Santa Ana River Wasteload Allocation Model Update

Basin Monitoring Program Task Force

December 9, 2019





Overview

- WLAM Update
- Assumptions of Predictive Scenarios
- Results of Predictive Scenarios

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• WLAM Update

- Assumptions of Predictive Scenarios
- Results of Predictive Scenarios

WLAM Update



- HSPF Computer Code
- Initial Steps
- Model Update and Calibration 2007 to 2016
- Expanded to include a portion of Orange County
- Model Recalibration
- Model Sensitivity Run

Hydrologic Simulation Program – Fortran (HSPF)



- Comprehensive & Physically Based
- Simulates ALL Water Cycle Components & Water Quality

Hydrologic Simulation Program – Fortran (HSPF) (cont.)



- Supported by EPA & USGS
- Widespread usage established
- Standard guidelines for model construction and calibration
- Software is free with powerful pre- and post-processors



Initial Steps

- 1. Compare results for the period 1994 to 2006
- 2. Update both models and compare the modeling results for the period from 2007 to 2016

San Timoteo Creek Near Loma Linda Daily Streamflow 1994-2006





San Timoteo Creek Near Loma Linda Monthly Streamflow 1994-2006





Warm Creek Near San Bernardino Daily Streamflow 1994-2006





Warm Creek Near San Bernardino Monthly Streamflow 1994-2006





Santa Ana River At E Street Daily Streamflow 1994-2006





Santa Ana River At E Street Monthly Streamflow 1994-2006





Santa Ana River At MWD Crossing Daily Streamflow 1994-2006







Santa Ana River At MWD Crossing Monthly Streamflow 1994-2006





San Timoteo Creek Near Loma Linda Daily Streamflow 2007-2016





San Timoteo Creek Near Loma Linda Monthly Streamflow 2007-2016





Warm Creek Near San Bernardino Daily Streamflow 2007-2016





Warm Creek Near San Bernardino Monthly Streamflow 2007-2016



2008 WLAM 100000 $R^2 = 0.80$ cfs 10000 Model-Calculated Monthly Streamflow, 1000 100 10 1 Good 0.1 0.1 10 100 1000 10000 100000 Measured Monthly Streamflow, cfs 2017 WLAM HSPF 100000 $R^2 = 0.91$ 10000 1000 100



Model-Calculated Monthly Streamflow, cfs

Santa Ana River At E Street Daily Streamflow 2007-2016





Santa Ana River At E Street Monthly Streamflow 2007-2016





Santa Ana River At MWD Crossing Daily Streamflow 2007-2016





Santa Ana River At MWD Crossing Monthly Streamflow 2007-2016





10

100

Measured Monthly Streamflow, cfs

1000

10000

100000

0.1

1

2008 WLAM

WLAM Update



- 564 subareas were delineated
- Each subarea consists of :
 - Stream segment,
 - Pervious land area, and
 - Impervious land area.
- Subareas were delineated based on:
 - Topography
 - Drainage patterns
 - Types of stream channels, and
 - Location of gaging stations and recharge basins



2012 Land Use Map



Source: Southern California Association of Governments (SCAG)





Discharge Point Locations





Precipitation Data

Precipitation Station

Sources:

- San Bernardino County Flood Control District
- Riverside County Flood Control and Water Conservation District
- County of Orange OC Public Works
- National Climatic Data Center (NCDC)

Coupling Process of HSPF and OCWD Recharge Facilities Model (RFM)





Gaging Station Locations for Streamflow Calibration



Gaging Station Locations for TDS/TIN Calibration



Rising Water Approach 2017 WLAM HSPF

HSPF Model Run:

- Streambed percolation is calculated by the model for Reach 4.
- No Percolation is assumed to occur in Reach 3 due to rising water.
- Model was calibrated so modelcalculated flow at MWD Crossing matched observed flow from the MWD gage.



Rising Water Approach 2017 WLAM HSPF (Cont.)

HSPF Post-Processing:

 The amount of rising water was determined from the existing groundwater flow model.

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Since this rising
water is contributing
to the modelcalculated flow at
MWD Crossing,
additional
percolation of the
same amount must
be added upstream
to equilibrate the
water balance.



Revised Approach 2017 WLAM HSPF

 Recalibrate WLAM with rising water as model input and compare results (Task 20).

Model Calibration Criteria

- Monthly and Daily Flow:
 - **R**²
 - Average Residual
 - Average Residual as Percentage of Observed
 - **RMSE**
 - RMSE as Percentage of Range of Observed
- TDS/TIN:
 - Average Residual
 - Average Residual Percentage of Observed
 - Standard Deviation
 - RMSE

Model Calibration Performance Criteria Using Goodness-of-Fit (R²)

Type of Flow Data	R ² (Goodness-of-Fit)	Calibration Performance
Daily Flow	R ² < 0.60	Poor
Daily Flow	0.60 < R ² < 0.70	Fair
Daily Flow	$0.70 < R^2 < 0.80$	Good
Daily Flow	R ² > 0.80	Very Good
Monthly Flow	R ² < 0.65	Poor
Monthly Flow	$0.65 < R^2 < 0.75$	Fair
Monthly Flow	0.75 < R ² < 0.85	Good
Monthly Flow	R ² > 0.85	Very Good
Santa Ana River at Prado Streamflow Calibration 2007-2016





Hydrographs of Measured and Model-Simulated Daily Streamflow at the Santa Ana River Inflow to Prado Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (2017 WLAM HSPF)



Hydrographs of Measured and Model-Simulated Monthly Streamflow at the Santa Ana River Inflow to Prado – Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (2017 WLAM HSPF)



Measured and Model-Simulated Daily TDS Concentrations at the Santa Ana River below Prado Dam Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (2017 WLAM HSPF)



Measured and Model-Simulated Daily TIN Concentrations at the Santa Ana River below Prado Dam Water Years 1995 to 2006 (2008 WLAM) and Water Years 2007 to 2016 (2017 WLAM HSPF)



Model-Calculated Daily TIN, mg/L





Summary of Streamflow Calibration Performance Using Goodness-of-Fit (R²)

	Daily Str	eamflow	Monthly S	treamflow
Gaging Station	2008 WLAM WY 1995-2006	2017 WLAM HSPF WY 2007-2016	2008 WLAM WY 1995-2006	2017 WLAM HSPF WY 2007-2016
San Timoteo Ck near Loma Linda	Good	Fair	Good	Fair
Warm Ck near San Bernardino	Fair	Good	Fair	Very Good
Santa Ana River at E Street	Good	Very Good	Very Good	Very Good
Santa Ana River at MWD Crossing	Fair	Very Good	Very Good	Very Good
Temescal Ck at Main Street	Poor	Good	Good	Poor
Chino Ck at Schaefer Avenue	Fair	Very Good	Good	Good
Cucamonga Ck near Mira Loma	Poor	Very Good	Good	Very Good
Santa Ana River into Prado Dam	Fair	Very Good	Very Good	Very Good
Santa Ana River at Santa Ana	NA	Poor	NA	Good

