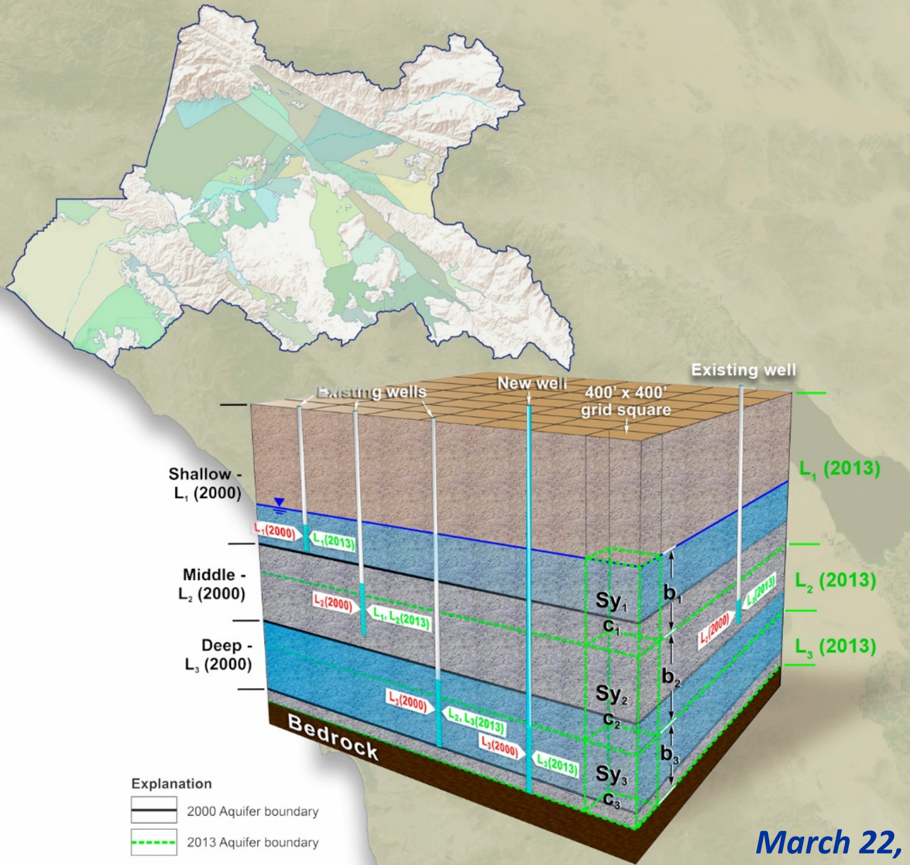
TDS/Nitrogen Management
Plan for the Santa Ana River Basin
Groundwater Monitoring Requirements

Basin Plan Amendments:
CEQA and Econ Analysis



CDM Smith

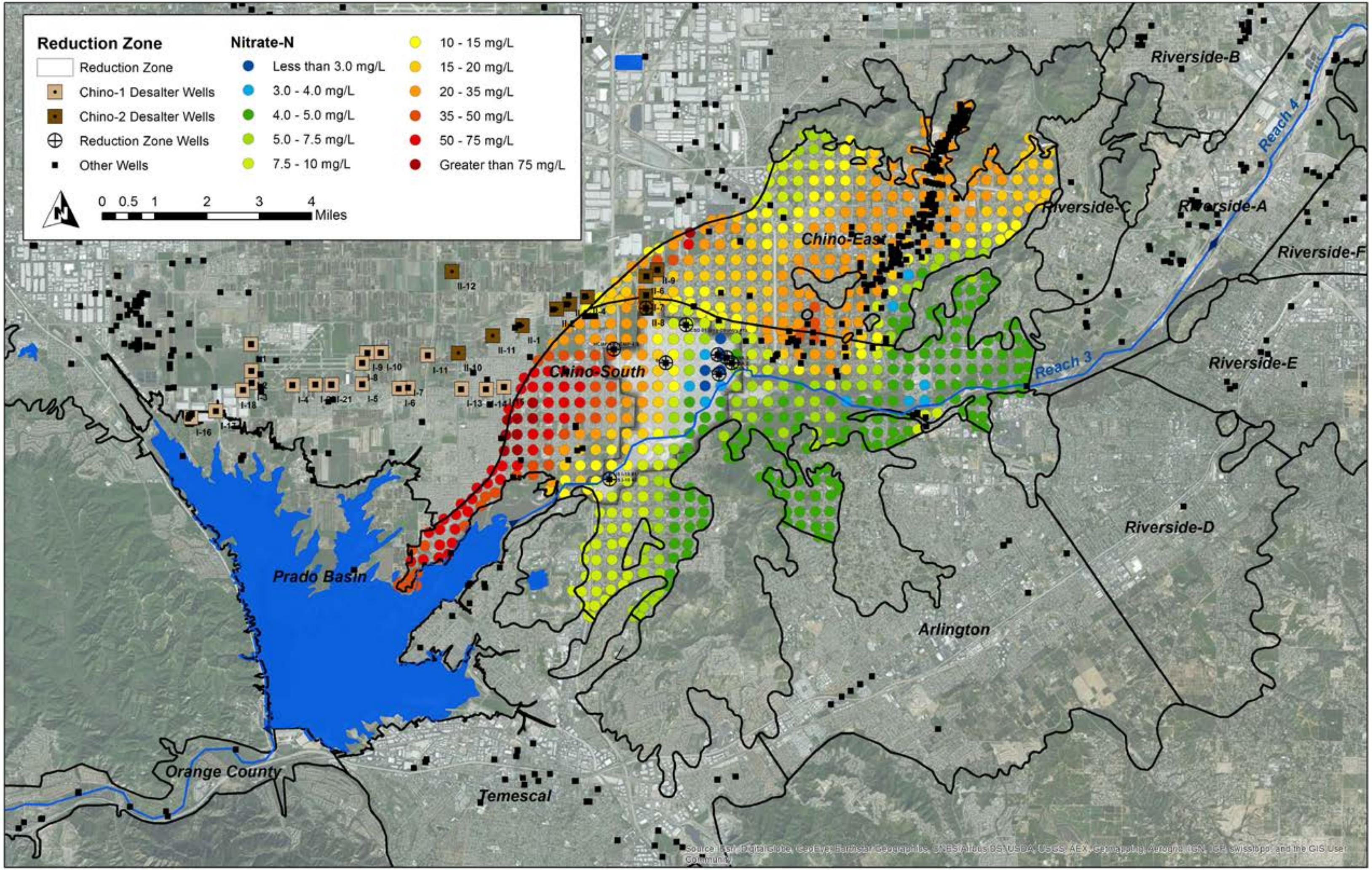
March 22, 2017

Chino South Groundwater Management Zone

- Based on the current ambient water quality determination and the Riverside A GMZ objective, there is no assimilative capacity for nitrogen in the basin.
    - WQO – 4.2 mg/L
    - Current ambient (2012) – 28 mg/L
- Current NPDES permits restrict the average TIN concentration of the WWTP effluent to be less than or equal to 10 mg/L; applying the nitrogen loss coefficient would result in concentration of 5 mg/L when the effluent reaches groundwater (not including dilution).
- The Regional Board is considering revising the Basin Plan to change the WQO for nitrate in the Chino-South Groundwater Management Zone (CS GMZ) from its current value of 4.2 mg/L to a new value of 5.0 mg/L.

Proposed Action

- Chino South Groundwater Management Zone
  - Proposed action - Determine additional cost required for CDA to pump a blend of native groundwater (with vadose zone contributions) and effluent (at 5 mg/L versus 4.2 mg/L).
  - Potential no-action alternative methods of compliance:
    - Additional nitrate reductions at WWTPs by upgrading the plants
    - Physically move the WWTP discharge locations downstream of CS GMZ (into the Prado Basin Management Zone).
    - Purchase and blend SPW in the Santa Ana River overlying the CS GMZ.


Reduction Zone
Reduction Zone
Chino-1 Desalter Wells
Chino-2 Desalter Wells
Reduction Zone Wells
Other Wells
Nitrate-N
Less than 3.0 mg/L
3.0 - 4.0 mg/L
4.0 - 5.0 mg/L
5.0 - 7.5 mg/L
7.5 - 10 mg/L
10 - 15 mg/L
15 - 20 mg/L
20 - 35 mg/L
35 - 50 mg/L
50 - 75 mg/L
Greater than 75 mg/L
0 0.5 1 2 3 4
Miles
Riverside-B
Reach 4
Riverside-C
Riverside-A
Chino-East
Riverside-F
Reach 3
Riverside-E
Chino-South
Prado Basin
Riverside-D
Arlington
Orange County
Temescal

Impact on Reverse Osmosis (RO) Operating Cost

Parameter	Unit	Chino I RO Feed	Chino II RO Feed
TDS1 at Nitrate1	mg/L	784.79	654.76
TDS2 at Nitrate2	mg/L	785.19	655.16
Change in TDS	%	0.05	0.06
RO Feed Flow	MGD	11.11	11.07
Feed Pump Power Draw @ TDS1	BHP	843.55	840.88
Feed Pump Power Draw @ TDS2	BHP	843.12	840.36
Change in Feed Pump Power Draw	BHP	0.43	0.51
Power Cost	$/kW-hr	$0.114	$0.114
Annual Power Cost at TDS1	$/year	$628,183	$626,188
Annual Power Cost at TDS2	$/year	$627,863	$625,805
Total Annual Operating Cost Delta		**$320**	**$382**

Key Assumptions:

- The increase in power draw required to operate the feed pumps is proportional to the increase in TDS. This is a conservative assumption.
- The RO feed pumps operate continuously, 24 hours/day, 7 days/week, 365 days/year.
- Power cost is $0.114/kW-hr.
- Feed pump head is 150 psi.
- Feed pump efficiency is 80%.

$$BHP = \frac{Q \times H}{3960 \times n} \times s.g.$$

Where:

BHP = brake horsepower
Q = flow
H = head
n = efficiency
s.g. = specific gravity (remains constant)

Impact on Ion Exchange (IX) Operating Cost Cont'd

Chino I IX System

Parameter	Unit	Value
Nitrate Removal System at Nitrate1		
IX Vessels Regen Cycles/Day	--	4.57
Regenerable Resin per Vessel	cf	668
Total Resin Volume	cf	3052
Regeneration System		
Regen Cycle	hrs	24.00
Salt Volumetric Weight	lb/cf	7.50
Daily Salt Usage	lb/day	22,887
Annual Salt Usage	lb/yr	8,353,658
Brine Pumping (2 pumps/train each @ 2 HP)	HP/regen	4
Pump Run Time	mins/regen	80
Daily Power Draw	KW-hr/day	18.17
Annual Power Draw	KW-hr/yr	6,631

Cost Calculations	Amount	Unit Price	Total
Nitrate Resin Regeneration - Salt	8,353,658	$0.05	$446,000
Brine Pumping	6,631	$0.114	$756
Total Annual Operating Cost @ Nitrate1			**$446,756**
Total Annual Operating Cost @ Nitrate2			**$447,963**
Chino I Total Annual Operating Cost Delta			**$1,207**

Chino II IX System

Parameter	Unit	Value
Nitrate Removal System at Nitrate1		
IX Vessels Regen Cycles/Day	--	8.20
Regenerable Resin per Vessel	cf	668
Total Resin Volume	cf	5481
Regeneration System		
Regen Cycle	hrs	24.00
Salt Volumetric Weight	lb/cf	7.50
Daily Salt Usage	lb/day	41,104
Annual Salt Usage	lb/yr	15,002,976
Brine Pumping (2 pumps/train each @ 2 HP)	HP/regen	4
Pump Run Time	mins/regen	80
Daily Power Draw	KW-hr/day	32.63
Annual Power Draw	KW-hr/yr	11,910

Cost Calculations	Amount	Unit Price	Total
Nitrate Resin Regeneration - Salt	15,002,976	$0.05	$801,000
Brine Pumping	11,910	$0.114	$1,358
Total Annual Operating Cost @ Nitrate1			**$802,358**
Total Annual Operating Cost @ Nitrate2			**$805,407**
Chino II Total Annual Operating Cost Delta			**$3,050**

Total Impact on CDA Annual Operating Cost

Operating Costs	Chino I	Chino II
Increase in RO Annual Operating Cost	$320	$382
Increase in IX Annual Operating Cost	$1,207	$3,050
Total Increase in RO and IX Annual Operating Cost	**$1,528**	**$3,433**

If the nitrate contribution in the native groundwater from the Santa Ana River after SAT increases by 0.8 mg/L-N, the CDA annual operating cost is estimated to increase by ~$5,000.

