U.S. Environmental Protection Agency

Los Angeles Area Lakes TMDLs
March 2012

Section 7 Lake Calabasas TMDLs

7 Lake Calabasas TMDLs

Lake Calabasas (#CAL4052100019990203084034) is listed as impaired by ammonia, DDT (originally on the consent decree, but not on the current 303(d) list), eutrophication, odor, organic enrichment/low dissolved oxygen, and pH (SWRCB, 2010). This section of the TMDL report describes the impairments and the TMDLs developed to address them. Nutrient load reductions are required to achieve the chlorophyll *a* target; these reductions are also expected to alleviate pH, odor, DO and ammonia problems.

7.1 Environmental Setting

Lake Calabasas is a private lake located in the Los Angeles River Basin (HUC 18070105) in the city of Calabasas (Figure 7-1). The Urban Lakes Study (UC Riverside, 1994) reported that the lake was constructed in 1968. The area occupied by the lake was excavated to bedrock, a layer of soil was added, and then a plastic liner was put down and covered with soil along with cement in some areas. The lake is surrounded by dense residential development (Figure 7-2) and owned by the Calabasas Park Homeowners Association. This 17.8-acre lake (surface area based on Southern California Association of Governments (SCAG) 2005 land use data) does not discharge to surface waters but rather loses water via evaporation (UC Riverside, 1994). During storm events water discharges to the storm drain system. With a volume of 71.2 acre-feet, the average depth is approximately 4 feet (depth provided by the city of Calabasas; volume is calculated from this depth and the land use-based surface area). Recreation includes paddle boating and limited fishing (catch and release fishing is mandated by the Calabasas Park Homeowner's Association). Bird feeding may be another recreational activity at Lake Calabasas; however, it has not been observed during recent fieldwork. Residents are not allowed to swim in the lake. Figure 7-3 shows a view of Lake Calabasas facing the southwest. There are approximately 25 aerators in the lake (Figure 7-4). Lake managers use algaecides (including Cutrine Plus and copper sulfate) to control algal growth in the lake on an as-needed basis. Additional characteristics of the watershed are summarized below.

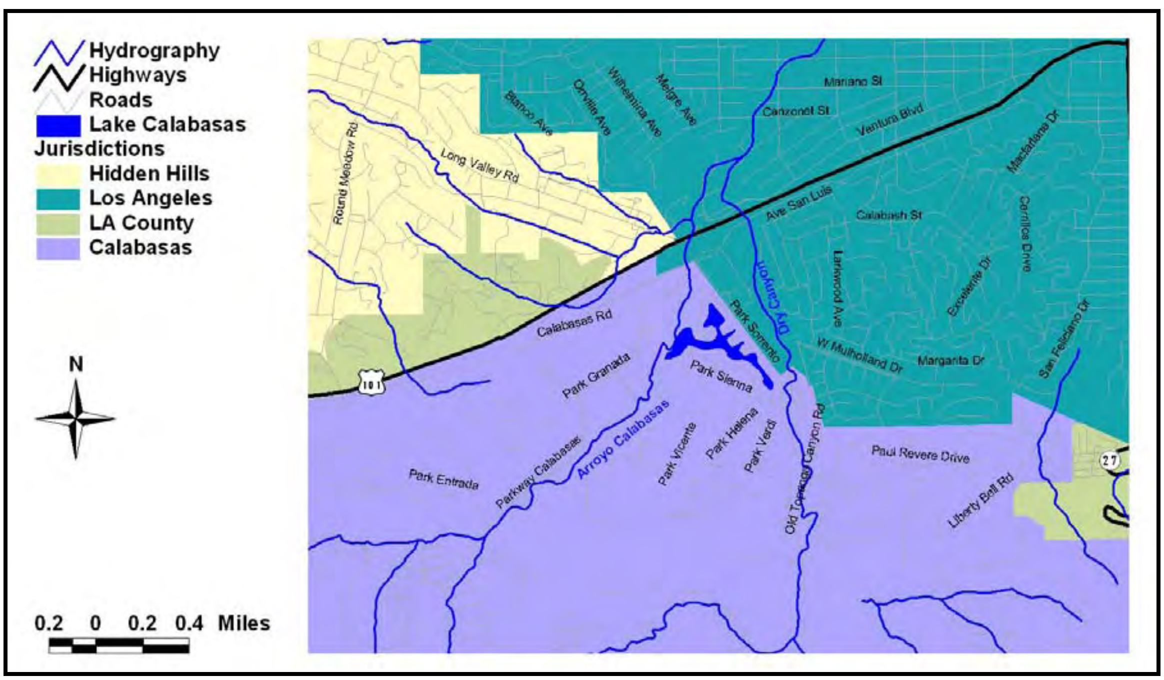

Figure 7-1. Location of Lake Calabasas

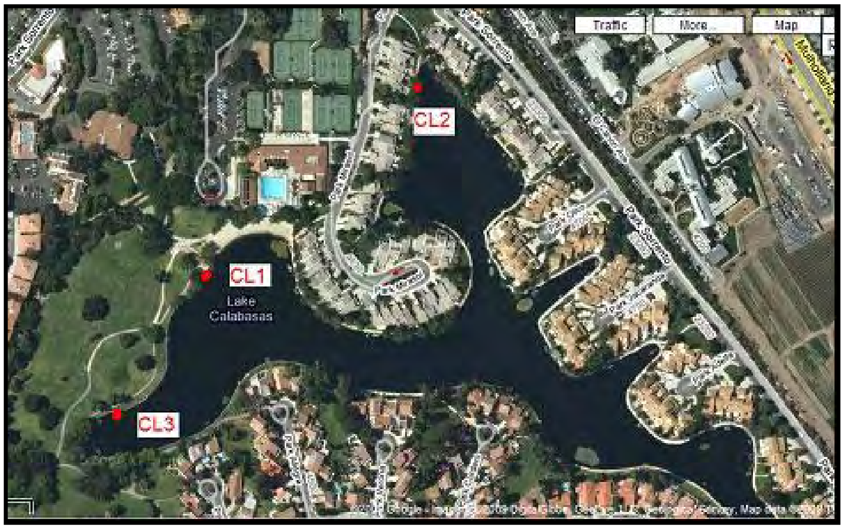

Figure 7-2. Satellite Imagery of Lake Calabasas

Figure 7-3. Lake Calabasas (facing southwest)

Note: multiple aerators are in the lake (several are visible in this picture)

Figure 7-4. Lake Calabasas Aerators

7.1.1 Elevation, Storm Drain Networks, and Subwatershed Boundaries

The Lake Calabasas watershed is 86.5 acres and ranges in elevation from 287 meters to 398 meters. Due to the small scale of this watershed, the boundary was manually delineated based on aerial photography, digital elevation data, and the county of Los Angeles storm drain coverage (Figure 7-5). Because many small storm drains discharge into the lake, all allocations for the TMDLs will be wasteload allocations except load allocations for atmospheric deposition. Figure 7-6 shows one of the storm drains capturing flow from the surrounding watershed. As shown in Figure 7-5, multiple storm drains contribute directly to the lake.

