2010 Emerging Constituents Sampling Report

of the

Emerging Constituents Program Task Force

December, 2010

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Table of Contents

List of Figures

List of Tables

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Section 1: Executive Summary

In 2008, the Santa Ana Watershed Project Authority (SAWPA) formed a Task Force to develop a plan to characterize emerging constituents throughout the region. "Emerging Constituents (EC)" is a phrase used to describe a large number of pharmaceuticals, personal care products, food additives, pesticides and other common household chemicals for which federal and state authorities have not yet established a water quality standard.

In 2009 the Task Force, and the Santa Ana Regional Water Quality Control Board accepted, a water quality monitoring plan to evaluate EC levels in municipal effluent, local receiving streams and other raw water supplies imported into the area.[1] The final Sampling and Analysis Plan is attached as Appendix A to this report.

Samples were collected and analyzed in the spring of 2010. Preliminary results were reported and carefully evaluated by the EC Task Force over the summer. A draft report was prepared in October and circulated among stakeholders throughout the Santa Ana River watershed for review and comment. Final results for the 2010 EC study are presented in this report and summarized in Table 1. Where detected, EC concentrations fell well within the range where other studies have shown that "no adverse health effects would be expected."[2]

Table 1: Summary of Analytical Results for 27 Sampling Sites in 2010

Compound	Primary Use	Freq. of Detection	Reported Range[3]	Common Dose
Acetaminophen	Analgesic	56%	ND – 0.000056 mg/L	500 mg
Bisphenol A (BPA)	Plastic Coating	26%	ND – 0.000043mg/L	n/a
Caffeine	Food Additive	48%	ND – 0.000680mg/L	100 mg
Carbamazepine	Anti-Convulsant	85%	ND – 0.000460mg/L	200 mg
DEET	Insecticide	89%	ND – 0.000340mg/L	270 mg
Diuron	Herbicide	74%	ND – 0.000110mg/L	n/a
Ethinyl Estradiol	Hormone	0%	Not Detected	1 mg
Gemfibrozil	Anti-cholesterol	30%	ND – 0.002200mg/L	600 mg
Ibuprofen	Analgesic	44%	ND – 0.000890mg/L	300 mg
Sulfamethoxazole	Antibiotic	52%	ND – 0.001900mg/L	800 mg
TCEP	Flame Retardant	93%	ND – 0.000780mg/L	n/a

Note: "mg/L" = milligram per Liter; 1 mg/L is one part per million. "ND" = Not Detected.

1Resolution No. R8-2009-0071 (December 10, 2009).

2 Intertox, Inc. Comparison of Analytical Results for Trace Organics in the Santa Ana River at the Imperial Highway to Health Risk-based Screening Levels. Seattle, WA. June 25, 2009. This report did not develop or evaluate health based screening levels for BPA or Ethinyl Estradiol.

[3] The study imposed a mandatory reporting limit of 0.000010 mg/L (10 nanograms per liter).

Although ECs were detected at many of the sampling sites, the measured concentrations were extremely small. For example, acetaminophen (the active ingredient in Tylenol) was detected at 15 (56%) of the 27 sampling sites. However, the highest reported concentration was less than six-one hundred-thousandths of a milligram. By comparison, one extra strength Tylenol capsule contains 500 milligrams of acetaminophen. Thus, a person would have to swallow more than 2 million gallons of recycled water to accidentally ingest the equivalent of one Tylenol pill. Similarly, one would have to drink more than 370,000 gallons of recycled water in order to consume the amount of caffeine normally found in a single cup of coffee.

Section 2: Background

Water quality is routinely sampled at thousands of locations all across the country. Samples are collected from rain water, storm water runoff, freshwater streams, lakes and reservoirs, groundwater wells and tap water to characterize the quality of various supply sources. Additional samples from the sewage systems are analyzed to ensure pollution prevention programs and wastewater treatment plants are meeting all federal and state water quality standards.

Most sampling programs focus on a few hundred of the most common chemical constituents to assess overall water quality. These chemicals were selected from the larger universe of known chemicals because there is sufficient scientific evidence to indicate they may pose an increased risk to humans, plants or animals (including aquatic organisms) when they occur at elevated concentrations.

Recent improvements in analytical technology have dramatically improved our ability to detect a wide range of common chemicals at much lower concentrations.[4] This new ability to detect infinitesimally small chemical concentrations has fundamentally altered our understanding of what's in the water. Today, we are able to identify and quantify these emerging constituents in the range of one part-per-trillion (ppt or nanogram per liter).[5] One trillion is equal to one million million. One part per trillion is equal to just one second in 32,000 years. One nanogram per liter is equivalent to a single drop of water in a pond the size of twenty Olympic swimming pools.

Trace levels (approx. 1-100 ppt) of many different man-made chemicals, particularly pesticides, pharmaceuticals and personal care products, have been found in waters across the United States. Collectively, these compounds are referred to as "Emerging Constituents" because their presence is just starting to be revealed by rapid advances in analytical technology.

4Vanderford, B.J., et al. "Analysis of Endocrine Disrupters and Personal Care Products in Water Using Liquid Chromatography and Tandem Mass Spectrometry." Analytical Chemistry. 2003 (75:6265-6274)

5Vanderford, B.J. and Shane Snyder. "Analysis of Pharmaceuticals in Water by Isotope Dilution Liquid Chromatography/Tandem Mass Spectrometry." Environmental Science and Technology. 2006 (p. 7312-7320).

Emerging Constituents is one of several similar phrases used to describe the same phenomena. Synonyms include: chemicals of emerging concern (CEC), micro-constituents, micro-pollutants, trace organics, etc. Such phrases may mistakenly imply that it is the concern that is "emerging" rather than the technology to detect such these compounds in a water sample. Similarly, referring to such compounds as Emerging Pollutants or Emerging Contaminants may improperly suggest that the levels detected pose a known hazard to people or the environment when the true risk is not yet known. The California Office of Environmental Health Hazard Assessment and U.S. EPA have primary legal responsibility for making the necessary risk assessments and publishing appropriate water quality standards for all chemicals including Emerging Constituents.

In general, chemical compounds can be divided into two categories: regulated and unregulated. Regulated chemicals include those for which no formal water quality standards or a state notification levels have been established.[6] State and federal authorities may issue orders governing the release of such compounds into the environment. These regulations may range from relatively simple monitoring and reporting requirements to strict discharge prohibitions.

By definition, ECs are usually considered unregulated chemicals. However, that status may change as new information is developed. To that end, additional data are needed to characterize the presence and persistence of ECs throughout various water sources. This information, along with epidemiological and toxicological data, may be used to set priorities for developing new water quality criteria, Maximum Contaminant Levels (MCLs), state notification levels and future water quality monitoring requirements.

Once new chemicals are detected, the question naturally arises as to what effect, if any, these compounds have on water sources. Several different regulatory agencies share responsibility for determining the acceptable concentration of potential pollutants. This is a formidable task as there are tens of thousands of chemical compounds in common use. Consequently, state and federal authorities rely on sales/usage information and monitoring data to establish appropriate research priorities for setting new water quality standards through a sophisticated and thorough regulatory review process.

6Concentrations of concern may be expressed as Maximum Contaminant Levels (MCLs), Public Health Goals (PHGs), State Notification Levels, 304(a) Criteria, Basin Plan objectives, TMDL targets, wasteload allocations, or receiving water limitations. Some of these also serve as formal regulatory thresholds.

The California Department of Public Health ("DPH") has suggested that periodic monitoring for trace organic chemicals may serve as a useful indicator of groundwater quality down gradient of recycled water projects.[7] Such data may also be used to corroborate the effectiveness of soil-aquifer treatment and the multi-barrier approach to preventing pathogen pollution. Therefore, as part of the proposed Groundwater Recharge Reuse Regulations, DPH prepared a draft list of ECs to guide planning and permitting efforts for recycled water projects.[8] However, the new regulation has not yet been finalized.

In early 2009, the California State Water Resources Control Board ("State Board') adopted a new Recycled Water Policy (RWP).[9] As part of that Policy, the State Board convened a Blue Ribbon Panel of Experts to recommend appropriate water quality monitoring strategies for ECs based on the best available pharmacological and toxicological information taking into consideration the fate and transport of such chemicals through advanced treatments systems and the natural environment. The Blue Ribbon Panel published their report in mid-2010.[10] The State Board has developed a draft EC monitoring policy based largely on the Blue Ribbon Panel's recommendations.[11] A public hearing is scheduled for December 15, 2010 and written comments are due by December 27th.

