Narrative Water Quality Objective

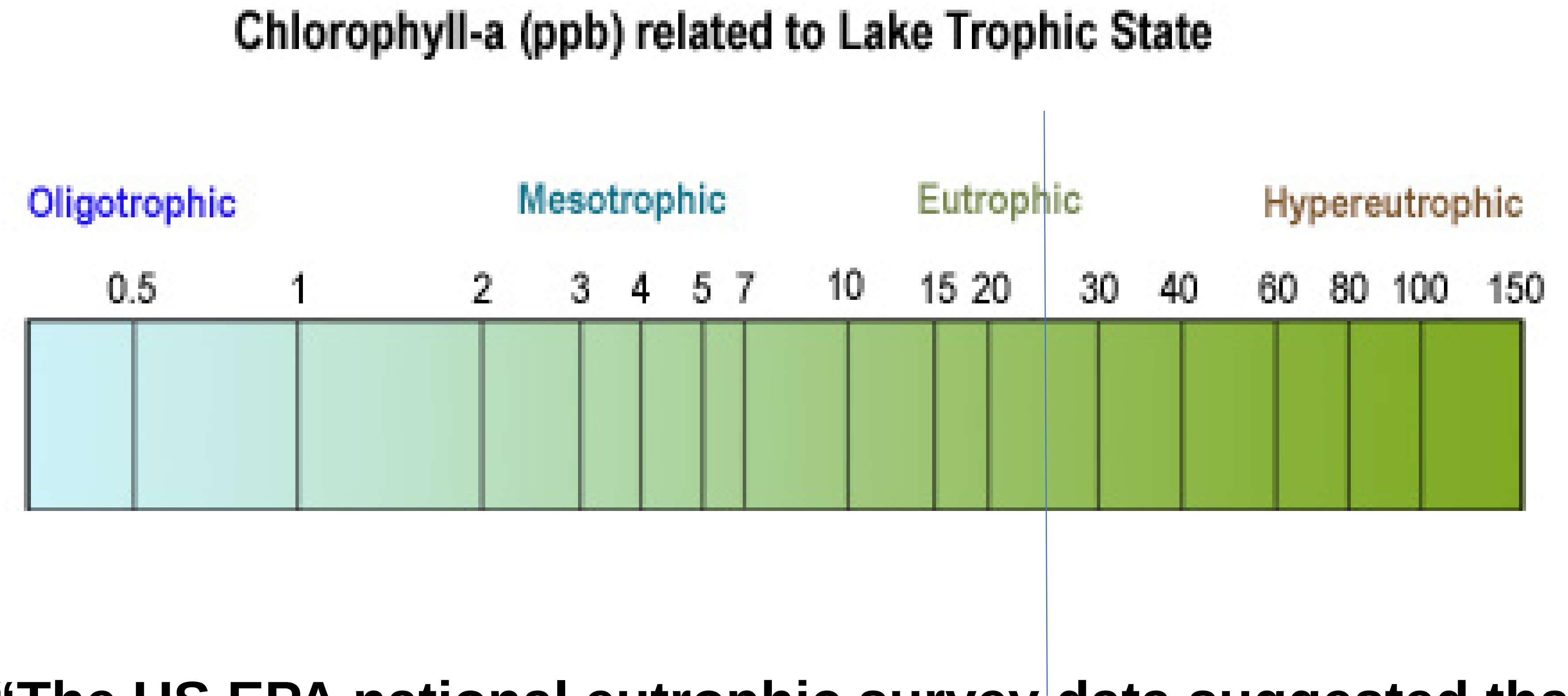
"Waste discharges shall not contribute to excessive algal growth in inland surface receiving waters."

(Basin Plan, 1995, pg. 4-5)

- "Excessive" is not defined
- No numeric standard for Chlorophyll-a

"Due to completely natural processes, Lake Elsinore has been at the eutrophic stage since the early 20th century, before the Clean Water Act was enacted. Therefore a reference state for Lake Elsinore based on historical water quality data seemed appropriate as the basis for selecting numeric targets. Using the same values for Canyon Lake provides consistency because the two lakes are nested in the same watershed, within five miles of each other." *(Staff Report, 2004, pg. 15)*

TMDL Final Chlorphyll-a Target = 25 ug/L



"The US EPA national eutrophic survey data suggested that a chlorophyll *a* concentration of 10-25 ug/L corresponds to eutrophic conditions." *(Staff Report, 2004, pg. 21)*

Phosphorus Target = 0.1 mg/L

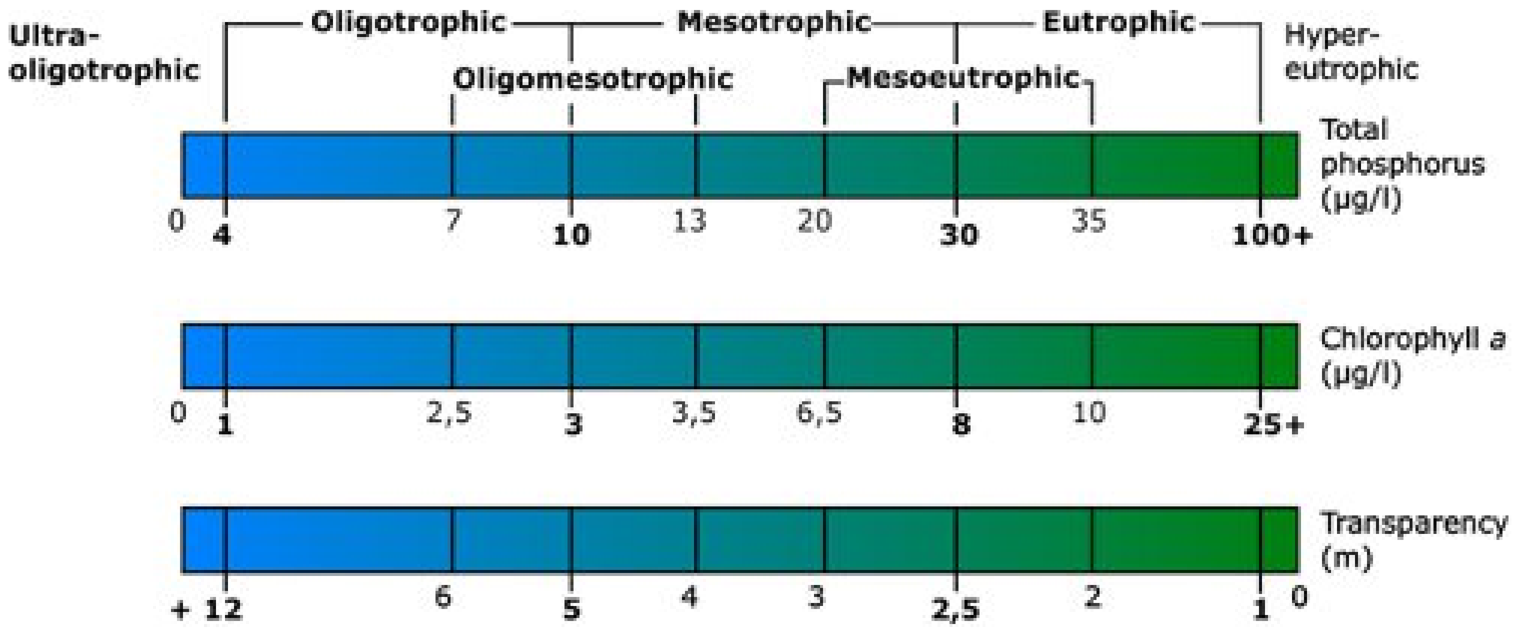
"The proposed interim target for total phosphorus is 0.1 mg/L as the annual average concentration in the water column. This number represents the 25th percentile of the total phosphorus concentration during the year 2000-2001 monitoring period. This time period is identified as the reference state since the lake did not experience severe algal blooms or fish kills, and the average lake elevation was 1240 feet above sea level, the acceptable operational level for Lake Elsinore." *(Staff Report, 2004, pg. 17)*

