released until fall 2024.

CEC monitoring in Demonstration Facility RO concentrate

Monitoring Plan

With respect to ocean discharge of RO concentrate for the Pure Water Southern California project, monitoring of CECs in the RO concentrate was/will be conducted for completed and future phases of piloting. These data will be used to assess the fate of CECs through the advanced treatment processes at the demonstration facility and can be used to evaluate compliance with any future regulatory requirements for these compounds.

CEC monitoring in the demonstration facility RO concentrate during pilot testing was based on the recommendations in the Science Advisory Panel reports. The list of constituents monitored is presented in Table 21, along with the type of chemical and applicability to recycled water and wastewater discharges to various aquatic ecosystems. In addition to CEC monitoring recommendations from the Science Advisory Panels, the CEC monitoring list for the RO concentrate is also consistent with ongoing voluntary monitoring conducted by the Sanitation Districts in the influent and effluent at most of its wastewater treatment plants, including JWPCP. Sanitation Districts’ voluntary CEC monitoring program includes an extensive list of additional compounds. For Year 1, CECs were monitored in the JWPCP secondary effluent and RO concentrate three times during the baseline phase (July – October 2020). Some compounds were monitored more frequently to satisfy other goals of the Testing and Monitoring Plan. Year 2 monitoring for CECs will include the same constituents and frequencies at the same locations as Year 1 testing, however additional PFAS compounds will be monitored due to the availability of improved analytical methods.

Table 21. CECs monitored for Compliance Assessment. W = Water Column Samples, S = Sediment Samples, T = Tissue Samples.

Chemical	Type of Compound	Monitoring Recommendations			
		Recycled Water[1]	Aquatic Ecosystems[2]		
			Ocean	Estuary	Freshwater
17-Alpha Ethinylestradiol	Pharmaceutical				
17-Beta estradiol	Pharmaceutical			W	W
4-Nonylphenol	Surfactant		S		
4-tert Octylphenol	Surfactant				
Acetaminophen	Pharmaceutical				
Amoxicillin	Pharmaceutical				
Atenolol	Pharmaceutical				
Azithromycin	Pharmaceutical				
Bifenthrin	Pesticide		W[3]	W, S	W
Bis(2-ethylhexyl)phthalate[4]	Plasticizer		S		
Bisphenol A	Plasticizer			W	W
Butyl benzyl phthalate	Plasticizer		S		
Caffeine	Stimulant				
Carbamazepine	Pharmaceutical				
Chlorpyrifos (Dursban)	Pesticide			W	W
DEET	Insect repellent				
Diazepam	Pharmaceutical				
Diclofenac	Pharmaceutical			W	W
Dilantin (Phenytoin)	Pharmaceutical				
Estrone	Pharmaceutical			W	W
Fipronil	Pesticide				
Fluoxetine	Pharmaceutical				
Galaxolide	Fragrance			W	W
Gemfibrozil	Pharmaceutical	W			
Ibuprofen	Pharmaceutical				W
Iohexol	X-ray contrast agent	W			
Iopromide	X-ray contrast agent				
Meprobamate	Pharmaceutical				
Metoprolol	Pharmaceutical				
N-nitrosomorpholine	Disinfection Byproduct	W			
Nonylphenol diethoxylate	Surfactant				
Nonylphenol monoethoxylate	Surfactant				
Octylphenol diethoxylate	Surfactant				
Octylphenol monoethoxylate	Surfactant				
PBDE-100	Flame retardant				
PBDE-153	Flame retardant				
PBDE-154	Flame retardant				
PBDE-183	Flame retardant				

Chemical	Type of Compound	Monitoring Recommendations			
		Recycled Water[1]	Aquatic Ecosystems[2]		
			Ocean	Estuary	Freshwater
PBDE-209	Flame retardant				
PBDE-28	Flame retardant				
PBDE-47	Flame retardant		S, T	S, T	T
PBDE-99	Flame retardant		S, T	S, T	T
Perfluorooctane sulfonate	PFAS	W	T	T	T
Perfluorooctanoic acid	PFAS	W			
Permethrin	Insect repellent (lice)				
Sucralose	Artificial Sweetener	W			
Sulfamethoxazole	Pharmaceutical	W			
Triclocarban	Disinfectant				
Triclosan	Disinfectant				W
Trimethoprim	Pharmaceutical				
TDCPP	Flame retardant				
TCEP	Flame retardant				
TCPP	Flame retardant				

1. Science Advisory Panel monitoring recommendations in the 2018 report: *Monitoring Strategies for Constituents of Emerging Concern in Recycled Water*.
2. Science Advisory Panel monitoring recommendations in the 2012 report: *Monitoring Strategies for Chemicals of Emerging Concern (CECs) in California's Aquatic Ecosystems.*
3. Recommended for monitoring in wastewater discharges to the ocean only when dilution is less than 100:1.
4. Regulated in the 2019 California Ocean Plan.

