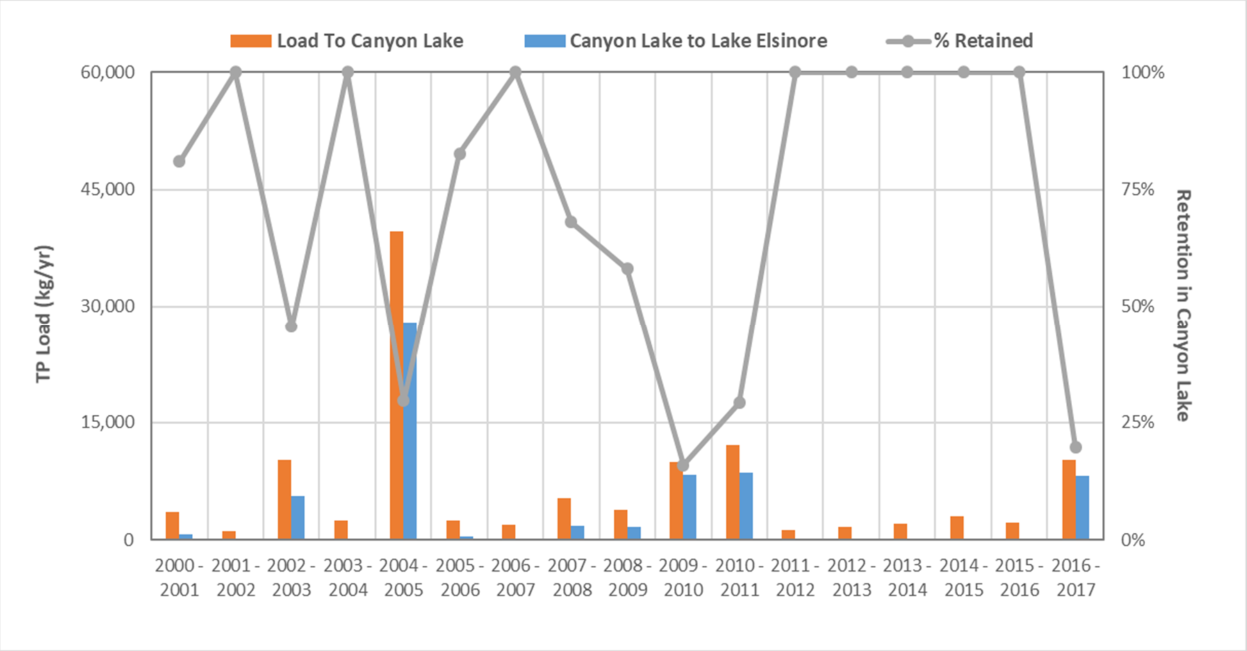

Figure 4-14. Annual Total Phosphorus Load into Canyon Lake and Overflow to Lake Elsinore

