Section 11

Economic Considerations

The adoption of revised nutrient TMDLs requires an amendment to the Basin Plan. As such, the Santa Ana Water Board is required to conduct an economic analysis of the proposed Basin Plan revisions to address the following legal requirements:

- California Public Resources Code §21159 requires the Santa Ana Water Board, when adopting an amendment that will require the installation of pollution control equipment or is a performance standard or treatment requirement, to include an environmental analysis of the reasonably foreseeable methods of compliance. As part of this analysis is necessary to demonstrate that there are reasonable, economically feasible means to comply with the provisions of the Basin Plan amendment.

- California Water Code §13141 requires that prior to implementation of any agricultural water quality control program, the Santa Ana Water Board must include an estimated cost of such a program, together with an identification of potential sources of funding.

- Consistent with the federal and state antidegradation review requirements, it may be necessary to demonstrate that the proposed Basin Plan amendment: (1) is "necessary to accommodate important social or economic growth in the region" (federal antidegradation policy at 40 CFR 131.12); and (2) provides "best practicable treatment or control consistent with maximum benefit to the people of the State" (State Water Board Resolution 68-16).

The proposed revisions to the nutrient TMDLs update response targets and allocations based on the findings of studies completed since the 2004 adoption of the original TMDLs. Revision of the 2004-adopted TMDLs was a required implementation task under the existing TMDL and was to be conducted after the completion of necessary modeling analyses and special studies (see Task 14, Santa Ana Water Board 2004a).

Compliance with the proposed revised TMDLs will likely require continued implementation of current, or equivalent, level of controls. In addition, studies conducted by the LECL Task Force since 2004 have shown that supplemental projects, e.g., as described in Section 7.3, may be needed to assure compliance with the TMDLs – regardless of whether the TMDLs are revised. Accordingly, adoption of the revised TMDLs will require that jurisdictions with an allocation either update existing TMDL implementation plans (i.e., CNRP for MS4 permittees; AgNMP for irrigated agricultural lands >20 acres) or develop new TMDL implementation plans (e.g., Caltrans, March JPA) to meet revised external nutrient load allocations and/or in-lake response targets. Through this process potential supplemental projects will be identified for implementation to comply with the TMDLs.

To fulfill the economic analysis requirements associated with the proposed Basin Plan amendment to incorporate revised nutrient TMDLS for Lake Elsinore and Canyon Lake, this section provides the following information:

- *Section 11.1 – Economic Costs*: This section provides a summary of the costs of the types of projects that may be employed to meet the allocations and in-lake response targets in the revised TMDLs. Projects may include a combination of implementation of existing controls and consideration of potential supplemental projects.
- *Section 11.2 – Economic Value*: The expected economic and environmental benefits associated with implementation of the revised TMDLs are summarized in this section.
- *Section 11.3 – Agricultural Costs*: A brief discussion of potential costs applicable to agriculture is provided along with potential funding sources.
- *Section 11.4 – Antidegradation Review*: This section addresses compliance with state and federal antidegradation review requirements, as applicable to the revised TMDLs.
- *Section 11.5 – Summary of Key Findings*: This section summarizes the key findings from this economic analysis.

11.1 Economic Costs

To evaluate the economic cost of the implementation of the revised TMDLs to meet the allocations and in-lake response targets in the revised TMDLs, it is assumed that costs will include continued implementation of existing controls and implementation of new supplemental projects. Each of these cost areas is evaluated below.

11.1.1 Existing Projects

Since 2004, numerous projects have been implemented to reduce nutrient loads from the San Jacinto River watershed and to improve water quality within Lake Elsinore and Canyon Lake. Since the 2004 adoption of the TMDLs these projects include activities implemented by MS4 and agricultural dischargers, reclaimed water addition to Lake Elsinore, and multi-agency projects implemented through the LECL Task Force, such as alum addition and carp management.[1] **Table 11-1** summarizes the average annual cost to implement some of these existing water quality controls. It is assumed that going forward the cost of continued implementation of these controls would be approximately equal to recent expenditures.

The greatest cost of currently implemented projects involves the addition of reclaimed water to Lake Elsinore for lake level stabilization, approximately $1.4 million annually. At present, this cost is shared between the City of Lake Elsinore and the EVMWD. During wet hydrologic periods, reclaimed water discharges to Lake Elsinore would be ceased temporarily to prevent use of minimum flood storage requirements. Since regular reclaimed water additions began in 2007, it has not been necessary to suspend discharges to Lake Elsinore due to low lake levels associated with an extended drought. However, if a prolonged period of wet weather returns to the region, EVMWD may be required to temporarily suspend reclaimed water discharges to Lake Elsinore to minimize the risk of shoreline flooding.

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[1] The implementation costs since 2004 do not include capital expenditures associated with other key projects completed in Lake Elsinore prior to TMDL adoption, including the construction of the levee, back-bay wetlands, and LEAMS.

Table 11-1. Summary of Current Annual Average Expenditures for Water Quality Control Type

Project	Core Programs[1] ($/yr)	TMDL Project ($/yr)[2]	Total Cost ($/yr)
MS4 Program BMP Control Measures	$400,000	--	$400,000
Reclaimed Water Addition (~4,000 AFY)	$1,400,000	--	$1,400,000
Monitoring Program, Task Force Administration	--	$400,000	$400,000
LEAMS[3]	--	$400,000	$400,000
Canyon Lake Alum Addition	--	$200,000	$200,000
Carp Removal	--	$100,000	$100,000
Total	**$1,800,000**	**$1,100,000**	**$2,900,000**

[1] Core programs include minimum control measures implemented by MS4 permittees and reclaimed water addition by EVMWD. Costs incurred by developers to construct LID BMPs in project WQMPs and specific BMPs implemented by agricultural land owners subject to the CWAD are not shown.

[2] TMDL Projects are implemented collaboratively through the LECL Task Force and funded through funds collected per the Task Force Agreement and grants.

[3] LEAMS costs include annual O&M plus $90,000/yr dedicated to a capital reserve fund to update/replace systems in future for operation of the system.

Many of the watershed BMPs deployed in the San Jacinto River watershed are associated with meeting core requirements in the MS4 permit (Santa Ana Water Board 2010), CWAD (Santa Ana Water Board 2017), and programs designed to meet groundwater basin objectives. "Core requirements" are general obligations imposed on all stormwater permittees to minimize pollutants to the Maximum Extent Practicable (MEP) by implementing BMPs. The expense incurred to implement these core requirements would occur regardless of whether the TMDL was adopted or is updated. Nevertheless, these core requirements do contribute to achieving compliance with the TMDL by helping reduce dry nutrient loads in urban runoff (e.g., street sweeping, restaurant inspections, etc.). Some of these costs are incurred by private entities. For example, the cost to implement post-construction BMPs to capture and infiltrate or treat runoff from new urban development to meet MS4 permit requirements is often incurred by private developers. Costs incurred by developers to implement WQMPs in the San Jacinto River watershed since 2004 may be in excess of $100 million when applying Los Angeles regional planning level cost functions for typical LID BMPs (Los Angeles County 2011).

Agricultural dischargers responsible for TMDL implementation have been participating in the Task Force through WRCAC and contribute funds to implement TMDL projects. In addition, specific BMPs are being implemented by agricultural land owners subject to the CWAD. It is estimated that since adoption of the original TMDLs in 2004, an estimated $10 million has been spent on the implementation of agricultural-related BMP projects in the San Jacinto River watershed (personal communication, Pat Boldt on behalf of WRCAC, April 9, 2018). Implementation of agricultural BMPs as required by the CWAD and participation in the Task Force will continue under the revised TMDLs.

The LECL Task Force has developed multiple plans for managing water quality in Lake Elsinore and Canyon Lake. Special studies have been conducted to provide the necessary data to guide the selection and design of in-lake water quality controls and to support development of plans for project implementation. In total, studies and plans conducted by the LECL Task Force have amounted to approximately $100,000 per year (personal communication with Rick Whetsel, Santa Ana Watershed Project Authority, April 27, 2018). The TMDL revision includes several requirements for future updates to pollution control plans as well as new special studies (See Section 7.4).

11.1.2 Potential Supplemental Projects

Section 7.3 identifies additional BMPs that could potentially be implemented to modify or supplement the current portfolio of water quality controls to meet the revised TMDL targets. With the exception of enhanced fishery management (projects other than carp removal) and LEAPs, planning level costs were developed for these potential supplemental projects. The following sections below provide project concept descriptions, anticipated water quality benefits, implementation assumptions, and a basis for the cost estimate. Enhanced fishery management is not included because of the varied options associated with this BMP and its dependence on other factors such as carp removal (see Tables 7-1 and 7-10 for discussion of fishery management and/or LESJWA 2005a). LEAPS is not included because the ability to estimate planning level costs is limited at this time given the highly conceptual nature of the existing project description.

When conducting an economic analysis over a future time period, such as from 2018 to 2040, it is necessary to consider the 'time value of money' through a process called 'discounting'. Discounting converts the dollar values in future time periods into today's value, called the 'present value'. By doing so, economic values from diverse time periods can be compared on an equal basis. The concept of discounting assumes that a dollar today is more valuable than a dollar in the future. For example, one million dollars 25 years from now does not have the same economic value as one million dollars today. In fact, the farther out in time the future value occurs, the less it is worth today. For example, one million dollars invested today earning 3 percent per year would be worth about $1,343,900 in 10 years, and about $2,100,000 in 25 years. Conversely, at a discount rate of 3 percent, one million dollars in 10 years is equivalent to about $744,000 today, and one million dollars in 25 years is equivalent to about $478,000 today.

In this section, the costs of implementing supplemental projects in the future were discounted back to a present worth to allow for cost comparisons to be made on an equal basis. For this cost discounting analysis, it was assumed that supplemental project implementation would begin in 2025, after approval of revised TMDL implementation plans (e.g., CNRP and AgNMP, see Section 7) and completion of engineering design and environmental permitting requirements. A discount rate of 3 percent was used to discount future dollars (25-year period from 2020-2045) into present worth dollars. This is the current minimum rate that municipalities pay for money, i.e., the interest paid out on municipal bonds.