W: water column samples
S: sediment samples
T: tissue samples

Year 1 Testing Results

The results of Year 1 testing for CECs in the RO concentrate produced by the demonstration facility are presented below. The results are organized as follows:

- RO concentrate concentrations compared to concentrations in JWPCP secondary effluent currently being discharged to the ocean,
- RO concentrate concentrations for constituents recommended to be monitored in wastewater discharge to the ocean based on the Ecosystems CEC Panel,
- PFAS RO concentrate results compared to EPA draft marine benchmarks, and
- RO concentrate concentrations compared to available MTLs for recycled water, freshwater and estuarine waters.

Results are presented considering applicable dilution ratios based on the JWPCP NPDES permit, as well as blending with JWPCP secondary effluent prior to discharge. For evaluating CECs, the blending ratio for the full-scale AWTF production (150 MGD of recycled water) was used as the most conservative scenario with the greatest volume of RO concentrate being discharged (i.e., 68% secondary effluent and 32% RO concentrate, per Table 2).

Figure 2 shows the average concentration in the RO concentrate compared to the average JWPCP secondary effluent concentration. The diluted concentrations of both the RO concentrate and JWPCP secondary effluent using a dilution ratio of 166:1 according to the JWPCP NPDES Permit are also shown. Finally, to represent discharge conditions for the full-scale project, concentrations accounting for blending of JWPCP secondary effluent and RO

concentrate (68% secondary effluent and 32% RO concentrate) and dilution with ocean water (166:1) are also presented.

Figure 3 presents the maximum concentration detected in the RO concentrate and JWPCP secondary effluent during Year 1 baseline testing, along with the diluted and blended concentrations, similar to Figure 2, calculated using the maximum concentrations.

Non-detect concentrations are not shown on Figures 2 and 3. Out of the 53 constituents monitored, a total of 16 were not detected in any RO concentrate samples:

- 17-Alpha Ethinylestradiol
- Amoxicillin
- Bis(2-ethylhexyl) phthalate
- Bifenthrin
- Butyl benzyl phthalate
- Diazepam
- PBDE-100, -153, -154, -183, -209, -28, 47, and -99
- Permethrin
- Triclocarban

