Agenda

Lake Elsinore/Canyon Lake TMDL

October 11, 2017

9:00-10:00 Meet at Regional Board Office

- Introductions
- Plan for the Day
- Basin Plan Water Quality Standards for both lakes
- Overview of 2004 TMDL

10:00-11:00 Drive to Lake Elsinore

- Discuss Problem Statement
- Reference Watershed Approach
- HABs

11:00-11:30 At Lake Elsinore Public Boat Ramp

- LEMP
- LEAMS

11:30-12:30 Lunch

12:30—1:30 Canyon Lake

- Two TMDLs for Canyon Lake, East Bay and Main Body
- Tour Canyon Lake by car
- Alum Addition and effects

1:30-2:30 Return to Regional Board Office

- Next Steps and Schedule

Table 2. Lake Elsinore and Canyon Lake Beneficial Uses and Water Quality Objectives (1995 Basin Plan as updated in 2008 and 2011)

Lake	Constituent	Relevant Water Quality Objectives
Lake Elsinore • Warm Freshwater Aquatic Habitat – (WARM) • Water Contact Recreation (REC1) • Non-Contact Recreation (REC2) • Wildlife Habitat (WILD)	Total Inorganic Nitrogen (TIN)[1]	1.5 mg/L
	Algae	Waste discharges shall not contribute to excessive algal growth in receiving waters
	Un-ionized Ammonia[2]	• Acute (1-hour) Objective = 0.822 [0.87/FT/FPH/2] • Chronic (4-day) UIA-N Objective = 0.822 [0.87/FT/FPH/RATIO]
	Dissolved Oxygen	Dissolved oxygen content of surface waters shall not be depressed below 5 mg/L for waters designated WARM
	Total Dissolved Solids (TDS)	2,000 mg/L TDS
Canyon Lake • Municipal and Domestic Water Supply (MUN) • Agriculture Water Supply (AGR) • Groundwater Recharge (GWR) • Water Contact Recreation (REC1) • Non-Contact Recreation (REC2) • Warm Freshwater Aquatic Habitat (WARM) • Wildlife Habitat (WILD)	Total Inorganic Nitrogen (TIN)[1]	8 mg/L
	Algae	Waste discharges shall not contribute to excessive algal growth in receiving waters
	Un-ionized Ammonia[2]	• Acute (1-hour) Objective = 0.822 [0.87/FT/FPH/2] • Chronic (4-day) UIA-N Objective = 0.822 [0.87/FT/FPH/RATIO]
	Dissolved Oxygen	Dissolved oxygen content of surface waters shall not be depressed below 5 mg/L for waters designated WARM

[1] TIN is the sum of nitrate, nitrite and ammonia forms of nitrogen. The TIN water quality objective was established based on the TIN historical average in the lake prior to 1975.
[2] See page 4-8 of the Basin Plan for formulas for "FT", "FPH", and "RATIO" relevant to pH and water temperature

Table 3. Summary of Fish Kills in Lake Elsinore, 1915-Present (* indicates fish kills previously documented in the 2004 Problem Statement, Santa Ana Water Board Resolution

Year	Description
1915	Low lake level, salty water, and die off of "black bass" documented by Couch (1952).
1917	Fish kill (unspecified) and associated high water temperature. Couch (1952).
1927	Fish kill (unspecified) reported by the Elsinore Valley News (September 22, 1927).
1933*	Fish kill (carp and minnows/ arroyo chub), and associated algal bloom in April reported by State Bureau of Sanitary Engineering and the Elsinore Reader Press (May 4, 1933).
1940*	Large fish kill reported by State Bureau of Fish Conservation.
1941*	Large fish kill reported by DFG.
1948*	300-500 tons of carp died from August 31 to approximately September 2. Reported by DFG.
1950*	"There are no fish in the Lake." Reported by Riverside County Health Department.
1966*	"An extensive die-off of fish." Reported by DFG.
1972*	"During the last week of August, and continuing through September, tons of fish were buried or taken to the dump, mostly thread-fin shad." Reported by DFG.
1975	Large fish kill documented in August by Bovee (1989).
1976	Large fish kill in fall with an estimate of 41 tons of fish documented by Bovee (1989).
1987	Minor fish kill in August, primarily threadfin shad documented by Bovee (1989).
1988	Minor fish kill in July/August (approximately 300 pounds) documented in October documented by Bovee (1989).
1990	Large fish kill of approximately 1500 tons (species not specified) documented by MWH (2002).
1991*	120 thousand tons of fish killed by algae. Reported by The Press Enterprise.
1992*	12-15 tons fish kill on August 17. Reported by The Press Enterprise.
1993*	More than 100,000 tons of fish died. Reported by Black & Veatch (1996).
1995	Approximately 200 tons of fish (various species) killed in June/July associated with low DO. Reported by the North County Times (22 August 2002).
1995*	10 tons of fish killed, shad and bluegill in September. Reported by The Press Enterprise.
1996*	Small fish die-off in August. Reported by The Press Enterprise.
1997*	7 tons of shad died of oxygen depletion in April. Reported by The Press Enterprise.
1998*	240 ton fish kill (threadfin shad) November 11 associated with low DO. Reported by The Press Enterprise.
2001	Die off of carp noted in August, volume unspecified. Reported by LESJWA (2002).
2002*	100 ton of fish kill (primarily carp) August 22 associated with low DO. Reported by The Press Enterprise and North County Times.
2009	Moderate to large fish kill (estimate of 500,000 shad and 6,000 larger fish), associated with high temperatures and low DO. July 27, 2009. Reported by the City of Lake Elsinore and the San Diego union
2012	Minor fish kill (threadfin shad) April 28. Reported by the Lake Elsinore-Wildomar Patch.
2015	Moderate fish kill of approximately 10 tons August 4-8 (primarily carp and threadfin shad, with some bass and catfish). Associated with high temperatures and low DO. Reported by the Press Enterprise

(CDM Smith, Nov. 2017, Table 2-2, Additional Sources: EDAW Inc., 1974, Press Enterprise Reports, and LEMA, 1996.)

Table 1: Comparison of 2004 TMDL and Proposed TMDL for Nutrients in Canyon Lake and Lake Elsinore

TMDL	Final Total Phosphorous TMDL (kg/yr)[a,b]	Final Total Nitrogen TMDL (kg/yr)[a,b]
Canyon Lake (2004)	8,691	37,735
Canyon Lake (Proposed)	8,172	34,369
Lake Elsinore (2004)	28,584	239,025
Lake Elsinore (Proposed)	36,815	330,226

a. Final Compliance to be achieved as soon as possible, but no later than December 31, 2020

b. TMDL Specified as a 10-year running average

Table 4. 2004 TMDL Numeric Compliance Targets

Indicator	Lake Elsinore	Canyon Lake
Total Phosphorus Concentration (Final)	Annual average no greater than 0.1 mg/L to be attained no later than 2020	Annual average no greater than 0.1 mg/L to be attained no later than 2020
Total Nitrogen Concentration (Final)	Annual average no greater than 0.75 mg/L to be attained no later than 2020	Annual average no greater than 0.75 mg/L to be attained no later than 2020
Ammonia Nitrogen Concentration (Final)	Calculated concentrations to be attained no later than 2020 *Acute*: 1-hour average concentration of total ammonia nitrogen (mg/L) not to exceed, more than once every three years on the average, the Criterion Maximum Concentration (CMC) (acute criteria), where $CMC = 0.411/(1+10^{7.204-pH}) + 58.4/(1+10^{pH-7.204})$ *Chronic*: 30-day average concentration of total ammonia nitrogen (mg/L) not to exceed, more than once every three years on the average, the Criterion Continuous Concentration (CCC) (chronic criteria), where $CCC = (0.0577/(1+10^{7.688-pH}) + 2.487/(1+10^{pH-7.688})) * \min(2.85, 1.45*10^{0.028(25-T)})$	Calculated concentrations to be attained no later than 2020 *Acute*: 1-hour average concentration of total ammonia nitrogen (mg/L) not to exceed, more than once every three years on the average, the Criterion Maximum Concentration (CMC) (acute criteria), where $CMC = 0.411/(1+10^{7.204-pH}) + 58.4/(1+10^{pH-7.204})$ *Chronic*: 30-day average concentration of total ammonia nitrogen (mg/L) not to exceed, more than once every three years on the average, the Criterion Continuous Concentration (CCC) (chronic criteria), where $CCC = (0.0577/(1+10^{7.688-pH}) + 2.487/(1+10^{pH-7.688})) * \min(2.85, 1.45*10^{0.028(25-T)})$
Chlorophyll *a* concentration (Interim)	Summer average no greater than 40 µg/L; to be attained no later than 2015	Annual average no greater than 40 µg/L; to be attained no later than 2015
Chlorophyll *a* Concentration (Final)	Summer average no greater than 25 µg/L; to be attained no later than 2020	Annual average no greater than 25 µg/L; to be attained no later than 2020
Dissolved Oxygen Concentration (Interim)	Depth average no less than 5 mg/L; to be attained no later than 2015	Minimum of 5 mg/L above thermocline; to be attained no later than 2015
Dissolved Oxygen Concentration (Final)	No less than 5 mg/L 1 meter above lake bottom to be attained no later than 2015	Daily average in hypolimnion no less than 5 mg/L; to be attained no later than 2015

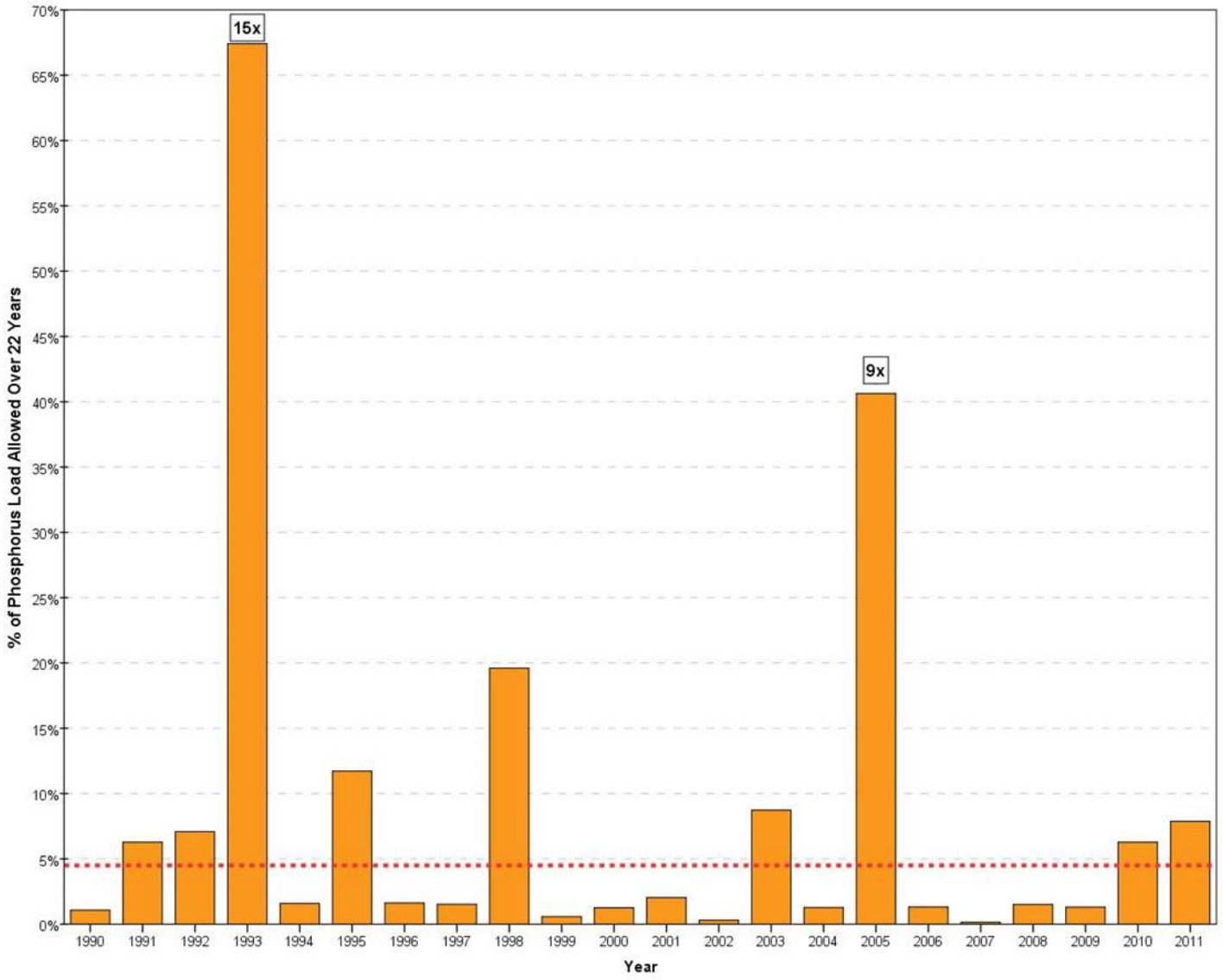
Since 2004 LESJWA has:

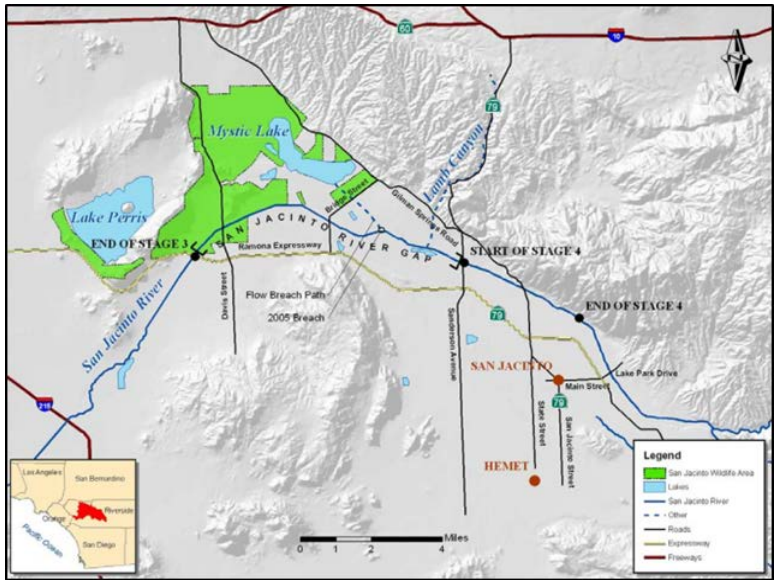
1. Established a comprehensive water quality monitoring program, which was approved by the Regional Board's Resolution No. R8-2006-0031
2. Prepared and submitted a Sediment Nutrient Reduction Plan for Lake Elsinore, which was approved by Regional Board Resolution No. R8-2007-0083.
3. Installed a large-scale aeration and mixing system in Lake Elsinore, as an offset for reclaimed water discharges of TN and TP and to help maintain Dissolved Oxygen levels in Lake Elsinore.
4. Initiated a fishery management program to reduce carp and shad in Lake Elsinore,
5. Applied more than 340 tons (330,000 gallons) of alum to Canyon Lake to reduce TP.
6. Dredged approximately 20,000 cubic yards of nutrient rich sediment from Canyon Lake.
7. Constructed or rehabilitated 200 acres of wetlands adjacent to Lake Elsinore.
8. Provided approximately 50,000 acre-feet of reclaimed water to stabilize the lake level.
9. Installed numerous Best Management Practices (BMPs) throughout the watershed.
10. Updated and calibrated the watershed runoff models.
11. Developed dynamic models for both lakes, to simulate and predict water quality.
12. Prepared and submitted a Comprehensive Nutrient Reduction Plan (CNRP), which was approved by Regional Board Resolution No. 2013-0044. (A similar nutrient reduction plan (AgNMP) has been submitted by the Agricultural stakeholders in April 2013. The Regional Board adopted a Conditional Waiver for Agricultural Discharges in the San Jacinto Watershed, Order No. R8-2016-0003, which requires the AgNMP to be updated based on current land use information.)
13. Sponsored more than a dozen public workshops and conferences to promote greater understanding and support for TMDL projects in the watershed.