TDS/TIN Calibration – SAR at MWD Crossing



TDS/TIN Calibration – SAR below Prado



TDS/TIN Calibration – SAR at Imperial HWY near Anaheim



	τι	DS	TIN	
Parameters	2008 WLAM WY 1995- 2006	2017 WLAM HSPF WY 2007- 2016	2008 WLAM WY 1995- 2006	2017 WLAM HSPF WY 2007- 2016
Average Residual, mg/L	20.7	-6.0	-0.07	-0.53
Average of Observed, mg/L	535	615	5.13	3.92
Average Residual as Percentage of Average Observed, %	3.9%	-1.0%	-1.4%	-13.6%
Standard Deviation, mg/L	74.7	104.1	1.61	1.35
RMSE	77.4	104.3	1.61	1.45

Average Annual TDS and Flow in SAR Reach 3 and Reach 4 Overlying the Riverside-A GMZ (WY2007-2016) – Rising Water Sensitivity Run



Summary of WLAM Update

- The 2017 WLAM HSPF was constructed using recent data and calibrated from October 1, 2006 through September 30, 2016.
- The calibration results show:
 - Similar temporal dynamics in model-simulated and measured daily and monthly streamflow and TDS/TIN concentrations.
 - Good to very good performance at the majority of the streamflow gages.
 - The results indicate a satisfactory model calibration.



- WLAM Update
- Assumptions of Predictive Scenarios
- Results of Predictive Scenarios

Major Assumptions for Predictive Scenarios

				Recycled W	/ater Discharge Water	to Surface	TDS ar	nd TIN
Model Scenario	Hydrologic Period	Model Conditions	Land Use	Maximum Expected Discharge	Most Likely Discharge	Minimum Expected Discharge	Permit TDS	Permit TIN
А				Х			Х	Х
В		WY 2020	2012		Х		Х	Х
С	WY 1950 -					Х	Х	Х
D	2016		General	Х			Х	Х
E		WY 2040	Plan		Х		Х	Х
F			(2040)			Х	Х	Х

City of Beaumont - Beaumont Wastewater Treatment Plant

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scenario	[MGD]	[mg/L]	[mg/L]
Scenario A	3.8	400 / 300 ^A	6 / 3.6 ^A
Scenario B	3.5	400 / 300 ^A	6 / 3.6 ^A
Scenario C	3.2	400 / 300 ^A	6 / 3.6 ^A
Scenario D	6.3	400 / 300 ^A	6 / 3.6 ^A
Scenario E	6.1	400 / 300 ^A	6 / 3.6 ^A
Scenario F	5.9	400 / 300 ^A	6 / 3.6 ^A

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Note:

A. A. Discharge requirements on the initial 1.8 MGD of flow have higher allowable TDS and TIN concentrations (400 mg/L and 6 mg/L, respectively) than any additional flow (300 mg/L for TDS and 3.6 mg/L for TIN).

Yucaipa Valley Water District - H.N. Wochholz Water Recycling Facility

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
SCENdIU	[MGD]	[mg/L]	[mg/L]
Scenario A	8.0	400	6.7
Scenario B	3.8	400	6.7
Scenario C	1.6	400	6.7
Scenario D	8.0	400	6.7
Scenario E	6.0	400	6.7
Scenario F	1.6	400	6.7

East Valley Water District - Sterling Natural Resource Center (SNRC)^B

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN	SAN GABRIEL MOUNTAINS
Scenario	[MGD]	[mg/L]	[mg/L]	SAR-6
Scenario A	8	500	6 ^C	SB Ceo-1 SB Ceo-1 SB Ceo-7
Scenario B	6.8	500	6 ^C	IEUA RP-1002 and RP-102 Carbon Canyon WRF
Scenario C	0.0	500	6 ^C	Les Angeles Co USACE SARINP Phase 5A USACE
Scenario D	10.0	500	6 ^C	Cronse SAR-2 County SAR-2 SAR-2 County SAR-2 SA
Scenario E	8.5	500	6 ^C	Tomescal Visitor TC-2 TC-3 TC-4 TC-5 EVMMO Regional EMV D Regional
Scenario F	0.0	500	6 ^C	SAR1

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Note:

B. SNRC will be online as early as 2021, but was simulated under 2020 conditions.C. Estimated 12-Month Volume-Weighted Rolling Average in 2040 (mg/L).

Discharge to City Creek - Operational Scenarios (Integrated SAR Model)



City of San Bernardino - San Bernardino Geothermal Plant

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scenario	[MGD]	[mg/L]	[mg/L]
Scenario A	1.0 ^D	264 ^D	0.7 ^D
Scenario B	1.0 ^D	264 ^D	0.7 ^D
Scenario C	1.0 ^D	264 ^D	0.7 ^D
Scenario D	1.0 ^D	264 ^D	0.7 ^D
Scenario E	1.0 ^D	264 ^D	0.7 ^D
Scenario F	1.0 ^D	264 ^D	0.7 ^D

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Note:

D. No discharge projection form (Appendix F) was provided. Discharge assumptions were based on average of last 5 years (WY 2012-2016)

City of Rialto- Rialto Wastewater Treatment Plant

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scenario	[MGD]	[mg/L]	[mg/L]
Scenario A	7.2	490	10.0
Scenario B	6.4	490	10.0
Scenario C	5.8	490	10.0
Scenario D	18.0	490	10.0
Scenario E	11.7	490	10.0
Scenario F	5.0	490	10.0



Colton/San Bernardino - Rapid Infiltration and Extraction (RIX) Facility

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scenario	[MGD]	[mg/L]	[mg/L]
Scenario A	34.5	550	10.0
Scenario B	17.8	550	10.0
Scenario C	16.9	550	10.0
Scenario D	30.1	550	10.0
Scenario E	18.4	550	10.0
Scenario F	17.3	550	10.0



City of Riverside - Riverside Regional Water Quality Control Plant (RWQCP)

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scenario	[MGD]	[mg/L]	[mg/L]
Scenario A	33.8	650	10.0
Scenario B	25.0	650	10.0
Scenario C	18.1 ^E	650	10.0
Scenario D	46.0	650	10.0
Scenario E	22.5 ^F	650	10.0
Scenario F	18.1 ^E	650	10.0

Note:

E. A portion of the plant's discharge will be piped to upstream tributary locations to provide Santa Ana Sucker habitat as part of a regional project with Valley District and the Upper SAR HCP. Discharge quantities and locations are described below. Supplemental discharges to Riverside-A have not yet been permitted.

- Plant Discharge: 13.7 MGD
- * Anza Drain (33.966, -117.415): 0.6 MGD
- * Old Farm Rd (33.970, -117.412): 1.3 MGD
- * Tequesquite (33.976, -117.397): 0.6 MGD
- * Evans Drain (33.997, -117.382): 1.9 MGD

F. Anza Drain, Old Farm Rd, Tequesquite, and Evans Drain discharges are the same as in Note E. Plant discharge is 18.1 MGD.



