# CV-SALTS

## Process for the Basin Plan Amendment for Salt Management in the Santa Ana Watershed

February 18, 2009

*Prepared for:*

*California Regional Water Quality Control Board – Central Valley Region*

**Central Valley**

**Area = 60,000 mi²**

**Pop. = 6.5 million**

**Santa Ana**

**Area = 2,800 mi²**

**Pop. = 6 million**

# A Completely Transferable Process

- Process is not scale-dependent
  - Technical process is not dependent upon area
  - Task Force approach is more affected by proper facilitation than by size (shuttle diplomacy)
- State Board Policies and California Water Code are the same for both Regions

# 2004 Basin Plan Amendment

- Established sub-basins based on hydrogeology
- Established water quality objectives
- Established current ambient water quality
- Allowed us to compute assimilative capacity
  - Difference between current ambient and objective
- Allowed us to develop new wasteload allocations for POTWs

# 2004 Basin Plan Amendment

- The BPA is a management tool that informs the Regional Board decision-making process with respect to:
  - The Watershed Approach
  - Priority setting
  - Project reviews
  - Integrated water-supply and water-quality planning
  - TMDLs

# Clearer Structure, Cleaner Water:

## Improving Performance and Outcomes at the State Water Boards

Little Hoover Commission

January 2009

# Outline

1. Geographic orientation & background
2. Institutional process
3. Technical process
4. Why was the N/TDS Task Force Successful?

3 0 3 6 Miles
N
Major POTWs
Santa Ana River Watershed
IEUA RP-4
IEUA RP-3
IEUA RP-1
IEUA CCWRP
IEUA RP-2
WRCRWTP
Riverside
San Bernardino
Redlands
Rialto
RIX
Colton
Yucaipa
Prado Dam
Corona-1
Corona-2
Beaumont
Moreno Valley
San Jacinto River
Hemet San Jacinto
San Jacinto
Perris Valley
Elsinore Valley
Sun City
Santa Ana River
Pacific Ocean

# Background

- In the early 1990s, the Regional Board was regulating based on a Basin Plan developed in the early 1970s
  - Under-staffed, under-funded, short schedule
- Objectives were based on:
  - TDS: About 200 wells; Two years of data
  - Nitrate objectives not scientifically calculated
- Dischargers wanted to evaluate the validity of the water quality objectives
  - Cost to comply with water quality objectives was ~ $6 billion
  - Limited water recycling opportunities

# Background

- Regional Board agreed to a review of the water quality standards, but did not have money to fund process
- Stakeholders offered to:
  - Form a Task Force to direct the institutional and scientific process
  - Fund the effort

# Nitrogen/TDS Task Force

- Task Force members:
  - Wastewater dischargers
  - Water supply agencies
  - Upper & Lower Basin agencies
  - Federal agencies invited (USGS & USEPA)
  - Environmental representatives
  - Regional Board staff
- Hired a team of consultants to lead the effort
  - Risk Sciences – Institutional scope and facilitation
  - Wildermuth Environmental – Technical scope

# "Double-Edged Sword"

- Regional Board agreed to participate with understanding that all parties must agree in advance to live with the results
  - Standards might be more or less restrictive
- Dischargers repeatedly claimed that they would live with process based on "good science"
- Consensus and integrity!

# Technical Scope of Work

1. Define hydrogeologic management zones
2. Compile data/screen data/identify and fill data gaps
3. Set historical period
4. Compute historical ambient
5. Objectives set consistent with State Anti-degradation Policy (Resolution 68-16)
6. Compute current ambient
7. Calculate assimilative capacity
8. Develop implementation plan

3 0 3 6 Miles
N
Sub-Basins of the Basin Plan
Big Bear Valley
Bunker Hill I
Lytle Creek
Cucamonga
Rialto
Chino I
Bunker Hill Pressure NO3-N = 1 mg/L
Bunker Hill II NO3-N = 5 mg/L
Colton
Chino II
Riverside I
San Timoteo
Riverside II
Chino III
La Habra
Riverside III
Perris North
Arlington
San Jacinto Lower Pressure
Temescal
Santa Ana Forebay TDS = 600 mg/L
Perris South I
Lakeview
San Jacinto Intake Upper Pressure
Bedford
San Jacinto Canyon
Coldwater
Perris South II
Irvine Forebay II
Lee Lake
Perris South III
Hemet
Idyllwild
Santa Ana Pressure TDS = 500 mg/L
Irvine Pressure
Irvine Forebay I
Winchester
Menifee I
Irvine Forebay II
Menifee II
Elsinore
Pacific Ocean

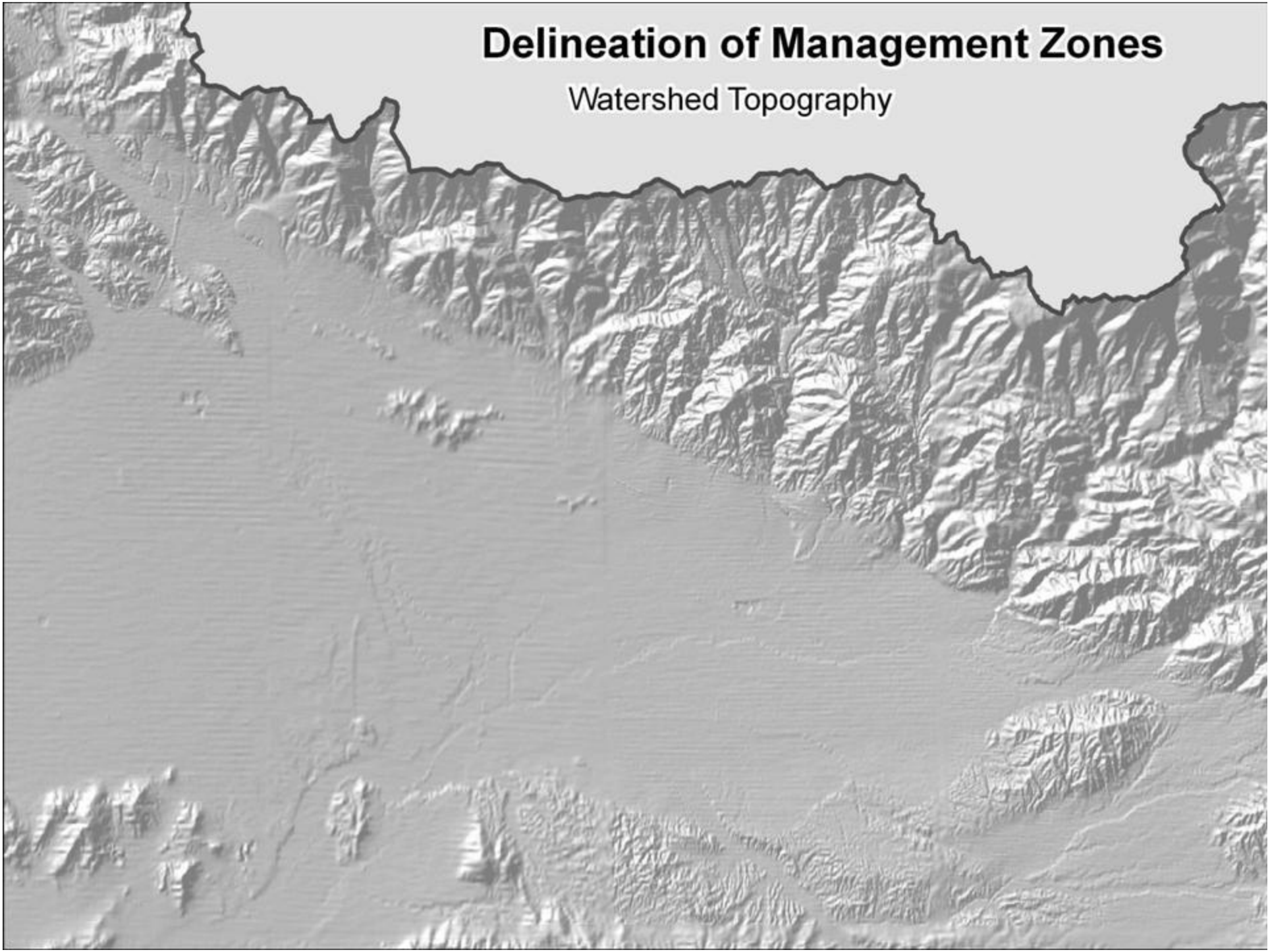
# Update Basin Boundaries

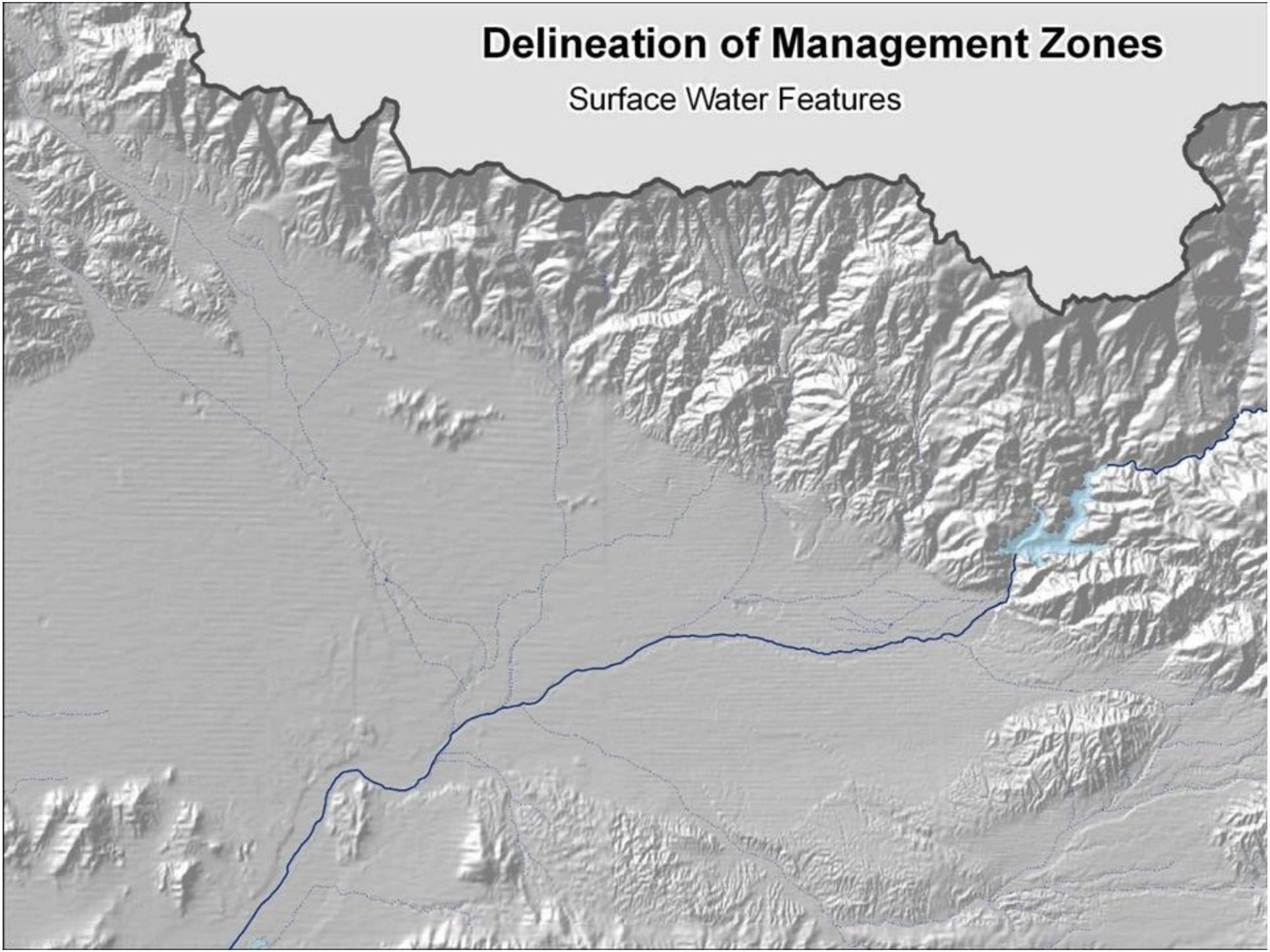
- **Objective**: Develop boundaries for groundwater *management zones* that are consistent with known groundwater hydrology