LESJWA's request to revise the TMDL also includes a list of technical information and regulatory changes that they ask the Regional Board and staff to consider in revising the TMDL. New information and regulatory changes, which were not available when the TMDL was done in 2004 include:

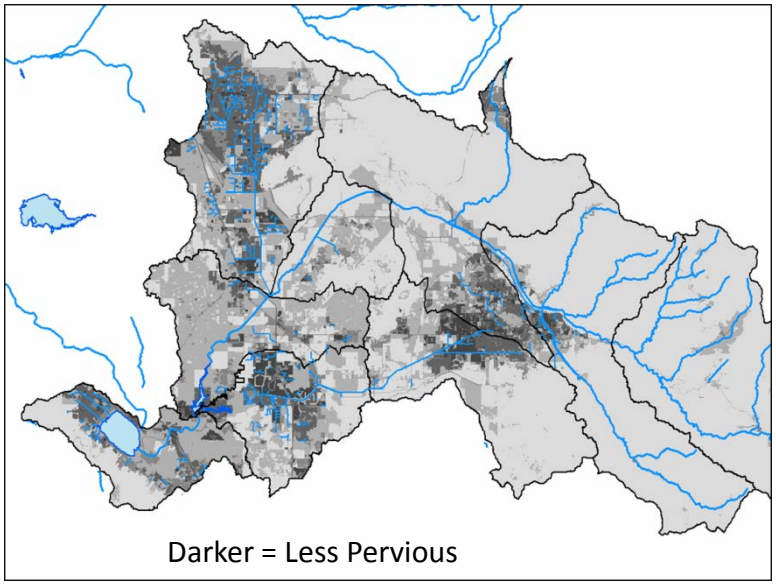
1. Subsidence and storage in Mystic Lake was significantly underestimated in the original TMDL.
2. Agricultural land use was significantly overestimated.
3. Nutrient decay cycles were significantly underestimated.
4. CAFO discharges were significantly overestimated.
5. Natural variations in precipitation were not characterized.
6. Natural salinity variations and the effects on algae production were not considered.
7. The effectiveness of the aeration and mixing system in Lake Elsinore was not known.
8. The original TMDL calculations assumed a static lake level (1240') for Lake Elsinore.
9. Mixing between the main Body and the east bay of Canyon Lake was overestimated.
10. New on site retention requirements for new development or redevelopment.
11. New SWRCB requirements for on-site wastewater treatment and disposal systems
12. Adoption of a Conditional Waiver for Agriculture Discharges, which does not apply to cumulative parcel ownership of less than 20 acres.
13. Deminimus Permit renewal
14. The CNRP and AgNMP were a condition of the original TMDL and have been completed and need to be updated and reconsidered.
15. New USEPA Criteria for ammonia.
16. SWRCB's policy for compliance schedules in NPDES permit.
17. Model Water Efficient landscape ordinance (AB 1881)

