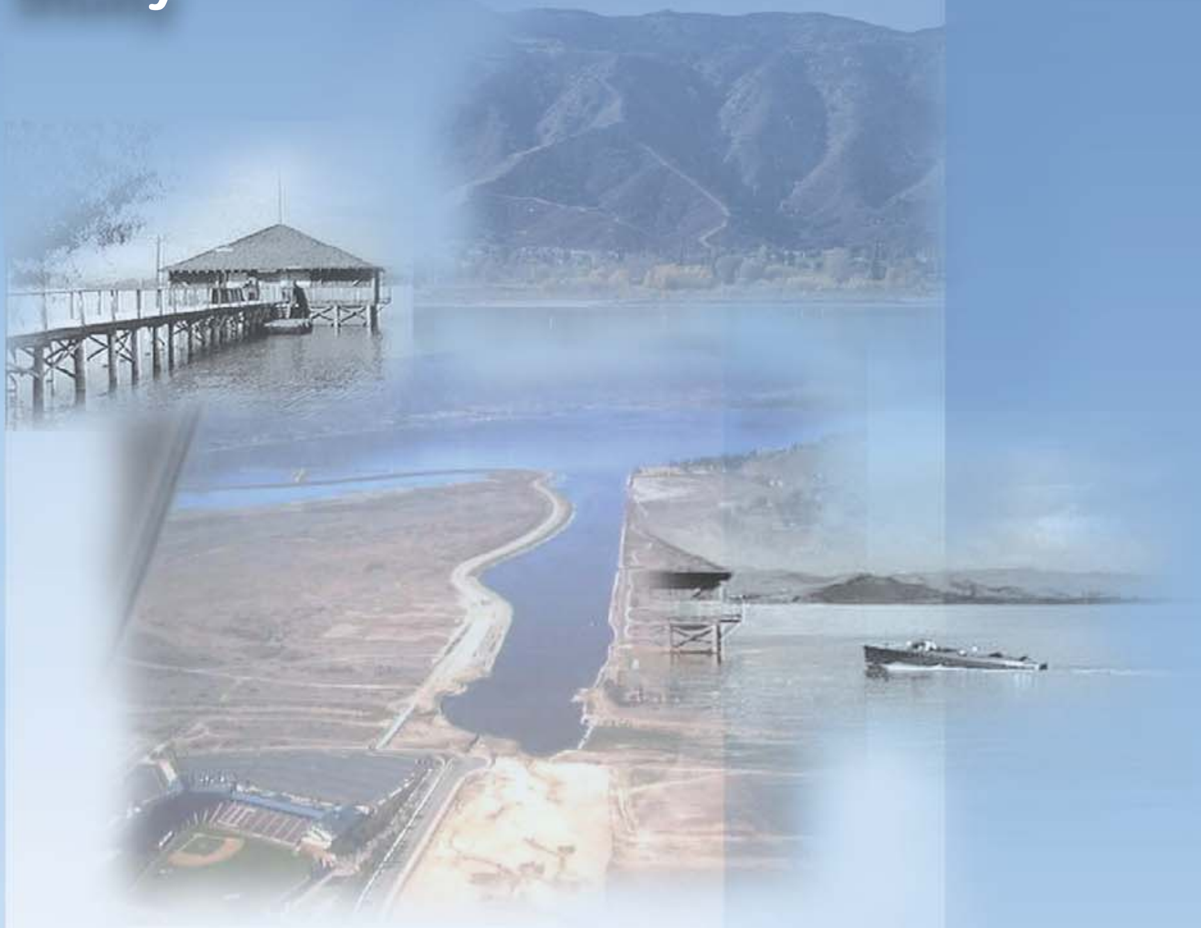
Lake Elsinore Nutrient Removal Study

Final Report



Prepared for

Lake Elsinore & San Jacinto Watersheds Authority

City of Lake Elsinore • City of Canyon Lake • County of Riverside
Elsinore Valley Municipal Water District • Santa Ana Watershed Project Authority

CH2MHILL

April 2004

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Funding for this project has been provided in full or in part through a contract with the State Water Resources Control Board (SWRCB) pursuant to the Costa-Machado Water Act of 2000 (Proposition 13) and any amendments thereto for the implementation of California's Nonpoint Source Pollution Control Program. The contents of this document do not necessarily reflect views and policies of SWRCB, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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Acronym List

Alum	aluminum hydroxide
BOD	biochemical oxygen demand
CCI	Construction Cost Index
COE	U. S. Army Corps of Engineers
Eastern MWD	Eastern Municipal Water District
Elsinore Valley MWD	Elsinore Valley Municipal Water District
Elsinore Valley MWD RWRF	Elsinore Valley Municipal Water District Regional Water Reclamation Facility
EPA	Environmental Protection Agency
FFA	Frequency Flood Analysis
FRP	fiberglass-reinforced plastic
HRT	Hydraulic residence time
JPA	Joint Powers Authority
LESJWA	Lake Elsinore and Jacinto Watershed Authority
Metropolitan	Metropolitan Water District of Southern California
O&M	Operation and Maintenance
PAO	phosphorus -accumulating organism
PPA	Preferred Project Alternative
PVC	polyvinyl chloride
PVDF	polyvinylidene fluoride
RRWS	Regional Reclaimed Water System
RWRF	Regional Wastewater Reclamation Facility
SRP	soluble-reactive phosphorus
SRT	solids residence time
Santa Ana RWQCB	Santa Ana Regional Water Quality Control Board
SAWPA	Santa Ana Watershed Project Authority
SRP	soluble-reactive phosphorus
DH	total dynamic pumping head

TIN	total inorganic nytrogen
TMDL	Total Maximum Daily Load
TSI	Trophic State Index
Temecula Valley RWRF	Temecula Valley Regional Water Reclamation Facility
USGS	U. S. Geological Survey
VFA	volatile fatty acids
WAS	waste activated sludge

EXECUTIVE SUMMARY

Executive Summary

Introduction

The Lake Elsinore Nutrient Removal Study has been undertaken for the Lake Elsinore and San Jacinto Watersheds Authority (LESJWA), which is a Joint Powers Authority (JPA) and is governed by five member agencies. The JPA agencies include the Elsinore Valley Municipal Water District (Elsinore Valley MWD), the City of Lake Elsinore, the City of Canyon Lake; the County of Riverside, and the Santa Ana Watershed Project Authority (SAWPA). SAWPA serves as the Authority administrator, and provided project management for this study.

LESJWA was specifically created for the purpose of implementing "projects and programs to rehabilitate and improve the San Jacinto and Lake Elsinore watersheds and the water quality of Lake Elsinore, in order to preserve agricultural land, protect wildlife habitat, protect and enhance recreational resources, and improve surface and subsurface water quality, all for the benefit of the general public."

LESJWA retained CH2M HILL to conduct an analysis on the effectiveness and feasibility of treatment wetlands and advanced treatment technologies to remove phosphorus in the water column of Lake Elsinore, reclaimed water and storm runoff.

Background

Lake Elsinore is located sixty miles southeast of Los Angeles and twenty-two miles south of the City of Riverside, California, and is the natural low point in the San Jacinto River watershed. Lake Elsinore is the terminus of the San Jacinto River watershed and only rarely does water flow out of Lake Elsinore into the Temescal Wash and ultimately into the Santa Ana River and the Pacific Ocean.

The San Jacinto River Watershed covers an area of approximately 735 square miles, as shown in Figure ES-1. Lake Elsinore's direct watershed comprises approximately 47 square miles making the total drainage basin area approximately 782 square miles. Over 90 percent of the San Jacinto River watershed drains to Canyon Lake, which is located about three miles upstream from Lake Elsinore. There are two main watercourses in the watershed: the San Jacinto River and Salt Creek. The San Jacinto River drains the western slopes of the San Jacinto Mountains and flows through the communities of San Jacinto and Perris before entering Canyon Lake. Salt Creek is tributary to the San Jacinto River and flows into Canyon Lake from the east. Discharges from Canyon Lake Dam flow southwest in the San Jacinto River to Lake Elsinore, which serves as a natural sink.

Lake Elsinore is a natural lake that, under historical conditions, has varied in size from over 6,000 acres in very wet years to a dry playa in drought years. The lake is technically eutrophic in that it exhibits the following characteristics:

- Large algae blooms, with blue-green algae (cyanobacteria) a common presence, especially *Microcysis*.

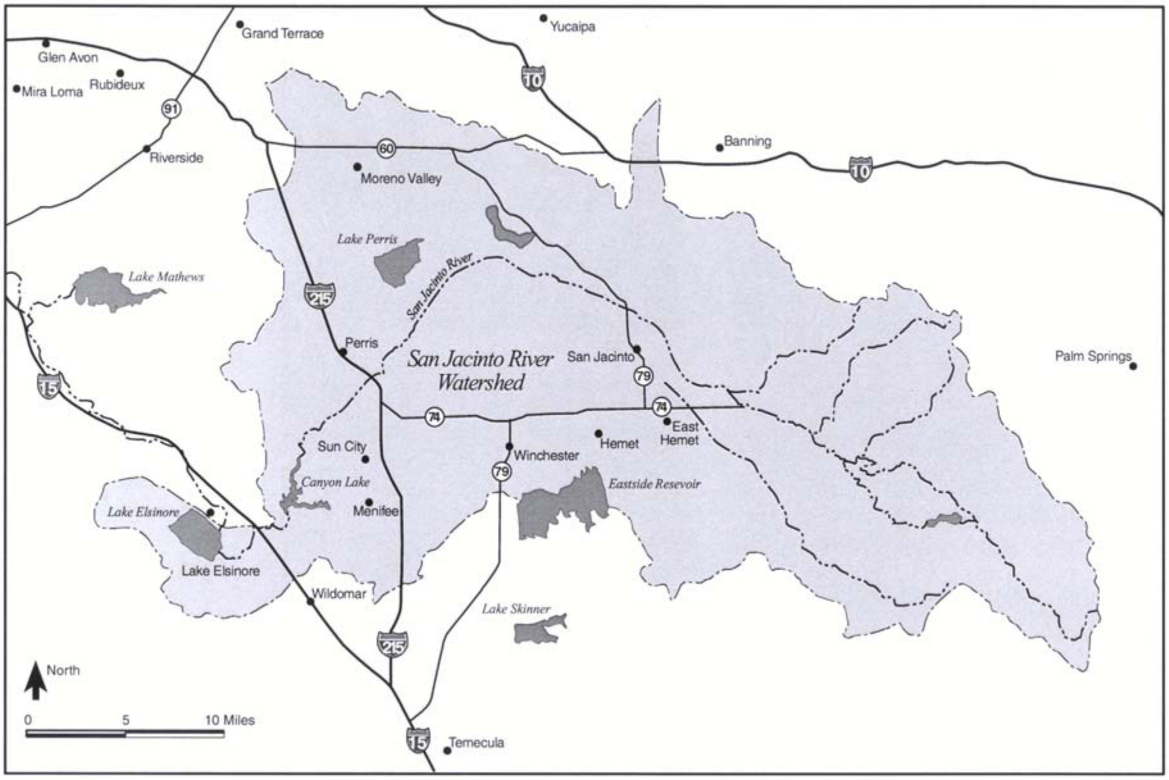

Figure ES-1
Lake Elsinore and San Jacinto River Watershed

Large seasonal and daily swings in the concentration of dissolved oxygen in the lake water column. Anoxic (zero dissolved oxygen) conditions have been recorded in most summers in the deeper lake waters.

- Low water clarity, with Secchi disc values of less than one meter of depth common.
- High concentrations of inorganic nitrogen and total phosphate in the lake water column.

In addition, the following are typical characteristics of eutrophic lakes that are also common to Lake Elsinore:

- Shallow water that does not show permanent thermal stratification in summer (technically a polymictic or many-mixing lake). This allows nutrients released from the lake bottom sediments to be rapidly carried to the algae growing at the lake surface.
- High ratio of watershed to lake surface area. Lake Elsinore has a ratio of about 167. Watershed to lake area ratios greater than 100 indicate potential eutrophy.
- Warm water that shows daily or short-lived thermal stratification allowing total oxygen depletion in the lake bottom water and sediments, even though the lake frequently mixes top-to-bottom.
- Highly variable depth, including total dry out that eliminates shoreline vegetation that could modify planktonic algae blooms.

Throughout its history, Lake Elsinore has been subject to flooding and drought, depending on the rainfall amounts. The lake loses an average of about 14,500 acre-feet a year to evaporation, dropping the surface level more than 4.5 feet a year.

Management criteria established the objective of a minimum lake water surface elevation of 1,240 feet above sea level, and maintaining the lake operating water surface within the elevation range of 1,240 feet to 1,247 feet. At the current surface elevation of 1,237 feet, the lake covers 2,896 acres with an average depth of 10 feet and a maximum depth of 14 feet. Current lake volume is about 29,800 acre-feet. The lake edges slope gently; so dry years result in extensive zones of unsightly exposed lake bottom sediment and dead vegetation. The fluctuating lake level prevents development of the shoreline, hinders visitor access and excludes natural methods of lake cleanup involving the growth of rooted vegetation in shallow water.

An alternative to preventing the lake drying up is through the addition of reclaimed water and/or imported water equal to the amount of water that evaporates each year. Of those two potential supplemental water sources, reclaimed water will be the more reliable source due to potential release restrictions at Canyon Lake. However, with the addition of reclaimed water, significant amounts of nutrients (phosphorus) will be added to Lake Elsinore that may cause algae to grow abundantly further degrading water quality, promoting numerous fish kills and having a devastating effect on the local economy. Thus the need for this study to evaluate treatment technologies to remove the phosphorus present in the reclaimed water and lake water to rectify that situation.

Purpose of the Study

The purpose of the study is to accomplish the following:

- Adopt short-term and long-term water quality goals for Lake Elsinore water, and nutrient loading criteria to support the adopted lake water quality goals.
- Evaluate treatment technologies for the removal of phosphorus in the potential supplemental water sources available to maintain the lake operating water level within the desired elevation range.
- Establish phosphorus removal efficiencies for the treatment technologies evaluated.
- Develop project alternatives to meet the short-term and long-term lake water quality goals and nutrient loading criteria and supplemental water requirements to maintain the lake operating water level in the desired elevation range.
- Define the construction and capital costs for the developed project alternatives.
- Define the annual operation and maintenance (O&M) costs for the project alternatives.
- Evaluate the project alternatives to select the best alternative.
- Develop a phased project approach to utilize available Proposition 13 funds.

Study Water Quality Goals and Nutrient Loading Criteria

Introduction

The water quality goals for the water in Lake Elsinore and the nutrient loading criteria for the lake supplemental water sources were established in a workshop that was attended by the study stakeholders on September 24, 2003. The workshop was held in SAWPA's offices in Riverside, California.

The purpose of the workshop was to develop consensus among the study stakeholders on the Lake Elsinore water quality goals to be adopted for the study, and the supplemental water nutrient loading criteria to support those goals. Table ES -1 summarizes the suggested Lake Elsinore long-term water quality goals that were presented in the "Lake Elsinore Restoration and San Jacinto Watershed Protection Program Proposal" submitted to the City of Lake Elsinore in 2000. Those long-term water quality goals served as the basis for the workshop discussions.

Lake Elsinore Modeling Results

In addition, a preliminary modeling analysis was conducted by Dr. Michael Anderson to develop phosphorus nutrient loading criteria appropriate to meet the Lake Elsinore water quality goals established in the workshop. The model utilized available lake water elevation data from 1992 to present, a published stage-volume relationship, and lake total phosphorus and total nitrogen data collected by various researchers from 1992 through the present.

TABLE ES-1
Suggested Lake Elsinore Long-Term Water Quality Goals

Parameter	1992-1999 Typical Range	Long-Term Goal
Lake Water Elevation	1,229 – 1,259 feet	1,240 – 1,249 feet
Clarity Index	Poor to Very Poor	Poor to Good
Secchi Depth	1 – 3 feet	2 – 4 feet
Total Phosphorus	0.2 – 0.65 mg/L	<0.05 mg/L
Ortho Phosphorus	0.01 – 0.63 mg/L	<0.01 mg/L
Total Nitrogen	2 – 11 mg/L	<0.75 mg/L
Total Inorganic Nitrogen	0.1 – 1.45 mg/L	<0.15 mg/L
Chlorophyll *a*	10 – 950 ug/L	Average <20 ug/L Maximum <80 ug/L
Dissolved Oxygen	0.1 – 16.0 mg/L	>3.0 mg/L @ 3 feet from the bottom and 100% saturation from mid-depth to surface.

Results of the model calibration are shown in Figure ES-2, which shows the predicted and observed concentrations of total phosphorus in Lake Elsinore from 1992 through 2002. The water balance model provided a very good simulation of the lake water volume, and the phosphorus mass balance model showed a similarly good fit with observed water column phosphorus concentrations.

The model simulated a steady-state lake water total phosphorus concentration of 0.117 mg/L. This value agreed closely with the annual average total phosphorus concentration of 0.119 mg/L reported by the Santa Ana Regional Water Quality Control Board (Santa Ana RWQCB) for the 2000-2001 period.

The predicted chlorophyll concentration for the lake at a stable water level elevation of 1,242 feet (without external loads) was estimated to be 73 µg/L, which is expected to produce a transparency of 0.52 meter. These values are in reasonable agreement with previously reported measured values for chlorophyll and Secchi depth of 52 µg/L and 0.62 meter, respectively.