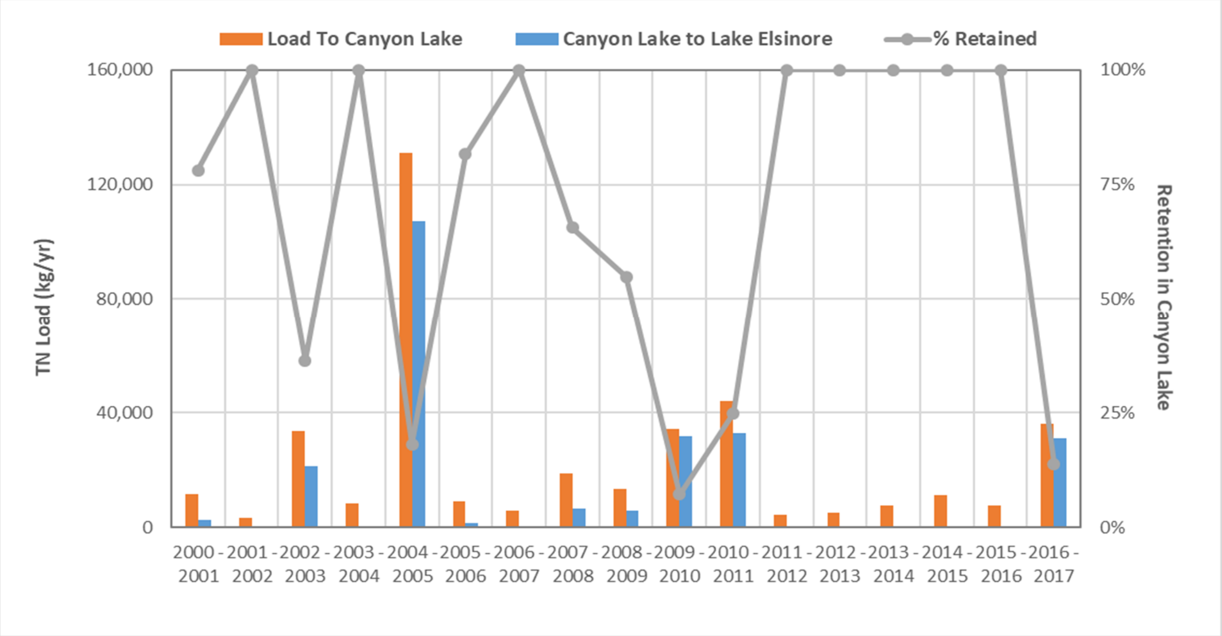

Figure 4-15. Annual Total Nitrogen Load into Canyon Lake and Overflow to Lake Elsinore

Thus, the estimation of nutrient loads delivered to downstream lake segments is based on hydrologic model results and assumed values for TP and TN concentrations in washoff from general land use categories. No accounting for variability in runoff volume or land use nutrient washoff concentration as a result of disproportionate deployment of watershed BMPs by individual jurisdictions was included in this source assessment.

Section 6

Total Maximum Daily Load, Wasteload Allocations and Load Allocations

The allowable nutrient loading to three lake segments, Canyon Lake Main Lake, Canyon Lake East Bay and Lake Elsinore, is determined from analysis of the hydrology and water quality for the hypothetical reference watershed based on pre-development conditions (see Section 3.2 for description of the reference watershed condition). Specifically, this information was developed in the following sections:

- The loading of nutrients to the lakes under reference conditions was simulated by evaluating reference watershed conditions using the watershed runoff model developed to assess existing sources of nutrients from the watershed (Section 4, Source Assessment).
- Section 5 (Linkage Analysis) documents for a reference watershed condition, approximations of internal loads associated with sediment nutrient flux, which comprises the single greatest source of TP and TN in Lake Elsinore.
- Reference watershed conditions were approximated from modeling the watershed subareas by reducing washoff concentrations to natural background levels (see Section 3).

This section partitions the total allowable loads of TP and TN from point sources into WLAs and non-point sources into load LAs for individual jurisdictions.[1] The chapter includes the following sections:

- *Section 6.1 – Total Maximum Daily Load*: The total allowable load of nutrients from external sources, plus a margin of safety, equals to the TMDL. In the case of Lake Elsinore and Canyon Lake, the TMDL is based on estimated nutrient concentrations in washoff from a hypothetical reference condition over the entire watershed. Due to the water quality benefits realized with increased lake volume, current volumes of runoff and supplemental water are allowed for in WLAs and LAs.
- *Section 6.2 – Watershed Runoff*: Nutrient loads delivered to the lakes from watershed runoff are allocated to upstream jurisdictional areas in this section. A key element of this allocation involves allocation of watershed nutrient loads to Lake Elsinore from upstream of both Canyon Lake by way of overflows from Canyon Lake. The difference between current loads (as determined in Section 4) and allowable loads is reported. This difference represents the reduction in TP and TN loads that must be achieved to meet WLAs and LAs.

---

[1] The WLA is the portion of a receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. The LA is the portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources.