Canyon Lake Asymmetric Loading

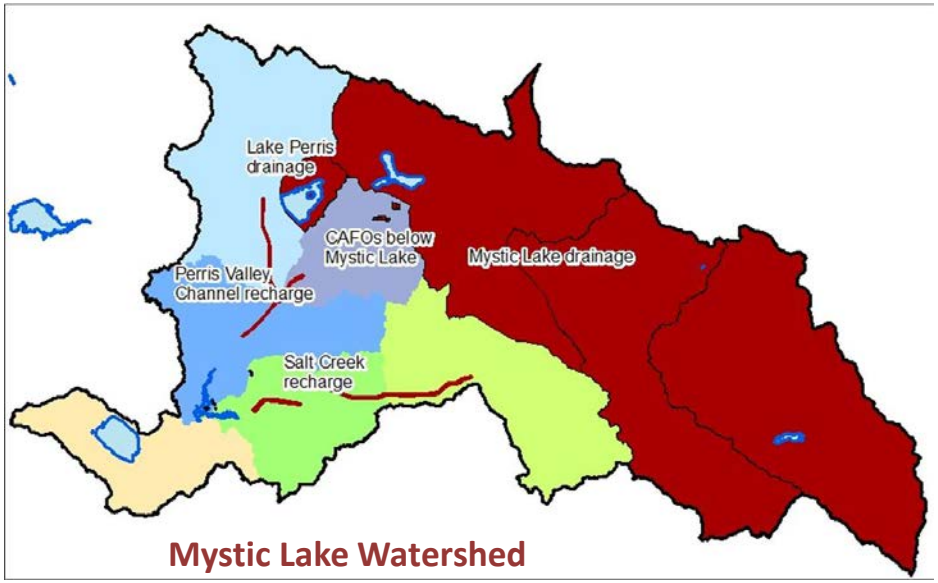




Mystic Lake



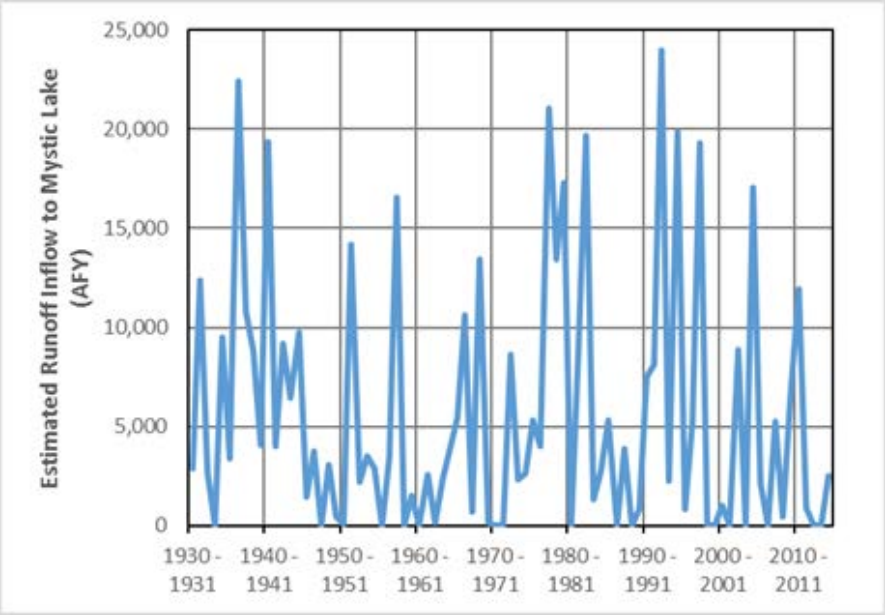
Darker = Less Pervious



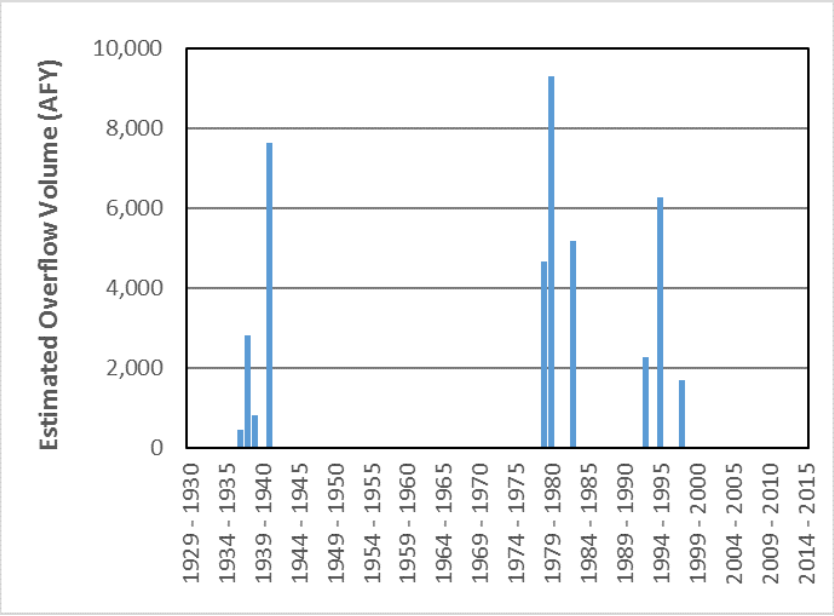
Mystic Lake Watershed

Mystic Lake

Inflow from San Jacinto River

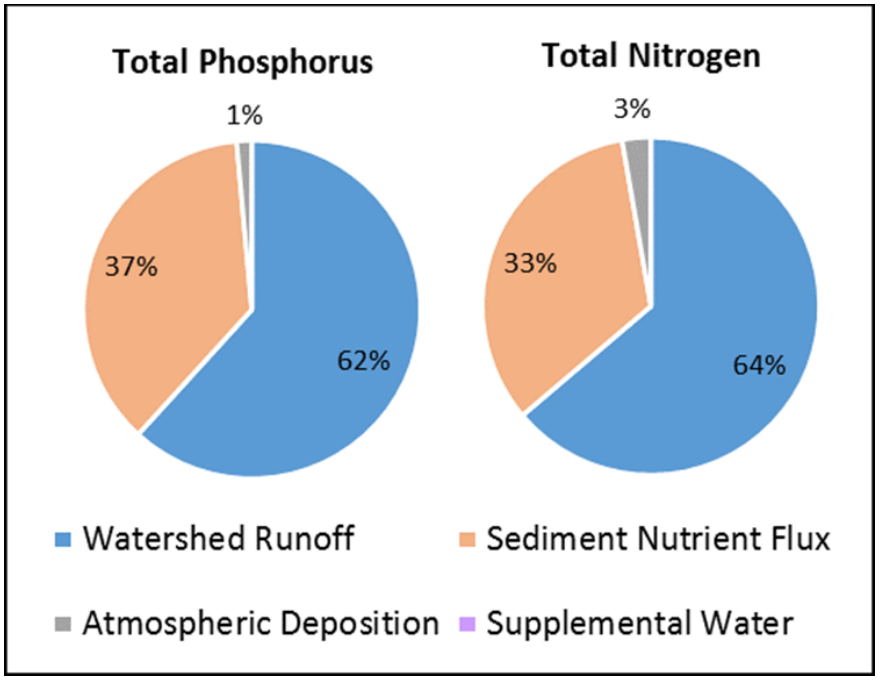


Outflow to Downstream Lakes

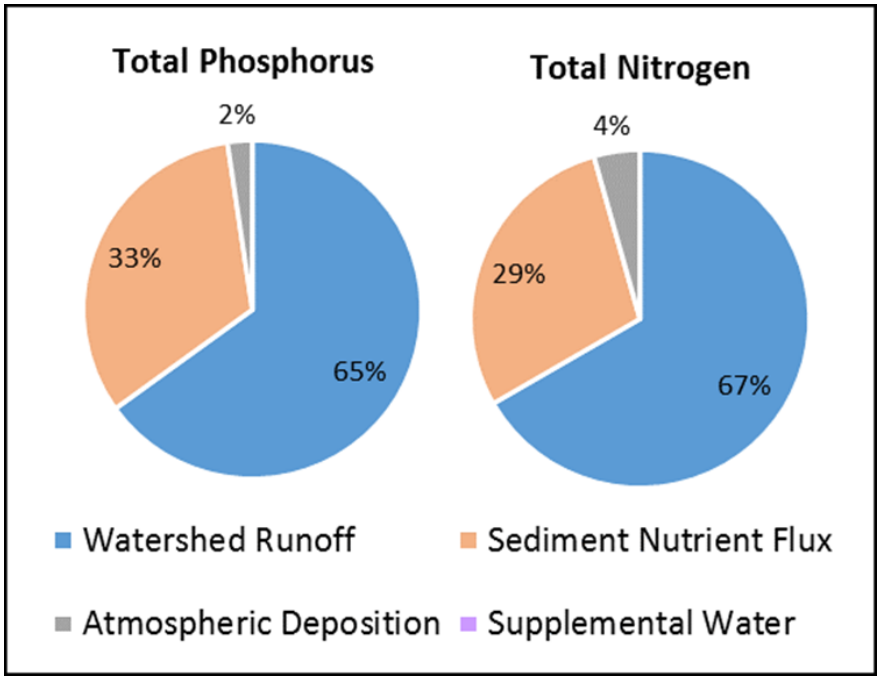


Canyon Lake Nutrient Loading

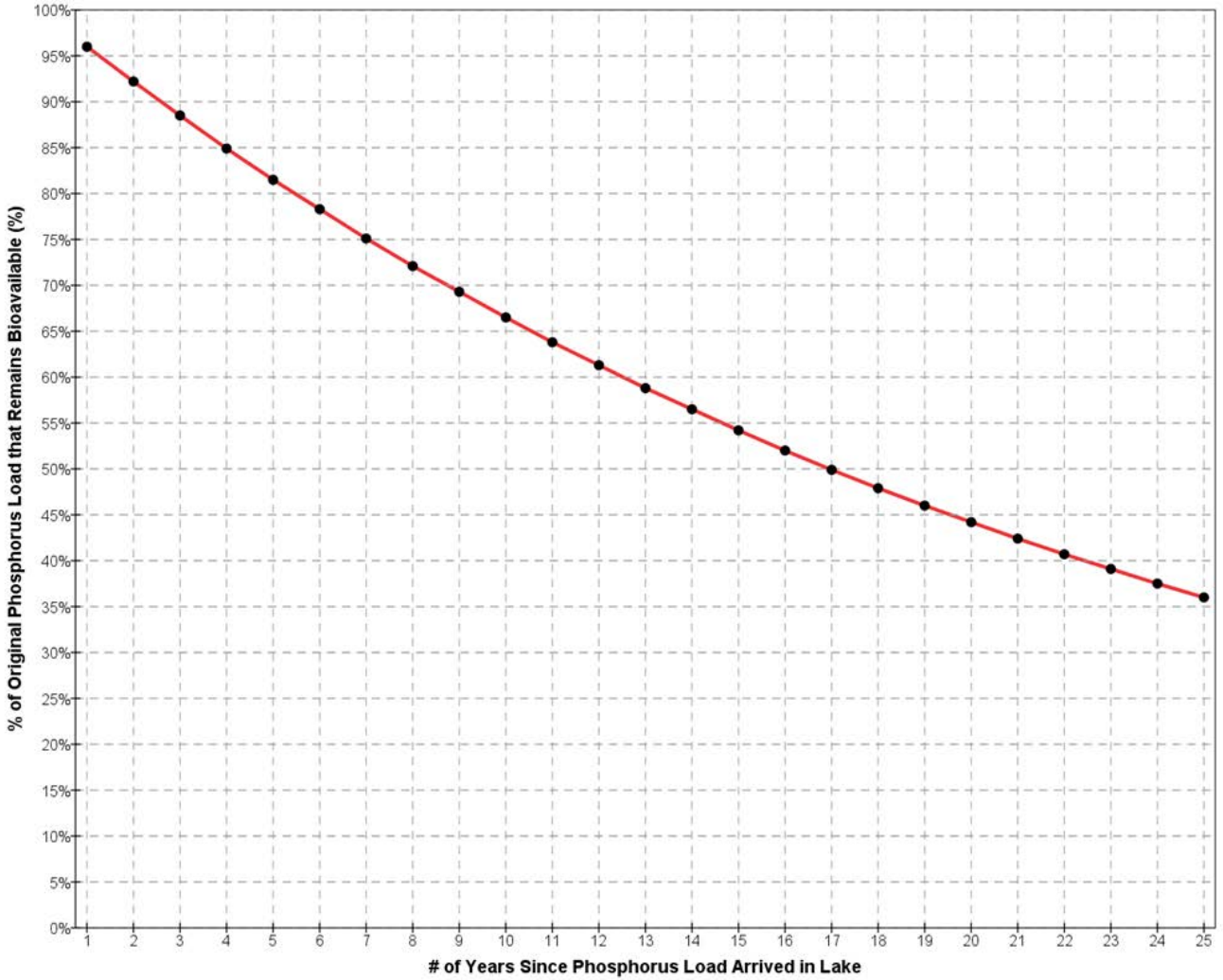
Main Body



East Bay



Phosphorus Decay Rate – 15 yr. Half Life

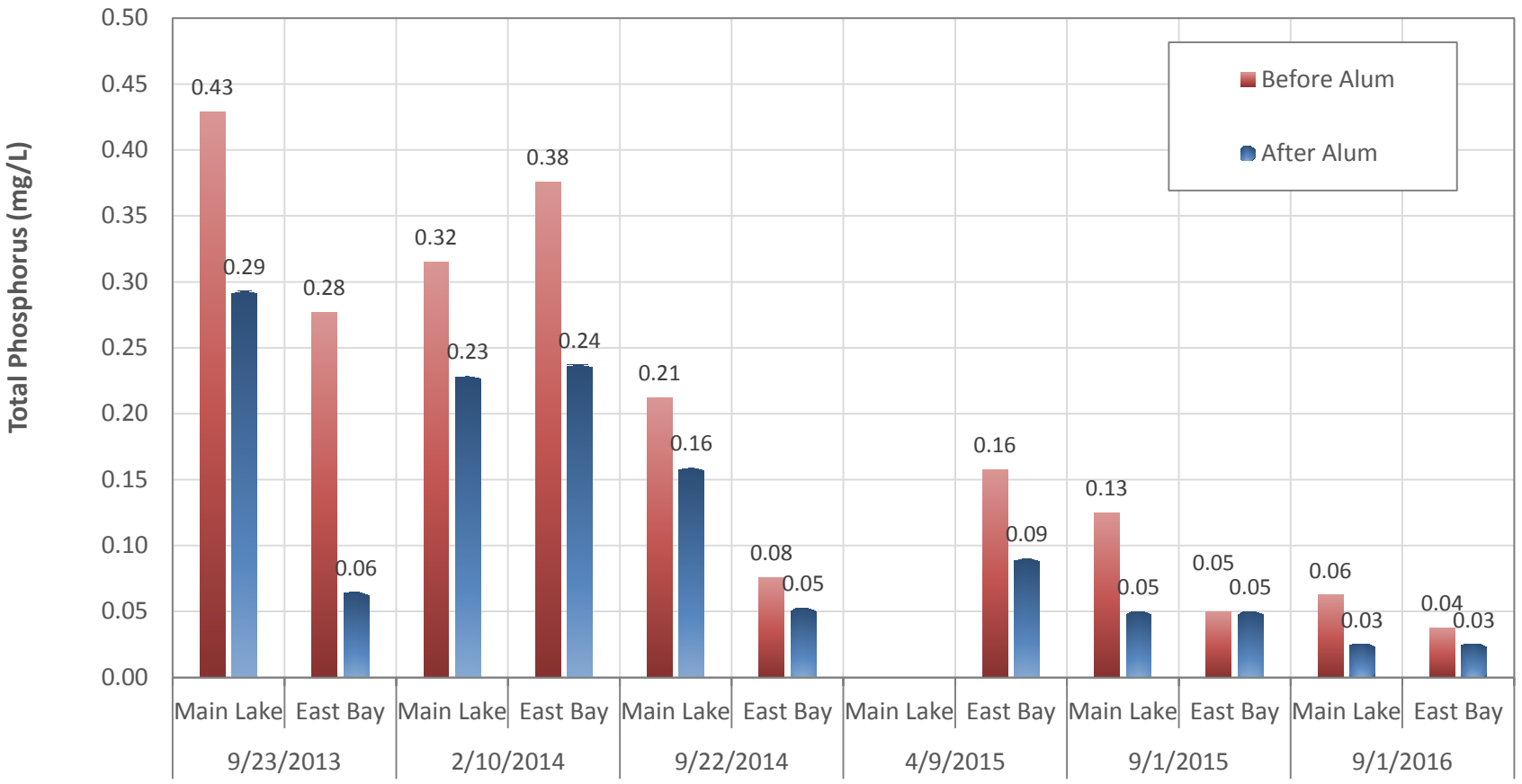


Watershed BMPs (2010 – 2015)

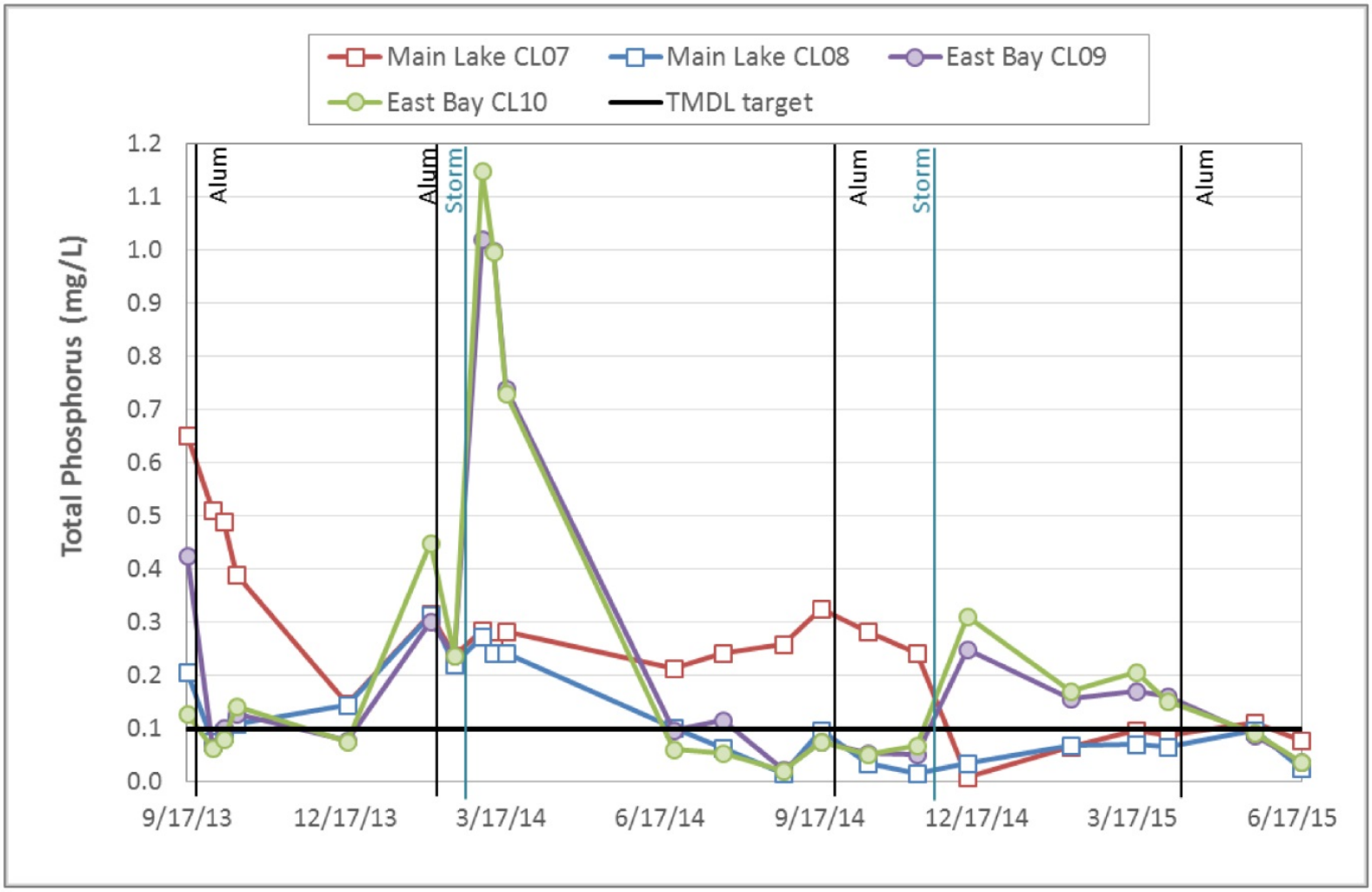
Nutrient	Mass Reduction	% of Existing Load
Phosphorus	559 kg/yr	34%
Nitrogen	3,827 kg/yr	30%

Best Management Practice	Effectiveness
Septic Systems Managed	2,140 systems
Stormwater Infiltration	949 acres treated
Extended Detention	4,163 acres treated
Hydrodynamic Separator	1,058 acres treated
Vegetated Swale	288 acres treated
Media Filters	458 acres treated
Street Sweeping	16,168 metric tons collected
Debris in MS4 Facilities	758 metric tons removed