Economic Analysis – Cost Summary

Action/Alternate Compliance Method	Method	Capital		O&M	
Cost Impacts to the CDA	1. Percent Operating Budget			$15.8K	
	2. Analysis of additional annual O&M			$5K	
Nitrate Reduction at WWTP	1. RO Sidestream of Effluent	$75M			
	2. Introduction of Methanol	$400K		$332K	
Move Discharge Locations		$13.4M	$26.8M		
Blend Effluent with SWP				$6.3M	$6.5M

AWQ - Status Update

- **Data Collection**

  - **Water level and water quality data uploaded for most GMZs**

  - **Chino Basin Watermaster to provide agricultural pool well data**

  - **Optional Task 2 - New locations for nitrate-N and TDS added from GeoTracker in Arlington, Riverside-A, and Riverside-B GMZs**

Status Update

- **Water Levels**
  - **Visually checked water level trends**
  - **Hand contoured water levels for all GMZs (expect Chino and EMWD)**
    - **Working with EMWD for contouring**
  - **Digitizing water level contours**

Status Update

Recomputaion of Ambient Water Quality for the Period 1996 to 2015

			Water Levels				TDS			Nitrate		
Management Zone	Layering	Firm	Contoured	Checked	Georeference	Digitized	Contoured	Checked	Digitized	Contoured	Checked	Digitized
Arlington	Unlayered	DBSA	X	X	X							
Bunker Hill	Unlayered	CDM	X	X	X							
Bunker Hill Pressure	Layer 1	CDM	NA	NA	NA	NA						
Bunker Hill Pressure	Layer 2	CDM	NA	NA	NA	NA						
Beaumont	Unlayered	DBSA	X	X	X							
Chino-North	Layer 1	DBSA										
Chino-North	Layer 2	DBSA	NA	NA	NA	NA						
Chino-North	Layer 3	DBSA	NA	NA	NA	NA						
Chino South and East	Unlayered	DBSA										
Cucamonga	Unlayered	DBSA	X	X	X							
Canyon	Unlayered	CDM										
Elsinore	Unlayered	CDM	X	X	X							
Lytle	Unlayered	DBSA	X	X	X							
Orange County/Irvine	Layer 1	CDM	X	X	X	X						
Orange County/Irvine	Layer 2	CDM	NA	NA	NA	NA						
Rialto and Colton	Unlayered	DBSA	X	X	X							
Riverside A,B,C,D,E	Unlayered	DBSA	X	X	X							
San Jacinto MZ's	Unlayered	CDM										
San Jacinto Pressure Zone	Unlayered	CDM										
San Timoteo	Unlayered	DBSA	X	X	X							
Temescal and Bedford	Unlayered	CDM	X	X	X							
Coldwater	Unlayered	CDM	X	X	X							
Yucaipa	Unlayered	CDM	X	X	X							

Status Update

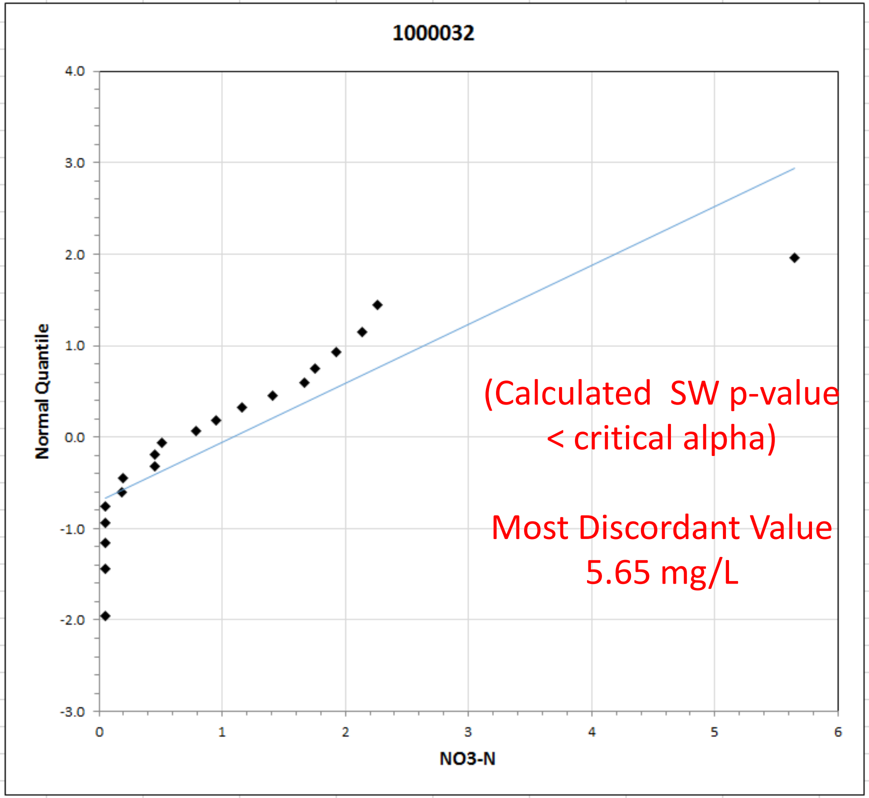
- **Water Quality**
  - **Visually checked water quality trends**
  - **Evaluation of data quality**
    - Anion-Cation balance
    - Comparison of measured and calculated TDS
    - Comparison of measured EC and the sum of ions
    - TDS to EC ratios
  - **Point Statistics for 20-Year Moving Average (1996-2015)**
    - Annualized Averages
    - At least 3 years of water quality (TDS or Nitrate-N) in 20-year period
    - Shapiro-Wilks test for normality
    - Point Statistics = mean plus t*standard error of the mean

Shapiro-Wilks Test for normality

Select (Ctrl-E)

Statistics	
site	Santa Ana
location	1000032
analyte	NO3-N
count	20
count detects	15
Sample_Year min	1993
Sample_Year max	2012
Annual_Average min	0.05
Annual_Average max	5.6474
Annual_Average mean	1.086754661
Annual_Average stdev	1.319874947
Shapiro-Wilk W	0.745676752
Shapiro-Wilk p-value	0.000148636
Critical Alpha	0.01
Most Discordant Value	5.6474
Pearson	NA
Slope	NA
Intercept	NA

Remove MDV



(Calculated SW p-value < critical alpha)

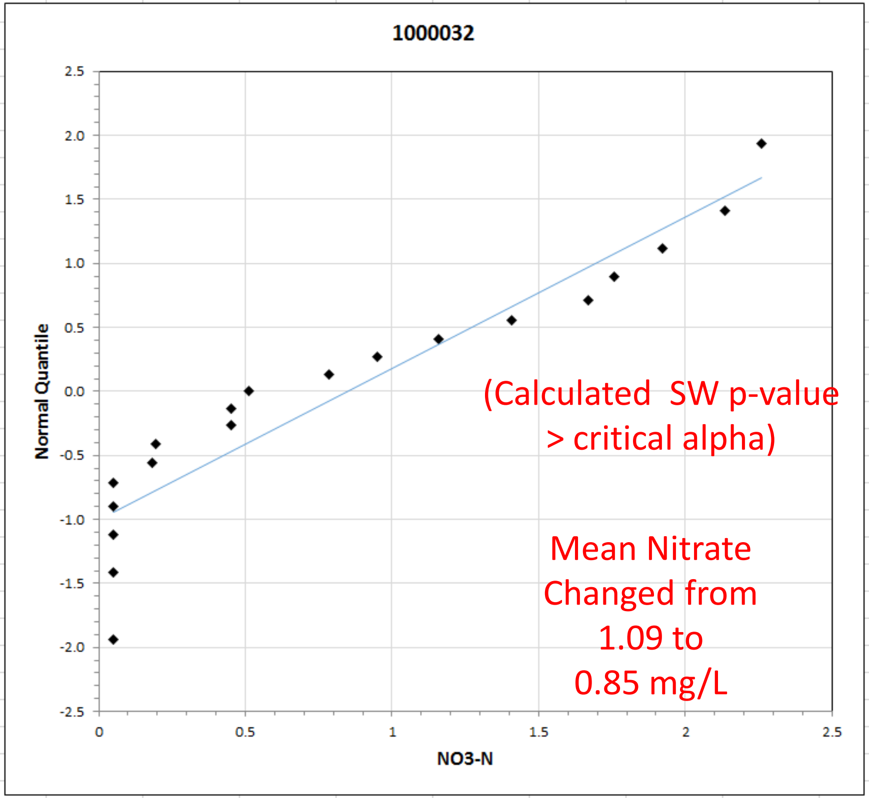
Most Discordant Value 5.65 mg/L

Shapiro-Wilks Test for Normality

Select (Ctrl-E)

Statistics	
site	Santa Ana
location	1000032
analyte	NO3-N
count	19
count detects	14
Sample_Year min	1993
Sample_Year max	2012
Annual_Average min	0.05
Annual_Average max	2.258
Annual_Average mean	0.846720696
Annual_Average stdev	0.788991338
Shapiro-Wilk W	0.867778889
Shapiro-Wilk p-value	0.013240144
Critical Alpha	0.01
Most Discordant Value	NA
Pearson	NA
Slope	NA
Intercept	NA

Remove MDV



Questions?

SUBSTITUTE ENVIRONMENTAL DOCUMENT

Environmental Resource Areas Analyzed:

- Aesthetics
- Agriculture and Forestry Resources
- Air Quality
- Biological Resources
- Cultural Resources
- Geology/Soils
- Greenhouse Gases
- Hazards/Hazardous Materials
- Hydrology/Water Quality
- Land Use/Planning
- Mineral Resources
- Noise
- Population/Housing
- Public Services
- Recreation
- Traffic/Transportation
- Tribal Cultural Resources
- Utilities/Service Systems
- Mandatory Findings of Significance

Environmental Impacts

No Impact

- Aesthetics
- Agriculture and Forestry Resources
- Air Quality
- Biological Resources
- Geology and Soils
- Greenhouse Gases
- Hazards and Hazardous Materials
- Land Use and Planning
- Mineral Resources
- Noise
- Population/Housing
- Public Services
- Recreation
- Traffic and Transportation
- Utilities