Pending final guidance from the State Board, stakeholders throughout the Santa Ana River watershed agreed to initiate a voluntary program to analyze water and wastewater samples for a select subset of ECs. Preliminary analyses were performed in 2008-2009.[12] And, a more comprehensive survey was conducted in 2010. Results of the most recent study are presented in Section 4 of this report.

7DPH serves several different regulatory roles with respect to groundwater recharge projects. DPH is responsible, under statute, for establishing water quality criteria for groundwater recharge projects. DPH also acts as a consultant to the Regional Boards on the permit requirements for specific groundwater recharge projects. And, DPH has a co-equal role with the Regional Boards in establishing permit requirements for groundwater recharge projects that rely on direct injection rather than surface percolation.

8http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Recharge/DraftRechargeReg2008.pdf (see Endnote 5). See also http://www.cdph.ca.gov/certlic/drinkingwater/Pages/EmergingContaminants.aspx

9SWRCB. Recycled Water Policy. Resolution No. 2009-0011 (adopted 2/3/09).

10Drewes, J.E., P. Anderson, N. Denslow, A. Olivieri, D. Schlenk & S. Snyder. Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water. Final Report and Recommendations of a Science Advisory Panel convened by the State Water Resources Control Board. Sacramento, CA. June 25, 2010.

11State Water Resources Control Board. Staff Report: Constituents of Emerging Concern (CEC) Monitoring for Recycled Water. November 8, 2010.

12Guo, Y.C., S. Krasner, S. Fitzsimmons, G. Woodside & N. Yamachika. Source, Fate, and Transport of Endocrine Disruptors, Pharmaceuticals, and Personal Care Products in Drinking Water Sources in California. National Water Research Institute; Fountain Valley, CA. May, 2010.

Because the analytical techniques used to analyze for ECs have not yet been formally approved by federal or state authorities, great care must be exercised when interpreting and reporting the results of such studies. The data generated from the non-standard methods employed during the preliminary characterization studies are not been certified for regulatory purposes such as: 303(d) listing decisions, antidegradation analyses, or translating narrative criteria into numeric effluent limits. These legal determinations depend on detailed risk assessments that are not yet available. However, the data from such studies is useful for determining which ECs, if any, should be prioritized for additional method development in order to determine whether more formal regulatory assessments may be needed in the future.

Section 3: Study Approach

Based on results reported in several previous EC survey studies, the Task Force selected eleven compounds for further investigation in the Santa Ana watershed (see Table 2).[13]

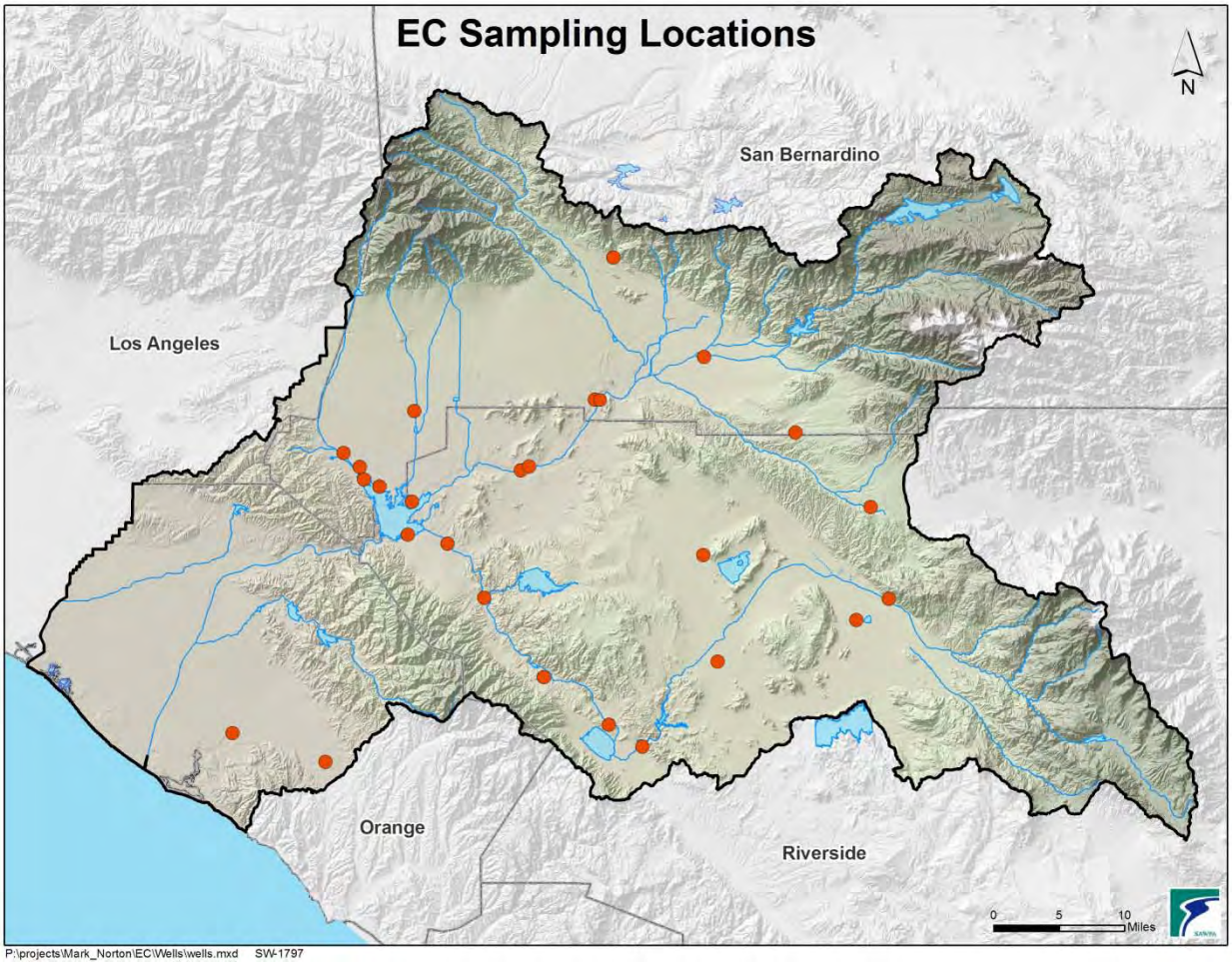
Table 2: ECs Analyzed in 2010

Compound	Category	Common Use
Acetaminophen (aka "Tylenol")	Pharmaceutical	Over-the Counter Analgesic
Bisphenol-A (BPA)	Industrial	Plastic Manufacturing
Caffeine (coffee, tea, soft drinks)	Food Additive	Non-Prescription Stimulant
Carbamazepine	Pharmaceutical	Prescription Anti-Convulsant
DEET (aka "Off")	Pesticide	Household Insect Repellent
Diuron	Pesticide	Weed Control
Ethynylestradiol/Ethinylestradiol	Pharmaceutical	Prescription Hormone
Gemfibrozil	Pharmaceutical	Prescription Anti-Cholesterol
Ibuprofen (aka "Advil")	Pharmaceutical	Over-the-Counter Analgesic
Sulfamethoxazole	Pharmaceutical	Prescription Antibiotic
TCEP	Industrial	Flame Retardant

Samples were collected from 23 different wastewater treatment plants operating in the region. (See Fig. 1) A description of these facilities is attached as Appendix B to this report. Samples were also collected from two locations along the Santa Ana River (MWD crossing and Prado Dam), one location in the State Water Project (Devil Canyon) and one location near the terminus of the Colorado River Aqueduct (San Jacinto West Portal).

[13] See, for example, Kent, Robert and Kenneth Belitz. Unites States Geological Survey (USGS). Ground-Water Quality Data in the Upper Santa Ana Watershed Study Unit, November 2006 - March 2007: Results from the California GAMA Program. Data Series 404. November, 2009.

Fig. 1: Map of Sites Sampled and Analyzed for ECs in the Santa Ana River Watershed in 2010



All of the samples were evaluated with the best analytical technology commercially available: Liquid Chromatography/Tandem Mass Spectrometry using the isotope dilution method. This technique is capable of detecting select ECs in de-ionized laboratory water at concentrations of 1 to 10 ng/L. However, the specific reporting detection level (RDL) varies over time and between laboratories especially in more complex water matrices. Therefore the mandatory reporting level for samples in this study was set to a minimum of 10 ng/L for all laboratories.