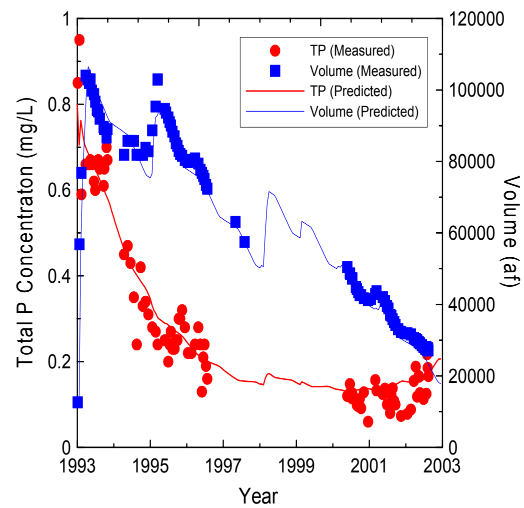

Figure ES-2
Predicted and Observed Phosphorus Concentrations and Lake Volume Estimates in Lake Elsinore, 1992-2002.
Source: Anderson (2002);preliminary, subject to revision.

Using this calibrated model, the effects of various external and internal phosphorus loading scenarios on lake water column total phosphorus concentration were investigated. Two scenarios were investigated. Each scenario involved the addition of 15,000 acre-feet per year of supplemental reclaimed water to the lake at different phosphorus concentrations ranging from zero to 1.0 mg/L. One scenario simulated the current lake water quality conditions, while the other scenario simulated a lake water quality condition with a 30 percent reduction in the lake total phosphorus concentration that that could potentially result from the two lake aeration projects planned by LESJWA. Those two projects include the surface aerator project and the lake diffused aeration project.

Table ES-2 presents the model lake water quality simulation results. The lake model results suggest a strategy that can be used to develop a phased approach for the treatment of reclaimed water, as a supplemental water source, that could meet the water quality goals for Lake Elsinore. With the existing internal lake loading conditions, the model simulations predict that a short-term chlorophyll *a* goal of 40 µg/L and a long-term goal of 20 µg/L will be difficult to meet regardless of the phosphorus concentration in the supplemental water.

Alternatively, the reduction in lake internal loading that can be achieved with lake aeration, or other similar means, will allow the short-term lake chlorophyll *a* goal of 40 µg/L to be attained with an inflow total phosphorus concentration up to 0.1 mg/L. The lake model results also suggest that the long-term lake trophic state goals may be achievable with a combination of internal nutrient load reduction and an inflow total phosphorus concentration of 0.05 mg/L, or less.

TABLE ES-2
Predicted Water Quality in Lake Elsinore Resulting from Addition of 15,000 Acre-Feet/Year of Reclaimed Water at Different Influent Total Phosphorus Concentrations

InfluentTotal Phosphorus (mg/L)	LakeTotal Phosphorus (mg/L)	Chlorophyll *a* (µg/L)	Secchi Depth (meter)
Existing Lake Water Quality Condition			
0	0.100 - 0.123	58 - 78	0.50 - 0.59
0.05	0.113 - 0.131	69 - 85	0.48 - 0.54
0.1	0.127 – 0.140	82 - 94	0.45 - 0.49
0.5	0.208 - 0.236	167 - 202	0.26 - 0.30
1.0	0.293 - 0.374	274 - 391	0.15 - 0.20
Lake Water Quality Condition with 30 Percent Reduction in Internal Loading			
0	0.036 – 0.076	12.8 – 38.9	0.71 - 0.98
0.05	0.040 – 0.079	15.4 – 41.1	0.69 - 0.94
0.1	0.045 – 0.082	18.2 – 43.5	0.68 - 0.90
0.5	0.084 – 0.108	45.2 – 65.9	0.56 - 0.67
1.0	0.133 – 0.152	87.1 – 105.6	0.42 - 0.47

Note: Assuming 15,000af/yr as some mix of recycled water, runoff, groundwater and other sources.

Lake Water Quality Goals

The workshop participants agreed to establish short-term (i.e., 5 to 10 years) and long-term (i.e., 10 to 20 years) water quality goals for Lake Elsinore. The approach is consistent with the development of phased alternatives to achieve the water quality objectives at Lake Elsinore. Table ES-3 presents the agreed upon short-term and long-term lake water quality goals.

Estimates of in-lake total phosphorus concentration and Secchi depth goals were made that correlate with the chlorophyll *a* goals, based on equations developed for Lake Elsinore by Dr. Anderson. The long-term water quality objectives are one-half the short-term objectives. Although the concentrations are non-enforceable, they could be utilized to develop Total Maximum Daily Load (TMDL) nutrient targets based on the volume and source water supply required to replenish Lake Elsinore.

TABLE ES-3
Workshop Adopted Lake Elsinore Short-Term and Long-Term Water Quality Goals

Parameter	Short-Term Goal	Long-Term Goal
Lake Water Elevation	1,240 – 1,247 feet	1,240 – 1,247 feet
Clarity Index	Poor to Good	Poor to Good
Secchi Depth	1 – 2 feet	2 – 4 feet
Total Phosphorus	<0.1 mg/L	<0.05 mg/L
Ortho Phosphorus	<0.02 mg/L	<0.01 mg/L
Total Nitrogen	<1.5 mg/L	<0.75 mg/L
Total Inorganic Nitrogen	<0.30 mg/L	<0.15 mg/L
Chlorophyll *a*	Average of 40 ug/L	Average of 20 ug/L
Dissolved Oxygen	>1.5 mg/L @ 3 feet from the bottom and 100% saturation from mid-depth to surface.	>3.0 mg/L @ 3 feet from the bottom and 100% saturation from mid-depth to surface.

Note: Dissolved oxygen criteria include bottom concentrations lower than the SARWQCB water quality criterion of 5 mg/L to account for low oxygen conditions in lake sediments, and are based on a 100 percent in the upper half of the water column to account for temperature effects on oxygen concentration.

Conceptual Reclaimed Water Treatment Options

The lake model results suggest a strategy that can be used to develop a phased approach for the treatment of the reclaimed water supplemental water addition that could meet the water quality goals established for Lake Elsinore. Conceptual options for the treatment of the reclaimed water supplemental water source are presented in Table ES-4. The table also includes lake water chlorophyll *a* predictions, based on lake water quality equations developed by Dr. Anderson.

If restoration of the lake operating water level through supplemental water addition can be assumed to be a greater short-term priority than achievement of the of the lake water quality goals, then the options listed in the table could achieve the multiple lake water level and quality goals. LESJWA could move through Options 1 and 2 simultaneously to achieve the lake stabilization goal; however, the lake water quality goal would not be attained. By moving directly to Option 3, LESJWA could achieve the short-term water quality goal established for the lake. Based on foregoing, it was proposed that treatment system alternatives be planned that could achieve the phosphorus nutrient loading target of 0.5 mg/L.

TABLE ES-4
Conceptual Options for Lake Elsinore Restoration and Reclaimed Water Quality Addition

Option	Activity	Reclaimed Water Total Phosphorus (mg/L)	Estimated Lake Chlorophyll *a* (ug/L)
0	Existing conditions	NA	10-950
1	Reduce internal loading through lake aeration	NA	100-300 (assumed)
2	Restore lake levels with supplemental water addition	1.0	87-106
3	Reduce reclaimed water inflow P load	0.5	45-66
4	Reduce reclaimed water inflow P load	0.1	18-43

Lake Elsinore Evaporation, Historic Inflows, Supplemental Water Requirements and Water Sources

Lake Elsinore Evaporation

A long-term operating objective for Lake Elsinore has been proposed to maintain the lake water level within a specific elevation range to enhance the aesthetics of the lake and mitigate the impact of in-lake nutrients on algae growth. The proposed long-term lake operating water level objective is to maintain the lake water level within the elevation range of 1,240 feet and 1,247 feet. The U.S. Army Corps of Engineers (COE) established the maximum water level elevation of 1,247 feet as the highest water level that supplemental water can be added to the lake.

The historic average annual evaporation rate for the Lake Elsinore area is about 4.6 feet per year. At a water surface elevation of 1,240 feet, the lake area is 3,074 acres, and the average annual evaporation loss is estimated to be 13,345 acre-feet per year. At a water surface elevation of 1,247 feet, the lake area is 3,386 acres, and the average annual evaporation loss is estimated to be 15,156 acre-feet per year.

Historic Lake Inflows

The U.S. Geological Survey (USGS) maintains a stream gage (No. 11070500) on the San Jacinto River between Canyon Lake and Lake Elsinore. The stream gage is located approximately one mile upstream of Lake Elsinore. Records of runoff flows in the San Jacinto River for the stream gage are available from 1916 to the present. The dam that forms Canyon Lake was constructed in 1928. The study therefore only evaluated the 73 years of stream gage flow records from 1928 through 2000.

The historic flow data for the stream gaging station shows some interesting trends. The maximum recorded annual flow for the period of evaluation is 161,147 acre-feet, which occurred in 1980. There have been two instances when the recorded annual flows exceeded 100,000 acre-feet (1980 and 1993). In the 73 years of flow records, there were only thirteen years when the inflows into Lake Elsinore equaled, or exceeded, the 13,345 acre-feet per year evaporation loss for the minimum lake operating water level elevation of 1,240 feet. There have been seven periods of four years, or longer, when annual flows were 800 acre-feet per year, or less; seven years between 1984 and 1990; four years between 1974 and 1977; five years between 1959 and 1963; five years between 1953 and 1957; eight years between 1944 and 1951; four years between 1933 and 1936, and four years between 1928 and 1931. Those extended low flow periods were spread evenly throughout the historical flow record for the stream gage. There are 47 years when the measured annual stream gage flows were equal to or less than 800 acre-feet per year, which represents about 65 percent of the historic annual flows. There are 41 years when the measured annual flows were equal to, or less than, 500 acre-feet per year, which represents about 55 percent of the historic annual flows. In addition, there were five years that no flows were recorded at the stream gage. Three of those no-flow years occurred during the 1980s. The historic flow records for the USGS stream gage indicate that very little of the San Jacinto River watershed runoff is getting to Lake Elsinore.

A frequency analysis was performed on the stream gaging station flow records. The frequency analysis was then used to determine the probability that the annual evaporation volume for Lake Elsinore will be equaled, or exceeded, by the watershed inflows. For the desired lake operating water level range of 1,240 feet to 1,247 feet, the San Jacinto River watershed inflows to the lake will offset the evaporation losses between 11.8 percent of the time (at the 1,247 foot elevation) and 12.5 percent of the time (at the 1,240 foot elevation). Within that lake water level operating range it can be expected that on a long-term basis, the San Jacinto River watershed inflows into lake Elsinore will be sufficient to off-set the estimated evaporation losses only one year out of ten, or a very low percentage of the time.

Conclusions and Supplemental Water Requirements

Lake Evaporation Loss

For long-term planning, it is suggested that an annual evaporation loss for Lake Elsinore of 15, 200 acre-feet per year be adopted for the study to make sure the lake water levels are maintained at the desired level for all hydrologic conditions.

San Jacinto River Watershed Inflows

The annual inflows to Lake Elsinore have been equal to, or less than, 800 acre-feet per year for about 65 percent of the 73 years of available flow records for the USGS stream gage on the San Jacinto River. In addition, there have been seven periods when the annual runoff flows have been equal to, or less than that flow volume for four or more years. For long-term planning purposes, a conservative approach of assuming no annual runoff from the San Jacinto River watershed was recommended.

Local Watershed Inflows

The runoff from the local watersheds, located downstream of the USGS stream gage, that discharge directly into Lake Elsinore was estimated using the San Jacinto River watershed model that was developed under another SAWPA-sponsored project. Local watershed runoff for the 10-year period from 1991 through 2000 was estimated, based on available rainfall data for that period, and ranged from 68 acre-feet per year to 7,106 acre-feet per year. The average annual runoff for the five watersheds for the 10-year period is estimated to be 2,345 acre-feet per year. Because the runoff evaluation for the local watersheds covers such a brief period, it was recommended that the median value of 1,400 acre-feet per year for the 10-year period be adopted for the study for long-term planning purposes.

Maximum Lake Supplemental Water Requirements

The maximum amount of supplemental water that may have to be made up in any one year during periods with very low inflow to the lake and the lake water level near its minimum operating range is estimated to be 13,800 acre-feet. That supplemental water volume was calculated as follows: 15,200 acre-feet per year evaporation loss minus the 1,400 acre-feet estimated inflow from the local watersheds.

Available supplemental water sources include groundwater pumped from the three existing Island Wells that are owned and operated by the Elsinore Valley MWD. Assuming 5,000 acre-feet per year of groundwater can be pumped from the Island Wells, a maximum supplemental water requirement of about 8,800 acre-feet per year would be needed under worst-case drought conditions, which will have to be made up by reclaimed water or imported water.

Long-Term Average Supplemental Water Needs

The Elsinore Valley MWD completed the “Lake Elsinore NPDES Permit Feasibility Study” in December 1997. The study included hydrologic and water quality analyses of the lake to evaluate the potential effects of reclaimed water addition from the agency’s regional water reclamation facilities. The study evaluated five hydrologic alternatives. The hydrologic evaluation showed that Alternative 4 produced the best results. Based on the hydrologic simulation results, it was suggested that a long-term average supplemental water requirement of 8,000 acre-feet per year be adopted for the study.

Supplemental Water Sources

Local groundwater, reclaimed water and imported water have been identified as the potential supplemental water sources to offset the Lake Elsinore evaporation losses, and maintain the lake water level within the desired operating elevation range.

Local Groundwater

One source of supplemental water is local groundwater pumped from the three existing Island Wells that are owned and operated by the Elsinore Valley MWD. The wells are drilled deep into the Lake Elsinore Basin that is beneath the lake, and pump groundwater directly into the lake. LESJWA is rehabilitating the well pump equipment. When the pump equipment rehabilitation is completed, it is estimated that the wells will be capable of producing 5,000 acre-feet per year.

Reclaimed Water

There are two potential sources for reclaimed water. One reclaimed water source is Title 22 effluent produced by the Elsinore Valley MWD Regional Water Reclamation Facility (Elsinore Valley MWD RWRF). The Elsinore Valley MWD RWRF currently produces about 4.0 million gallons per day (mgd) of treated effluent, of which approximately 3.5 mgd, or about 3,900 acre-feet per year, is available as a supplemental water source for Lake Elsinore.

The other reclaimed water source is Title 22 effluent from the Eastern Municipal Water District (Eastern MWD) Regional Reclaimed Water System, or reclaimed water produced by their Temecula Valley Regional Water Reclamation Facility (Temecula Valley RWRF). Reclaimed water from the Eastern MWD RRWS would be delivered through Reach 4 of their Temescal Creek Outfall Pipeline. Reclaimed water from the Temecula Valley RWRF would be delivered to Lake Elsinore through the planned Temecula Valley Effluent Pipeline.

Imported Water

Elsinore Valley MWD will purchase the imported water from the Metropolitan Water District of Southern California (Metropolitan). The imported water will be obtained through their WR-18b turnout that is located along the San Jacinto River about 12 miles upstream of Canyon Lake. The imported water will be conveyed to Lake Elsinore via the San Jacinto River and Canyon Lake.

Supplemental Water Availability

The reclaimed water source from the Elsinore Valley MWD and the imported water source are available year-round. Discussions were held with Eastern MWD staff to determine the availability of reclaimed water from their RRWS, or the Temecula Valley RWRF. Eastern MWD staff indicated that only surplus reclaimed water from their system would be available as a supplemental water source for Lake Elsinore, and that the surplus reclaimed water would only be available during the winter months from November through March (five month period) when agricultural irrigation is low.

Supplemental Water Requirement Estimate

The long-term average supplemental water requirement was developed to estimate the project alternative annual operation and maintenance costs. In addition, an estimate of the amount of supplemental water from each of the possible water sources was made to provide LESJWA a breakdown of the long-term average supplemental water requirement to assist in their future planning. The estimate assumed a future inflow pattern into Lake Elsinore identical to the 73 years of runoff data available for the USGS gaging station located on the San Jacinto River, downstream of Canyon Lake. The estimate since it is based only on San Jacinto River inflow to Lake Elsinore should be considered as an approximation. The breakdown of the supplemental water volumes produced by the estimate will therefore be different than the flow volumes presented for the project alternatives, since those latter values take into consideration treatment system and other water losses not included in this estimate.

The estimated supplemental water additions into Lake Elsinore for the 73-year period is presented in Table ES-5. The table breaks down the estimated supplemental water additions each year by the three possible supplemental water sources. Over the estimating period, a total of 487,800 acre-feet of supplemental water were added to Lake Elsinore to maintain the lake's water level above the minimum elevation of 1,240 feet. Of that total, approximately 290,900 acre-feet was Elsinore Valley MWD RWRF treated effluent (60 percent), 162,600 acre-feet was groundwater pumped from the Island Wells (33 percent), and 34,300 acre-feet of reclaimed water purchased from Eastern MWD (7 percent). Applying those percentages to the long-term average supplemental water requirement of 8,000 acre-feet per year, yields about 4,800 acre-feet per year of Elsinore Valley MWD RWRF treated effluent, about 2,700 acre-feet of groundwater pumped from the Island Wells, and about 500 acre-feet per year of reclaimed water purchased from Eastern MWD.