Less than Significant Impacts

- Hydrology and Water Quality
- Mandatory Findings of Significance

Significant Impacts

- None

Chino South Groundwater Management Zone

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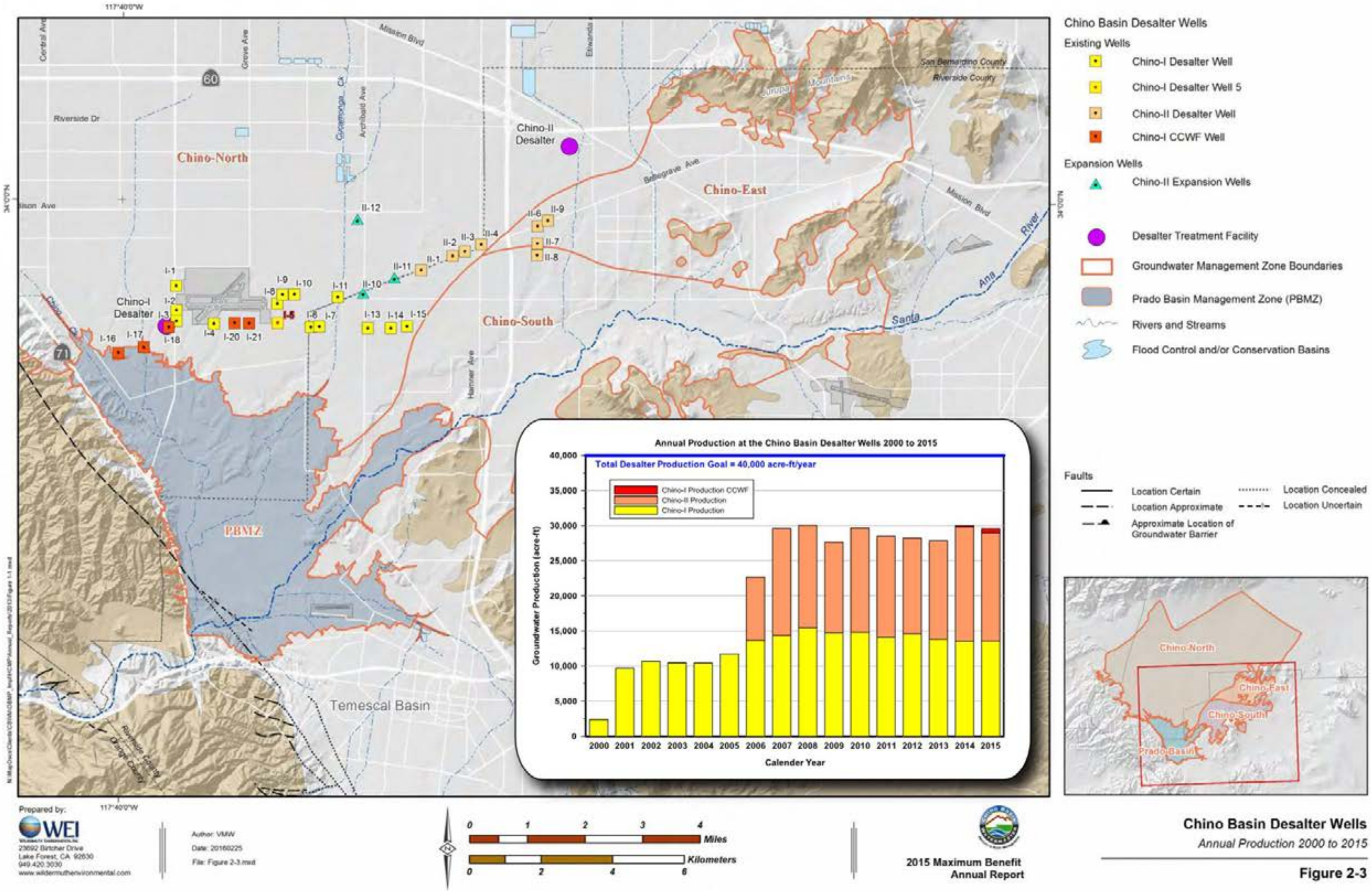
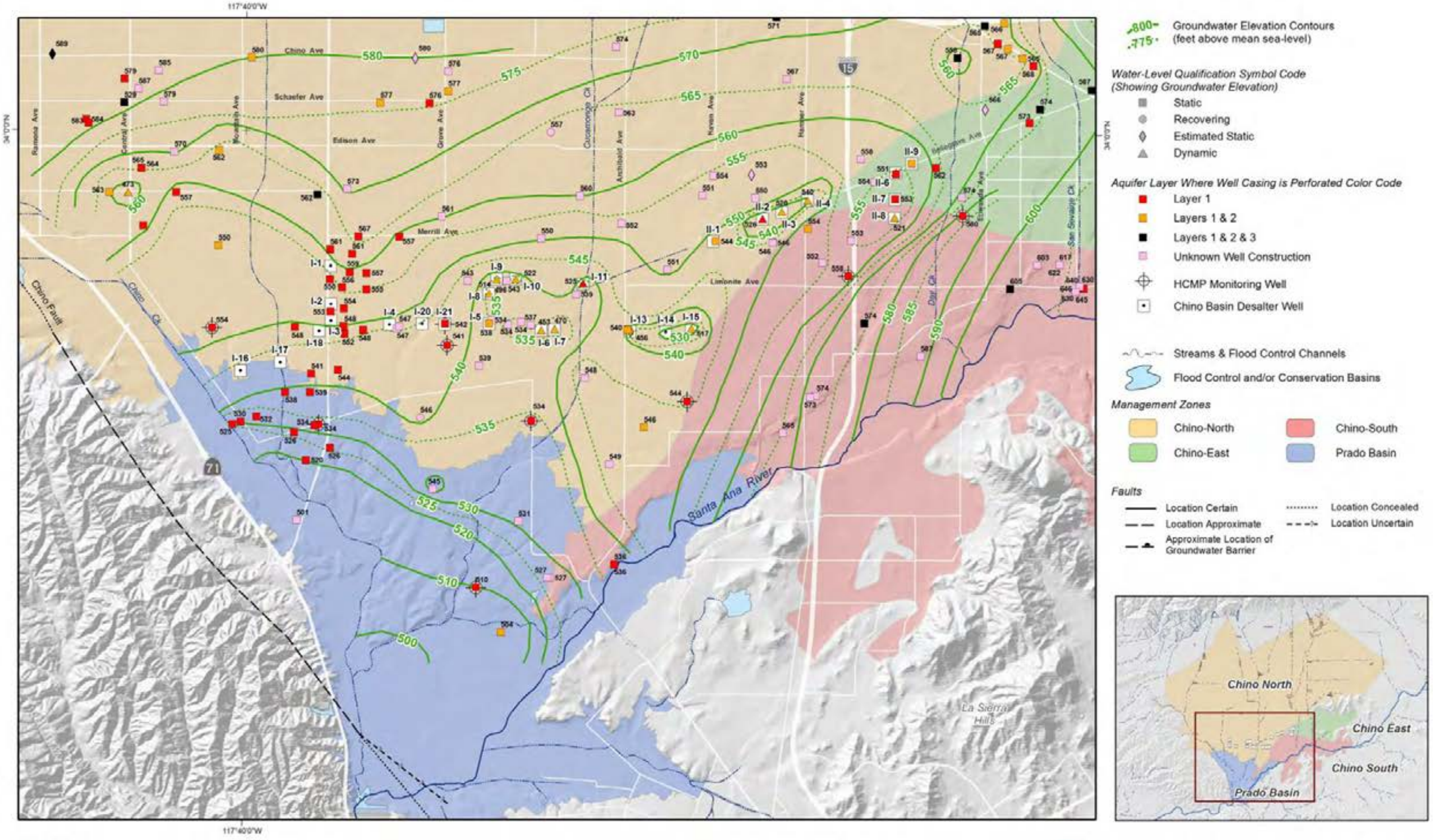


Chino Basin Desalter Wells
Existing Wells
Chino-I Desalter Well
Chino-I Desalter Well 5
Chino-II Desalter Well
Chino-I CCWF Well
Expansion Wells
Chino-II Expansion Wells
Desalter Treatment Facility
Groundwater Management Zone Boundaries
Prado Basin Management Zone (PBMZ)
Rivers and Streams
Flood Control and/or Conservation Basins
Faults
Location Certain
Location Approximate
Approximate Location of Groundwater Barrier
Location Concealed
Location Uncertain
Chino-North
Chino-East
Chino-South
PBMZ
Chino-I Desalter
Chino-II Desalter
Temescal Basin
Santa Ana River
Annual Production at the Chino Basin Desalter Wells 2000 to 2015
Total Desalter Production Goal = 40,000 acre-ft/year
Chino-I Production CCWF
Chino-II Production
Chino-I Production
Groundwater Production (acre-ft)
Calender Year
Prepared by:
WEI
23692 Birtcher Drive
Lake Forest, CA 92630
949.420.3030
www.wildermuthenvironmental.com
Author: VMW
Date: 20160225
File: Figure 2-3.mxd
Miles
Kilometers
2015 Maximum Benefit
Annual Report
Chino Basin Desalter Wells
Annual Production 2000 to 2015
Figure 2-3



Prepared by: WEI
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Lake Forest, CA 92630
949.420.3030
www.weiwater.com

Author: GAR
Date: 4/14/2016
Document Name: Figure 2-1_HC_Spring14

0 1 2 Miles
0 1 2 3 KM

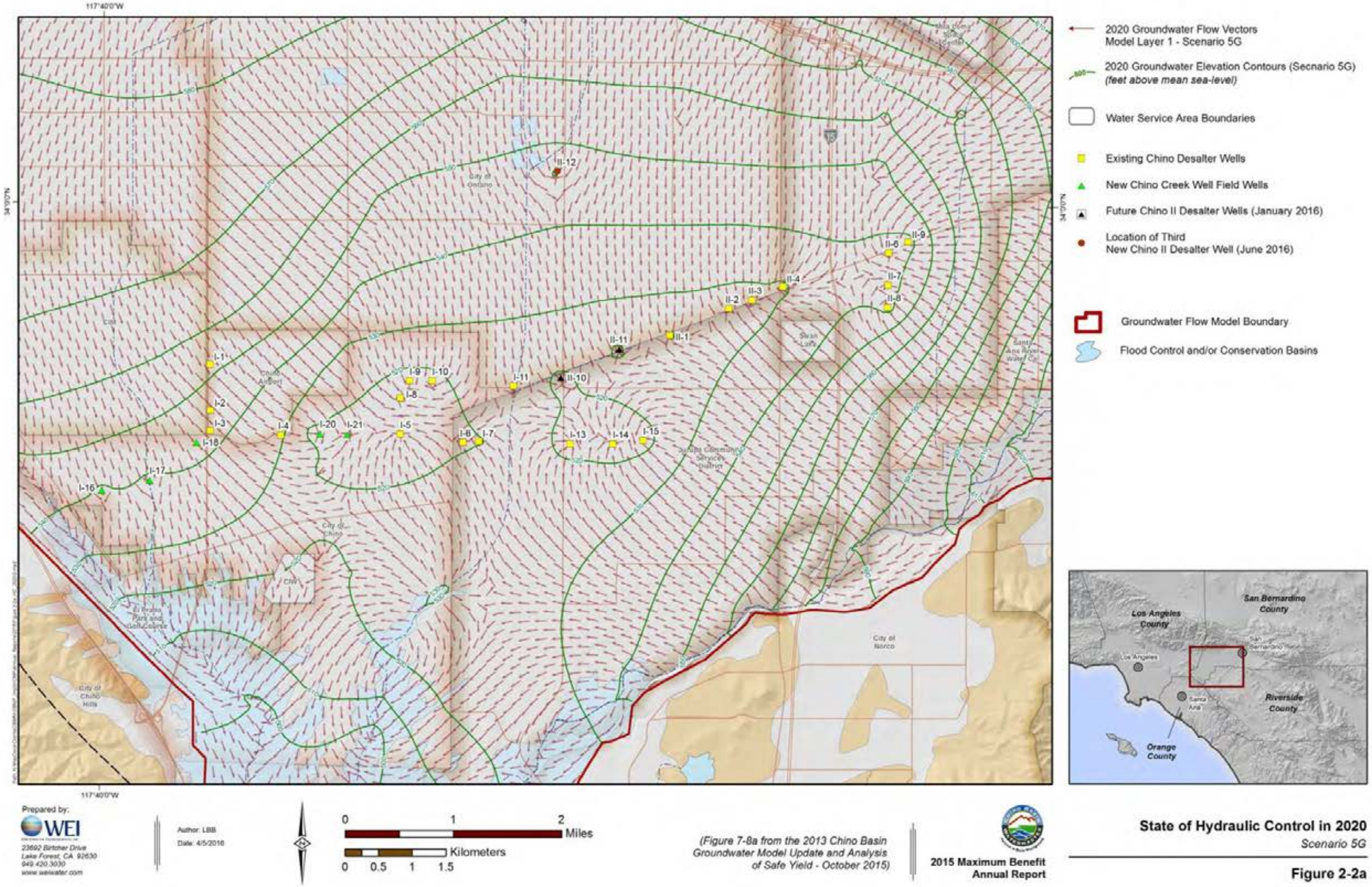
(Exhibit 22 from the 2014 Chino Basin State of the Basin Report - June 2015)