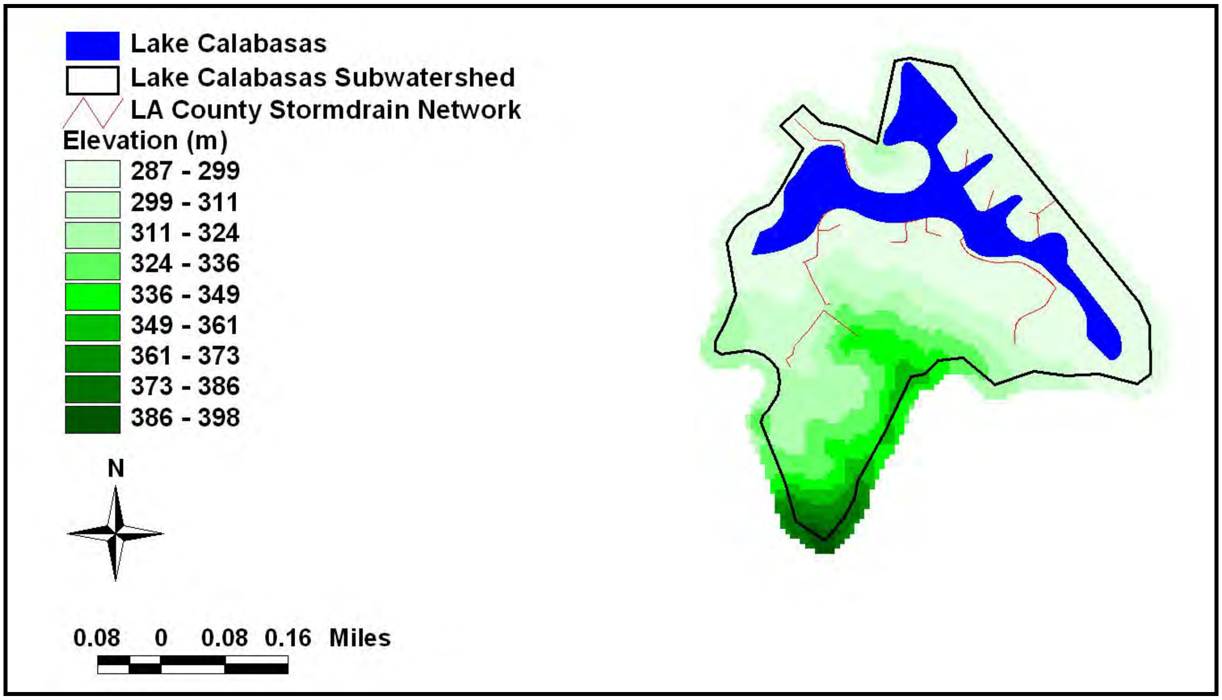

Figure 7-5. Elevation, Storm Drain Network, and the TMDL Subwatershed Boundary for Lake Calabasas

Note: many small storm drains capture flow from surrounding areas into the lake.

Figure 7-6. Lake Calabasas Storm Drain

7.1.2 MS4 Permittees

Figure 7-7 shows the MS4 stormwater permittee in the Lake Calabasas watershed. The entire subwatershed is comprised of the city of Calabasas. The storm drain coverage was provided by the county of Los Angeles.

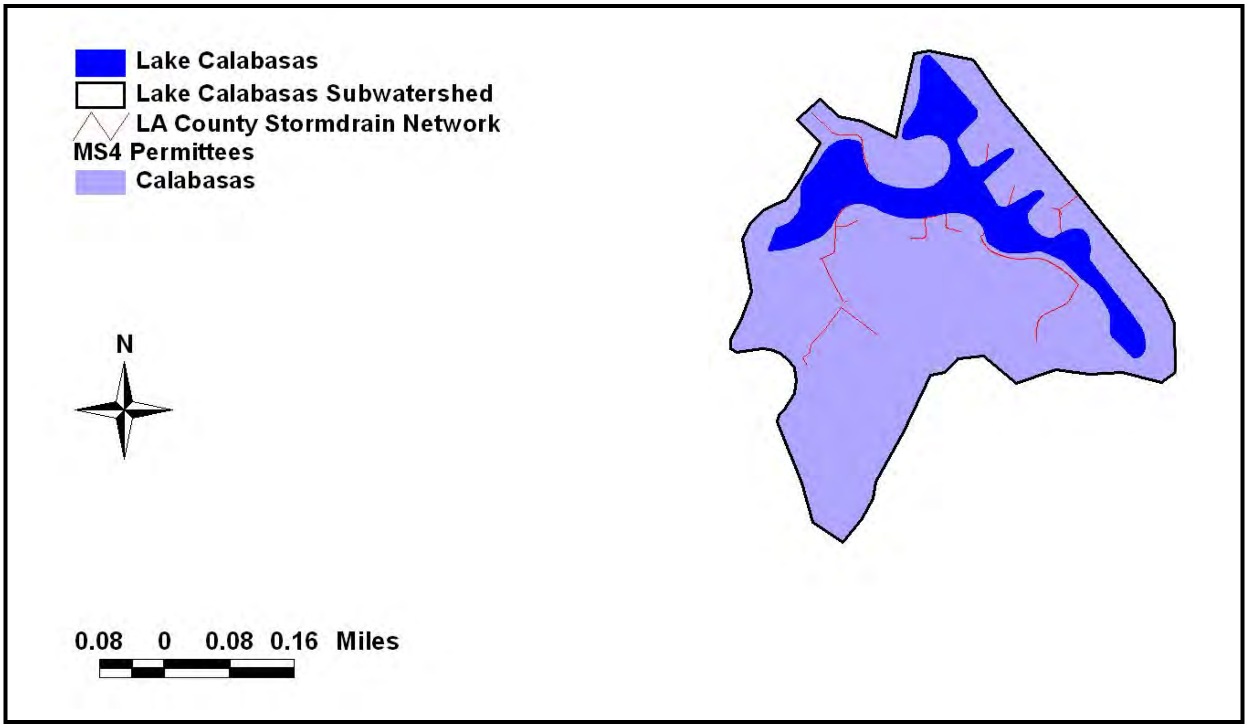

Figure 7-7. MS4 Permittee and the Storm Drain Network in the Lake Calabasas Subwatershed

7.1.3 Non-MS4 NPDES Dischargers

As of the writing of these TMDLs, there are no additional (non-MS4) NPDES permitted discharges in the Lake Calabasas watershed. This includes non-stormwater discharges (individual and general permits) as well as general stormwater permits associated with construction and industrial activities.

7.1.4 Land Uses and Soil Types

The analysis for this watershed includes estimates of existing watershed loading obtained from the Los Angeles River Basin LSPC Model, discussed in Appendix D (Wet Weather Loading) of this TMDL report. Land uses identified in the Los Angeles River Basin LSPC model are shown in Figure 7-8. The watershed is comprised of residential development and open space. Table 7-1 summarizes the land use areas draining to Lake Calabasas.