Inland Empire Utilities Agency - Regional Plant (RP) 1 -**Discharge Point (DP) 001**

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scenario	[MGD]	[mg/L]	[mg/L]
Scenario A	44.0	550	8.0
Scenario B	1.4 ^J	550	8.0
Scenario C	0.0	550	8.0
Scenario D	44.0	550	8.0
Scenario E	1.4 ^J	550	8.0
Scenario F	0.0	550	8.0
12/0/2010	Note:		

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Inland Empire Utilities Agency - RP 1 - DP 002 and RP 4

Predictive Surface Water Permit TDS Permit TIN
[MGD] [mg/L] [mg/L]
Scenario A 14.0 550 8.0
Scenario B 8.1 ^J 550 8.0
Scenario C 0.2 550 8.0
Scenario D 21.0 550 8.0
Scenario E 8.1 ^J 550 8.0
Scenario F 0.2 550 8.0

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Inland Empire Utilities Agency - RP-5

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scenario	[MGD]	[mg/L]	[mg/L]
Scenario A	15.0	550	8.0
Scenario B	2.5 ^J	550	8.0
Scenario C	0.0	550	8.0
Scenario D	30.0	550	8.0
Scenario E	2.5 ^J	550	8.0
Scenario F	0.0	550	8.0
12/0/2010	Note:		

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Inland Empire Utilities Agency - Carbon Canyon Water Recycling Facility

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scenario	[MGD]	[mg/L]	[mg/L]
Scenario A	12.0	550	8.0
Scenario B	3.2 ^J	550	8.0
Scenario C	0.3	550	8.0
Scenario D	12.0	550	8.0
Scenario E	3.2 ^J	550	8.0
Scenario F	0.3	550	8.0

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Exhibit 1 - Revised Assumptions for IEUA Discharges for Use in Scenarios B and D for the 2017 WLAM

Table A - Projected Aggregate Monthly Discharge - All IEUA DPs - Breakdown by Plant in tables B through E

	July	August	September	October	November	December	January	February	March	April	May	June	Total
2020 af	687	592	803	1,211	1,592	2,536	2,521	2,066	1,887	1,312	1,217	602	17,026
2020 mgd	7.2	6.2	8.7	12.7	17.3	26.7	26.5	24.0	19.8	14.2	12.8	6.5	15.2
2040 af	687	592	803	1,211	1,592	2,536	2,521	2,066	1,887	1,312	1,217	602	17,026
2040 mgd	7.2	6.2	8.7	12.7	17.3	26.7	26.5	24.0	19.8	14.2	12.8	6.5	15.2

Table B - Projected Monthly Discharge for RP1 - 001 (Prado)

	July	August	September	October	November	December	January	February	March	April	May	June	Total
2020 af	106	119	136	132	153	176	154	150	110	106	110	116	1,568
2020 mgd	1.1	1.3	1.5	1.4	1.7	1.8	1.6	1.7	1.2	1.1	1.2	1.3	1.4
2040 af	106	119	136	132	153	176	154	150	110	106	110	116	1,568
2040 mgd	1.1	1.3	1.5	1.4	1.7	1.8	1.6	1.7	1.2	1.1	1.2	1.3	1.4

Table C - Projected Aggregate Monthly Discharge for RP1/RP4 - 002 (Cucamonga Creek)

	July	August	September	October	November	December	January	February	March	April	May	June	Total
2020 af	281	237	451	719	947	1,688	1,473	1,049	1,007	521	542	157	9,073
2020 mgd	3.0	2.5	4.9	7.6	10.3	17.7	15.5	12.2	10.6	5.7	5.7	1.7	8.1
2040 af	281	237	451	719	947	1,688	1,473	1,049	1,007	521	542	157	9,073
2040 mgd	3.0	2.5	4.9	7.6	10.3	17.7	15.5	12.2	10.6	5.7	5.7	1.7	8.1

Table D - Projected Aggregate Monthly Discharge for RP5

	July	August	September	October	November	December	January	February	March	April	May	June	Total
2020 af	28	26	50	187	290	426	513	434	319	215	235	79	2,800
2020 mgd	0.3	0.3	0.5	2.0	3.1	4.5	5.4	5.0	3.3	2.3	2.5	0.9	2.5
2040 af	28	26	50	187	290	426	513	434	319	215	235	79	2,800
2040 mgd	0.3	0.3	0.5	2.0	3.1	4.5	5.4	5.0	3.3	2.3	2.5	0.9	2.5

Table E - Projected Aggregate Monthly Discharge for Carbon Canyon WRP

	July	August	September	October	November	December	January	February	March	April	May	June	Total
2020 af	350	238	149	112	108	123	313	424	532	594	358	282	3,584
2020 mgd	3.7	2.5	1.6	1.2	1.2	1.3	3.3	4.9	5.6	6.5	3.8	3.1	3.2
2040 af	350	238	149	112	108	123	313	424	532	594	358	282	3,584
2040 mgd	3.7	2.5	1.6	1.2	1.2	1.3	3.3	4.9	5.6	6.5	3.8	3.1	3.2

Updated IEUA POTW Discharge

Projected discharge
(varied monthly) was
provided by IEUA/Chino
Basin Watermaster



Inland Empire Utilities Agency Reduced Discharge HCP Activity (Integrated SAR Model)

Facility / Discharge Point	WLAM Scenario B (2020 Most Likely Discharge) [MGD]	WLAM Scenario C (2020 Minimum Discharge) [MGD]	Integrated SAR Model HCP Activity: Reduced IEUA Discharge [MGD]	Carbon Canyon WRF EUA RP-10 and RP-4 EUA RP-10 and RP-4 EUA RP-10 BACE SARMP Phase 54 EUA RP-10 EUA RP-10 BACE SARMP Phase 54 EUA RP-10 EUA RP-2 EUA RP-2 EUA EUA RP-2 EUA RP-2 EUA RP-2 EUA RP-2 EUA RP-2 EUA RP-
RP 1 – DP 001	1.4	0	1.0	RP5
RP 1 and RP 4 – DP 002	8.1	0.2	3.3	USACE SARMP Phase 5B SARMP Phase 4 UDper TC-2 TC-4
RP 5	2.5	0	1.4	TC-3 EVMWD Regional WWRF TC-6
CCWRF	3.2	0.3	0.7	

Western Municipal Water District - Western Riverside County Regional Wastewater Authority Plant

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN	SAN GABREL MOUNTAINS
Scenario	[MGD]	[mg/L]	[mg/L]	5 5 8 M
Scenario A	12.0	625	10.0	
Scenario B	9.0	625	10.0	EUA FID-1002 Carbon Canyon WRF
Scenario C	7.5	625	10.0	Los Argeles Co USACE SARMP Phase SA USACE SARMP Phase SA IEUA RP-1001 Predi Dan Predi TO Dan
Scenario D	15.3	625	10.0	Oranoe SAR-2 USACE SARMO Phase 5B USACE SARMO Country SAR-2 Phase 4
Scenario E	12.5	625	10.0	SAB-1
Scenario F	10.5	625	10.0	A starter of



City of Corona - Corona Wastewater Treatment Plant -1

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN		
Scenario	[MGD]	[mg/L]	[mg/L]		
Scenario A	11.5	700 ^G	10.0		
Scenario B	4.6	700 ^G	10.0		
Scenario C	1.5	700 ^G	10.0		
Scenario D	15.0	700 ^G	10.0		
Scenario E	8.5	700 ^G	10.0		
Scenario F	1.5	700 ^G	10.0		



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Note:

G. A TDS concentration of 665 mg/L was applied in wetter months (December through April) while a concentration of 725 mg/L was applied in drier months (May through November). The average TDS concentration is 700 mg/L.