A detailed quality assurance and quality control program was developed and submitted to the Regional Board staff for review in March of 2010. The Executive Officer approved that plan prior to collecting or analyzing any samples. A copy of that plan is attached as Appendix A and the QA/QC results are reported in Section 5 of this report.

Section 4: EC Sampling Results

Table 3: Emerging Constituent Sampling Results (ng/L)

Sampling Location	Acetaminophen	Bisphenol A	Caffeine	Carbamazepine	DEET	Diuron	Ethinyl Estradiol	Gemfibrozil	Ibuprofen	Sulfamethoxazole	TCEP
City of Beaumont WWTP No. 1	32	<10	34	350	270	57	<10	630	<10	360	94
City of Corona WRF 3	<10	<10	<10	18	140	<10	<10	<10	57	<10	520
City of Corona WRF 1B	18	<10	<10	20	340	<10	<10	<10	22	<10	590
City of Corona WRF 2	40	12	36	150	270	36	<10	180	70	1600	530
EMWD MV-RWRF	20	<10	18	52	150	19	<10	<10	36	<10	400
EMWD PV-RWRF	<10	<10	<10	<10	68	<10	<10	<10	14	<10	370
EMWD SJV-RWRF	20	<10	620	210	280	46	<10	1100	130	790	180
EMWD TV-RWRF	23	<10	66	130	130	22	<10	92	100	150	520
EVMWD Horsethief Canyon	<10	<10	<10	140	110	24	<10	<10	<10	<10	160
EVMWD Railroad Canyon WRP	<10	<10	<10	<10	32	<10	< 10 R5	<10	<10	<10	69
EVMWD Regional WRP	36	<10	64 R2	460	38	25	<10	<10	<10	410	140
IEUA CCWRF	<10	<10	<10	110	36	65 M1	<10	<10	<10	<10	77
IEUA RP1 02	15	<10	<10	160	<10	22	<10	<10	10	<10	130
IEUA RP1 1B	10	<10	<10	180	230	12	<10	<10	<10	<10	84
IEUA RP5	<10	<10	<10	98	28	29	<10	<10	<10	<10	90
IRWD Los Alisos Plant	<10	43	680	260	340	92	<10	2200	890	580	150
IRWD Michelson Plant	<10	<10	34	48	140	14	<10	<10	14	< 10	77
City of Redlands WWTP (re-sample)	11	<10	<10	140	33	<10	<10	<10	<10	<10	60
City of Rialto WWTP	<10	<10	<10	76	150	<10	<10	<10	<10	20	530
City of Riverside RWQCP	11	10	<10	220	180	50	<10	<10	12	16	150
City of San Bernardino RIX	21	12	34	250	11	15	<10	26	<10	240	110
WRCWRA 'River Rd. Plant	19	<10	51	250	220	50	<10	25	<10	1100	780
YVWD WRF	56	24	21	370	190	110	<10	410	17	1900	120
State Project Water at Devil Canyon (MWD)	<10	**NA**	<10	<10	<10	106	<10	<10	<10	13	<10
Colo River at San Jacinto West Portal (MWD)	<10	**NA**	65.2	<10	<10	<10	<10	<10	<10	<10	<10
Santa Ana River near MWD crossing (OCWD)	<10	**NA**	<10	116	14.4	71.3	<10	<10	<10	89.4	63.4
Santa Ana River near Prado Dam (OCWD)	14.8	**NA**	28.2	105	103	74.1	<10	<10	<10	56.6	239

Notes:

	10 ng/L was the Mandatory Reporting Limit (MRL) for this study. The Laboratory Reporting Limits (LRL) are provided in the supporting documentation.
M1	Matrix spike recovery was high, but the associated blank spike recovery was acceptable. The diuron spike amount (25 ppt) was less than 50% of the ambient concentration so the high spike recovery is not meaningful as per project QAPP. Analysis and spiking of follow up samples from this site would be desirable for assessing accuracy of result.
NA	Not Available
R2 or R5	RPD/RSD exceeded lab acceptance limit (note that the example of R2 is actually a caffeine MS/MSD so with the codes listed R2 and R5 go together). For ethynyl estradiol spike recoveries on this sample were 72 and 105%, both well within project expected variability, but the calculated RPD exceeds the 30%, so data must be flagged. Because of the good spike recovery there is no impact on the data from these spike results. For caffeine, spike recoveries were 52% and 105%, but the amount spiked (25 ppt) was less than 50% of the amount found in the native sample before spiking. As per the project QAPP the spike recovery is therefore not relevant. For caffeine based on the QAPP we should remove the flag because it would fit the M3 category.

Section 5: QA/QC Data for EC Samples

Table 4: QA/QC Data for Field and Travel Blank Samples (ng/L)

Sampling Location	Acetaminophen	Bisphenol A	Caffeine	Carbamazepine	DEET	Diuron	Ethinyl Estradiol	Gemfibrozil	Ibuprofen	Sulfamethoxazole	TCEP
City of Beaumont WWTP No. 1	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
City of Corona WRF 3	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
City of Corona WRF 1B	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
City of Corona WRF 2	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
EMWD MV-RWRF	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
EMWD PV-RWRF	<10	24	<10	<10	<10	<10	<10	<10	<10	<10	<10
EMWD SJV-RWRF	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
EMWD TV-RWRF	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
EVMWD Horsethief Canyon	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10 FA
EVMWD Railroad Canyon WRP	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
EVMWD Regional WRP	10 FP	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
IEUA CCWRF	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
IEUA RP1 02	<10	<10	<10	<10	<10	<10	<10	<10	< 10 M2	<10	<10
IEUA RP1 1B	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
IEUA RP5	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
IRWD Los Alisos Plant	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
IRWD Michelson Plant	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
City of Redlands WWTP (re-sample)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
City of Rialto WWTP	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
City of Riverside RWQCP	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
City of San Bernardino RIX	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	11 A-01a
WRCWRA 'River Rd. Plant	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
YVWD WRF	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
State Project Water at Devil Canyon (MWD)	<10	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10
Colo River at San Jacinto West Portal (MWD)	<10	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10
Santa Ana River near MWD crossing (OCWD)	<10	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10
Santa Ana River near Prado Dam (OCWD)	<10	NA	<10	<10	<10	<10	<10	<10	<10	<10	<10

Notes:

	10 ng/L was the Mandatory Reporting Limit (MRL) for this study. The Laboratory Reporting Limits (LRL) are provided in the supporting documentation.
A-01a	Method blank contained 7.8 ng/L of TCEP. Result in sample was >10X the amount in the method blank so there is no impact on the data from the method blank detection.
FA	Target analyte detected in trip or equipment or field blank above the lab MRL as per project QAPP, for the TCEP blank hit, there is no impact on the data because sample results are much higher than the level found in the blank; however data must be flagged. For City of Redlands, there was an error with collection of the field blank resulting in multiple hits. However the equipment blank associated with the sample was ND for the analytes with hits in the sample, except for TCEP, where the value in the sample was more than ten times the level measured in the blank.
FP	Sample for Elsinore Valley with acetaminophen in the associated field blank should be flagged as "possible false positive" because the field blank is 1-2X the MRL and the hit is >2X the field blank, but not >10X.
M2	Matrix spike recovery was low, but the associated blank spike recovery was acceptable. The sulfamethoxazole is a data entry error in the spike amount – entered as 50 rather than 25. A revised report is being issued, but the flag was still showing up in the electronic data deliverable. Flag has been removed in revised EDD. Ibuprofen hit in field blank may be biased low (spike recoveries were 43 and 66%), but actual value is <25% of MRL so the field blank is still clearly non detect. There is thus no impact on the data from these low spike recoveries.
NA	Not Available

Table 5: QA/QC Data for Reference Samples Spiked with Known EC Levels (ng/L)