Figure 11-1 presents a summary of costs for ongoing O&M for existing controls and potential implementation of supplemental controls. Additional information regarding the basis for the estimated costs for each project is provided in the sections below. For each project, costs are presented as present value including both capital and O&M over a 25-year period. These are planning level estimates developed solely to approximate the order of magnitude cost of different projects to provide context for evaluating whether a significant societal economic impact may be incurred as a result of implementation of the revised TMDLs. A few important caveats to these cost estimates include:

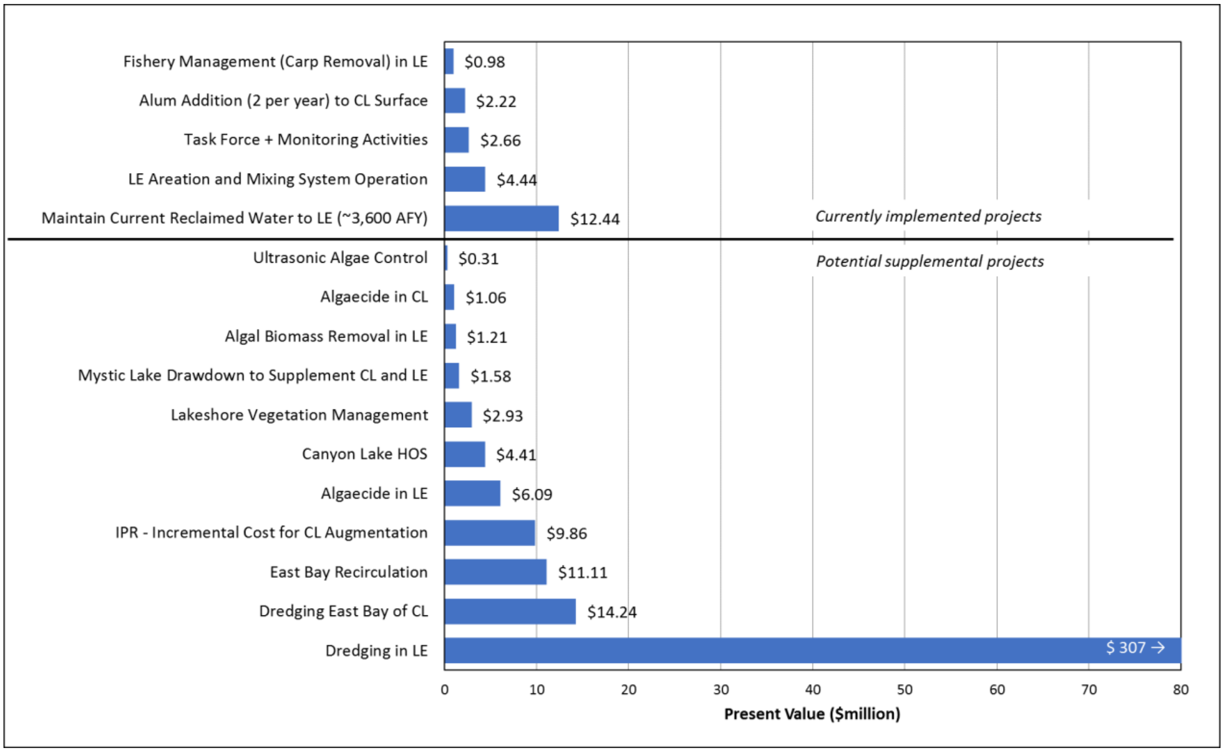

Figure 11-1. Approximate Present Value over Next 20 years for Existing and Potential Supplemental Projects (CL – Canyon Lake; LE – Lake Elsinore)

- Cost estimates are planning level and intended to understand the general magnitude for evaluating societal economic impacts.
- The level of implementation that may be sufficient to yield water quality benefits (e.g., volume of dredging, acres of macrophyte planting, drainage acres for stormwater BMP retrofits, etc.) was estimated based on past experience, published literature and best professional judgment.
- No quantitative analysis of the water quality effectiveness or progress toward TMDL compliance by any one option or combination of options is made in this analysis. The effectiveness of individual project(s) will be evaluated through the development of revised TMDL implementation plans.
- Estimated costs are expressed as collective amounts with no discussion or assumptions as to how such costs might be distributed among individual stakeholders.

- The identification of potential compliance projects and preparation of associated cost estimates imposes no obligation whatsoever on stakeholders to select one or more of these alternatives for implementation.

11.1.2.1 Mystic Lake Drawdown

Description

Mystic Lake is a depression in the upper San Jacinto River watershed that captures all runoff from the upper watershed via a breach in the levee on the north side of the river near Bridge Street. Most runoff that reaches Mystic Lake is retained and subsequently lost via evaporation. A potential project would involve pumping stored runoff out of Mystic Lake to the lower San Jacinto River (**Figure 11-2**). These flows to Canyon Lake would result in increased overflows of lower TDS water from Canyon Lake to Lake Elsinore.

Few data exist on the flow that reaches Mystic Lake. The USGS operates a gauge on the San Jacinto River at State Street, about 4 miles upstream of the levee breach. The average annual volume at that location is ~13,000 AFY. Much of this runoff is lost to channel bottom recharge, e.g., in the 2004-2005 wet season, the flow volume at State Street was ~34,000 AFY, yet field observations documented no overflows of Mystic Lake, which only has ~17,000 AF of storage.

The watershed model conservatively estimates an annual average inflow to Mystic Lake of ~4,000 AFY, with many years having zero and many years over 10,000 AF. While intermittent, the water that reaches Mystic Lake may have a significant value for EVMWD water supply (at Canyon Lake) and for improving water quality in both lakes (providing both flushing and dilution with low TDS water).

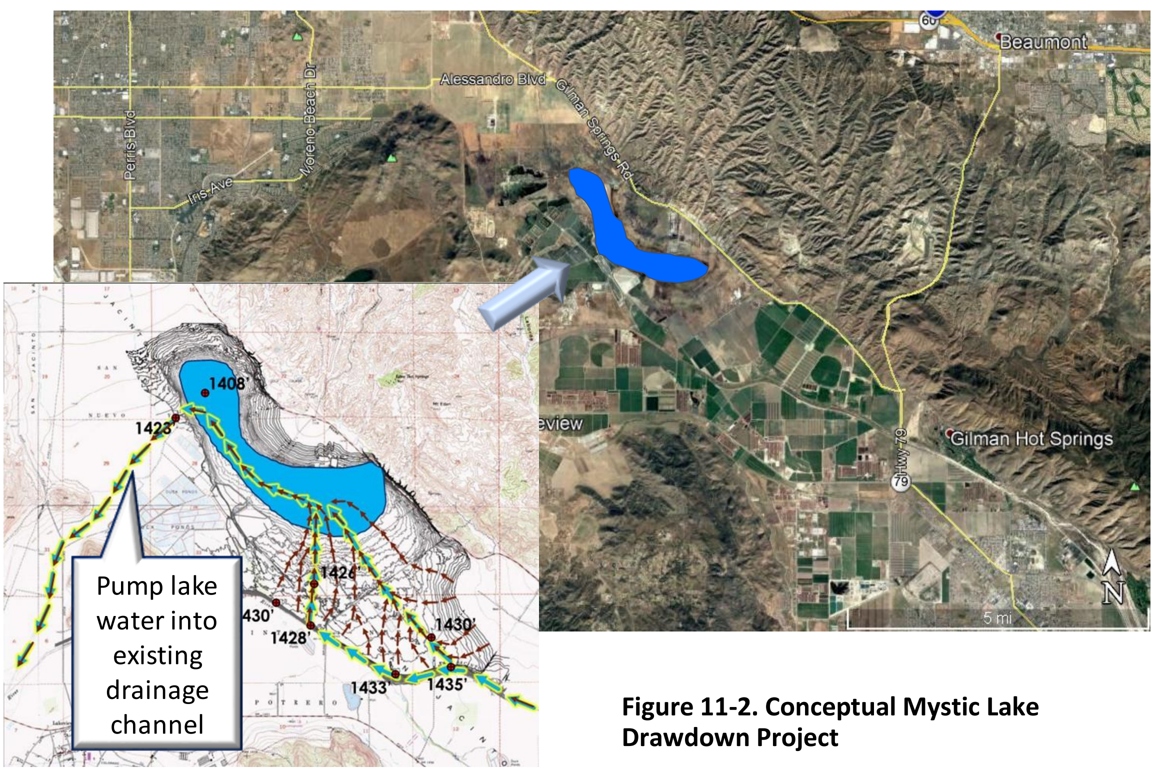

Figure 11-2. Conceptual Mystic Lake Drawdown Project

Potential Water Quality/Other Benefits

Water quality benefits may include increased flushing of nutrients and algae out of Canyon Lake, dilution of TDS in overflows from Canyon Lake to Lake Elsinore, and increased runoff volume to stabilize lake levels in Lake Elsinore. The potential project would improve raw water quality of water treated for water supply by EVMWD and limit the potential for flooding impacts to farms and other properties near Mystic Lake.

Potential Implementation Issues

Water from Mystic Lake would be available in wetter hydrologic years, when Lake Elsinore may need it least. However, Mystic Lake would detain runoff, allowing for drawdown to extend for months or years following large rain events. Also, the use of the existing overflow ditch for more consistent flow must be evaluated. Lastly, movement of the water downstream may impact local water rights.

Sizing Assumptions and Estimated Costs

To evaluate the economics of the Mystic Lake drawdown project, several cost options were evaluated involving different pump horsepower and required conveyance facilities. **Table 11-2** provides findings from the lowest cost option evaluated. By limiting the drawdown rate to 5 cfs (~4,000 AFY), it may be feasible to use the existing overflow ditch to route the water to the San Jacinto River mainstem. Higher drawdown rates would involve construction of pipelines, which could increase the capital cost to $16 million.