Nitrogen Targets

"To maintain the balance of nutrients for beneficial algal growth, a ratio of total nitrogen to total phosphorus of 10 is used to derive the 1.0 mg/L interim target for total nitrogen (US EPA, 1990)."
(Staff Report, 2004, pg. 17)

- Proposed Interim Target = 1.0 mg/L
- Proposed Final Target = 0.05 mg/L
- EPA Recommended = 0.02 mg/L
- **Adopted Final Target = 0.75 mg/L**

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**



Predicted Chlorophyll-a Concentration

"Using the nutrient data developed for 2000-2001 (Anderson, 2001), one estimates an internal loading rate constant, *k* of 0.0156 m/yr, a resuspension velocity of 0.0021 m/yr, a volumetric sediment TP concentration of 247,000 mg/m3 and a settling rate, *vs*, of 37.4 m/yr. Substituting these values into eq 9, one estimates a steady-state TP concentration of <u>0.117 mg/L</u>. This value is in excellent agreement with the annual average TP concentration of <u>0.119 mg/L reported by the RWQCB for the 2000-2001</u> period. The water quality associated with this TP concentration in the lake was predicted using empirical relationships. The relationship of Dillon and Rigler (1974) was used to predict lake chlorophyll levels, where:

$$\log chl\ (\mu g/L) = 1.449 \log TP\ (ug/L) - 1.136$$

The predicted chlorophyll level for the lake at a stable 1242 ft elevation (<u>without external loads</u>) is 73 µg/L…"

(Anderson, 2003, pg. 9)

Predicted Water Quality in Lake Elsinore after adding 15,000 af/yr of Recycled Water

(assumes zero load from other external sources)

Influent P Concentration	Lake TP Concentration	Chlorophyll-a	Secchi Depth
0 mg/L	0.100 - 0.123 mg/L	58 – 78 ug/L	0.50 – 0.59 m
0.05 mg/L	0.113 – 0.131 mg/L	69 – 85 ug/L	0.48 – 0.54 m
0.1 mg/L	0.127 – 0.140 mg/L	82 – 94 ug/L	0.45 – 0.49 m
0.5 mg/L	0.208 – 0.236 mg/L	167 – 202 ug/L	0.26 – 0.30 m
1.0 mg/L	0.293 – 0.374 mg/L	274 - 391 ug/L	0.15 - 0.20 m

Anderson, 2003, pg. 9

Predicted Water Quality in Lake Elsinore after adding 15,000 af/yr of Recycled Water

(assumes 30% reduction in internal loading rate from LEAMS)

Influent P Concentration	Lake TP Concentration	Chlorophyll-a	Secchi Depth
0 mg/L	0.036 - 0.076 mg/L	12.8 – 38.9 ug/L	0.71 – 0.98 m
0.05 mg/L	0.040 – 0.079 mg/L	15.4 – 41.1 ug/L	0.69 – 0.94 m
0.1 mg/L	0.045 – 0.082 mg/L	18.2 – 43.5 ug/L	0.68 – 0.90 m
0.5 mg/L	0.084 – 0.108 mg/L	45.2 – 65.9 ug/L	0.56 – 0.67 m
1.0 mg/L	0.133 – 0.152 mg/L	87.1 – 105.6 ug/L	0.42 - 0.47 m

Anderson, 2003, pg. 10

Predicted Water Quality in Lake Elsinore adding Recycled Water to maintain 1240' level

(assumes TP in runoff = 0.22 mg/L)

Lake Management Scenario	Lake TP Concentration	Chlorophyll-a	Secchi Depth
Baseline	0.377 mg/L	395 ug/L	0.15 m
Aeration Only (30%↓)	0.148 mg/L	102 ug/L	0.42 m
Carp Removal Only (50%↓)	0.331 mg/L	327 ug/L	0.18 m
Aeration + Carp Combined	0.121 mg/L	76 ug/L	0.51 m