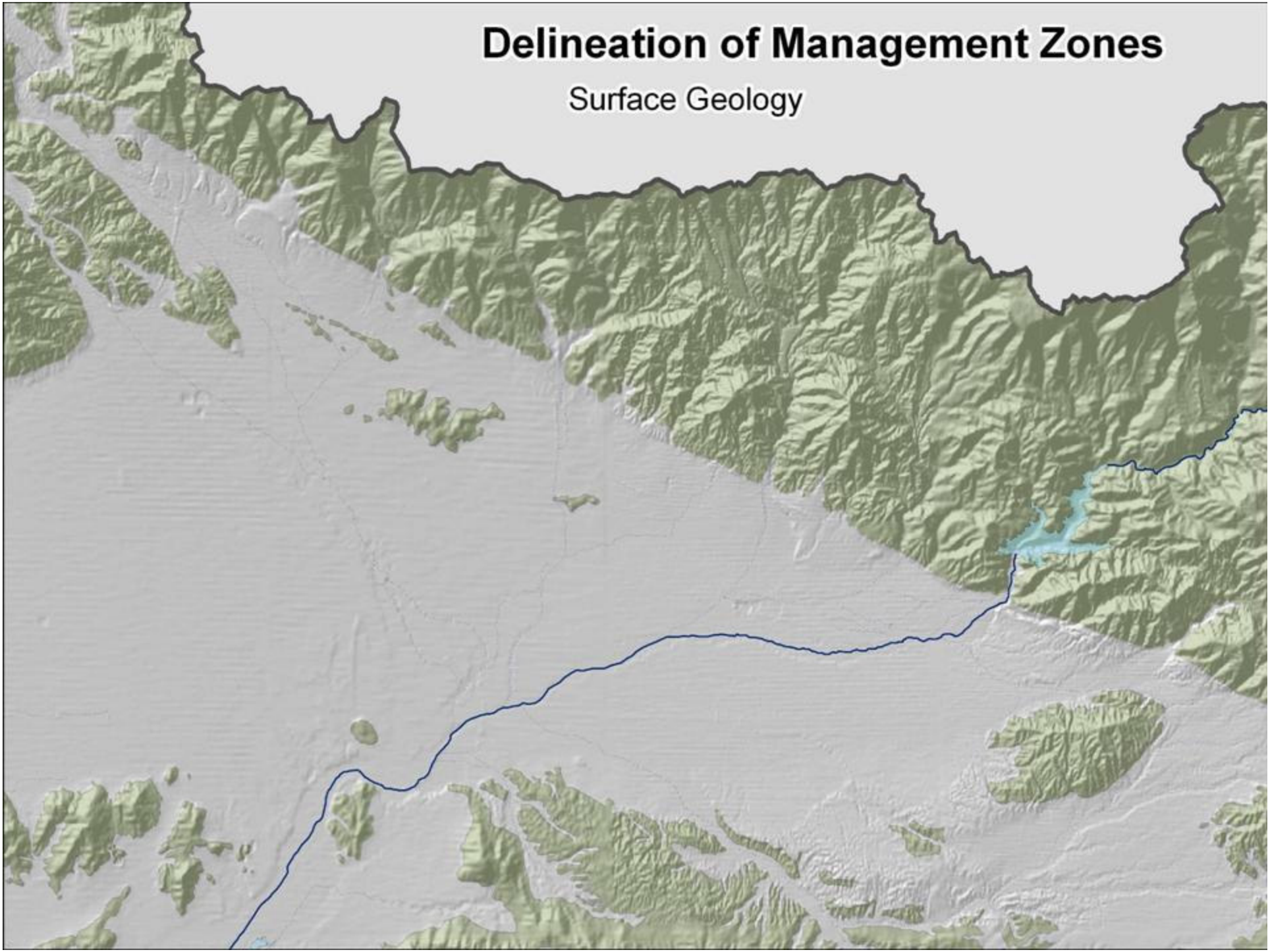
- Management zone = hydrologically distinct unit and consistent with groundwater flow systems
  - Areas of recharge connected with areas of discharge

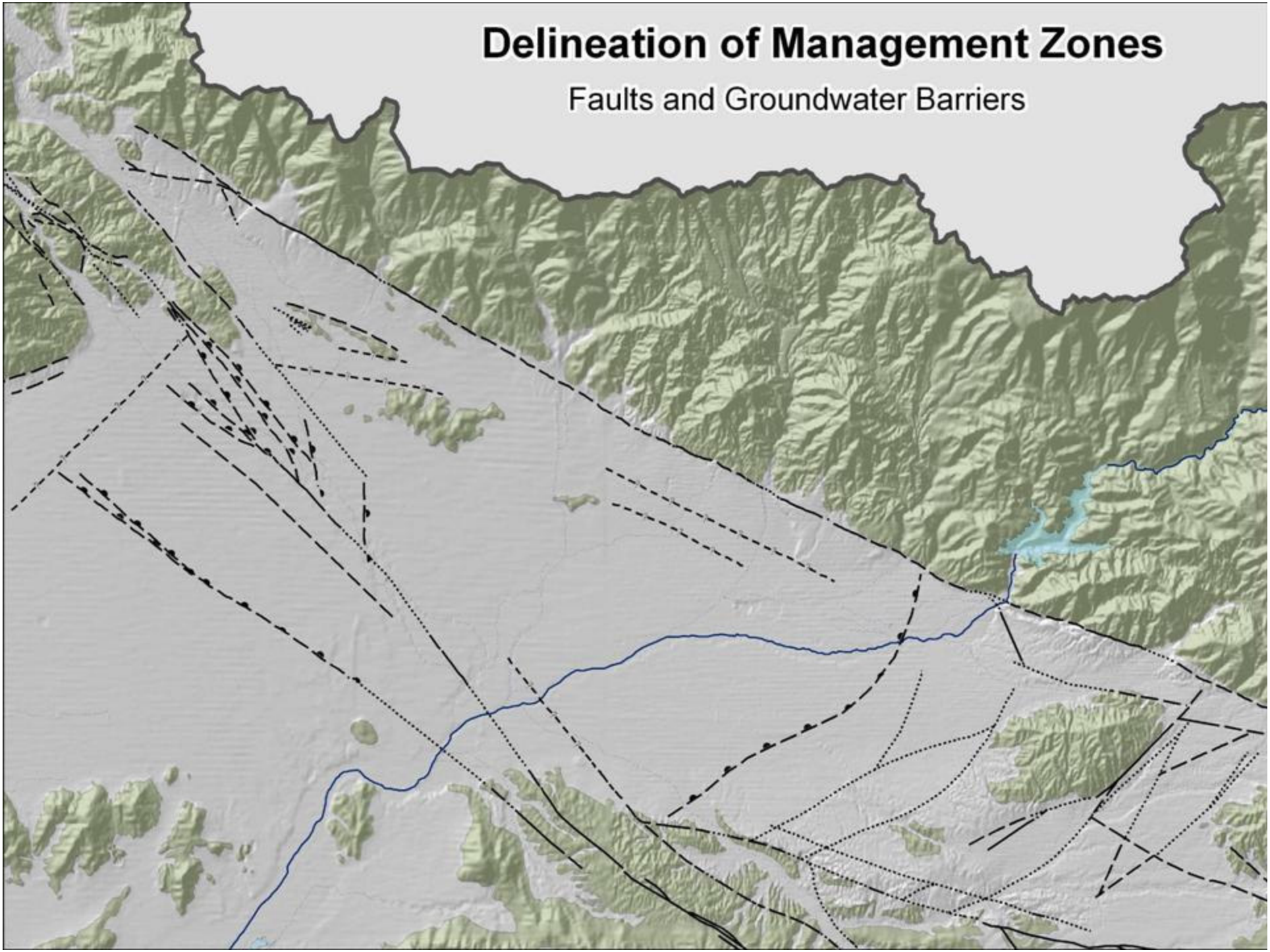
# Update Basin Boundaries

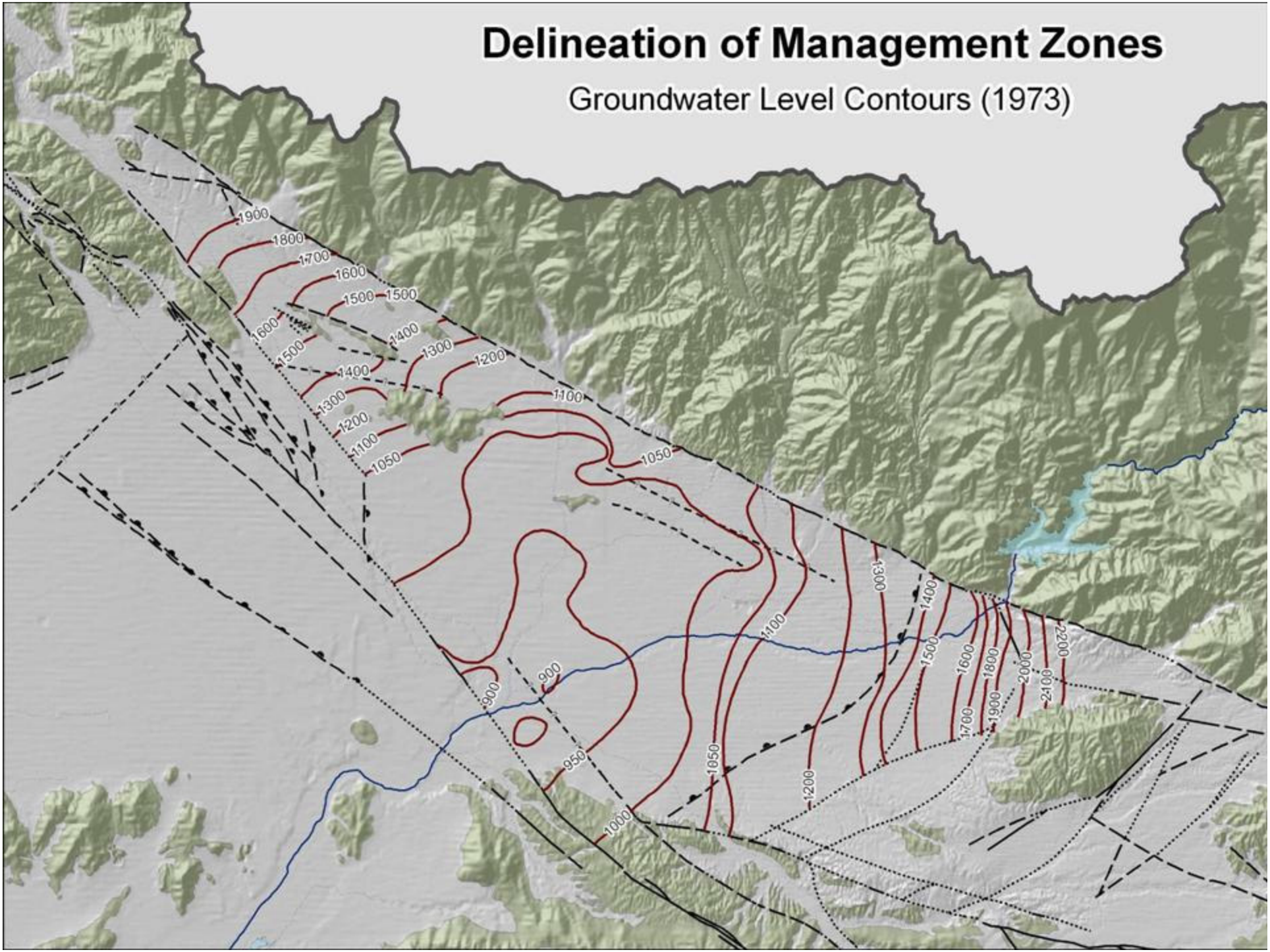
- Comprehensive literature review
- Delineate major basin boundaries
  - hard rock, groundwater barriers, groundwater divides
- Delineate internal flow systems
- Delineate management zones based on major boundaries and flow systems