Table 11-2. Estimated Implementation and O&M Costs for Potential Mystic Lake Drawdown Project

Facilities	Cost ($)
Intake pipeline (2500’, 12” diameter)[1]	$1,200,000
Pump Station (25 HP)[2]	$125,000
Discharge pipeline (500’, 12” diameter)[3]	$120,000
Capital Cost (2018)	$1,445,000
O&M[4] ($/yr)	$28,900
Present Value for 25 years ($)[5]	**$1,580,000**

[1] Pipeline cost assumes $480 per linear foot for trenchless construction – 2X open trench cost basis
[2] Pump station cost assumes $5,000 per Horsepower (HP) (Carollo 2017)
[3] Pipeline cost assumes $240 per linear foot for open trench construction (Carollo 2017)
[4] Assumes 2% of capital for annual O&M including power to run pumps and facility maintenance
[5] Assumes 3% discount rate with capital expenditure in 2025 and O&M in 2025-2045

11.1.2.2 Alum Addition to Wet Weather Flows

Description

Current alum additions to Canyon Lake involve the spreading of a slurry onto the lake surface twice per year, typically in September and in February or March. The timing of wet weather events that bring new external nutrient loads to Canyon Lake can limit the effectiveness of preceding alum additions, especially during the wet season in February and March. Wet weather may also extend into April in some years. An alternative to the current approach to applying alum is to apply the alum directly at the lake inflows during runoff events with installation of emitters, feed pumps, and on-site materials storage. Applications of alum at lake inflows using this alternative approach have been successful (Churchill et al. 2009; Cooke and Carlson 1986).

Potential Water Quality/Other Benefits

The addition of alum to wet weather inflows allows for the reduction of bioavailable phosphorus as it enters the lake. The shift to a dynamic application approach eliminates the potential for a large storm event to recharge nutrients to the lake shortly after a singular large surface application.

Alum floc that has the capacity to bind with orthophosphate requires the formation of aluminum hydroxide, which is most effective when the pH of the water is less than 8.0. Unlike the ambient pH in Canyon Lake and Lake Elsinore, the pH of wet weather runoff is typically between 7.5 and 8.0, thus more effective floc formation could be expected from additions at the lake inflows.

Potential Implementation Issues

A key consideration for this project is the need to house equipment and provide for on-site chemical storage alongside the creek inflows near developed areas. The rate of alum addition will be dependent upon real-time flow measurements to provide a consistent dose to the inflows. There is the potential for alum additions to be delivered at unplanned dose levels as a result of instrument malfunction or failure.

Estimated Costs

The costs of this project include constructing on-site chemical storage and feed systems and purchase of alum material. **Table 11-3** provides estimated costs for a typical on-site system, including the variable amounts of alum material required at three key inflow stations; Salt Creek inflow to East Bay, San Jacinto River inflow to Canyon Lake Main Lake, and San Jacinto River inflow to Lake Elsinore.

11.1.2.3 Increased Reclaimed Water Addition

Description

EVMWD, City of Lake Elsinore and the Lake Elsinore Redevelopment Agency entered into an agreement in 2003 (replacing prior agreements). This agreement requires EVMWD to maintain water levels in Lake Elsinore at 1,240 ft before it can divert water from Canyon Lake for water treatment (Lake Elsinore Comprehensive Water Management Agreement 2003).

Approximately, 50,000 AF of supplemental water has been added to Lake Elsinore since 2007, which is estimated to have prevented the lake from a desiccation event sometime in 2015 (**Figure 11-3**). However, these reclaimed water additions were not able to offset evaporative losses during the most recent extended drought, and lake levels have fallen to as low as 1,232 ft.

Table 11-3. Estimated Implementation and O&M Costs for Alum Addition to Wet Weather Flows

Wet Weather Inflow Alum Addition	SJR at Goetz (Main Lake)	Salt Creek at Murrieta (East Bay)	SJR near Elsinore (Lake Elsinore)
Average Annual Runoff (AFY)	6,120	2,400	6,850
Average TP in Runoff (mg/L)	0.73	0.39	0.46
Average TP in Watershed Runoff w/Additional Alum (mg/L)	0.48	0.2	0.2
TP Reduction (kg/yr)	1,887	563	2,197
Additional Alum Material (kg/yr)	283,116	84,380	329,561
Alum Dose (mg/L as alum)	37.5	28.5	39
Capital Cost (2018)	$165,000	$165,000	$165,000
O&M Cost ($/yr)	$244,986	$80,035	$283,536
Cost of Alum Material ($/yr)	$234,986	$70,035	$273,536
Present Value for 25 years ($)[1]	$3,280,000	$1,170,000	$3,780,000

[1] Assumes 3% discount rate with capital expenditure in 2025 and O&M in 2025-2045

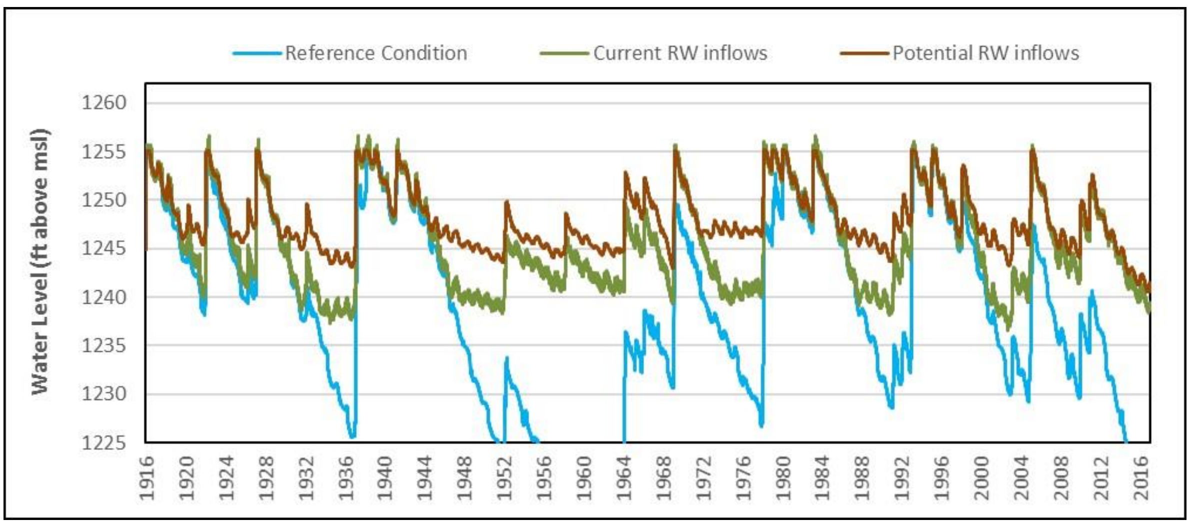

Figure 11-3. Modeled Lake Levels for Lake Elsinore Using a 100-year Simulation with and without Reclaimed Water (RW) Addition (Note: The blue line below 1,225 feet indicates the lake would have been dry).

The TMDL linkage analysis (see Section 5) shows that an increase in the inflow rate to 7.5 MGD would be sufficient to maintain lake levels above 1240 ft based on 1916-2016 hydrology (see green line in Figure 11-3). Currently, EVMWD produces ~6.0 MGD of reclaimed water (5.5 MGD available for discharge to Lake Elsinore; 0.5 MGD for discharge to Temescal Wash. EVMWD projects 7.5 MGD (~8,400 AFY in dry years) will be available for discharge to Lake Elsinore by 2020 (EVMWD 2017). Beyond 2020, EVMWD plans to continue to make reclaimed water available for lake level stabilization with the potential to increase the discharge to 9 MGD (~10,000 AFY in dry years). It may also be possible to allow for reclaimed water additions during periods when lake levels are between 1,240 and 1,247 ft, a recommendation in the 2003 agreement. This additional increment would allow for maintenance of lake levels above 1,241.5 ft at all times and keep levels closer to 1,245 ft in most years (see reddish-brown line Figure 11-3).

Potential Water Quality/Other Benefits

Reclaimed water represents an additional external source of nutrient loads in excess of reference conditions, despite the relatively low effluent nutrient concentration from EVMWD's Regional WRF (TP ~0.4 mg/L; TN~3.0 mg/L). Thus, the addition of reclaimed water has the potential to increase eutrophication relative to the reference watershed condition. The linkage analysis was used to evaluate the balance of increased nutrient loads against the benefits of increased water volume in Lake Elsinore, including reducing wind driven sediment resuspension, facilitating aquatic vegetation on shorelines, and diluting TDS under most conditions. The findings from this analysis shows that the implementation of other existing controls (watershed BMPs, levee, LEAMS, and fishery management) along with projected increases of reclaimed water addition to 7.5 MGD is expected to reduce eutrophication to levels better than reference condition in all but ~3 percent of the time (see Figure 7-7).

Reclaimed water additions to Lake Elsinore have unquestionably prevented a lakebed desiccation event, clearly providing better protection of recreational uses than would be realized in a reference condition. Moreover, other public health issues associated with periods of lakebed desiccation, such as severe gnat infestations and dust are prevented with reclaimed water addition (see description of the impact of previous desiccation events in Section 2). As noted in Section 7, the greatest potential impact of climate change to Lake Elsinore would involve increased evaporative losses and more severe extended droughts. Enhanced reclaimed water additions make Lake Elsinore more resilient to potential climate change impacts.

Water agencies have developed ways to increase capture of surface runoff for groundwater basin recharge in the upper watershed, which has resulted in a decline in Canyon Lake overflows. Thus, increasing EVMWD reclaimed water additions to Lake Elsinore will play a greater role in maintaining water levels above 1,240 ft, indirectly allowing for increased potable water supplies from Canyon Lake and groundwater recharge for the region.

Potential Implementation Issues

There is the potential for localized flooding to occur along the lakeshore in wet years if reclaimed water were to be added to the lake when levels are between 1,240 and 1,247 ft.

Estimated Costs

The current cost to add reclaimed water to Lake Elsinore is ~$1.4 million/year based on a cost to produce tertiary treated effluent at EVMWD's RWRF for discharge to Lake Elsinore of approximately $350 per AF. As a result of the current extended drought, EVMWD has been able to discharge its full capacity (minus 0.5 mgd for Temescal Wash) to Lake Elsinore since the start of supplemental water addition in 2007. Despite effluent rates at less than 7.5 mgd in the first decade of reclaimed water addition, the continuous discharge has amounted to an average annual volume of ~4,000 AFY, which exceeds what the DYRESM-CAEDYM model predicts would be necessary, on average, over a 100-yr period. Therefore, current average annual costs incurred are not reflective of a long-term hydrologic condition including wet periods when discharges would not be allowed. **Table 11-4** shows the estimated incremental increases in reclaimed water addition costs, which is only realized in future dry years when effluent rates are increased and can support increased volumes delivered in a single year. Present value is not calculated for increased reclaimed water addition because purchases over the next 25 years will be dependent upon hydrologic conditions. Moreover, if the next 25 years is representative of an average hydrologic condition, then the incremental cost above current expenditures would be zero.