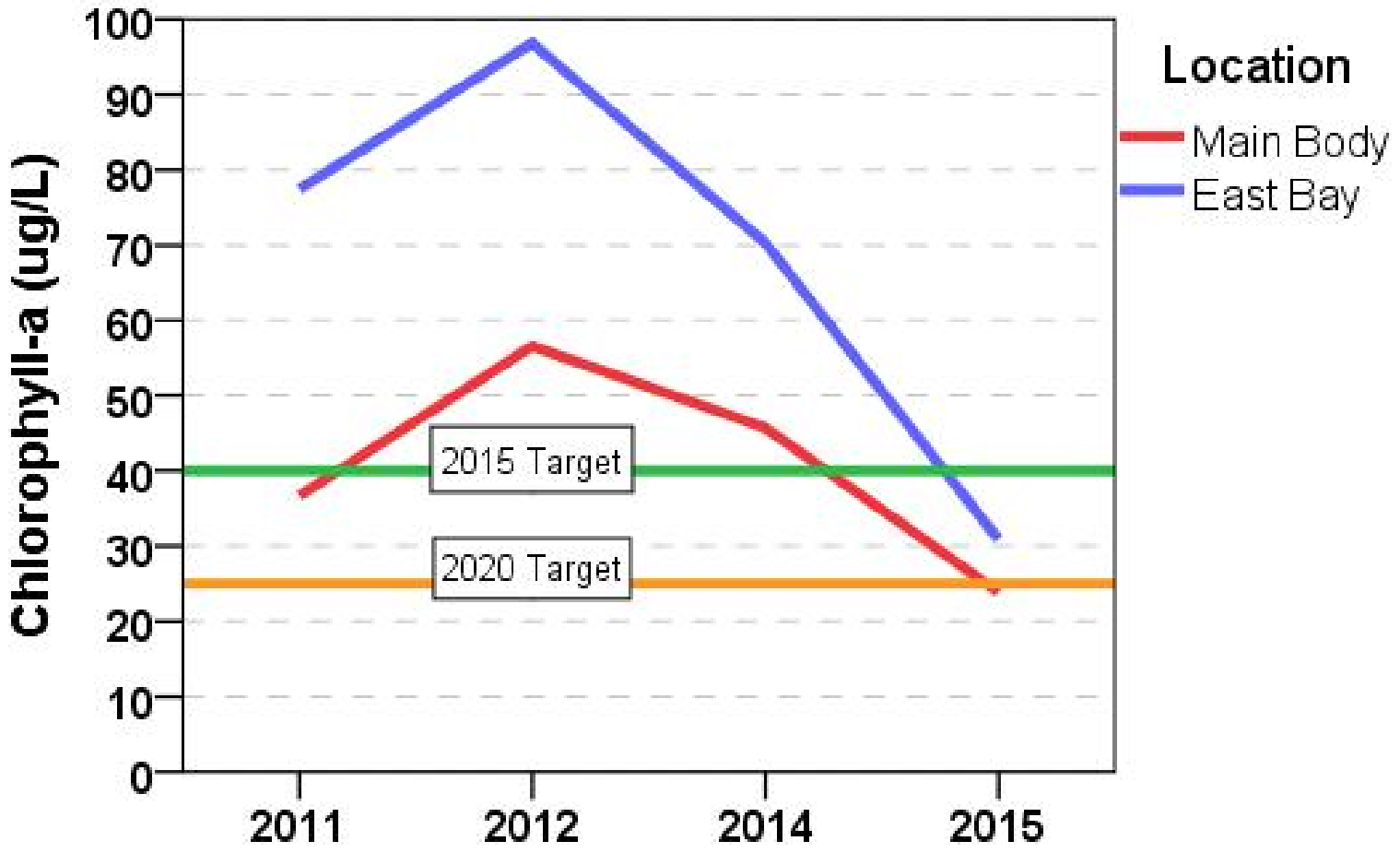
Canyon Lake Alum Applications



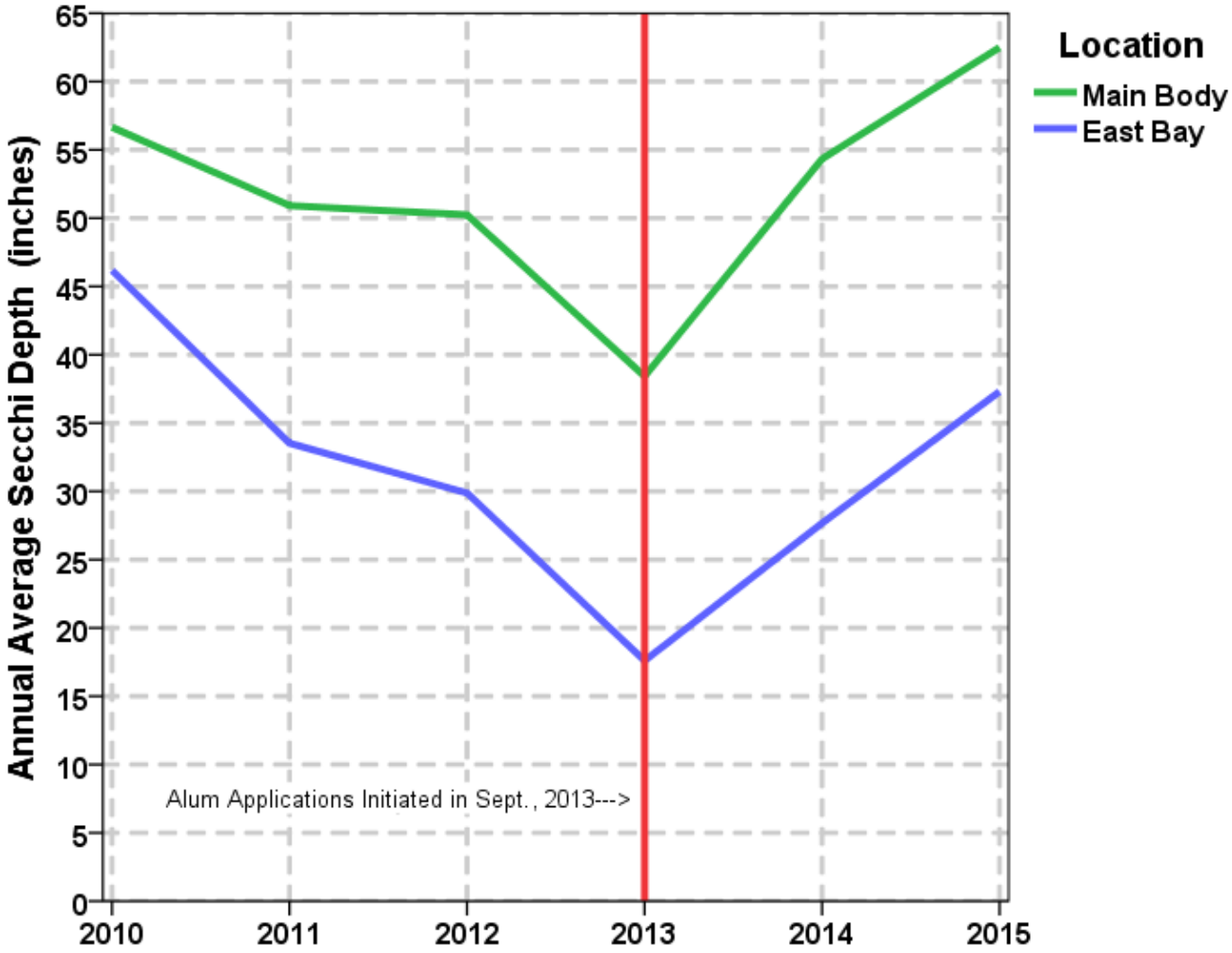
Canyon Lake Phosphorus Trend



Canyon Lake Algae Trend



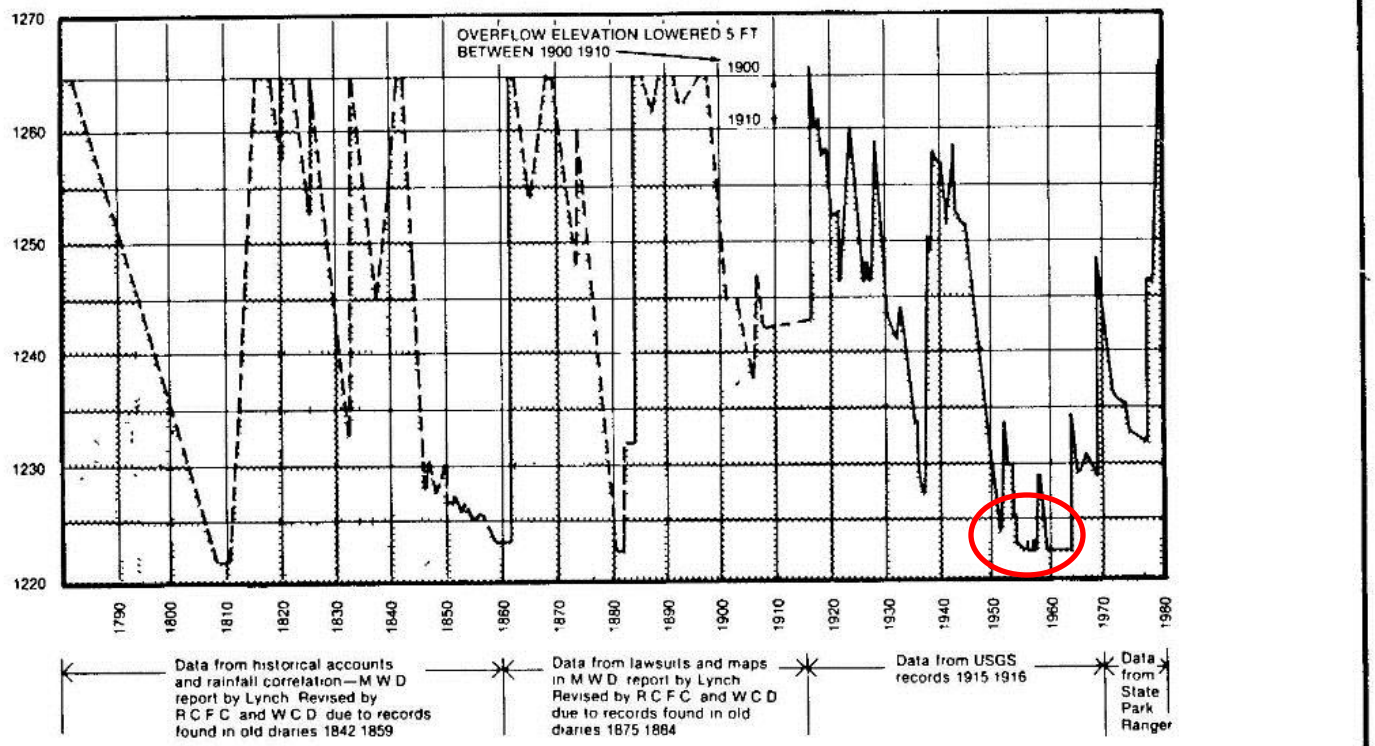
Canyon Lake Clarity Trend



Canyon Lake

- 457,000 acre watershed draining to a 436 acre lake
- Extremely asymmetric runoff hydrology
- 33% of nutrient loads from lake bottom sediments
- Watershed BMPs have reduced external loads by 32%
- Alum applications have reduced internal loads by 35%
- Avg. phosphorus concentrations meet TMDL target for 2020
- Avg. chlorophyll-a concentrations meet TMDL target for 2020
- Water clarity improved by about 20” (50-100% increase)
- Local residents: *“best water quality in 40 years”*

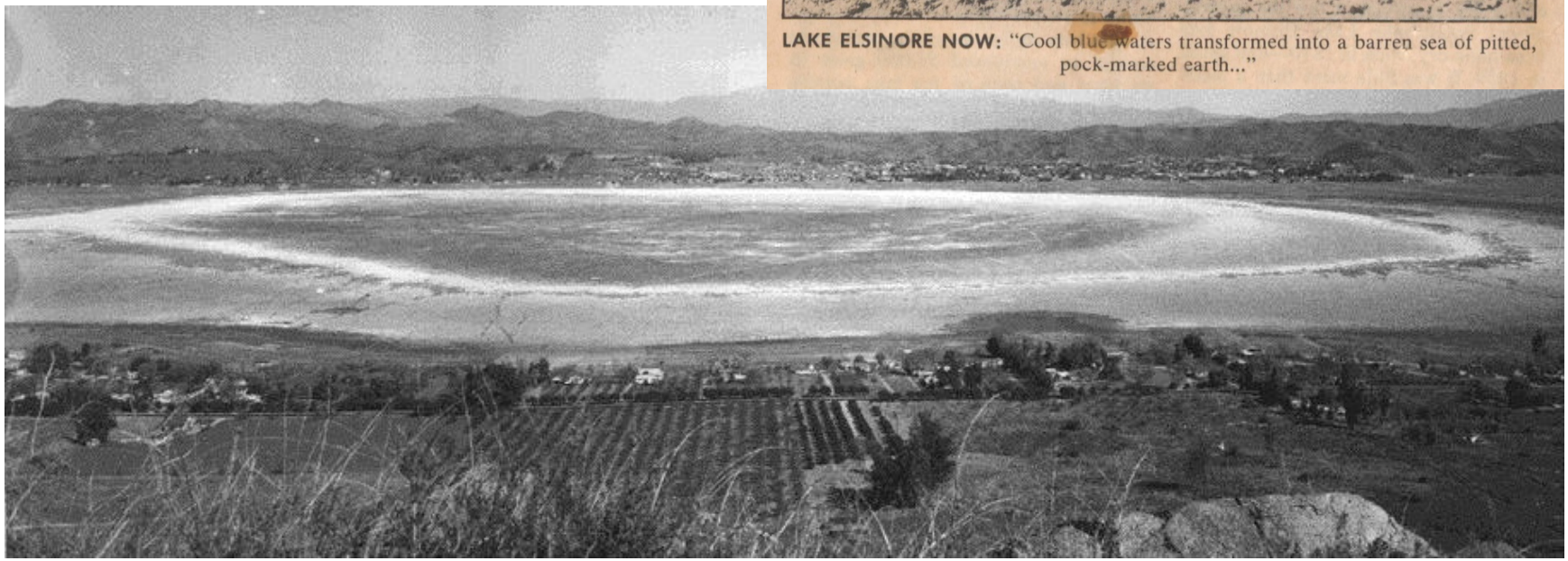
Lake Elsinore: 1770-1980



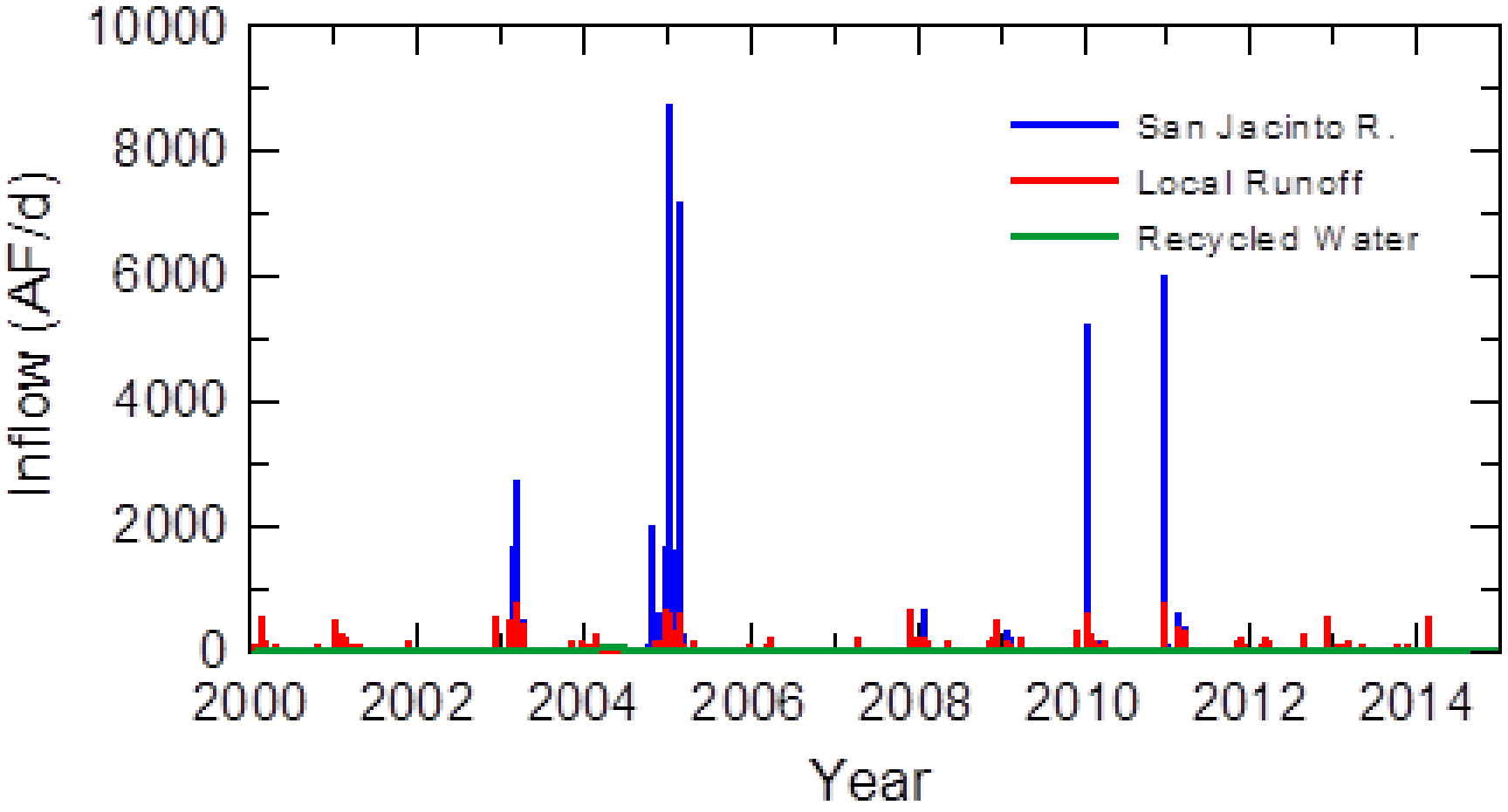
Lake Elsinore

1950 - 1964

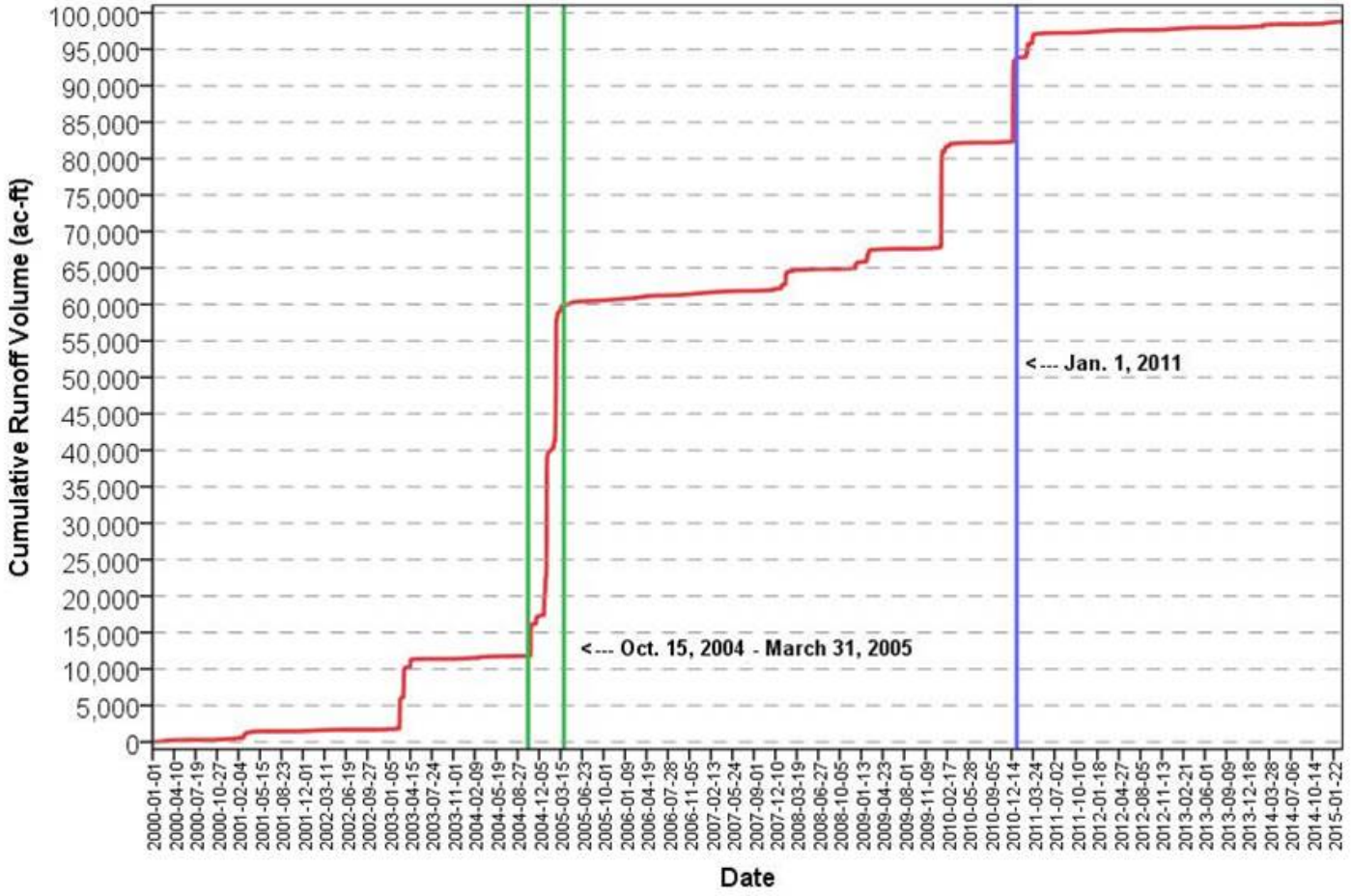
LAKE ELSINORE NOW: "Cool blue waters transformed into a barren sea of pitted, pock-marked earth..."