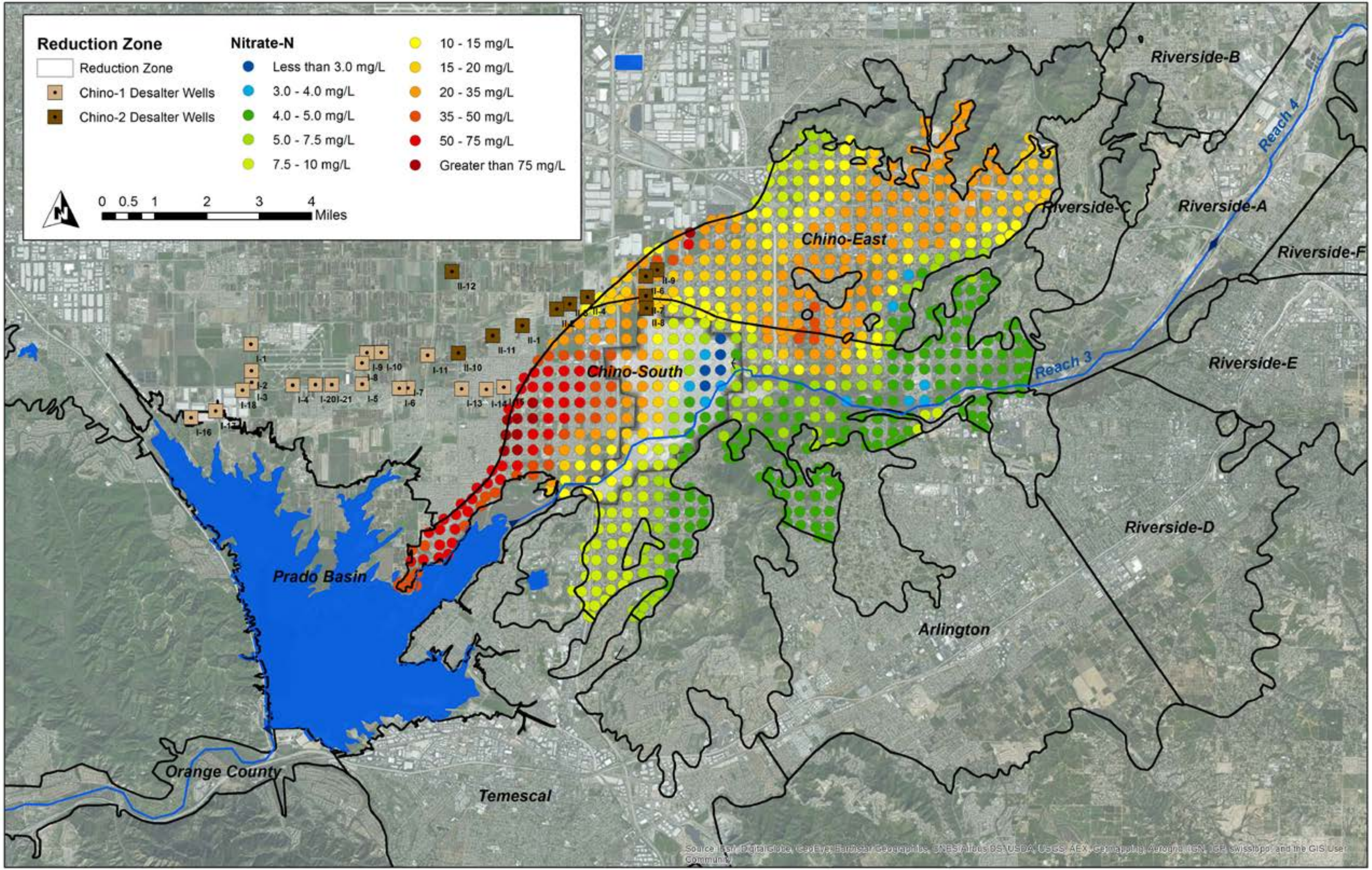
2015 Maximum Benefit Annual Report

State of Hydraulic Control in Spring 2014

Shallow Aquifer System

Figure 2-1


2020 Groundwater Flow Vectors
Model Layer 1 - Scenario 5G
2020 Groundwater Elevation Contours (Secnario 5G)
(feet above mean sea-level)
Water Service Area Boundaries
Existing Chino Desalter Wells
New Chino Creek Well Field Wells
Future Chino II Desalter Wells (January 2016)
Location of Third
New Chino II Desalter Well (June 2016)
Groundwater Flow Model Boundary
Flood Control and/or Conservation Basins
San Bernardino County
Los Angeles County
Riverside County
Orange County
Prepared by:
WEI
Author: LBB
Date: 4/5/2016
Miles
Kilometers
(Figure 7-8a from the 2013 Chino Basin Groundwater Model Update and Analysis of Safe Yield - October 2015)
2015 Maximum Benefit Annual Report
State of Hydraulic Control in 2020
Scenario 5G
Figure 2-2a


Reduction Zone
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Chino-1 Desalter Wells
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Nitrate-N
Less than 3.0 mg/L
3.0 - 4.0 mg/L
4.0 - 5.0 mg/L
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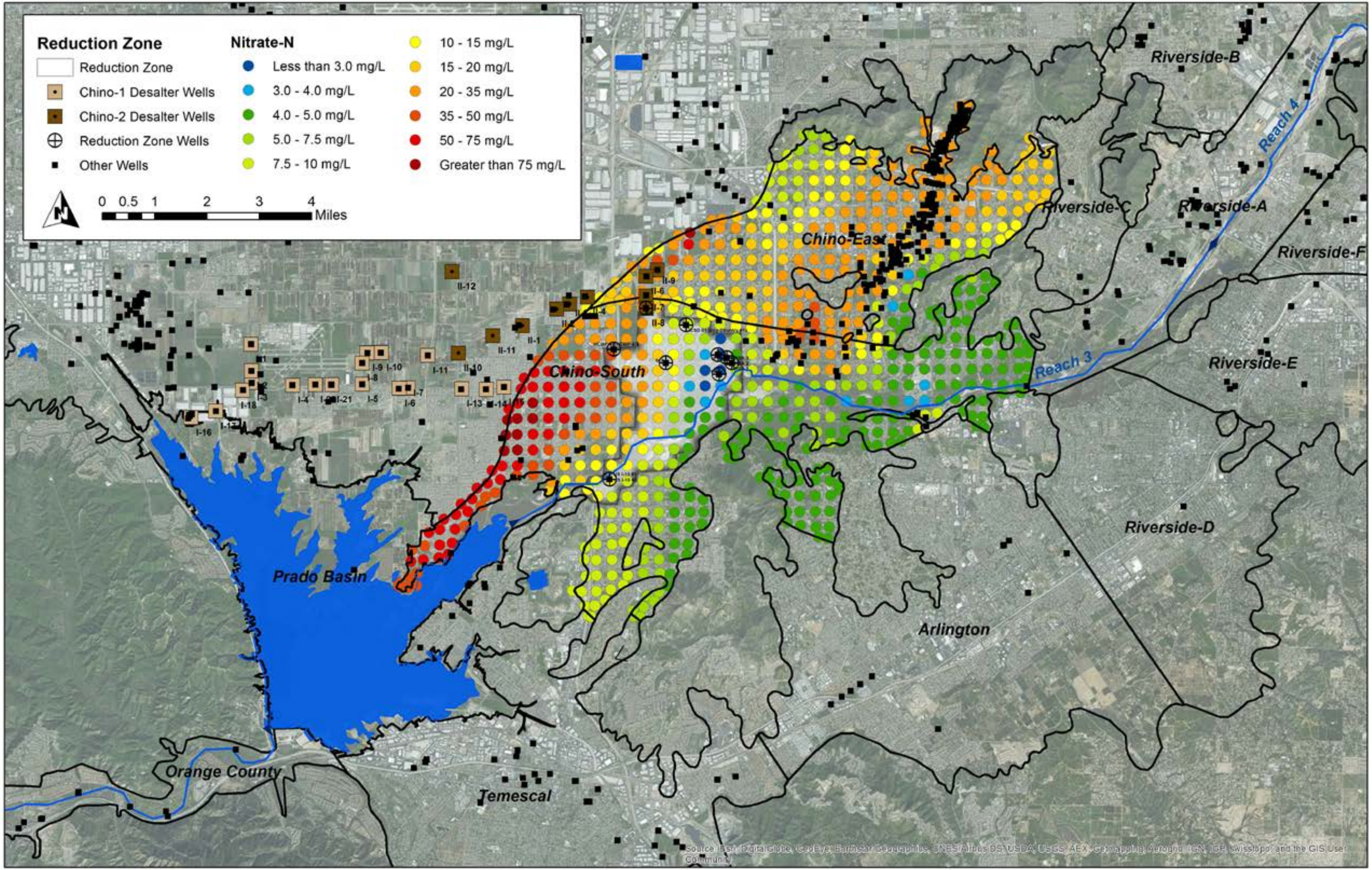
Greater than 75 mg/L
0 0.5 1 2 3 4
Miles
Riverside-B
Riverside-C
Riverside-A
Riverside-F
Riverside-E
Riverside-D
Reach 4
Reach 3
Chino-East
Chino-South
Prado Basin
Arlington
Orange County
Temescal



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Chino-1 Desalter Wells
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Reduction Zone Wells
Other Wells
Nitrate-N
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Greater than 75 mg/L
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Miles
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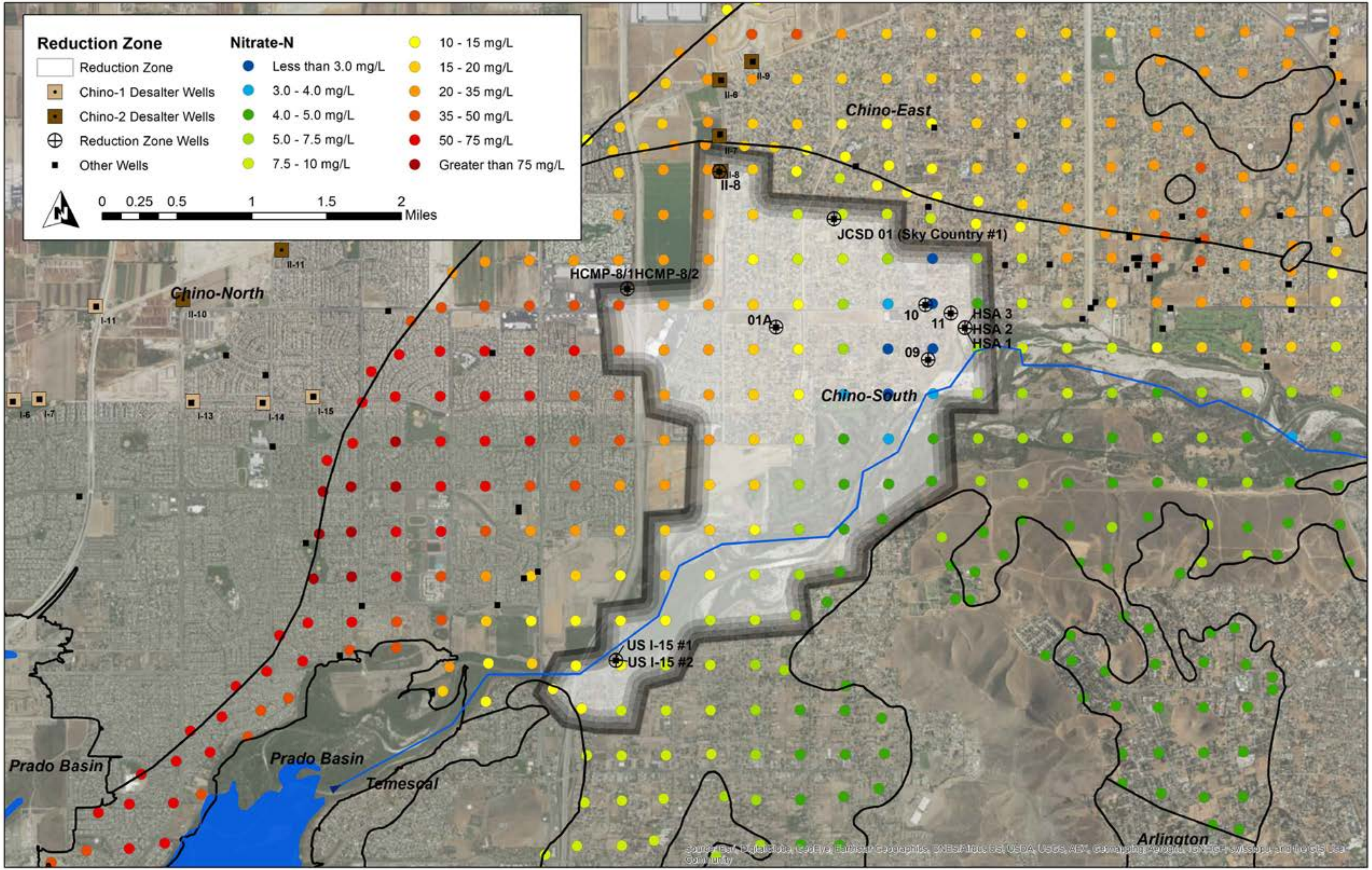
Riverside-C
Riverside-A
Chino-East
Riverside-F
Reach 3
Riverside-E
Chino-South
Prado Basin
Riverside-D
Arlington
Orange County
Temescal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10 - 15 mg/L
15 - 20 mg/L
20 - 35 mg/L
35 - 50 mg/L
50 - 75 mg/L
Greater than 75 mg/L
0 0.25 0.5 1 1.5 2
Miles
Chino-East
Chino-North
Chino-South
Prado Basin
Prado Basin
Temescal
Arlington
II-8
JCSD 01 (Sky Country #1)
HCMP-8/1HCMP-8/2
01A
10
11
09
HSA 3
HSA 2
HSA 1
US I-15 #1
US I-15 #2