Anderson, 2006, pg. 25

Predicted Chlorophyll-a in Canyon Lake

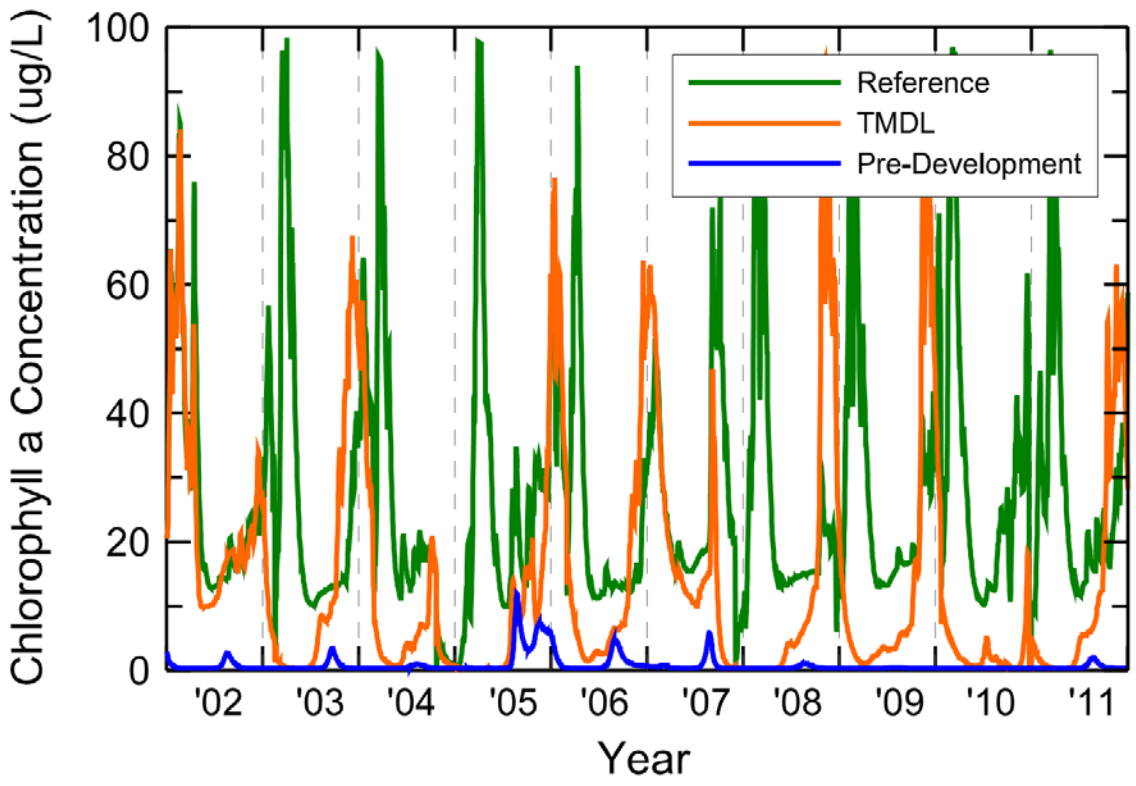


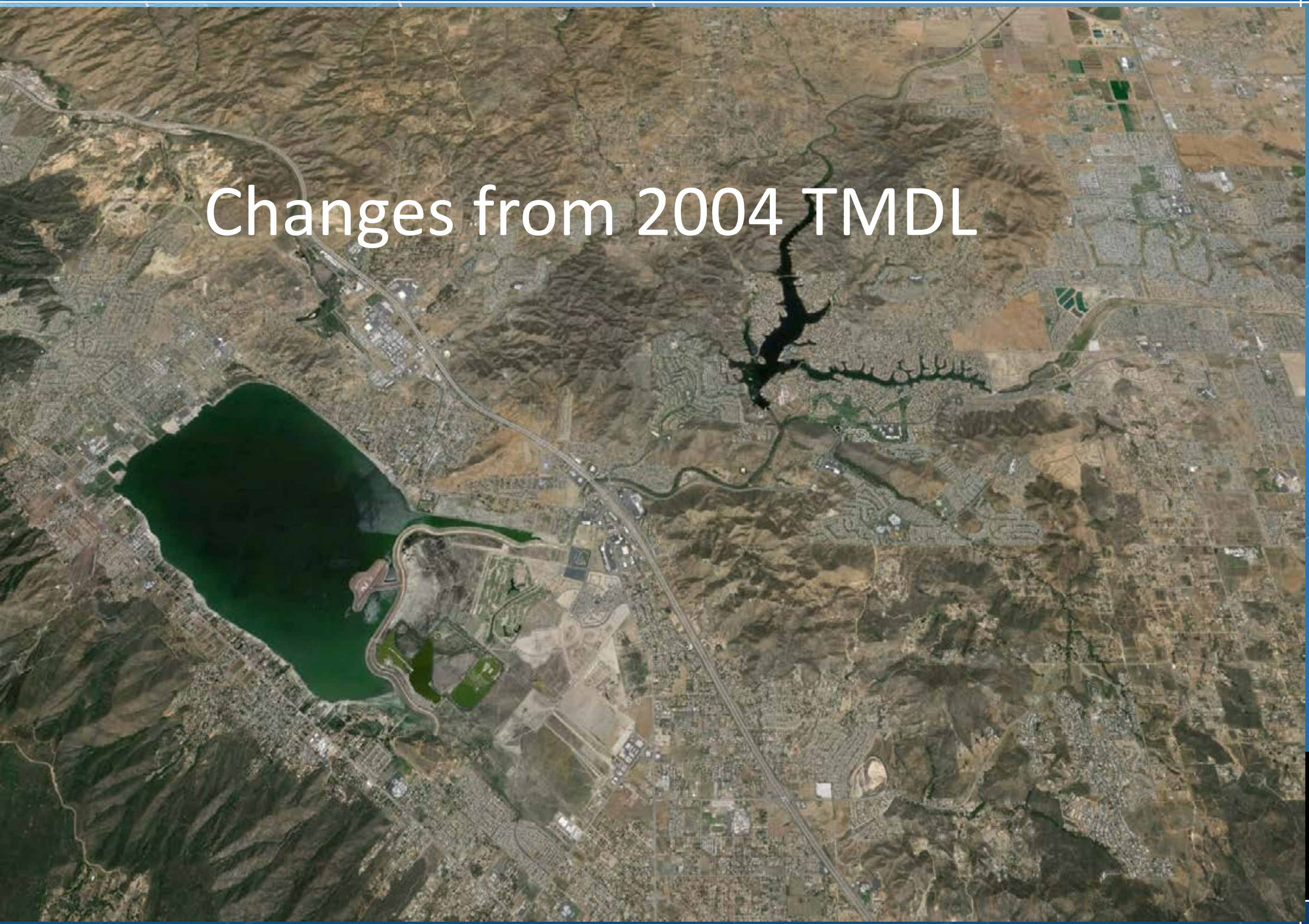
Fig. 5. Volume-weighted daily chlorophyll a concentrations under the reference (existing) condition, TMDL-prescribed reductions in external loading, and the pre-development scenario.

Anderson, June-2012, pg. 5

Revision of the Lake Elsinore & Canyon Lake Nutrient TMDL

CDM Smith Team & Risk Sciences

Changes from 2004 TMDL



May 16, 2017

Lake Elsinore/Canyon Lake Task Force Meeting

RISK SCIENCES

CDM Smith

Presentation Outline

- Comparison of 2004 TMDL and TMDL Revision
- Key Changes for External Sources
- Dynamic sediment nutrient flux