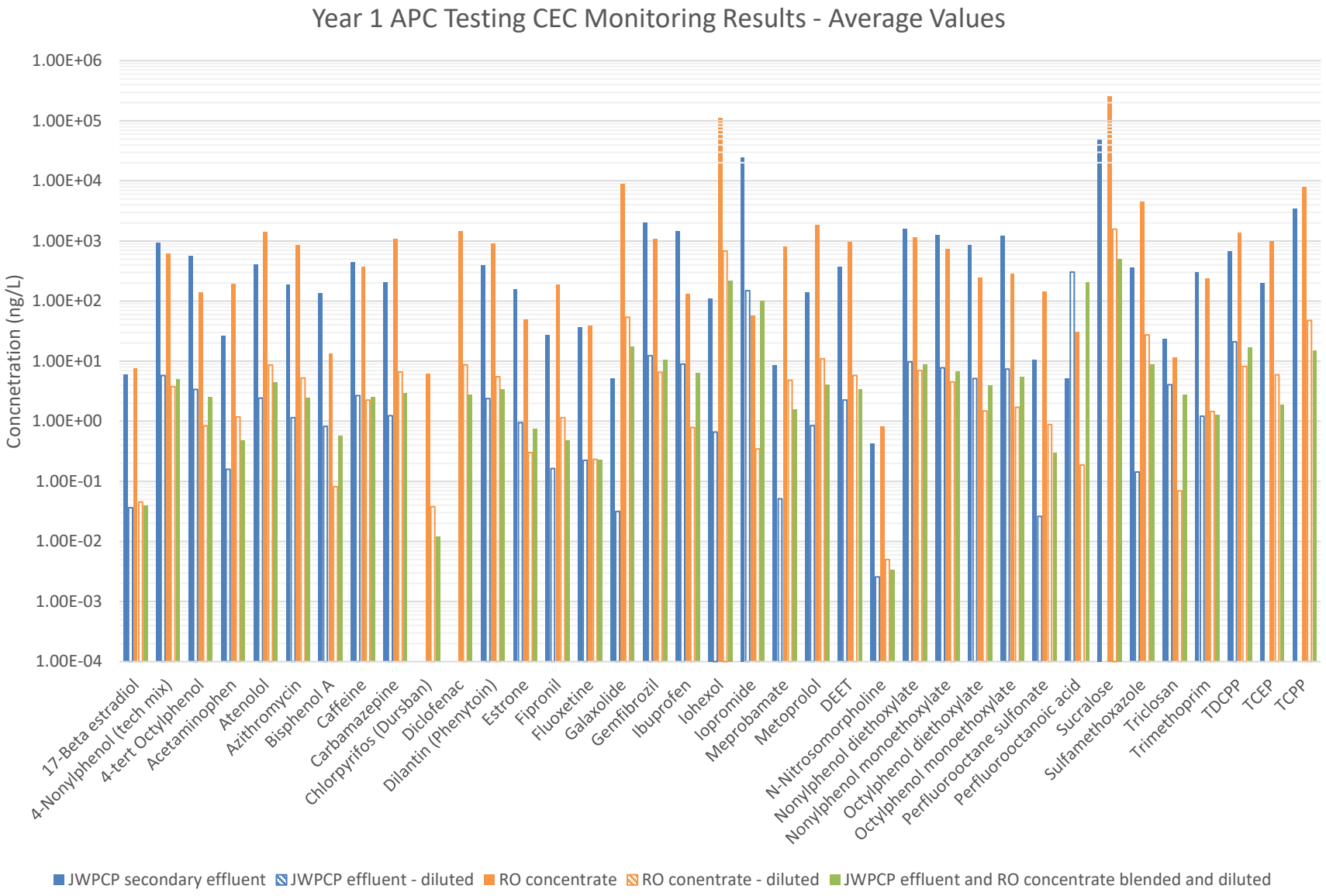

Figure 2. Average CEC concentrations in the Demonstration Facility RO concentrate and JWPCP secondary effluent