Proposed Action
Cost Impacts to the Chino Desalter Authority

Method 1. Costs based on percentage of CDA operating budget.

Additional Tons of Nitrate Removed

(0.8 mg/L vs. 28 mg/L)

Source	Production (AFY)	Influent Nitrate	Nitrate Removed (tons/year)
Santa Ana River	13,442	0.8	64.7
Native Groundwater	13,442	28	2264.5
		Difference (%)	*2.8%*

Additional Tons of Salt Removed

(0.8 mg/L vs. from 990 mg/L to 450 mg/L)

Source	Production (AFY)	Influent Salt (mg/L)	Salt Removed (tons/year)*
Santa Ana River	13,442	0.8	64.7
Native Groundwater	13,442	990	36393.5
		Difference (%)	*0.18%*

**Reduce TDS from 990 to 450 mg/L.*

CDA FY 2016/2017 Operating Budget is about $8.85M

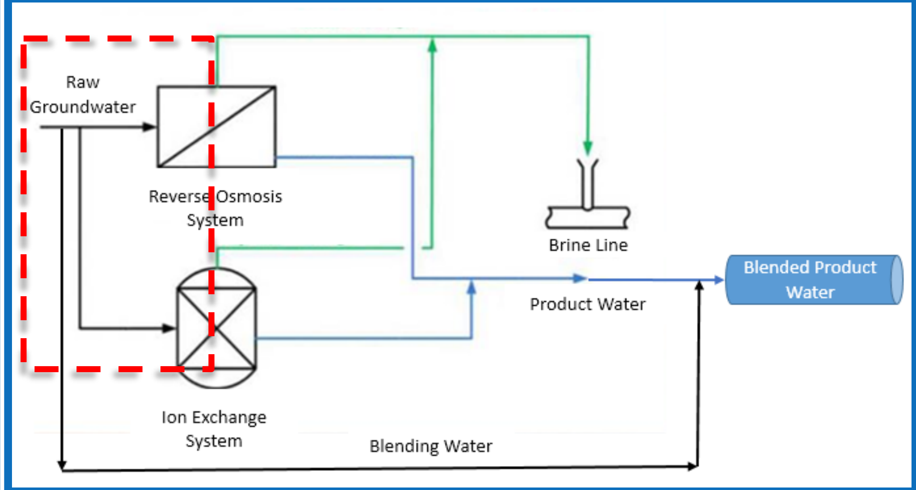
Percent additional salt removed at 0.8 mg/L multiplied by the budget is about $15.8K

Proposed Action
Cost Impacts to the Chino Desalter Authority

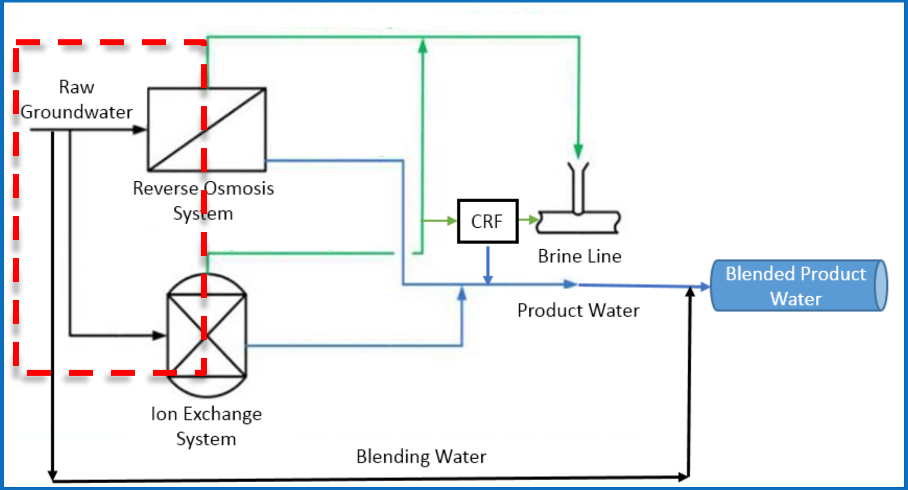
Method 2. Analysis of increase in annual operating cost to treat an additional 0.8 mg/L nitrate as nitrogen.

CDA Process Flow Diagrams

Chino I Process Flow Diagram



Chino II Process Flow Diagram



Chino I Mass Balance

RAW GROUNDWATER (SANTA ANA RIVER)

	Nitrate1	Nitrate2
Flow, gpm	5125	5125
Flow, MGD	7.38	7.38
Nitrate, ppd	259	308
TDS, ppd	30727	30776
River Nitrate, mg/L-N	4.20	5.00
River TDS, mg/L	499.20	500.00

Δ = 0.8 mg/L - N

Δ = 0.8 mg/L

RAW GROUNDWATER (CHINO BASIN)

	Nitrate1	Nitrate2
Flow, gpm	5125	5125
Flow, MGD	7.38	7.38
Nitrate, ppd	17968	17968
TDS, ppd	65883	65883
Basin Nitrate, mg/L-N	291.92	291.92
Basin TDS, mg/L	1070.38	1070.38

RAW GROUNDWATER TO CHINO I

	Nitrate1	Nitrate2
Flow, gpm	10250	10250
Flow, MGD	14.76	14.76
Nitrate, ppd	18227	18276
TDS, ppd	96610	96659
Nitrate, mg/L-N	148.06	148.46
TDS, mg/L	784.79	785.19

RO Plant

Stream	TDS	NO3	Flow, gpm
Influent	785.19	148.46	7713

	Nitrate1	Nitrate2
Flow, gpm	7713	7713
Flow, MGD	11.11	11.11
Nitrate, ppd	13714	13751
TDS, ppd	72690	72727
Nitrate, mg/L-N	148.06	148.46
	784.79	785.19

Δ = 0.4 r

IX Plant

Stream	TDS	NO3	Flow, gpm
Influent	785.19	148.46	2538

	Nitrate1	Nitrate2
Flow, gpm	2538	2538
Flow, MGD	3.65	3.65
Nitrate, ppd	4513	4525
TDS, ppd	23920	23932
Nitrate, mg/L-N	148.06	148.46
TDS, mg/L	784.79	785.19

Δ = 0.4 mg/L - N

Chino II Mass Balance

RAW GROUNDWATER (SANTA ANA RIVER)

	Nitrate1	Nitrate2
Flow, gpm	6123	6123
Flow, MGD	8.82	8.82
Nitrate, ppd	309	368
TDS, ppd	36709	36767
River Nitrate, mg/L-N	4.20	5.00
River TDS, mg/L	499.20	500.00

Δ = 0.8 mg/L - N

Δ = 0.8 mg/L

RAW GROUNDWATER (CHINO BASIN)

	Nitrate1	Nitrate2
Flow, gpm	6123	6123
Flow, MGD	8.82	8.82
Nitrate, ppd	15168	15168
TDS, ppd	59586	59586
Basin Nitrate, mg/L-N	206.27	206.27
Basin TDS, mg/L	810.31	810.31

RAW GROU

	Nitrate1	Nitrate2
Flow, gpm	12246	12246
Flow, MGD	17.63	17.63
Nitrate, ppd	15477	15536
TDS, ppd	96295	96354
Nitrate, mg/L-N	105.24	105.64
TDS, mg/L	654.76	655.16

RO Plants RO1 & RO2				
	Influent gpm	Effluent gpm	NO_3 mg/L	TDS mg/L
RO1	4,986	4,163	3	23
RO2	2,702	2,256	3	23
Total	7,688	6,419	3	23

Nitrate1	Nitrate2
7688	7688
11.07	11.07
9716	9753
60454	60491
105.24	105.64
654.76	655.16

Raw Water Flow					
Well	Capacity gpm	ON/OFF	NO_3 mg/L	TDS, mg/L	Flow gpm
Total Raw Water Blend			105.64	655.16	20.51 MGD

TDS, ppd

Δ

IX Vessels 1 - 8			
Influent gpm	Effluent gpm	NO_3 mg/L	TDS mg/L
4,558	4,403	2.1	605

	Nitrate1	Nitrate2
Flow, gpm	4558	4558
Flow, MGD	6.56	6.56
Nitrate, ppd	5761	5782
TDS, ppd	35841	35863
Nitrate, mg/L-N	105.24	105.64
TDS, mg/L	654.76	655.16

Δ = 0.4 mg/L - N

Impact on Reverse Osmosis (RO) Operating Cost

Parameter	Unit	Chino I RO Feed	Chino II RO Feed
TDS1 at Nitrate1	mg/L	784.79	654.76
TDS2 at Nitrate2	mg/L	785.19	655.16
Change in TDS	%	0.05	0.06
RO Feed Flow	MGD	11.11	11.07
Feed Pump Power Draw @ TDS1	BHP	843.55	840.88
Feed Pump Power Draw @ TDS2	BHP	843.12	840.36
Change in Feed Pump Power Draw	BHP	0.43	0.51
Power Cost	$/kW-hr	$0.114	$0.114
Annual Power Cost at TDS1	$/year	$628,183	$626,188
Annual Power Cost at TDS2	$/year	$627,863	$625,805
Total Annual Operating Cost Delta		**$320**	**$382**

Key Assumptions:

- The increase in power draw required to operate the feed pumps is proportional to the increase in TDS. This is a conservative assumption.
- The RO feed pumps operate continuously, 24 hours/day, 7 days/week, 365 days/year.
- Power cost is $0.114/kW-hr.
- Feed pump head is 150 psi.
- Feed pump efficiency is 80%.

$$BHP = \frac{Q \times H}{3960 \times n} \times s.g.$$

Where:

BHP = brake horsepower
Q = flow
H = head
n = efficiency
s.g. = specific gravity (remains constant)

Impact on Ion Exchange (IX) Operating Cost

Parameter	Unit	Chino I IX Feed	Chino II IX Feed
Nitrate1	mg-N/L	148.06	105.24
Nitrate2	mg-N/L	148.46	105.64
Change in Nitrate	%	0.27%	0.38%
Influent IX Flow	MGD	3.65	6.56
Regen Cycles per Day at Nitrate1	--	4.57	8.20
Regen Cycles per Day at Nitrate2	--	4.58	8.24

Key Assumptions:

- The brine pumps operate for 80 minutes/regen cycle.
- The IX currently regenerates once every 24 hours for 0.8 MG treated.
- The IX system operate continuously, 24 hours/day, 7 days/week, 365 days/year.
- Salt cost is $106.08/ton.
- Power cost is $0.114/kW-hr
- The number of regen cycles/day is proportional to the IX nitrate feed load.