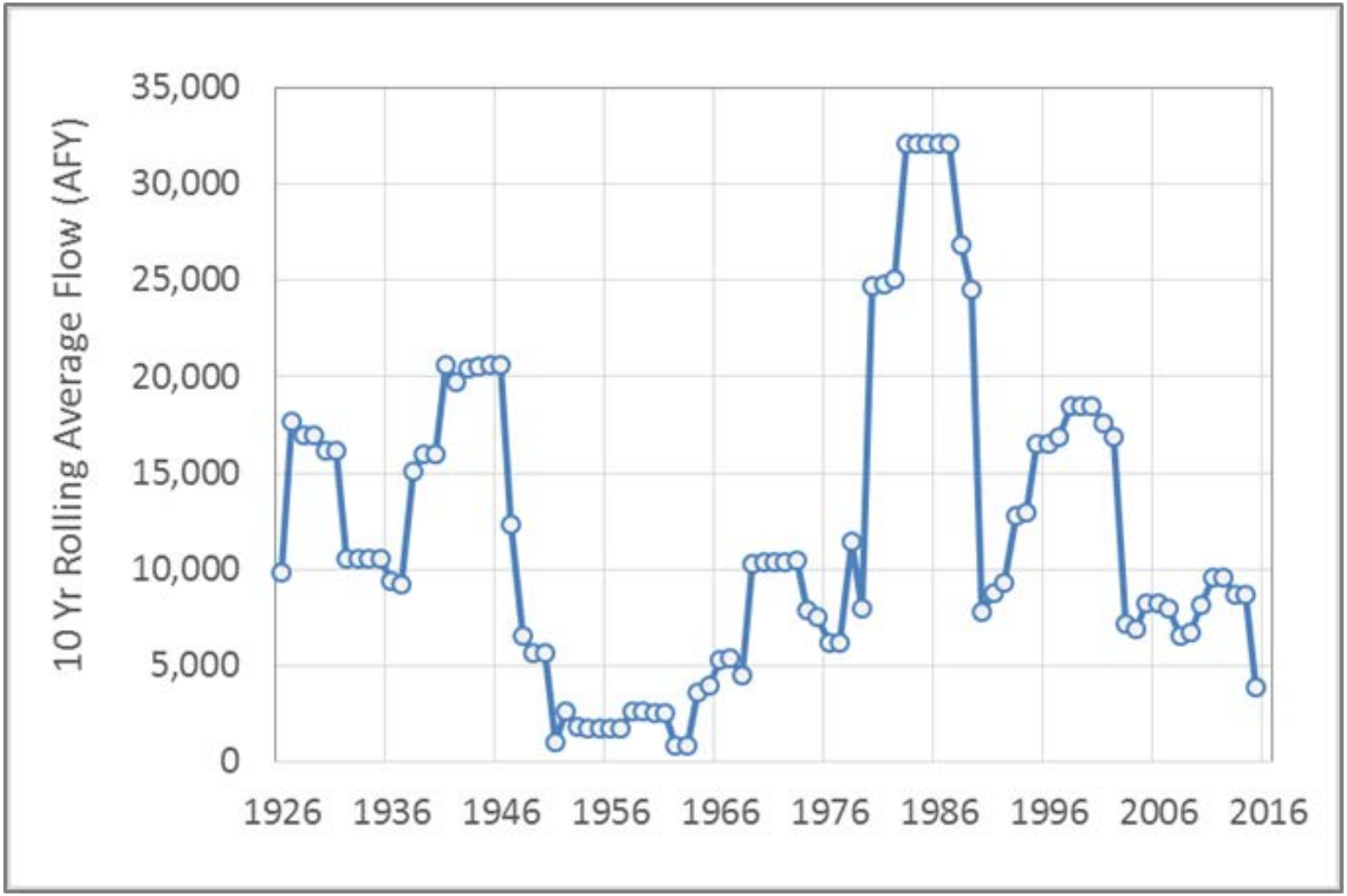
Runoff to Lk. Elsinore (2000-2014)



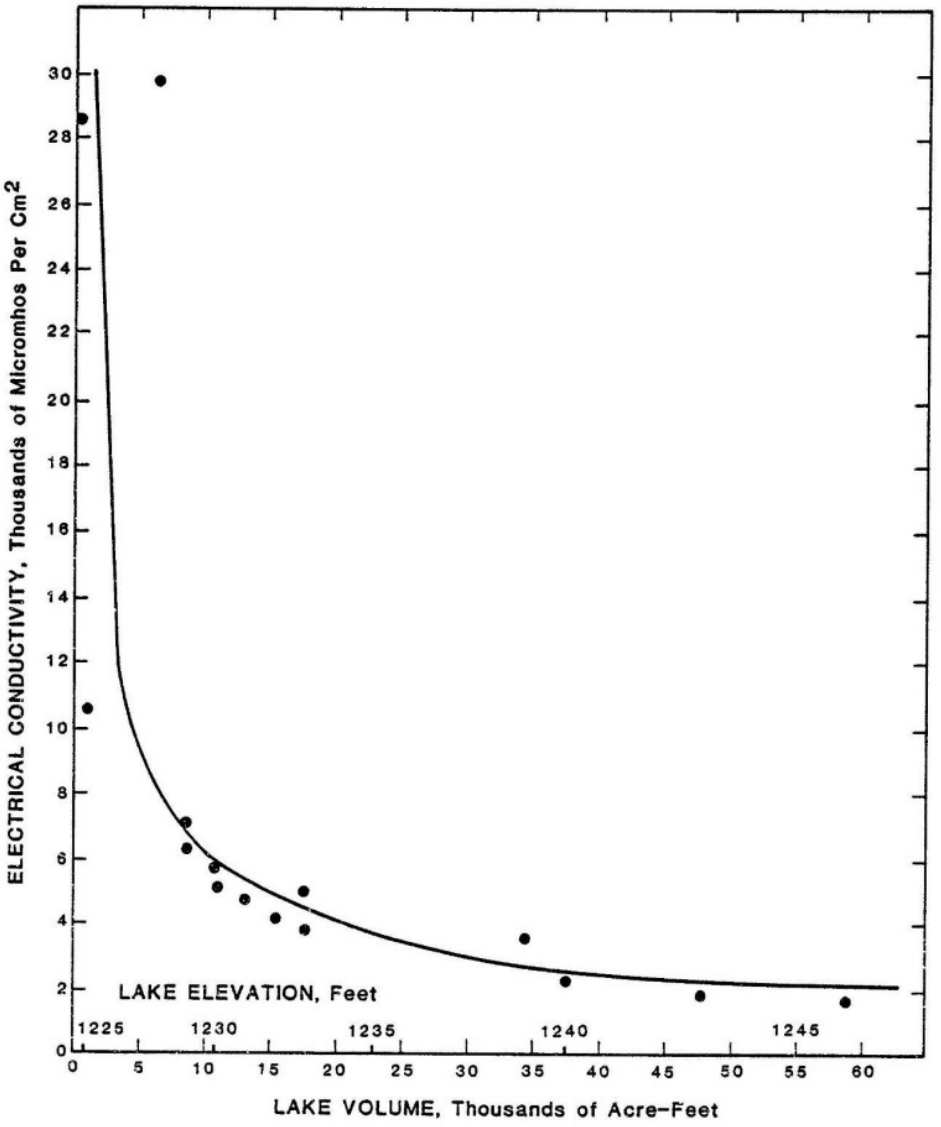
Runoff to Lk. Elsinore (2000-2014)



Runoff to Lk. Elsinore (1926–2016)