Temescal Valley Water District - Temescal Valley Water Reclamation Facility

[MGD] [mg/L] [mg/L] Scenario A 2.3 650 10.0 Scenario B 1.2 650 10.0 Scenario C 1.0 650 10.0 Scenario D 2.3 650 10.0 Scenario C 1.0 650 10.0 Scenario D 2.3 650 10.0 Scenario E 2.3 650 10.0 Scenario F 1.9 650 10.0	Di Predictive Sur	scharge to rface Water	Permit TDS	Permit TIN
Scenario A 2.3 650 10.0 Scenario B 1.2 650 10.0 Scenario C 1.0 650 10.0 Scenario D 2.3 650 10.0 Scenario E 2.3 650 10.0 Scenario F 1.9 650 10.0	Scenario	[MGD]	[mg/L]	[mg/L]
Scenario B 1.2 650 10.0 Scenario C 1.0 650 10.0 Scenario D 2.3 650 10.0 Scenario E 2.3 650 10.0 Scenario F 1.9 650 10.0	Scenario A	2.3	650	10.0
Scenario C 1.0 650 10.0 Scenario D 2.3 650 10.0 Scenario E 2.3 650 10.0 Scenario F 1.9 650 10.0	Scenario B	1.2	650	10.0
Scenario D 2.3 650 10.0 Scenario E 2.3 650 10.0 Scenario F 1.9 650 10.0	Scenario C	1.0	650	10.0
Scenario E 2.3 650 10.0 Scenario F 1.9 650 10.0	Scenario D	2.3	650	10.0
Scenario F 1.9 650 10.0	Scenario E	2.3	650	10.0
	Scenario F	1.9	650	10.0

SAN BERNARDINO

WWDHN

Elsinore Valley Municipal Water District - Regional WWRF - DP001 (Temescal Wash)

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN		
Scenario	[MGD]	[mg/L]	[mg/L]		
Scenario A	8.0 ^K	700	10.0		
Scenario B	0.5	700	10.0		
Scenario C	0.5	700	10.0		
Scenario D	12.0 ^K	700	10.0		
Scenario E	0.5	700	10.0		
Scenario F	0.5	700	10.0		

Note:

K. EVMWD's current permit allows discharge of up to 8.0 MGD to Lake Elsinore and/or Temescal Creek. Design capacity in 2040 is anticipated to be 12 MGD. Since the maximum and minimum discharge values provide sufficient bookends for discharge conditions, no spills from Lake Elsinore were considered.



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Eastern Municipal Water District- EMWD Regional Water Reclamation Facilities

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scenario	[MGD]	[mg/L]	[mg/L]
Scenario A	0.0 / 52.5 ^L	650 ^M	10.0
Scenario B	0.0 / 52.5 ^N	650 ^M	10.0
Scenario C	0.0	650 ^M	10.0
Scenario D	0.0 / 52.5 ^L	650 ^M	10.0
Scenario E	0.0 / 52.5 ^N	650 ^M	10.0
Scenario F	0.0	650 ^M	10.0

Note:

L. Discharge of 52.5 MGD was only applied in February for all years and from November through April (6 months) during the wettest half of the years (34 years of the 67-year simulation period) based on precipitation at Elsinore Station 67.

M. EMWD seeks to rerun the model at 700 mg/L TDS.

N. Discharge of 52.5 MGD was only applied in February (1 month).



Western Municipal Water District - Arlington Desalter⁰

Predictive Scenario	Discharge to Surface Water	Permit TDS	Permit TIN	Note: D. No discharge projection form (Appendix F) was provided. Discharge assumptions were based on average of last 5 years (WY 2012-2016) O. No discharge projection form (Appendix F) was provided. Discharge assumptions were developed through
	[MGD]	[mg/L]	[mg/L]	conversations with Western. Currently, there are no planned discharges from the Arlington Desalter to the Discharge is included here based on permitted discharge and possible future operations. P. Discharge of 6.3 MGD was only applied from November through April.
Scenario A	7.25	260 ^D	4.4 ^D	BB Geo-4 SB Geo-4 SB Geo-4 SB Geo-4 SB Geo-4 SB Geo-4 SB Geo-4
Scenario B	6.3 ^P	260 ^D	4.4 ^D	Billeto WVTP ST.1 Control ST.1 Control ST.1 Control ST.1 Control ST.1 Control ST.2 ST.1
Scenario C	0.0	260 ^D	4.4 ^D	Les Argeles Ge USACE SAMP Phase SA USACE SAMP Pha
Scenario D	7.25	260 ^D	4.4 ^D	USACE SARMP Phase 58 Country SAR-2 SAR-2 S SAR-2
Scenario E	6.3 ^P	260 ^D	4.4 ^D	SaB-1
Scenario F	0.0	260 ^D	4.4 ^D	
12/9/2019)			71

US Army Corps of Engineers – Santa Ana River Mainstem Project (SARMP)^H Dewatering Phase 4

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN	SAN GABREL MOUNTAINS
Scenario	[MGD]	[mg/L]	[mg/L]	SARG
Scenario A	6.8 ¹	985 ¹	1.0 ¹	SB Geo-3a SB Geo-4 SB Ge
Scenario B	0.0	-	-	Rink WWTP Rink Facility IELUA RP-1002 and RP-4 Cention Canyon, WRF
Scenario C	0.0	-	-	Les Angeles Ca USACE SARIAP Phase SA USACE SARIAP Phase SA Predo Les Angeles Ca Predo Les Angeles Ca
Scenario D	0.0	-	-	USACE SARIUP Dane 69 Phase 4 SARIUP Phase 4 Temescal Valley WRF
Scenario E	0.0	-	-	Tomesed Visity TC-3 TC-3 TC-5 EVMMD
Scenario F	0.0	-	-	SAR-1 WWFF

12/9/2019

Note:

H. De minimis discharge project that is only anticipated to operate for approximately 3 years.

I. No data available for Phase 4. Value represents the average of observed discharges or concentrations from Phase 5A and 5B monthly monitoring reports.
US Army Corps of Engineers – SARMP Dewatering Phase 5A