TABLE ES-5
Estimated Annual Supplemental Water Additions to Lake Elsinore

Year	Estimated Annual Supplemental Water Additions–Acre-Feet/Year			
	EVMWD Reclaimed Water	Island Wells	EMWD Reclaimed Water	Annual Total
1928	3,900	5,000	4,674	13,574
1929	4,061	5,000	4,544	13,605
1930	4,228	5,000	4,335	13,563
1931	4,402	5,000	4,180	13,582
1932	4,526	0	0	4,526
1933	4,772	5,000	3,770	13,542
1934	4,968	5,000	3,632	13,600
1935	5,173	5,000	3,407	13,580
1936	5,386	5,000	3,116	13,502
1937	0	0	0	0
1938	0	0	0	0
1939	0	0	0	0
1940	0	0	0	0
1941	0	0	0	0
1942	0	0	0	0
1943	0	0	0	0
1944	0	0	0	0
1945	0	0	0	0
1946	8,064	1,821	0	9,884
1947	8,397	5,000	149	13,546
1948	8,397	5,000	185	13,582
1949	8,397	4,722	0	13,119
1950	8,397	5,000	209	13,606
1951	8,397	5,000	210	13,607
1952	0	0	0	0
1953	8,397	3,509	0	11,906
1954	8,397	5,000	187	13,584
1955	8,397	5,000	159	13,556
1956	8,397	5,000	210	13,607
1957	8,397	5,000	192	13,589
1958	5,686	0	0	5,686
1959	8,397	5,000	174	13,571
1960	8,397	5,000	210	13,607
1961	8,397	5,000	210	13,607
1962	8,397	5,000	206	13,603
1963	8,397	5,000	210	13,607
1964	0	0	0	0
1965	0	0	0	0

TABLE ES-5 Continued
Estimated Annual Supplemental Water Additions to Lake Elsinore

Year	Estimated Annual Supplemental Water Additions–Acre-Feet/Year			
	EVMWD Reclaimed Water	**Island Wells**	**EMWD Reclaimed Water**	**Annual Total**
1966	102	0	0	102
1967	8,397	4,689	0	13,086
1968	8,397	5,000	149	13,546
1969	0	0	0	0
1970	0	0	0	0
1971	0	0	0	0
1972	391	0	0	391
1973	8,397	4,107	0	12,504
1974	8,397	4,609	0	13,006
1975	8,397	4,795	0	13,192
1976	8,397	4,890	0	13,287
1977	8,397	5,000	5	13,402
1978	0	0	0	0
1979	0	0	0	0
1980	0	0	0	0
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	8,397	278	0	8,675
1988	8,397	4,745	0	13,142
1989	8,397	4,747	0	13,144
1990	8,397	4,702	0	13,099
1991	4,299	0	0	4,299
1992	6,836	0	0	6,836
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	5,748	0	0	5,748
Totals:	290,863	162,614	34,321	487,798
Percentage:	60%	33%	7%	100%

Phosphorus Removal Treatment Systems

The study evaluated treatment wetlands, as well as, biological treatment technologies and physical-chemical treatment technologies for treating the reclaimed water source to the study phosphorus nutrient loading targets established for the study.

Both conventional treatment wetlands located in the Back Basin area and littoral wetlands were evaluated for the treatment of reclaimed water. Modeling of a 350 acre treatment wetland indicated that treated effluent with a phosphorus concentration of about 0.5 mg/L could be produced at a hydraulic loading rate of about 0.6 inch per day and a conservatively low removal rate of 10 meters per year. The same treatment wetlands, when treating lake water could produce a treated effluent with a phosphorus concentration of 0.1 mg/L, or less, under the same conditions. An expanded 600 acre treatment wetland would produce better treated water quality, but the water loss would be prohibitive.

Chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF were evaluated, and would consist of ferric chloride or aluminum hydroxide (alum) coagulant addition. The coagulant primary addition location would be upstream of the RWRF's secondary clarifiers. A secondary, or polishing, coagulant addition location would be downstream of the secondary clarifiers, before the tertiary filters. Chemical phosphorus treatment will be capable of producing a treated effluent with phosphorus concentration of 0.5 mg/L, or less, can be achieved with the multiple coagulant addition locations. It was assumed that chemical phosphorus upgrades at the Eastern MWD Temecula Valley RWRF would be implemented as recommended in the "Temecula Valley RWRF Live Stream Discharge Alternatives Analysis," dated March, 2001. The costs for those treatment system upgrades would be recovered in the reclaimed water purchase price.

Biological phosphorus treatment upgrades at the Elsinore Valley MWD RWRF were evaluated, and will consist of the addition of anaerobic basins upstream of the Treatment Train A oxidation ditches. Treatment Train A will not require an upgrade since it already uses the Kruger BioDenipho process for nutrient removal. The Elsinore Valley MWD RWRF will be capable of producing a treated effluent with a phosphorus concentration of 1.0 mg/L to 2.0 mg/L with the upgrades. Supplemental chemical addition will be required to achieve treated effluent phosphorus concentrations of less than 1.0 mg/L. It was assumed that the biological nutrient treatment upgrades at the Eastern MWD Temecula valley RWRF would be implemented in accordance with the alternatives presented in the previously mentioned report, and that the costs for the biological treatment upgrades would be recovered in the reclaimed water purchase price.

The physical-chemical treatment technology consisting of coagulant addition followed by filtration was evaluated as a remote treatment system for reclaimed water. Coagulant addition will involve inline dosing of ferric chloride or alum upstream of the filtration process. Both dual-stage granular media filtration (similar to the DynaSand® process) and membrane processes were investigated. The dual-stage granular media filtration process will be capable of achieving treated effluent phosphorus concentrations of 0.5 mg/L, or less. The membrane process will utilize ultrafiltration membranes, and will be capable of producing a treated effluent with a phosphorus concentration of less than 0.1 mg/L.

The calcium-sulfate addition process being investigated by Dr. Anderson for in-lake phosphorus treatment was evaluated for treating reclaimed water. Even though the process has limitations that may prevent its use for in-lake phosphorus treatment, it may have potential as an effective reclaimed water phosphorus removal process. Further investigations are needed to fully evaluate the calcium-sulfate addition process as a potential treatment process for reclaimed water.

Project Alternatives

A total of thirteen project alternatives and subalternatives (alternatives)were developed for evaluation. The project alternatives included treatment systems to treat the reclaimed water sources, and also treat lake water recycled through the treatment systems. The project alternatives developed for the study also included the ancillary facilities, including pipeline turnouts, pressure regulating stations, pumping stations, pipelines, lake water intakes and treated water discharge piping and diffusers in the lake. Table ES-6 lists the project alternatives evaluated for the study.

TABLE ES-6
Project Alternatives and Subalternatives

Alternative 1A:	Chemical Phosphorus Treatment at RWRFs (Elsinore Valley MWD RWRF and Eastern MWD RWRF)
Alternative 1B:	Biological Phosphorus Treatment at RWRFs (Elsinore Valley MWD RWRF and Eastern MWD RWRF)
Alternative 2A:	350-Acre Back Basin Treatment Wetland
Alternative 2B:	Elsinore Valley MWD RWRF Chemical Phosphorus Treatment and 350-Acre Back Basin Treatment Wetland
Alternative 3A:	600-Acre Back Basin Treatment Wetland
Alternative 3B:	Elsinore Valley MWD RWRF Chemical Phosphorus Treatment and 600-Acre Back Basin Treatment Wetland
Alternative 4:	350-Acre Littoral Treatment Wetland
Alternative 5A:	Remote Treatment at Elsinore Valley MWD RWRF
Alternative 5B:	Remote Treatment at Lake Elsinore
Alternative 6:	Calcium Treatment at Lake Elsinore
Alternative 7:	Imported Water
Alternative 8A:	Chemical Phosphorus Treatment at Elsinore Valley MWD RWRF, Imported Water and 107-Acre Treatment Wetland
Alternative 8B:	Chemical Phosphorus Treatment at Elsinore Valley MWD RWRF, Remote Granular Filtration and 107-Acre Treatment Wetland

Alternative Estimated Construction, Capital and Annual Operation and Maintenance (O&M) Costs

The construction, capital and annual O&M costs were estimated for the treatment systems and ancillary facilities required for each of the study alternatives and subalternatives, and are presented in Table ES-7.

The estimated construction costs for the project alternatives and subalternatives represent order of magnitude estimates, as defined by the American Association of Cost Engineers, since they represent approximate estimates that have been made without detailed engineering data. The estimated construction costs are broken down by major facility components, and include a 15 percent estimating contingency. The capital costs were calculated by adding 25 percent to the estimated construction cost. The markup includes the costs for design and construction engineering, assumed to be 15 percent, and LESJWA project management and financing costs, assumed to be 10 percent. The estimated construction costs for the alternative and subalternative facilities represent March 2003 costs, and have been referenced to an Engineering News-Record Construction Cost Index (CCI) of 7,275 for the greater Los Angeles area.

TABLE ES-7
Alternative Estimated Construction, Capital and Annual O&M Costs

Alternative	Estimated Construction Cost ($)	Estimated Capital Cost ($)	Estimated Annual O&M Cost ($/Year)
1A	$3,534,000	$4,418,000	$311,000
1B	$8,877,000	$11,096,000	$295,000
2A	$19,621,000	$24,526,000	$1,510,000
2B	$12,180,000	$15,225,000	$1,640,000
3A	$18,169,000	$22,711,000	$2,243,000
3B	$20,997,000	$26,246,000	$5,581,000
4	$18,622,000	$23,278,000	$710,000
5A	$12,779,000	$15,974,000	$553,000
5B	$19,985,000	$24,981,000	$598,000
6	$8,084,000	$10,105,000	$362,000
7	$0	$0	$5,994,000
8A	$6,749,000	$8,436,000	$767,000
8B	$12,296,000	$15,370,000	$850,000

The estimated annual O&M costs are based on the average long-term supplemental water condition, and include operation and maintenance labor, treatment chemical costs, power and supplemental water purchase costs and incidentals. The component costs were estimated from published data, information from other similar operating installations and supplier-furnished data. Power was estimated at $0.10 per kilowatt-hour. Labor costs are based on an hourly rate of $40 per hour, including fringe benefits. Pump station and pipeline O&M costs were calculated at 1.25 percent and 0.5 percent of the estimated facility construction cost, respectively. A price of $363 per acre-foot was used for reclaimed water purchased from Eastern MWD, which includes treatment system upgrade costs at the Temecula Valley RWRF. A water purchase price of $663 per acre-foot was used for the purchase of Metropolitan imported water. The water purchase rate reflects Metropolitan's current future price projection for non-interruptible untreated Tier 2 water, which was projected to the mid-point of the twenty-year study project life, assuming a 4 percent per year escalation.

Alternative Decision Analysis

A decision analysis of the study alternatives was conducted to identify the best alternative, based on cost and evaluation criteria established by the study stakeholders. Primary and secondary evaluation criteria were established and the primary criteria ranked by the study stakeholders in a workshop. The ranking of the alternatives against each of the secondary evaluation criteria was done with LESJWA staff, and those rankings were verified with the study stakeholders at a second workshop.

A decision matrix model consisting of two linked software modules was used for the study decision analysis. The decision matrix model calculates a benefit ratio for each alternative based on the primary and secondary evaluation criteria and their rankings. The model also calculates the present worth of each alternative, and the cost/benefit value. The present value of the annual O&M costs were calculated using an interest rate of 6 percent and a project life span of 20 years. The project total present value is the sum of the capital cost plus the present value of the annual O&M costs. The cost/benefit value for each alternative is calculated as the total present value divided by the total benefit score.

The result of the study decision analysis is presented in Figure ES-3. Table ES-8 lists each of the alternatives, and their corresponding cost/benefit values calculated by the decision analysis model. The table lists the alternatives in an ascending order, from most favorable to the least favorable. Alternative 1A is the most favorable alternative with a cost/benefit value of $11,119.910. Alternative 3B is the least favorable alternative with a calculated cost/benefit value of $133,275,908.

TABLE ES-8
Project Alternative Calculated Cost/Benefit Values Ranked in Descending Order From Most Favorable to Least Favorable

Alternative	Cost/Benefit Value ($/Benefit Value)
Alt 1A	$11,168,036
Alt 1B	$20,685,181
Alt 8A	$24,358,204
Alt 6	$31,682,470
Alt 5A	$38,643,925
Alt 8B	$39,096,394
Alt 5B	$60,360,214
Alt 2B	$61,050,531
Alt 4	$67,938,690
Alt 2A	$88,095,960
Alt 3A	$98,351,337
Alt 7	$109,562,881
Alt 3B	$166,377,199

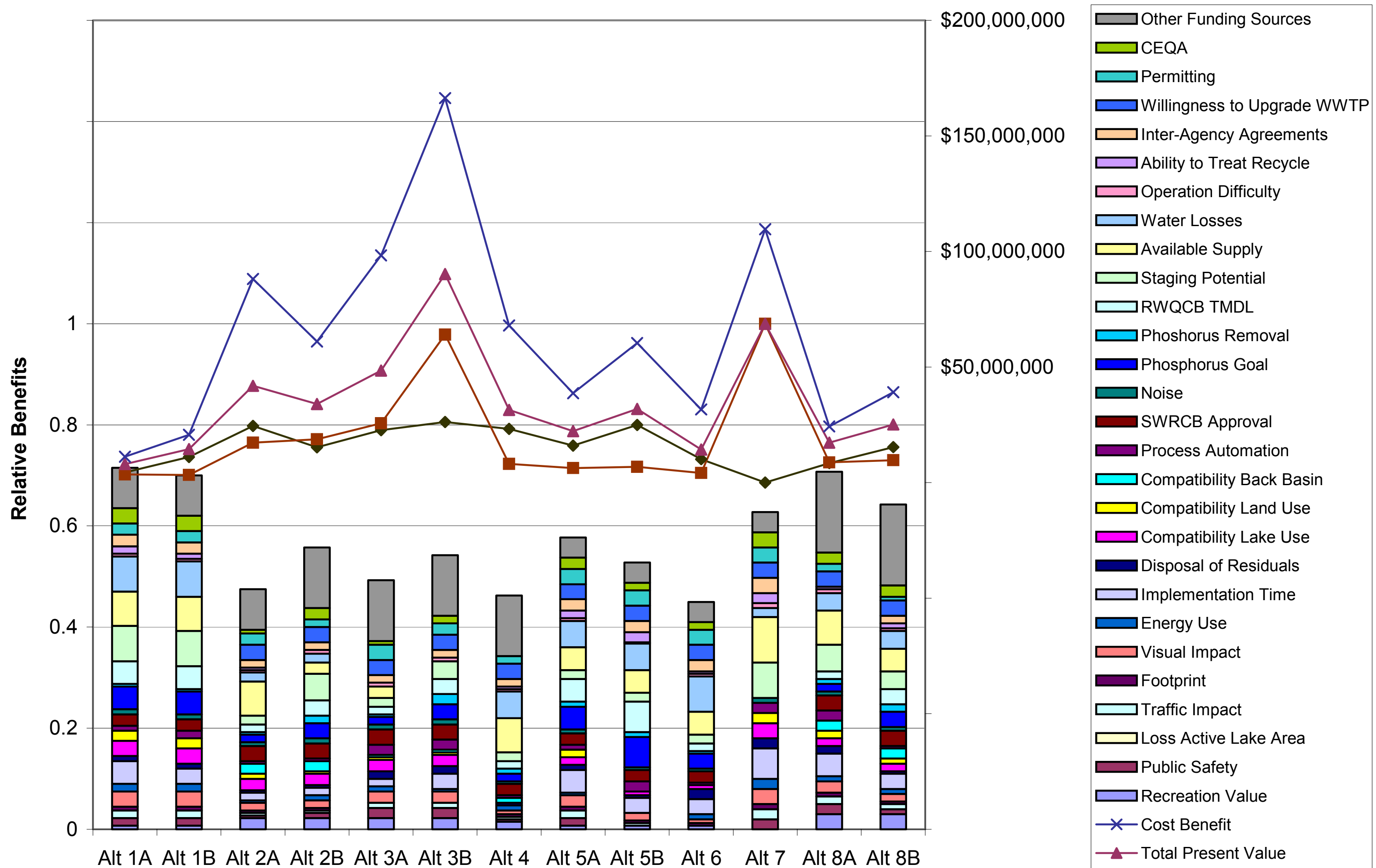

Figure ES-3
Alternative Decision Analysis Results

The individual benefit scores for the project alternatives are presented in Table ES-9. The alternative benefit scores range from 0.45 to 0.72. Alternative 1A is the most favorable alternative with a calculated benefit score of 0.72. The second and third best alternatives are Alternative 8A and Alternative 1B, with benefit scores of 0.71 and 0.70, respectively. The benefit scores of Alternative 1A, Alternative 8A, and Alternative 1B are so close that any of those alternatives could be considered equivalent if benefit scores are only taken into consideration.

TABLE ES-9
Project Alternative Benefit Scores Ranked in Descending Order From Most Favorable to Least Favorable

Alternative	Benefit Score
Alt 1A	0.72
Alt 8A	0.71
Alt 1B	0.70
Alt 8B	0.64
Alt 7	0.63
Alt 5A	0.58
Alt 2B	0.56
Alt 3B	0.54
Alt 5B	0.53
Alt 3A	0.49
Alt 2A	0.48
Alt 4	0.46
Alt 6	0.45

Preferred Project Alternative

Interpretation of Decision Analysis Results

The results of the decision analysis process identified Alternative 1A and Alternative 8A as the alternatives with the highest benefit rankings with benefit scores of 0.72 and 0.71, respectively. Alternative 1B was the third highest ranked alternative with a benefit score of 0.70. The benefit scores for those three alternatives are so close that they can be considered equivalent. Alternative 1A was also the highest ranked project alternative from a cost/benefit value perspective, with a calculated cost/benefit value of $11,168,036. Alternative 1B ranked second, with a calculated cost/benefit value of $20,685,181. Alternative 8A ranked third, with a calculated cost/benefit value of $24,358,204.