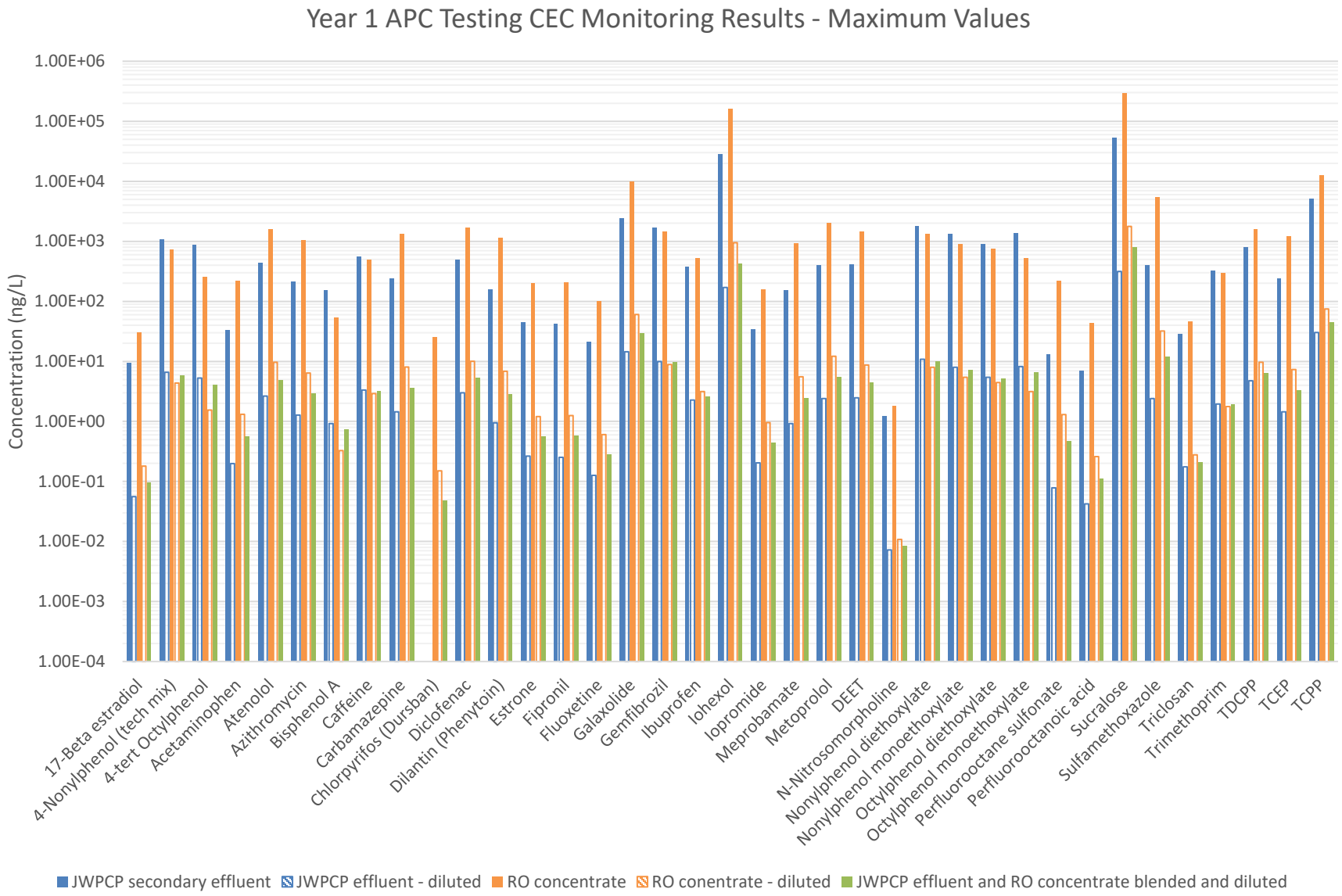

Figure 3. Maximum CEC concentrations in the Demonstration Facility RO concentrate and JWPCP secondary effluent

RO concentrate sample results for the constituents recommended for monitoring by the Ecosystems CEC Expert Panel Report for wastewater discharges to the ocean are presented in Table 22, with the exception of PFOS and PFOA, which is shown in Table 23. As discussed above, the Ecosystems CEC Expert Panel Report did not provide MTLs applicable to aqueous concentrations for these compounds. To represent discharge conditions for the full-scale project, Table 22 also includes the maximum concentration detected in JWPCP secondary effluent for each parameter, the calculated blended concentrations for the full-scale AWTF (68% JWPCP secondary effluent and 32% RO concentrate), and the blended concentration with dilution (166:1 with ocean water). Concentrations of bifenthrin, PBDE-47, PBDE-99, butylbenzyl phthalate, and bis(2-ethylhexyl)phthalate were non-detect or detected but not quantified in all RO concentrate samples. 4-nonylphenol was the only constituent in this group that was detected in the RO concentrate, however RO concentrate results were consistently lower than JWPCP effluent concentrations (currently discharged to the ocean), indicating that this compound was reduced in the MBR process at the demonstration facility prior to RO. Thus, ocean disposal of RO concentrate from the project will not adversely impact discharged concentrations of these compounds.

Table 22. Demonstration Facility RO Concentrate Monitoring Results – CECs of Interest for Ocean Discharge

Parameter	Sample Date (2020) and Result						Avg	Max	JWPCP secondary effluent - Max	JWPCP effluent blended w/ RO Concentrate (max values)	Blend w/ dilution (166:1)
	8/5	9/2	9/28	10/7	10/20	10/28					
4-nonylphenol (ng/L)	727		499	-	652	-	626	727	1090	974	5.87
Bifenthrin (ng/L)	<2.0	<0.40	-	-	<0.40	<0.40	ND	ND	2.62	1.78	0.01
Bis(2-Ethylhexyl) phthalate (ug/L)	<6.0	<3.0	-	-	0.83J	<3.0	ND	0.83J	0.75J	ND	ND
Butyl benzyl phthalate (ug/L)	<2.0	<20.0	-	<2.0	-	-	ND	ND	ND	ND	ND
PBDE-47 (ng/L)	<10	<10	-	-	<10	<10	ND	ND	ND	ND	ND
PBDE-99 (ng/L)	<10	<10	-	-	<10	<10	ND	ND	ND	ND	ND

1. ND = non-detect. In accordance with JWPCP NPDES permit (Order R4-2017-0180), when a non-detected value is included in the dataset, a median value is calculated in place of an average. When the calculated median is an ND, the ND could represent multiple potential detection limits. The detection limit is therefore not shown.
2. Concentration data for certain CECs were collected at the Sanitation Districts' laboratory. These data may have been collected using research analytical methods and should be used for informational and research purposes only.