Table 5a: QC Data, MWD

Analyte	Acetaminophen		Bisphenol A*		Caffeine		Carbamazepine		DEET		Diuron		Ethynylestradiol		Gemfibrozil		Ibuprofen		Sulfamethoxazole		TCEP	
MRL (ng/L)	5		30		5		2		2		5		10		5		10		2		3	
		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery
Method blank	<5		<30		<5		<2		<2		<5		<10		< 5		< 10		<2		< 3	
2 ppt	<5				<5		2.33	117%	2.1	105%	<5		<10		<5		< 10		2.06	103%	2.7	135%
5 ppt	4.91	98%			4.91	98%	5.41	108%	4.83	97%	4.6	92%	6.37	127%	4.41	88%	<10		4.8	96%	6.18	124%
10 ppt	9.83	98%			9.44	94%	10.4	104%	10.5	105%	9.6	96%	9.62	96%	9.32	93%	7.61	76%	10.2	102%	12.1	121%
50 ppt	52.1	104%			48.3	97%	53.9	108%	52.7	105%	49.4	99%	38.5	77%	49.1	98%	42.7	85%	49.8	100%	59.9	120%
250 ppt	249	100%			250	100%	250	100%	250	100%	250	100%	250	100%	250	100%	251	100%	250	100%	248	99%
San Jacinto Field Blank	<5				< 5		<2		< 2		<5		<10		< 5		< 10		< 2		<3	
San Jacinto	<5		<30		65.2		<2		4.67		<5		<10		< 5		< 10		<2		7.63	
San Jacinto spike 50 ppt			56.8	114%																		
San Jacinto spike 50 ppt duplicate			50.3	101%																		
Devil Canyon Field Blank	<5				< 5		<2		< 2		<5		<10		< 5		< 10		<2		< 3	
Devil Canyon	<5		<30		7.56		2.96		8.21		106		<10		< 5		< 10		12.9		4.49	
Devil Canyon_spike 50 ppt	53.9	108%			57.7	100%	57.6	109%	59.7	103%	155	98%	36.5	73%	49.5	99%	51.3	103%	62.9	100%	33.2	57%
Devil Canyon_spike 50 ppt duplicate	51.5	103%			53.5	92%	56.6	107%	61.4	106%	160	108%	39.5	79%	51.4	103%	49.5	99%	61.4	97%	33.7	58%

* Bisphenol A samples analyzed by GC/MS

Table 5b: QC Data, OCWD

Analyte	Acetaminophen		Bisphenol A		Caffeine		Carbamazepine		DEET		Diuron		Ethynylestradiol		Gemfibrozil		Ibuprofen		Sulfamethoxazole		TCEP	
RDL (ng/L)	5		10		3		1		1		5		2		1		1		1		5	
		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery		Recovery
1 ppt LFB**	1.08	108%	NA	NA	2.85	95%	1.14	114%	0.933	93%	0.707	71%	0.554	55%	0.952	95%	1.06	106%	**1.02**	102%	1.48	148%
10 ppt LFB**	7.23	72%	NA	NA	30.1	100%	9.98	100%	10.9	109%	9.61	96%	10.4	104%	7.78	78%	9.78	98%	**10.6**	106%	9.79	98%
SAR near Prado Dam (Initial)	14.8		NA		28.2		105		103		74.1		ND		8.15		ND		**56.6**		239	
SAR near Prado Dam Matrix Spike**	200	93%	NA	NA	639	101.8%	324	109.5%	296	96.5%	281	103.5%	202	101.0%	204	97.9%	189	94.2%	**284**	113.7%	413	87.0%
SAR near Prado Dam Mat Spk (dup)	209	97%	NA	NA	642	102.3%	317	106.0%	293	95.0%	286	109.0%	196	98.0%	207	99.4%	194	96.7%	**265**	104.2%	409	85.0%
MS/MSD Relative % Diff (RPD)	4.401		NA		0.468		2.1841		1.019		1.764		3.015		1.46		2.611		6.92		0.973	

**200 ppt spike - Caffeine Spikes 3x higher than other targets

Table 6: QA/QC Data for Analysis of Identical Split Samples Between Laboratories (ng/L)

Table 6a: ERA - QC Low-Level Check

Analyte	% RSD	Assigned Value	Mean Recovery	Median Recovery	OCWD Result (ng/L)	MWD Result (ng/L)	E.S.Babcock Result (ng/L)	MWH Result (ng/L)	OCWD Percent Recovery	MWD Percent Recovery	E.S.Babcock Percent Recovery	MWH Percent Recovery
Acetaminophen	18.0	14.0	102.5	105.7	16.9	14	10.9	15.6	120.7	100.0	77.9	111.4
Bisphenol A	9.9	10.4	97.1	97.1	NA	<30	10.8	<10 (9.39)	-	-	103.8	90.3
Caffeine	21.7	11.0	122.5	116.4	12.6	13	17.6	10.7	114.5	118.2	160.0	97.3
Carbamazepine	2.8	11.0	101.4	101.4	11.3	11	11.5	10.8	102.7	100.0	104.5	98.2
DEET	6.6	13.8	115.9	115.6	17.1	15	16.7	15.2	123.9	108.7	121.0	110.1
Diuron	-	ND	-	-	<5	<5	ND	<5	-	-	-	-
Ethynylestradiol	6.4	12.5	89.4	89.6	12.0	11	11.4	10.3	96.0	88.0	91.2	82.4
Gemfibrozil	-	ND	-	-	<1	<5	ND	<5	-	-	-	-
Ibuprofen	24.0	12.0	99.6	101.7	13.4	11	15.0	<10 (8.43)	111.7	91.7	125.0	70.3
Sulfamethoxazole	8.1	11.5	105.7	105.2	12.0	11	13.4	12.2	104.3	95.7	116.5	106.1
TCEP	-	ND	-	-	<5	<3	ND	<5 (2.1)	-	-	-	-

Table 6b: ERA - QC Mid-Level Check

Analyte	% RSD	Assigned Value	Mean Recovery	Median Recovery	OCWD Result (ng/L)	MWD Result (ng/L)	E.S.Babcock Result (ng/L)	MWH Result (ng/L)	OCWD Percent Recovery	MWD Percent Recovery	E.S.Babcock Percent Recovery	MWH Percent Recovery
Acetaminophen	13.3	150	107.5	108.3	184	136	173	152	122.7	90.7	115.3	101.3
Bisphenol A	5.1	102	85.3	83.5	NA	92	83.7	85.2	-	90.2	82.1	83.5
Caffeine	13.8	85	89.4	89.9	88.0	79	73.9	62.9	103.5	92.9	86.9	74.0
Carbamazepine	5.8	34.9	96.3	94.4	36.5	33	32.9	32.1	104.6	94.6	94.3	92.0
DEET	12.9	105	106.2	103.8	131	97	112	106	124.8	92.4	106.7	101.0
Diuron	13.1	134	108.0	106.0	138	125	146	170	103.0	93.3	109.0	126.9
Ethynylestradiol	18.4	145	82.2	80.7	148	118	116	94.6	102.1	81.4	80.0	65.2
Gemfibrozil	10.1	27.0	105.6	108.1	24.7	31	27.9	30.5	91.5	114.8	103.3	113.0
Ibuprofen	13.8	33.0	106.7	103.0	35.7	31	32.3	41.9	108.2	93.9	97.9	127.0
Sulfamethoxazole	4.2	77.5	103.7	104.5	82.4	76	79.6	83.6	106.3	98.1	102.7	107.9
TCEP	21.9	195	83.8	86.2	179	201	157	117	91.8	103.1	80.5	60.0

Table 6c: SAR-BELOWDAM-01 (Matrix Split)

Analyte	% RSD		Mean Result	Median Result	OCWD Result (ng/L)	MWD Result (ng/L)	E.S.Babcock Result (ng/L)	MWH Result (ng/L)
Acetaminophen	97.5		41.37	21.5	14.8	<5	87.8	21.5
Bisphenol A	-		-	-	NA	<30	ND	<10 (9.7)
Caffeine	7.7		31.63	32.15	28.2	32	34.0	32.3
Carbamazepine	4.1		103.95	104	105	109	98.8	103
DEET	12.3		88.08	85	103	89	81.0	79.3
Diuron	71.4		111.40	77.8	74.1	60	230	81.5
Ethynylestradiol	-		-	-	<2	<10	ND	<5
Gemfibrozil	29.2		9.60	8.575	8.15	9	13.7	7.54
Ibuprofen	-		-	-	<1	<10	48.6	<10 (4.2)
Sulfamethoxazole	11.7		58.83	57.3	56.6	58	52.2	68.5
TCEP	35.0		207.25	227	239	215	271	104

Site Blank - ND

Section 6: Conclusions and Recommendations

The EC Task Force's 2010 sampling program was performed in accordance with the approved study plan. In addition, analysis of the laboratory results indicates a high level of quality control for the reported data.

Unless the State Water Resource Control Board directs otherwise, the EC Task Force is committed to repeat the study in 2011 using the same sampling procedures and quality assurance plan previously approved by the Regional Board. Results will be summarized and reported to the Regional Board in December of 2011.

The EC Task Force had originally planned to expand the regional characterization study to include a representative sample of groundwater wells in 2011. However, this effort was deferred for one year in anticipation of two significant state actions. First, the State Board is likely to enact a new EC monitoring program in 2011. Second, the California Department of Public Health (DPH) is also expected to promulgate final regulations governing groundwater recharge using recycled water during the next twelve months.