- *Section 6.3 – Supplemental Water*: Allowable loads from the addition of supplemental water to the lakes is described in this section. While the addition of supplemental water to the lakes represents a discharge, it is important to recognize that the addition of supplemental water also represents a water quality management strategy. The WLA for supplemental water is based on a reference watershed runoff nutrient concentration (See Section 3.2.2.3) and does not consider additional water quality benefit for response targets that may be achieved with a deeper lake. Potential offset credits from supplemental water addition are described in Section 7 that describes TMDL implementation.

- *Section 6.4 – Internal Loads:* Estimates of allowable internal loads for atmospheric deposition and sediment nutrient flux are described in this section. Implementation of the TMDL will eventually return sediment nutrient flux rates to reference levels, but a significant lag time exists to account for legacy nutrient enrichment to cycle through the system. This section estimates the lag time for sediment nutrient flux rates to return to reference levels after the TMDL for external loads is achieved.

- *Section 6.5 – Summary of Allocated Loads.* This section summarizes the WLAs and LAs described in previous sections. In addition, this section discusses how compliance with allocations will be evaluated. As described in other chapters, the temporal variability associated with naturally occurring weather patterns results in significant variability in the delivery of nutrient loads to the lakes. Use of a 10-year averaging period for setting allocations in the revised TMDLs provides a more appropriate measure of progress toward TMDL compliance by reducing the influence of naturally occurring annual fluctuations.

6.1 Total Maximum Daily Load

The total maximum daily load (TMDL) is the sum of allowable nutrient loads from point (WLA) and non-point (LA) sources that can be delivered to Canyon Lake and Lake Elsinore to achieve the numeric targets, accounting for a margin of safety (MOS); as follows:

$$TMDL = \ WLA + LA + MOS$$

For the LECL TMDL, allowable loads are allocated based on nutrient washoff concentrations expected for a reference watershed condition and should be therefore considered as concentration-based. By setting a concentration-based allocation for the LECL TMDL revision, increases in volume (and thereby load) of discharges would be accompanied by proportionate increases in the allowable loading. Thus, the required load reduction (excess above reference) remains the same percentage with a change in runoff volume. The TMDL Task Force decided to use a concentration basis for allocations to support the objective of increasing the volume of clean water that reaches the lakes.

Since a TMDL is a measure of mass by definition, there must be a term for volume in the calculation of the TMDL and in-turn allocations for external sources. The following sections employ model estimates of long-term average runoff for existing watershed conditions (based on 2014 land use mapping) and near-term projections of long-term average supplemental water additions to convert reference concentrations into 10-year average allocations for loads delivered to three lake segments, Canyon Lake Main Lake, Canyon Lake East Bay, and Lake Elsinore. These mass allocations are expected to change as land use and jurisdictional areas in the watershed change, generally with a trend of declining agricultural use replaced by increasing urbanization.

Lastly, the MOS provides additional assurance that the TMDL will be achieved if programs are implemented to achieve the required reduction to meet allocated loads. The US Forest Service (USFS) collected 54 samples from the SJR at Cranston Guard Station reference site over the course of 11 wet weather events in 2003-2005, 2008, and 2010. MOS of greater than 10 percent can be assumed to be accounted for in the TMDL revision by the selection of a median value from the reference site when compared with the geometric mean (TP: 0.4 mg/L, TN: 1.24 mg/L) or arithmetic mean (TP: 2.43 mg/L, TN 2.60 mg/L) or median of event averages (TP: 0.39 mg/L, TN: 1.35 mg/L).

6.2 Watershed Runoff

6.2.1 Allowable Runoff Loads

Nutrient loads estimated for watershed runoff under a reference watershed condition represent the total allowable load to each lake segment from external watershed runoff sources. Allowable nutrient loads are determined as the product of average annual runoff volume (V_{annual}) and reference nutrient concentration ($C_{reference}$) at the point of discharge into each lake segment, as follows:

$$Load_{allowable} = V_{annual} * C_{reference}$$

Section 3.2 above describes how nutrient concentrations are estimated for a reference watershed condition. The numeric targets in the revised TMDL are expressed as CDFs for the estimated water quality response targets that are expected with external loads representative of a reference watershed condition. Allowable loads are calculated for determine the total allowable load from each of the individual nine subwatershed zones in the watershed (**Figure 6-1**).