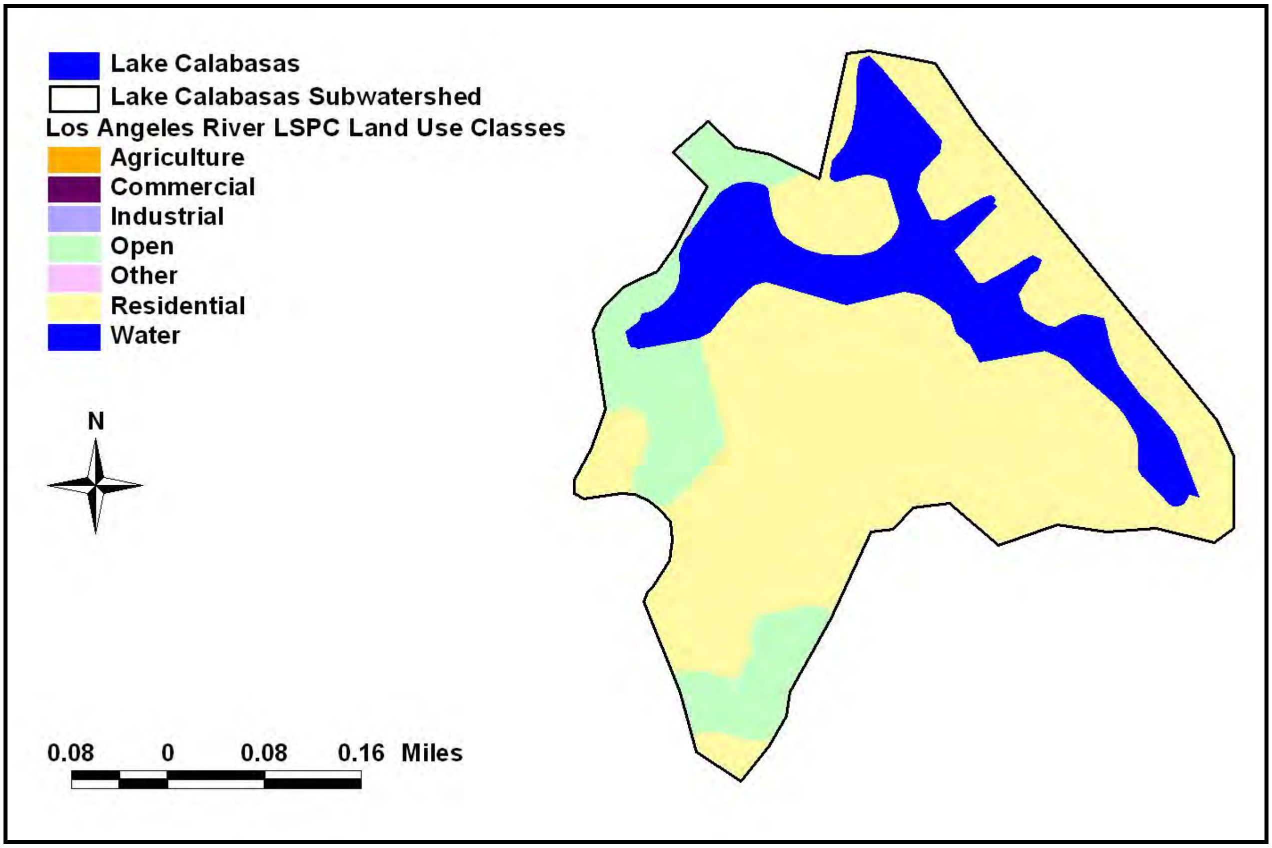

Figure 7-8. LSPC Land Use Classes for the Lake Calabasas Subwatershed

Table 7-1. Land Use Areas (ac) Draining to Lake Calabasas

Land Use	City of Calabasas
Agriculture	0
Commercial	0
Industrial	0
Open	14.2
Other Urban	0.0
Residential	72.3
Total	**86.5**

There are no Resource Conservation and Recovery Act (RCRA) contaminated industrial facilities located near the Lake Calabasas watershed. Figure 7-9 shows the predominant soils identified by STATSGO (Appendix D, Wet Weather Loading) in the Lake Calabasas subwatershed. The soil type identified as MUKEY 660489 is Urban Land-Lithic Xerorthents-Hambright-Castaic, a hydrologic group D soil, which has high runoff potential, very low infiltration rates, and consists chiefly of clay soils. Soil MUKEY 660473 is Urban Land-Sorrento-Hanford, a hydrologic group B soil, which has moderate infiltration rates and moderately coarse textures. The representative soil group for each LSPC modeling subbasin was based on the dominant soil type present in the subbasin. For the modeling subbasin that contains the Lake Calabasas watershed, the predominant soil type was type D. Additionally, the watershed around Lake Calabasas rests on alluvium and the Monterey Formation. The Monterey Formation is a petroleum source rock which can produce high concentrations of nutrients, organic carbon, trace metals, selenium and high sulfate salts (USGS, 2002).

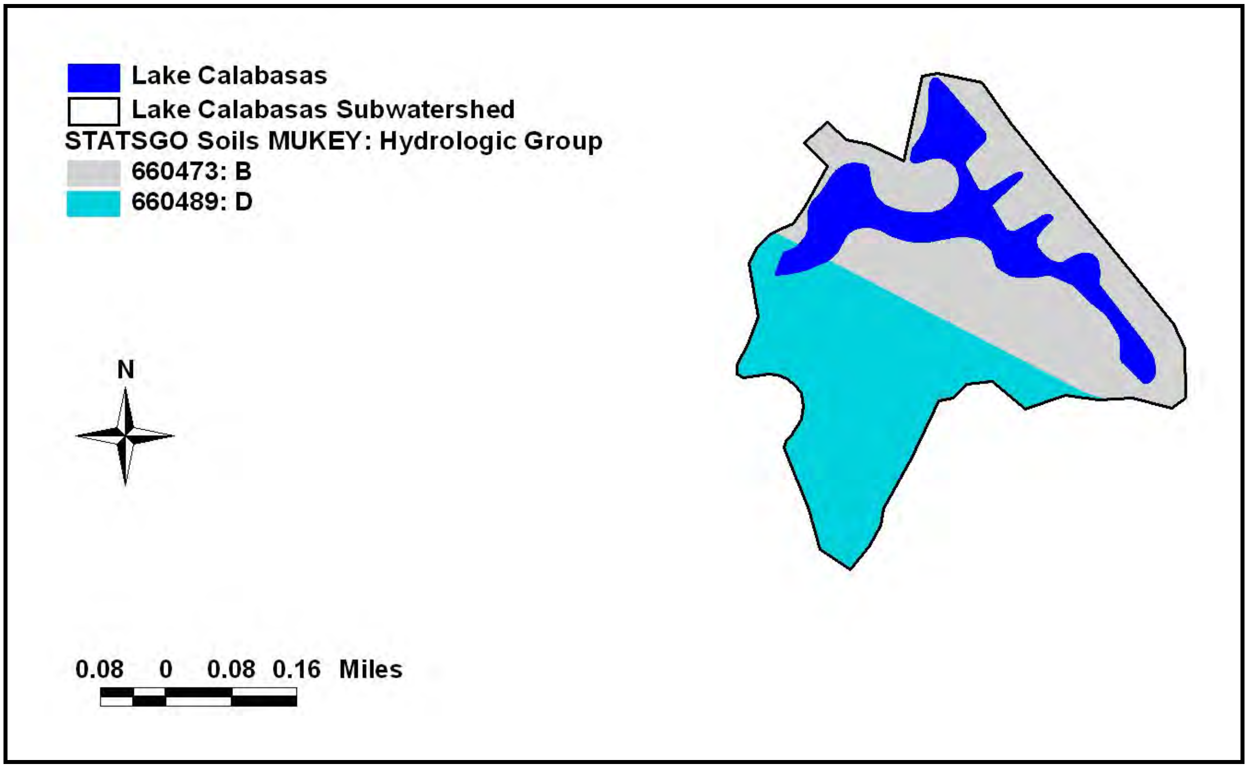

Figure 7-9. STATSGO Soil Types Present in the Lake Calabasas Subwatershed

7.1.5 Additional Inputs

According to the 1994 Urban Lakes Study (UC Riverside, 1994), the primary sources of water to Lake Calabasas are potable water from the Las Virgenes Municipal Water District and stormwater from the surrounding housing development. These water sources were confirmed during recent fieldwork performed by USEPA.

7.2 Nutrient-Related Impairments

A number of the assessed impairments for Lake Calabasas are associated with nutrients and eutrophication. Nutrient-related impairments for Lake Calabasas include ammonia, eutrophication, odor, organic enrichment/low dissolved oxygen, and pH (SWRCB, 2010). The loading of excess nutrients enhances algal growth (eutrophication). Algal photosynthesis removes carbon dioxide from the water, which can lead to elevated pH in poorly buffered systems. Respiration during nighttime hours may cause decreased dissolved oxygen (DO) concentrations. Algal blooms may also contribute to odor problems.