The EC Task Force intends to update the regional study plan to be consistent with any new EC monitoring requirements enacted by the State Board or DPH. The revised study plan for 2012 will be submitted to the Regional Board for approval prior to initiating a third round of EC sampling and analysis.

List of Participating Agencies:

- Eastern Municipal Water District
- Inland Empire Utilities Agency
- Orange County Water District
- San Bernardino Valley Muni Water District
- Western Municipal Water District
- Elsinore Valley Municipal Water District
- Irvine Ranch Water District
- Jurupa Community Services District
- Lee Lake Water District
- Metropolitan Water District of Southern California
- San Gorgonio Pass Water Agency
- Yucaipa Valley Water District
- City of Beaumont
- City of Corona
- City of Redlands
- City of Rialto
- City of Riverside
- Chino Basin Watermaster
- Colton/San Bernardino Regional Tertiary Treatment and Wastewater Reclamation Authority
- Western Riverside County Regional Wastewater Authority

Appendix A

Final Sampling and Analysis Plan

12/03/2010

Sampling and Laboratory Analysis Plan (SLAP) for the

2010-11 Emerging Constituents Characterization Study in the Santa Ana Watershed

The Santa Ana Watershed Project Authority's (SAWPA) Emerging Constituents (EC) Workgroup submitted a water quality investigation workplan to the Santa Ana Regional Water Quality Control Board (RWQCB) to characterize selected ECs in surface waters and imported waters for calendar year 2010[1]. The selected ECs include pharmaceuticals & personal care products (PPCPs), pesticides, herbicides, and industrial indicators of wastewater origin. The analytical laboratories supporting this effort will be able to follow the criteria presented within this Sampling and Laboratory Analysis Plan (SLAP), which is a required element of the workplan.

1. Sample Collection, Preservation, Storage and Holding Times

Sampling and laboratory analysis will be scheduled to meet the deadlines specified in Section 5E of the workplan described in the Phase-II report. Specifically, the results from all POTW (publicly owned treatment works) effluent samples, the State Water Project (SWP) and Colorado River samples from Metropolitan Water District of Southern California (MWDSC), and the first SAR sampling event (two sites) conducted by Orange County Water District (OCWD) are due to SAWPA by July 31st, 2010. These data will be included in the Annual Report that is due to the RWQCB by December 31, 2010. The second set of SAR samples are to be collected and analyzed by OCWD by September 30th, 2010, with these data to be included in the subsequent 2011 Annual Report.

Each designated lab will provide their own sample bottles (pre-cleaned amber glass) preserved with ascorbic acid (50 mg/L) and sodium azide (1 g/L) added to sample bottles before shipment to the sites. Samples bottles can be pre-labeled with site information, and will include date, sampling time, sampler, site location, and required testing. Bottles should include a label with the method's chemical preservatives.

Samplers and laboratory staff will be warned of low-level detection of ECs and potential background sources caused by the sampling process. These personnel should be aware of the potential for interference from the use of target compounds monitored within this investigation (prescription drugs, coffee, ibuprofen, acetaminophen, etc.). Specifically, they will be requested not to consume any caffeinated drinks while at the sample site, nor during the time of sample collection or laboratory analysis. Each designated agency will insure that these sampling guidelines are followed, and that qualified sampling staff are assigned to this investigation. Samplers will wear clean nitrile gloves at each site, and will follow the standard operating procedures outlined within their sampling programs.

[1] Phase-II Report of the Emerging Constituents Workgroup, approved by the Santa Ana Regional Water Quality Control Board on December 10th, 2009

Field Blanks will be taken at each site where a similar sample volume of laboratory reagent water is transferred into a labeled FIELD BLANK sample bottle (preserved). Each laboratory will provide the laboratory reagent water for their field blanks, and any other additional quality control samples required within their laboratory's analysis.

At least one site within each matrix group will be sampled as a duplicate, and noted within the chain of custody (COC) form. Field parameters will be measured and noted onto the COC – electrical conductivity, pH, temperature, dissolved oxygen, etc. Also, enough samples will be taken to ensure that matrix spike and matrix spike duplicates (25-200 ng/L) can be performed on at least 10% of the total samples collected.

Sample extraction holding time is 14 days and the extract analysis holding time 14 days. The laboratory should try and extract and process the EC method as soon as possible after delivery. Samples should be transported in ice (bagged or blue ice) and delivered to the lab at <10°C. Samples are to be kept refrigerated until ready to be extracted (<6°C).

One site location will be identified as a "split sample" and processed by all participating labs. We recommend the *SAR at Prado Dam* site for the split sample. This will represent the matrix split sample within the study. OCWD will collect, split, and distribute this sample to all participating laboratories.

2. Target Analytes

The SAWPA's EC team developed a listing of eleven target compounds to be monitored within this study (see Table 1). The selection criteria are based on detection within previous national studies and recommendations as surrogates for wastewater indicators.

All labs have different EC target lists, and therefore will generate specific information on the samples analyzed. Targets lists will continue to evolve and the reportable levels can also vary. For the purposes of this study, each lab will report to SAWPA the results and related QA/QC data for the eleven target compounds.

All targets will be analyzed using the isotope dilution technique, with the exception of TCEP, as its required labeled standard is cost-prohibitive at the present time.

Table 1: Chemicals to be Analyzed in 2010-11 EC Characterization Study

Analyte	CAS#	Category
Acetaminophen	103-90-2	Pharmaceutical
Diuron	330-54-1	Herbicide
Bisphenol-A	80-05-7	Industrial
Caffeine	58-08-2	Food Additive
Carbamazepine	298-46-4	Pharmaceutical
DEET	134-62-3	Pesticide
17α Ethynylestradiol	57-63-6	Pharmaceutical
Gemfibrozil	25812-30-0	Pharmaceutical
Ibuprofen	15687-27-1	Pharmaceutical
Sulfamethoxazole	723-46-6	Pharmaceutical
TCEP	115-96-8	Industrial

3. QA/QC Procedures

Each lab will operate their method according to their Standard Operating Procedure (SOP), and therefore have associated Quality Assurance/Quality Control (QA/QC) samples analyzed within their procedure to help confirm the reported values. However, general data quality objectives can be developed within this investigation. All laboratories should be able to meet the criteria listed below. In an effort to facilitate the comparison of data produced by multiple laboratories and to minimize the effects of sample interference, the study's minimum reporting level (S-MRL) will be set at 10 ng/L. SAWPA's EC study report will use the S-MRL for final reporting purposes. Each lab will provide their most recent method detection limit (MDL) value for each target reported.

Two "Blind QA Samples" prepared by Environmental Resource Associates (ERA) will be sent directly to each participating lab. The first blind sample will be a mid-level check, where each target compound from SAWPA's target list spiked between 25-200 ng/L in a clean water matrix. The second blind sample will be a low-level check S-MRL Verification, where seven or eight of the eleven target compounds are spiked at a 10-15 ng/L level. These QA samples will be processed along with all received study sites by each laboratory.

Table 2: Method Performance Checks for EC Characterization Study

Sample Description	Specification & Frequency	Acceptance Criteria	Remedial Action
Low-Level CCC at the MRL (RDL)	Each Analysis Run	50-150% target recovery	Instrument Maintenance and Check Standards
Mid-Level CCC	Each Analysis Run	70-130% target recovery	Instrument Maintenance and Check Standards
"RB" Reagent Blank	Each Extraction Set	All targets must be less than 1/3 of the MRL (RDL)	Isolate Source of Contamination and Re-Extract
Low LFB Spiked Reagent Water at the MRL	Each Analysis Run	50-150% target recovery	Check SPE Cartridge Lots Verify Extraction Procedures and Re-extract
LFB – mid level	Each Analysis Run	70-130% target recovery	Check SPE Cartridge Lots Verify Extraction Procedures and Re-extract
Matrix Spikes Matrix Spike Duplicates Spike/Spike Dup (e.g. 200 ng/L - SARMON)	Each Analysis Run 10% minimum of total sample load	60-140% recovery <30%RPD If MS/MSD spike level is <50% of the ambient concentration acceptance limits are not relevant	Investigate Matrix Issues Check Standards and Re-Extract
Field Sample	Run Analysis	Check Internal (Isotope) Recovery (compound independent)	Investigate Matrix Issues Check Standards and Re-Extract
Back Standards	Each Analysis Run Every 10 samples must be bracketed with a CCC std	70-130% target recovery	Instrument Maintenance and Check Standards
Initial Calibration	Started Before Each Analysis Run	Must use at least a 5-point calibration curve Lowest Standard must be at or below reportable detection level (RDL) Calib. Curve <20% RSD	Check Standard Lots and QC Re-shoot or Open New Standards Instrument Maintenance
SAWPA Project Sample Duplicates	Each Analysis Run 10% minimum of total sample load	<30%RPD	Results Reported Re-Extract to confirm if possible
MDLs	Each New SPE Lot or Major Instrument Maintenance	The goal is for the calculated MDL to be 1/3 the RDL. The MDL must be lower than the RDL.	Instrument Maintenance, Extraction Procedures and Check Standards

4. Data Assessment and Reporting

Data will be reviewed by each laboratory's procedure and potential re-extractions or analysis conducted. Any samples that fail specific QA/QC criteria, which require a re-sampling request, will be done and evaluated at each participating lab. A detailed description of the cause(s) of the request will be reviewed.