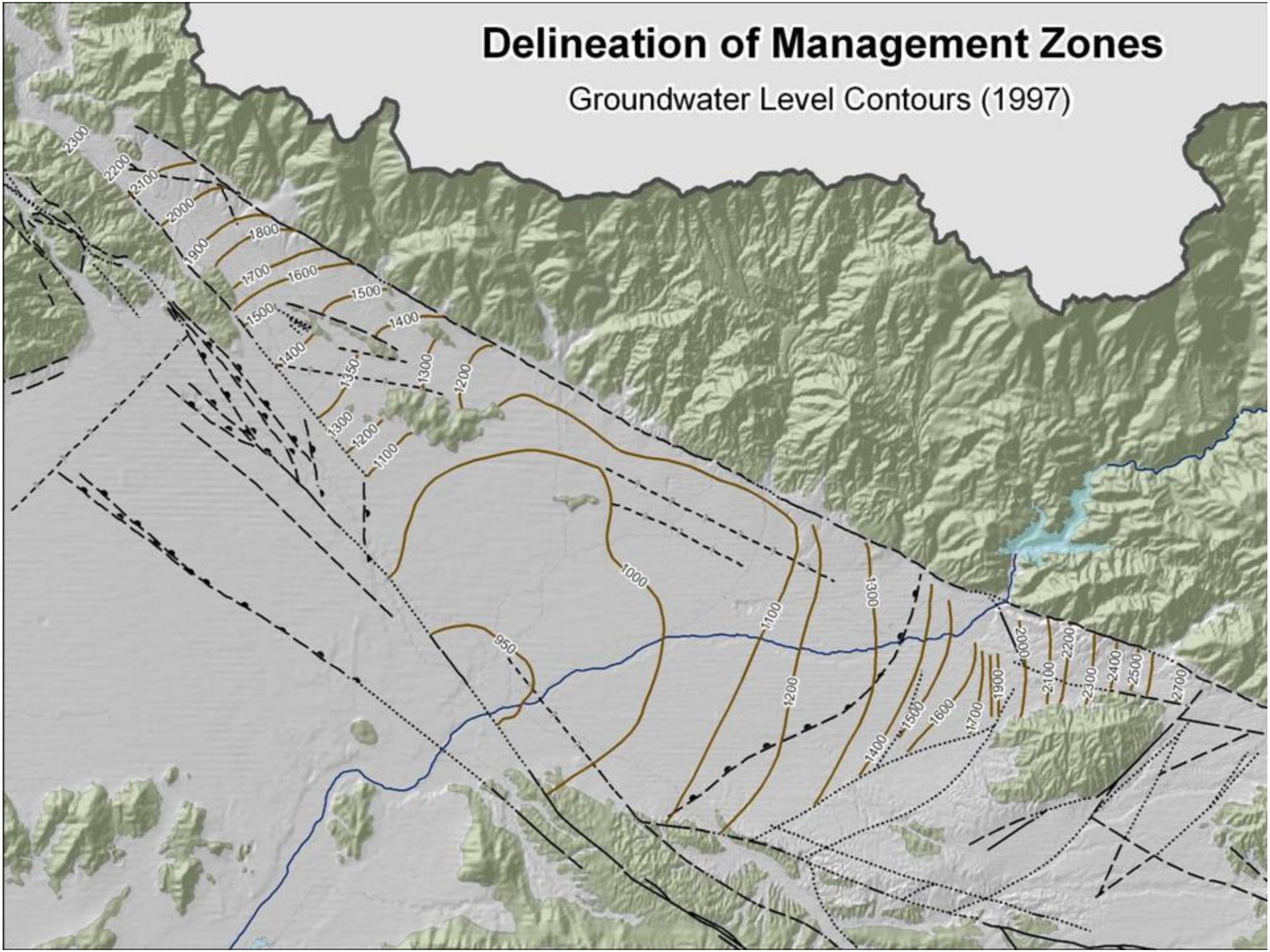

Delineation of Management Zones
Watershed Topography


Delineation of Management Zones
Surface Water Features


Delineation of Management Zones
Surface Geology


Delineation of Management Zones
Faults and Groundwater Barriers


Delineation of Management Zones
Groundwater Level Contours (1973)
1900
1800
1700
1600
1500
1500
1600
1500
1400
1400
1300
1200
1300
1200
1100
1050
1100
1050
1300
1400
1100
1500
1600
1800
2000
2100
2200
1700
1900
900
900
950
1050
1200
1000


Delineation of Management Zones
Groundwater Level Contours (1997)
2300
2200
2100
2000
1900
1800
1700
1600
1500
1500
1400
1400
1350
1300
1300
1200
1200
1100
1000
950
1100
1200
1300
2000
2100
2200
2300
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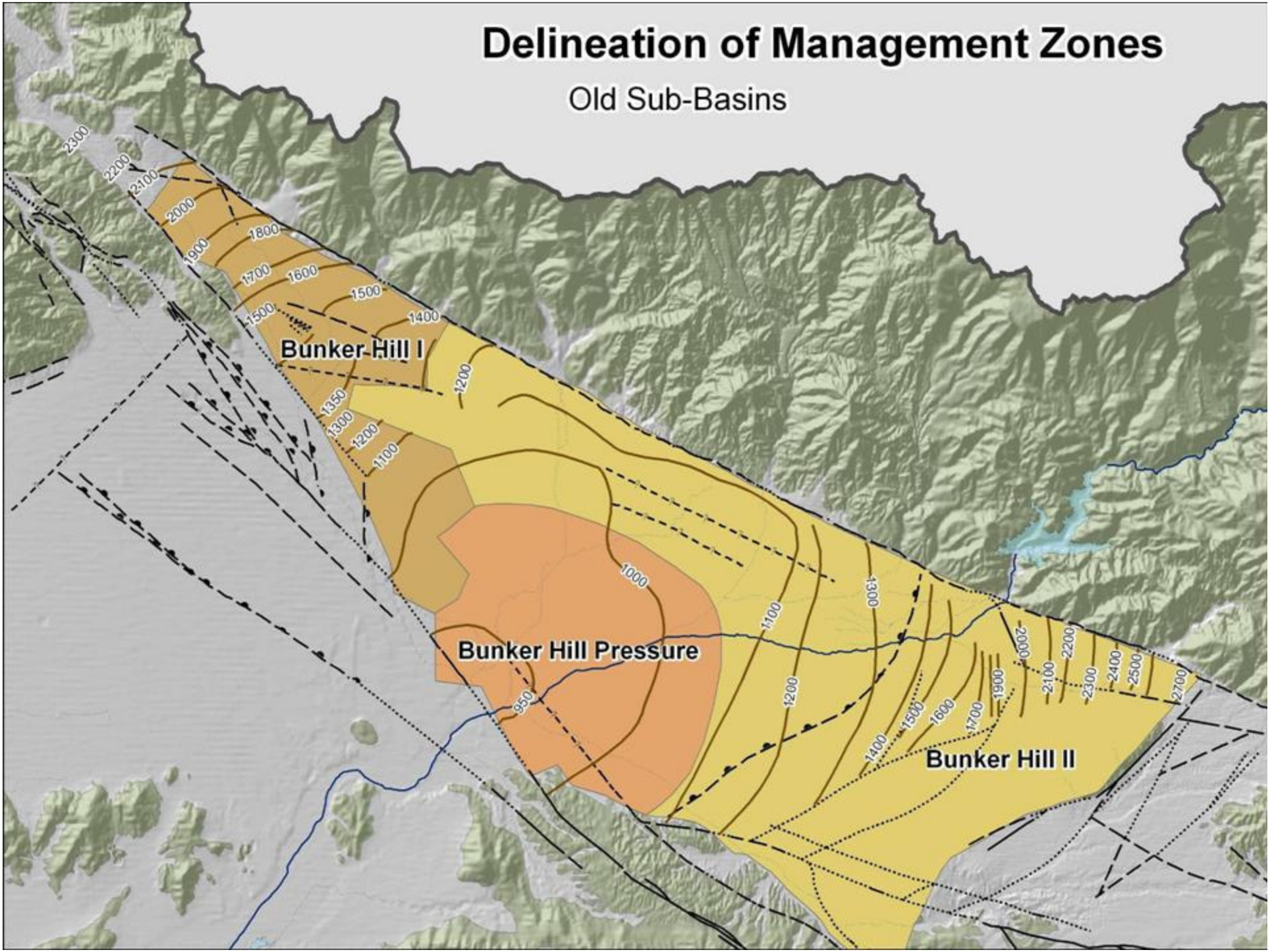
2500
2700
1900
1700
1600
1500
1400


Delineation of Management Zones
Old Sub-Basins
Bunker Hill I
Bunker Hill Pressure
Bunker Hill II
2300
2200
2100
2000
1900
1800
1700
1600
1500
1500
1400
1200
1350
1300
1200
1100
1000
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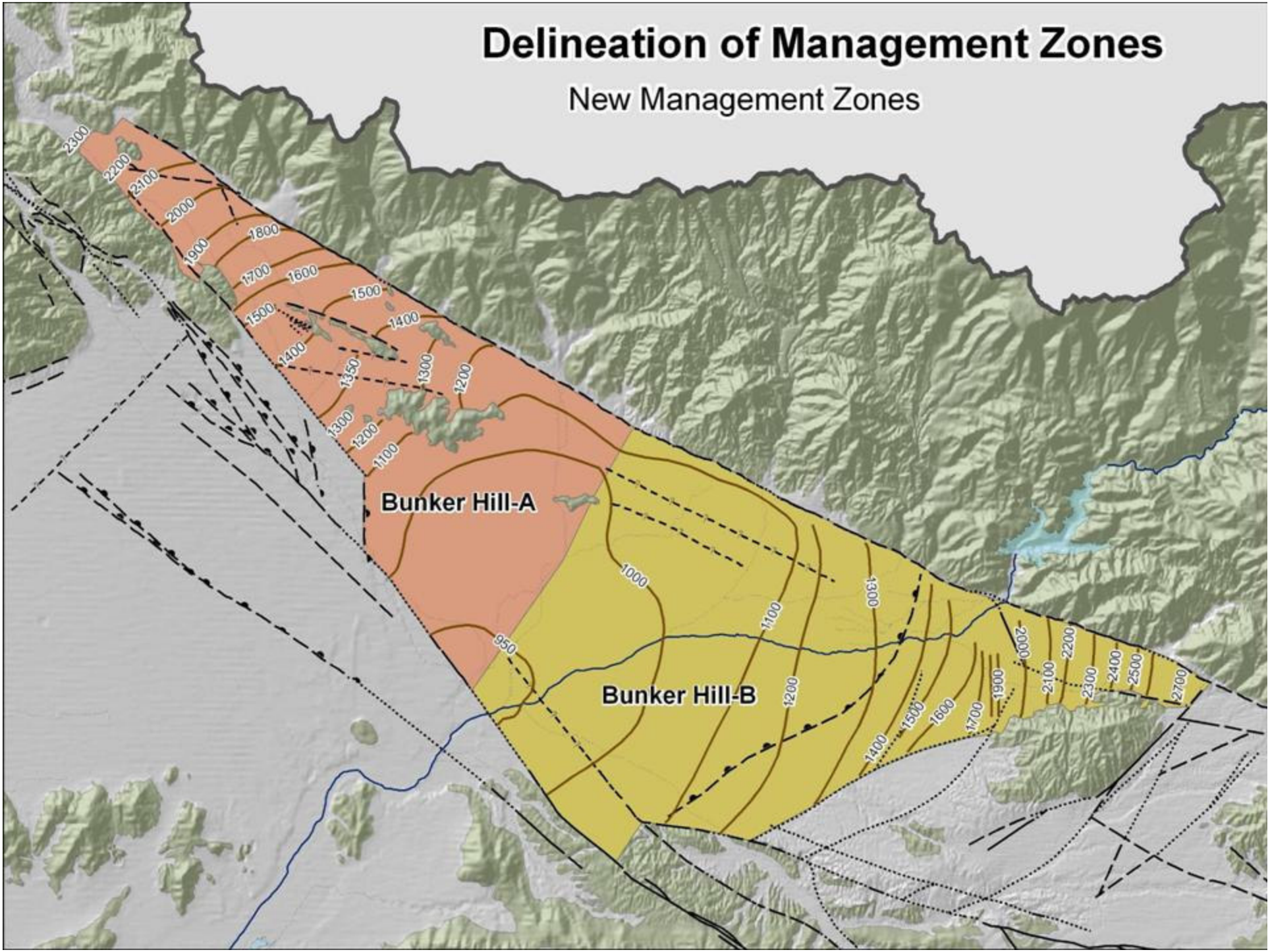
2200
2300
2400
2500
2700