7.2.1 Beneficial Uses

California state water quality standards consist of the following elements: 1) beneficial uses, 2) narrative and/or numeric water quality objectives, and 3) an antidegradation policy. In California, beneficial uses are defined by the Regional Water Quality Control Boards (Regional Boards) in the Water Quality Control Plans (Basin Plans). Numeric and narrative objectives are specified in each region's Basin Plan, designed to be protective of the beneficial uses of each waterbody in the region. Lake Calabasas was not identified specifically in the Basin Plan; therefore, the beneficial uses associated with the downstream segment (Arroyo Calabasas) apply: REC1, REC2, WARM, WILD, and MUN (personal communication, Regional Board, February 24, 2010). Descriptions of these uses are listed in Section 2 of this TMDL report. Elevated nutrient levels are currently impairing the REC1, REC2, and WARM uses by stimulating algal growth that may form mats that impede recreational and drinking water uses, alter pH and dissolved oxygen (DO) levels and alter biology that impair the aquatic life use, and cause odor and aesthetic problems. At high enough concentrations WILD and MUN uses could become impaired.

7.2.2 Numeric Targets

The Basin Plan for the Los Angeles Region (LARWQCB, 1994) outlines the numeric targets and narrative criteria that apply to Lake Calabasas. The following targets apply to the ammonia, eutrophication, odor, organic enrichment/low dissolved oxygen, and pH impairments (see Section 2 for additional details and Table 7-2 for a summary):

- The Basin Plan expresses ammonia targets as a function of pH and temperature because un-ionized ammonia (NH_3) is toxic to fish and other aquatic life. In order to assess compliance with the standard, the pH, temperature and ammonia must be determined at the same time. For the purposes of setting a target for Lake Calabasas in these TMDLs, a median temperature of 21.8 ºC and a 95th percentile pH of 9.4 were used, as explained in Section 2. The resultant acute (one-hour) ammonia target is 0.78 mg-N/L, the four-day average is 0.46 mg-N/L, and the 30-day average (chronic) target is 0.19 mg-N/L (Note: the median temperature and 95th percentile pH values were calculated from the observed data and used in the calculation of the acute and chronic targets. These are presented as example calculations since the actual target varies with the values determined during sample collection.).
- The Basin Plan addresses excess aquatic growth in the form of a narrative objective for nutrients. Excessive nutrient concentrations (e.g., nitrogen and phosphorous) in a waterbody can lead to nuisance effects such as algae, odors, and scum. The objective specifies, "waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses." The Regional Board has not adopted numeric targets for biostimulatory nutrients or chlorophyll *a* in Lake Calabasas; however, as described in Tetra Tech (2006), summer (May to September) mean and annual mean chlorophyll *a* concentrations of 20 µg/L are selected as the maximum allowable level consistent with full support of contact recreational use and is also consistent with supporting warm water aquatic life. The mean chlorophyll *a* target must be met at one-half the Secchi depth during the summer (May – September) and annual averaging periods.
- The Basin Plan states that "waters shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible aquatic resources, cause nuisance, or adversely affect beneficial uses."
- The Basin Plan states "at a minimum the mean annual dissolved oxygen concentrations of all waters shall be greater than 7 mg/L, and no single determinations shall be less than 5.0 mg/L, except when natural conditions cause lesser concentrations." In addition, the Basin Plan states, "the dissolved oxygen content of all surface waters designated as WARM shall not be depressed below 5 mg/L as a result of waste discharges." Shallow, well-mixed lakes, such as Lake Calabasas, must meet the DO target in the water column from the surface to 0.3 meters above the bottom of the lake.

- The Basin Plan states that "the pH of inland surface waters shall not be depressed below 6.5 or raised above 8.5 as a result of waste discharges. Ambient pH levels shall not be changed more than 0.5 units from natural conditions as a result of waste discharge." Shallow, well-mixed lakes, such as Lake Calabasas, must meet the pH target in the water column from the surface to 0.3 meters above the bottom of the lake.

Nitrogen and phosphorus target concentrations are based on simulation of allowable loads with the NNE BATHTUB model (see Section 7.2.5). Based on the calibrated model for Lake Calabasas, the target nutrient concentrations within the lake are

- 0.66 mg-N/L summer average (May – September) and annual average
- 0.066 mg-P/L summer average (May – September) and annual average

Table 7-2. Nutrient-Related Numeric Targets for Lake Calabasas

Parameter	Numeric Target	Notes
Ammonia[1]	0.78 mg-N/L acute (one-hour) 0.46 mg-N/L four-day average 0.19 mg-N/L chronic (30-day average)	Based on median temperature and 95th percentile pH
Chlorophyll *a*	20 µg/L summer average (May – September) and annual average	
Dissolved Oxygen	7 mg/L minimum mean annual concentrations and 5 mg/L single sample minimum except when natural conditions cause lesser concentrations	
pH	The pH of inland surface waters shall not be depressed below 6.5 or raised above 8.5 as a result of waste discharges. Ambient pH levels shall not be changed more than 0.5 units from natural conditions as a result of waste discharge. (Basin Plan) 6.5 – 9.0 (EPA's 1986 Recommended Criteria)	The existing water quality criteria for pH is very broad and in cases where waste discharges are not causing the alteration of pH it allows for a wider range of pH than EPA's recommended criteria. For this reason, EPA's recommended criteria is included as a secondary target for pH.
Total Nitrogen	0.66 mg-N/L summer average (May – September) and annual average	Based on simulation of allowable loads from the NNE BATHTUB model
Total Phosphorous	0.066 mg-P/L summer average (May – September) and annual average	Based on simulation of allowable loads from the NNE BATHTUB model

[1] The median temperature and 95th percentile pH values were calculated from the observed data and used in the calculation of the acute and chronic targets. These are presented as example calculations since the actual target is the water quality objective which is dependent on pH and temperature. When assessing compliance refer to the water quality objective as expressed in the Basin Plan..

7.2.3 Summary of Monitoring Data

This section briefly summarizes the nutrient-related monitoring data for Lake Calabasas. Appendix G (Monitoring Data) contains more detailed information regarding water quality sampling in the lake.

Lake Calabasas was monitored from the southwestern lobe of the lake as part of the Urban Lakes Study (UC Riverside, 1994). Total Kjeldahl nitrogen (ammonia plus organic nitrogen; TKN) ranged from 1.0 mg-N/L to 1.8 mg-N/L with two samples less than the detection limit (0.01 mg-N/L). Ammonium concentrations were usually less than or equivalent to the detection limit (0.01 mg-N/L) although four samples collected in February and March 1993 ranged from 0.3 mg-N/L to 0.5 mg-N/L (less than the acute target assuming the analysis methodology converted all ammonia to ammonium). All of the nitrite and nitrate samples were less than the detection limit (0.01 mg-N/L) except one nitrate sample of 0.1 mg/L. Five of 28 phosphate samples measured 0.1 mg-P/L; the others were less than the detection limit (0.01 mg-P/L). Total phosphorus concentrations ranged from 0.1 mg-P/L to 0.2 mg-P/L with seven samples less than detection (0.01 mg-P/L). pH in the lake ranged from 8.3 to 9.3 throughout the water column, and 78 percent of samples exceeded the allowable range. The summary table from the 1994 Lakes Study Report (UC Riverside, 1994) lists chlorophyll *a* concentrations ranging from 5 µg/L to 172 µg/L with an average of 39 µg/L, which is greater than the target summer average of 20 µg/L.

The 1996 Water Quality Assessment Report (LARWQCB, 1996) states that DO was partially supporting the aquatic life use and that 92 measurements of DO were collected which ranged from 0.2 mg/L to 15.7 mg/L. pH was partially supporting the aquatic life use and not supporting the secondary drinking water standards. pH was measured 85 times, and values ranged from 7.4 to 9.3. Ammonia was listed as not supporting the aquatic life or contact recreation uses. Twenty-eight ammonia samples were collected ranging from non-detect to 0.45 mg-N/L with an average of 0.06 mg-N/L. Raw data are not available to assess location, date, time, depth, temperature, or pH with regard to these samples. Odor was listed as not supporting the contact and non-contact recreation uses. Eutrophication was not supporting the aquatic life use.