6.2.2 Allocations of Allowable Nutrient Loads to Lake Segment TMDLs

Allocations for nutrient loads were developed for each of the following: Canyon Lake Main Lake; Canyon Lake East Bay; overflows from Canyon Lake to Lake Elsinore; and Local Lake Elsinore. Although each lake segment is given an allocation, there are only three TMDLs since Canyon Lake Overflows to Lake Elsinore and Local Lake Elsinore comprise the Lake Elsinore TMDL (**Table 6-1**). Subwatershed zones upstream of Canyon Lake may contribute to multiple downstream waters and therefore will have allocations defined for more than one of the lake segments (see Figure 6-1). Naturally occurring recharge losses between jurisdictional areas and lake inflows (by channel bottom recharge downstream of zones 4, 5, and 6 and by Mystic Lake retention of runoff from zones 7-9) are accounted for in the allocation of loads arriving at the lakes (Table 6-2) and in the remaining load reductions (Table 6-3) equal to excess loads estimated to arrive at the lakes. Allowable loads expressed as washoff from upstream jurisdictional areas are reported in Appendix B.

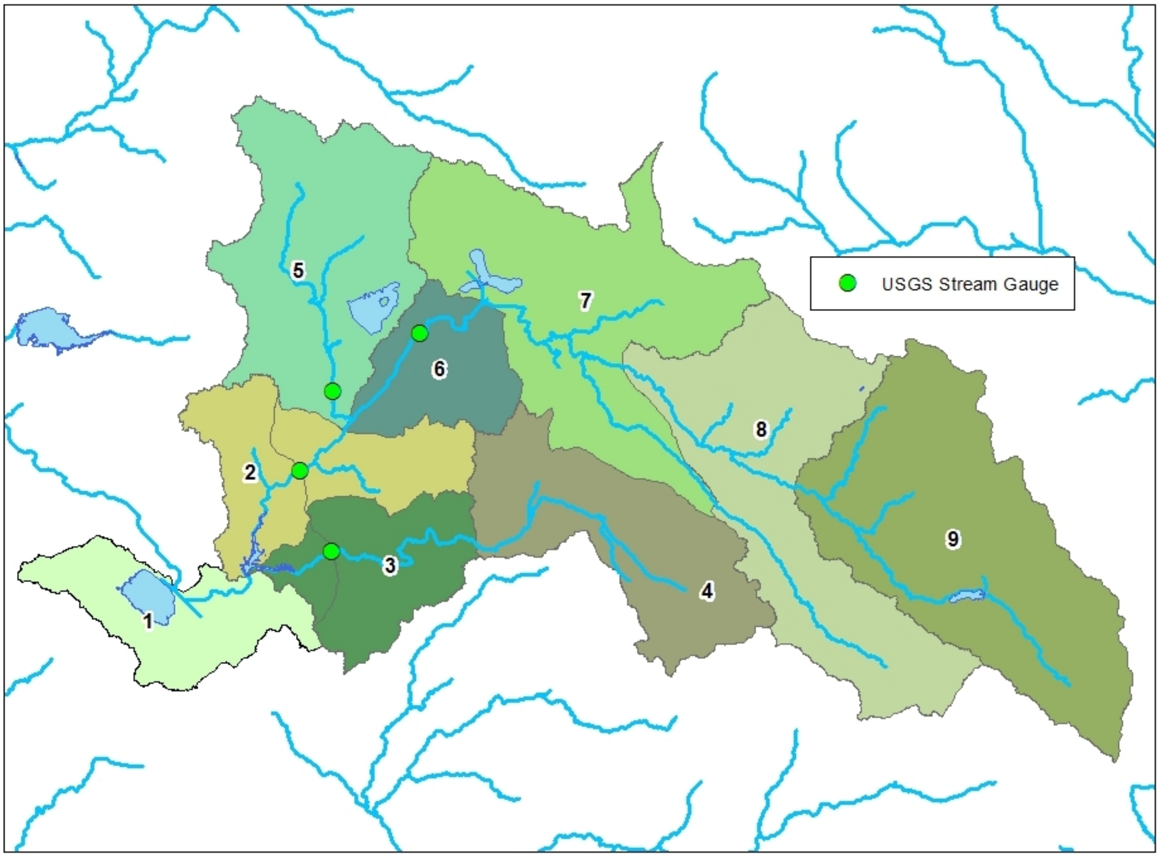

Figure 6-1. Location of Subwatershed Zones in the San Jacinto River Watershed (Zones 2, 5-9 drain to Canyon Lake – Main Lake [except note that Zones 7-9 may be intercepted by Mystic Lake]; Zones 3-4 drain to Canyon Lake – East Bay; and Zone 1 drains to Lake Elsinore)

Table 6-1. Matrix Showing Three TMDLs and Allocation of Allowable Nutrient Loads by Subwatershed Zone (see Figure 6-1 for location of zones)

Subwatershed Zone	Canyon Lake		Lake Elsinore	
	Main Lake	East Bay	Canyon Lake Overflows	Local Watershed
1	--	--	--	100%
2	40%	--	60%	--
3[1]	--	40%	60%	--
4[1]	--	40%	60%	--
5	40%	--	60%	--
6	40%	--	60%	--
7	--	--	100% [2]	--
8	--	--	100% [2]	--
9	--	--	100% [2]	--

[1] East Bay volume is transferred to Main Lake via a culvert under the Canyon Lake Drive causeway. The residence time for volume originating in East Bay that transfers to the Main Lake is limited prior to overflowing to Lake Elsinore and is considered negligible for the TMDL revision. Thus, no allocations are given to jurisdictions in subwatershed zones 3 and 4 (East Bay subwatershed) for Canyon Lake Main Lake

[2] Allowable loads are reduced to account for naturally occurring retention in Mystic Lake (see Section 4.1.3.4)