Table 11-4. Estimated Costs to Increase Reclaimed Water Additions to Lake Elsinore.

Cost Basis	Reclaimed Water Addition 7.5 mgd up to 1,240 ft	Reclaimed Water Addition 9.0 mgd up to 1,247 ft
Maximum RW addition (AF/yr)	8,400	10,000
Maximum Annual Incremental[1] Cost ($million)	$1,500,000	$2,100,000
Long-Term Average Reclaimed Water incremental[2] addition (AF/yr)	0	0
Long-Term Average Annual Incremental[1] Cost ($million)	$0	$0

[1] The incremental cost is in addition to the current $1.4 million spent per year on ~4,000 AFY of reclaimed water addition.

[2] With current drought conditions, supplemental water inputs have been maximized in most years since 2007, thus current annual volume (even at lower inflow rates) are greater than the simulated 100-year average at 7.5 and 9.0 mgd, which would include wet years with no supplemental water addition.

11.1.2.4 Oxygenation – Canyon Lake Hypolimnetic Oxygenation System

Description

HOS is used to inject liquid oxygen into lake water within a pressurized chamber. This pumped lake water becomes oxygen enriched in the chamber and is then piped to the anoxic water layer overlying the sediment, which can rapidly increase DO concentrations throughout the hypolimnion. The increase in DO greatly reduces the diffusive flux rates of phosphorus and nitrogen from the sediment into the water column. A Canyon Lake HOS would deliver a greater amount of oxygen to the lake bottom than could be achieved with an aeration system and is thereby a more effective method for suppressing sediment nutrient flux. In the case of the Main Lake of Canyon Lake, thermal stratification is a naturally occurring process that serves to limit the pool of bioavailable nutrients in the photic zone over much of the year. HOS would maintain thermal stratification while delivering oxygen rich water into the hypolimnion. PACE (2011) developed a preliminary design for a HOS system in Canyon Lake (**Figure 11-4**). This system was considered for inclusion in the CNRP and AgNMP, but ultimately the LECL Task Force decided to pursue alum addition as the primary in-lake nutrient control strategy. A key decision factor was the fact that HOS would not provide water quality benefits within East Bay. If alum additions in the Main Lake do not provide sufficient water quality improvement to meet the revised TMDL response target CDFs for DO, chlorophyll-*a* and ammonia, then HOS may be a supplemental project to consider.

Potential Water Quality/Other Benefits

HOS would directly increase DO in the lake bottom and would be able to create a condition that is significantly more oxygen rich than estimated for a reference condition. Reduction in sediment nutrient flux would reduce nutrients in the water column potentially available to support excess algae growth. Increased DO in the lake bottom would also support increased rates of nitrification of ammonia released from the lake bottom to the less toxic nitrate form.

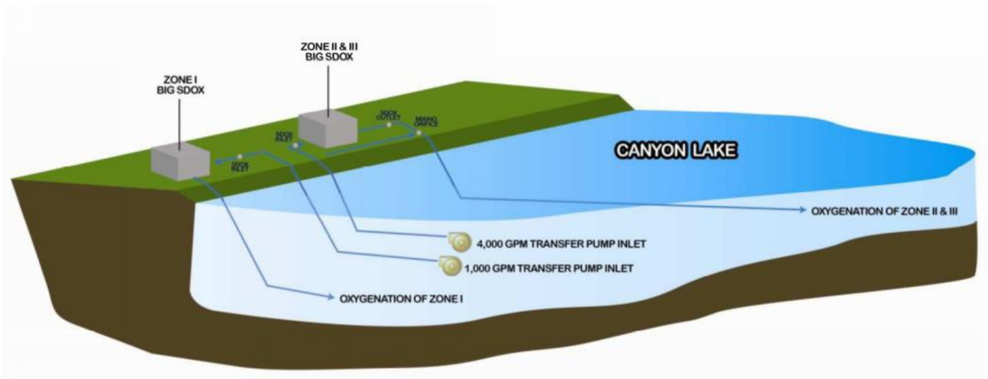

Figure 11-4. Conceptual Drawing of Canyon Lake Dual On-Shore Oxygenation System (adapted from Figure ES-4, PACE 2011)

Potential Implementation Issues

HOS would require shoreline disturbance and underwater construction activities.

Sizing Assumptions and Estimated Costs

To estimate the economic cost of this potential supplemental project, the recommended alternative (10b) in the preliminary design report was evaluated (PACE 2011). This alternative included two shoreline oxygen generation locations, ~10,000 feet of underwater oxygen delivery pipe along the lake bottom, pumps, and other equipment. **Table 11-5** provides the estimated implementation and operational cost; costs were updated to reflect 2018 dollars using the standard Engineering News-Record (ENR) index.

Table 11-5. Estimated Costs to Implement HOS in Canyon Lake (adapted from PACE 2011)

Cost Item	Cost ($)[1]
Total Capital Cost[1]	$3,382,000
Annual O&M[2]	$123,000
Present Value[3]	$4,410,000

[1] Cost from PACE 2011 escalated to 2018 dollars using ENR index 11936 (December 2017)
[2] O&M cost escalated assuming 3% inflation over seven years since original estimate in 2011.
[3] Assumes 3% discount rate with capital expenditure in 2025 and O&M in 2025-2045

11.1.2.5 Dredging of Canyon Lake East Bay

Project Description

A project to remove bottom material from Canyon Lake East Bay would reduce the pool of potentially mobile nutrients and thereby reduce internal loads. Incubation chamber studies from Canyon Lake in 2001, 2006 and 2014 showed that sites in the East Bay had some of the greatest rates of diffusive flux from the lake bottom sediments (Anderson 2016a; see Section 4.3.1.2).

In 2006/2007, a dredging project implemented in Canyon Lake removed approximately 21,000 cubic yards (CY) of sediment but was ceased (for non-technical reasons) before reaching the sediment removal goal of 182,000 CY. A potential future dredging project that targets the most downstream end of East Bay near the causeway to the Main Lake could provide significant water quality improvement (**Figure 11-5**).

Potential Water Quality/Other Benefits

Dredging, which will reduce the internal diffusive sediment nutrient flux for both TP and TN, will improve water quality in East Bay. Other benefits include addition of flood storage capacity and extension of the lifespan of Canyon Lake Reservoir.

Potential Implementation Issues

The long-term benefits remain limited, since the bioavailable P loading would resume after dredging. Without a local disposal area, project implementation costs would be significant.

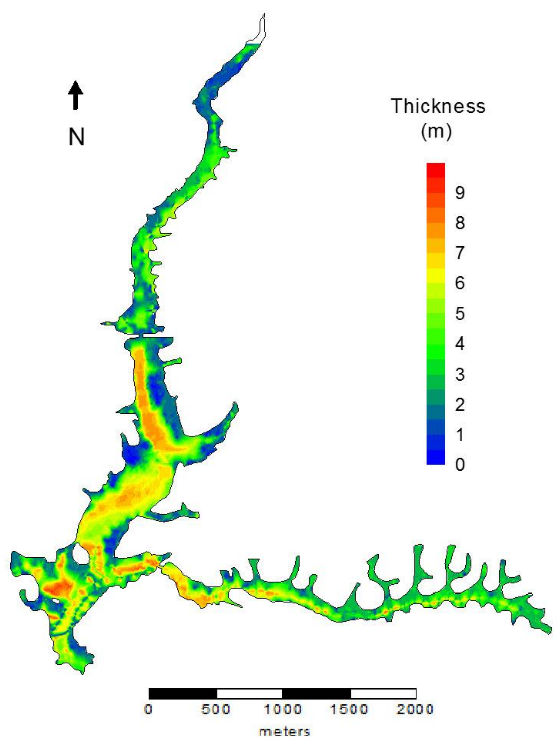

Figure 11-5. Sediment Thickness (Meters) in Canyon Lake (Anderson 2016a)

Estimated Cost

For this cost estimate, it was assumed that dredging would focus on the top two feet of the lake bottom sediment (consistent with the earlier dredging project) and extend over ~50 acres in areas with the greatest thickness of bottom sediments, based on the recent hydroacoustic survey analysis (see Figure 11-5; Anderson 2016a). Dredging this area to this depth would require removal of approximately 200,000 CY of sediment. To develop a cost estimate, the following factors were considered:

- The 2005 cost estimate for dredging at East Bay was ~$11/CY removed. Using the Army Corps of Engineers (ACOE) Civil Works Construction Cost Index System (CWCCIS) for Navigation, Ports, and Harbors (ACOE 2017), this cost escalated to 2018 dollars is ~$14/CY. Originally, the Canyon Lake POA intended to manage the dredging operations, which would help manage cost. However, if all costs were fully contracted, these costs are likely to increase; accordingly, it is estimated that the cost/CY removed is $20 per CY. This estimate is consistent with the dredging cost estimate developed for the Machado Lake Nutrient TMDL (Los Angeles Water Board 2008).
- The 2005 cost estimate states that sediment disposal to a landfill would cost $9 million, or $13 million in 2018 dollars. Thus, disposal cost is estimated at $65 per CY. Disposal cost would be drastically reduced if a local disposal area was identified.
- Dredging is assumed to occur once, with no annual O&M.

Table 11-6. Summary of Estimated Costs to Dredge East Bay of Canyon Lake

Cost Item	Cost ($)
Excavation Cost (200,000 CY)	$4,000,000
Landfill Disposal Cost	$13,000,000
Present Value[1] (capital cost only; no annual O&M)	$14,240,000

[1] Assumes 3% discount rate with capital expenditure in 2025

Based on the above considerations, **Table 11-6** provides a summary of the estimated cost to dredge and dispose of sediments from East Bay.

11.1.2.6 Indirect Potable Reuse

Project Description

This project would rely on the use of Canyon Lake as an environmental buffer to support indirect potable reuse (IPR) by EVMWD (EVMWD 2017). Advanced treated reclaimed water would be discharged at the upstream end of the lake to maximize residence time prior to water being withdrawn for treatment at the Canyon Lake Water Treatment Plant at the lower end of Canyon Lake (**Figure 11-6**). This IPR approach, involving reservoir augmentation, was evaluated against other methods such as groundwater recharge and recovery (EVMWD 2017).

While the primary objective of this project is not to improve lake-wide water quality, the addition of advanced treated reclaimed water would result in the dilution of nutrients in the lake. Continuous inflows would also reduce water level fluctuations that occur under current operations during the dry season. By maintaining water levels in advance of the wet season, storm event overflows from Canyon Lake to Lake Elsinore would be expected to occur more frequently, resulting in an increase in the downstream transport of water and associated nutrients.