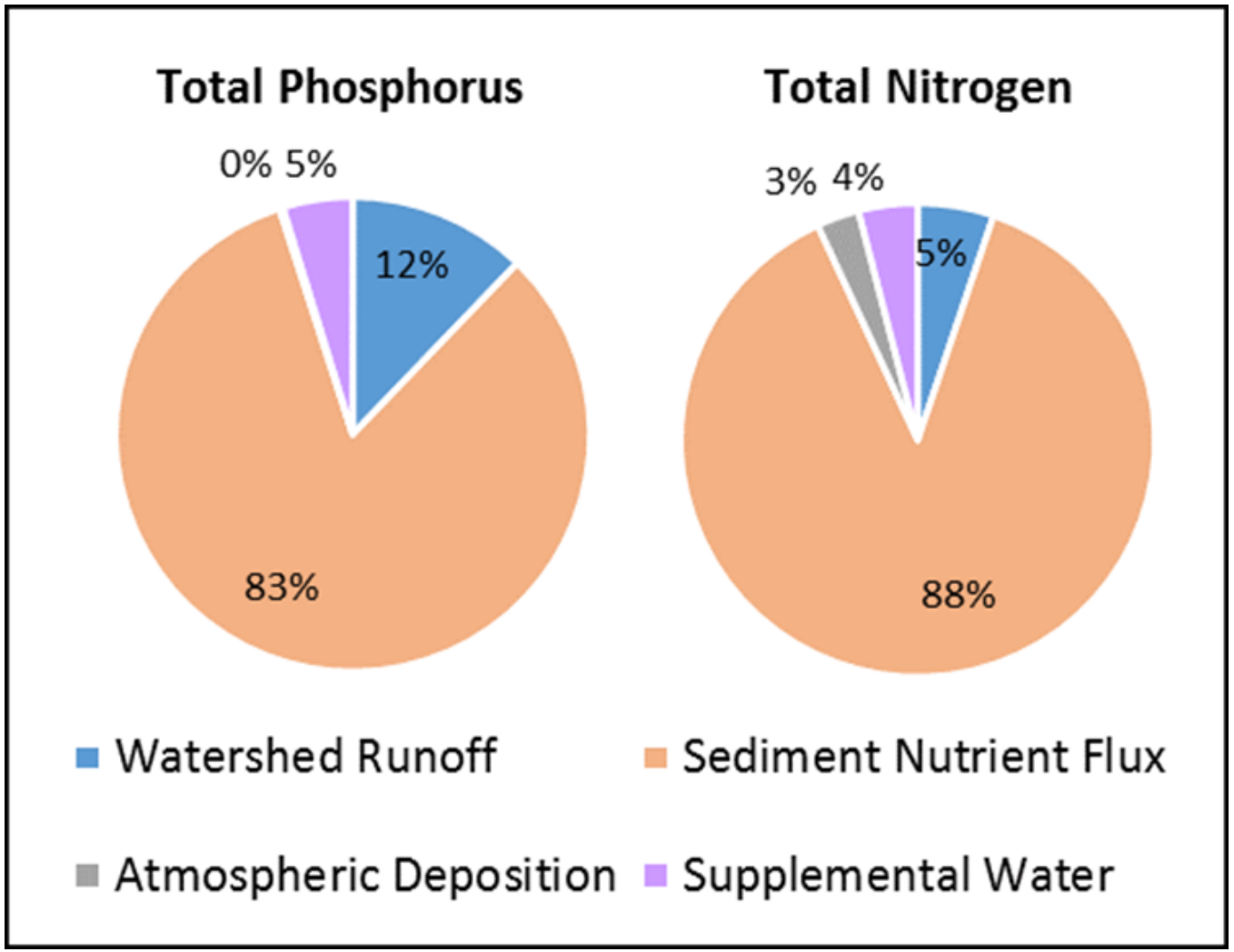


WATER CONDUCTIVITY AS A FUNCTION OF LAKE VOLUME AND LAKE LEVEL

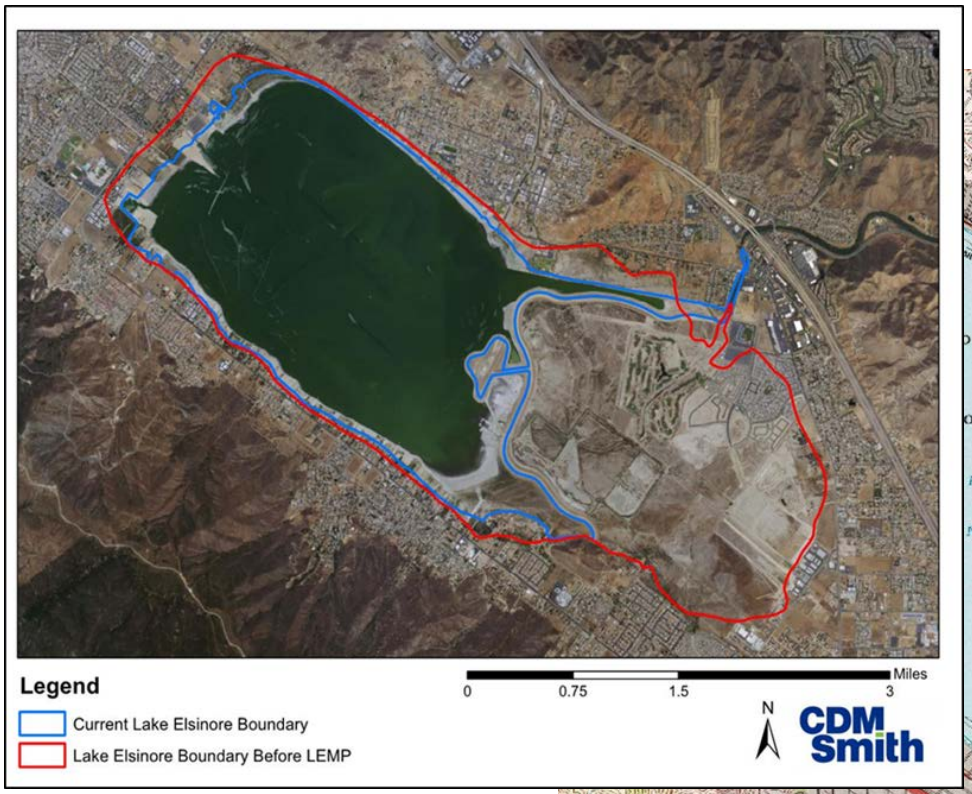


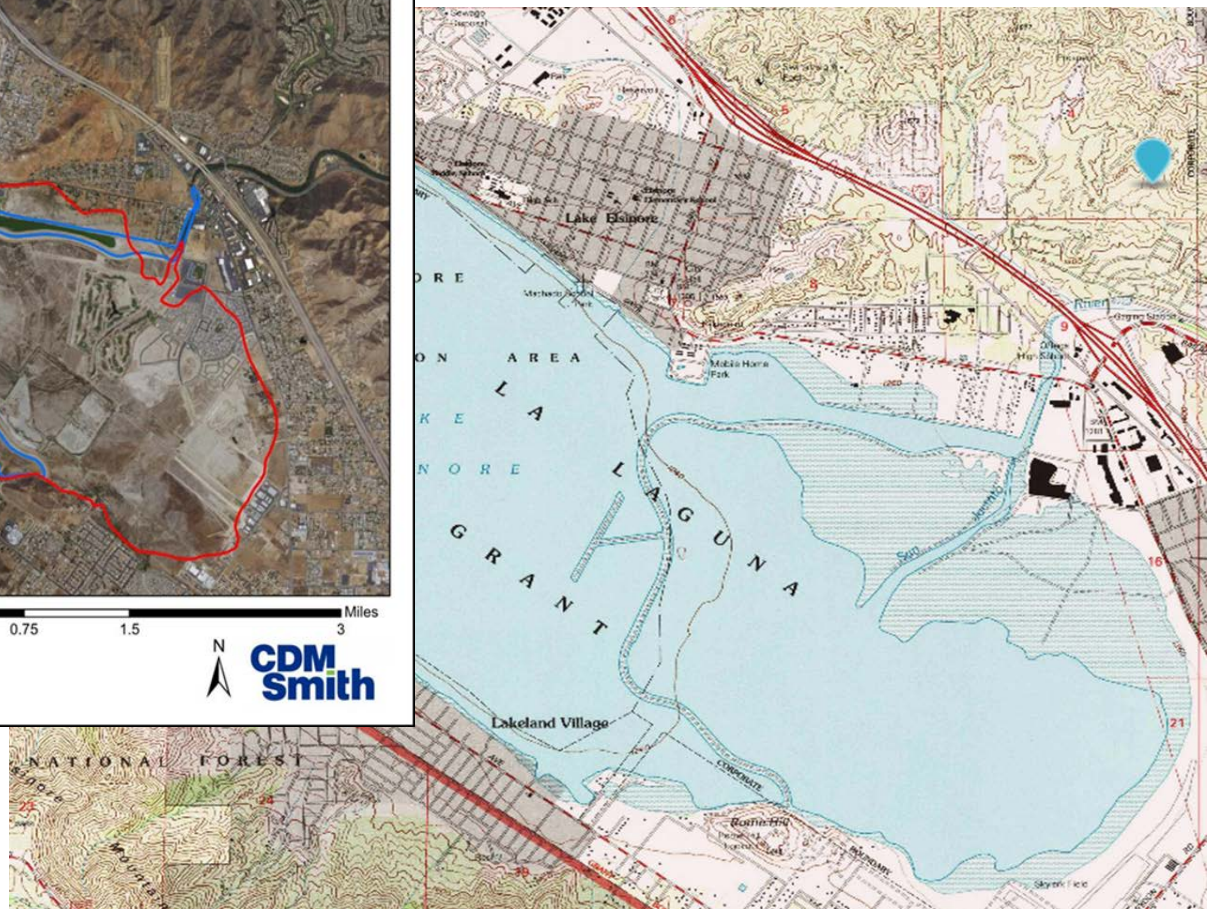
SOURCE OF DATA: FILES REGIONAL WATER QUALITY CONTROL BOARD (SANTA ANA)

Nutrient Loads to Lake Elsinore



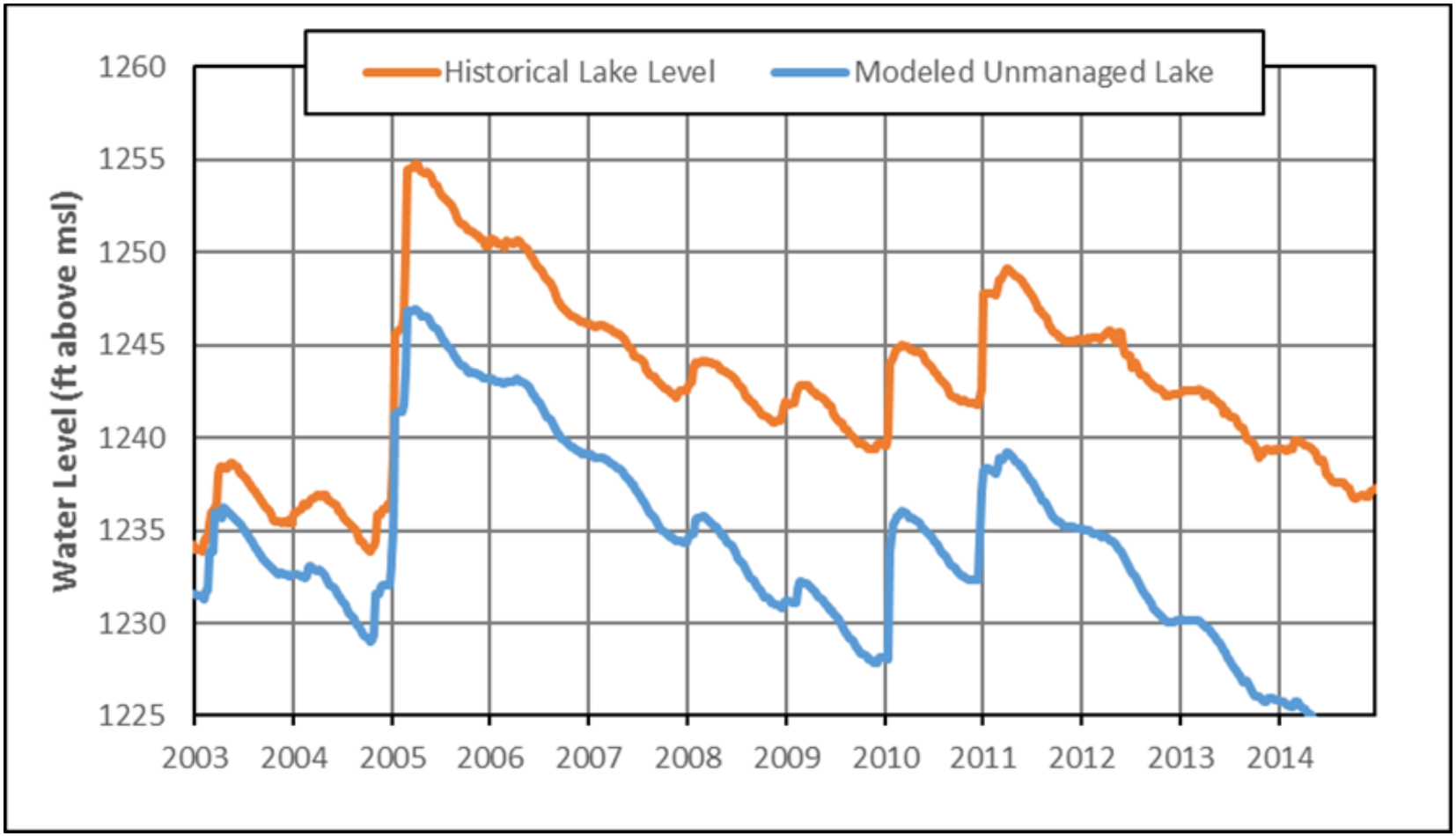
Lake Elsinore Levee Project (1996)



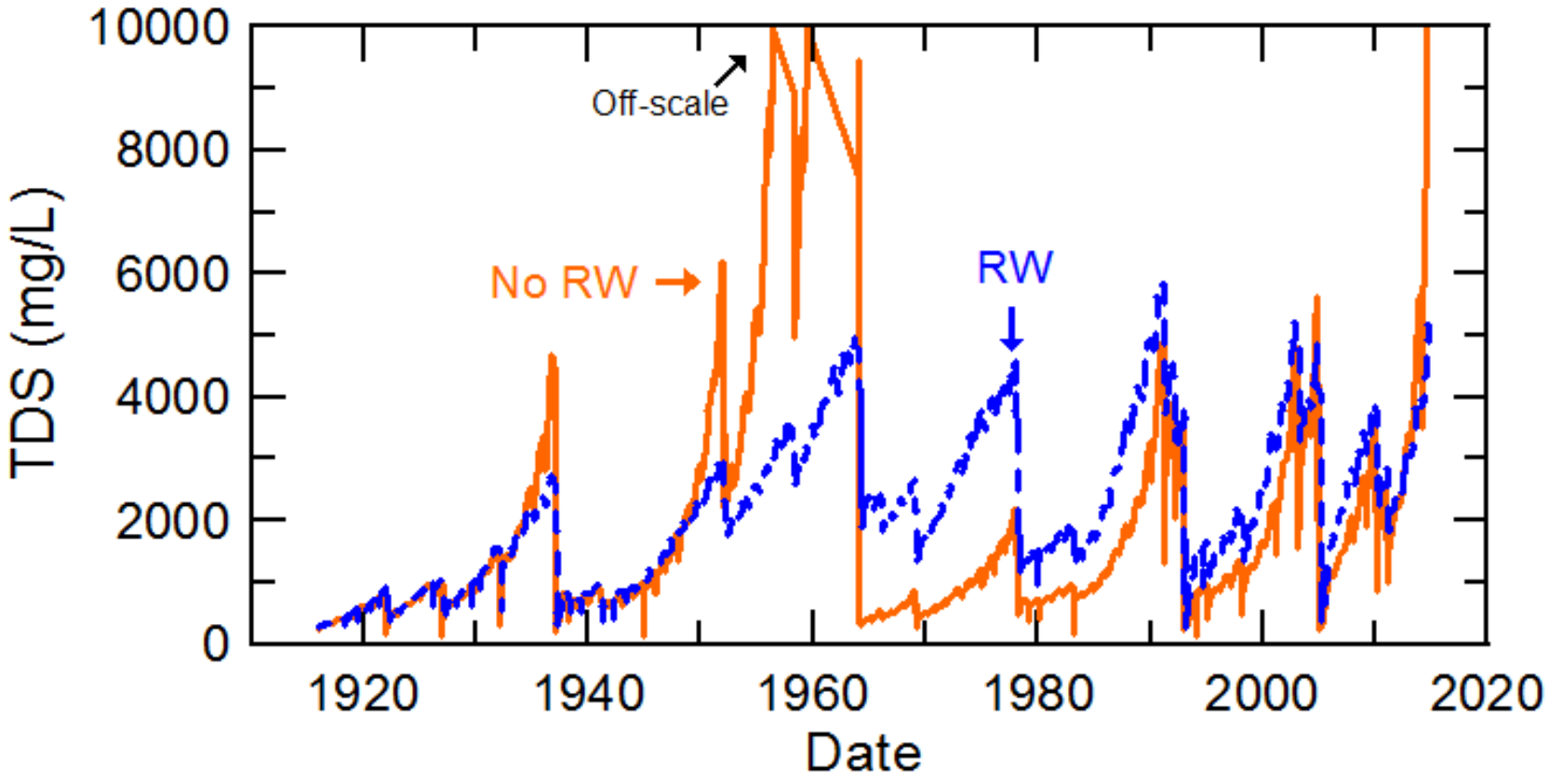


Reduce total lake area by 50% (from 6,000 acres to 3,000 acres)

Recycled Water in Lake Elsinore



TDS w/ & w/o Recycled Water



TDS w/ & w/o Recycled Water

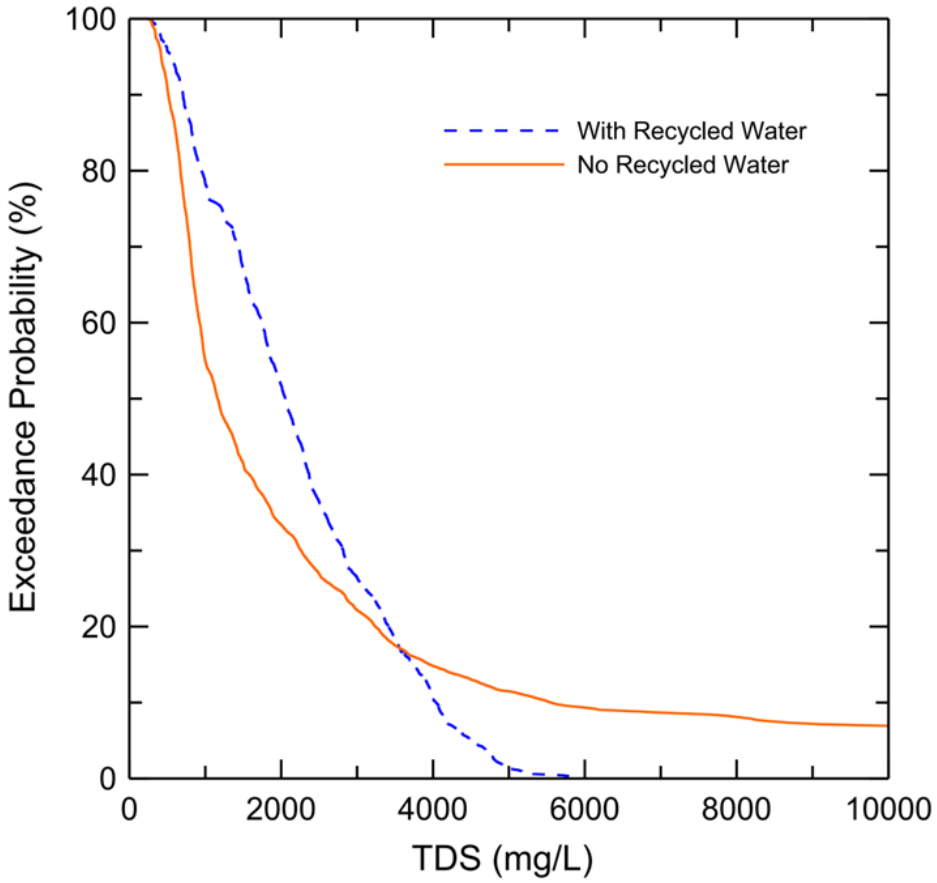
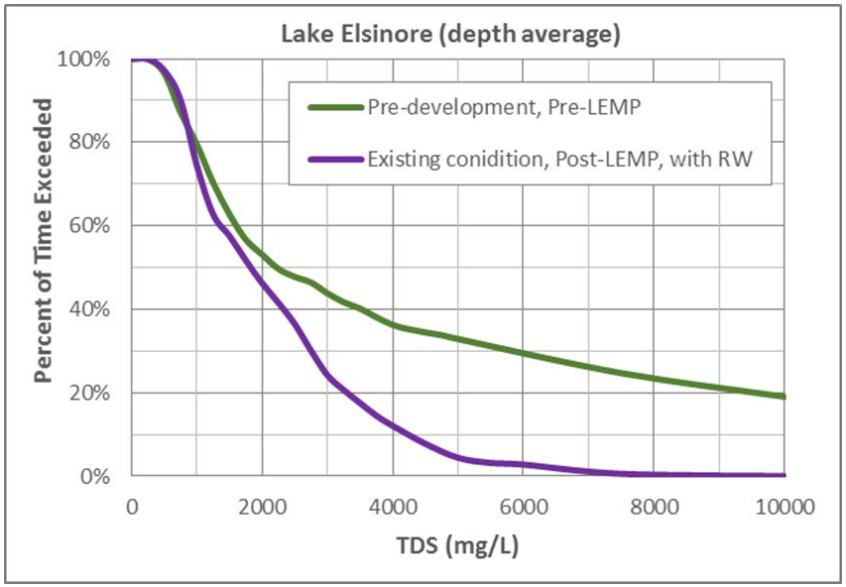
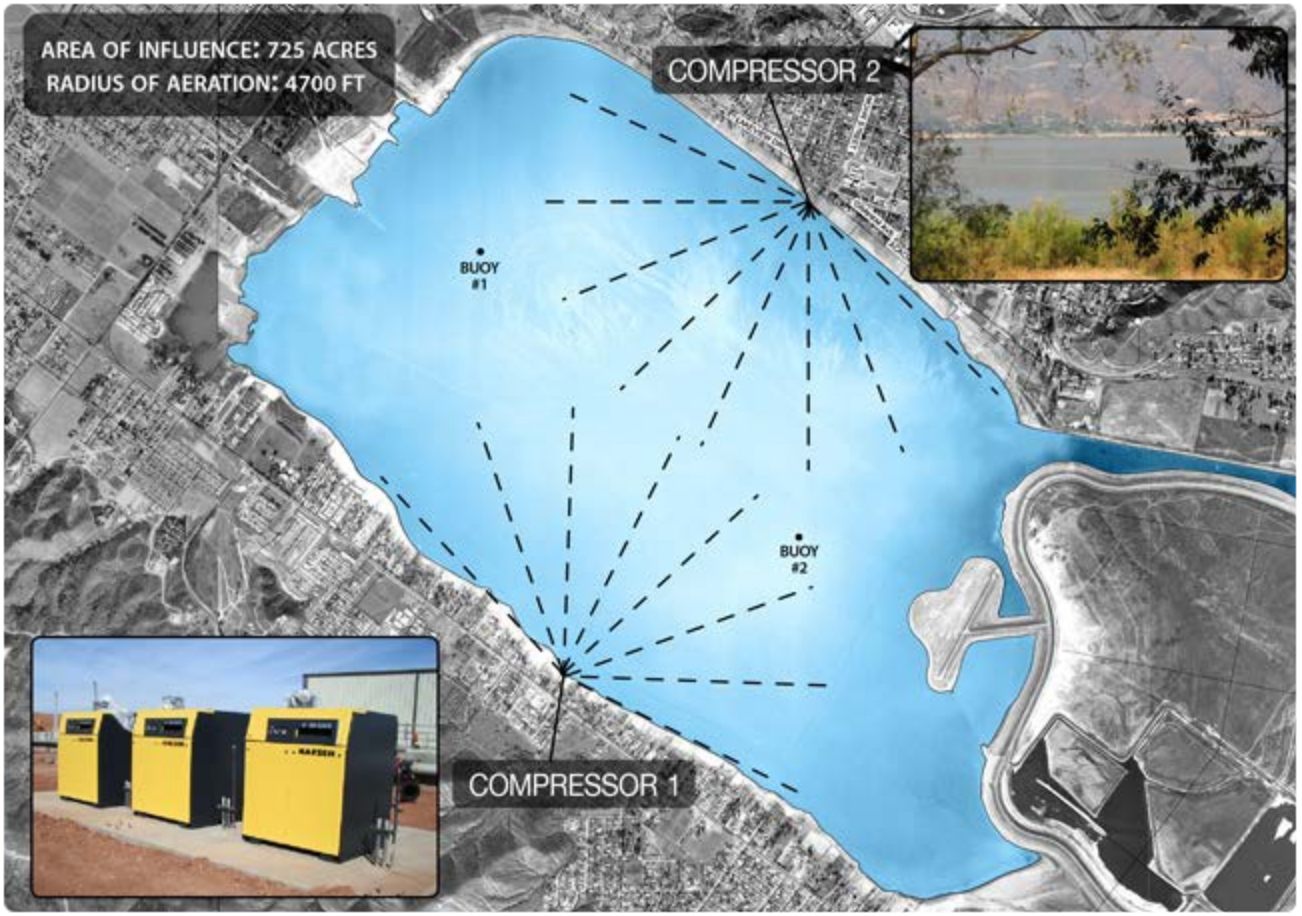