Delineation of Management Zones
New Management Zones
Bunker Hill-A
Bunker Hill-B
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1350
1300
1200
1100
1000
950
2000
2400
2500
2700

1995 Basin Plan
Sub-Basins
Big Bear Valley
Bunker Hill I
Lytle Creek
Claremont Heights (LA Region)
Cucamonga
Rialto
Chino I
Bunker Hill Pressure
Bunker Hill II
Colton
Chino II
Riverside I
San Timoteo
Riverside II
Chino III
Riverside III
La Habra
Perris North
Arlington
San Jacinto-Lower Pressure
Temescal
Santa Ana Forebay
Perris South I
Lakeview
San Jacinto--Intake/ Upper Pressure
Bedford
Perris South II
San Jacinto Canyon
Santa Ana Pressure
Irvine Forebay II
Coldwater
Lee Lake
Perris South III
Hemet
Irvine Pressure
Irvine Forebay I
Menifee I
Winchester
Irvine Forebay II
Menifee II
Elsinore
N
0
10
Miles

2004 Basin Plan
Anti-Degradation
Management Zones
Lytle
Cucamonga
Bunker Hill-A
Rialto
Bunker Hill-B
Chino 1
Chino 2
Chino 3
Riv-B
Colton
Riv-C
Riv-A
Riv-F
Yucaipa
Chino-East
San Timoteo
Riv-E
Chino-South
Beaumont
Prado
Basin
Riv-D
La Habra
Arlington
Perris-North
San Jacinto-
Lower Pressure
Temescal
Lakeview/
Hemet-North
San Jacinto-
Upper Pressure
Orange County
Santiago
Bedford
Canyon
Coldwater
Warm
Springs
Valley
Perris-South
Hemet-South
Lee Lake
Irvine
Menifee
Elsinore
N
0
10
Miles

# Procedures to calculate groundwater quality objectives

- Objective-setting period:
  - 1954-1973
  - SWRCB Resolution 68-16 (Anti-deg policy)
  - Spanned variations in precipitation record
- N/TDS Study:
  - Used about 1,800 wells; 20 years of data
  - Nitrate and TDS objectives rigorously calculated

# Procedures to calculate groundwater quality objectives

- Develop *volume-weighted* management zone estimates of TDS and nitrate concentrations
  - $\text{Concentration}_{MZ} = {}^{\text{Mass}_{MZ}} / {}_{\text{GW Volume}_{MZ}}$
  - historical ambient conditions (1954 – 1973)
    - Objective setting period
  - current ambient conditions (1978 – 1997)
    - Measure of compliance

# Data Collection

- Massive data collection effort
  - Well info, water quality, water level
- Procedures:

  Task 1: Meet with Agencies/Develop Protocols

  Task 2: Collect Historical Data (1954 to 1997)

  Task 3: Process, Check, and Upload Historical Data
- Data provided in various formats
  - RDBMS (*e.g.* OCWD)
  - Ad hoc storage (*e.g.* spreadsheets, hard copy)

# Develop Queries to Extract Data

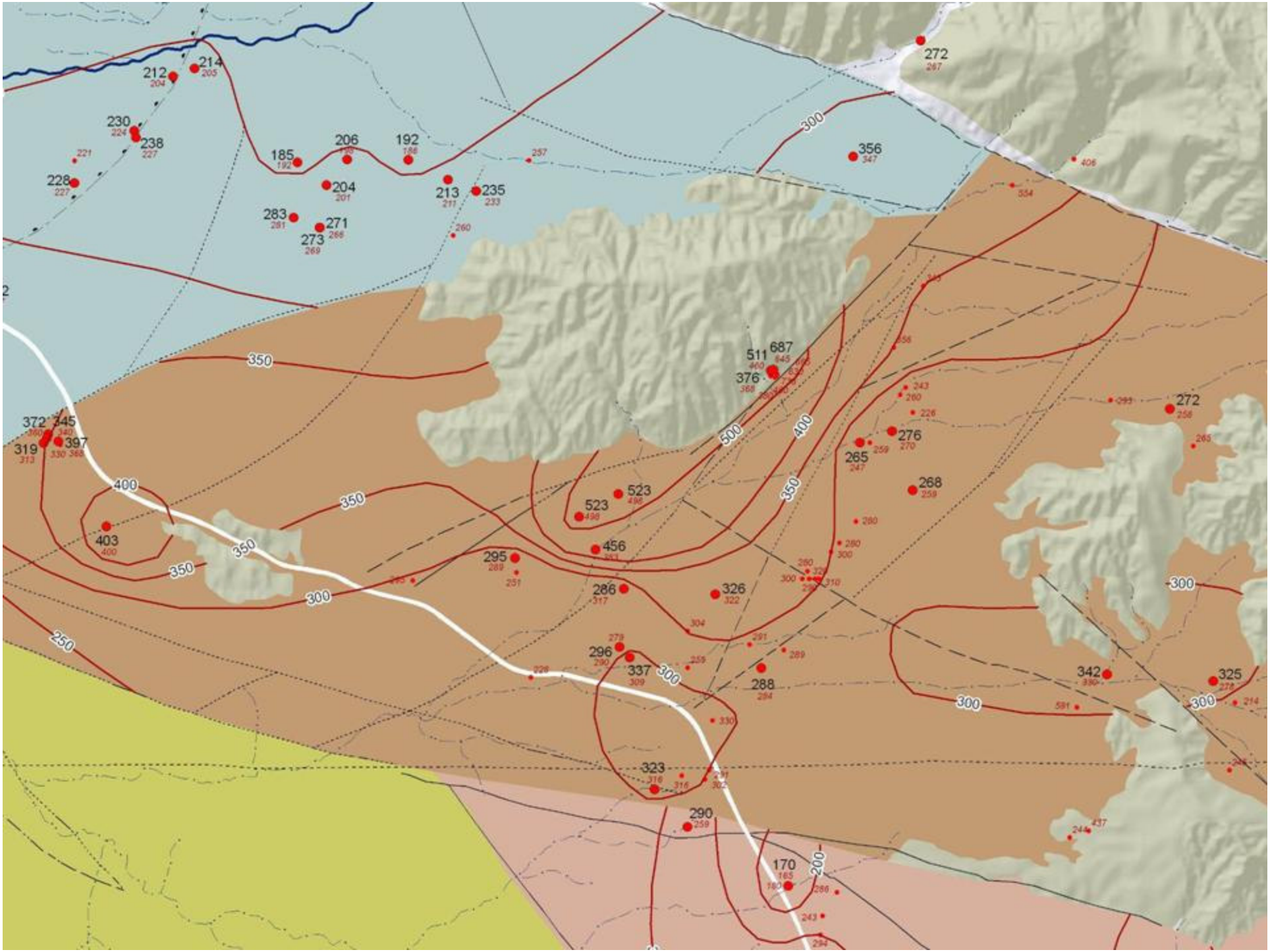
- QA/QC Checks
  - Develop TDS and $NO_3$-N time histories
  - Appropriate statistical tests for normality and outliers
    - Shapiro-Wilk test
  - Standard methods tests
    - Anion-cation balance
    - Measured TDS vs. calculated TDS
    - Measured EC and ion sums
    - TDS to EC ratios
  - Reject data if any test failed

# Develop WQ Point Statistics at Each Well

- Each well must have at least three data points in separate years during the 20-year analysis period.
  - TDS and Nitrate-nitrogen
- Computed a TDS and nitrate statistic that accounts for variability resulting from:
  - sampling error
  - analytical error
  - hydrological/climatic events
  - non-homogeneous hydrogeologic properties