Laboratories will provide a copy of their detailed SOP within the support of this investigation. Final reports will provide all QA/QC information including spike recovery information, LFB recoveries, blanks, calibration check information, MDLs, and applied method techniques. Blanks and MRL criteria referenced in Table 3 will be followed by all laboratories.

Table 3: Blanks and MRL Criteria for Preliminary EC Characterization Study

Batch QC	QC result	Secondary check	Reporting qualifiers
Method Blank	<MRL		OK to report - not clear that 1/3 MRL is always feasible (e.g. caffeine)
	>MRL	Samples ND	OK to report
	>MRL	Samples positive	Reprocess all positive samples
MRL - Check	<50%		Reprocess entire batch
	50-150%		Proceed
	>150%		Report if samples ND & note qualifier
LCS (spike must be <10x the MRL and should be representative of samples)	<70%		Reprocess entire batch
	70-130%		Proceed
	>130%		Report if samples ND & note qualifier
Field QC	**QC result**	**Secondary check**	**Reporting qualifiers**
Field Blank	< MRL		Proceed
	1-2x MRL		
	1-2x MRL	Samples ND	Report
	1-2x MRL	samples >2x field blank	Report value with flag (field blank contains target analyte but sample >2X field blank level)
	1-2x MRL	samples <2x field blank	Report ND with flag (field blank contains similar levels to sample)
	>2x MRL		
	>2x MRL	samples <10x Field Blank	Field Contamination (Resample required)
	>2x MRL	samples>10x field blank	Report value with flag (field blank contains target analyte but sample >10X field blank level)

5. Data Interpretation and Application

Because the analytical techniques used to support EC characterization studies are still in the early stages of development, great care must be exercised when using the results of such studies. To ensure that water quality monitoring data is used appropriately, EPA has established formal Data Quality Assurance requirements:

> *"EPA has developed a mandatory Agency-wide Quality System (or QA program) that requires all organizations performing work for EPA to assure that: environmental data collected are of the appropriate type and quality for their intended use...."*[2]

> *"Data Quality Objectives (DQOs) are statements of the level of uncertainty that a decision maker is willing to accept in results derived from environmental data, when the results are going to be used in a regulatory or programmatic decision (e.g., setting or revising a standard, or determining compliance). They are a tool that the permit writer may use to ensure that resources are being expended in the most efficient way, and that data collected are sufficient to support the decision making process and not extraneous to that process. To be complete, these quantitative DQOs must be accompanied by clear statements of: decisions to be made; why environmental data are needed and how they will be used; time and resource constraints on data collection; descriptions of the environmental data to be collected; specifications regarding the domain of the decision; calculations, statistical or otherwise, that will be performed on the data in order to arrive at a result. Without first developing DQOs, a QA program can only be used to document the quality of obtained data, rather than to ensure that the data quality obtained will be sufficient to support a permitting decision."*[3]

The most common use of water quality monitoring data is to evaluate compliance with relevant water quality standards. Therefore, DQOs are usually established in order to ensure that the resulting information is suitable for that intended regulatory purpose. The data quality criteria established in conjunction with California's 303(d) listing guidance is an example of such DQOs.[4]

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[2] U.S. EPA. EPA Requirements for Quality Management Plans; EPA QA/R-2; Nov., 1999.

[3] U.S. EPA. NPDES Permit Writer's Guide to Data Quality Objectives; Nov., 1990; p. 1-4 & 1-5.

[4] State Water Resources Control Board. Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. Sept. 30, 2005; Section 6.1 @ pgs. 17-26. See also Final Functional Equivalent Document for Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. Sept., 2004. Pgs. 232-235.

However, since there are no federal or state water quality standards for the ECs analyzed during this characterization study, it is not possible to establish appropriate DQOs for evaluating compliance with such standards.[5] Therefore, until EPA approves standard analytical methods, the data collected as part of this preliminary EC characterization study should be considered "provisional."[6] This is consistent with EPA's guidance:

> *…methods which will be used extensively for regulatory purposes or where significant decision must be based on the quality of the analytical data normally require more extensive validation and standardization than methods developed to collect preliminary baseline data.*[7]

The data quality objectives established in this Sampling and Analysis Plan are suitable for supporting an early effort to characterize EC concentrations in the Santa Ana watershed. However, a more rigorous data quality review will be necessary before the new information can be deemed suitable to support some regulatory applications, such as: 303(d) listing decisions, antidegradation analyses or translating narrative criteria into numeric TMDL targets or effluent limits. This issue is best addressed by the State Board, through the normal public hearing process, after the Blue Ribbon Panel on Emerging Constituents submits its recommendations.

[5] EPA publishes recommended federal water quality criteria pursuant to Section 304(a) of the Clean Water Act. State water quality standards are normally documented in the Water Quality Control Plan (aka "Basin Plan") adopted by each of the California Regional Water Quality Control Boards.

[6] EPA's criteria for certifying a new standard method, pursuant to 40 CFR Part 136, requires a thorough demonstration of accuracy, precision, method detection levels, representativeness, ruggedness, comparability and availability for the proposed analytical procedure. See U.S. EPA. Availability, Adequacy, and Comparability of Testing Procedures for the Analysis of Pollutants Established Under Section 304(h) of the Federal Water Pollution Control Act - Report to Congress; EPA/600/9-87/030; September, 1988 for a more detailed discussion.

[7] U.S. EPA. Availability, Adequacy, and Comparability of Testing Procedures for the Analysis of Pollutants Established Under Section 304(h) of the Federal Water Pollution Control Act - Report to Congress; EPA/600/9-87/030; September, 1988; pg.3-5S

6. Definitions

Blind QA Samples – An unknown quality assurance sample, which is spiked with the study's target compounds in a reagent water matrix. QA samples are provided by a method Performance Evaluation (PE) vendor – Environmental Resource Associates (ERA). Two QA samples are provided within this study – a mid level calibration check (25-200 ng/L) and an S-MRL check (10-15 ng/L). QA samples are sent directly to participating labs by the PE vendor for analysis.

CCC – Continuous Calibration Check – a method required standard to verify the calibration curve – most labs will run verification at the mid-level of the calibration – and at the reportable detection level - RDL (minimum reporting level – MRL).

COC - Chain of Custody – document that provides field and site information and conditions. COC information is transferred into the lab's database, includes basic field parameters. This is a legally required lab document.

Field Blank – A quality control sample used to monitor/verify sampling conditions at the site. The field blank is processed by pouring laboratory reagent water into a preserved sample container for the required method. The process mimics the sampling techniques for the site sample; tested to insure that none of the targets determined within the sample are coming from the process of sampling.

LFB/LCS (low/high) -Laboratory Fortified Blank/Laboratory Control Sample – is a laboratory reagent water sample, which is spiked with the method targets, and extracted within each method batch of samples. Processed just like a sample. This quality control sample insures that the method is generating acceptable data. Labs may run both an MRL/RDL level LFB (low) as well as a mid-level LFB (high).

MBLK / BLK/ RB – Method Blank/ Blank / Reagent Blank – is a method quality control sample consisting of laboratory reagent water and extracted and analyzed identically to all samples within each analytical batch. It monitors the laboratory method and techniques for any sources of contamination or interference.

MDLs – Method Detection Levels – are a statistical calculated value for each target analyzed by the laboratory's method. MDLs are performed by processing seven or more spiked replicates samples at a low-level, and analyzed over a three or more day period under method conditions. MDLs represent the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDLs goal is to be 3x lower than the laboratory established RDL/MRL.