The Source Assessment (Section 4) applied USGS gauge records and long-term watershed monitoring data to estimate nutrient mass inflow to Canyon Lake from two key stations on San Jacinto River at Goetz Rd and Salt Creek at Murrieta Rd as well nutrient mass overflow to Lake Elsinore from the San Jacinto River downstream of Railroad Canyon Dam (see Figures 4-13 and 4-14). The retention of nutrient loads was estimated as the difference between the summed annual loading for stations upstream and downstream of Canyon Lake for years when Canyon Lake overflows occurred. This analysis shows an average of 40 percent of nutrient loads that reach Canyon Lake are retained in the lake and 60 percent of the loads overflow to Lake Elsinore. Therefore, allowable loads from the Canyon Lake watershed are converted into WLAs and LAs involving a 40/60 split to Canyon Lake (either East Bay or Main Lake) or Lake Elsinore TMDLs, respectively (Table 6-1).

Allocations of nutrient loads were parsed by current (2014 mapping) estimates of the land use areas within jurisdictional boundaries (**Figure 6-2**). Estimates of runoff and nutrient loading from these areas was done by reducing nutrients to reference concentrations in the watershed model. The subwatershed zone for jurisdictional areas plays a role in reference loading, due to a number of factors specific to each subwatershed (i.e., variations in annual rainfall and levels of downstream retention in Mystic Lake and in channel bottom characteristics). Distributions of allowable load by subwatershed were converted to allocations to each TMDL and jurisdiction based on the factors presented in Table 6-1. These allocations represent the nutrient load estimated to be delivered to each lake segment from upstream runoff under the reference watershed condition. The results of this analysis, presented in **Table 6-2** provides a snapshot based on 2014 jurisdictional boundaries, of allocations at lake inflows for each of the TMDLs. As jurisdictional areas change, anticipated to be largely from undeveloped or agricultural to urban areas, the allowable loads and need to reduce existing loads is transferred to the jurisdiction that is taking ownership (ex. for an agricultural field in Hemet that is converting to a commercial development, the City of Hemet would receive an increased allowable load to accommodate the increase in existing load).