Data Updates and Error Corrections

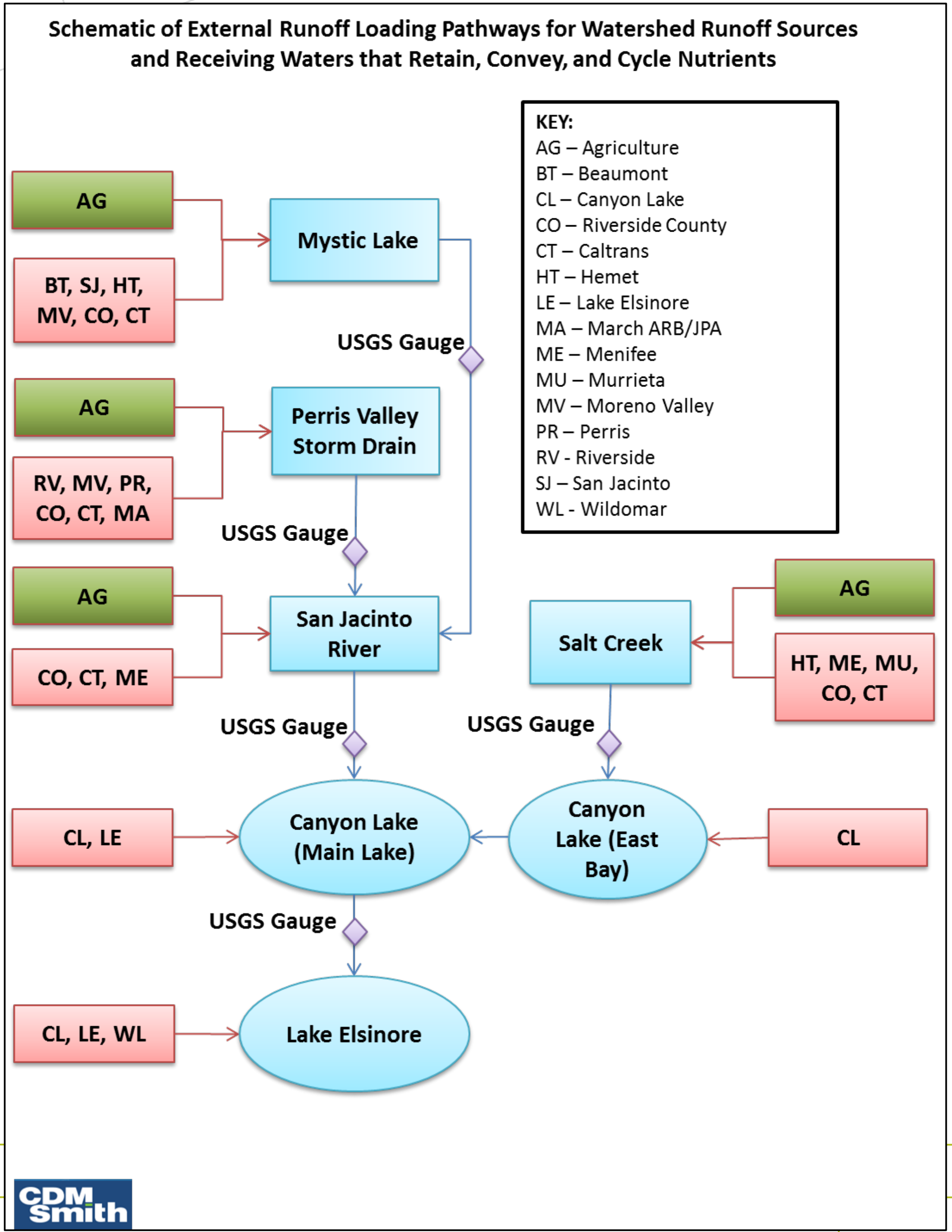
CDM Smith

Key Changes in TMDL Revision

Category	2004 TMDL Issue	Resolution	Impact
Canyon Lake Segments	A single TMDL was developed for Canyon Lake; however studies have indicated that the East Bay and Main Lake are distinct	TMDL revision was developed to provide separate TMDLs for Canyon Lake Main Lake and Canyon Lake East Bay.	TMDL for two waters rather than one, ensuring the entire lake achieves water quality representative of a reference watershed
Temporal resolution	The numeric targets for the Lake Elsinore TMDL was developed based on a static lake level of 1240' above msl.	The TMDL revision develops frequency based numeric targets for a reference watershed loading to the lakes to account for naturally occurring water quality variability caused by lake level fluctuation.	Compliance assessment with in-lake targets requires development of long-term monitoring data over multiple years
Wet year hydrology	Overflow volumes for 1997-1998, the representative 'wet' hydrologic year, were overestimated by ~750%.	Flow gauge data and robust water quality monitoring dataset to estimate current mass emissions and develop total allowable nutrient load	Reference watershed approach generates total allowable load the to lakes that is less than the 2004 TMDL allowed
Forest land use nutrient concentration	Literature values used for open space / forest loading and allocations	New data from SJR watershed (Cranston Guard Station site) was used to provide a basis for a reference watershed approach in the TMDL revision	High nutrient loads from open space / forest lands make a reference watershed approach reasonable for this TMDL
Mystic Lake overflow	Updated Mystic Lake bathymetry suggests 2004 TMDL may have overestimated wet year overflow volume	A new estimate was developed to account for long term (>90 yr) period of rainfall, runoff, storage, evaporation, overflow, and continued subsidence.	Separate allocations are now developed for jurisdictional areas upstream of Mystic Lake to Lake Elsinore.
Channel bottom recharge	Jurisdictional allocations not developed to differentiate delivery of nutrients based on proximity to lakes.	Allocations developed for individual jurisdictions accounting for reduced delivery to Canyon Lake from channel bottom recharge in Salt Creek (Zone 4) and San Jacinto River (Zones 5 and 6).	A reduced relative source load estimate and load allocation for jurisdictional areas in headwater subwatersheds relative to those close to lake inflows
Septic system loading	Septic nutrients load from assumptions about proximity to waterways, failure rates, and wastewater concentrations.	Nutrient monitoring data from Quail Valley supports an empirical method with unsewered residential included in spatially distributed land use washoff	Reduced load from septic source areas, reduced nutrient load credit that could be achieved from sewering projects
CAFOs	The 2004 TMDL did not assume compliance with NPDES Permit requirements for CAFOs.	CAFOs are assumed to have all volume up to 25 year return period retained on-site. A factor was included to estimate runoff overflows from larger events.	Existing load and WLAs for remaining CAFO jurisdictions is reduced
Atmospheric Deposition	Methods to estimate atmospheric deposition were not consistent between Canyon Lake and Lake Elsinore	Update calculations for Canyon Lake to be consistent with those for Lake Elsinore after Walker, 1995 for TP and Meixner, 2004 for TN.	Minimal impact to overall TMDL or implementation requirements

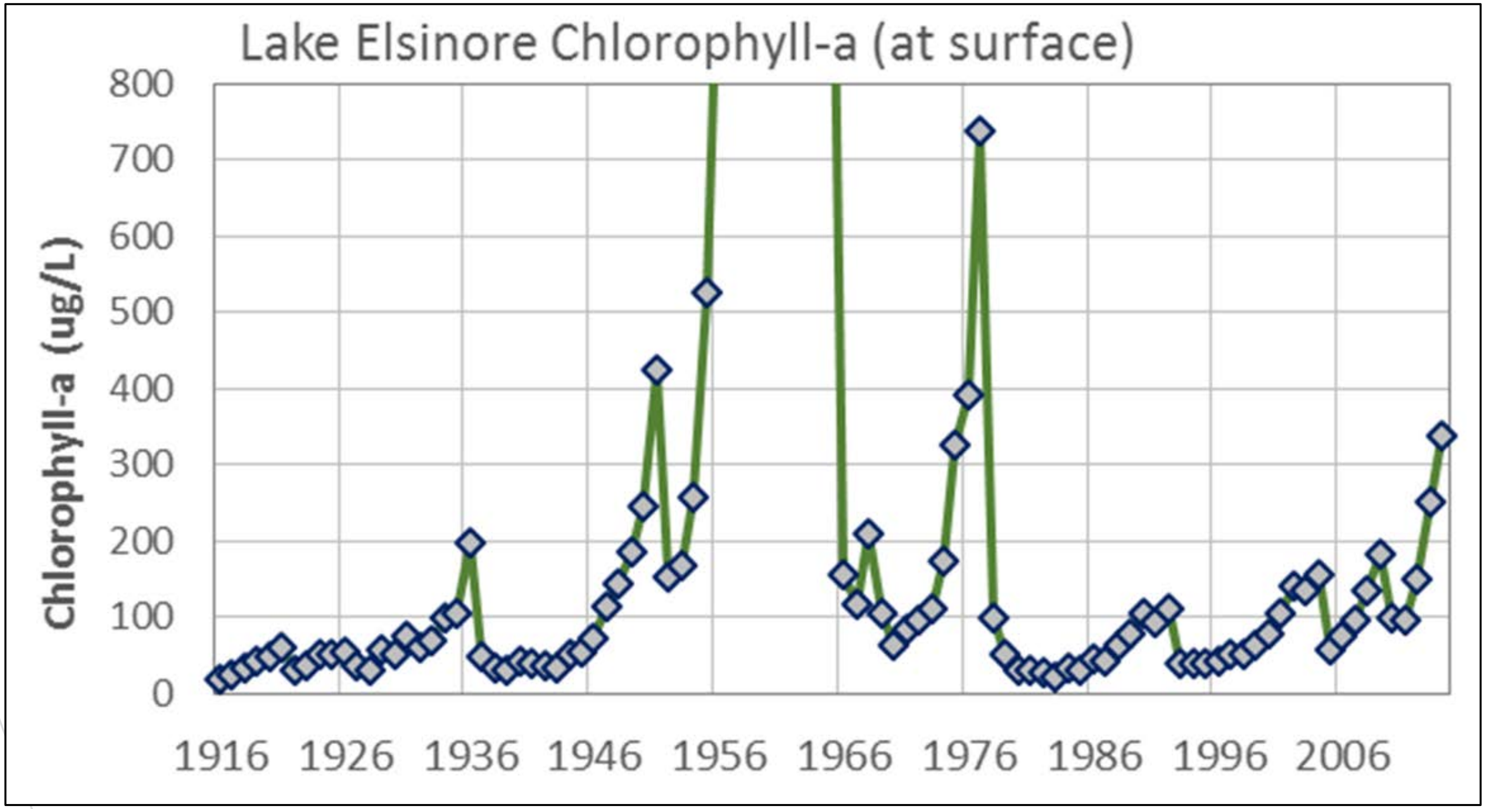
Canyon Lake Segments

- Separate East Bay and Main Lake
- Different drainage areas
- Minimal dry season exchange



Temporal Resolution

- Water quality for reference watershed loading fluctuates based on natural hydrologic variability



Wet Year Hydrology

- Corrected volume for representative wet year

Water Year	Frequency	Overflow (AFY) Canyon Lake to Lake Elsinore	
		Estimated (EFDC)	USGS Gauge Data [1]
1994 (mod)	41%	2,483	2,483
1998 (wet)	16%	133,981	17,230
2000 (dry)	43%	0	69
Frequency-weighted Average		22,520	3,948