Alternative 1A will have a fatal flaw if the Eastern MWD Temecula Valley Effluent Pipeline conveys treated effluent from any other wastewater treatment plants than their Temecula Valley RWRF. The combined treated effluent flows in the pipeline would not receive the same amount of phosphorus treatment, and the phosphorus concentration in the flow will most likely be greater than the goal established for the study. Accordingly, the study stakeholders decided to develop a Preferred Project Alternative (PPA) that encompasses the best attributes from the top four alternatives, ranked by benefit score. Since Alternative 1B is essentially the same as Alternative 1A, and more costly due to the type of phosphorus treatment, the study stakeholders selected the best attributes from Alternative 1A, Alternative 8A and Alternative 8B to develop the PPA.

Preferred Project Alternative

The study stakeholders selected the following facility elements to comprise the PPA:

- Use of existing three Island Wells, as needed.
- Conversion of the south one-third of the existing Back Basin Wetland (350 acres) to a 107 acre treatment wetland, with the remainder of the Back Basin Wetland staying in its current configuration.
- Construction of lake water recycle pump station and pipeline to convey lake water to the Old San Jacinto Channel, and subsequent conveyance in the Old San Jacinto River Channel to the new treatment wetland.
- Lining of the Old San Jacinto River Channel from the vicinity of the ballpark to the new treatment wetland to convey lake water recycle flows.
- Construction of a new Title 22 effluent pipeline from the Eastern MWD Temescal Pipeline at Wasson Sill to convey purchased Title 22 effluent to the Elsinore Valley MWD RWRF, including turnout facility at the Temescal Valley Pipeline and pressure regulating facilities at the RWRF.
- Construction of chemical phosphorus treatment facilities at the Elsinore Valley MWD RWRF up to the 8.0 mgd existing treatment capacity of the plant.
- Construction of a remote granular media filtration facility at the Elsinore Valley MWD RWRF to treat Title 22 effluent purchased from Eastern MWD.
- Construction of a new treated water pump station at the Elsinore Valley MWD RWRF and treated water pipeline to the Lake Elsinore Outlet Channel near the Wasson Sill to convey treated effluent to Lake Elsinore via the lake outlet channel.

Preferred Project Alternative Construction, Capital and Annual O&M Costs

The PPA estimated construction cost, capital cost and annual O&M costs are presented in Table ES-10. The estimated annual O&M costs include treatment system labor, chemicals, power and sludge disposal costs; facility maintenance and operation costs; water quality monitoring costs, and supplemental reclaimed water and imported water costs.

TABLE ES-10
Preferred Project Alternative Estimated Construction, Capital and Annual O&M Costs

Cost	Estimated Cost ($ or $/Yr)
Construction	$12,737,000
Capital	$15,921,000
Annual O&M	$728,000

Preferred Project Alternative Phasing

Available LESJWA Funding

LESJWA has been able to secure $15,000,000 in Proposition 13 funding for programs and projects associated with Lake Elsinore and its surrounding watersheds. Current contracts and projects have appropriated about $9,130,000 of that funding. In addition, planned projects and potential future projects could potentially use another $4,087,000 of the existing Proposition 13 funding. That leaves a current funding balance of about $1,783,000 available to fund the components of the PPA. The total estimated capital cost for the PAA is $15,921,000, if all of the components are implemented. LESJWA will therefore have to find additional funding to implement most of the components of the PPA.

Proposed PPA Component Phasing

Table ES-11 presents the proposed phasing of the PPA components. The phasing approach presented in the table, by the phasing priority ranking of the project elements, prioritizes the project components to maximize the available lake supplemental water and lake water quality improvement benefits.

TABLE ES-11
PPA Component Phasing Approach

Phasing Priority	Component Description	Component Capital Cost	Annual O&M Cost
1	Chemical Phosphorus Upgrades at Elsinore Valley MWD RWRF	$1,366,000	$197,000
2	Construction of the Eastern MWD Reclaimed Water Pipeline and Associated Facilities, Treated Water Pump Station at Elsinore Valley MWD RWRF and Treated Water Pipeline	$5,410,000	$155,000
3	Construction of Lake Water PS, Discharge Pipeline & Relining the Old San Jacinto River Channel	$2,505,000	$15,000
4	Conversion of 107-Acre Treatment Wetland, Treated Water Pump Station and Discharge Pipeline	$2,122,000	$88,000
5	Construction of the Granular Media Filtration System at Elsinore Valley MWD RWRF	$4,518,000	$72,000

The costs presented in the table have been broken down to show the estimated capital cost and annual O&M cost for each of the PPA components. The annual O&M costs for water quality monitoring and Lake Elsinore inlet channel dredging amount to $200,000 per year, and are common to all of the project components. Those annual O&M costs have not been included in the table annual O&M costs. Under the long-term average supplemental water condition, up to 310 acre feet of reclaimed water may have to be purchased from Eastern MWD. The estimated annual O&M cost of that reclaimed water purchase has been included in the component that includes the construction of the Eastern MWD reclaimed water pipeline.

Estimated Alternative Annual Phosphorus Removal Amounts

Table ES-12 presents an estimate of the amount of phosphorus that will be removed by each of the project alternative treatment systems, and the PPA treatment systems. The estimated phosphorus removal amounts represent the amount of phosphorus removed from the treated reclaimed water and recycled lake water that is discharged into Lake Elsinore.

TABLE ES-12
Estimated Alternative Total Annual Phosphorus Removed

Alternative	Estimated Phosphorus Removed				Total Estimated Removed Phosphorus
	Wetlands		Remote Treatment		
	Reclaimed Water	Lake Recycle	Reclaimed Water	Lake Recycle	
1A	0	0	20,400	0	20,400
1B	0	0	20,400	0	20,400
2A	16,200	300	4,100	3,800	24,700
2B	8,800	700	26,500	0	36,000
3A	20,100	2,500	0	0	22,600
3B	30,600	1,300	26,500	0	58,400
4	22,000	1,000	0	3,700	26,700
5A	0	0	20,400	5,000	25,400
5B	0	0	23,700	5,800	29,500
6	0	0	22,000	500	22,500
7	0	0	0	0	0
8A	0	400	25,100	0	25,500
8B	0	400	25,200	2,000	27,600
PPA	0	400	25,200	2,000	27,600

Notes:

1. PPA = Preferred Project Alternative.

Estimated Annual Phosphorus Loads

Table ES-13 presents estimates of the annual phosphorus loads to Lake Elsinore that will result from the addition of reclaimed water and imported water, as supplemental water sources, for each of the alternatives and the PPA.

TABLE ES-13
Estimated Annual Phosphorus Loads to lake Elsinore from Reclaimed Water and Imported Water Sources

Alternative	Estimated Annual Phosphorus Load (lbs/yr)
1A	4,100
1B	4,100
2A	5,200
2B	7,300
3A	5,200
3B	12,400
4	3,900
5A	5,800
5B	1,400
6	2,600
7	2,600
8A	5,100
8B	5,500
PPA	5,500

Notes:

1. PPA = Preferred Project Alternative

INTRODUCTION

Section 1: Introduction

Introduction

The Lake Elsinore Nutrient Removal Study has been undertaken for LESJWA, which is a JPA and is governed by five member agencies. The JPA agencies include the Elsinore Valley MWD, the City of Lake Elsinore, the City of Canyon Lake; the County of Riverside, and SAWPA. SAWPA serves as the Authority administrator, and provided project management for this study.

LESJWA was specifically created for the purpose of implementing "projects and programs to rehabilitate and improve the San Jacinto and Lake Elsinore Watersheds and the water quality of Lake Elsinore, in order to preserve agricultural land, protect wildlife habitat, protect and enhance recreational resources, and improve surface and subsurface water quality, all for the benefit of the general public."

LESJWA staff completed a study on nutrient removal for reclaimed water added to Lake Elsinore. The purpose of the study was to gather pertinent data and information from existing reports and studies to assist the LESJWA Technical Advisory Committee in making recommendations to their Board for improving the water quality of Lake Elsinore. LESJWA retained CH2M HILL for this study to conduct an analysis on the effectiveness and feasibility of treatment wetlands and other advanced treatment technologies to remove phosphorus in the water column of Lake Elsinore, reclaimed water and storm runoff.

Background

Lake Elsinore is located sixty miles southeast of Los Angeles and twenty-two miles south of the City of Riverside, California, and is the natural low point in the San Jacinto River watershed. Lake Elsinore is the largest freshwater lake in California between the San Francisco Bay area and the United States and Mexico Border. Lake Elsinore is the terminus of the San Jacinto River Watershed and only rarely does water flow out of Lake Elsinore into the Temescal Wash and ultimately into the Santa Ana River and the Pacific Ocean.

The San Jacinto River Watershed covers an area of approximately 735 square miles, as shown in Figure 1-1. Lake Elsinore's direct watershed comprises approximately 47 square miles making the total drainage basin area approximately 782 square miles. Over 90 percent of the San Jacinto River watershed drains to Canyon Lake, which is located about three miles upstream from Lake Elsinore. There are two main watercourses in the watershed: the San Jacinto River and Salt Creek. The San Jacinto River drains the western slopes of the San Jacinto Mountains and flows through the communities of San Jacinto and Perris before entering Canyon Lake. Salt Creek is tributary to the San Jacinto River and flows into Canyon Lake from the east. Discharges from Canyon Lake Dam flow southwest in the San Jacinto River to Lake Elsinore, which serves as a natural sink.

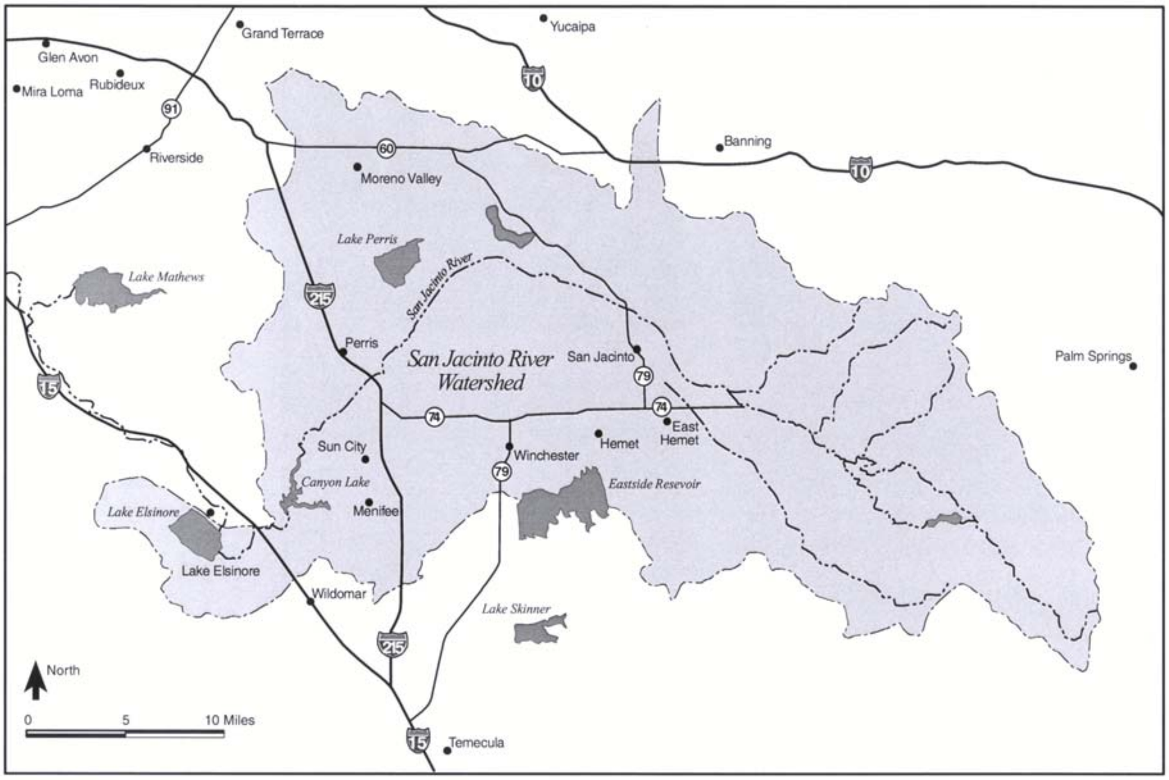

Figure 1-1
Lake Elsinore and San Jacinto River Watershed

Lake Elsinore is a natural lake that, under historical conditions, has varied in size from over 6,000 acres in very wet years to a dry playa in drought years. The lake is technically eutrophic in that it exhibits the following characteristics:

- Large algae blooms, with blue-green algae (cyanobacteria) a common presence, especially *Microcysis*.
- Large seasonal and daily swings in the concentration of dissolved oxygen in the lake water column. Anoxic (zero dissolved oxygen) conditions have been recorded in most summers in the deeper lake waters.
- Low water clarity, with Secchi disc values of less than one meter of depth common.
- High concentrations of inorganic nitrogen and total phosphate in the lake water column.

In addition, the following are typical characteristics of eutrophic lakes that are also common to Lake Elsinore:

- Shallow water that does not show permanent thermal stratification in summer (technically a polymictic or many-mixing lake). This allows nutrients released from the lake bottom sediments to be rapidly carried to the algae growing at the lake surface.
- High ratio of watershed to lake surface area. Lake Elsinore has a ratio of about 167. Watershed to lake area ratios greater than 100 indicate potential eutrophy.

- Warm water that shows daily or short-lived thermal stratification allowing total oxygen depletion in the lake bottom water and sediments, even though the lake frequently mixes top-to-bottom.
- Highly variable depth, including total dry out that eliminates shoreline vegetation that could modify planktonic algae blooms.

Throughout its history, Lake Elsinore has been subject to flooding and drought, depending on the rainfall amounts. The lake loses an average of 14,500 acre-feet a year to evaporation, dropping the surface level more than 4.5 feet a year. In the last 70 years, average annual inflow to the lake exceeded 14,500 acre-feet only thirteen times.

Management criteria established the objective of a minimum lake water surface elevation of 1,240 feet above sea level, and maintaining the lake operating water surface within the elevation range of 1,240 feet to 1,247 feet. At the current surface elevation of 1,237 feet, the lake covers 2,896 acres with an average depth of 10 feet and a maximum depth of 14 feet. Current lake volume is about 29,800 acre-feet. The lake edges slope gently; so dry years result in extensive zones of unsightly exposed lake bottom sediment and dead vegetation. The fluctuating lake level prevents development of the shoreline, hinders visitor access, and excludes natural methods of lake cleanup involving the growth of rooted vegetation in shallow water.

An alternative to preventing the lake drying up is through the addition of reclaimed water and/or imported water equal to the amount of water that evaporates each year. Of those two potential supplemental water sources, reclaimed water will be the more reliable source due to potential release restrictions at Canyon Lake. However, with the addition of reclaimed water, significant amounts of nutrients (phosphorus) will be added to Lake Elsinore that may cause algae to grow abundantly, further degrading water quality, promoting numerous fish kills, and having a devastating effect on the local economy. Thus the need for this study to evaluate treatment technologies to remove the phosphorus present in the reclaimed water and lake water to rectify that situation.

Regulatory Requirements

With respect to Lake Elsinore water quality, the Santa Ana RWQCB has established water quality objectives to protect the designated beneficial uses of the lake. Those beneficial uses include body contact and non-body contact recreation, warm water aquatic habitat and wildlife habitat. Based on water quality analyses performed by the US Environmental Protection Agency (EPA) in the early 1970s, Lake Elsinore was classified as a eutrophic lake.

The Santa Ana RWQCB is currently in the process of developing standards for Total Maximum Daily Loads (TMDLs) for nutrients in Lake Elsinore. The outcome of the TMDL process will impact the discharges to the lake. The Santa Ana RWQCB was still in progress during this study. The Santa Ana RWQCB participated in the study workshop that adopted the lake water quality goals and nutrient loading criteria, and had input into that process.

Purpose of the Study

The purpose of the study is to accomplish the following:

- Adopt short-term and long-term water quality goals for Lake Elsinore water, and nutrient loading criteria to support the adopted lake water quality goals.
- Evaluate treatment technologies for the removal of phosphorus in the potential supplemental water sources available to maintain the lake operating water level within the desired elevation range.
- Establish phosphorus removal efficiencies for the treatment technologies evaluated.
- Develop project alternatives to meet the short-term and long-term lake water quality goals and nutrient loading criteria and supplemental water requirements to maintain the lake operating water level in the desired elevation range.
- Define the construction and capital costs for the developed project alternatives.
- Define the annual operation and maintenance (O&M) costs for the project alternatives.
- Evaluate the project alternatives to select the best alternative.
- Develop a phased project approach to utilize available Proposition 13 funds.

Study Report Organization

The study report has been organized into the following nine sections:

Section 1: Introduction
Section 2: Study Water Quality Goals
Section 3: Lake Elsinore Evaporation Losses, Inflows, Supplemental Water Requirements and Sources
Section 4: Phosphorus Removal Treatment Technologies
Section 5: Project Alternatives
Section 6: Estimated Alternative Construction, Capital and Annual Operation and Maintenance Costs
Section 7: Project Alternatives Decision Analysis
Section 8: Preferred Project Alternative
Section 9: Preferred Project Alternative Phasing

In addition to the study report sections listed above, the report contains the following Appendices:

Appendix A: Conceptual Wetland Water Balance
Treatment Wetland Water Quality Model
Comparison of Reclaimed Model Runs
Appendix B: Supplemental Water Requirement Spreadsheet

STUDY WATER QUALITY GOALS

Section 2: Study Water Quality Goals

Introduction

The water quality goals for the study were established in a workshop that was held on September 24, 2002 at the SAWPA's offices in Riverside, California. This section of the report summarizes the points discussed during the workshop to reach a consensus on the water quality goals established for Lake Elsinore, and the supplemental water nutrient limits that support those water quality goals.