6.2.3 Watershed Runoff Load Reductions to Meet TMDL Allocations

The incremental load above the allocations (see Table 6-2) represents the nutrient load attributable to anthropogenic watershed development. Thus, the difference between existing nutrient loads delivered at the lake inflow and allocations at the lake inflows is the reduction needed for each watershed jurisdiction to comply with the TMDLs (**Table 6-3**). This same mass reduction would be needed if watershed BMPs were used to reduce excess load from an individual jurisdictional area.

6.3 Supplemental Water

Supplemental water is added to Lake Elsinore to maintain lake levels, as authorized by the Santa Ana Water by Order No. R8-2002-0008-A02 (Santa Ana Water Board 2002). The DYRESM-CAEDYM model for Lake Elsinore showed that without supplemental water additions since 2002, lakebed desiccation would have likely occurred in 2014 under reference conditions (**Figure 6-3**). A WLA for supplemental water additions to Lake Elsinore based on projected effluent rates for EVMWD reclaimed water is provided in **Table 6-4**. Additional sources of supplemental water for the lakes are provisionally allowable, as long as the concentration of nutrients is equal to or less

7.2.3 Review of Existing Water Quality Control Activities

7.2.3.1 Overview

Stakeholders in the San Jacinto River watershed have actively planned and implemented watershed and in-lake water quality controls since the 1980s beginning with the LEMP project and followed by a diverse set of projects in the watershed and in each lake. Currently, the LECL Task Force or its member agencies implement BMPs, oversee operations required for many existing water quality controls, direct routine watershed and in-lake monitoring, and conduct important water quality studies to assess the effectiveness of existing controls. The various watershed and in-lake management activities are discussed below.

7.2.3.2 Watershed Best Management Practices

MS4 permittees in Riverside County within the San Jacinto River watershed have been implementing BMPs within their respective jurisdictions as part of the implementation of the CNRP (RCFC&WCD 2013). The agricultural community is also actively implementing BMPs through requirements established in the CWAD (Santa Ana Water Board 2017), which includes implementation of an AgNMP (WRCAC 2013a) and the General Waste Discharge Requirements for CAFOs applicable to the area (Santa Ana Water Board 2013c). The following subsections describe the existing water quality control activities that are being implemented under these various programs and the water quality benefits provided with regards to nutrient load reductions. Estimates of existing watershed runoff loads from jurisdictions in the watershed were developed using a simple model (see Section 4.1.4.3) that computes downstream annual nutrient loads as a function of average annual runoff and generalized land use nutrient washoff concentrations over spatially lumped jurisdictional. Reductions in loading from MS4 program or agricultural BMPs deployed at varying levels by each jurisdiction were not accounted for in the estimation of jurisdictional loads for the TMDL revision. It is anticipated that the CNRP and AgNMP updates will assess effectiveness of existing watershed BMPs and focus plans for future load reductions in areas that are not treated by existing controls.

MS4 Program

The Riverside County MS4 program is currently implementing the following BMPs within the portions of the San Jacinto River watershed subject to the LECL TMDL:

- *Street Sweeping and Debris Removal* - Street sweeping and MS4 facility debris removal activities reduce a significant source of nutrients in urban environments. Nutrient load reductions from street sweeping and debris removal activities were included in the CNRP compliance analysis. A continuous simulation model of exponential pollutant buildup and washoff was employed to estimate the nutrient load reduced as a result of street sweeping and debris removal program implementation (RCFC&WCD 2013). The model provides an estimate of 0.15 kg/yr TP and 0.5 kg/yr TN of nutrient load avoided for every metric ton of sediment removed from streets or drains by the MS4 program.