The city of Calabasas has been monitoring water quality in Lake Calabasas since 2004. Samples were collected from the surface waters. Nitrate concentrations have ranged from 0.04 mg-N/L to 1.6 mg-N/L; phosphate concentrations ranged from 0.03 mg-P/L to 0.77 mg-P/L. Secchi depths range from 0.5 m to greater than 2.7 m, and pH ranged from 7.91 to 9.69. Dissolved oxygen has been observed ranging from 4.8 mg/L to 15.82 mg/L with water temperatures ranging from 9.2 ºC to 32.7 ºC. Exceedances of the pH target were observed in approximately 77 percent of the measurements; DO exceedances were observed approximately 3 percent of the time.

The Regional Board sampled Lake Calabasas from two in-lake sites on August 6, 2009. Ammonia concentrations were less than or equal to 0.03 mg-N/L; TKN ranged from 1.17 mg-N/L to 1.23 mg-N/L. Nitrate and nitrite samples were less than the detection limit of 0.01 mg-N/L. Orthophosphate ranged from 0.0129 mg-P/L to 0.0453 mg-P/L and total phosphorus ranged from 0.152 mg-P/L to 0.221 mg-P/L. Chlorophyll *a* ranged from 35 µg/L to 81 µg/L. Secchi depth ranged from 0.66 m to 0.74 m. Profile data were also collected between 9:00 a.m. and 9:50 a.m. The temperature in the lake ranged from 25.6 °C to 26.4 °C. The DO ranged from 6.37 to 9.74 mg/L, and pH ranged from 7.98 to 9.30 over the assessment depth. Exceedances of the pH target occurred in 98 percent of the measurements taken during the profiles conducted on this day (excluding the measurements taken less then 0.3 m above the lake bottom).

Water quality data collected in Lake Calabasas indicate impairment due to elevated nutrient loads. Summer average chlorophyll *a* concentrations exceed the target concentration of 20 µg/L. The DO target has been met during recent sampling events, but historic data indicate that low DO may have been an issue for the lake. Currently, aerators appear to be controlling DO concentrations. No odors were observed during two recent sampling events by USEPA and/or Regional Board. pH measurements have exceeded the maximum allowable value (8.5) during recent and historic monitoring. There were no exceedances of the acute or chronic ammonia criteria during any recent sampling events with associated pH and temperature measurements. The nutrient TMDLs for Lake Calabasas presented in Section 7.2.6 account for summer season critical conditions by assessing loading rates consistent with meeting the summer chlorophyll *a* target concentration of 20 µg/L. These reductions in nutrient loading are expected to alleviate pH, odor, DO, and ammonia problems associated with excessive nutrient loading and eutrophication.

7.2.4 Source Assessment

The majority of nutrient loading to Lake Calabasas originates from the surrounding watershed (Appendix D, Wet Weather Loading; Appendix F, Dry Weather Loading), including irrigation (5.3 percent of the total irrigation volume is assumed to reach the lake). The watershed is entirely within the city of Calabasas and contributes 97.7 percent of the total phosphorus load and 74.4 percent of the total nitrogen load. Loading due to direct deposition from the atmosphere is discussed in Appendix E (Atmospheric Deposition).

Table 7-3. Summary of Average Annual Flows and Nutrient Loading to Lake Calabasas

Responsible Jurisdiction	Input	Flow (ac-ft)	Total Phosphorus (lb-P/yr) (percent of total load)	Total Nitrogen (lb-N/yr) (percent of total load)
City of Calabasas	MS4 Stormwater[1]	69.3	129 (97.7)	769 (74.4)
Calabasas Park Homeowners Association	Supplemental Water Additions (Potable Water)	57.9	3.28 (0.03)	252 (24.4)
City of Calabasas	Parkland Irrigation	0.151	0.0085 (0.00)	0.655 (0.00)
	Atmospheric Deposition (to the lake surface) [2]	26.0	NA	12.4 (0.01)
Total		**153**	**132**	**1,034**

[1] This input includes effluent from storm drain systems during both wet and dry weather.

[2] Loads for atmospheric deposition are based on direct precipitation to the lake (calculated by the annual average precipitation multiplied by the surface area of the lake).

7.2.5 Linkage Analysis

The linkage analysis defines the connection between numeric targets and identified pollutant sources and may be described as the cause-and-effect relationship between the selected indicators, the associated numeric targets, and the identified sources. This provides the basis for estimating total assimilative capacity and any needed load reductions. To simulate the impacts of nutrient loading on Lake Calabasas, the nutrient numeric endpoints (NNE) BATHTUB Tool was set up and calibrated to lake-specific conditions. The NNE BATHTUB Tool is a version of the US Army Corps of Engineers (USACE) BATHTUB model and was developed to support risk-based nutrient numeric endpoints in California (Tetra Tech, 2006).

BATHTUB is a steady-state model that calculates nutrient concentrations, chlorophyll *a* concentration (or algal density), turbidity, and hypolimnetic oxygen depletion based on nutrient loadings, hydrology, lake morphometry, and internal nutrient cycling processes. BATHTUB uses a typical mass balance modeling approach that tracks the fate of external and internal nutrient loads between the water column, outflows, and sediments. External loads can be specified from various sources including stream inflows, nonpoint source runoff, atmospheric deposition, groundwater inflows, and point sources. Internal nutrient loads from cycling processes may include sediment release and macrophyte decomposition. The net sedimentation rates for nitrogen and phosphorus reflect the balance between settling and resuspension of nitrogen and phosphorus within the waterbody. Thus, internal loading is implicitly accounted for in the model. Since BATHTUB is a steady-state model, it focuses on long-term average conditions rather than day-to-day variations in water quality.

Target nutrient loads and resulting allocations are determined based on the secondary target – summer mean chlorophyll *a* concentration. The NNE spreadsheet tool allows the user to specify a chlorophyll *a* target and predicts the probability that current conditions will exceed the target, as well as showing a matrix of allowable nitrogen and phosphorus loading combinations to meet the target. The user-defined chlorophyll *a* target can be input directly by the user, or can be calculated based on an allowable change in water transparency measured as Secchi depth. Appendix A (Nutrient TMDL Development) describes additional details on the NNE BATHTUB Tool and its use in determining allowable loads of nitrogen and phosphorus. In addition to loading rates of nitrogen and phosphorus, the NNE BATHTUB Tool requires basic bathymetry data for the simulation of chlorophyll *a* during the summer. For Lake Calabasas, the following inputs apply: surface area of 17.8 acres, average depth of 4 ft, and volume of 71.2 ac-ft. Based on the phosphorus turnover ratio for this lake (Walker, 1987), the annual averaging period is appropriate (i.e., annual loads are input to the model rather than summer season loads).

The NNE BATHTUB Tool was calibrated to average summer season water quality data observed over twice the typical Secchi depth (2*1.1 m = 2.2 m). To predict the average observed total nitrogen concentration over this depth (1.47 mg-N/L), the calibration factor on the net nitrogen sedimentation rate was set to 1.5. The calibration factor on the net phosphorus sedimentation rate was set to the maximum suggested (2) (Walker, 1987) and the resulting concentration is 0.11 mg-P/L, slightly higher than the average observed 0.099 mg-P/L. Although this calibrated sedimentation rate reflects the net effects of phosphorus settling and resuspension, the high calibration factor indicates that settling is the more dominant mechanism in this system, and internal phosphorus loading is likely insignificant relative to the other sources of loading. The reductions in external phosphorus loading in the lake required by this TMDL should lead to further suppression of internal loading. To simulate the average observed chlorophyll *a* concentration, the calibration factor on concentration was set to 0.84 for a predicted concentration of 48.7 µg/L.