1) Includes a small (<1 mi²) drainage area downstream of Railroad Canyon Dam

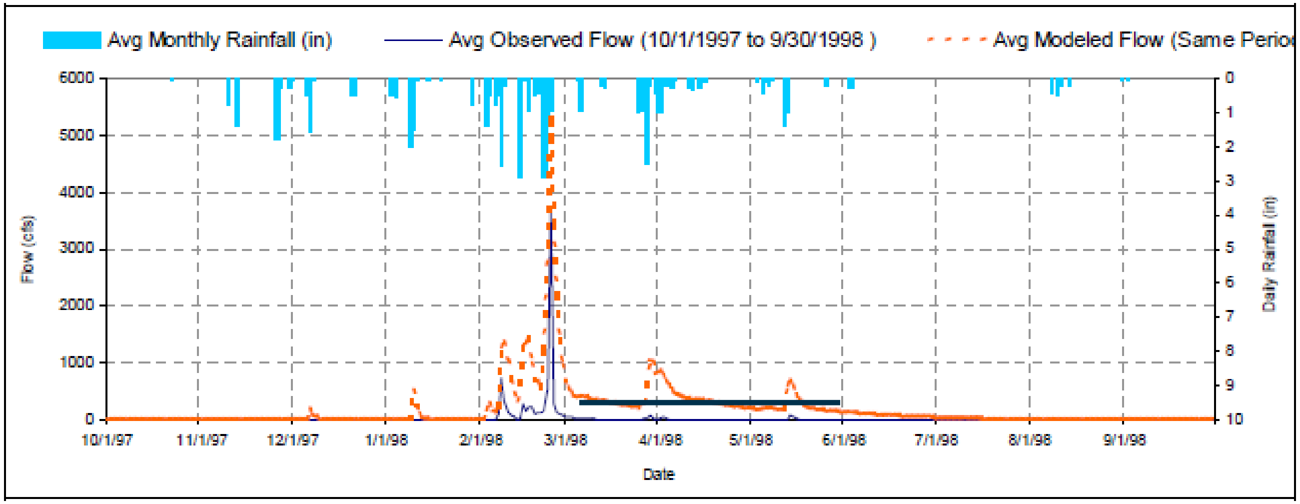


Figure 4-72 Validation of Canyon Lake overflow (1997-1998)

- Post-storm volume of ~70,000 AF when gauge showed zero discharge

Wet Year Hydrology

- Phosphorus inflow to Canyon Lake
  - $Load_{inflow} = 0.1\ mg/L * V_{net} * V/H + Load_{overflow}$

  where V_{net} is TP settling rate, V is lake volume, and H is lake depth

- Nitrogen in overflows to Lake Elsinore
  - $Load_{overflow} = Q_{inflow} * 0.75\ mg/L$

Water Year	Frequency	Allowable TP inflow to Canyon Lake (kg/yr)	
		2004 TMDL	2004 TMDL Corrected
1994 (mod)	41%	1,664	1,664
1998 (wet)	16%	1,249	1,249
2000 (dry)	43%	17,838	3,478
Allowable TP Load (kg/yr)		4,073	1,776

Water Year	Frequency	Allowable TN in Overflows from Canyon Lake to Lake Elsinore (kg/yr)	
		2004 TMDL	2004 TMDL Corrected
1994 (mod)	41%	1,808	1,808
1998 (wet)	16%	28,041	3,391
2000 (dry)	43%	167	167
Allowable TN Load (kg/yr)		22,512	4,024

Forested Landuse Nutrients

- Model results closer to literature values from experimental forest (Western US) in 2004 TMDL and 2010 LSPC update
- TMDL revision involves reference watershed approach based on high naturally occurring nutrient loads

Version	San Jacinto River at Cranston Guard Station Data Period	Median SJR at Cranston Guard Sta for Calibration Period	Average Model Concentration	Experimental Forest
		TP (mg/L)	TP (mg/L)	TP (mg/L)
2004 TMDL Staff	1995-2001	0.35	0.13	0.11
2010 LSPC Update	Jan-Apr 2008	0.16	0.08	0.11
TMDL Revision	2001-2011	0.31	0.31	0.11

CDM Smith

Forested Landuse Nutrients

- Model results closer to literature values from experimental forest (Western US) in 2004 TMDL and 2010 LSPC update
- TMDL revision involves reference watershed approach based on high naturally occurring nutrient loads

Version	San Jacinto River at Cranston Guard Station Data Period	Median SJR at Cranston Guard Sta for Calibration Period	Average Model Concentration	Experimental Forest
		TN (mg/L)	TN (mg/L)	TN (mg/L)
2004 TMDL Staff	1995-2001	1.90	0.39	0.66
2010 LSPC Update	Jan-Apr 2008	0.57	0.21	0.66
TMDL Revision	2001-2011	0.95	0.95	0.66

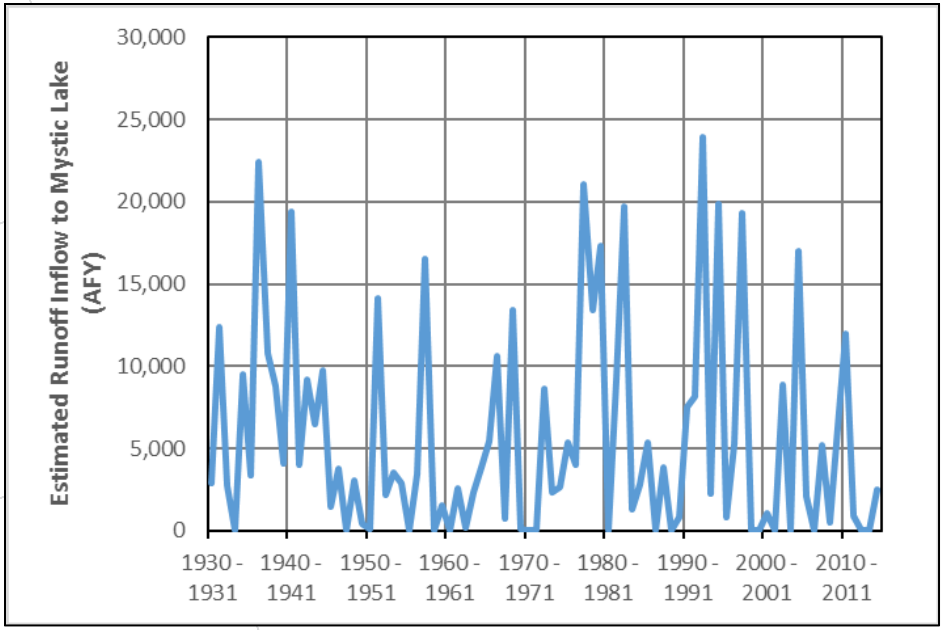
Mystic Lake Overflow

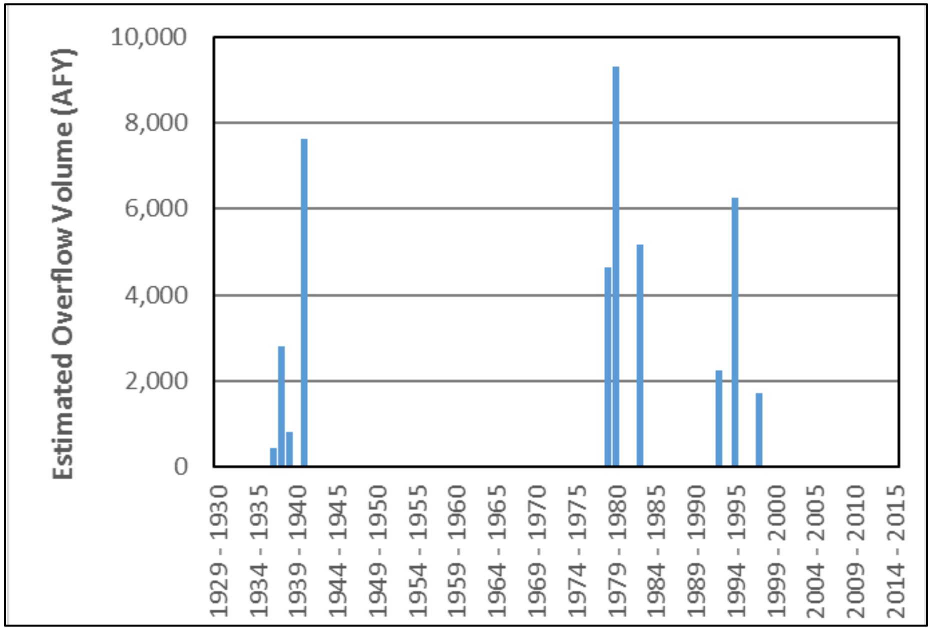
- Retention in Mystic Lake accounted in TMDL, LSPC update, and TMDL revision
- No downstream data for overflow volume measurements