Impact on Ion Exchange (IX) Operating Cost Cont'd

Chino I IX System

Parameter	Unit	Value
Nitrate Removal System at Nitrate1		
IX Vessels Regen Cycles/Day	--	4.57
Regenerable Resin per Vessel	cf	668
Total Resin Volume	cf	3052
Regeneration System		
Regen Cycle	hrs	24.00
Salt Volumetric Weight	lb/cf	7.50
Daily Salt Usage	lb/day	22,887
Annual Salt Usage	lb/yr	8,353,658
Brine Pumping (2 pumps/train each @ 2 HP)	HP/regen	4
Pump Run Time	mins/regen	80
Daily Power Draw	KW-hr/day	18.17
Annual Power Draw	KW-hr/yr	6,631

Cost Calculations	Amount	Unit Price	Total
Nitrate Resin Regeneration - Salt	8,353,658	$0.05	$446,000
Brine Pumping	6,631	$0.114	$756
Total Annual Operating Cost @ Nitrate1			**$446,756**
Total Annual Operating Cost @ Nitrate2			**$447,963**
Chino I Total Annual Operating Cost Delta			**$1,207**

Chino II IX System

Parameter	Unit	Value
Nitrate Removal System at Nitrate1		
IX Vessels Regen Cycles/Day	--	8.20
Regenerable Resin per Vessel	cf	668
Total Resin Volume	cf	5481
Regeneration System		
Regen Cycle	hrs	24.00
Salt Volumetric Weight	lb/cf	7.50
Daily Salt Usage	lb/day	41,104
Annual Salt Usage	lb/yr	15,002,976
Brine Pumping (2 pumps/train each @ 2 HP)	HP/regen	4
Pump Run Time	mins/regen	80
Daily Power Draw	KW-hr/day	32.63
Annual Power Draw	KW-hr/yr	11,910

Cost Calculations	Amount	Unit Price	Total
Nitrate Resin Regeneration - Salt	15,002,976	$0.05	$801,000
Brine Pumping	11,910	$0.114	$1,358
Total Annual Operating Cost @ Nitrate1			**$802,358**
Total Annual Operating Cost @ Nitrate2			**$805,407**
Chino II Total Annual Operating Cost Delta			**$3,050**

Total Impact on CDA Annual Operating Cost

Operating Costs	Chino I	Chino II
Increase in RO Annual Operating Cost	$320	$382
Increase in IX Annual Operating Cost	$1,207	$3,050
Total Increase in RO and IX Annual Operating Cost	**$1,528**	**$3,433**

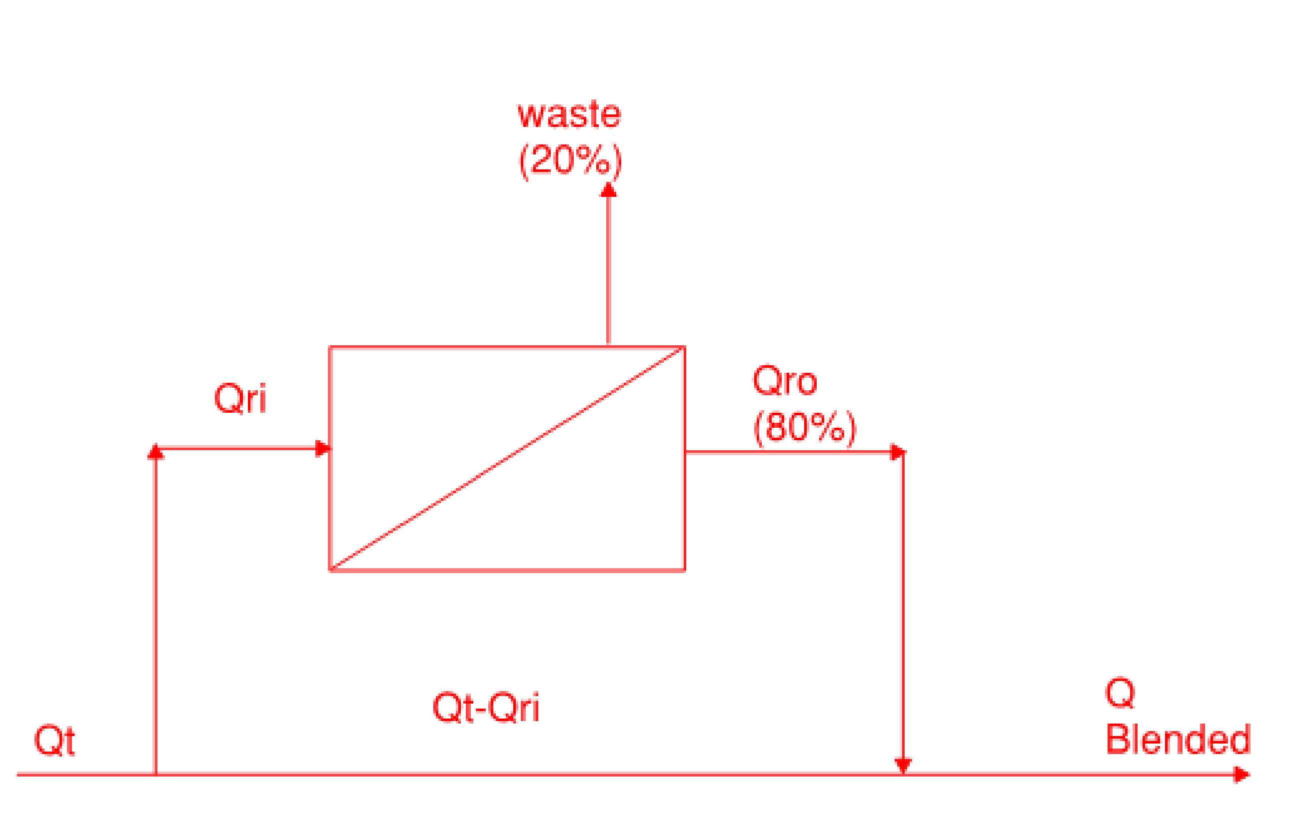
If the nitrate contribution in the native groundwater from the Santa Ana River after SAT increases by 0.8 mg/L-N, the CDA annual operating cost is estimated to increase by ~$5,000.

Nitrate-Nitrogen Reduction at the WWTPs

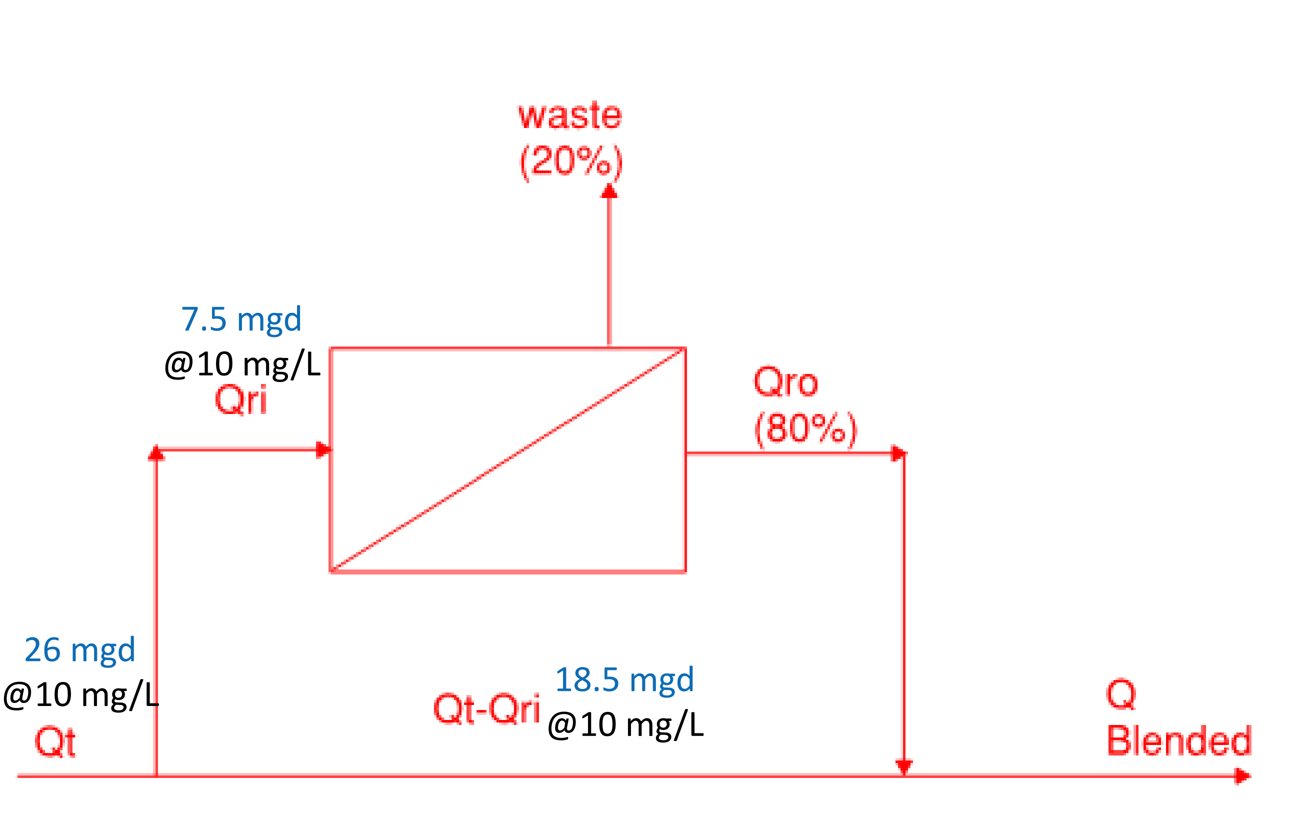
Nitrate-Nitrogen Reduction at the WWTPs

- Assumptions
  - Reduce NO_3-N in effluent from 10 to 8 mg/L
  - Assumed 26 MGD design capacity of Riverside WQCP Plant 1 as an example to determine order of magnitude costs.
  - Two common TIN reductions methods investigated: Reverse Osmosis (RO) and introduction of additional carbon to secondary treatment anoxic zone to provide additional nitrogen reduction.