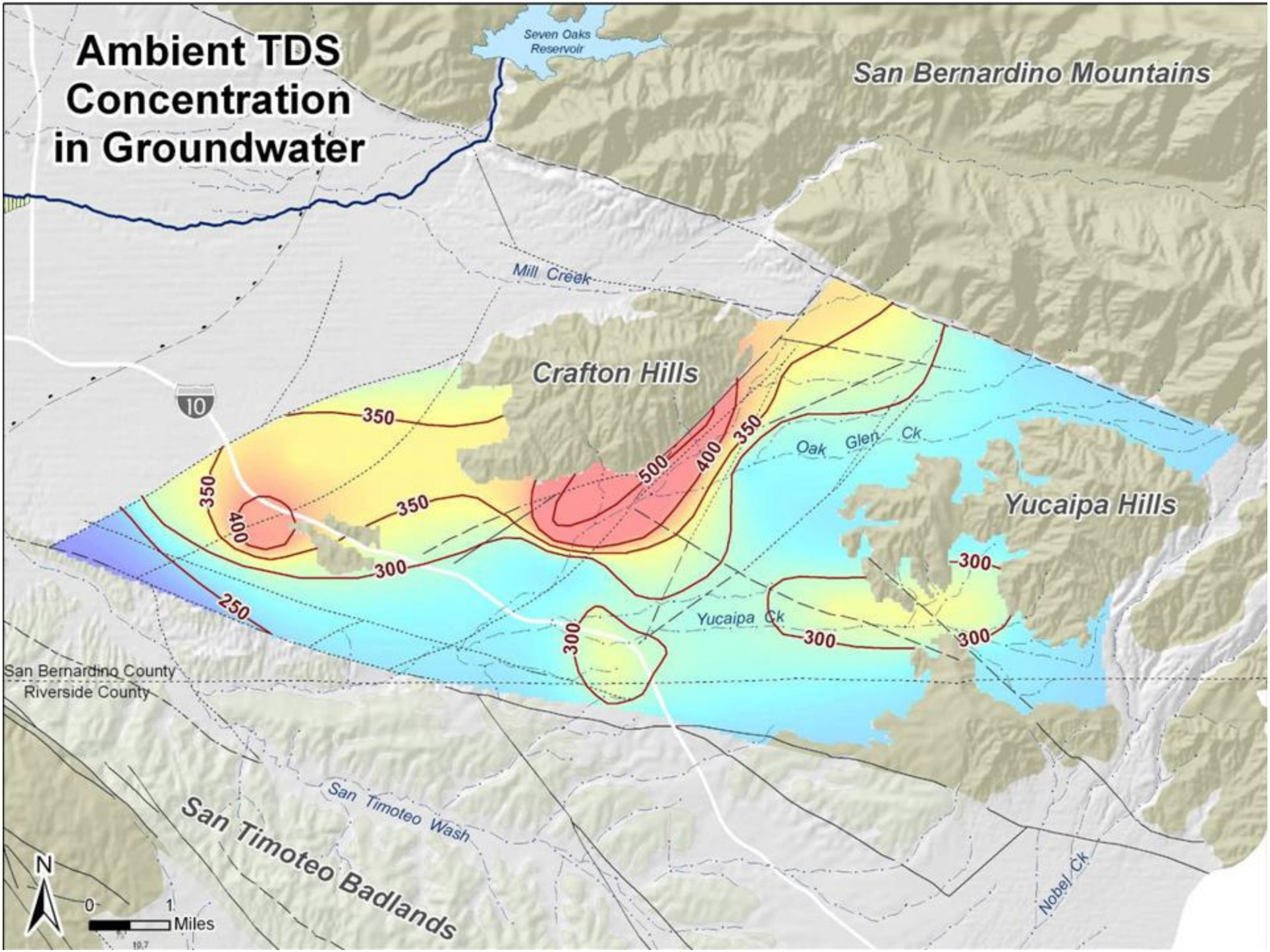
# Estimate Regional Water Quality

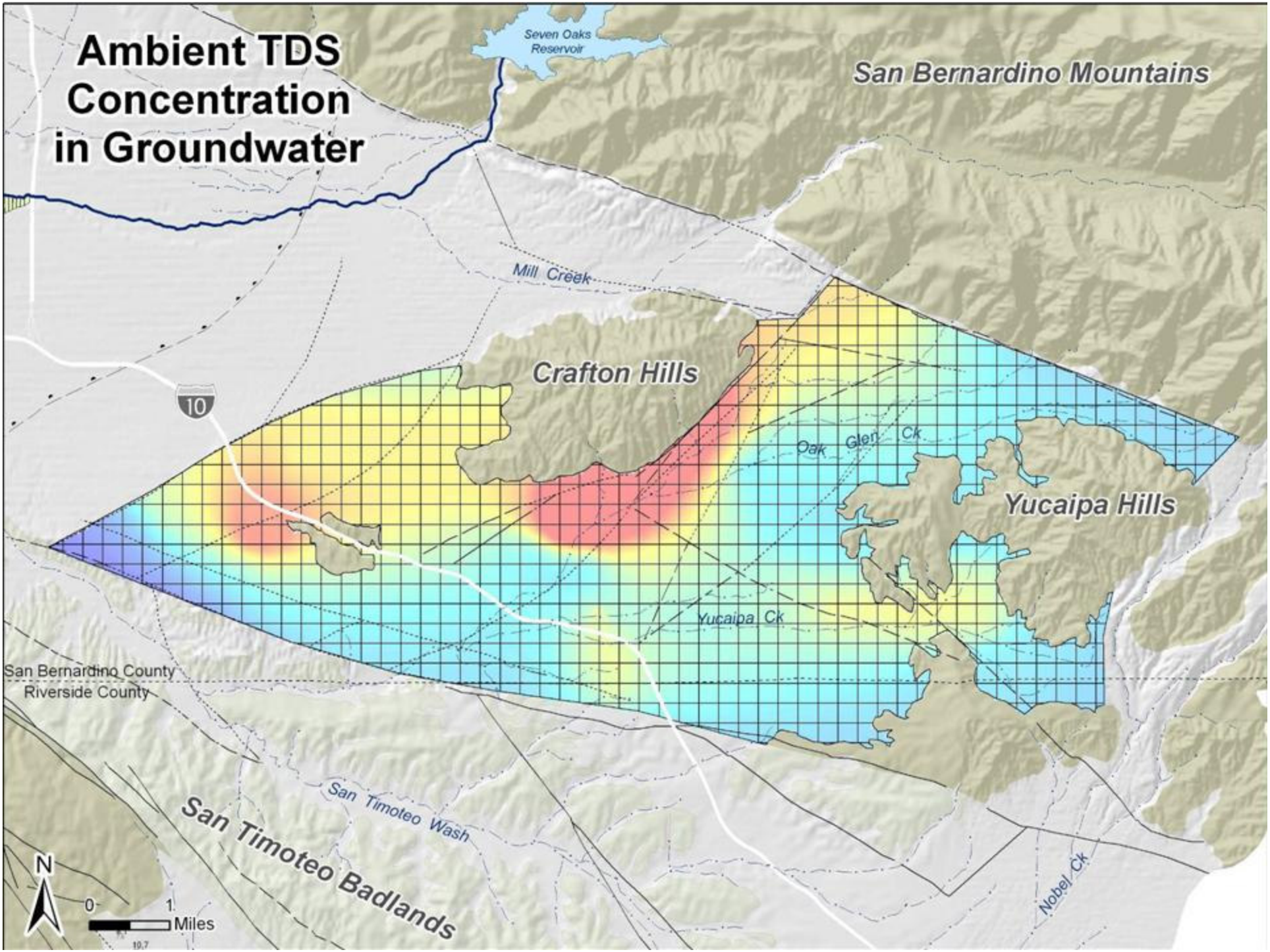
- Procedures:
  - Plot point statistics on maps
    - TDS and $NO_3$-N
    - Total maps = 22
  - Develop and digitize contours of water quality, accounting for:
    - Management zone boundaries
    - Mean values


212
214
230
238
228
185
206
192
204
213
235
283
271
273
272
356
511
687
376
372
345
319
397
403
523
456
295
286
326
265
276
268
296
337
288
342
325
323
290
170
350
400
300
250
500

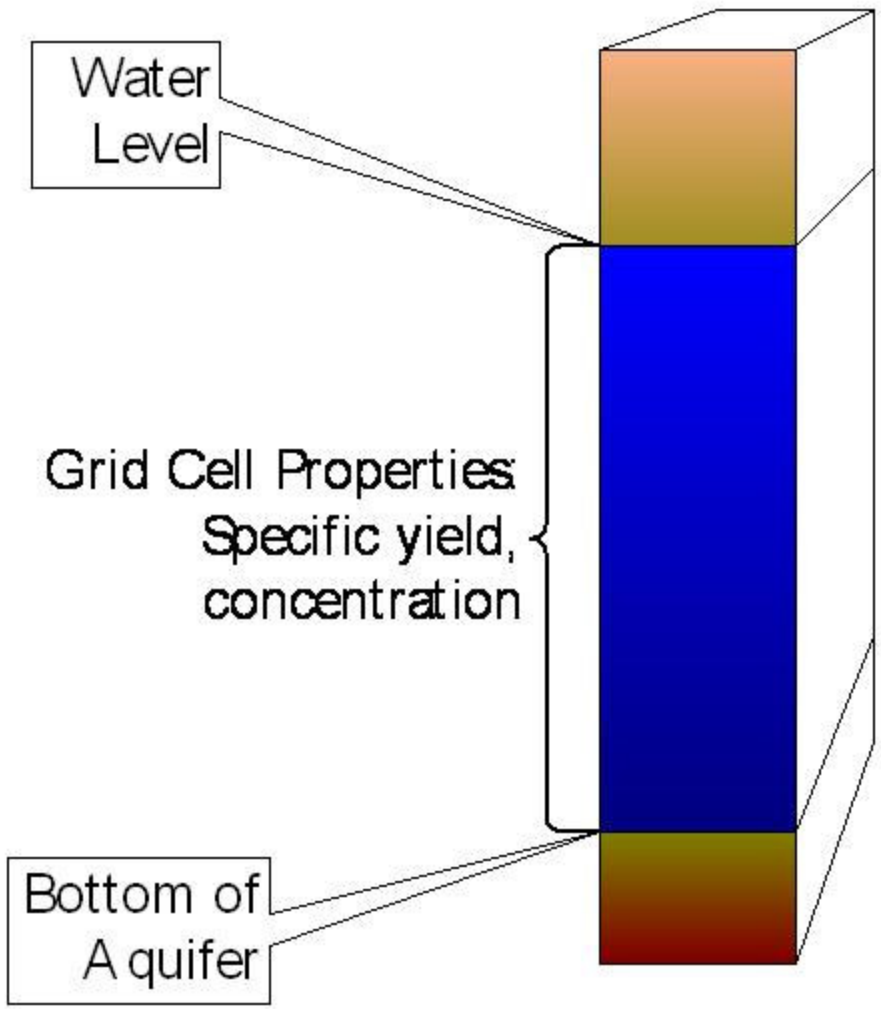
# Compute Ambient Water Quality for Management Zones

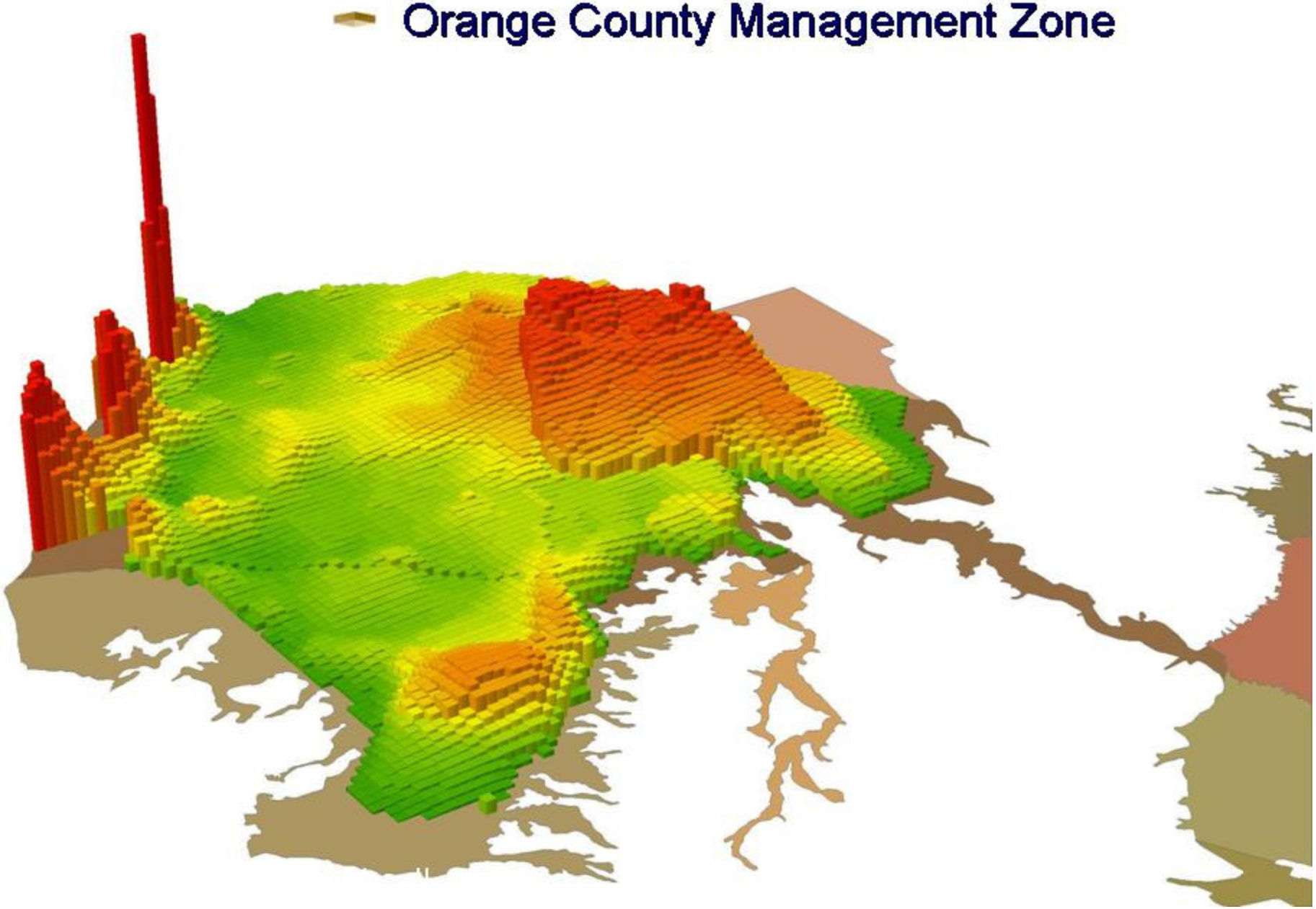
- Create 3-D GIS layers (rasters) of:
  - Water quality (TDS and Nitrate)
  - Groundwater elevations
  - Specific yield
  - Bottom of the aquifer
  - Aquifer geometry (layering) where appropriate
- 3rd dimension is value of layer


Ambient TDS Concentration in Groundwater
Seven Oaks Reservoir
San Bernardino Mountains
Mill Creek
Crafton Hills
10
350
350
350
400
500
400
350
Oak Glen Ck
Yucaipa Hills
300
300
250
300
Yucaipa Ck
300
300
San Bernardino County
Riverside County
San Timoteo Wash
San Timoteo Badlands
Nobel Ck
N
0
1
Miles