Fig. 6. Cumulative distribution function showing exceedance probability for TDS concentrations for the LEMP basin with natural flows (solid orange line) and inflows supplemented with recycled water (dashed blue line).

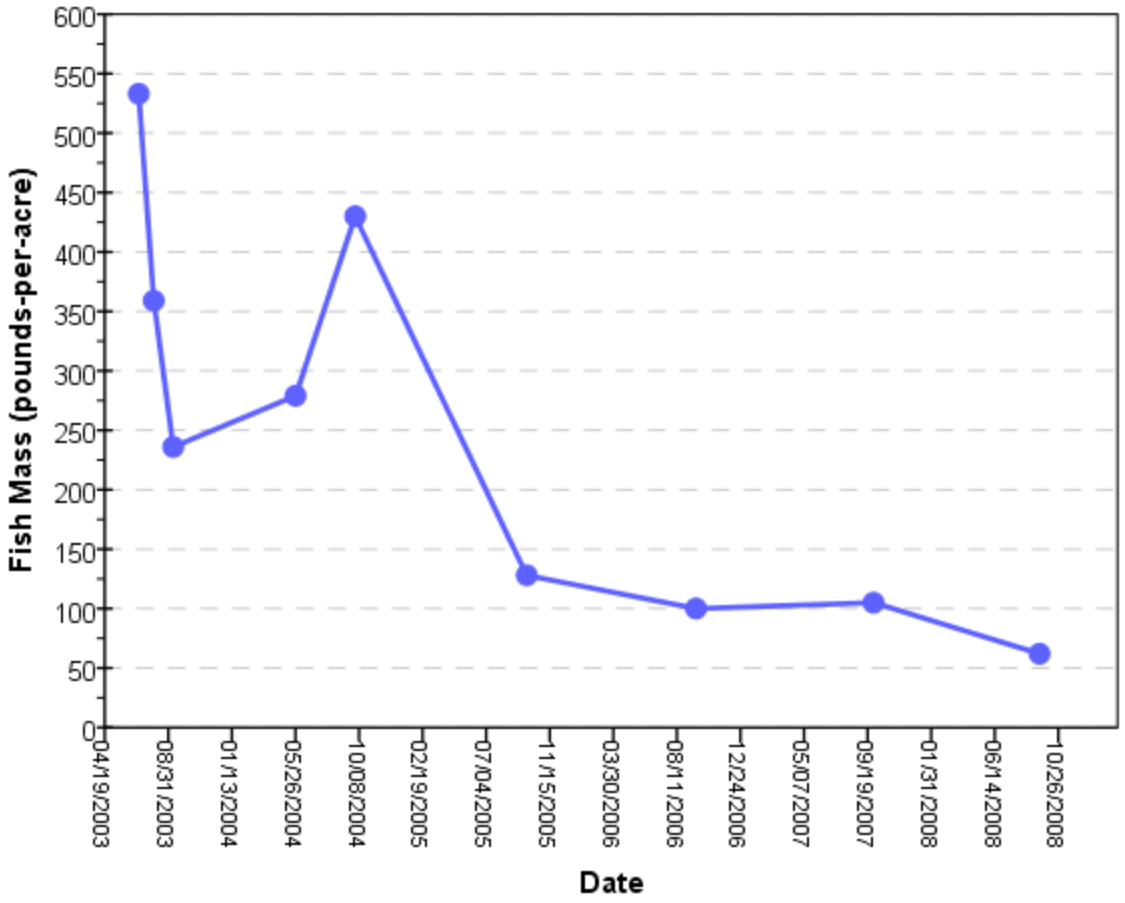

Lake Elsinore (depth average)
Percent of Time Exceeded
100%
80%
60%
40%
20%
0%
0
2000
4000
6000
8000
10000
TDS (mg/L)
Pre-development, Pre-LEMP
Existing conidition, Post-LEMP, with RW