Version	Storage Capacity (AF)	Annual Average Mystic Lake Overflow (kg/yr)		Source	Notes
		TP	TN		
2004 TMDL	~5,000	4,700	7,798	Lake Elsinore and Canyon Lake Nutrient Source Assessment (Tetra Tech, 2003)	More than half total P load to Canyon Lake from Mystic Lake overflows in 16 percent of years Ag / CAFO half Zone 7-9 nutrient load.
2010 LSPC Update	~17,000	0.4	0.9	San Jacinto Watershed Model Update (Tetra Tech, 2010)	Upper watershed (~50 percent of LE/CL drainage area) largely disconnected
Draft Source Assessment (as of 2040)	22,000	985	3,324	Draft Source Assessment Chapter (CDM Smith, Oct. 2016)	Most Mystic lake overflow nutrients assumed to pass through Canyon Lake to Lake Elsinore; Higher open space EMC than 2004 TMDL

Mystic Lake Overflow

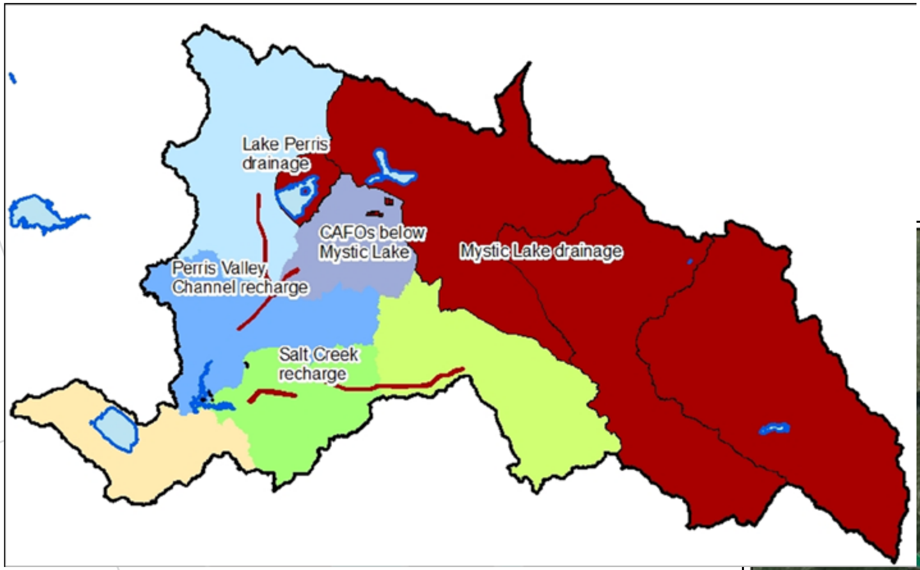
- Inflows to Mystic Lakes from subwatershed zones 7-9 (left) and estimated overflows to San Jacinto River (right)
- Average overflow ~4100 AFY (excluding years with no overflow)
- WY 1997-98 overflow ~1700 AF