Ambient TDS Concentration in Groundwater
Seven Oaks Reservoir
San Bernardino Mountains
Mill Creek
Crafton Hills
10
Oak Glen Ck
Yucaipa Hills
Yucaipa Ck
San Bernardino County
Riverside County
San Timoteo Wash
San Timoteo Badlands
Nobel Ck
N
0
1
Miles

$$C_{amb} = 1/V_T * \Sigma(V_i * c_i)$$



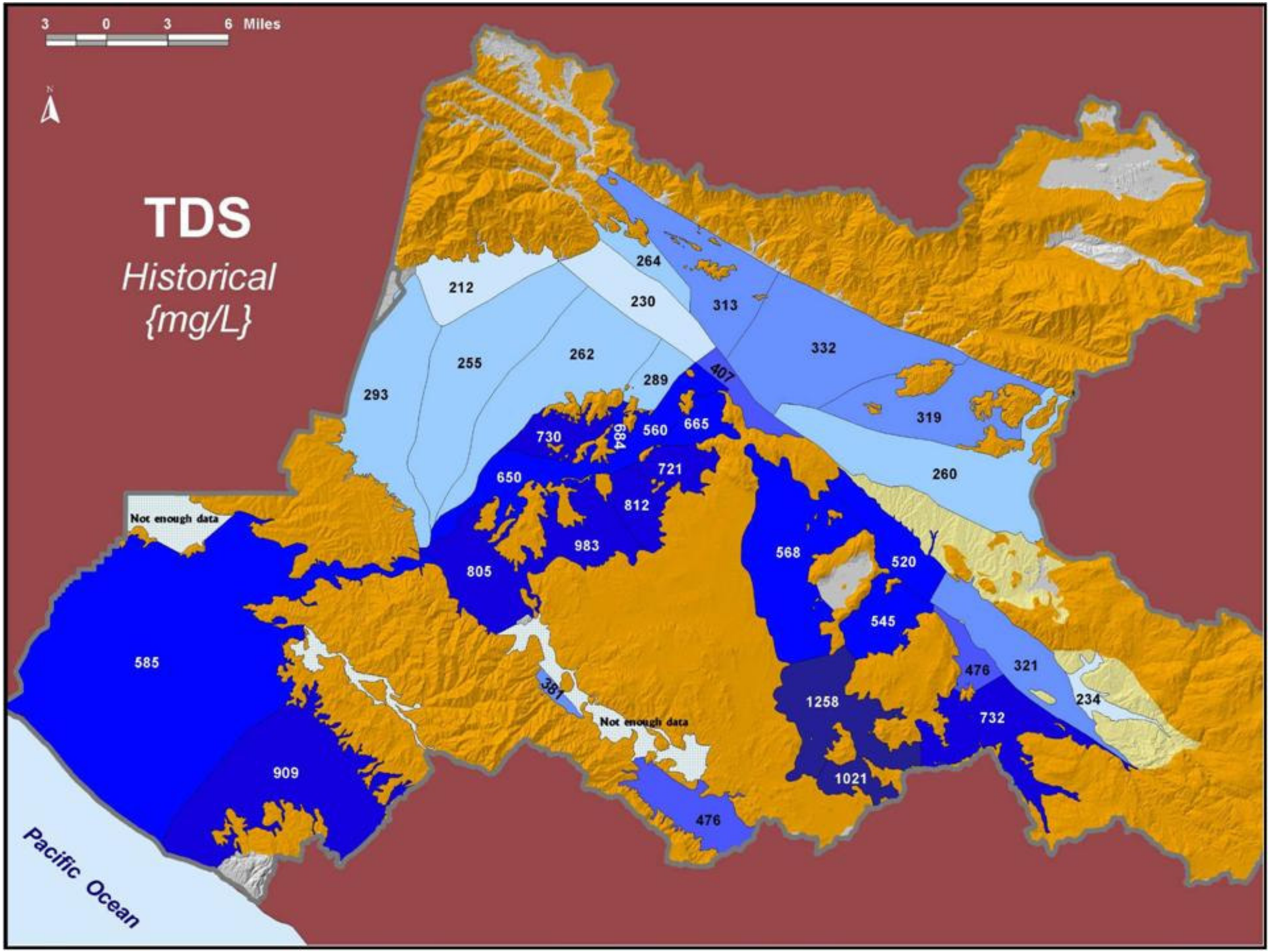

Orange County Management Zone

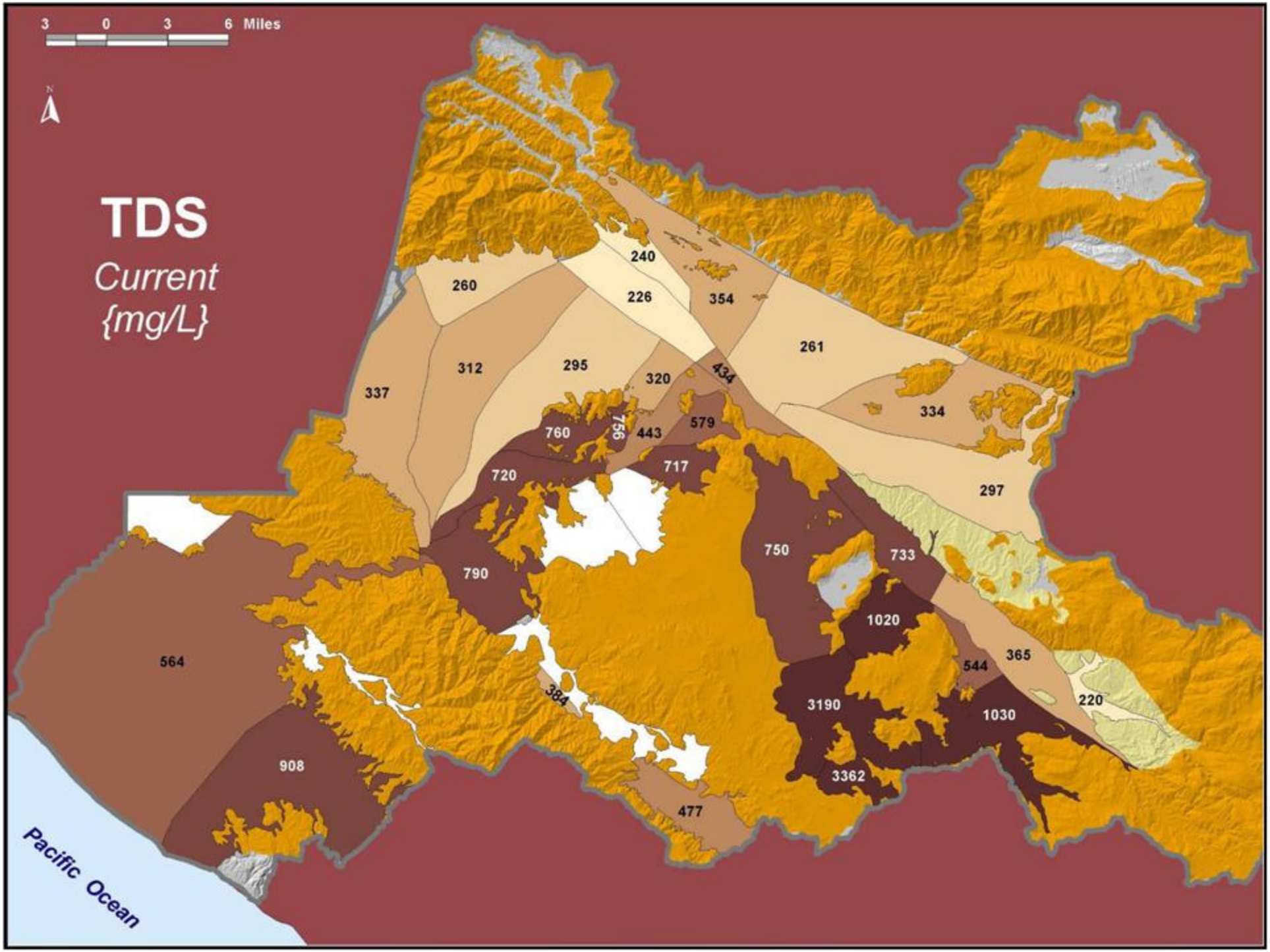
# Compute Ambient Water Quality for Management Zones

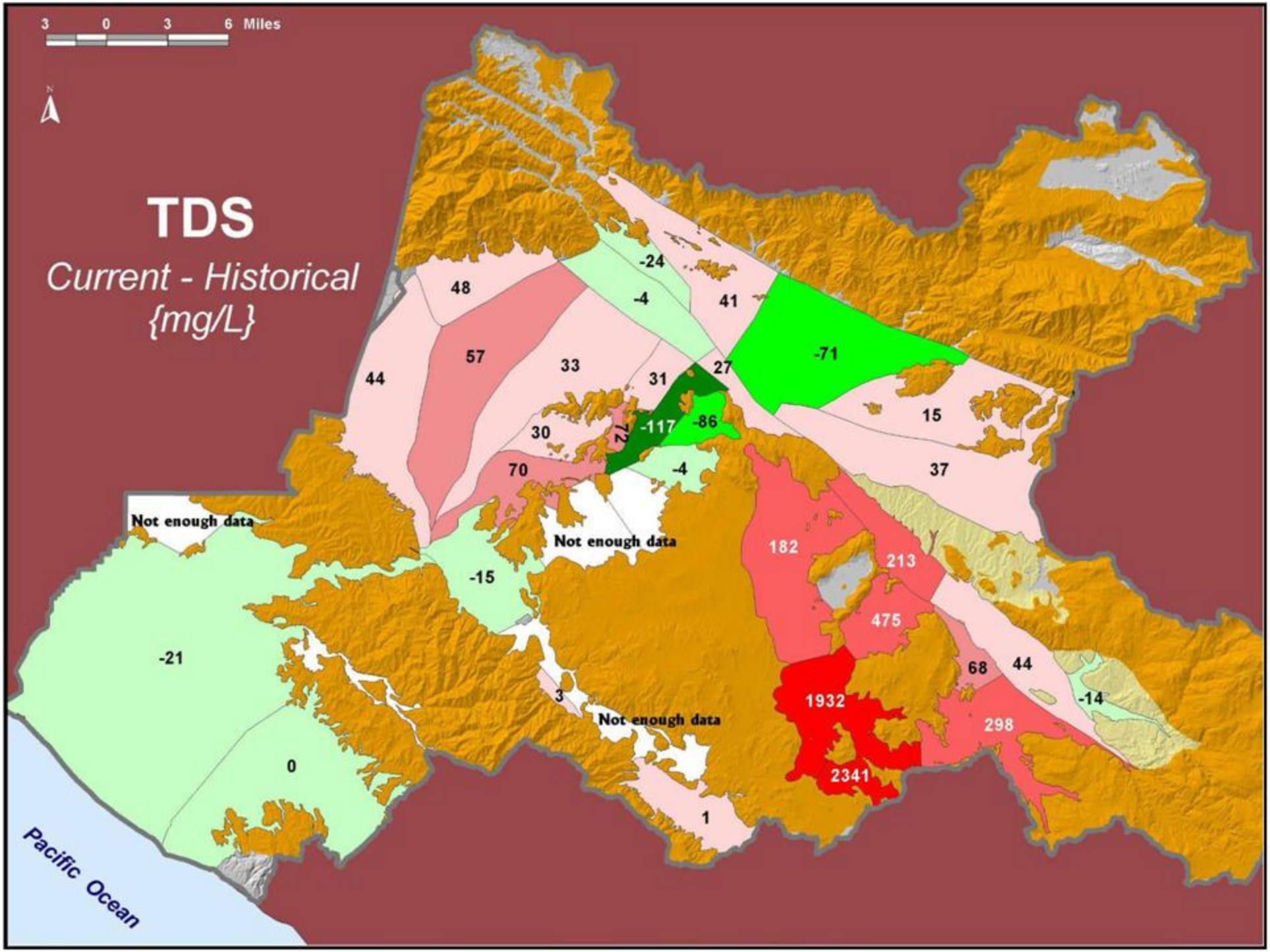
- Post-process GIS grid
  - Ambient TDS and $NO_3$ in each MZ
  - Historical (1954-1973) – Objective
  - Current (1978-1997) – Compliance
  - Recomputation – Compliance
    - Every three years
    - 1984-2003 and 1987-2006
- Calculate assimilative capacity
  - Current - Objective