Potential Water Quality/Other Benefits

The most significant benefit is the development of a new source of local potable water supply. The project will also reduce TP and TN concentrations in the water column and increase downstream transport of nutrients out of Canyon Lake.

Potential Implementation Issues

Even with the expected improvements to water quality from the discharge of advanced treated wastewater, there may be times when conditions are sufficient to influence the treatability of water that could require temporary shutdowns of EVMWD's RWRF. Water quality in the lake may limit the amount of reclaimed water than can be diverted for potable supply. Operation of the system during the wet season may be less reliable given water quality and capacity limitations. In addition, public acceptance of the discharge of treated reclaimed water to the lake by local homeowners and users of the lake for recreation is a potentially major obstacle to implementing an IPR project.

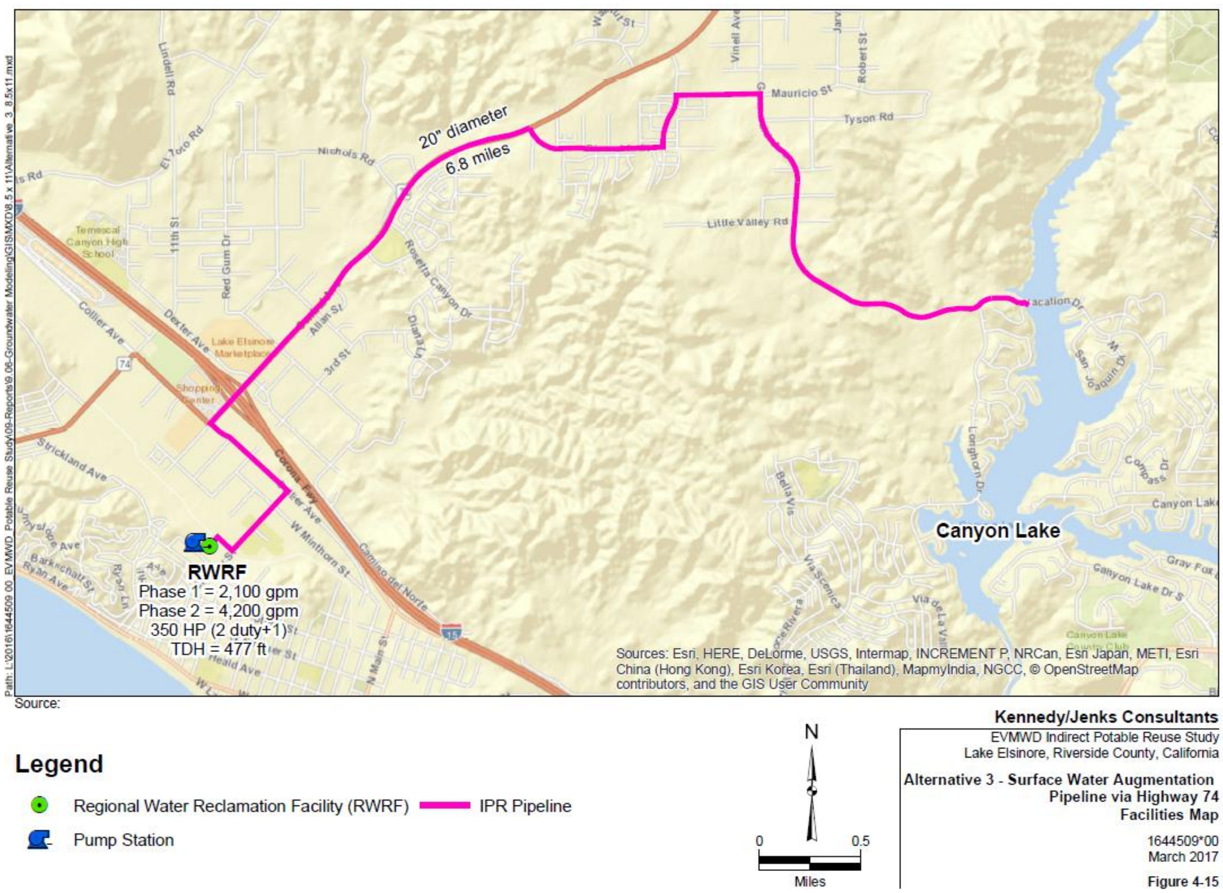

Figure 11.6 Surface Water Augmentation Concept for Canyon Lake (from EVMWD 2017).

Estimated Cost

The sizing assumptions and estimated costs for an IPR project in Canyon Lake are based on Alternative 3 presented in EVMWD (2017) (**Table 11-7**). The required facilities include:

- Construction of an Advanced Water Treatment Facility (AWTF) to produce water from RWRF treated tertiary effluent;
- Disposal of brine; and
- Conveyance of the product water to the discharge location in Canyon Lake.

The AWTF capacity is 3.0 mgd in Phase 1 and expanded to 6.0 mgd in Phase 2. The planned water pipeline from the RWRF to the AWTF to be constructed in Phase 1 is 6.8 miles in length. Costs presented Table 11-7 represent the incremental difference between Alternative 3 (surface water augmentation) and Alternative 1 (injection wells) or ~$2.2 million in capital and a total of $9 million for life cycle cost.

Table 11-7. Summary of Estimated Incremental Costs to Implement Indirect Potable Reuse Project by Canyon Lake Reservoir Augmentation Relative to Injections Wells

Cost Item	Alternative 3 (Canyon Lake Augmentation)	Alternative 1 (Injection Wells)	Incremental Cost for Canyon Lake Augmentation (Alt 3 – Alt 1)
Present Value for Capital Cost[1]	$68,950,000	$71,090,000	($2,140,000)
Present Value for O&M (25 years)[1]	$111,000,000	$99,000,000	$12,000,000
Total Present Value [1]	$179,950,000	$170,090,000	$9,860,000

[1] Estimates of present value as reported in EVMWD 2017, including discount rate of 4% over 25-year period of analysis

11.1.2.7 Lakeshore Vegetation Management

Description

This project would establish a community of emergent and submerged aquatic vegetation in the Lake Elsinore littoral zone that can take up nutrients and release oxygen to the water column (**Figure 11-7**). These plants can compete with algae for limited nutrients and light thereby providing a potential control on the growth of nuisance algae.

Potential Water Quality/Other Benefits

Established lakeshore vegetative cover would reduce bank erosion and physical resuspension of sediments. Submerged plants take up phosphorus and nitrogen, thereby reducing the pool of bioavailable nutrients to fuel algae growth. Some lakeshore vegetation can provide shade and some reduction in localized water temperatures. Other benefits include the creation of habitat areas for fish and wildlife.

Potential Implementation Issues

Efforts to establish submerged aquatic vegetation may be challenging given that fluctuations in water levels can kill vegetation by either desiccation or drowning. In the case of Lake Elsinore, fluctuations in salinity may also stress plants; therefore, the selection of salt tolerant species will be important.

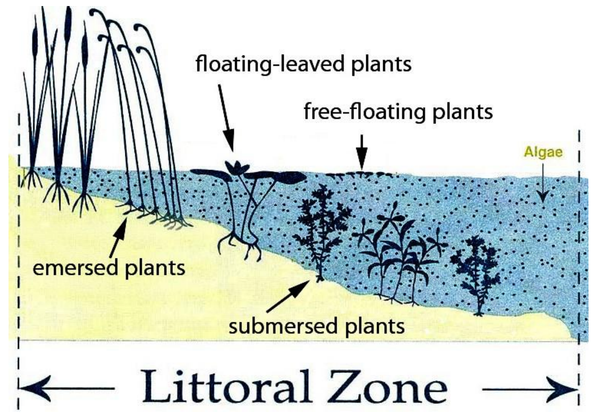

Figure 11-7. Conceptual View of the Littoral Zone of a Typical Lake (Source: https://plants.ifas.ufl.edu/manage/why-manage-plants/aquatic-and-wetland-plants-in-florida/)

Sizing Assumptions and Estimated Costs

The cost estimate for this potential project includes the following assumptions:

- Up to 100 acres of shoreline in Lake Elsinore are candidate areas for establishment of macrophytes.
- Vegetation establishment, including labor, installation, and plant cost, is approximately ~$35,000 per converted acre based on an analysis performed for the San Francisco Bay Joint Venture (Steere 2004).
- No extensive O&M is necessary once plants are established.

Given these assumptions, the estimated project cost in 2025 to establish 100 acres of shoreline discounted to present value at 3 percent is $2,930,000.

11.1.2.8 Artificial Recirculation in Canyon Lake

Project Description

This potential Canyon Lake project would recirculate oxygen depleted, nutrient rich water from the hypolimnion in Canyon Lake Main Lake through East Bay and back to the Main Lake (**Figure 11-8**). The transfer of water from the hypolimnion in Main Lake to East Bay would be expected to cause a rise in DO at the sediment interface; a reduction of internal loads of TP and TN may also be realized. For East Bay, water delivered from the Main Lake would be reaerated through the process of discharge and flushing through the shallow East Bay. This activity would facilitate flushing of nutrients out of East Bay to reduce the duration of algal blooms. Over time, the reduced cycling of nutrient within East Bay would limit sediment nutrient flux and thereby the concentration of bioavailable nutrients flushed to Main Lake. A conceptual facility plan for this option includes:

- 16,000-ft of 30-inch diameter pipeline
- 400 HP pump station
- Riser intake with mechanical sluice gates