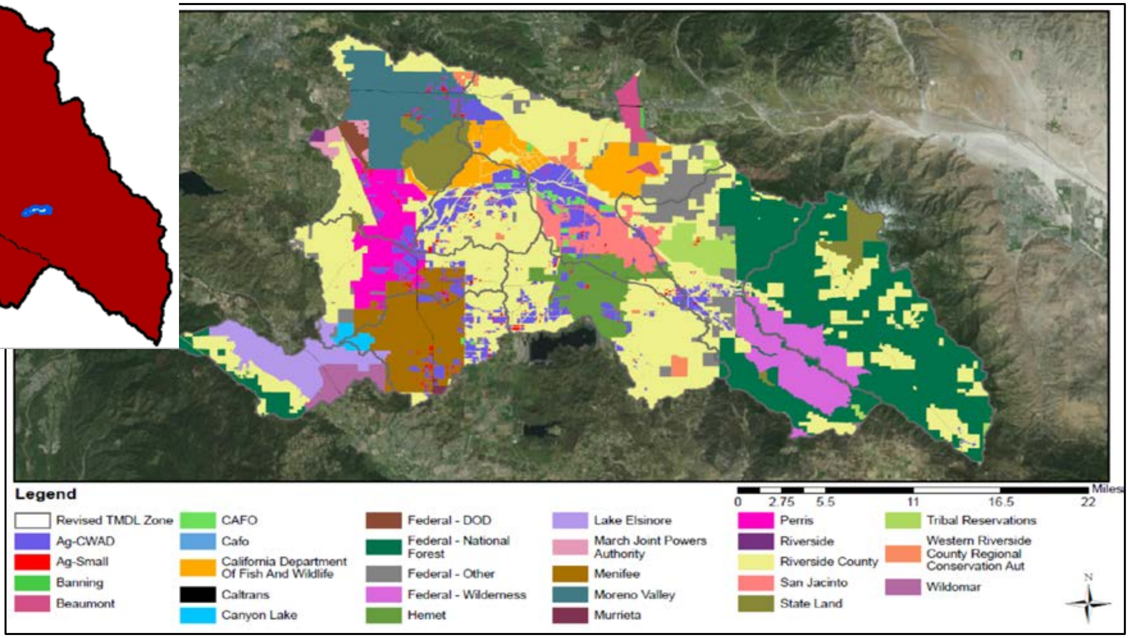




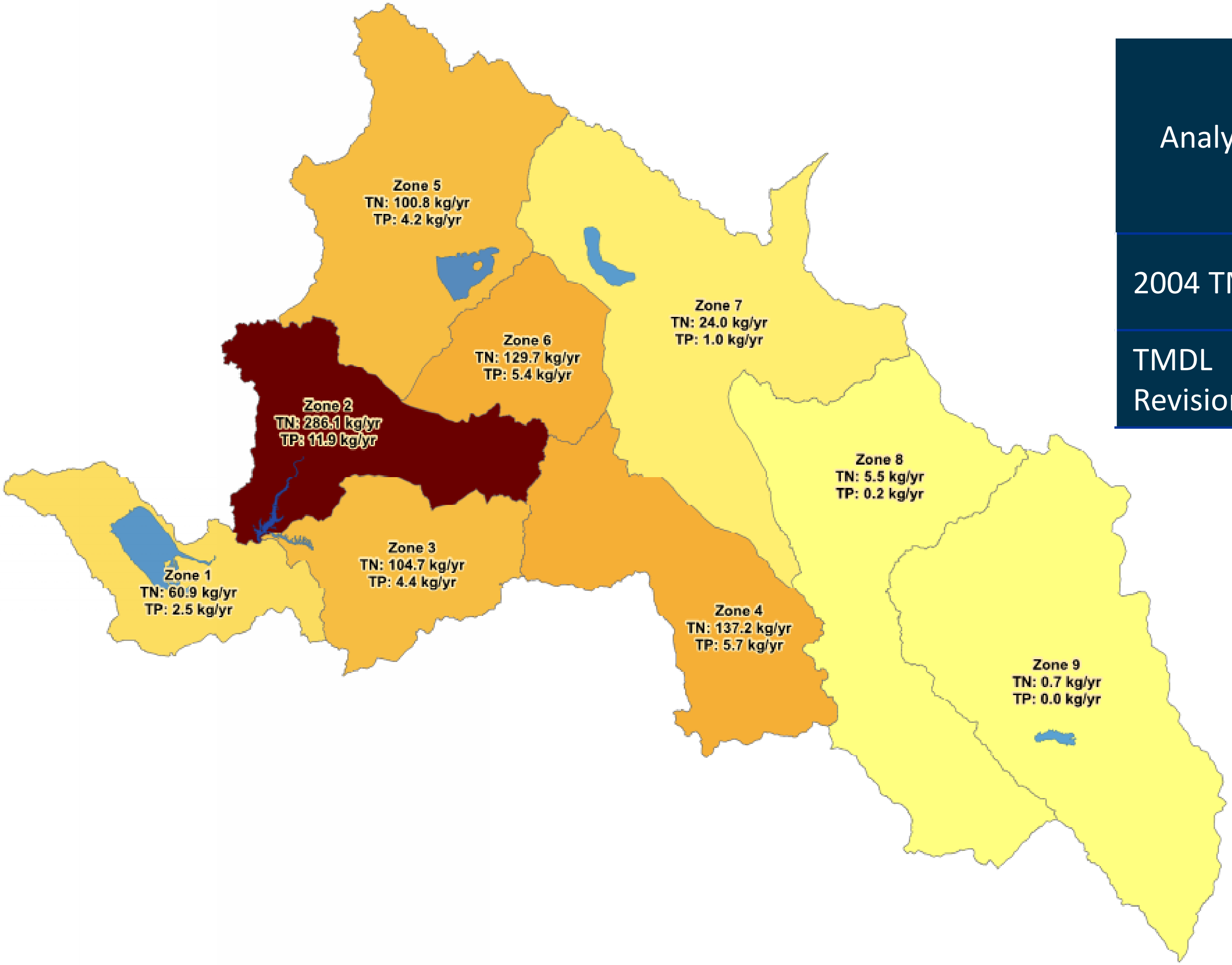
Channel Bottom Recharge

- Jurisdictional allocations account for recharge in channel bottoms





Septic System Management



Analysis	Existing Load from Septics	
	TP (kg/yr)	TN (kg/yr)
2004 TMDL	518	8,129
TMDL Revision	44	940

CAFOs

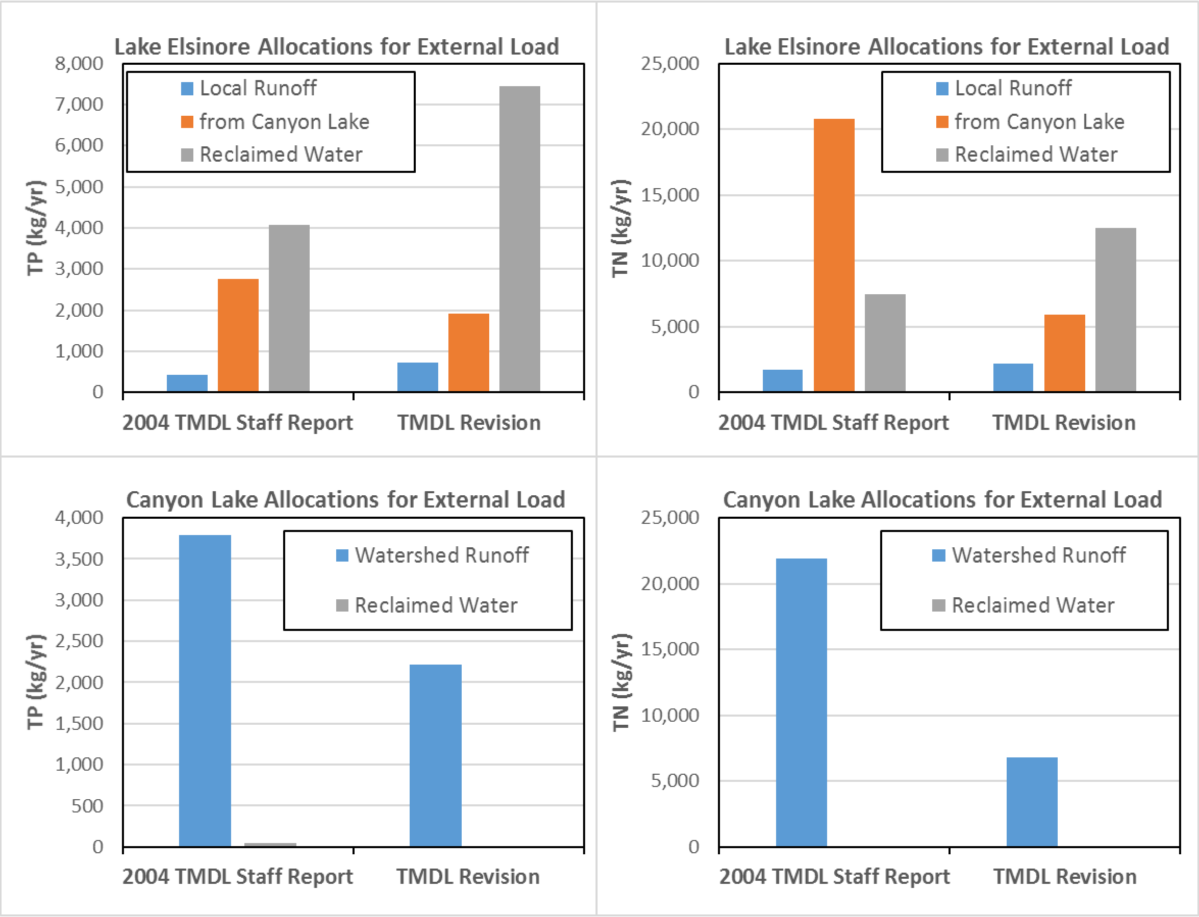
- TMDL revision assumes compliance with NPDES permit requirement
- WLA is equal to reference load for acreage of CAFO lands

Water Year	Existing Load from CAFOs		Wasteload Allocations	
	TP (kg/yr)	TN (kg/yr)	TP (kg/yr)	TN (kg/yr)
2004 TMDL	494	2,783	132	1,908
TMDL Revision	18	36	7	20

Total External Allocations

External Load Allocations

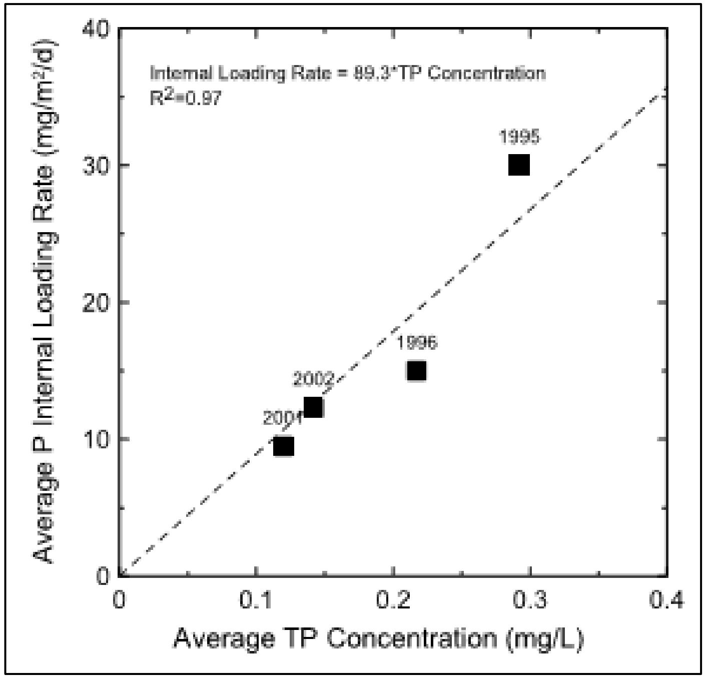
- Changes from land use conversion, corrections, and new data