# Assimilative Capacity

- Management Zones with assimilative capacity
  - Regional Board, at its discretion, can permit discharges at TDS and $NO_3$ concentrations higher than the objective
- Management Zones that lack assimilative capacity
  - Discharges to these basins must have TDS and $NO_3$ concentrations at or below the objectives (SWRCB Order No. 73-4 – Rancho Caballero decision)


3 0 3 6 Miles
N
TDS
Historical
{mg/L}
264
212
230
313
332
255
262
289
407
293
319
730
684
560
665
650
721
260
812
Not enough data
983
805
568
520
545
585
476
321
381
1258
234
Not enough data
732
909
1021
476
Pacific Ocean

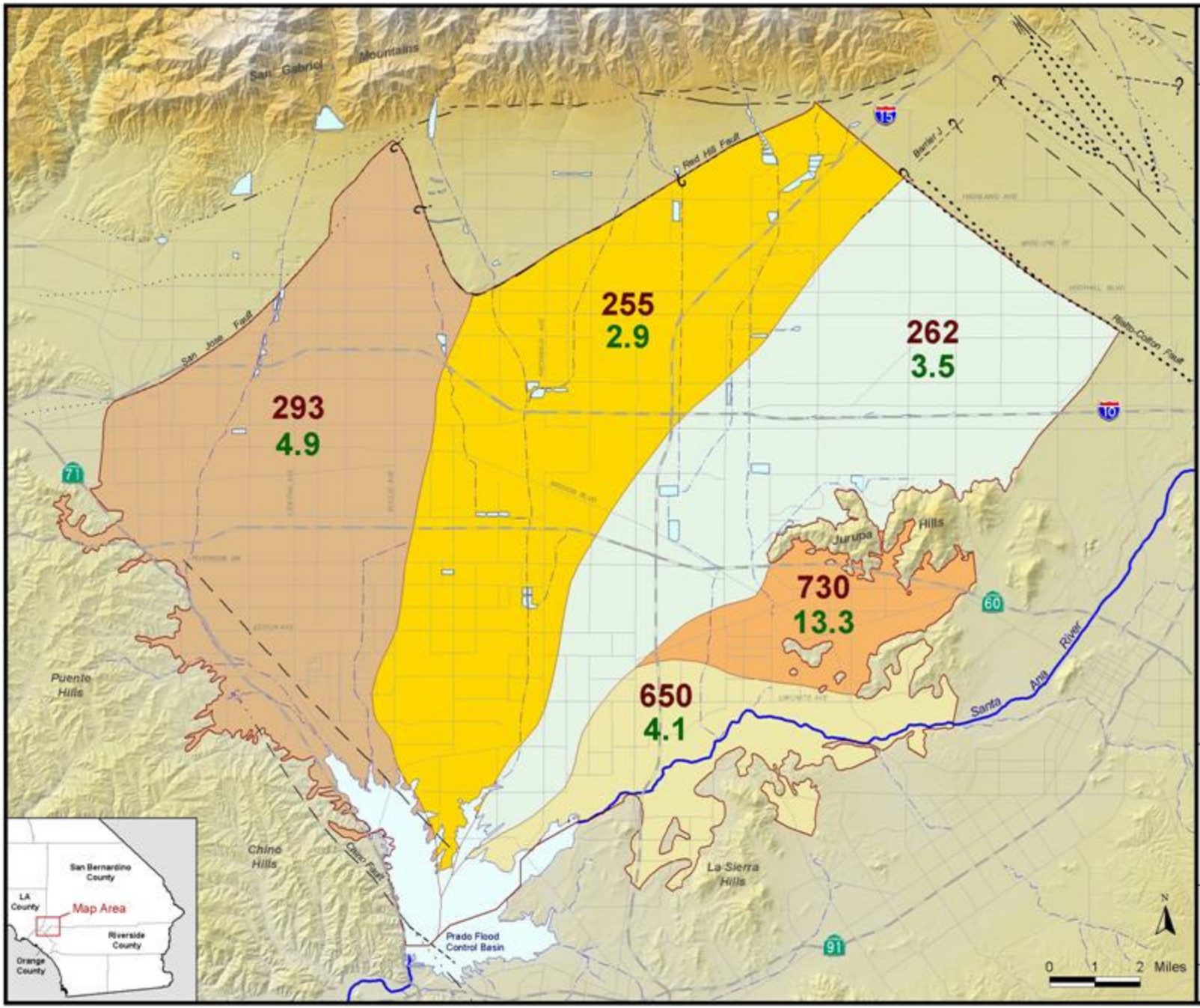

3 0 3 6 Miles
N
TDS
Current
{mg/L}
240
260
226
354
261
312
295
320
434
337
334
760
756
443
579
720
717
297
750
733
790
1020
564
365
544
384
3190
1030
220
908
3362
477
Pacific Ocean



3 0 3 6 Miles
TDS
Current - Historical
{mg/L}
48
-24
-4
41
57
33
31
27
-71
44
30
72
-117
-86
15
70
-4
37
Not enough data
Not enough data
182
213
-15
475
-21
68
44
3
1932
-14
Not enough data
298
0
2341
1
Pacific Ocean

# Implications of the N/TDS Study

- There were many MZs with no assimilative capacity
- Possible effects per Rancho Caballero:
  - Costly mitigation for recycled water re-use and/or aquifer recharge
  - RWQCB would require mitigation for imported water recharge if TDS in imported water exceeds the objective




**Optimum Basin M**

*Chino Basi*

***Proposed Wate***
***by Mana***

**262** TDS
**3.5** Nitr

1 2 3 4 5

***Other M***

Flood Control an

Fault
Solid where know
Dotted where con
Large dots where

**Fig**

Proposed Wate
Based on Historica
for Chino Basin

**WE**

*Prepared by: AEM*
*Date: April 2002*

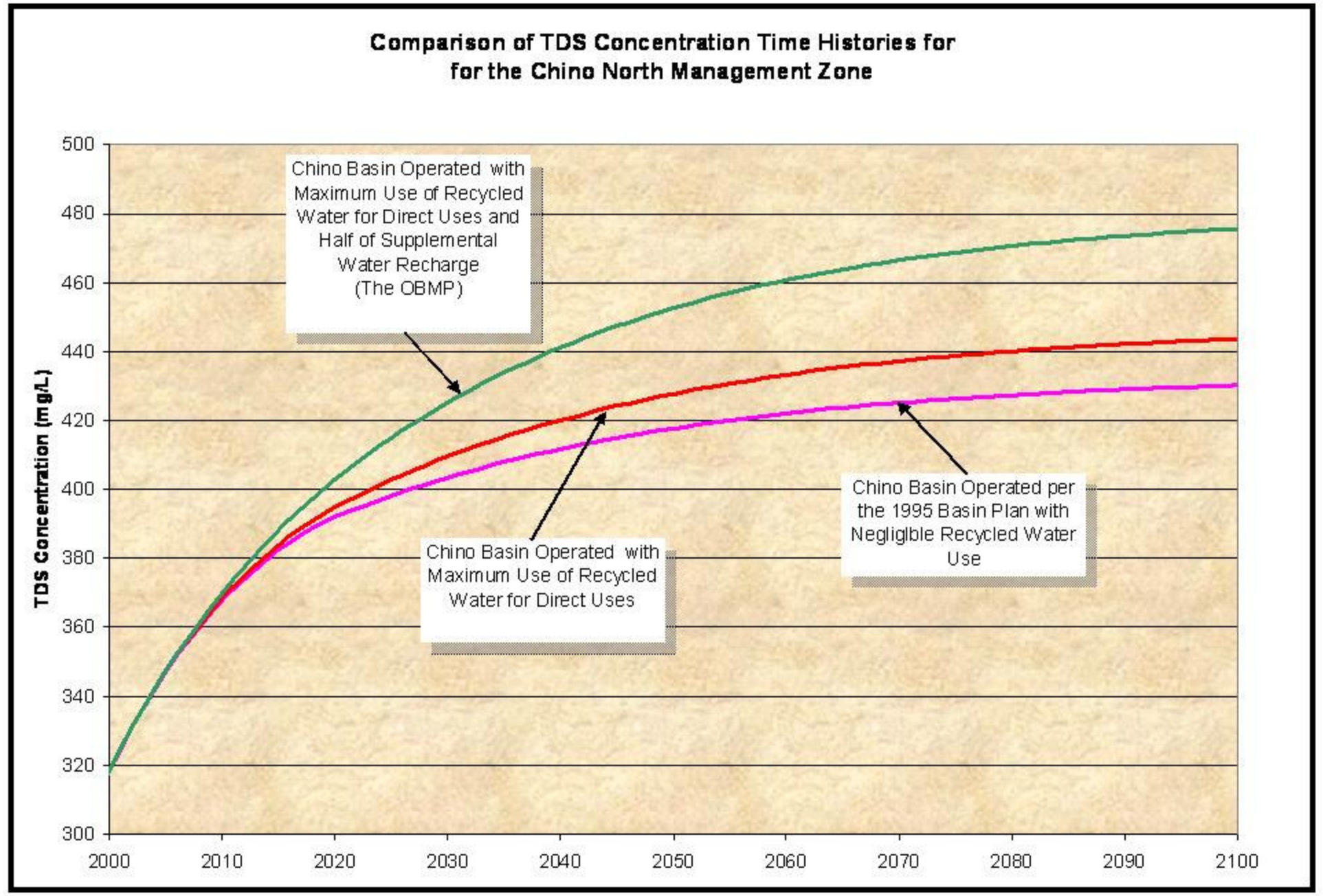
*File:*

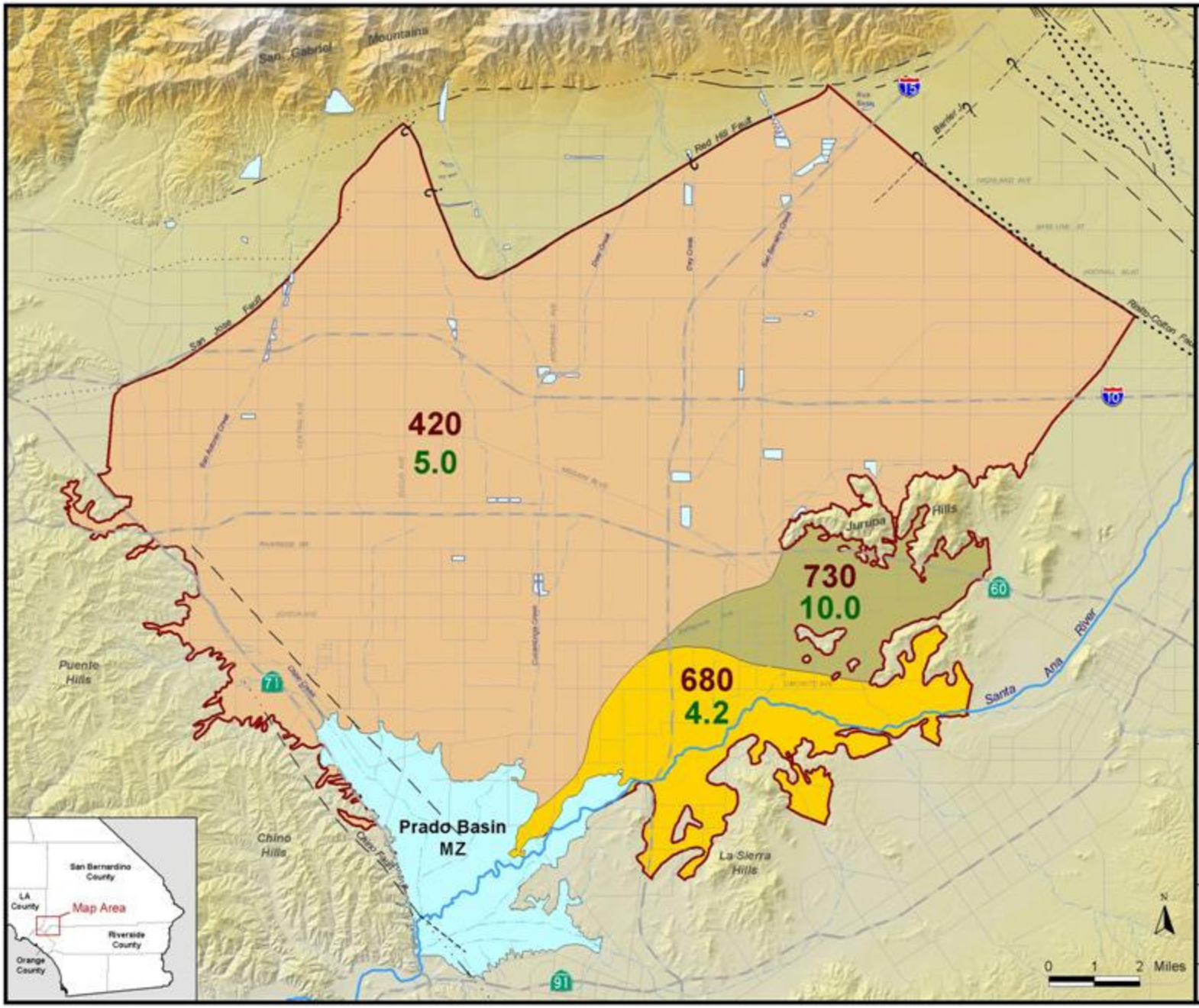
# The "Maximum Benefit" Argument

- So…how could recycled water recharge be implemented?
- SWRCB Resolution 68-16
  - Water quality objectives can be changed, if:
    - Changing the objectives does not unreasonably affect beneficial uses
    - Changing the objectives is consistent with the maximum benefit to the people of the State