In addition, a preliminary modeling analysis was conducted by Dr. Michael Anderson to develop nutrient loading criteria appropriate to meet the Lake Elsinore water quality goals established in the workshop. The results of this modeling analysis are described herein, and are cited as Anderson (2002)[1].

The Lake Elsinore water quality goals agreed to by the study stakeholders, and the supplemental water nutrient loading limitations supporting those water quality goals are presented. In addition, phased options for achieving the agreed upon lake water quality goals and associated supplemental water nutrient loading criteria are also presented and discussed.

Background

The purpose of the workshop was to develop consensus among the study stakeholders on the Lake Elsinore water quality goals to be adopted for the study, and the supplemental water nutrient loading criteria to support those goals. Those water quality goals and nutrient loading criteria are important to evaluate lake water treatment technologies, supplemental water treatment technologies, and to develop the project alternatives. Table 2-1 summarizes the suggested Lake Elsinore long-term water quality goals that was presented in the "Lake Elsinore Restoration and San Jacinto Watershed Protection Program Proposal" submitted to the City of Lake Elsinore in 2000. Those long-term water quality goals served as the basis for the workshop discussion.

Lake Elsinore's water surface elevation has been significantly reduced during recent years due to evaporation and lack of inflows into the lake. This lowering of the lake water level has resulted in an increased internal nutrient loading, excessive algal growth and decomposition, and fish kills associated with episodes of low dissolved oxygen concentrations. The current lake water level management objective is to maintain the lake operating water level elevation within the range of 1,240 feet to 1,247 feet. It has been estimated that 14,000 to 15,000 acre-feet per year of inflow to the lake is needed to offset the lake evaporation losses, and to maintain the lake operating water level within the desired elevation range. During wet weather, runoff from the San Jacinto River flows into Canyon Lake and periodically spills from Canyon Lake into Lake Elsinore. In addition to the San Jacinto River inflows, Lake Elsinore also receives a limited supply of runoff from its surrounding watersheds that drain directly into the lake. The runoff from both of those water sources is not considered adequate to stabilize the lake water levels within the desired

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[1] Anderson, M. 2002. Water Quality in Lake Elsinore: Model Development and Results.

operating elevation range. Thus, this study will need to consider other sources of supplemental water to make up the natural runoff deficiency. Those other sources of water supply could potentially include local groundwater, reclaimed water and imported water.

TABLE 2-1
Suggested Lake Elsinore Long-Term Water Quality Goals

Parameter	1992-1999 Typical Range	Long-Term Goal
Lake Water Elevation	1,229 – 1,259 feet	1,240 – 1,247 feet
Clarity Index	Poor to very poor	Poor to good
Secchi Depth	1 – 3 feet	2 – 4 feet
Total Phosphorus	0.2 – 0.65 mg/L	<0.05 mg/L
Ortho Phosphorus	0.01 – 0.63 mg/L	<0.01 mg/L
Total Nitrogen	2 – 11 mg/L	<0.75 mg/L
Total Inorganic Nitrogen	0.1 – 1.45 mg/L	<0.15 mg/L
Chlorophyll *a*	10 – 950 ug/L	Average <20 ug/L Maximum <80 ug/L
Dissolved Oxygen	0.1 – 16.0 mg/L	>3.0 mg/L @ 3 feet from the bottom and 100% saturation from mid-depth to surface.

Current treated effluent production from Elsinore Valley MWD RWRF is about 4.0 million gallons per day (mgd), or about 4,460 acre-feet per year. Of that treated effluent production, about 0.5 mgd, or 560 acre-feet per year is dedicated to environmental discharges. The remaining 3.5 mgd, or 3,900 acre-feet per year is therefore available as a supplemental source of water for Lake Elsinore. LESJWA is also currently rehabilitating the three existing Island Wells that pump deep groundwater from the Lake Elsinore Basin beneath Lake Elsinore. When rehabilitated, those three wells will have a combined production capacity of about 5,000 acre-feet per year. Additional sources of water supply may include reclaimed water from the Eastern MWD, and imported water purchased from Metropolitan. The imported water will be obtained through Elsinore Valley MWD's WR-18b turnout along the San Jacinto River.

In order to evaluate the water supply alternatives described above, the water quality goals for Lake Elsinore must be identified and translated into nutrient treatment objectives for the available water sources. The study will then evaluate various treatment technologies and alternatives to achieve the lake water quality goals established for the study, taking into consideration the lake internal nutrient loading. Treatment technologies would include chemical and biological treatment upgrades to the Elsinore Valley MWD RWRF and Eastern MWD Temecula Valley RWRF, as well as physical-chemical and natural treatment technologies that could provide remote treatment at the lake.

Water Quality Targets

Santa Ana RWQCB staff participated in the workshop, and presented information pertinent to establishing water quality goals for Lake Elsinore. The Santa Ana RWQCB is currently going through a Total Maximum Daily Load (TMDL) process to establish TMDLs for the San Jacinto River watershed, including Canyon Lake and Lake Elsinore. The TMDL activities will also take into consideration the internal nutrient loadings for both lakes.

It was indicated that in-lake chlorophyll *a* values, in lieu of phosphorus limits, will most likely be established by the Santa Ana RWQCB to control algae growth and fish kills in Lake Elsinore. Also, a numeric criterion of 5 mg/L has been proposed for dissolved oxygen (DO) by the Santa Ana RWQCB as a water quality indicator at Lake Elsinore. This criterion would be a monthly average measured biweekly during the summer-fall months, and monthly during the winter-spring months, when the lake stratifies. Also, average dissolved oxygen over depth would be no less than 5 mg/L when the lake is well mixed from top to bottom. Additional work is being conducted by Santa Ana RWQCB to refine this criterion.

Information pertaining to the water quality goals at Lake Elsinore and numeric targets to achieve beneficial uses was also presented. Water quality indicators may include nitrogen, phosphorus, DO, and chlorophyll *a*. The current basin plan includes a total inorganic nitrogen (TIN) concentration of 1.5 mg/L as a numeric water quality objective for Lake Elsinore. The Santa Ana RWQCB has proposed that chlorophyll *a* and DO be used as nutrient TMDL indicators. In-lake water quality parameters would be correlated to phosphorus and nitrogen loads.

Currently, one year of watershed loading data has been collected by the Santa Ana RWQCB. Additional monitoring data is needed extending over more than one year. Once obtained, the data will be utilized to update a lake water quality response model, possibly the lake-specific model developed by Dr. Anderson for this project. The lake-specific model could be used to develop a linkage between chlorophyll *a* and DO parameters and phosphorous and nitrogen loadings. This may be accomplished by performing mass balance calculations utilizing historical data over a selected period of time. The linkage between nutrient loading and water quality response would be utilized by determining how much nutrient reduction is necessary to attain the desired water quality, as defined by the numeric target. Analytical tools that could be used to develop this relationship include historical data analysis, Vollenweider load/response relationships, BATHTUB, mass balance, Eutromod, and other dynamic models.

Region 9 of the Environmental Protection Agency (EPA) and the Santa Ana RWQCB are also working on a plan to establish nutrient criteria developed from local data sources. The EPA Nutrient Criteria Recommendation for Ecoregion III- Xeric West criteria could potentially be applied to Lake Elsinore; however, the criteria were developed from a dataset that included waterbodies in Nevada and Utah and may not be applicable to Lake Elsinore. The EPA Ecoregion III criteria include a total nitrogen concentration of 0.40 mg/L, a chlorophyll *a* concentration of 3.4 µg/L (using the fluorometric method), and a Secchi depth of 2.7 meters.

The EPA water quality criteria may not be achievable for Lake Elsinore. Using the available data from Lake Elsinore, Dr. Anderson developed the following empirical relationships between chlorophyll *a*, total phosphorus, and Secchi depth (Anderson, 2002):

$$\log \text{chlorophyll } (\mu g/L) = 1.449 \log \text{TP } (\mu g/L) - 1.136$$

$$\text{Secchi depth (m)} = 67.16 \;/\; (\text{chlorophyll } (\mu g/L) + 55.98)$$

Using these equations, a chlorophyll *a* goal of 3.4 ug/L would equate to an in-lake TP concentration of 14 ug/L and a Secchi depth of 1.1 m.

Nutrient Loading Allocations

The workshop participants discussed several approaches to developing nutrient loading allocations for Lake Elsinore. The key points of those discussions included:

- Concentration-based nutrient loading limits are preferred over numerical nutrient loading limits, since the concentration-based limits can be more easily monitored at the source.
- Average Trophic State Index (TSI) values can be used to establish water quality objectives to ensure that beneficial uses of the lake are maintained. An analysis could be performed to determine acceptable nutrient loadings from various supplemental water sources that would in a eutrophic average TSI of no more than 60, which would still preserve the lake's current beneficial uses.
- Analysis of historical lake water quality data may also be an acceptable approach to establish water quality goals and nutrient loading criteria. Lake historical phosphorus concentrations have been measured during times when the lake water level was within the desired operating elevation range. An associated source water nutrient concentration could be established for the desired in-lake water quality target, given the lake evaporation rate and water source inflows.
- The existing lake model developed by Dr. Anderson could be modified to take into consideration new water sources and associated nutrient loads to the lake. An explicit in-lake nutrient loading term would have to be incorporated into the model to simulate the lake's nutrient assimilative capacity.

Most of the discussion beyond the general nutrient loading allocation approaches centered around the use of historical lake nutrient concentration data to establish acceptable lake water quality goals. Based on lake historical water quality data presented in the workshop for the 2000 to 2001 period when the lake water level were within the desired operating elevation range, the in-lake phosphorous concentration averaged approximately 0.1 mg/L. A chlorophyll *a* concentration of about 40 ug/L was stated to correspond to a phosphorus concentration of about 0.1 mg/L. This general relationship is also supported by the water quality analysis conducted by Dr. Anderson in development of his lake model. Applying Dr. Anderson's empirical phosphorus-chlorophyll equations, a chlorophyll *a* concentration of 40 ug/L equates to an in-lake phosphorus concentration of 78 ug/L, and a Secchi depth of 0.7 meter. A chlorophyll *a* value of 80 ug/L corresponds to a total phosphorus concentration of 125 ug/L, and a Secchi depth of 0.5 meter.

Summary of Nutrient Load Allocation Modeling Results

In a separate effort to directly address the question of allowable phosphorus loading to Lake Elsinore to meet lake water quality goals, Dr. Anderson developed a simple coupled water and phosphorus mass-balance model. The model utilized available lake water elevation data from 1992 to present, a published stage-volume relationship, and lake total phosphorus and total nitrogen data collected by various researchers from 1992 through the present (Anderson, 2002). The mass-balance model developed by Dr. Anderson has the following attributes:

- A net sedimentation rate dependent upon the rate in internal loading that includes both dissolved and particulate phosphorus, with the dissolved phosphorus being converted to algal forms within the water column.
- Lake bottom sediment suspension component, based on lake water depth, wind speed and lake fetch (distance wind blows unobstructed over water).
- Total phosphorus concentration in the sediments, which is assumed to be constant, and the total phosphorus concentration in the water column.

Results of the model calibration are shown in Figure 2-1, which shows the predicted and observed concentrations of total phosphorus in Lake Elsinore from 1992 through 2002. The water balance model provided a very good simulation of the lake water volume, and the phosphorus mass balance model showed a similarly good fit with observed water column phosphorus concentrations.

The model estimated a steady-state total phosphorus concentration of 0.117 mg/L. This value agreed closely with the annual average total phosphorus concentration of 0.119 mg/L reported by the Santa Ana RWQCB for the 2000-2001 period (Anderson, 2002).

The predicted chlorophyll concentration for the lake at a stable water level elevation of 1,242 feet (without external loads) was 73 µg/L, which is expected to produce a transparency of 0.52 meter. These values are in reasonable agreement with previously reported measured values for chlorophyll and Secchi depth of 52 µg/L and 0.62 meter, respectively (Anderson, 2002).

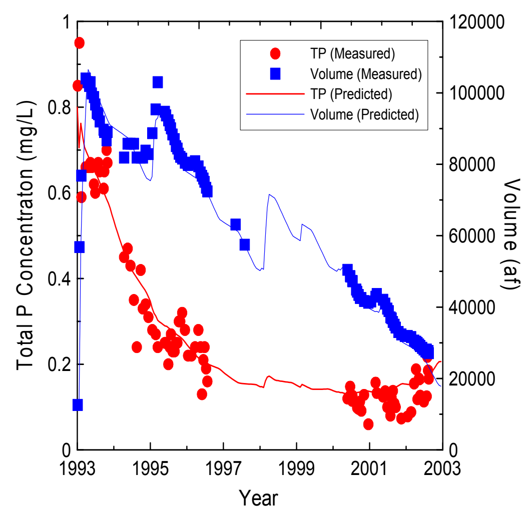


Figure 2-1
Predicted and Observed Phosphorus Concentrations and Lake Volume Estimates in Lake Elsinore, 1992-2002.
Source: Anderson (2002);preliminary, subject to revision.

Using this calibrated model, the effects of various external and internal phosphorus load management scenarios on lake water column total phosphorus were investigated. Table 2-2 presents the results of an analysis to predict steady-state total phosphorus, chlorophyll and transparency values for the lake subject to recycled water addition at different total phosphorus inlet concentrations, assuming existing internal loading rates. A preliminary sensitivity analysis showed that the internal loading (*k*) and resuspension (*r*) terms drive the predicted total phosphorus levels in the lake. Accordingly, two different model parameterizations were used to estimate the likely range (*i.e.*, uncertainty) in predicted steady-state water quality in the lake. While these results are preliminary, future publication of Dr. Anderson's manuscript will provide the opportunity for the model to be peer-reviewed and potentially for wider application.

TABLE 2-2
Predicted Water Quality in Lake Elsinore Resulting from the Addition of 15,000 Acre-Feet/Year of Reclaimed Water at Different Influent Total Phosphorus Concentrations

Influent Total Phosphorus (mg/L)	Lake Total Phosphorus (mg/L)	Chlorophyll (μg/L)	Secchi Depth (meter)
0	0.100 - 0.123	58 - 78	0.50 - 0.59
0.05	0.113 - 0.131	69 - 85	0.48 - 0.54
0.1	0.127 – 0.140	82 - 94	0.45 - 0.49
0.5	0.208 - 0.236	167 - 202	0.26 - 0.30
1.0	0.293 - 0.374	274 - 391	0.15 - 0.20

Note: Assuming 15,000af/yr as some mix of recycled water, runoff, groundwater and other sources.

As shown in Table 2-2, adding the equivalent of 15,000 acre-feet per year of supplemental water to lake Elsinore with no phosphorus matches the range of concentrations predicted for the lake under steady-state conditions.

The model results predict that low concentrations of phosphorus in recycled will have relatively small effect on lake water quality. Adding 15,000 acre-feet per year of water to the lake with a total phosphorus concentration of 0.05 mg/L will increase the in-lake total phosphorus concentration by 0.008 mg/L to 0.013 mg/L. The corresponding chlorophyll concentrations will increase by 7 μg/L to 11 μg/L. This nominal increase in chlorophyll would be expected to lower the Secchi depth by 0.02 meter to 0.05 meter, to about 0.5 meter.

Increasing the influent total phosphorus concentration to the lake to 0.1 mg/L will have a proportionately greater effect, and increase average total phosphorus in the lake by 27 percent and chlorophyll to 82 μg/L to 94 μg/L. Higher concentrations of total phosphorus in the influent flows to the lake are expected to have a more substantial effect on water quality. These values, while assumed to be steady-state, required up to 3 years in the simulation before a steady-state condition in the lake was approached, indicating the continuing importance of the internal loading in controlling the lake trophic state.

Similar projections were made assuming a 30 percent reduction in the internal loading and resuspension rates within Lake Elsinore, but with the same range of external phosphorus inflow concentrations. The 30 percent reduction in the lake internal loadings represents the effect of in-lake restoration measures, such as the lake aeration projects that are currently planned by LESJWA. In a separate evaluation, Anderson (2002) found aeration to reduce internal loading rates from 12.9±0.7 to 8.7 mg/m^2/d under rather aggressive aeration conditions, corresponding to a 33 percent reduction in soluble-reactive phosphorus (SRP) release and is consistent with an earlier analysis conducted by Anderson (unpubl. data) in November 2000 in which aeration reduced SRP release from 8.8±0.7 to 5.4±0.7 mg/m²/d (a reduction of 39 percent) Anderson (2003). Table 2-3 presents the lake total phosphorus and chlorophyll concentration, and Secchi depth predictions from the model for various influent phosphorus concentrations.