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN	SAM GADREL	A.	SAN
Scenario	[MGD]	[mg/L]	[mg/L]	T A	SB Geo-3 SB Geo-3 SB Geo-4	SB Geo-2 SB Geo-2a
Scenario A	5.8	950	1.0		SB Geo-1 SB Geo-1 SB Geo-7	Bunker Hill B SNRC SAR-5
Scenario B	0.0	-	-	Carbon Carton WRF	002/ RIX Facility - E Riverside A SAR-4 Evans Drait Chino South South - Evans Drait Chino South - Evans Drait Chino South - Evans Drait - Evans Drait	ST-1 Coliton ST-2 San Timeso ST-3 2 ST-3 2 ST-4 ST-4
Scenario C	0.0	-	-	Lan Angulas Car Grange Ca USACE SARMP Phase 5A USACE SARMP PHAS	Anza Drain Riverside Co. Riverside RWOCP TC-18 TC-19 TC-19 TC-19	WWD H.N. Wochholz Wi
Scenario D	0.0	-	-	Orance SAR.2 County SAR.2	Corona WWTP-1 5 Temescal Valley WRF	
Scenario E	0.0	-	-	SAR-1	TC-3 TC-3 TC-5 EVMMD Regional	EMWD Regional WRFs
Scenario F	0.0	-	-		Tree	2-1/

US Army Corps of Engineers – SARMP Dewatering Phase 5B

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN
Scendrio	[MGD]	[mg/L]	[mg/L]
Scenario A	7.7	1,020	1.0
Scenario B	0.0	-	-
Scenario C	0.0	-	-
Scenario D	0.0	-	-
Scenario E	0.0	-	-
Scenario F	0.0	-	-

Overview

- WLAM Update
- Assumptions of Predictive Scenarios
- Results of Predictive Scenarios

Analysis of Model Results

- 1-year averaging period : representative of the period of compliance for permits
- 5-year averaging period : typically covers the duration of the permit

Analysis of Model Results (cont.)

 10-year averaging period : useful for identifying possible future compliance issues and is intended to identify periods of prolonged drought and to provide a surrogate indication of what might be expected to occur in response to projected climate change in the region.

Analysis of Model Results (cont.)

- 20-year averaging period : represents the amount of time over which ambient groundwater concentrations are generally computed.
- 67-year averaging period : covers the entire predictive scenario duration and is useful for long-term planning.



Noble Creek and San Timoteo Creek – Reach 4 Overlying Beaumont GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

			Assimila- tive Capacity		SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F
	Objective	Ambient		Period	2020 Ex	opected Dis	2040 Ex	2040 Expected Discharge		
			Capacity		Max.	Avg.	Min.	Max.	Avg.	Min.
				1-year	202	204	206	177	177	177
TDC	2201/2202	200	10	5-year	176	177	177	163	163	163
TDS	330-/230-	290	40	10-year	172	172	173	157	157	157
				20-year	167	168	169	150	150	150
				1-year	1.94	1.97	2.01	1.42	1.42	1.43
TIN		2.0	2.1	5-year	1.46	1.49	1.51	1.19	1.19	1.19
	5.07/1.5	2.9	2.1	10-year	1.40	1.41	1.43	1.16	1.16	1.16
				20-year	1.36	1.37	1.39	1.13	1.13	1.14

Estimated Annual Streambed Recharge and Volume-Weighted TDS Concentration of San Timoteo Creek - Reach 4 and Tributaries¹ Overlying Beaumont GMZ Scenario B - 2020 Most Likely Discharge



¹Noble Creek: unnamed tributary to Marshall Creek below Beaumont DP 007: Cooper's Creek

SAN BERNARDINO MOUNTAINS

ST-2

SAR-5

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Seven Oaks

YVWD H.N. Wochholz WRF

12/9/2019



¹Noble Creek; unnamed tributary to Marshall Creek below Beaumont DP 007; Cooper's Creek

Estimated Annual Streambed Recharge and Volume-Weighted TIN Concentration of San Timoteo Creek - Reach 4 and Tributaries¹ Overlying Beaumont GMZ Scenario B - 2020 Most Likely Discharge



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Seven Oaks

YVWD H.N. Vochholz WRF

ST-2

SAR-5

¹Noble Creek: unnamed tributary to Marshall Creek below Beaumont DP 007: Cooper's Creek



Estimated Cumulative Frequency Distribution of Volume-Weighted TIN Concentration of San Timoteo Creek - Reach 4 and Tributaries¹ Overlying Beaumont GMZ Scenario B - 2020 Most Likely Discharge



Summary: Noble Creek and San Timoteo Creek – Reach 4 Overlying Beaumont GMZ

• TDS and TIN concentrations under Scenario A through Scenario F conditions do not exceed TDS or TIN maximum benefit objectives or ambient groundwater quality for the Beaumont GMZ.



San Timoteo Creek – Reach 2, 3, and 4 Overlying San Timoteo GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

			Assimila-		SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F	
	Objective	Ambient	Assimila- tive	Period	iod 2020 Expected Discharge				2040 Expected Discharge		
			Capacity		Max.	Avg.	Min.	Max.	Avg.	Min.	
				1-year	371	368	369	348	344	327	
DC	4001/2002	420		5-year	355	353	352	305	302	286	
D2	400-/300-	420	none	10-year	337	335	333	280	277	265	
				20-year	337	334	331	279	276	264	
				1-year	4.26	4.14	4.01	3.79	3.70	3.25	
-1.6.1		2.0	2.0	5-year	4.07	3.94	3.80	3.26	3.17	2.84	
IN	5.072.7	2.0	3.0	10-year	3.84	3.72	3.57	2.98	2.92	2.61	
				20-year	3.83	3.69	3.53	2.98	2.91	2.58	

Bold black values represent concentrations above ambient, but below objective.

Summary: San Timoteo Creek – Reach 2, 3, and 4 Overlying San Timoteo GMZ

- TDS concentrations under Scenario A through Scenario F conditions do not exceed TDS maximum benefit objectives or ambient groundwater quality for the San Timoteo GMZ.
- TIN concentrations exceed ambient groundwater quality in San Timoteo GMZ under all scenario conditions, but do not exceed maximum benefit objectives.



San Timoteo Creek – Reach 1; Santa Ana River - Reach 5 Overlying Bunker Hill-B GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

			Assimila		SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F	
	Objective	Ambient	Assimila- tive	Period	eriod 2020 Expected Discharge				2040 Expected Discharge		
			Сарасну		Max.	Avg.	Min.	Max.	Avg.	Min.	
				1-year	328	294	239	310	301	266	
TDC	222	200	10	5-year	294	261	226	272	262	230	
IDS	330	290	40	10-year	281	249	220	260	250	225	
				20-year	273	244	216	254	246	220	
			1.5	1-year	3.63	3.25	2.84	3.35	3.23	2.81	
TIN	7.0			5-year	3.21	2.69	2.36	2.83	2.67	2.28	
	7.3	5.8		10-year	3.09	2.62	2.27	2.74	2.59	2.21	
				20-year	2.93	2.50	2.19	2.65	2.51	2.13	

Bold black values represent concentrations above ambient, but below objective.

Summary: San Timoteo Creek – Reach 1; Santa Ana River -Reach 5 Overlying Bunker Hill-B GMZ

- TIN concentrations under Scenario A through Scenario F conditions do not exceed TIN objectives or ambient groundwater quality for the Bunker Hill-B GMZ.
- The maximum 1-year volume-weighted average TDS concentration under Scenarios A and D (maximum expected discharge for 2020 and 2040), and Scenarios B and E (most-likely discharge for 2020 and 2040) exceeds ambient TDS concentrations. The 5-year volume-weighted average under Scenario A conditions also exceeds the ambient TDS concentration.