7.2.6 TMDL Summary

A waterbody's loading capacity represents the maximum load of a pollutant that can be assimilated without violating water quality standards (40 CFR 130.2(f)). This is the maximum nutrient load consistent with meeting the numeric target of 20 µg/L of chlorophyll *a* as a summer average. The methodology for determining the loading capacity is described briefly in this section. For more detail, refer to Appendix A (Nutrient TMDL Development).

Following calibration of the NNE BATHTUB Tool (Section 5.2.5), the allowable loading combinations of nitrogen and phosphorus were calculated using Visual Basic's GoalSeek function (Appendix A, Nutrient TMDL Development). The loading combination that is predicted to result in an in-lake ratio of total nitrogen concentration to total phosphorus concentration close to 10 was selected to match that typically observed in natural systems and to balance biomass growth and prevent limitation by one nutrient (Thomann and Mueller, 1987). The corresponding in-lake concentrations of nitrogen and phosphorus are

- 0.66 mg-N/L summer average (May – September) and annual average
- 0.066 mg-P/L summer average (May – September) and annual average

The loading capacities for total nitrogen and total phosphorus are 328 lb-N/yr and 55.1 lb-P/yr, respectively. These loading capacities can be further broken down into the wasteload allocations (WLAs), load allocations (LAs), and Margin of Safety (MOS) using the general TMDL equation:

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

For total nitrogen, the allocatable load (divided among WLAs and LAs) is 28.6 percent of the existing load of 1,034 lb-N/yr, or 295 lb-N/yr. This value represents 90 percent of the loading capacity, while the MOS is 10 percent of the loading capacity. WLAs and LAs are developed assuming equal percent load reductions in all sources. The resulting TMDL equation for total nitrogen is then:

$$328 \text{ lb-N/yr} = 292 \text{ lb-N/yr} + 3.54 \text{ lb-N/yr} + 32.8 \text{ lb-N/yr}$$

For total phosphorus, the allocatable load (divided among WLAs and LAs) is 37.7 percent of the existing load of 132 lb-P/yr, or 49.7 lb-P/yr. This value represents 90 percent of the loading capacity, while the MOS is 10 percent of the loading capacity. The resulting TMDL equation for total phosphorous is then:

$$55.1 \text{ lb-P/yr} = 49.7 \text{ lb-P/yr} + 0 \text{ lb-P/yr} + 5.51 \text{ lb-P/yr}$$

Allocations are assigned for these TMDLs by requiring equal percentage reductions of all sources. Details associated with the WLAs, LAs, and MOS are presented in the following three sections. As previously mentioned, in-lake concentrations of nitrogen and phosphorus have been determined based on simulation of allowable loads with the NNE BATHTUB model (see Section 7.2.5). These in-lake concentrations are calculated from a complex set of equations that consider internal cycling processes (see Appendix A, Nutrient TMDL Development) and, therefore, differ from concentrations associated with various inflows. Nutrient concentrations associated with the WLA and LA inputs are described below. These values are provided as examples as they are calculated based on existing flow volumes (and will need to be recalculated if flow volumes change). Because the input concentrations do not consider internal cycling processes and are based on existing flow volumes, they do not match the allowable in-lake nitrogen and phosphorous concentrations.

7.2.6.1 Wasteload Allocations

Federal regulations require that NPDES permits incorporate water quality based effluent limitations (WQBELs) consistent with the requirements and assumptions of any available wasteload allocations (WLAs). These TMDLs establish WLAs and alternative WLAs for total phosphorous and total nitrogen. The alternative WLAs will be effective and supersede the WLAs listed in Table 7-4 if the conditions described in Section 7.2.6.1.2 are met.

Under any of the wasteload allocation schemes responsible jurisdictions are encouraged to consider the construction of wetland systems and bioswales (or other retention or treatment options) to treat the stormwater and supplemental water flows entering the lake, as well as stormwater diversion and infiltration using methods such as porous pavements and rain gardens. Implementing these options can reduce the lake's nutrient loads and, in the case of recirculation through constructed wetlands, reduce in-lake nutrient concentrations. Additionally, persons that apply algaecides as part of an overall lake management strategy must comply with the Aquatic Pesticide General Permit (General Permit Order No. 2004-0009-DWQ, CAG990005).

Local jurisdictions have performed studies on nearby waterbodies that may be considered when evaluating nutrient-reduction strategies for this lake. For example, the City of Los Angeles has modeled expected nutrient concentration reductions to stormwater flows to Echo Park Lake from constructed wetlands, and construction is currently underway. Information about this and other City of Los Angeles water quality improvement projects are available on the Proposition O website: http://www.lapropo.org/sitefiles/lariver.htm.

7.2.6.1.1 Wasteload Allocations

The Lake Calabasas watershed drains to a series of storm drains prior to discharging to the lake. Therefore, all loads associated with the surrounding drainage area are assigned WLAs (Note: the loading associated with irrigation is included in the City of Calabasas' WLA). The supplemental water source used to maintain lake levels discharges at a single point and is also assigned a WLA. The relevant permit number associated with the stormwater input is

- County of Los Angeles (including the city of Calabasas): Board Order 01-182 (as amended by Order No. R4-2006-0074 and R4-2007-0042), CAS004001

Table 7-4 summarizes the existing nutrients loads and WLAs for these sources. Total phosphorus WLAs represent a 62.4 percent reduction in existing loading, and total nitrogen WLAs represent a 71.4 percent reduction in existing loading (Table 7-4). Each WLA must be met at the point of discharge.

Table 7-4. Wasteload Allocations of Phosphorus and Nitrogen Loading to Lake Calabasas

Responsible Jurisdiction	Input	Existing Total Phosphorus Load (lb-P/yr)	Wasteload Allocation Total Phosphorus[1] (lb-P/yr)	Existing Total Nitrogen Load (lb-N/yr)	Wasteload Allocation Total Nitrogen[1] (lb/yr)
City of Calabasas	MS4 Stormwater[2]	129	48.5	770	220
Calabasas Park Homeowners Association	Supplemental Water Additions	3.28	1.23	252	72.0
Total		**132**	**49.7**	**1,022**	**292**

[1] The wasteload allocation must be met at the point of discharge.

[2] This input includes effluent from storm drain systems during both wet and dry weather.

7.2.6.1.2 Alternative "Approved Lake Management Plan Wasteload Allocations"

Concentration-based WLAs not exceeding the concentrations listed in Table 7-5 are effective and supersede corresponding WLAs for a responsible jurisdiction in Table 7-4 if:

1. The responsible jurisdiction requests that concentration-based wasteload allocations not to exceed the concentrations established in Table 7-5 apply to it;
2. The responsible jurisdiction provides to USEPA and the Regional Board a Lake Management Plan describing actions that will be implemented and cause each of the following to be met: the applicable water quality criteria for ammonia, dissolved oxygen and pH; and the chlorophyll *a* targets listed in Table 7-2. Responsible jurisdictions may work together to develop, submit and implement the Lake Management Plan. A Lake Management Plan may include the following types of actions: increasing the volume of the lake that is aerated; installing hydroponic islands to remove nutrients; increasing flow volume or circulation in the lake; reducing stormwater discharges by improved infiltration; treating stormwater or supplemental water inputs with a wetland system; alum treatment to immobilize nutrients in sediments; and/or fisheries management actions to reduce nutrient availability from sediments. The responsible jurisdiction may use monitoring data and modeling to show that the water quality criteria, targets and requested WLAs will be met;
3. The Regional Board Executive Officer approves the request and applies concentration-based wasteload allocations for total nitrogen and total phosphorus. These wasteload allocations are not to exceed the concentrations in Table 7-5 as a summer average (May-September) and annual average; and,
4. USEPA does not object to the Regional Board's determination within sixty days of receiving notice of it.