MRL/RDL – Minimum Reporting Limit/ Reportable Detection Level - Represents the minimum quantifiable concentration level for a target analyte within the method. It usually represents the lowest calibration level within the standard curve. The MRL/RDL must be higher than the statistically calculated MDL.

MS/MSD - Matrix Spike / Matrix Spike Duplicate – are quality control samples processed within each analytical batch. They represent field samples that have been spiked with a known concentration of target analytes and processed within the entire method along with all samples. These QC samples are used to monitor the impact of sample matrix on the accuracy and precision of the results.

RPD – Relative Percent Difference – is a quality control value calculated from the MS/MSD samples (as well as other QC duplicates) as a measure of the precision of the method. $RPD = ((X1-X2) / ((X1+X2)/2))*100$

S-MRL – Study's Minimum Reporting Limit – The lowest concentration level at which each target within this study will be quantified and reported – 10 ng/L.

SOP – Standard Operating Procedure – the laboratory document that provides detailed directions as to the steps and procedures within the method of analysis. Procedure followed by laboratory technicians and chemists so as to produce consistent reliable results. SOPs are also used by field staff.

SPE – Solid Phase Extraction – analytical technique used within the lab to extract and process samples. Disks and cartridges are used to retain the targets of interest during the extraction process – eluted with appropriate solvents and then concentrated for final analysis.

Split Sample – Split Sample – is a quality assurance control, which is an actual field sample that is sent to multiple labs for analysis. The split samples provide a comparison of quality analysis between different labs.

Appendix B

Summary Description of Treatment Processes at POTWs in the Santa Ana Region

12/03/2010

City of Beaumont	
Facility(ies)	**City of Beaumont WWTP No. 1**
Preliminary & Primary Treatment	Bar Screens & Equalization tanks
Secondary Treatment	Variation of Activated sludge process called Biolac and Secondary Clarification
Tertiary Treatment	Sand filtration and disinfection by Ultra Violet
Design Capacity (mgd)	4
Solids Handling	Sludge is gravity thickened aerobically digested and centrifuged . It is then hauled off – site for disposal.
Location (X,Y)	(33.92411000,-116.99210000)
Comments	Effluent is discharged to Cooper's Creek and Marshall Creek

City of Corona Facilities				
Facility(ies)	**WRF 1**		**WRF 2**	**WRF 3**
	WRF 1a	**WRF 1b**		
Preliminary & Primary Treatment	Flow process starts through headworks equipped with a solids grinders, screenings removal systems and grit removal. Flow is then split and metered to two separate processes		Influent is pumped from a wet well to an elevated headworks consisting of a channel grinder assembly, and a grit removal chamber. Flow continues through 2 primary clarifiers. Primary effluent flows to two equalization basins and is pumped to aeration. The activated sludge aeration basin has 3 mechanical aerators. Aeration basin effluent enters three secondary clarifiers. Secondary effluent is discharged to percolation ponds (Lincoln, South Cota or North Cota).	Influent is pumped from a wet well to a rotating drum screen system.
Secondary Treatment	2 primary clarifiers 3 activated sludge aeration basins arranged in serpentine flow. Each basin has step feed and an anoxic zone. 6 rectangular secondary clarifiers All solids from both facilities are thickened by a gravity belt system and sent to anaerobic digestion.	2 activated sludge carrousel oxidation ditches 2 circular secondary clarifiers All solids from both facilities are thickened by a gravity belt system and sent to anaerobic digestion.	All primary and waste activated sludge and scum are gravity fed into the sewer system for treatment at WRF #1.	Flow continues into three activated sludge trains through anoxic zones then into aeration portion of the three trains.
Tertiary Treatment	Secondary effluent from both facilities then flows into an equalization basin. Effluent is then pumped to percolation ponds (Lincoln, South Cota, and North Cota) or tertiary sand filtration. Filtered effluent then flows through two chlorine contact basins for disinfection. Disinfected effluent is then sent to the recycled water distribution reservoir system or through a dechlorination system for discharge to the Butterfield Drain.			Water is then permeated by negative pressure through membrane modules. Permeate flow is then pumped and dosed for disinfection into a chlorine contact basin. From the chlorine contact basin permeate is pumped into the recycled water system or is dechlorinated for discharge into the Temescal Creek
Design Capacity (mgd)	5.5	6	3	1
Solids Handling	Anaerobic digestion solids are dewatered by a belt filter press. Filter press cake is then thermally dried to a 90% dry pellet.			
Location (X,Y)		(33.89202000, -117.60907000)	(33.88220442, -117.55613382)	(33.82240000,-117.50724000)
Comments				

City of Riverside	
Facility(ies)	**Riverside Regional Water Quality Control Plant**
Preliminary & Primary Treatment	Mechanical bar screens, grit chambers, chemical addition, primary clarifiers.
Secondary Treatment	Aeration trains with oxic/anoxic zones, secondary clarifiers, flow equalization.
Tertiary Treatment	Coagulation/Flocculation, sedimentation, filtration, chlorination, dechlorination
Design Capacity (mgd)	40
Solids Handling	Dissolved Air Flotation Thickening (DAFT) of Waste Activated Sludge (WAS), mesophilic anaerobic digestion of primary and secondary solids, and belt press and centrifuge dewatering of digested sludge.
Location (X,Y)	(33.96405000,-117.45873000)
Comments	

City of Redlands WWTP	
Facility(ies)	**WWTP**
Preliminary & Primary Treatment	• Headworks with grit removal • Primary clarification • Trickling filter to reduce peak organic loadings
Secondary Treatment	• Equalization basins • Nitrification/denitrification basins • Secondary clarification • Percolation ponds • MBR (Membrane Biological Reactor) to provide coagulated, filtered and disinfected effluent (recycled water use) • Chlorine contact basins
Tertiary Treatment	
Design Capacity (mgd)	9.5
Solids Handling	• 3 Primary anaerobic digesters • 1 Secondary digester • 2 Dissolved air floatation thickeners • 2 Centrifuges • Degas ponds • Drying Beds
Location (X,Y)	(33.96405000,-117.4587300)
Comments	

City of Rialto Facility	
Facility(ies)	**City of Rialto WRF**
Preliminary & Primary Treatment	Mechanical bar screens, grit chambers, primary clarifiers, flow equalization/emergency storage basins
Secondary Treatment	Aeration trains with oxic/anoxic zones, secondary clarifiers
Tertiary Treatment	Coagulation/Flocculation, filtration, chlorination, dechlorination
Design Capacity (mgd)	11.7
Solids Handling	Solids treatment includes gravity thickener, anaerobic digestion, digester gas utilization, and belt press dewatering. Belt press filtrate is pumped to the headworks for re-treatment
Location (X,Y)	
Comments	

City of San Bernardino Facilities			
Facility(ies)	**Colton**	**San Bernardino**	**RIX**
Preliminary & Primary Treatment	Mechanical bar screens, grit chambers, chemical addition, primary clarifiers.	Mechanical bar screens, grit chambers, chemical addition, primary clarifiers.	
Secondary Treatment	Aeration trains with oxic/anoxic zones, oxidation ditches, secondary clarifiers.	Aeration trains with oxic/anoxic zones, oxidation ditches, secondary clarifiers.	
Tertiary Treatment			Infiltration/extraction through in-situ soil (conventional tertiary filtration using Dynasand or Aquadisk also available for partial flows) followed by ultraviolet disinfection.
Design Capacity (mgd)	40 MGD, influent flow to RIX.	40 MGD, influent flow to RIX.	
Solids Handling			
Location (X,Y)			(34.04290345,-117.36050077)
Comments	Colton and San Bernardino Facilities provide treatment through secondary effluent.		RIX receives secondary effluent treated water only for infiltration.