Santa Ana River – Reach 4 Overlying Colton GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

			Assimila- tive		SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F
	Objective	Ambient		Period	riod 2020 Expected Discharge				2040 Expected Discharge	
			Capacity		Max.	Avg.	Min.	Max.	Avg.	Min.
TDS			none	1-year	399	307	260	346	356	293
	410	480		5-year	340	250	221	307	300	237
				10-year	317	246	217	290	281	233
				20-year	305	237	211	282	275	225
				1-year	3.97	2.35	2.30	3.53	3.43	2.23
TIN	27	2.2		5-year	3.33	1.99	1.81	3.02	2.76	1.85
	2.7	3.3	none -	10-year	3.12	1.95	1.64	2.87	2.64	1.81
				20-year	3.01	1.84	1.56	2.81	2.58	1.72

Bold red values represent concentrations above basin objective.

Summary: Santa Ana River – Reach 4 Overlying Colton GMZ

- TDS concentrations under Scenario A through Scenario F conditions do not exceed TDS objectives or ambient groundwater quality for the Colton GMZ.
- TIN concentrations exceed TIN objectives under Scenario A, Scenario D, and Scenario E (1-year and 5-year only) conditions.

Santa Ana River – Reach 4 Overlying Riverside-A GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

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Seven Oaks

YVWD H.N.

Wochholz WRF

SB Geo-2

SB Geo-2a

EMWD Regional WRFs

SAR-5

SB Geo-3

— Evans Drain

Old Farm Rd Anza Drain

Riverside RWQCP

rlington Desalter

Temescal Valley WR

TC-5

TC-6

TC-4

EVMWD

Regional WWRF

TC-2

TC-3

SB Geo-3a SB Geo-4c

SB Geo-1

SB Geo-7

Rialto WWTP

107

SAR-3

Western Riverside Co.

RWAP TC-1a

TC-1b Corona WWTP-1

1 002 RP-4

				Assimila- tive Canacity		SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F
-		Objective	Ambient		Period	od 2020 Expected Discharge			2040 Ex	2040 Expected Discharge	
5				Capacity		Max.	Avg.	Min.	Max.	Avg.	Min.
- 51					1-year	510	487	486	492	477	471
1	TDC	500	440	120	5-year	487	453	449	467	446	431
2	TDS	500	440	120	10-year	477	440	436	457	434	417
					20-year	472	434	430	452	428	410
allan a					1-year	6.95	6.67	6.63	6.80	6.57	6.38
	TIN 6.2		0.6	5-year	6.59	6.15	6.09	6.42	6.09	5.78	
		6.2	5.6	0.6	10-year	6.44	5.96	5.90	6.27	5.90	5.57
					20-year	6.35	5.83	5.77	6.16	5.77	5.42

Bold black values represent concentrations above ambient, but below objective. Bold red values represent concentrations above basin objective.

Summary: Santa Ana River – Reach 4 Overlying Riverside-A GMZ

- **TDS concentrations under Scenario A through Scenario F conditions do not exceed TDS** objectives for the Riverside-A GMZ. TDS concentrations also rise above ambient for all of the 1-year volume-weighted averages (all scenarios), 5-year volume-weighted averages under Scenarios A through E conditions, and 10-year and 20-year volumeweighted averages under Scenarios A and D conditions.
- All of the maximum 1-year volume-weighted average TIN concentrations exceed TIN objectives, along with the maximum 5-year and 10-year concentrations under maximum expected discharge conditions (Scenarios A and D). 12/9/2019



Santa Ana River – Reach 3 Overlying Chino-South GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

			Assimila- tive Canacity		SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F
	Objective	Ambient		Period	od 2020 Expected Discharge				2040 Expected Discharge	
			Capacity		Max.	Avg.	Min.	Max.	Avg.	Min.
				1-year	629	644	646	599	618	624
TDC	600	040		5-year	497	506	509	461	461	464
TDS	680	940	none	10-year	458	466	468	417	419	422
				20-year	457	465	466	415	418	420
				1-year	4.47	4.45	4.42	4.35	4.27	4.25
TIN	5.0	27.0		5-year	3.48	3.47	3.45	3.29	3.12	3.11
	5.0	27.8	none -	10-year	3.20	3.18	3.16	2.96	2.84	2.82
				20-year	3.20	3.17	3.15	2.95	2.83	2.81

Summary: Santa Ana River – Reach 3 Overlying Chino-South GMZ

 TDS and TIN concentrations under Scenario A through Scenario F conditions do not exceed TDS or TIN objectives or ambient groundwater quality for the Chino-South GMZ.



Temescal Creek - Reach 2, 3, 4, 5 and 6 Overlying Upper Temescal Valley GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

			Assimila-		SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F
	Objective	Ambient	Assimila- tive	Period	2020 Ex	opected Dis	2040 Expected Discharge			
			Сарасну		Max.	Avg.	Min.	Max.	Avg.	Min.
				1-year	657	404	317	645	431	378
TDC	820	750	70	5-year	639	367	292	615	393	343
102	820	750	70	10-year	629	354	279	604	374	327
				20-year	624	349	276	595	367	320
				1-year	7.03	4.48	3.44	6.88	4.80	4.17
TIN	7.0		3.2	5-year	6.89	4.02	3.11	6.65	4.29	3.68
	7.9	4.7		10-year	6.80	3.84	2.92	6.50	4.04	3.44
				20-year	6.73	3.75	2.86	6.40	3.93	3.36
				•						

Bold black values represent concentrations above ambient, but below objective.

Summary: Temescal Creek - Reach 2, 3, 4, 5 and 6 Overlying Upper Temescal Valley GMZ

- TDS concentrations under Scenario A through Scenario F conditions do not exceed TDS objectives or ambient groundwater quality for the Upper Temescal Valley GMZ.
- TIN concentrations rise above ambient groundwater concentrations, but below proposed objectives, under maximum discharge conditions (Scenarios A and D) as well as the 1-year maximum concentration under Scenario E conditions.



Santa Ana River – Reach 2 Overlying Orange County GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

			Assimila-		SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F	
	Objective	Ambient	Assimila- tive	Period	2020 E>	pected Dis	scharge	2040 Expected Discharge			
			Capacity		Max.	Avg.	Min.	Max.	Avg.	Min.	
				1-year	632	679	732	588	684	726	
	F 80	COO	Nego	5-year	601	647	684	546	645	676	
ID2	580	600	None	10-year	561	610	634	509	597	611	
				20-year	555	<u>602</u>	622	504	593	607	
				1-year	3.23	3.05	2.62	3.51	3.21	2.64	
TIN	2.4	2.0	0.4	5-year	3.06	2.92	2.48	3.32	3.03	2.51	
	3.4	3.0	0.4	10-year	2.88	2.78	2.33	3.10	2.84	2.30	
				20-year	2.84	2.74	2.28	3.08	2.81	2.28	

Bold black values represent concentrations above ambient, but below objective. Bold red values represent concentrations above basin objective.