The concentration-based WLAs must be met in the lake. However, if applicable water quality criteria for ammonia, dissolved oxygen and pH, and the chlorophyll *a* target are met, then the total phosphorus and total nitrogen allocations are considered attained.

Table 7-5. Alternative Wasteload Allocations of Phosphorus and Nitrogen in Lake Calabasas if an Approved Lake Management Plan Exists

Responsible Jurisdiction	Input	Maximum Allowable Wasteload Allocation Total Phosphorus[1] (mg-P/L)	Maximum Allowable Wasteload Allocation Total Nitrogen[1] (mg-N/L)
City of Calabasas	MS4 Stormwater[2]	0.1	1.0
Calabasas Park Homeowners Association	Supplemental Water Additions	0.1	1.0

[1] Each concentration-based wasteload allocation must be met in the lake. However, if applicable water quality criteria for ammonia, dissolved oxygen and pH, and the chlorophyll *a* target are met, then the total phosphorus and total nitrogen allocations are considered attained.

[2] This input includes effluent from storm drain systems during both wet and dry weather.

7.2.6.2 Load Allocations

Atmospheric deposition of nitrogen to the lake surface is a nonpoint source and is assigned a load allocation (LA). Table 7-6 lists the existing and allowable load (28.6 percent of the existing load) from this source. Atmospheric deposition does not contribute significant loads of phosphorus (Appendix E, Atmospheric Deposition). LAs are provided for each responsible jurisdiction and input. These loading values (in pounds per year) represent the TMDL load allocations (Table 7-6).

Table 7-6. Load Allocations of Nitrogen Loading to Lake Calabasas

Input	Existing Total Phosphorus Load (lb-P/yr)	Load Allocation Total Phosphorus (lb-P/yr)	Existing Total Nitrogen Load (lb-N/yr)	Load Allocation Total Nitrogen (lb/yr)
Atmospheric Deposition (to the lake surface)*	0	0	12.4	3.54
Total	**0**	**0**	**12.4**	**3.54**

* Loads for atmospheric deposition are based on direct precipitation to the lake (calculated by the annual average precipitation multiplied by the surface area of the lake).

7.2.6.3 Margin of Safety

TMDLs must include a margin of safety (MOS) to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality. The MOS may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. To account for the uncertainties concerning the relationship between nutrient loading and the resultant in-lake chlorophyll *a* an explicit MOS is included in these TMDLs. This explicit MOS is set at 10 percent of the loading capacity for total phosphorus and total nitrogen.

7.2.6.4 Critical Conditions/Seasonality

TMDLs must include consideration of critical conditions and seasonal variation to ensure protection of the designated uses of the waterbody at all times. Critical conditions for nutrient impaired lakes typically occur during the warm summer months when water temperatures are elevated and algal growth rates are high. Elevated temperatures not only reduce the saturation levels of DO, but also increase the toxicity of ammonia and other chemicals in the water column. Excessive rates of algal growth may cause large swings in DO, elevated pH, odor, and aesthetic problems. Loading of nutrients to lakes during winter months are often biologically available to fuel algal growth in summer months. These nutrient TMDLs account for summer season critical conditions by using the NNE Bathtub model to calculate possible annual loading rates consistent with meeting the summer chlorophyll *a* target concentration of 20 µg/L. These TMDLs are expected to alleviate any pH, odor, DO, and ammonia problems associated with excessive nutrient loading and eutrophication. These TMDLs therefore protect for critical conditions.

7.2.6.5 Daily Load Expression

USEPA recommends inclusion of a daily load expression for all TMDLs to comply with the 2006 D.C. Circuit Court of Appeals decision for the Anacostia River. These TMDLs present a maximum daily load according to the guidelines provided by USEPA (2007). Because the majority of nutrient loading to Lake Calabasas occurs during wet weather events that deliver pollutant loads from the surrounding watershed, the daily maximum allowable loads of nitrogen and phosphorus are calculated from the maximum daily storm flow rate (estimated from the 99^{th} percentile flow) to the Lake multiplied by the allowable concentrations consistent with achieving the long-term loading targets. These maximum loads are not allowed each day of the year because the annual loads specified by the TMDLs must also be achieved. The WLA and LA loads presented above are annual loading caps that cannot be exceeded.

No USGS gage currently exists in the Lake Calabasas watershed. USGS Station 11105500, Malibu Creek at Crater Camp near Calabasas, CA, was selected as a surrogate for flow determination. This gage is the closest USGS StreamStats gage. The 99^{th} percentile flow was chosen to represent the peak flow for this drainage. Choosing the 99^{th} percentile flow eliminates errors due to outliers and is reasonable for development of a daily load expression.

The USGS StreamStats program was used to determine the 99^{th} percentile flow for Malibu Creek (355 cfs) (Wolock, 2003). To estimate the peak flow to Lake Calabasas, the 99^{th} percentile flow for Malibu Creek was scaled down by the ratio of drainage areas (86.5 acres/67,200 acres; Lake Calabasas watershed area/Malibu Creek watershed area at the gage). The resulting peak flow estimate for Lake Calabasas is 0.457 cfs.

The allowable concentrations for phosphorus and nitrogen were calculated from the annual allowable load (49.7 lb-P/yr and 295 lb-N/yr, respectively; sum of WLA and LA values) divided by the total annual volume delivered to the lake (127 ac-ft). Multiplying the average allowable concentrations (0.257 mg-P/L for phosphorous and 1.17 mg-N/L for nitrogen) by the 99^{th} percentile peak daily flow (0.457 cfs) yields the daily maximum load. The daily maximum allowable loads of phosphorus and nitrogen for Lake Calabasas are 0.634 lb-P/d and 2.88 lb-N/day, respectively. These loads represent the maximum allowable daily load, which for Lake Calabasas, is entirely due to wet weather stormwater from city of Calabasas areas (supplemental water additions and irrigation are not needed during large storm events). For comparison, the existing phosphorus load (132 lb-P/yr) would yield an event mean concentration of 0.382 mg-P/L and a daily load of 0.942 lb-P/d. The existing nitrogen load (1,034 lb-N/yr) would yield an event mean concentration of 2.99 mg-N/L and a daily load of 7.38 lb-N/d. As described above, in order to achieve in-lake nutrient targets as well as annual load-based allocations, the maximum allowable daily loads cannot be discharged to the lake every day. The WLA and LA loads presented above are annual loading caps that cannot be exceeded.

7.2.6.6 Future Growth

The Lake Calabasas watershed is fully developed. No load allocation has been set aside for future growth, and it is unlikely that any dischargers will be permitted in the watershed.

If any sources currently assigned load allocations are later determined to be point sources requiring NPDES permits, those load allocations are to be treated as wasteload allocations for purposes of determining appropriate water quality-based effluent limitations pursuant to 40 CFR 122.44(d)(1).

7.3 IMPLEMENTATION RECOMMENDATIONS

Implementation measures may be developed in the future by the Regional Board through an implementation plan, NPDES permits, or non-point source enforcement. This section describes USEPA's recommendations to the Regional Board as to the implementation procedures and regulatory mechanisms that could be used to provide reasonable assurances that water quality standards will be met. General information about various lake management strategies can be found in a USEPA document titled *Managing Lakes and Reservoirs (EPA 841-B-01-006)*. Lake management options that could reduce pollutant loading to lakes include but are not limited to: increasing the volume of the lake that is aerated; installing hydroponic islands to remove nutrients; increasing flow volume or circulation in the lake; reducing stormwater discharges by improved infiltration; treating stormwater or supplemental water inputs with a wetland system; alum treatment to immobilize nutrients in sediments; dredging in lake sediments; and/or fisheries management actions to reduce nutrient availability from sediments.