  Assuming these programs continue to be implemented at similar levels in the future, reductions in watershed loads are considered existing controls and reflective of current conditions (as reported in RCFC&WCD 2013) (**Table 7-2**). MS4 permittee jurisdictions may enhance existing programs to yield significant increases of sediment removal from street sweeping, catch basin cleaning, or other measures. If implemented, increased sediment

With regard to the observations in the San Jacinto River at Goetz Road monitoring site, the apparent increase in the median TP concentration should not be interpreted as a lack of improvement (Table 7-4). Assessment based on downstream concentration alone does not account for load reduction as a result of increased volume retention in stormwater BMPs. Other factors such as changing land use and soil erosion from burned undeveloped hillsides may have yielded even higher post-2011 nutrient concentrations without any deployment of watershed BMPs. For example, RCFC&WCD collected samples from the undeveloped portion of the Ortega Channel drainage area in the 2014-15 wet season following the Falls Fire in August 2013. Results showed TP and TN concentrations over one orders of magnitude greater than measured in an experimental forest in Colorado (**Table 7-5**). Thus, forest land management by the US Forest Service to prevent and contain fires may be an important nutrient control measure in the San Jacinto River watershed.

7.2.3.3 In-Lake Best Management Practices

Several existing in-lake BMPs have been working to accrue water quality benefits since adoption of the 2004 TMDL. In-lake water quality data analyses have evaluated the effectiveness of these controls on water quality in the lakes (Risk Sciences 2016; Horne 2015, 2018). These analyses generally have concluded that water quality improvements have been achieved; however, the post-implementation period is insufficient to develop representative CDFs to assess progress toward compliance with in-lake response targets. In the interim, progress toward achieving CDF numeric targets is estimated with the Linkage Analysis lake water quality models. The sections below provide specific effectiveness assessments for in-lake water quality control projects.

Canyon Lake Activities

Alum addition, an in-lake nutrient control BMP, has been implemented in Canyon Lake since 2013. When added to water, alum (aluminum sulfate) forms an aluminum hydroxide floc, which then binds with phosphorus in the water column and settles to the lake bottom. Once on the lake bottom, any remaining binding capacity is used to sequester a portion of phosphorus in porewater. The portion of phosphorous bound with aluminum on the lake bottom is inert and insoluble. It is no longer available for cycling back to the water column by processes of desorption and diffusive flux.

The LECL Task Force, with partial support from a Proposition 84 grant, implemented a pilot project to demonstrate the efficacy of alum addition for reducing bioavailable phosphorus as an algae control strategy in Canyon Lake. To satisfy CEQA requirements, a review of the planned project was completed in the summer of 2013. Carefully controlled doses of alum have been applied via surface spreading twice per year in Canyon Lake since September 2013 (**Table 7-6**).

Table 7-6. Dates of Alum Application and Kilograms of Dry Alum Applied by Lake Segment since September 2013

Date	Main Lake	East Bay	North Ski Area	Total
9/15/2013	140,000	50,000	0	190,000
2/10/2014	70,000	50,000	0	120,000

9.4 Approach 4: In-Lake Offsets

Allocations are developed for nutrients in external sources with an allowable concentration of nutrients, TN and TP, representative of a reference watershed. Demonstrating compliance involves first computing the excess nutrients in external sources. This amount is then used for determining the necessary offset credits from implementation of in-lake BMPs. Lastly, a project specific effectiveness analysis must be developed that computes the internal nutrient load reduction achieved with in-lake BMPs. The estimation of excess nutrients should consider the following:

- The load of nutrients in excess of reference conditions is computed from 10-yr average of flow weighted composite samples, collected as described in Section 8, Monitoring Requirements.
- Any samples collected at a downstream monitoring station that is influenced by atypical levels of erosion from burned hillsides (e.g. TSS > 1,000 mg/L) may be excluded from the calculation of average nutrient concentrations.
- Flow gauge data over the same 10-yr period at the same monitoring station is necessary to compute the mass of excess nutrients.
- If only one nutrient is found to meet the WLA/LAs at the first TMDL compliance reporting period following adoption of the TMDL revision, then a demonstration using either Approach 1 or 2 must accompany use of a single nutrient control strategy in all subsequent TMDL compliance reporting periods.

Figure 9-4 provides an example demonstrating compliance using this method for phosphorus in the San Jacinto River watershed to Canyon Lake Main Lake. The example is based on hypothetical (2020-2030) results from continued implementation of the watershed monitoring program.