Summary: Santa Ana River – Reach 2 Overlying Orange County GMZ

- All of the maximum 1-year volume-weighted average TDS concentrations in Orange County exceed TDS objectives, along with some of the maximum 5-year, 10-year and 20-year concentrations.
- Maximum 1 year volume-weighted TIN concentrations exceed TIN objectives under Scenario D conditions and rise above the ambient but below the objective in Scenarios A, B, and E. 5-year maximum volume-weighted TIN concentrations also rise above ambient concentration but below objectives under Scenarios A, D, and E conditions.



Santa Ana River – Reach 3 Overlying Prado Basin MZ above River Rd.

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

58 G											
SB				Assimila- tive Canacity	Period	SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F
1		Objective	Ambient			2020 E	xpected Dis	scharge	2040 E	2040 Expected Discharge	
ST				Capacity		Max.	Avg.	Min.	Max.	Avg.	Min.
15					1-year	652	662	666	636	650	654
	TDS na	22		5-year	637	646	649	622	635	638	
		na	na	na	10-year	630	638	640	616	627	629
FILE					20-year	621	629	630	607	617	619
1					1-year	6.46	6.34	6.26	6.53	6.29	6.21
1	TIN				5-year	6.30	6.18	6.09	6.38	6.13	6.05
1		na	a na	na	10-year	6.24	6.10	6.00	6.31	6.05	5.97
EMWD WRFs					20-year	6.16	6.02	5.92	6.24	5.97	5.88

Summary: Santa Ana River – Reach 3 Overlying Prado Basin MZ above River Rd.

 TDS and TIN concentrations under Scenario A through Scenario F conditions do not exceed TDS or TIN objectives or ambient groundwater quality for the PBMZ.



Santa Ana River Reach 3 Below Prado Dam

Maximum Value for the Volume-Weighted Stream Concentration (Units in mg/L)

			Assimila- tive	Period	SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F
	Objective	Ambient			2020 Ex	pected Dis	scharge	2040 Expected Discharge		
			Capacity		Max.	Avg.	Min.	Max.	Avg.	Min.
TDS	700	na	na		619	733	774	617	730	761
TIN	10.0	na	na	Baseflow Average	7.04	5.95	5.34	6.98	6.25	5.28

Bold red values represent concentrations above basin objective.



Santa Ana River Reach 2 Below Prado Dam

Maximum Value for the Volume-Weighted Stream Concentration (Units in mg/L)

	Objective	Ambient	Assimila- tive Capacity	Period	SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F
					2020 Expected Discharge			2040 Expected Discharge		
					Max.	Avg.	Min.	Max.	Avg.	Min.
TDS	650	na	na		523	481	445	522	464	421
TIN	na	na	na	5-year moving average of the 1- year volume- weighted average	5.77	4.14	3.17	5.86	4.16	3.06

Estimated Annual Discharge and Volume-Weighted TDS Concentration at Santa Ana River Below Prado Dam Scenario A - 2020 Maximum Expected Discharge



Streamflow (acre-ft/y



Estimated Annual Discharge and Volume-Weighted TIN Concentration at Santa Ana River Below Prado Dam Scenario A - 2020 Maximum Expected Discharge



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MOUNTAINS

IEUA RP-1 002

USACE

Phase 4

12/9/2019

Canyon WRF

IEUA RP-1 00

IEUA RP-5 IEUA RP-2

E SARMP

Phase 5B

and RP-4

Estimated Cumulative Frequency Distribution of Volume-Weighted TIN Concentration at Santa Ana River Below Prado Dam Scenario A - 2020 Maximum Expected Discharge



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Canvon WRF

IEUA RP-5

E SARMP

Phase 5B

IEUA RP-

IEUA RP-1 00

USACE

Phase 4




Estimated Annual Discharge and Volume-Weighted TIN Concentration at Santa Ana River Below Prado Dam Scenario B - 2020 Most Likely Discharge 12 1,000,000 SAN GABRIEL MOUNTAINS 🛛 Annual Discharge at Santa Ana River Below Prado Dam (Average = 171,456 acre-ft/yr) Baseflow TIN Objective for Reach 3 (10.0 mg/L) 9 750,000 Baseflow Volume-Weighted Average for TIN at Below Prado Dam (Max = 5.9 mg/L) 1-Year Volume-Weighted Average for TIN at Below Prado Dam (Max = 5.2 mg/L) 5-Year Moving Average of the 1-Year Volume Weighted Average for TIN at Below Prado Dam (Max = 4.1 mg/L) 5-Year Volume-Weighted Running Average for TIN at Below Prado Dam (Max = 4.1 mg/L) 10-Year Volume-Weighted Running Average for TIN at Below Prado Dam (Max = 3.6 mg/L) 20-Year Volume-Weighted Running Average for TIN at Below Prado Dam (Max = 3.6 mg/L) 67-Year Volume-Weighted Average for TIN at Below Prado Dam (3.2 mg/L) IEUA RP-1 002 ПN, mg/L and RP-4 Canyon WRF 6 500,000 SAR-3 IEUA RP-5 **~~**~ IEUA RP-2 **IEUA RP-1 00** Western Riverside Co RWAP TC-1a TC-1b Corona WWTP-1 E SARMP USACE Phase 5B 250,000 3 Phase 4 C-2 TC-3 0 1949 1954 1959 1964 1969 1974 1979 1984 1989 1994 1999 2004 2009 2014 12/9/2019 109 Water Year

Estimated Cumulative Frequency Distribution of Volume-Weighted TIN Concentration at Santa Ana River Below Prado Dam Scenario B - 2020 Most Likely Discharge



E SARMP

Phase 5B

Estimated Annual Discharge and Volume-Weighted TDS Concentration at Santa Ana River Below Prado Dam Scenario C - 2020 Minimum Expected Discharge





Estimated Annual Discharge and Volume-Weighted TIN Concentration at Santa Ana River Below Prado Dam Scenario C - 2020 Minimum Expected Discharge 12 1,000,000 SAN GABRIEL MOUNTAINS] Annual Discharge at Santa Ana River Below Prado Dam (Average = 141,033 acre-ft/yr) Baseflow TIN Objective for Reach 3 (10.0 mg/L) 9 750,000 Baseflow Volume-Weighted Average for TIN at Below Prado Dam (Max = 5.3 mg/L) 1-Year Volume-Weighted Average for TIN at Below Prado Dam (Max = 4.4 mg/L) 5-Year Moving Average of the 1-Year Volume Weighted Average for TIN at Below Prado Dam (Max = 3.2 mg/L) 5-Year Volume-Weighted Running Average for TIN at Below Prado Dam (Max = 3.1 mg/L) ---- 10-Year Volume-Weighted Running Average for TIN at Below Prado Dam (Max = 2.7 mg/L) BIX 67-Year Volume-Weighted Average for TIN at Below Prado Dam (2.3 mg/L) IEUA RP-1 002 ПN, mg/L and RP-4 Canyon WRF 500,000 6 SAR-3 IEUA RP-5 IEUA RP-2 **IEUA RP-1 00** Western Riverside Co. RWAP TC-1a TC-1b Corona WWTP-1 E SARMP USACE Phase 5B 250,000 3 Phase 4 TC-2 TC-3 0 1949 1954 1959 1964 1969 1974 1979 1984 1989 1994 1999 2004 2009 2014 12/9/2019 Water Year

Estimated Cumulative Frequency Distribution of Volume-Weighted TIN Concentration at Santa Ana River Below Prado Dam Scenario C - 2020 Minimum Expected Discharge





SAN GABRIEL

Summary: Santa Ana River Reach 3 Below Prado Dam

- The maximum Baseflow TDS concentration for volume-weighted discharge exceeds the Reach 3 objective under Scenarios B, C, E, and F conditions.
- Baseflow Average maximum TIN concentrations meet the Reach 3 water quality objective under all scenario conditions.