# The Chino Basin "Maximum Benefit" Argument

- Optimum Basin Management Program
  - Desalter facilities
  - Nitrate-removal facilities
  - Storage and recovery programs
  - Storm water capture programs
  - Recycled water re-use and recharge
  - Hydraulic isolation of the groundwater basin
- Clear demonstration of "maximum benefit" to the people of the State


Comparison of TDS Concentration Time Histories for
for the Chino North Management Zone
TDS Concentration (mg/L)
500
480
460
440
420
400
380
360
340
320
300
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Chino Basin Operated with Maximum Use of Recycled Water for Direct Uses and Half of Supplemental Water Recharge (The OBMP)
Chino Basin Operated with Maximum Use of Recycled Water for Direct Uses
Chino Basin Operated per the 1995 Basin Plan with Negligible Recycled Water Use




**Optimum Basin Man**

*Chino Basin W*

***Proposed Water Qua***
***by Manageme***

**680** TDS (n

**4.2** Nitrate

***Chino Basi***
***Management***

North

Sou

***Other Map Fe***

Flood Control and Con

Fault

Solid where known; Dash
Dotted where concealed;
Large dots where probab

Figure

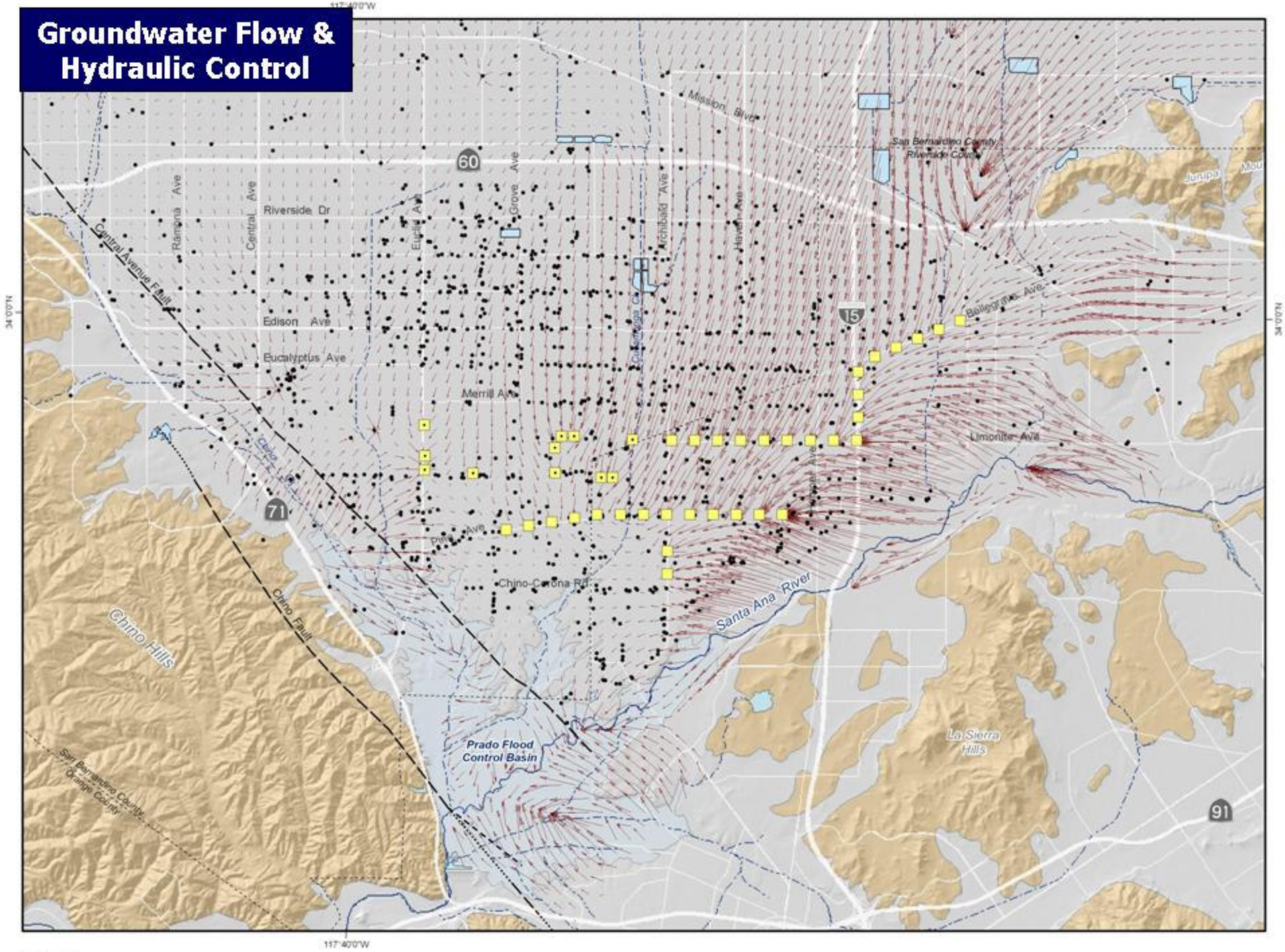
Proposed Water Qu
Based on Maximum Ber
for Chino Basin Man

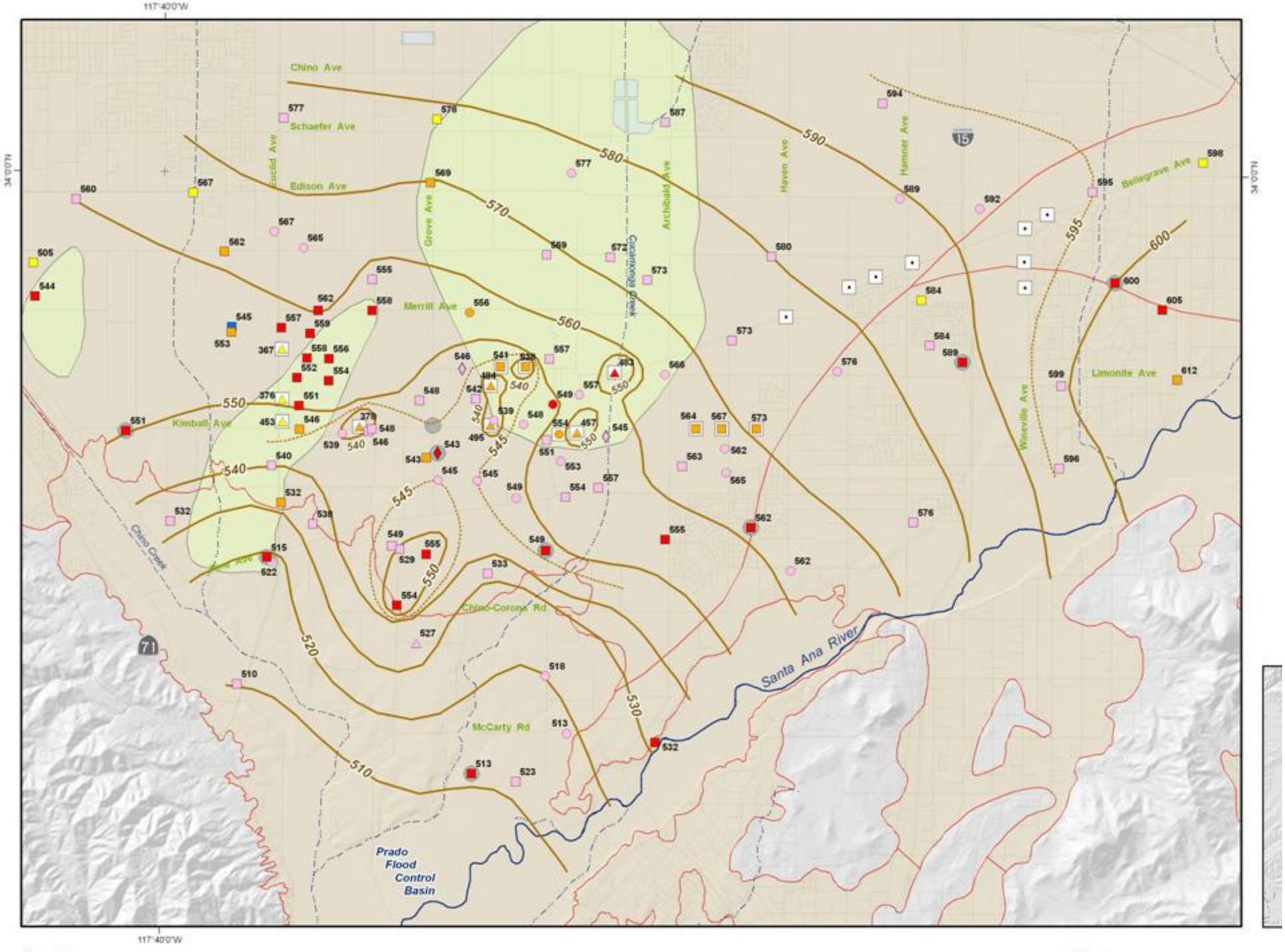
WE WIL
ENV

*Prepared by: AEM*
*Date: December 2002*

*File: max_b*

# Groundwater Flow & Hydraulic Control




117°40'0"W
34°0'0"N
Chino Ave
Schaefer Ave
Edison Ave
Merrill Ave
Kimball Ave
Chino-Corona Rd
McCarty Rd
Limonite Ave
Bellegrave Ave
Santa Ana River
Chino Creek
Cucamonga Creek
Grove Ave
Archibald Ave
Haven Ave
Hamner Ave
Wineville Ave
Euclid Ave
71
15
Prado
Flood
Control
Basin

# Why the N/TDS Task Force was Successful

- Alternative to traditional "command and control"
- Consensus-driven stakeholder process to collaboratively address water quality matters
  - Collaborative
  - Open
  - Transparent
  - Inclusive

# Why Use Task Forces?

- Opportunity to work out stakeholder differences in collaborative setting
- More efficient and less costly to reach consensus in advance of hearings before Regional and State Water Boards
- Avoids appeal process and litigation

# Task Force Formation

- Process managed by SAWPA
- TF hired consultants:
  - Risk Sciences for facilitation, mediation, regulatory maze
  - Wildermuth Environmental to develop scientific approach to:
    - generate water quality objectives
    - evaluate current ambient conditions
    - assess assimilative capacity
- Regional Board: stakeholder

# Ground Rules

- Respect all points of view
- Operate within state and federal laws, regulations, and policies
- Reach consensus on science and agree that an approach is correct BEFORE applying any data
- LIVE WITH THE RESULTS, since agreed to validity of process

# Summary

- Task Force process generates very strong science
- Provides for informed and valid regulatory decision-making process
- Provides regulatory certainty for regulated community
- Results in fewer petitions and less litigation