RO concentrate sample results for PFOA and PFOS are summarized in Table 23 and compared to the draft EPA marine benchmarks. The benchmarks with the 166:1 dilution ratio in the JWPCP NPDES permit are also shown. Additionally, to represent discharge conditions for the full-scale project, Table 23 includes the maximum concentration detected in JWPCP secondary effluent for each parameter and the calculated blended concentrations for the full-scale AWTF (68% JWPCP secondary effluent and 32% RO concentrate). The RO concentrate results are several orders of magnitude below the draft EPA benchmarks that are protective of marine aquatic life. These concentrations will be further reduced by blending with JWPCP effluent and dilution with ocean water.

Table 23. Demonstration Facility RO Concentrate Monitoring Results - PFOS and PFOA

Parameter	Sample Date (2020) and Result					Avg	Max	JWPCP secondary effluent Max	JWPCP effluent blended w/ RO Concentrate (max values)	Draft EPA Marine Acute Bench-marks	Draft Bench-marks w/ dilution (166:1)
	8/5	9/2	10/7	10/9	10/28						
PFOS (ng/L)	216	178	101	126	112	147	216	13	78.0	5.5E+5	9.13E+7
PFOA (ng/L)	28	30	26	28	43	31	43	7	18.5	7.0E+6	1.16E+9

The RO concentrate CEC results compared to recycled water, freshwater and estuary MCLs are shown in Table 24.[6] The benchmarks with the 166:1 dilution ratio are also shown. Additionally, to represent discharge conditions for the full-scale project, Table 24 includes the maximum concentration detected in JWPCP secondary effluent for each parameter and the calculated blended concentrations for the full-scale AWTF (68% JWPCP secondary effluent and 32% RO concentrate). When blending and dilution are accounted for, concentrations of these CECs were below all MTLs.

These MTLs are not regulatory limits, criteria, or objectives. Comparison of RO concentrate concentrations of CECs to future benchmarks and criteria will be evaluated, as necessary, if and when these become available. It should also be noted that the recycled water, freshwater and estuary MTLs have limited applicability for assessing impacts to ocean aquatic life for the following reasons: these MTLs were developed to inform responses to monitoring data, not to regulate these chemicals for human health or aquatic life protection. Additionally, they were developed using toxicity data applicable to human health, freshwater aquatic life, or estuarine aquatic life and are not representative of impacts to ocean water species. Furthermore, the bioavailability and toxicity of certain compounds to aquatic life is impacted by other water quality parameters, such as temperature, pH, hardness and salinity, which vary extensively from freshwater to salt water. Limited toxicity data were also available to the Science Advisory Panels in developing the MTLs. In particular, the estuary MTLs presented in the Ecosystems CEC Panel Report were based on freshwater toxicity data with a safety factor of 10 or 100.[7]

Conclusion

During Year 1 testing, RO concentrate results did not exceed the numeric requirements associated with the Ocean Plan, TMDL or other NPDES permit limits, or MTLs for CECs when dilution and blending were taken into account. Technology-based, water quality-based, and TMDL-based parameters with NPDES permit limits that were monitored in the RO concentrate met all applicable permit limits (Tables 8 to 11). Concentrations of microorganisms in the RO concentrate also met NPDES permit limits for receiving waters (Table 13). Additionally, toxicity testing results show that the discharge of RO concentrate with JWPCP secondary effluent at the outfall would be non-toxic and not expected to cause harm to aquatic life (Tables 14 to 20).

Monitoring of a wide array of CECs showed that 16 of 53 compounds were not detected in the RO concentrate. Concentrations of the remaining detected compounds were lower than applicable MTLs described by the CEC Panel Advisory Board when accounting for blending with JWPCP secondary effluent and dilution with ocean water (166:1) at the outfall (Table 24). PFOA and PFOS concentrations in the RO concentrate were well under the EPA's draft marine acute benchmarks for the protection of aquatic life (Table 23). Although six CECs of interest for ocean

[6] Concentration data for certain CECs were collected at the Sanitation Districts' laboratory. These data may have been collected using research analytical methods and should be used for informational and research purposes only.
[7] Southern California Coast Water Research Project, 2012. *Monitoring Strategies for Chemicals of Emerging Concern (CECs) in California's Aquatic Ecosystems*

discharge do not have corresponding MTLs, five of these compounds were either non-detect or detected but not quantified in the RO concentrate (Table 22). The concentration of the remaining CEC (4-nonylphenol) was lower in the RO concentrate than in JWPCP secondary effluent, indicating it is reduced during the MBR process at the demonstration facility.