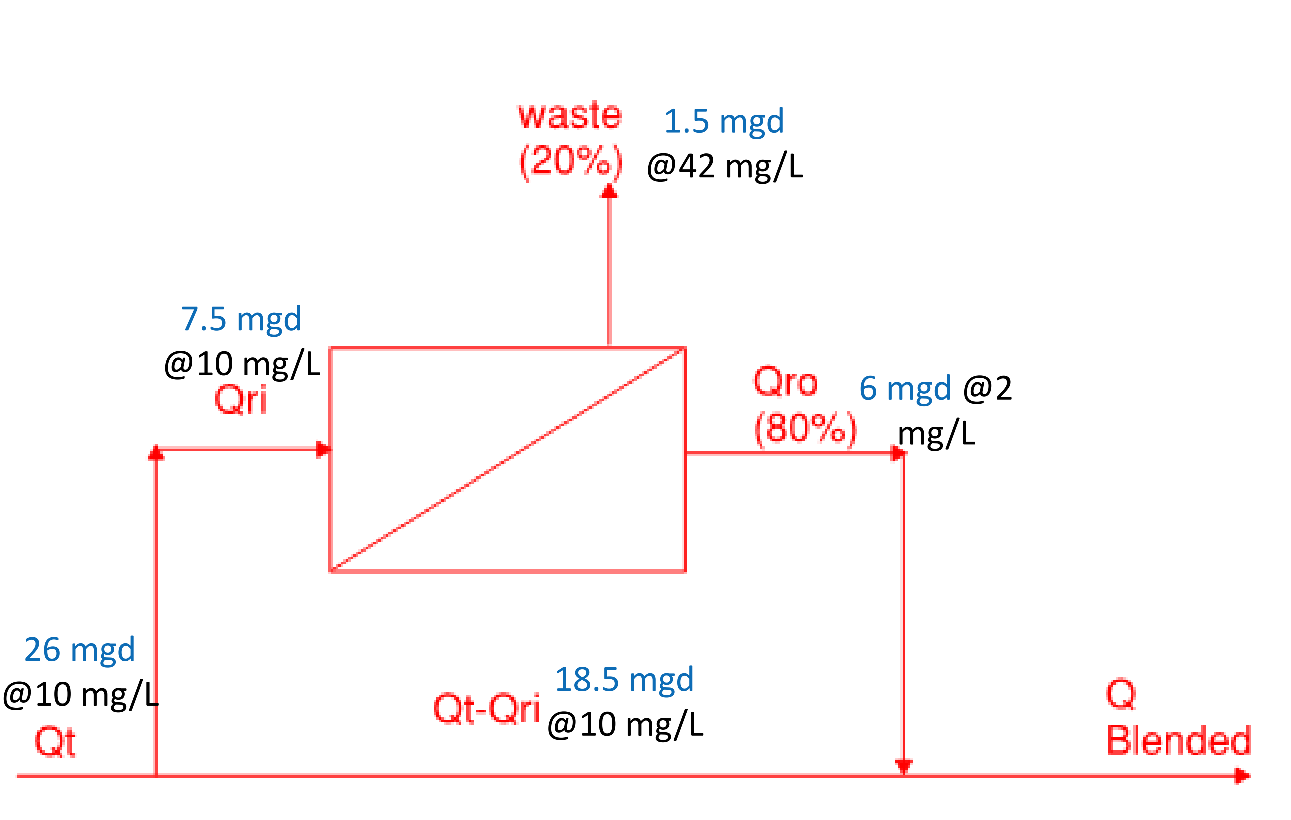
Nitrate-Nitrogen Reduction - RO Side Stream



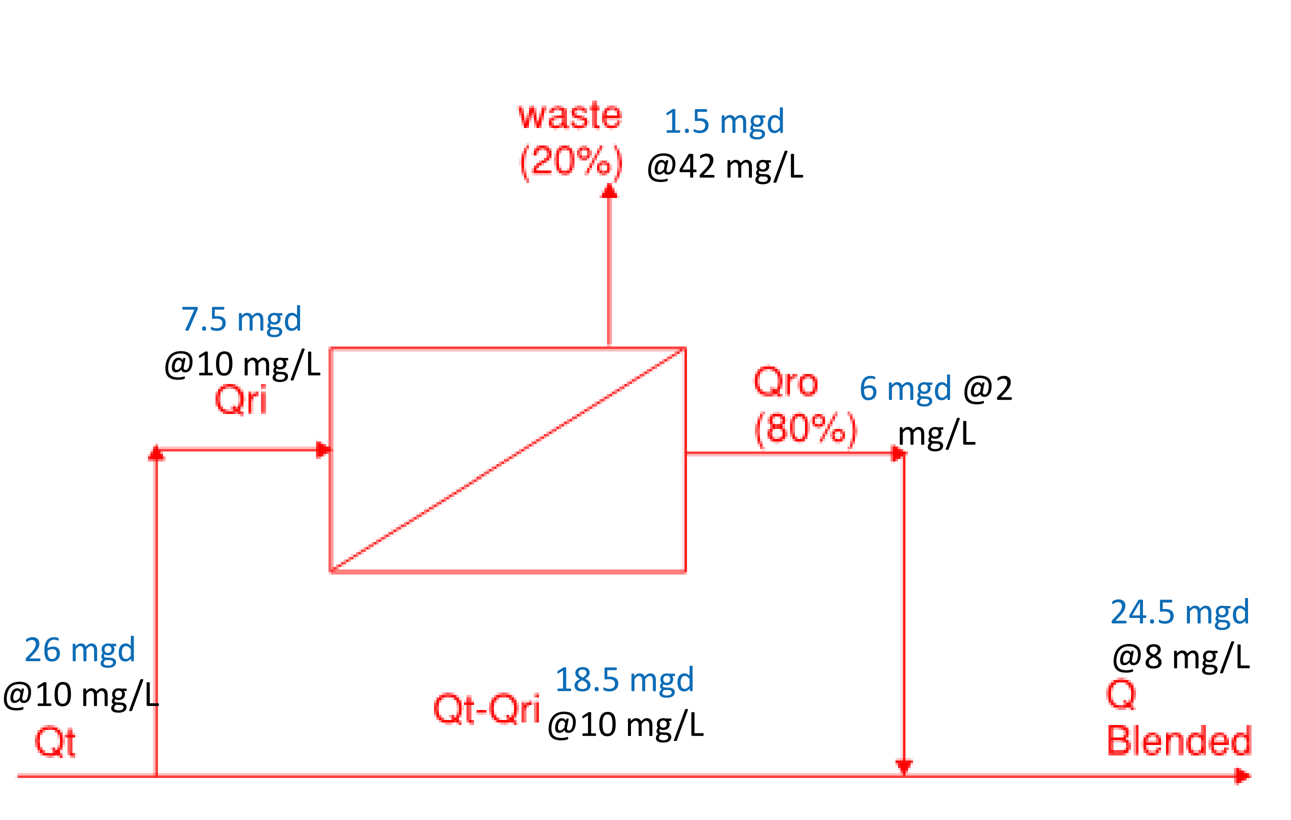
Nitrate-Nitrogen Reduction - RO Side Stream



Nitrate-Nitrogen Reduction - RO Side Stream



Nitrate-Nitrogen Reduction - RO Side Stream



Nitrate-Nitrogen Reduction - RO Sidestream

- Riverside (RWQCP) effluent limit, per NPDES permit: 10 mg/L

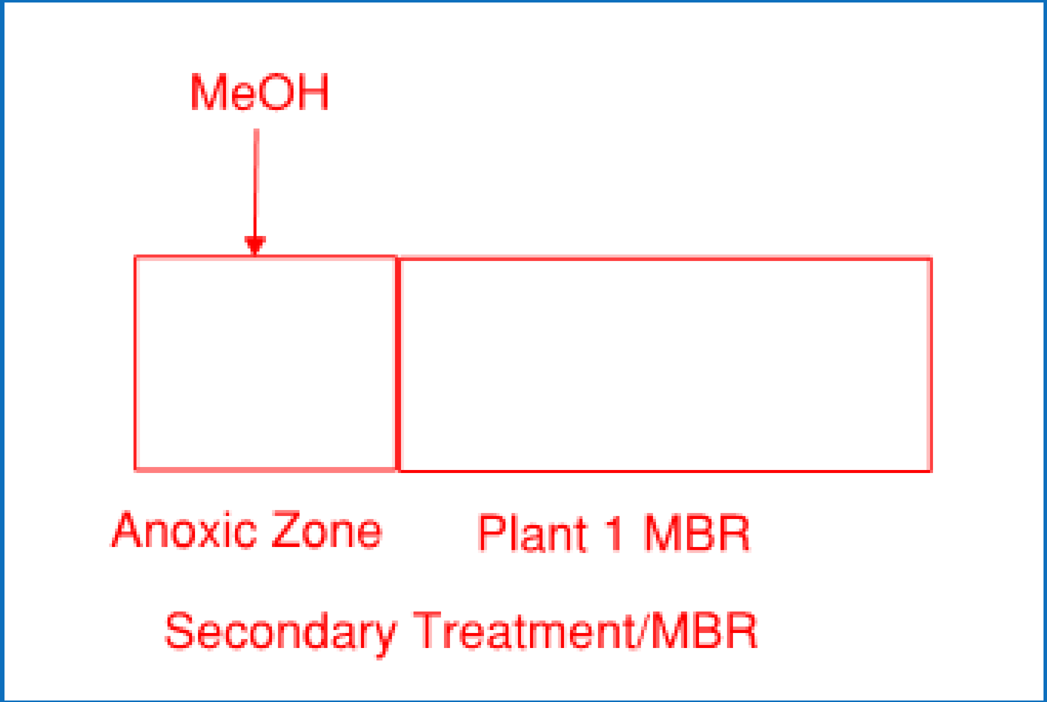
- Limit reduced to 8 mg/L for 26 MGD flow from Plant 1 at RWQCP

  - MBR effluent low through RO would be approximately 7.5 MGD to achieve 8 mg/L in blended effluent

  - Capital Cost @ $10/gpd: $75 Million

  - Does not include O&M or IEBL fees.

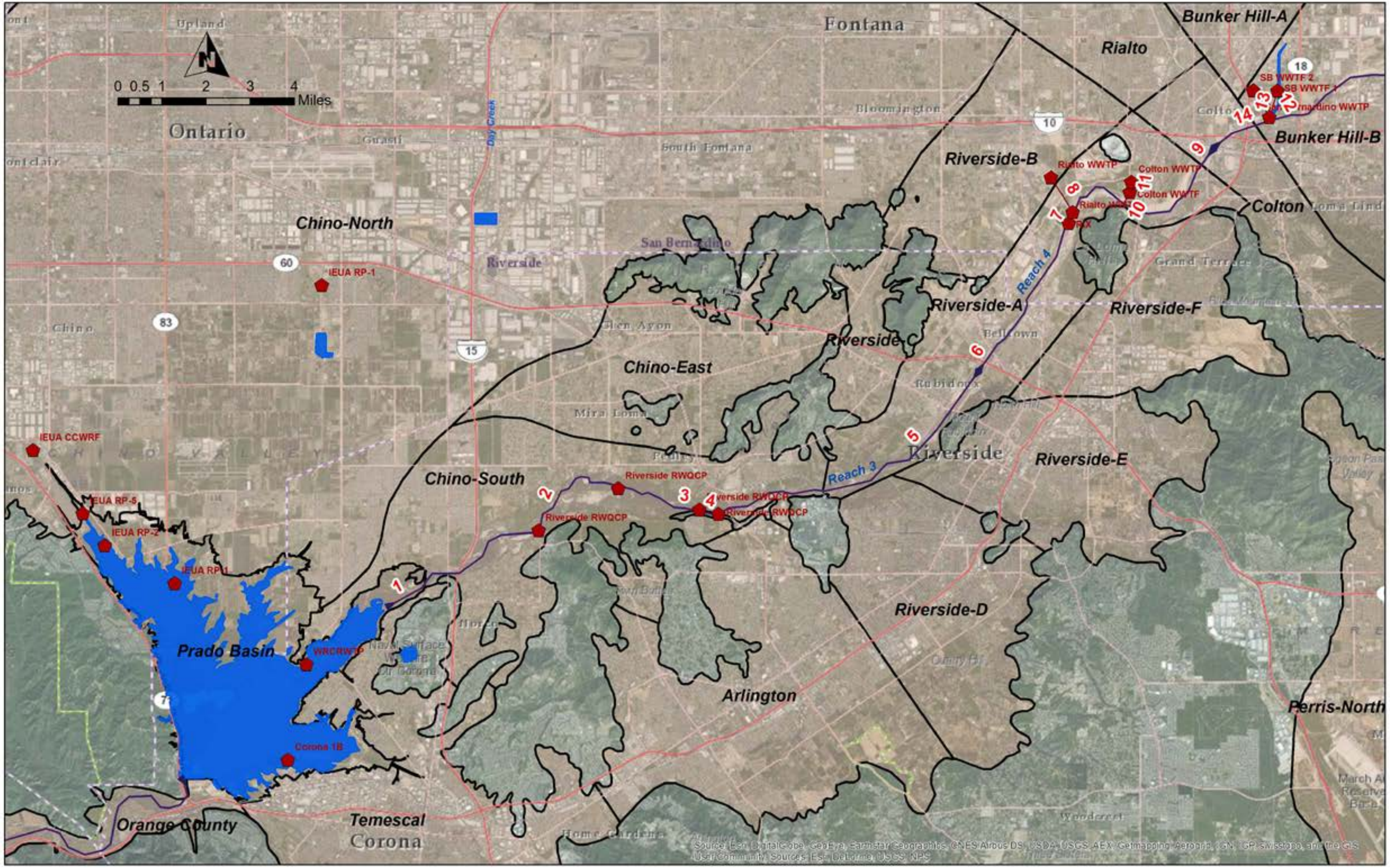
Nitrate-Nitrogen Reduction - Methanol (MeOH)