EMWD Regional Water Reclamation Facilities Treatment Processes						
RWRF	**San Jacinto Valley**	**Moreno Valley**	**Perris Valley**		**Sun City**	**Temecula Valley**
Plant #	**1**	**1 & 2**	**1**	**2**	**1**	**1 & 2**
Preliminary Treatment	Mechanical Screens and Grit removal	Common Mechanical Screens and Grit removal (Plant 1 Influent EQ Basin)	Screens and Grit removal	Mechanical Screens and Grit removal	Screens and Grit removal	Common Mechanical Screens and Grit
Primary Treatment	Primary Clarifiers	Plant 1Primary Clarifiers; Plant 2 Modified Bardenpho Selectors	Primary Clarifiers	Modified Bardenpho Selectors	Primary Clarifiers w/ Primary EQ Basin	Primary Clarifiers w/ Primary EQ Basin
Secondary Treatment	Diffused activated sludge modified for biological nitrification/denitrification (NDN), secondary clarifiers	Plant 1Diffused activated sludge modified for biological NDN, secondary clarifiers; Plant 2 MLE modified, secondary clarifiers	Diffused activated sludge, secondary clarifiers	Temporary Modified Bardenpho with additional aeration	Diffused activated sludge, secondary clarifiers	Diffused activated sludge w/ biological NDN, secondary clarifiers
Secondary EQ Basin	Yes	Yes	No	Yes	No	Yes
Secondary Capacity (mgd)	11	16	3	12 (Temporary)	3	18
Tertiary Train #	1	1	1 (Not in Use)	2	N/A	1
Tertiary Treatment	Coagulant, Filtration (cloth), Chlorination	Coagulant, Filtration (media), Chlorination	Diverted to Tertiary Train 2	Coagulant, Filtration (media & cloth), Chlorination	N/A	Coagulant, Filtration (media & cloth), Chlorination
Tertiary Capacity, mgd	12.45	15.8	2.41	30	N/A	22.4
Solids Handling	Sludge thickening, Anaerobic digestion, belt press & centrifuge, sludge drying beds and co-generation (future)	Sludge thickening, Anaerobic digestion, belt press & centrifuge, sludge drying beds and Fuel Cell (future)	Aqua belt thickener, Aerobic digestion	Straight Waste	Aqua belt thickener, Aerobic digestion, Belt Press	Sludge thickening, Anaerobic digestion, belt press & centrifuge, sludge drying beds and co-generation (future)
			Belt Press & Centrifuge			
Location	(33.79858075,-117.01134973)	(33.87057566,-117.21547013)	(33.75201130,-117.19584693)			(33.50632258,-117.16913646)
Comments						

Pictures of EMWD's RWRF's

Moreno Valley Plant

San Jacinto Valley Plant

Perris Valley Plant

Temecula Valley Plant

Elsinore Valley Municipal Water District Facilities			
Facility(ies)	**Regional WRP**	**Railroad Canyon WRP**	**Horsetheif Canyon Facility**
Preliminary & Primary Treatment	Mechanical bar screens, grit chambers	Mechanical rotating screen	Mechanical bar screens, gravity grit chambers
Secondary Treatment	Aeration trains with oxic/anoxic zones, secondary clarifiers, Biological and Chemical P removal	Aeration trains with oxic/anoxic zones, secondary clarifiers	Oxidation Ditch, secondary clarifiers
Tertiary Treatment	Coagulation/Flocculation, sedimentation, filtration, UV disinfection	Coagulation/Flocculation, sedimentation, filtration, chlorination,	Coagulation/Flocculation, sedimentation, filtration, chlorination
Design Capacity (mgd)	8	1.3	0.5
Solids Handling	The solids handling for this facilityis accomplished in one of two processes (drying Beds and mechanical dewatering) and is comprised of waste activated sludge. Mechanical dewatering is through a belt filter press. The belt press filtrate is recycled through the headworks. Dewatered solids are sent off site to be composted and disposed of.	Biosolids (WAS) from this facility is sent to the District's Regional Facility for final treatment and disposal.	Waste activated sludge is dewatered and sent off site for composting and final disposal
Location (X,Y)	(33.68152116,-117.34027456)	(33.65741929,-11729547283)	(33.73423322,-117.42690348
Comments			

Inland Empire Utilities Agency Facilities				
Facility(ies)	**RP-1**	**RP-4**	**RP-5**	**CCWRF**
Preliminary & Primary Treatment	Mechanical bar screens, gritchambers, chemical addition,primary clarifiers, flow equalization/emergency storage basins	Mechanical bar screens, grit chambers, chemical addition, primary clarifiers	Mechanical bar screen, grit chambers, one storage basin, primary clarifiers	Mechanical bar screen, grit removal, chemical addition, primary clarifiers, emergency storage basin
Secondary Treatment	Aeration trains with oxic/anoxiczones, secondary clarifiers	Aeration basins with oxic/anoxic zones, secondary clarifiers	Aeration basins with anoxic/oxic zones, secondary clarifiers	Aeration basins with anoxic/oxic zones, secondary clarifiers
Tertiary Treatment	Coagulation/Flocculation, sedimentation, filtration, chlorination, dechlorination	Coagulation/Flocculation, filtration, chlorination, de-chlorination (not used), emergency diversion pond	Coagulation/Flocculation, filtration, chlorination, dechlorination, emergency overflow pond	Coagulation/flocculation, filtration, chlorination, dechlorination
Design Capacity (mgd)	44	14	15 (and 1.3 mgd RP-2 sludge treatment system wastewater flows)	11.4
Solids Handling	The solids handling for these facilities takes place at RP-1. RP-4 primary sludge and waste activated sludge are conveyed through the sewer system and enter RP-1 as influent. Solids treatment includes gravity thickener and dissolved air flotation thickeners, anaerobic digestion, digester gas utilization, and belt press dewatering. Belt press wash water is pumped to the DAFT units where the solids can be recovered and the remaining liquid is returned to the activated sludge process Belt press filtrate is pumped to the Non-Reclaimable Waste System (NRWS) line and is ultimately treated by the County Sanitation Districts of Los Angeles County.		Primary and waste activated sludge wastes from RP-5 and CCWRF are piped to the regional solids handling facility at RP-2 for sludge treatment. The solids treatment system at RP-2 includes gravity thickeners; dissolved air flotation thickeners; anaerobic digestion; aerobic digestion; belt press, and centrifuge dewatering. Dewatered biosolids are hauled away to approved disposal sites Sludge treatment system wastewater from RP-2 is pumped back to headworks of RP-5.	
Location (X,Y)			(33.96655000,-117.67358000)	(33.98223500, -117.69530000)
Comments	IEUA plans to construct a building to house four new centrifuges for dewatering digested sludge. This will replace the belt press dewatering. The tentative project completion and start-up date is 2012.	Sample identified as RP-1 002 is a blend of RP-1 and RP-4		

Irvine Ranch Water District Facilities		
Facility(ies)	**Michelson Water Reclamation Plant Unit Processes**	**Los Alisos Water Reclamation Plant Unit Processes**
Preliminary & Primary Treatment	Bar screens, grinders, iron salts addition, Settling of raw sewage and tertiary filter backwash, Storage to equalize flow into the activated sludge system	Gravity grit removal and disposal, Stair screens, grinders
Secondary Treatment	Anoxic-Oxic activated sludge with nitrogen removal, chemical addition	Sequential aerated pond system with settling, CBOD removal only
Tertiary Treatment	Chemical addition, dual media gravity filtration Disinfection with sodium hypochlorite, extended contact time to meet Title 22 requirements	Chemical addition, dual media gravity filtration, Disinfection with sodium hypochlorite
Design Capacity (mgd)		
Solids Handling	Primary and secondary sludge mixed with iron salts and pumped to Orange County Sanitation District for treatment and disposal	Sludge digestion in the aerated pond system, chemical addition, plate and frame filter press dewatering, hauled off site for disposal/reuse.
Location (X,Y)	(33.67001735,-117.84088528)	(33.63874857,-117.71700366)
Comments		

Western Riverside County Regional Wastewater Authority Facility	
Facility(ies)	**WRCRWA River Road Plant**
Preliminary & Primary Treatment	Aerobic Digestion Oxidation Ditch
Secondary Treatment	Secondary Clarifiers
Tertiary Treatment	UV Disinfection Tertiary Filters
Design Capacity (mgd)	
Solids Handling	
Location (X,Y)	(33.92829244,-117.60371742)
Comments	

WRCRWA River Road Plant

Yucaipa Valley Water District Facility	
Facility(ies)	**Henry N. Wochholz Regional Water Reclamation Facility (WRWRF)**
Preliminary & Primary Treatment	Mechanical bar screens, grit chambers, primary clarifiers, flow equalization and emergency storage basins
Secondary Treatment	Parallel anoxic basins, Integrated fixed-film activated sludge aeration basins, secondary clarification basins
Tertiary Treatment	Secondary equalization basins, Pall Microfiltration system, Ultraviolet disinfection system
Design Capacity, mgd	6.7
Solids Handling	DAF (dissolved air flotation) system, Anaerobic digesters receive sludges from primary sedimentation basins and DAF system. Belt Filter Press for dewatering of solids. Solids are taken to a local recycler for additional treatment (composting).
Location (X,Y)	(34.00692000,-117.09277000)
Comments	