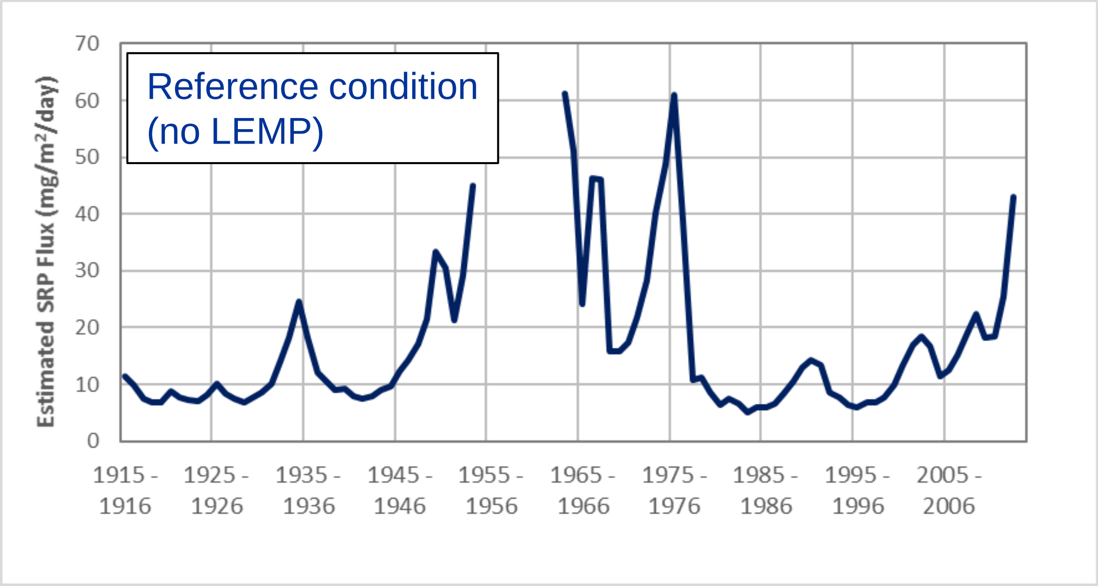


Dynamic Sediment Nutrient Flux

Sediment Nutrient Flux

- Relationship between annual average TP in water column and experimental sediment core flux rates
- Convert water column model results to estimates of dynamic flux rates

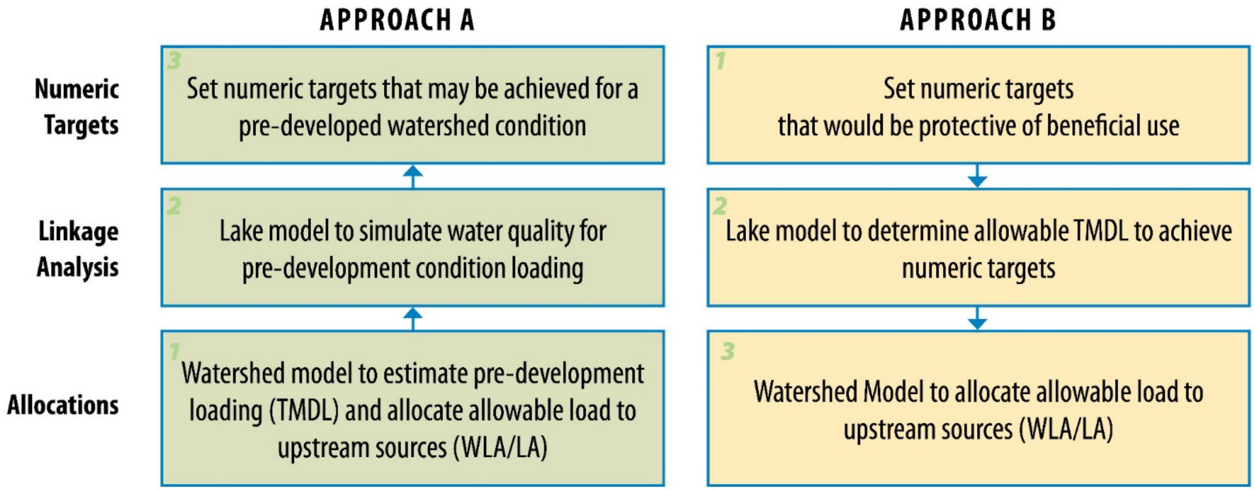




Average of estimate flux for reference watershed condition – 13.9 mg/m^2/day SRP

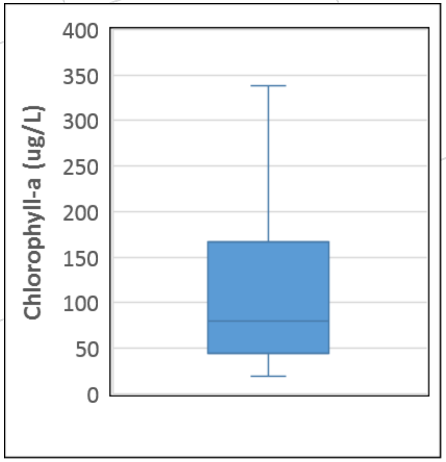
Internal Load Allocation

- Higher TP allocation for internal sources by removing aeration system operation credit
- LEMP project reduced lake bottom surface area for flux to occur
- Does not impact allowable external loads with reference watershed approach for revised TMDL



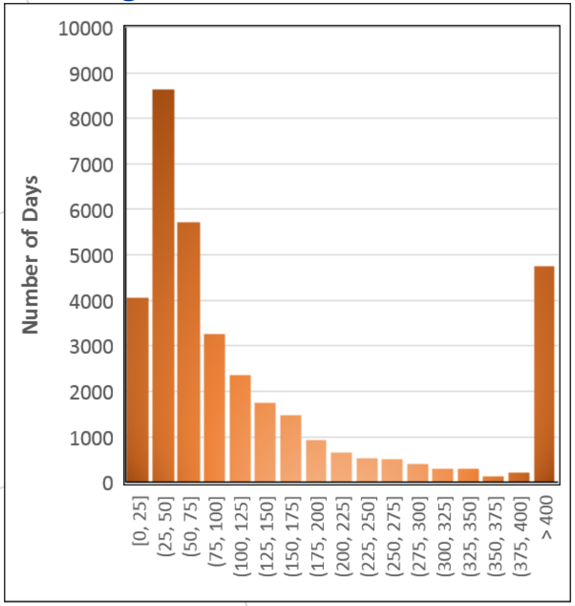
Numeric Target Expression

Alternative Numeric Target Expression

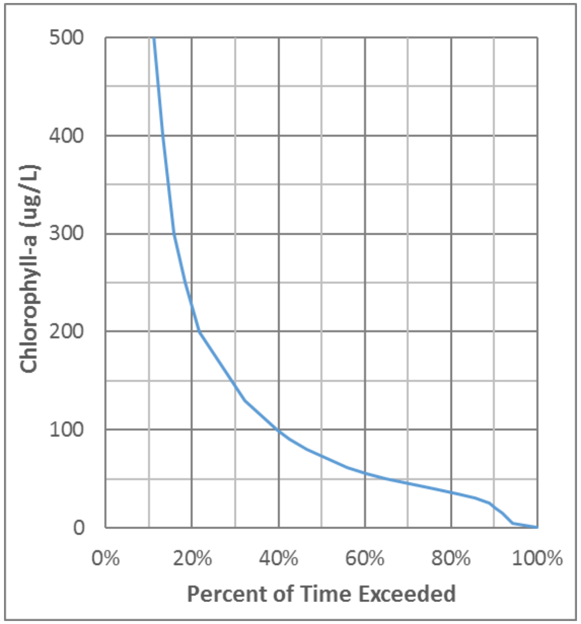


Box-Whisker

Histogram



Cumulative Frequency Distribution



Time series