Nitrate-Nitrogen Reduction - Methanol

- Riverside (RWQCP) effluent limit, per NPDES permit: 10 mg/L
- Limit reduced to 8 mg/L for 26 MGD flow from Plant 1 at RWQCP
  - MeOH required (ppd): Qeff x amount of NO_3-N to be removed x 3 mg MeOH/ NO_3-N removed x 8.34
  - For 26 MGD and 2 mg/L NO_3-N removed, 1300 pounds per day (ppd) of MeOH is required.
  - Costs:
    - $7/gallon for MeOH: $911 per day, $332K per year.
    - Capital cost: approximately $400,000

Move WWTP Discharge Locations


Fontana
Bunker Hill-A
Rialto
Upland
0 0.5 1 2 3 4
Miles
Ontario
Guasti
Bloomington
South Fontana
Day Creek
SB WWTF 2
SB WWTF 1
Bunker Hill-B
Riverside-B
Rialto WWTP
Colton WWTP
Colton WWTF
Colton
Chino-North
San Bernardino
Riverside
IEUA RP-1
Reach 4
Grand Terrace
Riverside-A
Riverside-F
Chino
Glen Avon
Belltown
Riverside-C
Chino-East
Rubidoux
Mira Loma
IEUA CCWRF
Riverside
Riverside-E
Reach 3
Chino-South
Riverside RWQCP
IEUA RP-5
IEUA RP-2
IEUA RP-1
Riverside-D
Prado Basin
WRCRWTP
Arlington
Perris-North
Corona 1B
Orange County
Temescal
Corona
Woodcrest
Home Gardens
1
2
3
4
5
6
7
8
9
10
11
12
13
14
10
15
60
83
18

Relocate WWTP Discharge Locations

- Moving discharge points from Riverside's WQCP Plant 1 as an example to determine order of magnitude costs.
- Distance from the upstream-most discharge location to Prado Basin MZ is 39,854 linear feet (7.5 miles).
- Effluent volume of 33.9 mgd is the maximum from the WLAM.

Relocate WWTP Discharge Locations

Pipe Sizing Calculation

Flow converted from million gallons per day to cubic feet per second.

$$Flow\ Rate\left(\frac{ft^3}{s}\right) = \frac{33.9\ million\ gallons}{day} \times \frac{1\ day}{24\ hours} \times \frac{1\ hour}{60\ minutes} \times \frac{1\ minute}{60\ seconds} \times \frac{1{,}000{,}000\ gallons}{1\ million\ gallon} \times \frac{0.133681\ ft^3}{1\ gallon}$$

$$Flow\ Rate\left(\frac{ft^3}{s}\right) = 52.5\ \frac{ft^3}{s}$$

Relocate WWTP Discharge Locations

- *Pipeline diameter estimated to be 56 inches to target a flow velocity between 2 and 5 ft/s.*
- *Cross-sectional area of pipe calculated.*
- $Cross\ Sectional\ Area\ (ft^2) = \pi * \left(\frac{56\ inches}{2} \times \frac{1\ foot}{12\ inches}\right)^2$
- $Cross\ Sectional\ Area\ (ft^2) = 17.1\ ft^2$

Relocate WWTP Discharge Locations

- *Flow velocity calculated.*
- $Flow\ Velocity\ \left(\frac{ft}{s}\right) = \frac{flow\ rate\ \left(\frac{ft^3}{s}\right)}{cross\text{–}sectional\ area\ (ft^2)} = \frac{52.5\ \frac{ft^3}{s}}{17.1\ ft^2}$
- $Flow\ Velocity\ \left(\frac{ft}{s}\right) = 3.1\ \frac{ft}{s}$

Relocate WWTP Discharge Locations

- *Cost Estimate Calculation*

- *Low cost assumed to be $6 per linear foot per inch diameter and high cost assumed to be $12 per linear foot per inch diameter.*

- $Low\ Cost\ Estimate = 39{,}854\ linear\ feet \times 56\ inch\ diameter \times \frac{\$6}{linear\ foot{-}inch\ diameter} = \$13.4\ million$

- $High\ Cost\ Estimate = 39{,}854\ linear\ feet \times 56\ inch\ diameter \times \frac{\$12}{linear\ foot{-}inch\ diameter} = \$26.8\ million$

Relocate WWTP Discharge Locations

- Cost of pipeline only.
- Does not include environmental permitting.
- No O & M costs are assumed

Blend Effluent with SWP

Blend Effluent with SWP

- Assumptions
  - SWP varies nitrate from 0.75 to 1 mg/L
  - $C_{blend} = \frac{(Q_{WW} * C_{WW} + Q_{SWP} * C_{SWP})}{(Q_{WW} + Q_{SWP})}$
  - Rearranging, $Q_{SWP} = \frac{Q_{WW} * (C_{blend} - C_{WW})}{(C_{SWP} + C_{blend})}$
  - Solving for Q_{SWP} = 9.35 to 9.69 mgd
  - Or, 12,600 to 13,100 AFY at $6.3M to $6.5M per year

C_{ww} = 10 mg/L

Q_{ww} = 33.9 mgd

C_{SWP} = 0.75 to 1 mg/L

Economic Analysis – Cost Summary

<table>
<tr><th>Action/Alternate Compliance Method</th><th>Method</th><th colspan="2">Capital</th><th colspan="2">O&M</th></tr>
<tr><td rowspan="2">Cost Impacts to the CDA</td><td>1. Percent Operating Budget</td><td></td><td></td><td colspan="2">$15.8K</td></tr>
<tr><td>2. Analysis of additional annual O&M</td><td></td><td></td><td colspan="2">$5K</td></tr>
<tr><td rowspan="2">Nitrate Reduction at WWTP</td><td>1. RO Sidestream of Effluent</td><td colspan="2">$75M</td><td></td><td></td></tr>
<tr><td>2. Introduction of Methanol</td><td colspan="2">$400K</td><td colspan="2">$332K</td></tr>
<tr><td>Move Discharge Locations</td><td></td><td>$13.4M</td><td>$26.8M</td><td></td><td></td></tr>
<tr><td>Blend Effluent with SWP</td><td></td><td></td><td></td><td>$6.3M</td><td>$6.5M</td></tr>
</table>

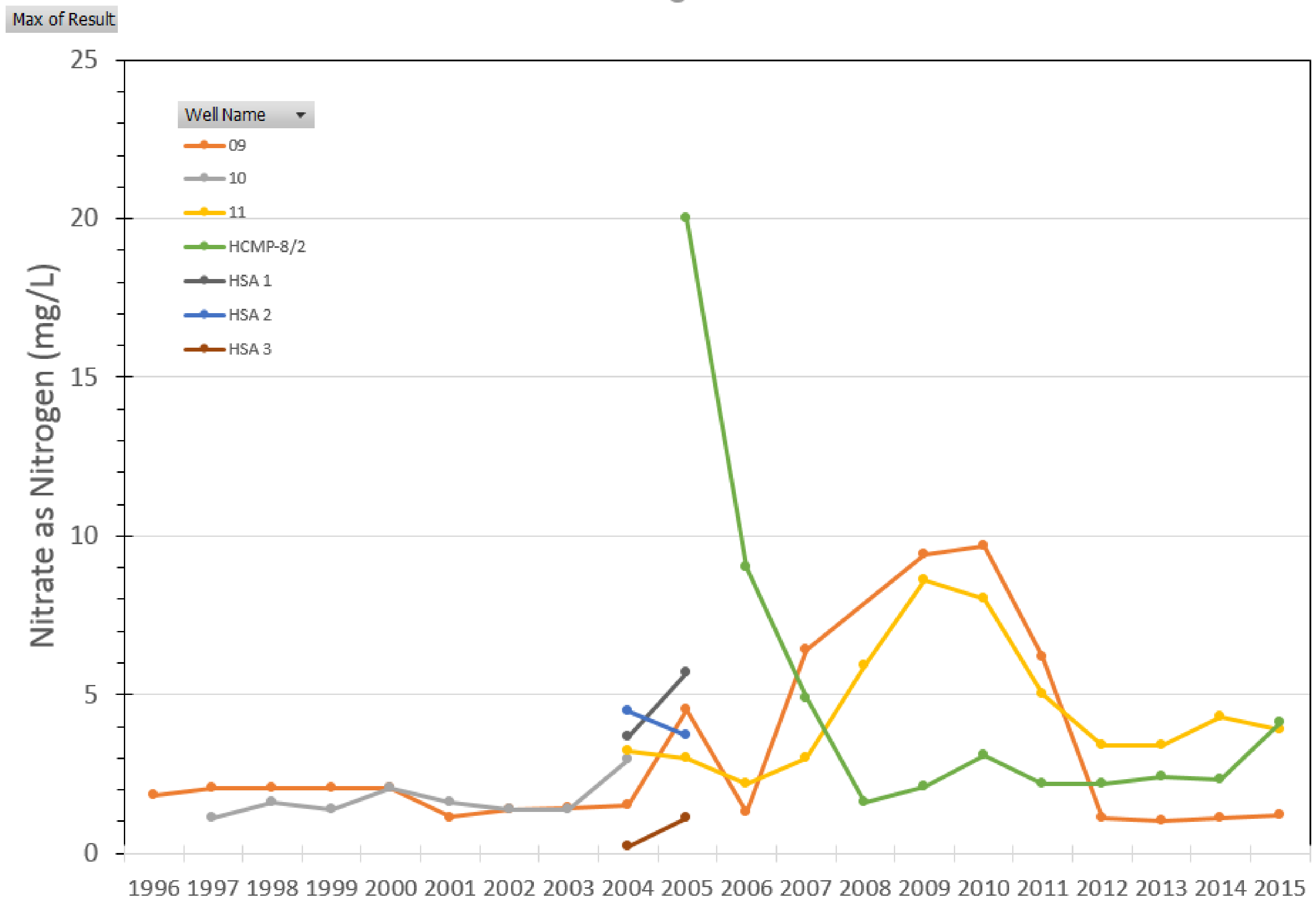
Riverside A Groundwater Management Zone

- Riverside A Groundwater Management Zone
  - Based on the current ambient water quality determination and the Riverside A GMZ objective, there is 0.8 mg/L of assimilative capacity for nitrogen in the basin.
    - WQO – 6.2 mg/L
    - Current ambient (2012) – 5.4 mg/L
  - WLAM results suggest that the average nitrate concentration over the 63-year modeling period is 5.5 mg/L – higher than the current AWQ, but less than the objective.
  - Because incidental streambed recharge is likely to lower water quality (by increasing TIN concentrations) in the Riverside A GMZ, an allocation of assimilative capacity is required in order to permit the continued discharges of recycled water into the Santa Ana River reaches overlying Riverside A GMZ.

Additional Tons of Nitrate Removed

(5 mg/L vs. 4.2 mg/L)

Source	Production (AFY)	Influent Nitrate (mg/L)	Nitrate Removed (tons/year)
Santa Ana River	13,442	5	404.4
Native Groundwater	13,442	28	2264.5
Santa Ana River	13,442	4.2	339.7
Native Groundwater	13,442	28	2264.5
404.4 tons/year vs. 339.7 tons/year = 64.7 tons/year			



Max of Result
Nitrate as Nitrogen (mg/L)
0
5
10
15
20
25
Well Name
09
10
11
HCMP-8/2
HSA 1
HSA 2
HSA 3
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015