Discharge of the RO concentrate or blended concentrate is also expected to meet all receiving water limitations (i.e., Ocean Plan standards) specified in the NPDES permit. The comprehensive coastal monitoring program employed by the Sanitation Districts continues to show that environmental impacts associated with current effluent discharge, as measured by water and sediment quality, benthic and fish surveys, tissue analyses, and microbiological assessments, are insignificant. Although there have been historic impacts to sediment quality and fish tissue associated with legacy contamination, these impacts are declining over time and space and reflect improvements in JWPCP effluent quality since the 1970s. Because the total mass of chemicals discharged to the ocean from the RO concentrate is anticipated to be the same as the current mass discharged from JWPCP effluent, it is expected that marine impacts, if any, will continue to be minimal and receiving water standards will continue to be upheld during discharge of the concentrate.

Similarly, the total mass of CECs discharged in the RO concentrate is expected to be the same as the total mass currently discharged. The ongoing coastal monitoring program has shown no evidence that the current discharge of CECs negatively impacts the marine environment, and future discharges of the same CEC mass via RO concentrate would not be expected to generate negative impacts. The high dilution and rapid mixing of the RO concentrate at the outfall will significantly and quickly reduce CEC concentrations below associated benchmark levels (e.g., MTLs).

Additionally, some chemical concentrations in the RO concentrate may decrease from their current levels. Implementation of an enhanced source control program for compliance with DPR regulations could potentially reduce some chemicals in influent wastewater, and thus effluent wastewater and RO concentrate. Additional wastewater treatment steps, such as nitrification/denitrification or tertiary filtration, may be implemented prior to RO treatment in order to remove nutrients and organics. Reducing these concentrations in treated effluent would correspondingly reduce them in the RO concentrate and may facilitate compliance with potential future nutrient limitations for wastewater discharges or receiving waters.

Table 24. Demonstration Facility RO Concentrate Monitoring Results – CECs with Recycled Water and Aquatic Life MTLs

Parameter	Sample Date (2020) and Result					Avg	Max	JWPCP secondary effluent Max	JWPCP secondary effluent blended with RO Concentrate, based on max values	MTLs			MTLs with dilution (166:1)		
	8/5	9/2	9/28	10/20	10/28					Recycled Water	Fresh-water	Estuary	Recycled Water	Fresh-water	Estuary
17-Alpha Ethinylestradiol (ng/L)	<5.0	-	<5.0	<12	<12	ND	ND	ND	ND	280	-	-	46500	-	-
17-Beta Estradiol (ng/L)	<5.0	-	<5.0	30	<12	ND	30	9.3	15.9	0.9	2	0.2	149	332	33.2
4-Nonylphenol (ng/L)	727	-	499	652		626	727	1090	974	110000	-	-	18300000	-	-
4-tert Octylphenol (ng/L)	256	-	149	<125	153	140	256	879	680	50000	-	-	8300000	-	-
Acetaminophen (ng/L)	208	218	-	170	188	196	218	33	92.2	350000	-	-	58100000	-	-
Amoxicillin (ng/L)	<25	<25	-	<25	<25	ND	ND	ND	ND	1500	-	-	249000	-	-
Atenolol (ng/L)	1290	1600	-	1510	1340	1440	1600	440	811	4000	-	-	664000	-	-
Azithromycin (ng/L)	614	760	-	1060	1040	868	1060	212	483	3900	-	-	647000	-	-
Bifenthrin (ug/L)	<2.00	<0.40	-	<0.40	<0.40	ND	ND	2.62	1.78	-	0.4	0.04	-	66.4	6.64
Bisphenol A (ug/L)	<100	54	-	<40	<40	ND	54	DNQ	121	350000	60	6	58100000	9,960	996
Caffeine (ng/L)	308	378	-	484	327	374	484	153	530	350	-	-	58100	-	-
Carbamazepine (ng/L)	808	945	-	1340	1300	1100	1340	ND	592	1000	-	-	166000	-	-
Chlorpyrifos (Dursban) (ng/L)	<20	<20	-	<20	25	ND	25	552	8	8400	5	1	1390000	830	166
DEET (ng/L)	810	510	-	1440	1080	960	1440	240	741	2500	-	-	415000	-	-
Diazepam (ng/L)	<100	<50	-	<40	<40	ND	ND	ND	ND	2500	-	-	415000	-	-
Diclofenac (ng/L)	1380	1300	-	1400	1670	1440	1670	412	872	1800	100	-	299000	16600	-
Dilantin (Phenytoin) (ng/L)	823	800	-	1140	892	914	1140	ND	472	2000	-	-	332000	-	-
Estrone (ng/L)	<5.0	-	<5.0	200	<12	ND	200	496	93.9[1]	350	6	0.6	58100	996	99.6
Fluoxetine (ng/L)	<100	<50	-	100	54	38	100	158	46.3	2000	-	-	332000	-	-
Galaxolide (ng/L)	8600	10000	-	9100	8200	8980	10000	44	4830	1800000	700	70	2.99E+08	116000	11620
Gemfibrozil (ng/L)	1470	935	-	944	1000	1090	1470	41.78	1599	45000	-	-	7470000	-	-
Ibuprofen (ng/L)	<50	<25	-	<20	520	ND	520	21	423	50000	100	-	8300000	16600	-
Iohexol (ng/L)	107000	140000	-	46400	158000	113000	158000	2400	69700	720000	-	-	1.20E+08	-	-