The LECL TMDL Task Force currently uses in-lake offset credits to demonstrate compliance with the 2004 TMDL for Lake Elsinore as described in the CNRP for urban sources and AgNMP for agricultural sources. As of 2018, the methods of estimating demand for offset credits have not involved evaluation of downstream flow and nutrient concentration data relative to a reference condition, as conducted in Steps 1-6 in approach 4 shown below. Instead, loads in excess of a reference condition are computed for jurisdictional areas based on 2014 land use mapping and per acre export coefficients estimated in the LSPC watershed model developed for the 2004 TMDL. Approach 4 will allow in-lake BMPs to be operated on an as needed basis by using actual measured hydrologic and water quality conditions, thereby building in any actual load reductions realized from implementation of watershed BMPs.

Step 1. Compile 10 years of wet weather composite sample concentrations

Year	Storm 1 TP (mg/L)	Storm 2 TP (mg/L)	Storm 3 TP (mg/L)	Storm 1 TN (mg/L)	Storm 2 TN (mg/L)	Storm 3 TN (mg/L)
Year 1	0.47	0.71	0.41	2.80	2.40	1.73
Year 2	0.40	0.63	0.53	3.20	3.10	2.45
Year 3	0.38	0.52	1.10	5.00	2.90	2.14
Year 4	0.36	0.64	0.52	5.10	3.50	2.64
Year 5	0.30	0.34	0.34	2.90	4.57	4.08
Year 6	0.31	0.41	0.31	2.20	4.92	3.69
Year 7	0.53	0.44	2.88 *	2.00	2.91	6.02 *
Year 8	0.49	0.57	0.40	1.60	3.16	1.48
Year 9	0.62	0.73	0.41	1.76	1.58	1.63
Year 10	0.88	0.52	0.52	4.20	1.71	1.83

Step 2. Compute 10-yr Average Nutrient Concentration in Runoff	TP (mg/L) 0.51	TN (mg/L) 2.87
* Sample removed from average calculation because of influence of burned hillside erosion (TSS = 3163 mg/L)		
Step 3. Compute 10-yr Average Annual Runoff from Co-located Gauge (AF/yr):		1800
Step 4. Compute Nutrient Loads in Runoff (Step 2 * Step 3)	TP (kg/yr) 1,132	TN (kg/yr) 6,369
Step 5. Compute Allowable Nutrient Load (Step 3 * Ref Conc)	TP (kg/yr) 711	TN (kg/yr) 2,043
Step 6. Compute Nutrient Offset Offset to be demonstrated with in-lake BMPs (Step 4 - Step 5)	TP (kg/yr) 422	TN (kg/yr) 4,326
Step 7. Independent In-lake BMP Offset Effectiveness Demonstration:	**422 kg/yr TP**	Compliance √ - TP only

Figure 9-4. Hypothetical Example of Use of Nutrient Data to Evaluate Use of In-Lake Offsets as an Approach to Demonstrating Compliance

The use of in-lake BMPs to offset excess watershed nutrient loads involves multiple upstream entities, except for those able to demonstrate that allowable loads are met within the watershed. The relative contribution of each upstream entity to measured downstream loads is difficult to apportion without extensive upstream monitoring data. The PLOAD model used in the source assessment generalizes nutrient washoff by landuse across all jurisdictions and is not equipped to account for disproportionate deployment of watershed BMPs between upstream jurisdictions. Moreover, jurisdictional area is continually evolving in the SJR watershed (e.g. agricultural land conversion to urban jurisdictions), which would quickly make obsolete a model based on a snapshot in time of land use distribution. Relative contributions to excess downstream nutrient loading, and thereby apportionment of offset demands, must account for jurisdictional and land use changes through routine land use mapping updates. Updates to the CNRP and AgNMPs would benefit from a systematic method for reporting and tracking watershed BMP deployments by subwatershed to support a fair and scientifically defensible distribution of excess nutrient load measured at downstream lake inflows to apportion offset demands to upstream jurisdictions.