Additionally, responsible jurisdictions implementing these TMDLs are encouraged to utilize Los Angeles County's Structural Best Management Practice (BMP) Prioritization Methodology which helps identify priority areas for constructing BMP projects. The tool is able to prioritize based on multiple pollutants. The pollutants that it can prioritize includes bacteria, nutrients, trash, metals and sediment. More information about this prioritization tool is available at: labmpmethod.org

If necessary, these TMDLs may be revised as the result of new information (See Section 7.4 Monitoring Recommendations).

7.3.1 Nonpoint Sources and the Implementation of Load Allocations

Regional Board may regulate nonpoint pollutant sources through the authority contained in sections 13263 and 13269 of the California Water Code, in conformance with the State Water Resources Control Board's Nonpoint Source Implementation and Enforcement Policy, and the Conditional Waiver for Discharges from Irrigated Lands, adopted by the Los Angeles Regional Water Quality Control Board on November 3, 2005. Additionally, South Coast Air Quality Management District has authority to regulate air emissions throughout the basin that affect air deposition. Load allocations are expressed in Table 7-6.

7.3.2 Point Sources and the Implementation of Wasteload Allocations

Wasteload allocations apply to MS4 Stormwater permits as well as supplemental water additions (Table 7-4 for Standard and Table 7-5 for Alternative Allocations). The MS4 stormwater mass-based wasteload allocations will be incorporated into the Los Angeles County MS4 permit. Wasteload allocations for supplemental water additions will be implemented by the Regional Board.

7.3.3 Source Control Alternatives

Responsible jurisdictions are encouraged to consider the construction of wetland systems and bioswales (or other retention or treatment options) to treat the stormwater and supplemental water flows entering the lake, as well as stormwater diversion and infiltration using methods such as porous pavements and rain gardens. Implementing these options can reduce the lake's nutrient loads and, in the case of recirculation through constructed wetlands, reduce in-lake nutrient concentrations. The City of Los Angeles has modeled expected nutrient concentration reductions to stormwater flows to Echo Park Lake from constructed wetlands, and construction is currently underway. Information about this and other City of Los Angeles water quality improvement projects are available on Proposition O website: http://www.lapropo.org/sitefiles/lariver.htm.

To address nutrient-related impairments, source reduction and pollutant removal BMPs designed to reduce sediment loading should be implemented throughout the watershed as these management practices will also reduce the nutrient loading associated with sediments. Dissolved loading associated with dry and wet weather stormwater also contributes nutrient loading to Lake Calabasas. Some of the sediment reduction BMPs may also result in decreased concentrations of nitrogen and phosphorus in the runoff water. Storage of storm flows in wet or dry ponds may allow for adsorption and settling of nutrients from the water column. BMPs that provide filtration, infiltration, and vegetative uptake and removal processes may retain nutrient loads in the upland areas.

The rules and regulations set forth by the Calabasas Park Homeowners Association regarding waterfowl, fertilization, pesticide application, and pets aim to reduce pollutant loading to the lake. Fertilizers and pesticides may be used on adjacent lake properties and properties that eventually drain to the lake. However, fertilizers and pesticides are prohibited from reaching the lake by any means per the rules and regulations. Education of homeowners and lake maintenance staff regarding the proper placement, timing, and rates of fertilizer and pesticide products will result in reduced pollutant loading. Citizens should be advised to follow product guidelines regarding product amounts and to spread products when the chance of heavy precipitation in the following days is low. Pet owners are required to properly dispose of pet wastes. Visitors to the lake (members, tenants, and guests) are prohibited from feeding birds or other animals. Following these rules will reduce nutrient loading associated with fecal material or fertilizers that may wash directly into the lake or into storm drains that eventually discharge to the lake.

In order to meet the fine particulate ($PM_{2.5}$) and ozone (O_3) national ambient air quality standards by their respective attainment dates of 2015 and 2024, the South Coast Air Quality Management District and the California Air Resources Board have prepared an air quality management plan that commits to reducing nitrogen oxides (NOx, a precursor to both $PM_{2.5}$ and ozone) by over 85 percent by 2024. These reductions will come largely from the control of mobile sources of air pollution such as trucks, buses, passenger vehicles, construction equipment, locomotives, and marine engines. These reductions in NOx emissions will result in reductions of ambient NOx levels and atmospheric deposition of nitrogen to the lake surface.

7.4 Monitoring Recommendations

Although estimates of the loading capacity and allocations are based on best available data and incorporate a MOS, these estimates may potentially need to be revised as additional data are obtained. The mass-based loading capacity will be affected by changes in flow volumes; therefore, loading capacities may be reconsidered if significant volume reductions or additions occur.

To provide reasonable assurances that the assigned allocations will indeed result in compliance with the chlorophyll *a* target, a commitment to continued monitoring and assessment is warranted. The purposes of such monitoring will be 1) to determine compliance with wasteload and load allocations, 2) to determine if numeric targets are being attained, 3) to evaluate whether numeric targets and allocations need to be adjusted to attain beneficial uses, 4) to evaluate the efficacy of control measures instituted to achieve the needed load reductions, and 5) to document trends over time in algal densities and bloom frequencies.

To assess compliance with the nutrient TMDLs, monitoring for nutrients and chlorophyll *a* should occur at least twice during the summer months and once in the winter. At a minimum, compliance monitoring should measure the following in-lake water quality parameters: ammonia, TKN or organic nitrogen, nitrate plus nitrite, orthophosphate, total phosphorus, total suspended solids, total dissolved solids and chlorophyll *a*. Measurements of the temperature, dissolved oxygen, pH and electrical conductivity should also be taken throughout the water column with a water quality probe along with Secchi depth measurement. All parameters must meet target levels at half the Secchi depth. DO and pH must meet target levels from the surface of the water to 0.3 meters above the lake bottom. Additionally, in order to accurately calculate compliance with wasteload allocations to the lake expressed in yearly loads, monitoring should include flow estimation or monitoring as well as the water quality concentration measurements. At Lake Calabasas wasteload allocations are assigned to supplemental water additions. This source should be monitoring once a year during the summer months (critical conditions) for at minimum; ammonia, TKN or organic nitrogen, nitrate plus nitrite, orthophosphate, total phosphorus, total suspended solids and total dissolved solids. Wasteload allocations are also assigned to stormwater inputs from the City of Calabasas. This source should be measured near the points where it enters the lakes twice a year for at minimum: ammonia, TKN or organic nitrogen, nitrate plus nitrite, orthophosphate, total phosphorus, total suspended solids and total dissolved solids.

The nutrient TMDLs for Lake Calabasas conclude that a 62.4 percent reduction in total phosphorus loading and a 71.4 percent reduction in total nitrogen loading are needed to maintain a summer average chlorophyll *a* concentration of 20 µg/L. As an example of concentrations that responsible jurisdiction may need to target in order to meet and comply with the mass-based WLAs, this discussion provides concentrations calculated based on existing flow volumes (a recalculation is needed if flow volumes change). Assuming flow volumes remain at existing levels (Table 7-3), the targeted concentrations may be 0.257 mg-P/L and 1.17 mg-N/L for the city of Calabasas. For the supplemental water additions, the targeted concentrations may be 0.0078 mg-P/L and 0.46 mg-N/L. Assuming average precipitation depths, the targeted concentration of nitrogen in precipitation may be 0.0569 mg-N/L. As stated above, these concentrations are provided as guidelines; however, mass-based WLAs must be achieved.