Parameter	Sample Date (2020) and Result					Avg	Max	JWPCP secondary effluent Max	JWPCP secondary effluent blended with RO Concentrate, based on max values	MTLs			MTLs with dilution (166:1)		
	8/5	9/2	9/28	10/20	10/28					Recycled Water	Fresh-water	Estuary	Recycled Water	Fresh-water	Estuary
Iopromide (ng/L)	159	<75	-	<60	71	ND	159	1660	74	750000	-	-	1.25E+08	-	-
Meprobamate (ng/L)	718	815	-	920	756	802	920	378	398	100000	-	-	16600000	-	-
Metoprolol (ug/L)	1650	1750	-	2020	1910	1830	2020	28200	917	25000	-	-	4150000	-	-
N-Nitrosomorpholine (ng/L)	0.22	0.38	-	0.91	1.8	0.83	1.8	34	1.39	0.012	-	-	1.99	-	-
Permethrin (ng/L)	<2.00	<0.40	-	<0.40	<0.40	ND	ND	153	3.95	3700	1	0.1	614000	166	16.6
Sucralose (ng/L)	219000	258000	-	294000	270000	260000	294000	398	130000	1.5E+08	-	-	2.49E+10	-	-
Sulfamethoxazole (ng/L)	3800	5350	-	4800	4280	4560	5350	1.2	1980	35000	-	-	5810000	-	-
Triclocarban (ng/L)	<100	<50	-	<40	<40	ND	ND	1800	ND	140000	-	-	23200000	-	-
Triclosan (ng/L)	<100	<50	-	<40	46	11	46	1330	34.4	350	-	-	58100	-	-
Trimethoprim (ng/L)	194	290	-	187	293	241	293	907	313	40000	-	-	6640000	-	-
TCEP (ng/L)	891	875	-	1220	960	986	1220	1360	554	2500	-	-	415000	-	-

1. The calculated concentration of estrone in a blended mixture of RO concentrate and JWPCP effluent (93.9 ng/L, based on the maximum concentration of estrone measured in RO concentrate) is close to the MTL for estuaries at a 166:1 dilution rate (99.6 ng/L). However, the MTL for estuaries of 0.6 ng/L is based on the freshwater MTL (6 ng/L) with an applied safety factor of 0.1; this likely reflects uncertainty in the appropriate trigger levels for estuarine environments. Therefore, 99.6 ng/L may not be an appropriate MTL for estuaries with the expected dilution of the RO concentrate.
2. ND = non-detect. In accordance with JWPCP NPDES permit (Order R4-2017-0180), when a non-detected value is included in the dataset, a median value is calculated in place of an average. When the calculated median is an ND, the ND could represent multiple potential detection limits. The detection limit is therefore not shown.
3. Concentration data for certain CECs were collected at the Sanitation Districts' laboratory. These data may have been collected using research analytical methods and should be used for informational and research purposes only.