TABLE 2-3
Predicted Water Quality in Lake Elsinore Resulting From the Addition of 15,000 Acre-Feet/Year of Reclaimed Water at Different Influent Phosphorus Concentrations with 30 Percent Reduction in Internal Lake Loading Rate

Influent Total Phosphorus (mg/L)	Lake Total Phosphorus (mg/L)	Chlorophyll (µg/L)	Secchi Depth (meter)
0	0.036 – 0.076	12.8 – 38.9	0.71 - 0.98
0.05	0.040 – 0.079	15.4 – 41.1	0.69 - 0.94
0.1	0.045 – 0.082	18.2 – 43.5	0.68 - 0.90
0.5	0.084 – 0.108	45.2 – 65.9	0.56 - 0.67
1.0	0.133 – 0.152	87.1 – 105.6	0.42 - 0.47

The model results predict that a 30 percent reduction in the internal lake loading yields a 38 percent to 61percent reduction in the lake total phosphorus concentration. The reduction in lake internal loading also results in correspondingly low chlorophyll levels and high transparencies relative to the natural condition described in Table 2-2. This counter-intuitive lake response to internal load reductions is attributable to the reduction in the internal loading rate by some amount (e.g., 30 percent) resulting in a lowering of the water column concentration, which in turn, supports a still lower subsequent internal loading rate. These results show that up to a two time net reduction in the steady-state total phosphorus concentration in the lake may be achieved for a given internal loading rate reduction, underscoring the importance of internal loading.

A consequence of this is that internal load reductions, *e.g.*, through aeration or other control strategies, appear to allow relatively high levels of phosphorus in reclaimed water to be added to the lake. Ongoing work being conducted by Dr. Anderson is expected to improve the predictive power of the model, especially to quantify and substantiate the simulated 30 percent reduction in internal lake phosphorus concentrations resulting from the in-lake aeration and other projects.

Lake Elsinore Water Quality Targets

Based on the approach described above, the workshop participants agreed to establish short-term (i.e., 5 to 10 years) and long-term (i.e., 10 to 20 years) water quality and nutrient goals for Lake Elsinore. These water quality and nutrient objectives would be adopted for the study. The approach is consistent with the development of phased alternatives to achieve the water quality objectives at Lake Elsinore. In general, Table 2-4 presents the agreed upon short-term and long-term water quality goals.

Using the equations provided by Dr. Anderson, estimates of in-lake total phosphorus concentration and Secchi depth goals were made that correlate with the chlorophyll *a* goals. The long-term water quality objectives are one-half the short-term objectives. Although the concentrations are non-enforceable, they could be utilized to develop TMDL nutrient targets based on the volume and source water supply required to replenish Lake Elsinore.

TABLE 2-4
Workshop Adopted Lake Elsinore Short-Term and Long-Term Water Quality Goals

Parameter		Short-Term Goal	Long-Term Goal
Lake Water Elevation		1,240 – 1,249 feet	1,240 – 1,249 feet
Clarity Index		Poor to good	Poor to good
Secchi Depth	Meeting	1 – 2 feet	2 – 4 feet
	Model	2.3 feet	2.9 feet
Total Phosphorus	Meeting	<0.1 mg/L	<0.05 mg/L
	Model	0.08 mg/L	0.05 mg/L
Ortho Phosphorus		<0.02 mg/L	<0.01 mg/L
Total Nitrogen		<1.5 mg/L	<0.75 mg/L
Total Inorganic Nitrogen		<0.30 mg/L	<0.15 mg/L
Chlorophyll *a*		Average of 40 ug/L	Average of 20 ug/L
Dissolved Oxygen		>1.5 mg/L @ 3 feet from the bottom and 100% saturation from mid-depth to surface.	>3.0 mg/L @ 3 feet from the bottom and 100% saturation from mid-depth to surface.

Note: Dissolved oxygen criteria include bottom concentrations lower than the Santa Ana RWQCB water quality criterion of 5 mg/L to account for low oxygen conditions in lake sediments, and are based on a 100 percent in the upper half of the water column to account for temperature effects on oxygen concentration.

The lake model results presented in Table 2-2 and Table 2-3 suggest a strategy that can be used to develop a phased approach for the treatment of the reclaimed water addition that could meet the water quality goals for Lake Elsinore. Table 2-2 indicates that if existing internal lake loading conditions are maintained, then the chlorophyll *a* short-term (40 µg/L) and long-term (20 µg/L) goals will be difficult to meet regardless of the phosphorus concentration in the supplemental water.

Alternatively, the reduction in lake internal loading that can be achieved with lake aeration, or other similar means, will allow the short-term lake chlorophyll goal of 40 µg/L to be attained with an inflow total phosphorus concentration up to 0.1 mg/L. In theory, reclaimed water with a total phosphorus concentration of up to 1 mg/L could be applied to the lake, assuming that internal load reductions are in effect, with little significant change from existing lake conditions and lake operating water levels within the desired range.

These results also suggest that the long-term lake trophic state goals may be achievable with a combination of internal nutrient load reduction and an inflow total phosphorus concentration of 0.05 mg/L, or less.

If restoration of the target water elevation range can be assumed to be a greater short-term priority than achievement of the lake water quality goals, then the restoration options outlined in Table 2-5 offer alternatives that could achieve these multiple goals. Conceptually, LESJWA could move through Options 1 and 2 simultaneously to achieve lake level goals but lake water quality goals would not yet be attained. By moving directly to Option 3, LESJWA could more readily achieve the short-term water quality goals. All predictions of water quality response and restoration activity effectiveness should be considered preliminary and subject to revision as model enhancements are made and lake response is measured. The primary consideration in an adaptive management approach would be to implement actions that are relatively inexpensive first, and then monitor their performance. The need for and features of future improvements would then be determined based upon the initial results of the restoration activities.

For the purpose of this study, conceptual treatment systems should be planned that could achieve a target total phosphorus discharge quality goal of 0.5 mg/L. That treatment objective is achievable by a combination of treatment wetland and/or conventional wastewater treatment methods.

TABLE 2-5
Conceptual Options for Lake Elsinore Restoration and Reclaimed Water Quality Addition

Option	Activity	Reclaimed Water Total Phosphorus (mg/L)	Lake Chlorophyll *a* (µg/L)
0	Existing Condition*	NA	10-950
1	Reduce internal loading through lake aeration	NA	100-300 (assumed)
2	Restore lake levels with supplemental water addition	1.0	87-106
3	Reduce reclaimed water inflow P load	0.5	45-66
4	Reduce reclaimed water inflow P load	0.1	18-43

* Lake Elsinore Water Quality Data 1993-2002.

LAKE ELSINORE EVAPORATION LOSSES, INFLOWS, SUPPLEMENTAL WATER REQUIREMENTS, AND SOURCES

Section 3: Lake Elsinore Evaporation Losses, Inflows, Supplemental Water Requirements, and Sources

Introduction

The primary source of inflow into Lake Elsinore is natural runoff from the San Jacinto River watershed and local watersheds that discharge directly into the lake. The total lake watersheds encompass an area of 782 square miles. Lake Elsinore is a natural sink at the terminus of the San Jacinto River watershed, which covers an area of approximately 735 square miles. In addition to the San Jacinto River watershed there is 47 square miles of local watersheds that contribute runoff directly to the lake and Back Basin area. Over 90 percent of the San Jacinto River watershed drains into Canyon Lake on the San Jacinto River that was constructed in 1928 in Railroad Canyon, and is located about three miles upstream of Lake Elsinore. Most of the runoff from the San Jacinto River watershed that reaches Lake Elsinore is from storm spills and releases from Canyon Lake. A minor amount of additional runoff is derived from 21 square miles of local watersheds that drain directly into the lake. The runoff from the remaining 26 square miles of local watersheds drains into the Back Basin area then into Lake Elsinore. In addition to local watershed runoff, the lake also receives a negligible amount of flow from septic tank systems adjacent to the lake.

Groundwater levels in wells in the vicinity of Lake Elsinore suggest that groundwater is not a natural source of inflow into the lake. Well logs and geologic studies indicate that clay layer completely underlies Lake Elsinore, which prevents the flow of groundwater into the lake and the percolation of lake water into the underlying groundwater basin. [1]

The Lake Elsinore evaporation losses will be quantified along with the historic storm runoff inflows into the lake so that the supplemental water requirements can be established for the long-term lake operating water level goal can be attained. In addition to the worst-case supplemental water requirement, the long-term average supplemental water requirement will also be quantified so that the annual operation and maintenance costs can be determined for the study alternatives.

Lake Elsinore Evaporation Rates

A long-term operating objective for Lake Elsinore has been proposed to maintain the lake water level within a specific elevation range to enhance the aesthetics of the lake and mitigate the impact of in-lake nutrients on algae growth. The proposed long-term lake operating objective is to maintain the lake water level within the elevation range of 1,240 feet and 1,247 feet. The COE established the maximum water level elevation of 1,247 feet as the highest water level that supplemental water can be added to the lake. Table 3-1 presents

[1] Lake Elsinore Water Quality Master Plan, Black & Veatch, 1994.

the water surface area of the lake, and the estimated annual evaporation rate for Lake Elsinore within the long-term operating water level range of 1,240 feet to 1,247 feet.

TABLE 3-1
Lake Elsinore Operating Water Elevation Water Surface Area and Estimated Annual Evaporation Rates

Operating Water Elevation (feet)	Lake Water Surface Area (acres)	Estimated Annual Evaporation Rate (acre-feet/year)
1,247	3,386	15,156
1,246	3,345	14,957
1,245	3,319	14,745
1,244	3,271	14,473
1,243	3,218	14,166
1,242	3,175	13,850
1,241	3,124	13,547
1,240	3,074	13,345

Source: SAWPA

Within the long-term operating water level range, the water surface area ranges will range from 3,074 acres (at the 1,240 foot elevation) to 3,386 acres (at the 1,247 foot elevation). The estimated annual evaporation loss from the lake water surface will range from 13,345 acre-feet per year, at the 1,240 foot operating water level, to 15,156 acre-feet per year, at the 1,247 foot operating water level. The lake evaporation loss was calculated using an annual evaporation rate of 4.6 feet. That annual evaporation rate represents a long-term annual average evaporation rate for the Lake Elsinore area.

San Jacinto River Watershed Runoff

Natural runoff from the San Jacinto River watershed first flows into Canyon Lake before it reaches Lake Elsinore. Most of the flows from the San Jacinto River watershed that reach Lake Elsinore are made up of storm spills and releases from Canyon Lake. The USGS maintains a stream gage (No. 11070500) on the San Jacinto River between Canyon Lake and Lake Elsinore. The stream gage is located about one mile upstream of Lake Elsinore. Records of runoff flows in the San Jacinto River for the stream gage are available from 1916 to the present. The dam that forms Canyon Lake was constructed in 1928. The dam and Canyon Lake, as previously indicated, affect the amount of runoff that reaches Lake Elsinore. Accordingly, the stream gage flows recorded before 1928 do not reflect the effects of the dam and the lake; therefore, flow data for the 1916 to 1927 period cannot be used for any river flow analysis. Table 3-2 presents the annual flows in the San Jacinto River measured at the USGS stream gage for the 73 year period from 1928 through 2000. Only partial 2001 flow data is available; therefore, the 2001 annual runoff could not be included in the stream gage historical flow data.

TABLE 3-2
USGS Stream Gage No. 11070500 Annual Flows

Year	Annual Flow (ac-ft/yr)	Year	Annual Flow (ac-ft/yr)	Year	Annual Flow (ac-ft/yr)
2000	387	1975	431	1950	1
1999	370	1974	624	1949	507
1998	16,374	1973	1,146	1948	26
1997	3,170	1972	186	1947	63
1996	527	1971	74	1946	147
1995	34,409	1970	422	1945	267
1994	2,142	1969	55,586	1944	850
1993	102,260	1968	63	1943	7,231
1992	7,182	1967	541	1942	238
1991	9,765	1966	12,962	1941	44,631
1990	528	1965	3,504	1940	239
1989	481	1964	26,054	1939	4,822
1988	483	1963	0	1938	54,447
1987	436	1962	4	1937	84,065
1986	393	1961	0	1936	109
1985	370	1960	0	1935	28
1984	563	1959	37	1934	7
1983	68,570	1958	8,353	1933	67
1982	2,101	1957	19	1932	9,533
1981	737	1956	0	1931	26
1980	161,147	1955	53	1930	46
1979	22,185	1954	24	1929	2
1978	50,916	1953	16	1928	34
1977	213	1952	15,880		
1976	332	1951	0		

Notes:
1. Annual runoff volumes have been rounded to the nearest whole number.
2. ac-ft/yr = acre-feet per year.

The annual runoff volumes presented in Table 3-2 represent the actual flow volumes measured at the USGS stream gage. The annual amount of inflow into Lake Elsinore will be less than the annual runoff amounts listed in the table due to percolation, transpiration and evaporation losses within the river channel between the stream gage and the lake. The COE provided adjustment of the stream gage flows for the 1994 Lake Elsinore Water Quality Master Plan study to account for river channel percolation and measurement errors by the COE HEC-5 model.[2] An attempt was made to obtain flow adjustment data from the COE to assess the magnitude of the flow reduction between the stream gage and Lake Elsinore. The COE has not been able to provide that information. That information may not be important

[2] Lake Elsinore Water Quality Master Plan, Black&Veatch, 1994.

to this analysis when the historic flow records are taken into consideration, especially the numerous extended periods of very low flows that have been recorded at the stream gage.

The historic flow data for stream gaging station No. 11070500 shows some interesting trends. The maximum recorded annual flow for the period of evaluation is 161,147 acre-feet, which occurred in 1980. There have been two instances when the recorded annual flows exceeded 100,000 acre-feet (1980 and 1993). In the 73 years of flow records, there were only thirteen years when the inflows into Lake Elsinore equaled, or exceeded, the 13,345 acre-feet per year evaporation loss for the minimum lake operating water level elevation of 1,240 feet. There have been seven periods of four years, or longer, when annual flows were 800 acre-feet per year, or less; seven years between 1984 and 1990; four years between 1974 and 1977; five years between 1959 and 1963; five years between 1953 and 1957; eight years between 1944 and 1951; four years between 1933 and 1936, and four years between 1928 and 1931. Those extended low flow periods were spread evenly throughout the historical flow record for the stream gage. There are 47 years when the measured annual stream gage flows were equal to or less than 800 acre-feet per year, which represents about 65 percent of the historic annual flows. There are 41 years when the measured annual flows were equal to or less than 500 acre-feet per year, which represents about 55 percent of the historic annual flows. In addition, there were five years that no flows were recorded at the stream gage. Three of those no-flow years occurred during the 1980s. The historic flow records for the USGS stream gage indicate that very little of the San Jacinto River watershed runoff is getting to Lake Elsinore.

A flow frequency analysis was performed on the historical flow record for stream gaging station No. 11070500 to determine the long-term average annual inflow to Lake Elsinore. The Frequency Flood Analysis (FFA) software program, developed by the COE, was used for the frequency analysis. The program was developed in accordance with Bulletin No. 15, "A Uniform Technique for Determining Flood Flow Frequencies," that was published by the U.S. Water Resources Council in 1967. The output from the frequency analysis of the stream gage historic flow data is presented in Figure 3-1. The frequency analysis shows that 50 percent of the time, the inflow into Lake Elsinore will be less than 700 acre-feet per year. Accordingly, the historic flow data indicates that the long-term annual runoff that can be expected to flow into Lake Elsinore is minimal.

The frequency analysis data can also be used to determine the probability that the annual evaporation volume for Lake Elsinore will be equaled, or exceeded. Table 3-3 presents the probability estimates that the runoff from the San Jacinto River watershed will equal or exceed the annual volume of water lost from the lake due to evaporation. For the desired lake operating water level range of 1,240 feet to 1,247 feet, the San Jacinto River watershed will produce sufficient runoff below Canyon lake to offset Lake Elsinore evaporation losses only between 11.8 percent of the time (at the 1,247 foot elevation) and 12.5 percent of the time (at the 1,240 foot elevation). Within that lake water level operating range it can be expected that on a long-term basis, the San Jacinto River watershed inflows into lake Elsinore will be sufficient to off-set the estimated evaporation losses only one year out of ten, or a very low percentage of the time.