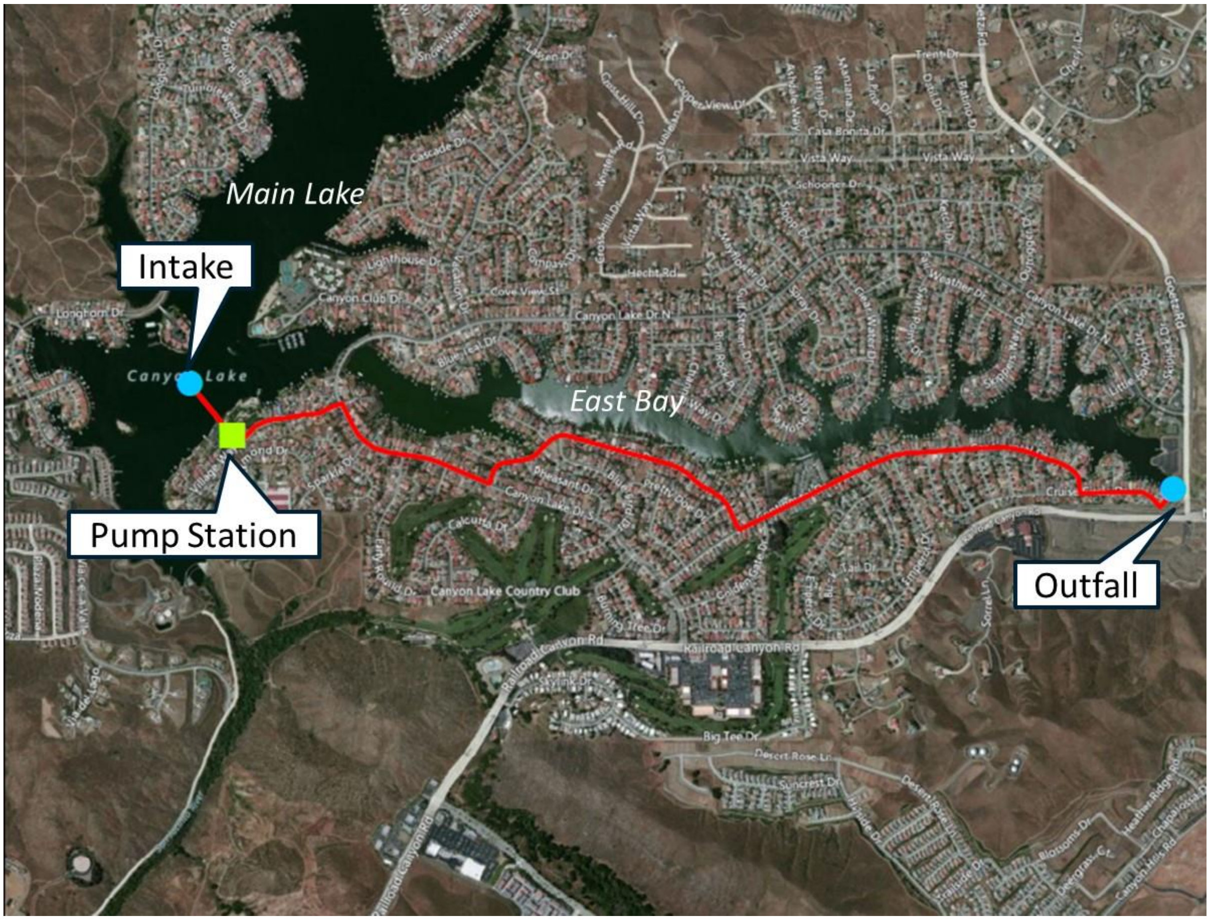

Figure 11-8. Canyon Lake Recirculation Project Concept

Potential Water Quality / Other Benefits

The recirculation process would result in a net reduction of internal nutrient load and net increase in DO. Algae blooms would be expected to be shortened in duration within East Bay and conditions with DO > 5 mg/L would extend deeper in the water column in the Main Lake. Also, the project would improve raw water quality at the EVMWD water treatment plant.

Potential Implementation Issues

Although a net reduction in nutrients is expected, there may be periods when high concentrations of bioavailable nutrients in the hypolimnion of Canyon Lake Main Lake could cause an increase in nutrient concentrations within East Bay. One alternative would involve incorporation of a process to treat the recirculated water.

Sizing Assumptions and Estimated Costs

A simulation of the effects of a recirculation project was completed using the Simplified Lake Analysis Model (SLAM). SLAM is a single dimensional model. Estimates of water quality benefits from increased flushing are determined by adjusting terms in an empirical phytoplankton growth estimation. Using the model, it was determined that a recirculation rate of ~10 mgd of Main Lake water, or roughly one month to completely flush East Bay water into the Main Lake, would yield significant water quality improvements. Sizing criteria for preliminary designs would need to be developed based on results of a more spatially rigorous three-dimensional model of Canyon Lake, such as ELCOM-CAEDYM. **Table 11-8** summarizes the estimated costs for construction operation of a recirculation facility in Canyon Lake.

Table 11-8. Planning-Level Cost Estimate for a Recirculation Facility in Canyon Lake

Facilities	Cost ($)
Intake pipeline (16,000 ft, 30-inch diameter)[1]	$8,450,000
Intake, outfall with rock protection	$500,000
Pump Station (400 HP)[2]	$1,200,000
Capital Cost (2018)	$10,150,000
O&M ($/yr)[3]	$203,000
Present Value for 25 years ($)[4]	**$11,110,000**

[1] Pipeline (30-inch diameter) cost assumed $528 per linear foot (Carollo 2017)
[2] Pump station cost assumes $3,000 per HP (Carollo 2017)
[3] Assumes 2% of capital for annual O&M including power to run pumps and facility maintenance
[4] Assumes 3% discount rate with capital expenditure in 2025 and O&M in 2025-2045

11.1.2.9 Ultrasonic Algae Control

Project Description

Many species of cyanobacteria contain gas vacuoles that provide a competitive advantage by allowing algae cells to regulate their position in the water column. However, gas vacuoles make cyanobacteria more susceptible to cavitation, and research has been conducted to evaluate the potential to control them by sonication. Deployment of devices that emit directional ultrasonic waves are effective in killing cyanobacteria by causing cavitation. Multiple studies have shown sonication to significantly reduce growth of cyanobacteria (Rajasekhar et al. 2012).

Sound waves produced by sonication have a limited area of influence (~8 acres); therefore, this potential project is generally envisioned only for Canyon Lake East Bay. However, this option could be incorporated as an element of other in-lake controls where isolated locations (e.g., near intakes) would benefit from reduced concentrations of cyanobacteria.

Potential Water Quality/Other Benefits

The primary benefit of this type of project is control of algae growth and preferential reduction of cyanobacteria species. Reduction in cyanobacteria would in turn reduce levels of cyanotoxins, thereby reducing the risk of exposure for swimmers.

Potential Implementation Issues

Sonication has been proven effective over a small area but may require many devices to impact larger zones. Impacts to other non-target aquatic species is an important consideration.

Sizing Assumptions:

Each ultrasonic unit provides sufficient wave signals to kill algae over roughly 8 acres. Twelve units are assumed for East Bay at a cost of $4,795 each (Quote provided by Sonic Solutions, June 2016, www.sonicsolutionsllc.com). The units can be powered in different ways, but for this estimate it was assumed that three floating solar units would be necessary at a cost of $7,510 each. Shipping and installation costs are estimated. Per the unit owner's manuals, ultrasonic units require monthly maintenance, estimated at 1-hour each per month. The units have a useful equipment life of 10 years; thus, reinvestment is assumed at year 11. **Table 11-9** provides a summary of the estimated cost for a project in East Bay Canyon Lake.

Table 11-9. Estimated Cost to Deploy Ultrasonic Units in East Bay Canyon Lake

Cost Item	Cost ($)
Total Equipment plus Installation Cost[1]	$93,230
Annual O&M	$10,080
Present Value[2]	$310,000

[1] Includes cost of replacement at year 11

[2] Assumes 3% inflation rate and a 25-year period with annual O&M in years 2025 - 2045

11.1.2.10 Algaecide

Project Description

The application of an algaecide directly to the surface of either Lake Elsinore or Canyon Lake would kill algae and prevents algal blooms from forming (**Figure 11-9**). PAK® 27 is an algaecide that works through an oxidation process, releasing hydrogen peroxide into the water supply. This algaecide allows for selective treatment for cyanobacteria and is non-toxic to other forms of aquatic life. Other algaecides could also be considered that may be more effective for all types of algae, but potentially more toxic to other aquatic species after repeated usage over multiple years (e.g., copper sulfate). Algaecides may be used on an as-needed basis or as part of a treatment train with alum or other treatment methods. California has a statewide general NPDES permit for use of algaecides or aquatic herbicides registered for use in California (State Water Board 2013). Costs were estimated for a single application, but multiple applications per year, timed around historical algal blooms, would provide the greatest benefit.

Figure 11-9. Example of Application of Algaecide to a Surface Waterbody (Source: http://www.peroxygensolutions.com/pak-27/how-to-apply)

Water Quality Benefits

Algaecides may be used to control algae growth and impairments caused by eutrophication.

Constraints and Limitations

Repeated use of some algaecides can cause elevated levels of toxins in the lake bottom. Given that nutrients are not addressed, new algae blooms may arise shortly after an algaecide treatment. The frequency of application required to achieve effective results is unknown and will require additional study.

Costs & Assumptions

Table 11-10 summarizes the estimated planning level costs for this BMP project. The analysis assumes the top four feet of both Lake Elsinore and Canyon Lake are treated annually with PAK27 at an application rate of 30 lbs/AF. The cost per pound is assumed at $1.30, based on discussions with a leading algaecide provider in spring 2018. Additional costs are assumed for shipping and application by lake staff.

Table 11-10. Planning-Level Costs for Application of Algaecide to Lake Elsinore or Canyon Lake

Per Application Cost Items	Canyon Lake	Lake Elsinore
Surface Acres	500	3,000
Volume of Treatment (AF)[1]	2,000	12,000
Algaecide Application (lbs/Event)	60,000	360,000
Total Annual Algaecide Product Cost ($/Event)	$78,000	$468,000
Shipping and Application Labor ($/Event)	$4,400	$6,600
Present Value ($) [2]	$1,060,000	$6,090,000

[1] Treated volume is top 4 feet of water column

[2] Assumes 3% inflation rate and a 25-year period with annual applications in years 2025 - 2045

11.1.2.11 Physical Harvesting of Algal Biomass

Description

Several technologies exist to remove algal biomass from lakes using screens, filters, or flotation/separation processes. In the 66,000-acre Upper Klamath Lake, physical harvesting of algae in conducted commercially to produce a dietary supplement from nitrogen-fixing cyanobacterium *Aphanizomenon flos-aquae* (AFA) (**Figure 11-10**) (Klamath Valley Botanicals 2018). AFA production from Upper Klamath Lake is currently conducted using two methods, a lakeshore filtration system and a floating barge equipped with algal screens.