Lk. Elsinore Aeration & Mixing System

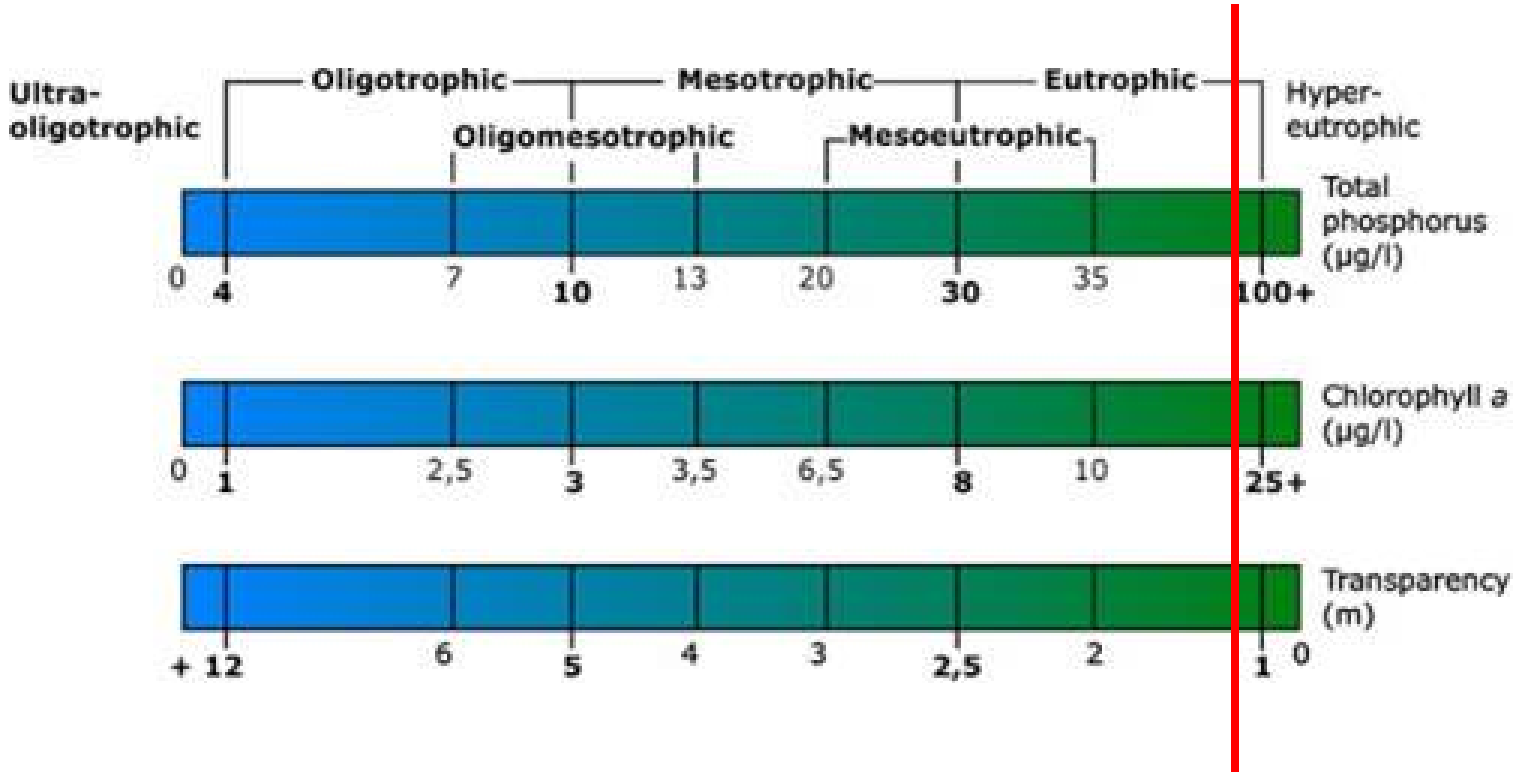


35% Reduction in Internal Phosphorus Loads from Lake Bottom Sediments

Carp Control in Lake Elsinore

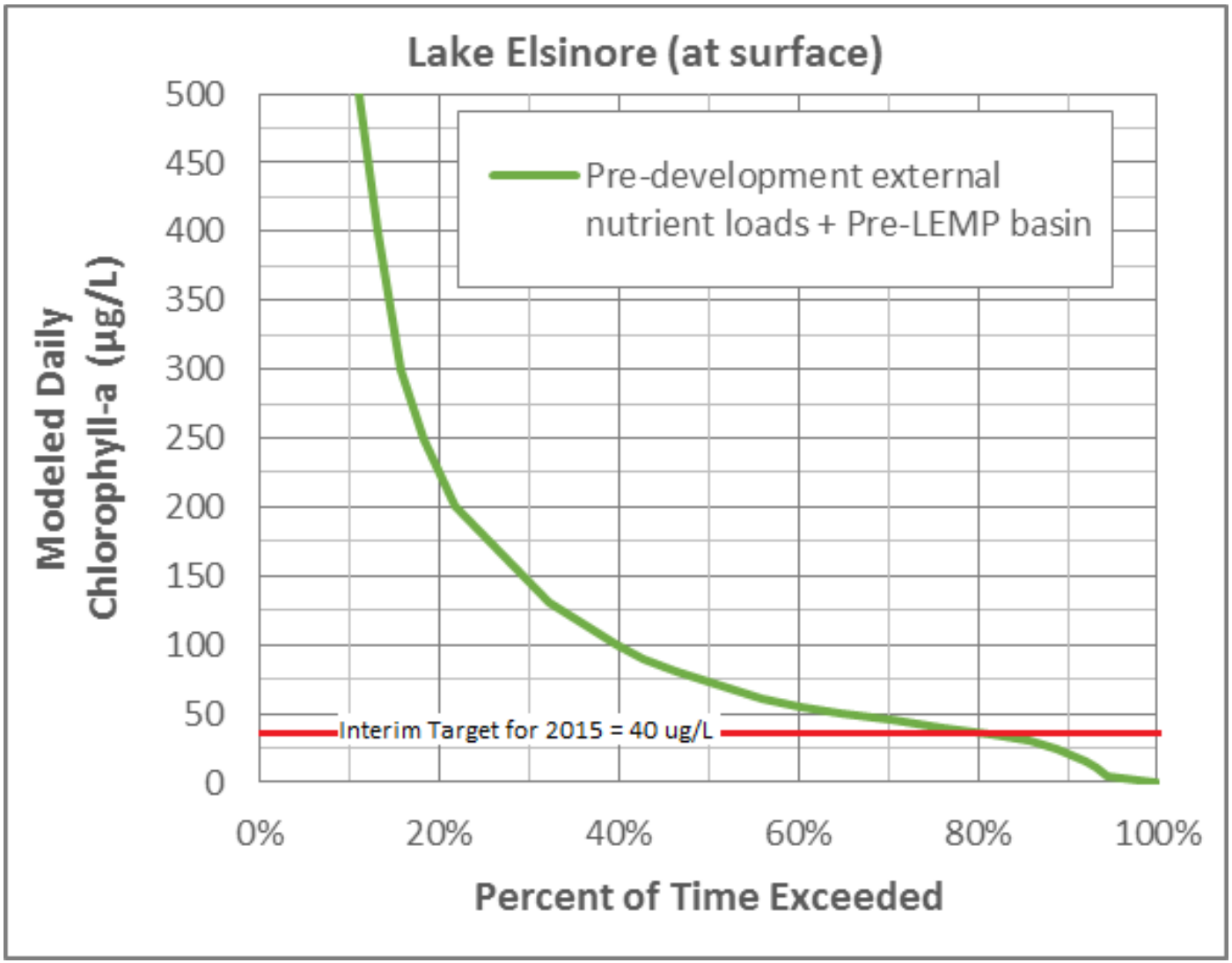


7% of Internal Nutrient Load Caused by Carp Bioturbation of Sediment

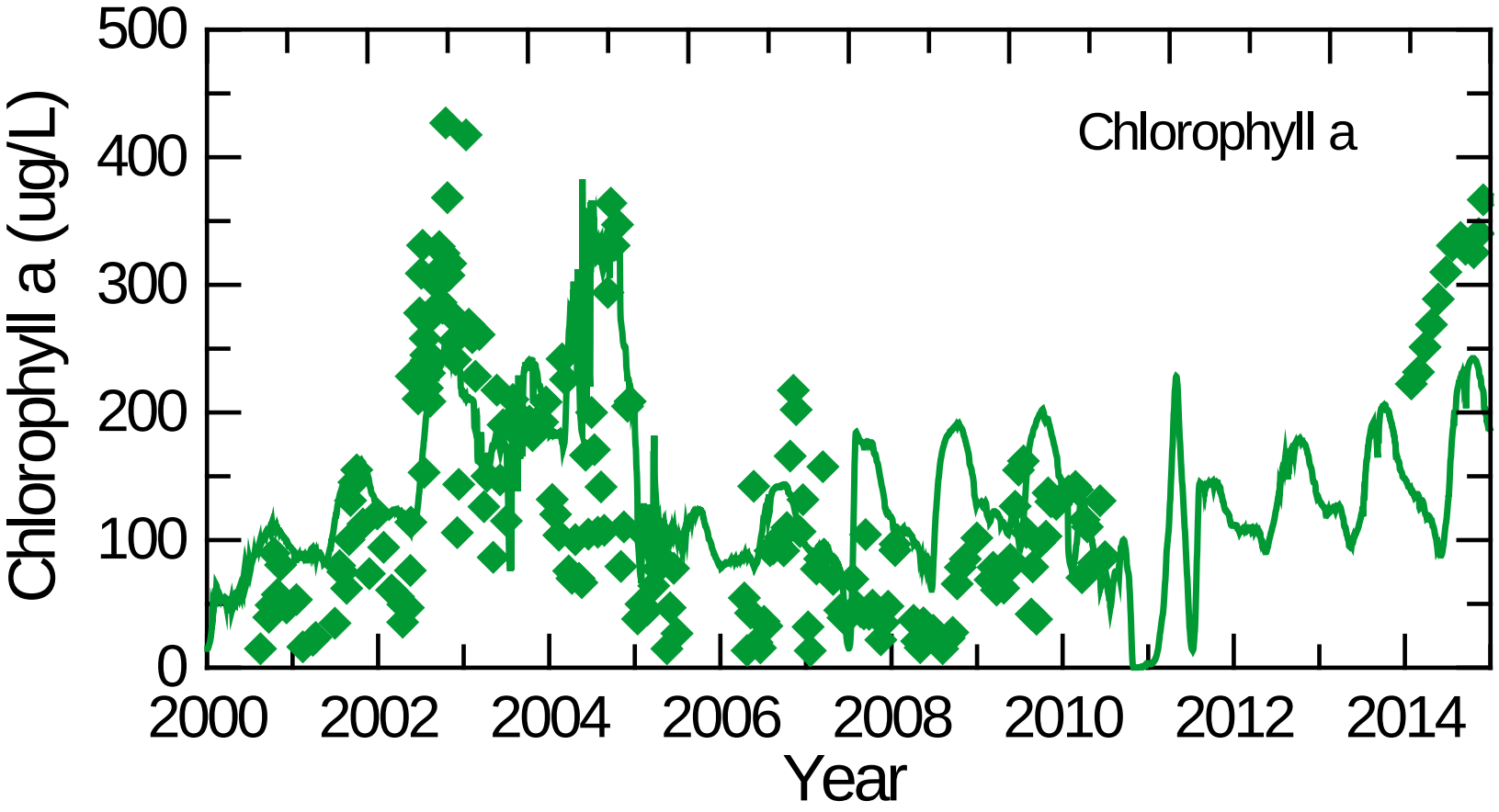


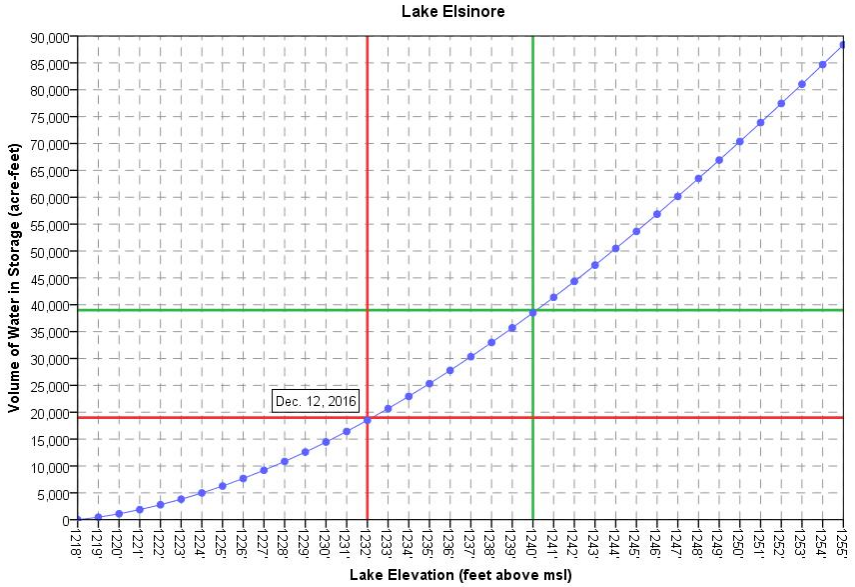
Trophic classification based on chlorophyll a, water clarity measurements, and total phosphorous values			
Trophic class	**Total phosphorous (µg/L)**	**Chlorophyl a (µg/L)**	**Clarity (m)**
Oligotrophic	**0 - 12**	**0 – 2.6**	**>8 - 4**
Mesotrophic	**12 - 24**	**2.6 - 20**	**4 - 2**
Eutrophic	**24 - 96**	**20 - 56**	**2 – 0.5**
Hypereutrophic	**96 – 384+**	**56 – 155+**	**0.5 - <0.25**

Lk. Elsinore Natural Reference Condition

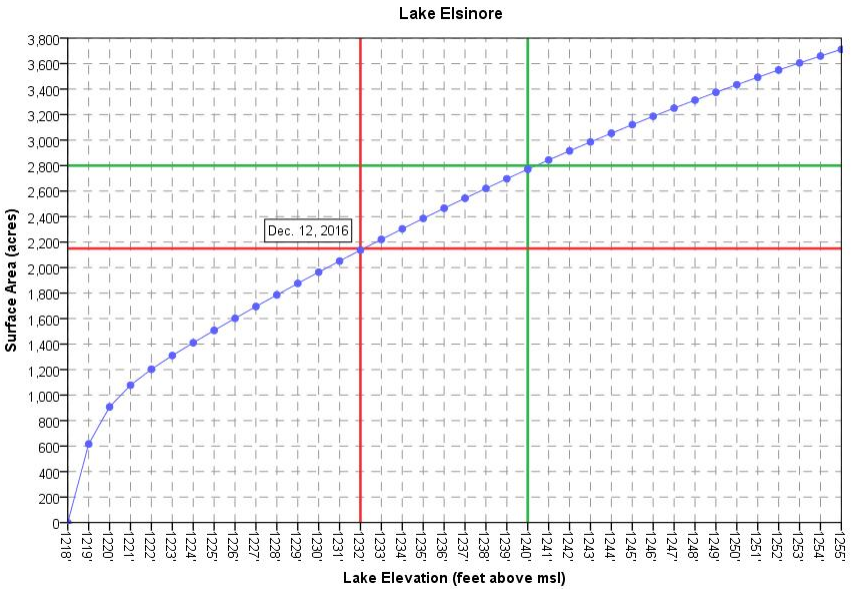


Algae Trends in Lk. Elsinore

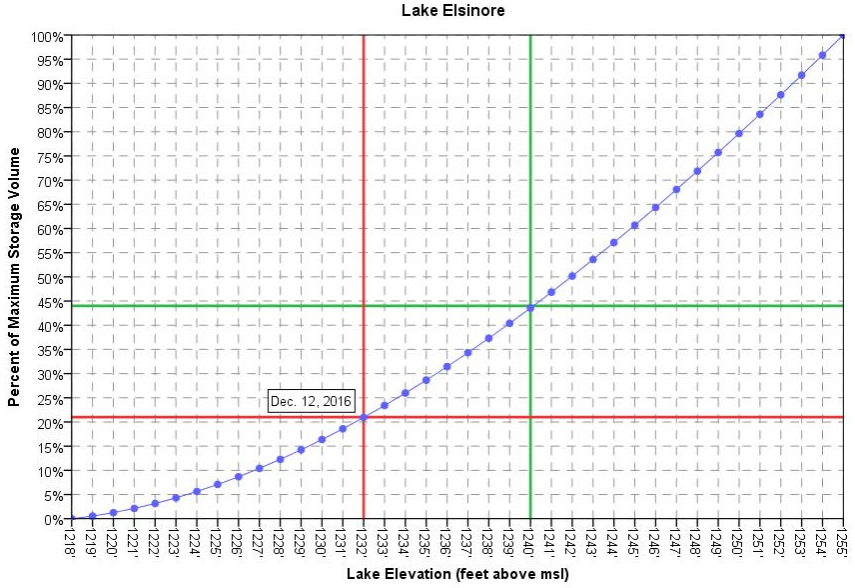


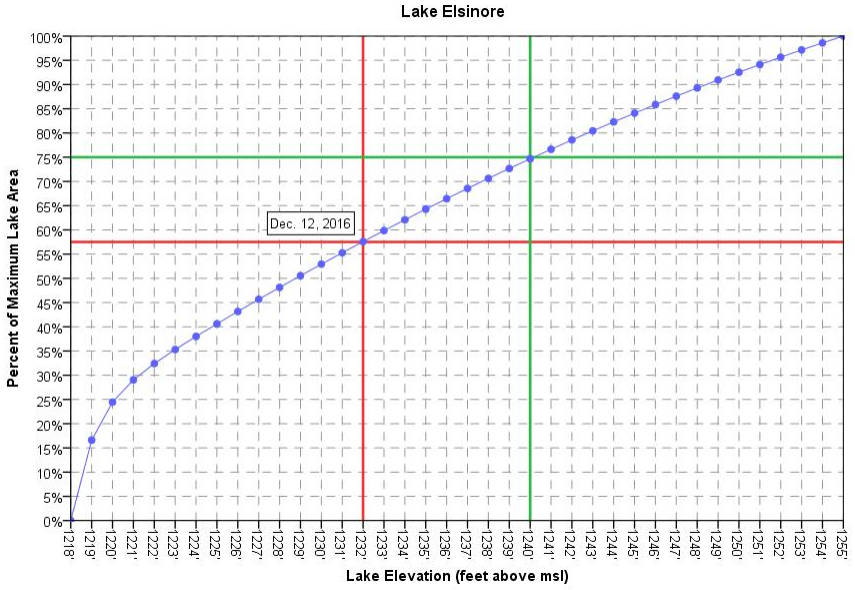


Storage Volume



Surface Area

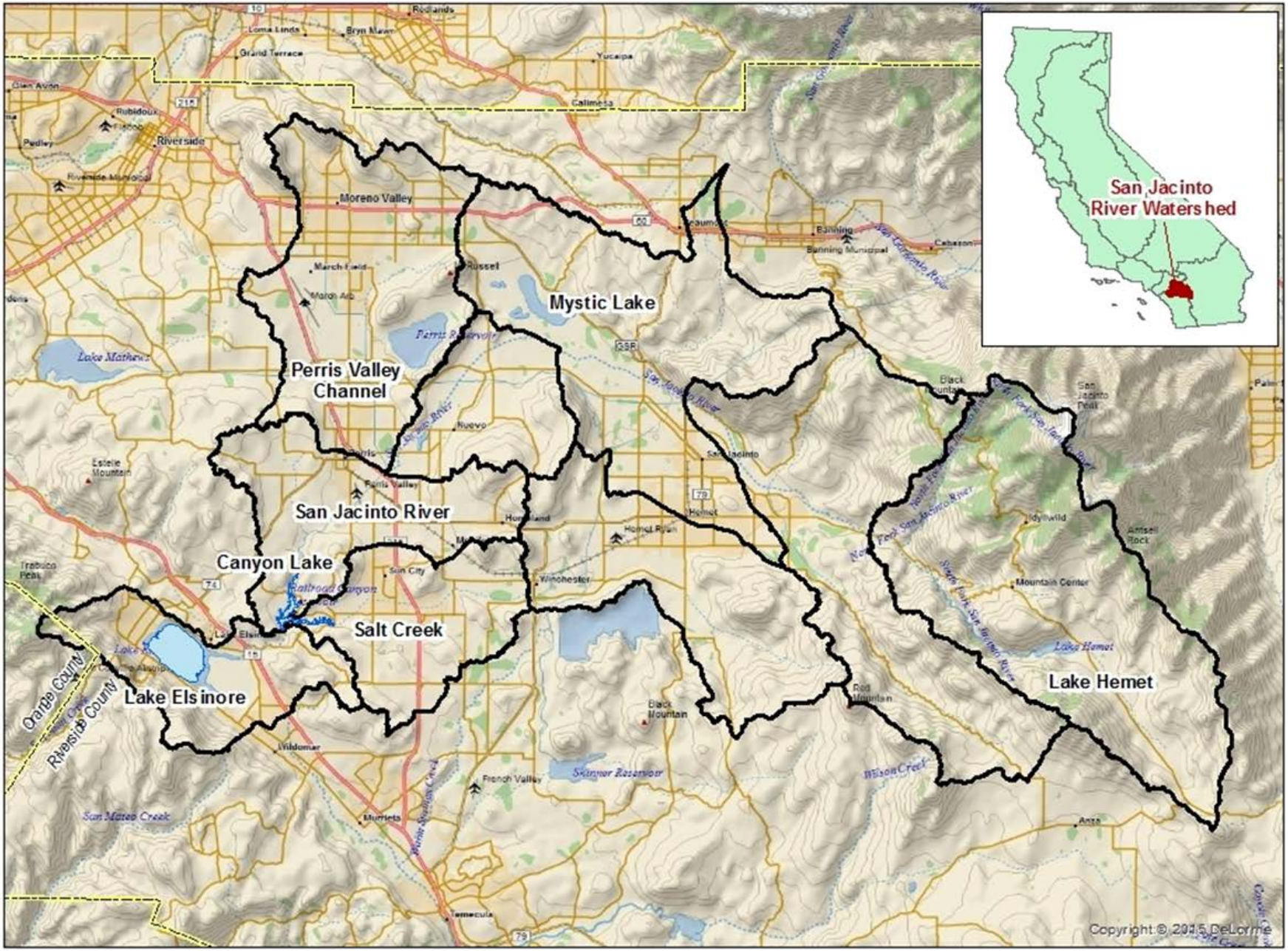




Lake Elsinore

- Terminal Lake in an area that receives ≈12”/yr. of average annual rainfall
- Evaporates ≈12,000 acre-feet/year; loses ≈4’ of depth annually
- On average, dries up completely every ≈40-50 years; stays dry for ≈2 years
- TDS concentrations exceed 4,000 mg/L when lake falls below half full
- ≈85% of total nutrient load comes from lake bottom sediments
- ≈90% of external flows and nutrient loads arrive in just 3% of all days
- Lake is naturally hypereutrophic (>56 ug/L Chlorophyll-a) ≈60% of the time
- Lake is naturally eutrophic (>10 ug/L Chlorophyll-a) ≈95% of time
- Recycled water prevents lake from drying up completely; preserves uses
- Recycled water prevents TDS from exceeding 6,000 mg/L
- Aeration system reduced internal nutrient loads by ≈35%
- Carp control reduces internal nutrient loads by ≈5%
- Phosphorus concentrations in runoff near background levels last winter

Lake Elsinore and Canyon Lake


San Jacinto River Watershed
Mystic Lake
Perris Valley Channel
San Jacinto River
Canyon Lake
Salt Creek
Lake Elsinore
Lake Hemet
Orange County
Riverside County
Copyright © 2015 DeLorme