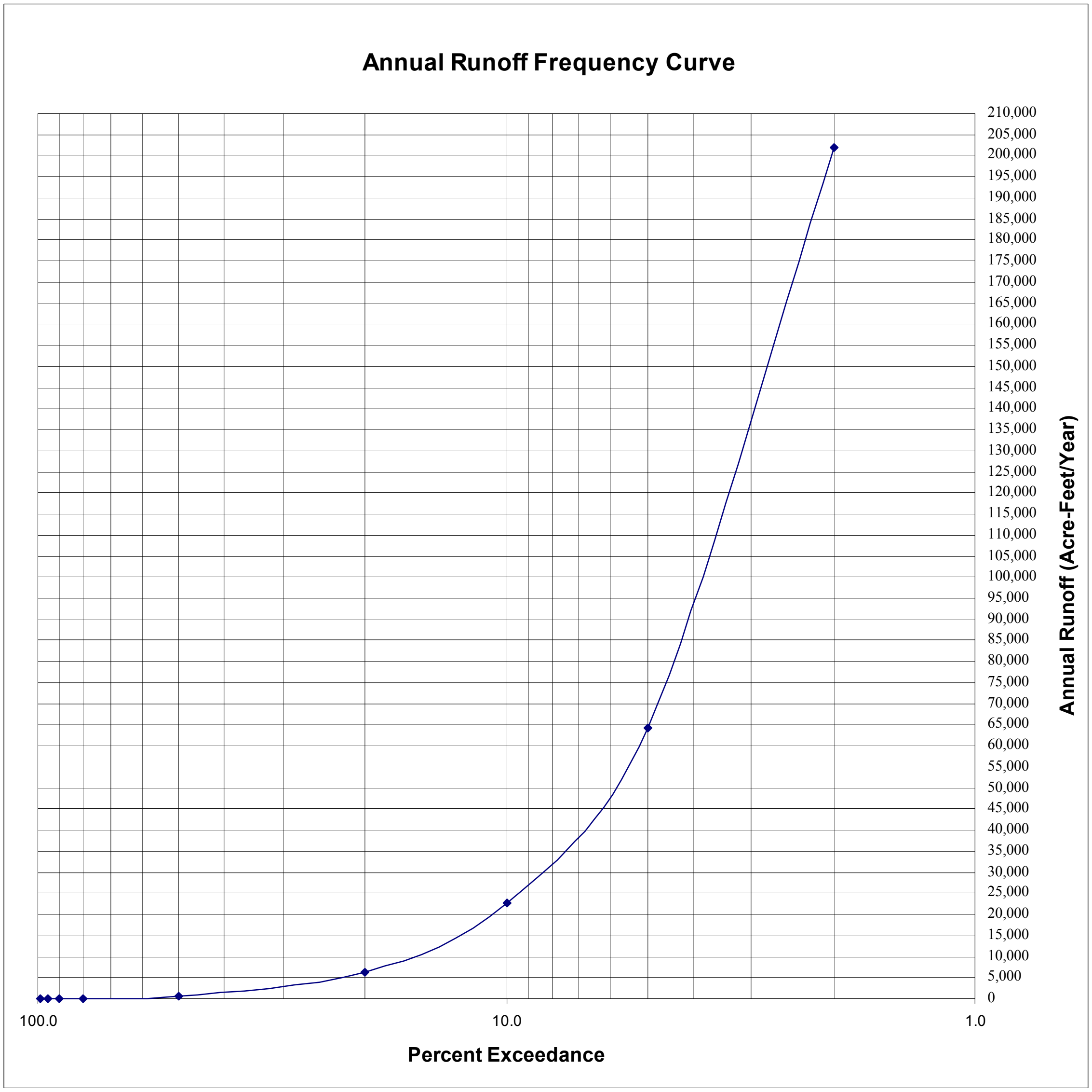


Figure 3-1
USGS Gaging Station No. 11070500
Runoff Frequency Curve

TABLE 3-3
Probabilities that San Jacinto River Flows will Off-Set Lake Elsinore Annual Evaporation

Lake Operating Water Level Elevation (feet)	Estimated Lake Annual Evaporation Rate (acre-feet/Year)	San Jacinto River Runoff Probability (percent)
1,247	15,156	11.8
1,246	14,957	11.9
1,245	14,745	12.0
1,244	14,473	12.1
1,243	14,166	12.2
1,242	13,850	12.3
1,241	13,547	12.4
1,240	13,345	12.5

Local Watershed Runoff

SAWPA is sponsoring a project that is utilizing Proposition 13 funding to develop a watershed model for the San Jacinto River watershed to estimate the nutrient loads from the various land uses within the watershed. The developed model will then be used in a follow-on project to assist the Santa Ana RWQCB in developing the best management strategies to achieve the TMDL nutrient goals being considered for Lake Elsinore and Canyon Lake. The watershed model has a hydrology component that calculates runoff from rain gage data throughout the watershed. The San Jacinto River watershed model was used to determine the amount of runoff that can be expected from the local watersheds that discharge directly into Lake Elsinore. The model was used because its methodology to calculate runoff is more sophisticated than the Rational Method of calculating storm runoff, and it has the capability to simulate runoff dynamically over time based on actual rainfall data.

Table 3-4 presents the calculated annual runoff flows from the watershed model for the five local watersheds that discharge directly into Lake Elsinore downstream of USGS stream gage No. 11070500. The runoff data presented in the table is for the 10-year period form 1991 through 2000. The estimated annual runoff from the local watersheds ranges from a low of 68 acre-feet per year in 1999 to a high of 7,106 acre-feet per year in 1998. The average annual runoff calculated for the local watersheds for the 10-year period is 2,345 acre-feet per year. There was one two-year period in 1996 and 1997 when the annual runoff ranged between 400 and 600 acre-feet per year.

TABLE 3-4
Estimated Annual Runoff from Local Watersheds Discharging Directly into Lake Elsinore

Year	Estimated Annual Watershed Runoff (ac-ft/yr)
2000	285
1999	68
1998	7,106
1997	602
1996	400
1995	3,490
1994	652
1993	6,329
1992	1,360
1991	3,157

Notes:
1. ac-ft/yr - acre-feet per year.

Conclusions and Suggested Lake Supplemental Water Requirements

Lake Elsinore Annual Evaporation Rate

The estimated annual evaporation losses from Lake Elsinore for the desired lake water level operating elevation range of 1,240 feet to 1,247 feet is 13,345 acre-feet per year and 15,156 acre-feet per year, respectively. The estimated annual lake evaporation losses were calculated using an average annual evaporation rate of 4.6 feet for the Lake Elsinore area. The actual annual evaporation rate will vary from the average rate, and could be greater than that calculated. For long-term planning, it is suggested that an annual evaporation loss for Lake Elsinore of 15, 200 acre-feet per year be adopted for the study to make sure the lake water levels are maintained at the desired level for all hydrologic conditions. The suggested annual evaporation loss for Lake Elsinore is approximately 13.5 percent more than the estimated annual evaporation loss for the lake operating water level of 1,240 feet. Adopting the suggested annual evaporation loss for the lake will provide a contingency to account for any variability in the annual evaporation rate at the lake.

San Jacinto River Watershed Runoff Inflows

The historical flow data for USGS stream gage No. 11070500, which is located on the San Jacinto River between Canyon Lake and Lake Elsinore, shows that the predominance of annual inflows to Lake Elsinore have been very low. The annual inflows to Lake Elsinore have been equal to, or less than, 800 acre-feet per year for about two-thirds of the 73 years of available flow records for the USGS stream gage. In addition, there have been seven periods when the annual runoff flows have been equal to, or less than, 800 acre-feet per year for four or more years. Based on the historical flow data, the San Jacinto River watershed has produced runoff equal to, or greater than, the estimated annual evaporation loss from Lake Elsinore only about 10 percent of the time, or one year out of every ten years.

The long-term operating objective for Lake Elsinore is to maintain the lake water level within a seven-foot elevation range from elevation 1,240 feet to 1,247 feet. With an estimated average annual evaporation rate of 4.6 feet per year and the lake water level close to the desired upper operating elevation, it would take only two years with minimal inflow to the lake to lower the water surface to an elevation below the desired minimum operating level. For long-term planning purposes, assuming a minimal amount of annual runoff from the San Jacinto River watershed of about 500 acre-feet per year would be reasonable. However, taking into consideration the extended very low flow periods a more conservative approach would be to assume no flow from the watershed. It is suggested that the more conservative approach be adopted for the study, with no annual runoff being assumed for the San Jacinto River watershed.

Local Watershed Runoff Inflows

The runoff from the five local watersheds, located downstream of the USGS stream gage, that discharge directly into Lake Elsinore was estimated using the San Jacinto River watershed model that was developed under another SAWPA-sponsored project. Local watershed runoff for the 10-year period from 1991 through 2000 was estimated based on available rainfall data for that period. The estimated annual runoff into Lake Elsinore for the local watersheds ranges from 68 acre-feet per year to 7,106 acre-feet per year. The average annual runoff for the five watersheds for the 10-year period is 2,345 acre-feet per year. Based on the estimated annual runoff volumes, it appears that the local watersheds may be more productive in producing runoff inflows into the lake, since those inflows are not affected by impoundments upstream of the lake. Because the runoff evaluation for the local watersheds covers such a brief period, it is suggested that the median value for the 10-year period of 1,360 acre-feet per year be adopted, which would yield an annual inflow of 1,400 acre-feet per year. This approach is more conservative than adopting the average annual runoff volume, and would be prudent for long-term planning purposes.

Maximum Lake Supplemental Water Requirements

Based on the foregoing, the natural runoff from the San Jacinto River and local watersheds will not be consistently adequate to offset the calculated annual evaporation losses from Lake Elsinore if the lake water level is maintained within the desired operating elevation range of 1,240 feet to 1,247 feet. The maximum amount of supplemental water that may have to be made up in any one year during periods with very low inflow to the lake and the lake water level near its minimum operating range is estimated to be 13,800 acre-feet. That supplemental water volume was calculated as follows: 15,200 acre-feet per year evaporation loss minus the 1,400 acre-feet estimated inflow from the local watersheds. At that supplemental water requirement, it can be expected, on a long-term basis, that the contributing watersheds would produce runoff equal to, or greater than, that volume about one year out of every ten years.

Available supplemental water sources include groundwater pumped from the three Lake Elsinore Island wells, or reclaimed water produced from the Elsinore Valley MWD and Eastern MWD systems. Assuming that 5,000 acre-feet per year of groundwater can be pumped from the Island wells, leaves a maximum supplemental water requirement of about 8,800 acre-feet per year that may have to be made up by reclaimed water. That amount of reclaimed water would only have to be acquired during periods of low natural inflow to the lake, and with the lake operating water level close to the minimum desired operating elevation (elevation 1,240 feet). The amount of supplemental water that will be needed each year will be dependent upon the local hydrology of the watersheds tributary to Lake Elsinore and the lake operating water level elevation. A smaller volume of reclaimed water would be needed to offset the lake evaporation losses during those years when there is more natural runoff and/or the lake water level is close to the upper elevation of the desired operating range (elevation 1,247 feet).

Supplemental water, in addition to the 8,800 acre-feet per year needed during low runoff years, will be needed to offset evaporative losses from the Back Basin wetlands for those treatment alternatives that include treatment wetlands to achieve the nutrient goals of the study. The amount of additional supplemental water that will be needed will depend upon the area of the wetlands, flow-through characteristics of the wetlands and the hydraulic residence time within the wetlands.

Long-Term Average Supplemental Water Needs

An average supplemental water need has to be quantified to evaluate the costs of the study nutrient treatment alternatives. Elsinore Valley MWD completed the *Lake Elsinore NPDES Permit Feasibility Study* in December 1997. The study included hydrologic and water quality analyses of the lake to evaluate the potential effects of reclaimed water addition from the Elsinore Valley MWD and Eastern MWD reclamation plants.

The hydrologic analysis included the development of a spreadsheet-based model that incorporated current Lake Elsinore facilities and operating procedures, along with hydrologic data for the period from 1928 through 1990. The hydrologic balance model for Lake Elsinore performs mass balance calculations (inflow minus outflow equals change in storage). The model, as developed, included inflows from the San Jacinto River watershed downstream of Canyon Lake, local tributary watersheds, direct precipitation on the lake and potential supplemental water introduced to the lake as part of the Lake Elsinore Management Plan. The model inflow and hydrologic data was obtained from the BVYIELD model that was developed for the Lake Elsinore Management Plan. The model outflows from the lake include evaporation losses and overflows leaving the lake through the outlet channel.

The study hydrologic analysis evaluated the following five alternatives:

Alternative 1: Baseline Conditions (No Action Alternative). Hydrologic conditions occurring with existing lake conditions with no supplemental makeup water.

Alternative 2: Hydrologic conditions occurring with existing lake conditions, with the delivery of 3.0 mgd of reclaimed makeup water from Elsinore Valley MWD in any month when the lake water level is below elevation 1,249.

Alternative 3: Hydrologic conditions occurring with existing lake conditions, with the delivery of 5.5 mgd of reclaimed makeup water from Elsinore Valley MWD in any month when the lake water level is below elevation 1,249.

Alternative 4: Hydrologic conditions occurring with existing lake conditions, with the delivery of 3.0 mgd of reclaimed makeup water from Elsinore Valley MWD and 10.0 mgd from Eastern MWD in any month when the lake water level is below elevation 1,249.

Alternative 5: Hydrologic conditions occurring with existing lake conditions, with the delivery of 3.0 mgd of reclaimed makeup water from Elsinore Valley MWD and 10.0 mgd from Eastern MWD during the 90 days between December 15th and March 15th. The reclaimed makeup water is added in any month when the lake water level is below elevation 1,249.

Table 3-5 summarizes the results of the study hydrologic analysis.

TABLE 3-5
Summary of Lake Elsinore Hydrologic Balance and Makeup Water Simulations

Simulation Results	Alt. 1 (Baseline)	Alt.2 (3.0 mgd)	Alt. 3 (5.5 mgd)	Alt. 4 (13.0 mgd)	Alt. 5 (3+10 mgd)
Percent of Months with Lake Elevation Below 1,232	42	22	6	0	6
Percent of Months with Lake Elevation Below 1,232	65	55	43	1	43
Percent of Months with Lake Elevation Above 1,255	4	5	7	8	7
Percent of Months with Lake Elevation Above 1,262	0	0	0	0	0
Percent of Months When Makeup Water is Taken	0	76	74	55	EV = 74 E = 25
Percent of Months Lake is Within 1,240-1,249 Operating Range	14	19	34	60	30
Number of Months Lake Spills to Temescal Wash	30	36	51	57	51

Notes:

1. EV = Elsinore Valley Municipal Water District and E = Eastern Municipal Water District.

The study hydrologic simulation also identified extended periods when the lake water level was below elevation 1,232, which were as follows for the simulation alternatives:

Alternative 1: 1930-1936, 1949-1951, 1953-1965, 1966-1968 and 1989-1990 (28 years)

Alternative 2: 1933-36, 1954-1964 (15 years)

Alternative 3: 1960-1963 (4 years)

Alternative 4: None

Alternative 5: 1960-1963 (4 years)

The results of the study hydrologic simulation show that Alternative 4 produced the best results. Alternative 4 had the lowest number of months when the lake water level was below elevation 1,240, and no extended periods when the lake water level was below elevation 1,232. Alternative 4 also had the highest percentage of months when the lake water level was within the elevation 1,240 to 1,249 desired operating range evaluated in the study. Based on the hydrologic simulation results, it is suggested that a long-term average supplemental water requirement of 8,005 acre-feet per year, which represents 55 percent of the annual makeup water volume of 13.0 mgd (14,555 acre-feet per year). This long-term average supplemental requirement will be used to evaluate the study nutrient treatment alternatives to quantify annual O&M costs. Assuming that 5,000 acre-feet per year of groundwater can be pumped from the Island wells, leaves a average annual supplemental water requirement of about 3,005 acre-feet per year that will have to be made up by reclaimed water.

Supplemental Water Requirements

A long-term average supplemental water addition of about 8,000 acre-feet per year is needed to maintain the Lake Elsinore water levels and achieve the water quality improvement goals for the lake. Under worst-case drought conditions, with the lake water level near the lower portion of the desired water level range, up to 13,800 acre-feet per year of supplemental water may have to be added to Lake Elsinore. These two supplemental water requirements establish the range of supplemental water volumes that need to be provided by each of the project alternatives to achieve the lake operating water level and water quality goals.

Supplemental Water Sources

Three sources of water have been identified to supplement the natural runoff that reaches Lake Elsinore. Each of those supplemental water sources will be described in the following sections.

Local Groundwater

One source of supplemental water that has been identified is local groundwater pumped from the three existing Island Wells that are owned and operated by the Elsinore Valley MWD. The wells are drilled deep into the Lake Elsinore Basin that is beneath the lake, and pump groundwater directly into the lake. The wells are being rehabilitated by a LESJWA project, and after the wells are rehabilitated the total groundwater production capacity is estimated to be 5,000 acre-feet per year. Taking this groundwater production into consideration yields a supplemental water deficiency that ranges from 3,000 acre-feet per year for the long-term average supplemental water condition, to 8,800 acre-feet for the worst-case supplemental water condition during a severe drought.

Imported Water

Another source of water for Lake Elsinore is imported water purchased from the Metropolitan. The imported water can be obtained through Elsinore Valley MWD's WR-18b turnout or WR-31 turnout. The two turnouts are situated next to each other, adjacent to the San Jacinto River about 12 miles upstream from Canyon Lake. Imported Colorado River Water is available through the WR-18b turnout. Imported State Project Water is available through the WR-31 turnout. The imported water will be conveyed to Lake Elsinore via the San Jacinto River and Canyon Lake. The release from Canyon Lake will be through overflow discharges over the dam spillway, or through the discharge facilities in the dam. For the latter flow release option, the water level of Canyon Lake will have to be above elevation 1,319 feet. Elsinore Valley MWD, by agreement, has to maintain a minimum water elevation of 1,372 feet in Canyon Lake; thus, releasing water downstream to Lake Elsinore should not pose a problem.

Reclaimed Water

The last source of water to make up a Lake Elsinore supplemental water deficiency is reclaimed water. There are two potential sources of reclaimed water within the project area.

One source of reclaimed water is Title 22 tertiary effluent from Elsinore Valley MWD's RWRF. The other source of reclaimed water is Title 22 effluent from either Eastern MWD's Regional Reclaimed Water System (RRWS), or Title 22 effluent produced from Temecula Valley RWRF. The Elsinore Valley MWD RWRF currently treats about 4.0 million gallons per day (mgd) of wastewater, of which approximately 3.5 mgd, or about 3,900 acre-feet per year, is available as a supplemental water source for Lake Elsinore.

Title 22 reclaimed water from Eastern MWD's RRWS is available from Reach 4 of their Temescal Creek Outfall Pipeline in the vicinity of Lake Elsinore. Eastern MWD is considering the construction of a new pipeline (Temecula Valley RWRF Effluent Pipeline) to convey treated effluent from their Temecula Valley RWRF to Reach 4 of their Temescal Creek Outfall Pipeline. Temecula Valley RWRF Title 22 treated effluent will be directly available as a reclaimed water source for the lake when the planned pipeline is constructed. Construction of that new pipeline is a critical component for Alternative 1A and Alternative 1B. Those two alternatives evaluate chemical treatment and biological treatment upgrades at the two RWRFs to achieve the phosphorus nutrient loading targets established for the study. Those alternatives will not be feasible if the pipeline is not constructed, since it will be infeasible to upgrade all of Eastern MWD's RWRFs for phosphorus removal to achieve the phosphorus removal goals of the study. The Temecula Valley RWRF currently treats about 8.7 mgd of wastewater per day, which equates to an annual reclaimed water production rate of about 9,750 acre-feet per year.