A floating barge system could be used to removal algal biomass from Lake Elsinore and/or Canyon Lake. Instead of producing AFA dietary supplements, other potential uses of the harvested algae from the lakes could include production of biofuels or soil amendments. Alternatively, harvested algae could be disposed of in a composting facility.

Figure 11-10. Floating Algal Harvesting Barge on Upper Klamath Lake in Oregon (Source: http://www.spiritofleadership.info/health/earths-first-foods/algae-information/

Potential Water Quality/Other Benefits

Physical removal of algae will reduce concentrations of chlorophyll-*a* in lake water, reduce potential for release of cyanotoxins, and remove nitrogen and phosphorus mass from the system. The harvested algae may be useful to other entities in the region to reduce operational costs by providing a sustainable source for production of biofuels or in composting operations.

Potential Implementation Issues

Due to the limited lake surface area and narrow configuration, it may be difficult to conduct algal biomass removal in Canyon Lake East Bay by floating barge. In addition, if algal toxins are present at high levels in collected biomass, these conditions may constitute a hazardous waste and involve additional disposal requirements. Lastly, the regular operation of a floating barge may disturb recreational use within the lakes.

Table 11-11. Estimated Costs for Algal Biomass Harvesting

Cost Item	Cost ($)
Total Capital Cost[1]	$144,000
Annual O&M[2]	$84,000
Present Value[3]	$1,210,000

[1] Cost of filtration barge and off-load tender estimated for Klamath Lake, escalated to 2018 dollars, and downscaled by 20 percent for Lake Elsinore surface area, includes cost of replacement at year 11.

[2] O&M cost includes fuel, labor, and maintenance involved in 100 days of operation per year, downscaled by 20 percent for Lake Elsinore surface area.

[3] Assumes 3% inflation rate and a 25-year period with annual applications in years 2025 -2045.

Sizing Assumptions and Estimated Costs

Cost estimates were developed based on the assumption used in estimating potential costs to expand commercial AFA harvesting in Klamath Lake to target all algal species and operate on a more regular 100-day per year schedule (**Table 11-11**) (Stillwater Sciences et al. 2012). Costs were updated to reflect 2018 dollars using the standard ENR index. There were no comparable projects implemented on a smaller lake, so capital and O&M is downscaled by 80% given that the surface area of Lake Elsinore (~3,000 acres) is 20% the surface area of Upper Klamath Lake (~60,000 acres). Consistent with the Upper Klamath Lake estimate, useful equipment life is assumed to be

10 years; thus, reinvestment is assumed at year 11. A detailed take-off estimate should be developed if this technology is to be further considered in subsequent implementation plans. Potential disposal costs are not included in this estimate.

11.1.2.12 Watershed BMPs in Urban Drainage Areas

Description

Watershed runoff and associated excess nutrient loads could be captured and infiltrated or treated prior to reaching Canyon Lake and Lake Elsinore with watershed-wide deployment of low LID BMPs. Examples of LID BMPs include bioretention facilities, porous pavement, detention basins, media filtration, and regional infiltration basins. Under the areas MS4 permit, such projects are required in new urban development and significant re-development projects within the San Jacinto River watershed (Santa Ana Water Board 2010) (**Figure 11-11**).

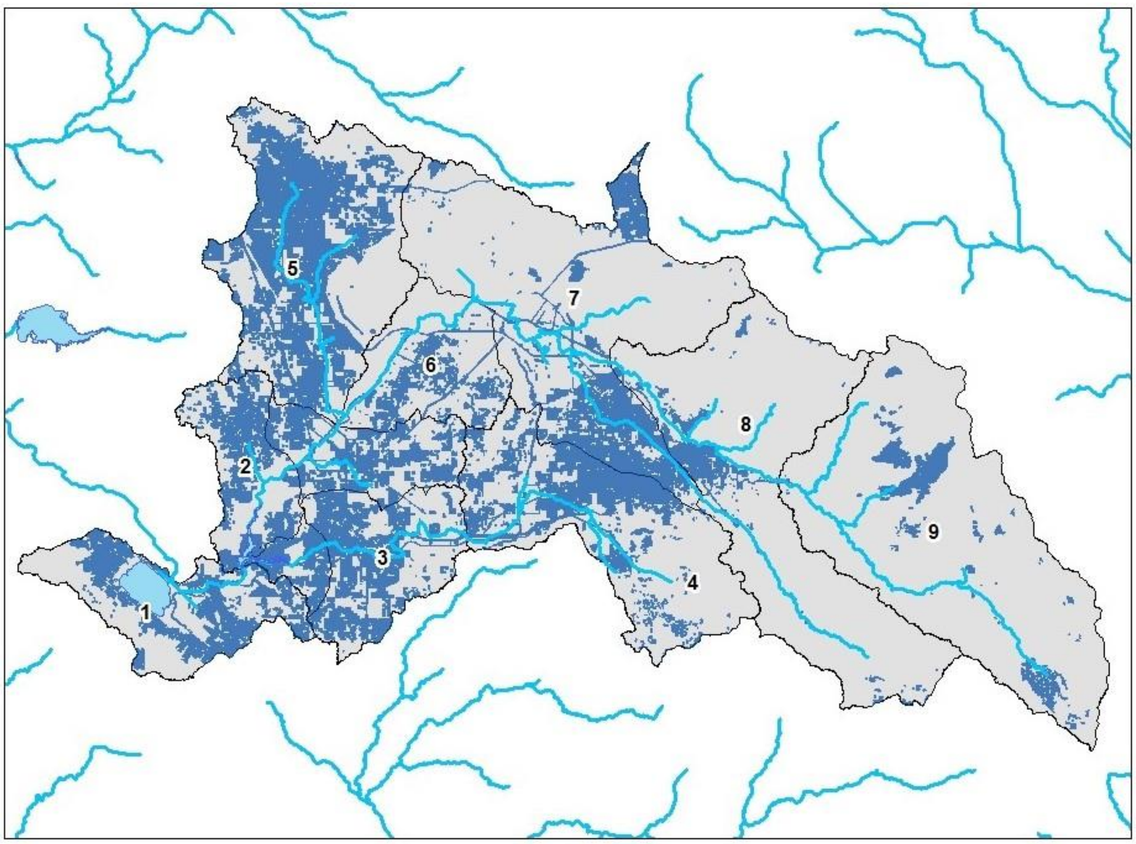

Figure 11-11. Urbanized Area of the San Jacinto River Watershed

Collectively, MS4 permittees have overseen the construction of numerous LID BMPs within ~7,000 acres of new development in the San Jacinto River watershed. These LID BMPs are designed to capture at a minimum, all runoff from storms events up to the 85^{th} percentile depth. To minimize nutrients loads to Canyon Lake and Lake Elsinore from the watershed, it is larger storm events (> 5-year return period) that must be controlled to protect downstream waters. These events occur infrequently but are responsible for the majority of total watershed nutrient loading. The nutrients ultimately settle to the bottom of Canyon Lake and Lake Elsinore, where data analysis suggests cycling between the sediment, water column, and phytoplankton pools proceed over multiple decades (Anderson 2011).

In the future, jurisdictions could retrofit other urbanized areas in the San Jacinto River watershed (up to ~90,000 acres, see Figure 11-12) with similar water quality controls; however, costs to deploy LID BMPs in existing urban land use areas are much greater than in new development. For some jurisdictions with limited drainage area and potential for establishing downstream BMPs to capture urban runoff, watershed BMPs to capture excess nutrient loads from large storms may be a viable alternative path to compliance.

Potential Water Quality/Other Benefits

Reduction of nutrient loads from urban areas within the areas that drain to the MS4 in the Lake Elsinore and Canyon Lake watersheds.

Potential Implementation Issues

Implementation of BMPs to capture runoff would need to consider a number of potential constraints, including, for example, land availability, technical feasibility, environmental impacts from construction activities, and reduction in runoff volume delivered to lakes that support beneficial uses dependent on adequate water, e.g., municipal water supply in Canyon Lake and recreation in Lake Elsinore.

While LID BMPs can be very effective in managing stormwater quality within localized areas, reliance on these BMPs only to comply with WLAs applicable to watershed runoff would be costly. For example, for Riverside County jurisdictions in the Santa Ana Region, it was estimated previously that the cost to achieve bacteria water quality objectives in urban runoff under dry weather conditions only was $780 million (Santa Ana Water Board 2012b). Based on this information the Santa Ana Water Board made the following finding related to compliance with bacteria water quality objectives under wet weather conditions (Santa Ana Water Board 2012b):

> *Given the large challenges and costs that would be associated with reducing bacterial indicators and the associated potential pathogens under large storm event flows, it may be economically infeasible for local agencies to implement actions to try and attain these standards under all flow conditions. Expending resources to address standards compliance under all flow conditions could delay expenditures to address compliance when and where most needed, i.e., when and where recreational use occurs. This would be contrary to the public interest.*

While these findings were applicable to compliance with bacteria water quality objectives, it is expected that the cost to deploy BMPs to control nutrients to meet the WLAs applicable to watershed runoff (e.g., see Table 6-3) would also likely be very high. Therefore, while LID-based BMPs can be a useful water quality management tool in local areas, it is expected that compliance with the revised TMDL will require implementation of other watershed or in-lake projects.

Sizing Assumptions and Estimated Costs

The watershed model developed to complete the source assessment in the revised TMDLs (Section 4) was used to estimate minimum runoff capture requirements. The model estimates that the capture of ~16 AF would be sufficient to capture and infiltrate or treat excess nutrients from a typical 500-acre urban drainage area from a five-year return period rainfall event (~3.2 inches). To development a cost estimate, three types of watershed BMPs were evaluated, including regional BMPs on public land, bioretention, and permeable pavement. Assumptions include:

- Maximum depth of ponded water for each BMP: (a) Regional BMP = 6.0 ft; (b) bioretention = 1.5 ft; and (c) permeable pavement = zero depth.
- Depth of gravel sublayer: 2-foot for all three BMP types (regional BMP, bioretention, and permeable pavement).

Costs can vary significantly depending upon the types of BMPs that may be feasible for a given watershed, with regional BMPs on public lands being the most cost effective, i.e., ~$3 million capital and $200,000 per year O&M (**Table 11-12**). In some cases, regional BMPs costs could be further reduced if there are existing facilities that could be repurposed to capture runoff. Permeable pavement is the most cost prohibitive and would not be reasonable to implement at a subwatershed scale. Regardless of BMP type, individual opportunities for deployment of these or other types of BMPs may be implemented at lower costs when incorporated as features within other public infrastructure projects.