Santa Ana River Reach 2 at Santa Ana

Maximum Value for the Volume-Weighted Stream Concentration (Units in mg/L)

			Assimila		SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F
	Objective	Ambient	Assimila- it tive Capacity	Period	2020 Expected Discharge			2040 Expected Discharge		
					Max.	Avg.	Min.	Max.	Avg.	Min.
TDS	650	na	na		363	159	141	375	177	139
TIN	na	na	na	5-year moving average of the 1- year volume- weighted average	2.61	1.15	1.02	3.11	1.41	1.15

Summary: Santa Ana River Reach 2 at Santa Ana

 The 5-year moving average of the 1-year volume-weighted average TDS and TIN concentrations at Santa Ana do not exceed surface water objectives in Reach 2 of the SAR.

Eastern Municipal Water District- EMWD Regional Water Reclamation Facilities

Predictive	Discharge to Surface Water	Permit TDS	Permit TIN		
Scenario	[MGD]	[mg/L]	[mg/L]		
Scenario A'	0.0 / 52.5 ^L	700	10.0		
Scenario B'	0.0 / 52.5 ^N	700	10.0		
Scenario C'	0.0	700	10.0		
Scenario D'	0.0 / 52.5 ^L	<mark>700</mark>	10.0		
Scenario E'	0.0 / 52.5 ^N	<mark>700</mark>	10.0		
Scenario F'	0.0	<mark>700</mark>	10.0		

Note:

L. Discharge of 52.5 MGD was only applied in February for all years and from November through April (6 months) during the wettest half of the years (34 years of the 67-year simulation period) based on precipitation at Elsinore Station 67.

N. Discharge of 52.5 MGD was only applied in February (1 month).





Temescal Creek - Reach 2, 3, 4, 5 and 6 Overlying Upper Temescal Valley GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

(Ambient	Assimila- tive Capacity	SCEN A Period 2020 Max.	SCEN A'	SCEN B'	SCEN C'	SCEN D'	SCEN E'	SCEN F'	
	Objective				2020 E	pected Dis	scharge	2040 Expected Discharge			
					Max.	Avg.	Min.	Max.	Avg.	Min.	
				1-year	660	412	317	648	439	378	
TDC	820	750		5-year	648	375	292	627	399	343	
IDS	820 750	70	10-year	640	362	279	614	380	327		
				20-year	635	356	276	606	373	320	



Difference in TDS between Alternative Scenarios (Scenarios A' – F') and 2017 WLAM HSPF Predictive Scenarios (Scenarios A – F) – Upper Temescal Valley GMZ

Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

			Assimila- tive Capacity	Period	SCE A' – SCE A	SCE B' – SCE B	SCE C' – SCE C	SCE D' – SCE D	SCE E' – SCE E	SCE F' – SCE F
	Objective	Ambient			2020 Expected Discharge 2040 Expected Discharg					
					Max.	Avg.	Min.	Max.	Avg.	Min.
	820	750	70	1-year	+3	+8	0	+3	+8	0
				5-year	+9	+8	0	+12	+6	0
TDS				10-year	+11	+8	0	+10	+6	0
				20-year	+11	+7	0	+11	+6	0
				67-year	+10	+6	0	+9	+5	0



Santa Ana River Reach 3 Below Prado Dam

Maximum Value for the Volume-Weighted Stream Concentration (Units in mg/L)

	Objective	Ambient	Assimila- tive Capacity	Period	SCEN A'	SCEN B'	SCEN C'	SCEN D'	SCEN E'	SCEN F'
					2020 Expected Discharge			2040 Expected Discharge		
					Max.	Avg.	Min.	Max.	Avg.	Min.
TDS	700	na	na	Baseflow Average	619	733	774	617	730	761

Bold red values represent concentrations above basin objective.



Santa Ana River Reach 2 Below Prado Dam

Maximum Value for the Volume-Weighted Stream Concentration (Units in mg/L)

		Ambient	Assimila- tive Capacity	Period	SCEN A'	SCEN B'	SCEN C'	SCEN D'	SCEN E'	SCEN F'	
	Objective				2020 E>	pected Dis	scharge	2040 E>	xpected Discharge		
					Max.	Avg.	Min.	Max.	Avg.	Min.	
				5-year moving							
TDS	650	na	na	of the 1- year	523	481	445	522	464	421	
				volume- weighted average							



Maximum Value for the Volume-Weighted Recharge (Units in mg/L)

		Ambient	Assimila- tive Capacity		SCEN A'	SCEN B'	SCEN C'	SCEN D'	SCEN E'	SCEN F'	
	Objective			Period	2020 Ex	opected Dis	scharge	2040 Expected Discharge			
					Max.	Avg.	Min.	Max.	Avg.	Min.	
	580	600	None	1-year	632	679	732	588	684	726	
TDC				5-year	601	647	684	546	645	676	
IDS				10-year	561	610	634	509	597	611	
				20-year	555	602	622	504	593	607	

Bold red values represent concentrations above basin objective.

SB

SB Geo-1 SB Geo-7 ~

SAR

Anza

Riverside

Arlington Desalt

Temescal Valley W

TC-4

EVMWD Regional

WWRF

TC-5

TC-2

TC-3

110

SAR-3

Western Riverside Co.

RWAP

Corona WWTP-1

IEUA RP-1 002 and RP-4

USACE

Phase 4

SAN GABRIEL MOUNTAINS

Carbon Canyon WRF

USACE SARMP

Phase 5B

Los Angales Co

USACE SARMP, Phase 5A

SAR-2

Oranoe County

100

SAR-1

IEUA RP-5

IEUA RP-2

IEUA RP-1 00



Santa Ana River Reach 2 at Santa Ana

Maximum Value for the Volume-Weighted Stream Concentration (Units in mg/L)

			Assimila- tive Capacity	Period	SCEN A'	SCEN B'	SCEN C'	SCEN D'	SCEN E'	SCEN F'
	Objective	Ambient			2020 E>	pected Di	scharge	2040 E>	pected Dis	scharge
					Max.	Avg.	Min.	Max.	Avg.	Min.
				5-year moving average						
TDS	650	na	na	of the 1- year volume- weighted average	363	159	141	375	177	139