Table 11-12. Estimated Costs to Deploy Selected BMPs in the San Jacinto River Watershed

Costs to Control 5-yr, 24-hr Storm from 500-acre Urban Drainage Area	Regional BMP on Public Land ($)	Bioretention (million $)	Permeable Pavement (million $)
Capital[1]	$3,410,000	$8,350,000	$17,660,000
O&M ($/year)[1]	$220,000	$1,180,000	$1,210,000
Total Net Present Value[2]	$5,720,000	$22,140,000	$30,360,000

[1] Capital and O&M cost based on functions developed for Los Angeles County (Upper Los Angeles River Watershed Management Group 2016)

[2] Assumes 3% inflation rate and a 25-year period with annual applications in years 2025 - 2045

11.2 Economic Value

Costs of existing TMDL implementation activities that are likely to continue, as well as planning level cost estimates for potential supplemental projects, are provided above. The specific environmental and economic benefits that may be realized from protection of water quality are more difficult to measure given that economic benefits are subject to large sources of uncertainty, are highly subjective, and can be rather time consuming and expensive (Keplinger 2003). For this TMDL revision, a detailed quantitative analysis in economic terms was not developed to quantify anticipated benefits of improved water quality in Lake Elsinore and Canyon Lake. Instead, this section provides qualitative information on the economic and environmental benefits associated with implementation of revised TMDLs.

Water quality improvement in both lakes will positively benefit the biological diversity in the area by increasing the extent and health of aquatic and terrestrial habitats. Lake Elsinore is the largest natural lake in southern California but provides unreliable support for aquatic habitat in the reference (naturally occurring) condition, mostly caused by dramatic fluctuations in water level and water quality, especially with regards to salinity. As discussed in Section 9, Lake Elsinore is being managed in a manner that targets a stable lake level with a surface elevation of 1,240 ft. This management strategy is contrary to the natural condition, which results in a periodically dry lake (see Section 2). Implementation of this wet-lake management strategy ensures support of existing recreational and aquatic life beneficial uses. Under the revised TMDLs this preferred management approach is presumed to continue.

By managing Lake Elsinore to have a more consistent water level, the following benefits are expected to be realized:

- Lakeshore vegetation will have an opportunity to become established, and in turn provide habitat for many species as well as facilitate the uptake of nutrients otherwise used by algae.

- Visitors to Lake Elsinore and Canyon Lake enjoy fishing, boating, swimming, and other outdoor recreation activities. Numerous studies in other areas have found that water quality impacts recreational lake usage, resulting in a significant loss of tourism revenue for local areas as water quality declines (Abidoye and Herriges 2012; Hjerppe et al. 2017). The decrease in lake usage impacts tourism spending in the local area surrounding the lakes, especially when water clarity is decreased during summer months (Voigt et al. 2015).

- Water quality also impacts fishing and the purchase of fishing licenses and lake passes, a condition experienced in recent years by the City of Lake Elsinore, as shown in a downward trend in day use passes purchased (**Figure 11-12**).

- Improved water quality can positively impact nonuser benefits, such as aesthetics and the overall ecological health of the watershed (Keplinger 2003). These are benefits that are difficult to quantify but still highly valued by residents and visitors to the area.

- Lastly, the water quality in recreation lakes has been proven to impact surrounding parcel scale property values. Voigt et al. (2015) found that a one-meter increase in water clarity is equated with a nearly 3 percent average increase in single family home value and a 37 percent increase in seasonal home values.

- Reduced algae growth in Canyon Lake Main Lake will improve the treatability of water drawn from the lake by EVMWD for municipal water supply. Taste and order issues would be reduced with improved water quality in the source water.

- Implementation of the TMDLs will improve the health and water quality of upstream Canyon Lake. As part of a shared watershed the health and quality of Canyon Lake is vital to the health of species in and around the lake and the entire watershed.

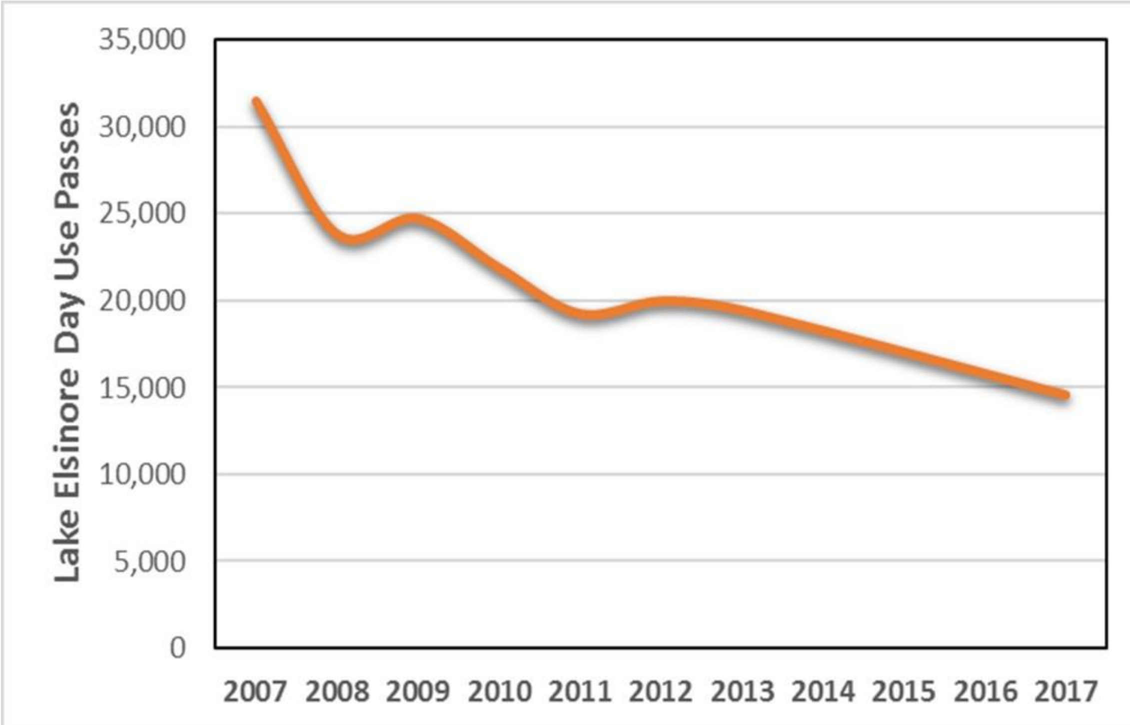

Figure 11-12. Declining Trend in Purchases of Lake Elsinore Day Use Passes (Data provided by Nicole Dailey, City of Lake Elsinore)

11.3 Agricultural Costs

California Water Code §13141 requires that prior to implementation of any agricultural water quality control program, the Santa Ana Water Board must include an estimated cost of such a program and identify potential sources of funding. With the adoption of the revised TMDLs, agricultural costs are expected to be similar with continued implementation of existing control programs, e.g., as required by the CWAD, and continued support of the LECL Task Force and TMDL Monitoring Program. Where supplemental projects are identified for implementation, the portion of the costs allocated to agriculture will be determined as part of the development and implementation of the project. With the ongoing urban development and declining agricultural operation in the San Jacinto River watershed, regional BMP cost shares for agricultural operators are likely to be reduced from historical levels. When it becomes necessary to secure funds for selected projects, the following are potential sources for obtaining funding:

1. Private financing by individual and/or group sources;
2. Bonded indebtedness or loans from governmental institutions;
3. Federal grants or low-interest loan programs;
4. Single-purpose appropriations from federal or State legislative bodies;

5. Grant and loan programs administered by the State Water Board and California Department of Water Resources (CDWR), which are targeted for agricultural water quality improvement. These programs currently include:

   (a) Clean Water Act funds (State Water Board);

   (b) Agricultural Water Quality Grant Program (State Water Board);

   (c) Clean Water State Revolving Fund (State Water Board); and

   (d) Integrated Regional Water Management grants (State Water Board, CDWR)

11.4 Antidegradation Analysis

The proposed Basin Plan amendment to revise the nutrient TMDLs complies with both the federal and state antidegradation policies. The proposed amendment will ensure the protection of existing uses in Lake Elsinore and Canyon Lake by establishing allocations necessary to meet water quality objectives in the waterbodies designed to provide protection for those uses. Overall, the proposed revisions to the TMDLs are expected to result in better water quality than current conditions in Lake Elsinore and Canyon Lake. Ultimately, water quality conditions achieved with the proposed TMDL revision will represent conditions that are equal to or better than a reference watershed condition.

Comparing water quality expected from complying with the proposed TMDL revision to the 2004 TMDL (i.e., No Action) is complicated by an error in the original linkage analysis to translate in-lake nutrient targets to allowable watershed loads (see Section 10.2.2.2 for detail). The error created a condition whereby the proposed TMDLs Revision would reduce allowable nutrient loads, presumably improving downstream water quality with the new allocations, but make some numeric response targets less stringent than the 2004 TMDLs. Therefore, the allocations and response targets set forth in the TMDL revision consist of an advancement of the scientific basis and not a reduction in expected lake water quality, so long as data continues to support the expected outcome involving equal or better water quality than a reference watershed condition.

Neither Lake Elsinore or Canyon Lake are part of an Outstanding National Resource Waters area. The proposed revisions to the TMDLs do not relate potential impairments that could be caused by a thermal discharge.

Discharges in the watersheds associated with Lake Elsinore and Canyon Lake are regulated under various Santa Ana Water Board-issued orders, including the discharge of recycled water, municipal stormwater and discharges from agriculture subject to the CWAD. Where necessary, as noted in Section 7.4.2.2, the Santa Ana Water Board will revise WDRs to incorporate the requirements of the revised TMDLs. Any substantial change in discharge quantity or quality for any type of discharger will trigger further environmental evaluation at that time.

11.5 Summary of Key Findings

Several of the potential supplemental in-lake water quality controls identified in the TMDL revision may be less costly than current expenditures on existing projects. Thus, supplemental project options do exist that could be implemented without causing an unmanageable increase in the total cost for water quality controls in the San Jacinto River watershed. Updates to TMDL implementation plans, e.g., CNRP and AgNMP, should consider these low-cost options and their potential water quality benefit toward compliance with the revised TMDL allocations and response targets.

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