For the purpose of this study, it has been assumed that the planned Temescal Valley RWRF pipeline will be constructed and reclaimed water from Eastern MWD's RRWS will originate from their Temecula Valley RWRF for those two alternatives evaluating phosphorus removal treatment process upgrades at the RWRFs. Eastern MWD completed a study entitled "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" that was completed in October 2000. The study evaluated three alignments for the Temecula Valley RWRF effluent pipeline. The study concluded that the Alternative 2 alignment along the I-15 Freeway offered the best apparent solution for reclaimed water disposal from the ultimate Temecula Valley RWRF. The Alternative 2 pipeline will be 36 inches in diameter, and will connect into Reach 4 of the existing Eastern MWD Temescal Valley Pipeline at Casino Drive in the vicinity of the San Jacinto River.

The amount of reclaimed water available for Lake Elsinore supplemental water from Elsinore Valley MWD's RWRF and Eastern MWD's Temecula Valley RWRF will continue to increase from their current levels as future development occurs within each plant's service area. In the future, as the wastewater flows increase within the Elsinore Valley MWD's RWRF service area, more supplemental reclaimed water will be available from that source to supplement the natural runoff into Lake Elsinore. As a result, less reclaimed water will have to be obtained from Eastern MWD in the future.

Supplemental Water Availability

Local groundwater pumped from the three Island Wells is available on a year-round basis. Reclaimed water from Elsinore Valley MWD's RWRF is also available on a year-round basis. Discussions were held with Eastern MWD staff to determine the availability of reclaimed water from their RRWS, or the Temecula Valley RWRF. Eastern MWD staff indicated that only surplus reclaimed water from their system would be available as a supplemental water source for Lake Elsinore, and that the surplus reclaimed water would only be available during the winter months when agricultural irrigation is low from November through March (five-month period). Figure 3-2 shows the availability of the Lake Elsinore supplemental water sources throughout a typical water year from October of one year through September of the following year. The figure also shows the priority of the supplemental water sources. The local groundwater pumped from the Island Wells and reclaimed water produced by the Elsinore Valley RWRF will be the two primary sources of supplemental water for the lake. The water that is currently available from those two sources should be sufficient to meet the Lake Elsinore supplemental water needs for long-term average conditions. When those two supplemental water sources are not sufficient to maintain the lake operating water level within the desired elevation range, then additional reclaimed water will have to be obtained from Eastern MWD RRWS to make up the deficiency. The supplemental water deficiency will have to be made up over the five-month period from November through March, which is a 151 day period.

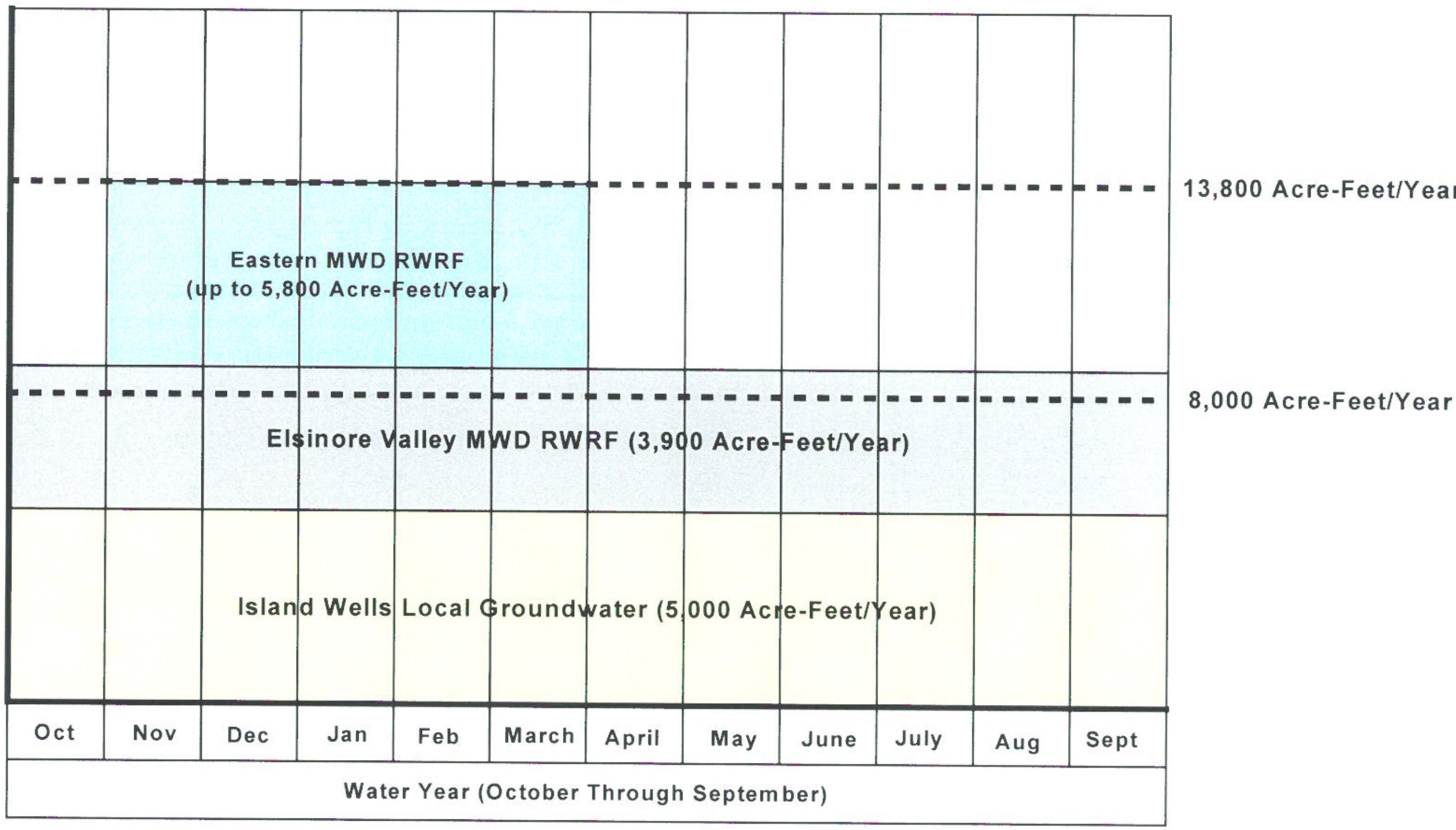


Figure 3-2

Annual Supplemental Water Availability

CH2MHILL

Supplemental Water Requirement Estimate

The long-term average supplemental water requirement was developed to estimate the project alternative annual operation and maintenance costs. In addition, an estimate of the amount of supplemental water from each of the possible water sources was made to provide LESJWA a breakdown of the long-term average supplemental water requirement to assist in their future planning. The estimate assumed a future inflow pattern into Lake Elsinore identical to the 73 years of runoff data available for the USGS gaging station located on the San Jacinto River, downstream of Canyon Lake. The estimate since it is based only on San Jacinto River inflow to Lake Elsinore should be considered as an approximation. The breakdown of the supplemental water volumes produced by the estimate will therefore be different than the flow volumes presented for the project alternatives, since those latter values take into consideration treatment system and other water losses not included in this estimate.

The supplemental water requirement estimate is based on the following:

- Beginning lake water level in year 1 of the estimate (corresponding to 1928) was set at 1,240 feet.
- The change in lake water level in any given year is the starting elevation, plus San Jacinto River inflows (as measured at the USGS gaging station), minus evaporation loss.
- Local tributary watershed inflows into the lake were not included in the estimate because comparable annual runoff records were not available, and using an average or median value is not appropriate for this type of analysis with actual annual inflow data for the lake.
- Annual rainfall that falls upon the lake surface was not included in the estimate.
- An average annual evaporation loss of 4.60 feet per year was assumed.
- Objective each year is to add enough supplemental water so that the minimum lake water level objective of 1,240 feet is maintained.
- No supplemental water is added to the lake if the water level at the end of each annual period is above elevation 1,240 feet.
- The maximum lake operating water level is 1,255 feet, with any lake inflow above that elevation being considered lost through the Lake Elsinore Overflow Channel.
- Supplemental water sources include groundwater pumped from the three Island Wells, and reclaimed water obtained from Elsinore Valley MWD RWRF and the Eastern MWD Regional Reclaimed Water System.
- Reclaimed water from the Elsinore Valley RWRF was used first as a supplemental water source, followed by groundwater pumped by the Island Wells, and lastly reclaimed water purchased from Eastern MWD.

- The Elsinore Valley MWD reclaimed water source started out at 3,900 acre-feet per year in the first year of the estimate (corresponding to 1928 and current total treated effluent flows from the plant), and was increased to 8,397 acre-feet per year over an initial 20 year period.
- The Elsinore Valley MWD RWRF treated water capacity was held constant at the 8,397 acre-feet per year volume for the remainder of the estimating period after the initial 20-year increase period.
- The Elsinore Valley MWD RWRF treated effluent flows include a 560 acre-foot per year deduction for the 0.5 mgd of treated effluent capacity that is dedicated to other uses, and it was assumed that that deduction would not change over the estimating period.

The estimated supplemental water additions into Lake Elsinore for the 73-year period is presented in Table 3-6. The table breaks down the estimated supplemental water additions each year by the three possible supplemental water sources. A copy of the spreadsheet used for the estimate is presented in Appendix B.

Over the 73-year estimating period, a total of 487,800 acre-feet of supplemental water were added to Lake Elsinore to maintain the lake's water level above the minimum elevation of 1,240 feet. Of that total, approximately 290,900 acre-feet was Elsinore Valley MWD RWRF treated effluent (60 percent), 162,600 acre-feet was groundwater pumped from the Island Wells (33 percent), and 34,300 acre-feet of reclaimed water purchased from Eastern MWD (7 percent). Applying those percentages to the long-term average supplemental water requirement of 8,000 acre-feet per year, yields about 4,800 acre-feet per year of Elsinore Valley MWD RWRF treated effluent, about 2,700 acre-feet of groundwater pumped from the Island Wells, and about 500 acre-feet per year of reclaimed water purchased from Eastern MWD.

TABLE 3-6
Estimated Annual Supplemental Water Additions to Lake Elsinore

Year	Estimated Annual Supplemental Water Additions–Acre-Feet/Year			
	EVMWD Reclaimed Water	Island Wells	EMWD Reclaimed Water	Annual Total
1928	3,900	5,000	4,674	13,574
1929	4,061	5,000	4,544	13,605
1930	4,228	5,000	4,335	13,563
1931	4,402	5,000	4,180	13,582
1932	4,526	0	0	4,526
1933	4,772	5,000	3,770	13,542
1934	4,968	5,000	3,632	13,600
1935	5,173	5,000	3,407	13,580
1936	5,386	5,000	3,116	13,502
1937	0	0	0	0
1938	0	0	0	0
1939	0	0	0	0
1940	0	0	0	0
1941	0	0	0	0
1942	0	0	0	0
1943	0	0	0	0
1944	0	0	0	0
1945	0	0	0	0
1946	8,064	1,821	0	9,884
1947	8,397	5,000	149	13,546
1948	8,397	5,000	185	13,582
1949	8,397	4,722	0	13,119
1950	8,397	5,000	209	13,606
1951	8,397	5,000	210	13,607
1952	0	0	0	0
1953	8,397	3,509	0	11,906
1954	8,397	5,000	187	13,584
1955	8,397	5,000	159	13,556
1956	8,397	5,000	210	13,607
1957	8,397	5,000	192	13,589
1958	5,686	0	0	5,686
1959	8,397	5,000	174	13,571
1960	8,397	5,000	210	13,607
1961	8,397	5,000	210	13,607
1962	8,397	5,000	206	13,603
1963	8,397	5,000	210	13,607
1964	0	0	0	0
1965	0	0	0	0

TABLE 3-6 (Continued)
Estimated Annual Supplemental Water Additions to Lake Elsinore

Year	Estimated Annual Supplemental Water Additions–Acre-Feet/Year			
	EVMWD Reclaimed Water	Island Wells	EMWD Reclaimed Water	Annual Total
1966	102	0	0	102
1967	8,397	4,689	0	13,086
1968	8,397	5,000	149	13,546
1969	0	0	0	0
1970	0	0	0	0
1971	0	0	0	0
1972	391	0	0	391
1973	8,397	4,107	0	12,504
1974	8,397	4,609	0	13,006
1975	8,397	4,795	0	13,192
1976	8,397	4,890	0	13,287
1977	8,397	5,000	5	13,402
1978	0	0	0	0
1979	0	0	0	0
1980	0	0	0	0
1981	0	0	0	0
1982	0	0	0	0
1983	0	0	0	0
1984	0	0	0	0
1985	0	0	0	0
1986	0	0	0	0
1987	8,397	278	0	8,675
1988	8,397	4,745	0	13,142
1989	8,397	4,747	0	13,144
1990	8,397	4,702	0	13,099
1991	4,299	0	0	4,299
1992	6,836	0	0	6,836
1993	0	0	0	0
1994	0	0	0	0
1995	0	0	0	0
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	5,748	0	0	5,748
Totals:	290,863	162,614	34,321	487,798
Percentage:	60%	33%	7%	100%

PHOSPHORUS REMOVAL TREATMENT TECHNOLOGIES

Section 4: Phosphorus Removal Treatment Technologies

Introduction

This section of the report describes the possible treatment technologies that can be used to treat the Lake Elsinore water and supplemental water sources to achieve the water quality goals and nutrient loading criteria established for the study. Since phosphorus has been identified as the predominant nutrient of concern, the treatment technology considerations will concentrate on that constituent. Both natural, physical-chemical and biological treatment technologies will be described that can achieve the phosphorus loading rate limits established for the study. Natural treatment technologies considered for supplemental water and lake water treatment concentrated on treatment wetlands.

In Section 3, the Lake Elsinore evaporation loss was established for the desired lake water level operating range of 1,240 feet to 1,247 feet. In addition, an analysis of historic inflows into the lake determined that a long-term average supplemental water addition of about 8,000 acre-feet per year will be needed to maintain the lake water levels within the desired operating range. Under worst-case drought conditions with the lake water level near the lower operating level elevation, up to 13,800 acre-feet per year of supplemental water may have to be added to the lake to maintain desired water levels. Potential sources of supplemental water for the lake include local groundwater, reclaimed water and imported water. Of those potential sources of water, both groundwater and imported water are low in nutrients and would not require additional treatment prior to being discharged into the lake. Only reclaimed water, with total phosphorus concentrations above the established nutrient loading criteria adopted for the study, will require treatment. In addition, the removal of phosphorus from the lake water column will be important component of the alternatives considered in this study to reduce the phosphorus concentration in the lake. Accordingly, treatment technologies appropriate to treat lake water to remove phosphorus will also be described.

The water quality goals and nutrient loading criteria for the study were adopted by the project stakeholders in a workshop held solely for that purpose. The workshop participants agreed to establish short-term (i.e., 5-10 years) and long-term (i.e., 10-20 years) phosphorus nutrient loading criteria for the supplemental water added to Lake Elsinore. The agreed upon short-term and long-term phosphorous nutrient loading criteria of 1.0 mg/L and 0.5 mg/L, respectively, were established during the workshop. Those nutrient loading criteria were used to screen the available treatment technologies to identify those that can meet the criteria, based on the expected phosphorus concentration in the reclaimed water available from the Elsinore Valley MWD and Eastern MWD sources.

Phosphorus Removal Treatment Technologies

The following are descriptions of natural, physical-chemical and biological treatment technologies that have been identified as being appropriate for the treatment of reclaimed water, as a supplemental water source for Lake Elsinore and lake water. In addition to the treatment technology description, the advantages and disadvantages of each treatment technology, as it applies to the Lake Elsinore situation, are also presented.

Treatment Wetland Systems

Background

LESJWA is evaluating a conceptual approach to supply supplemental water to offset deficiencies in the amount of natural runoff that reaches Lake Elsinore. Accordingly, a treatment wetland system could potentially be used as a polishing treatment system for the reclaimed water supplemental water source, and for the treatment of lake water circulated through the treatment wetland. Treatment wetlands could be incorporated into the study alternatives in the following ways:

- Reconfiguration of the existing 356-acre Back Basin Wetland into a 350-acre treatment wetland, and the possible expansion of the existing wetland area into a 600-acre treatment wetland.
- Construction of a treatment wetland located along the lakeshore within the existing lake boundary. Conceptually, this type of littoral wetland would be created along suitable portions of the lakeshore, and would operate within the desired lake water level operating range.

For either treatment wetland configuration, the treatment wetland could be utilized to remove phosphorus from two different water sources:

- Reclaimed water obtained from the Elsinore Valley MWD RWRF, or reclaimed water purchased by LESJWA from the Eastern MWD RRWS. The reclaimed water will flow by gravity through the wetlands, with the polished wetland effluent being discharged into the lake. Reclaimed water from the Elsinore Valley MWD RWRF will have to be pumped to the treatment wetland. The Eastern MWD RRWS should have sufficient residual pressure so that pumping of the reclaimed water to the treatment wetland will not be necessary.
- Water could be pumped from a location within the lake to the wetlands, and allowed to flow by gravity through the wetlands, with the polished wetland effluent being discharged into the lake.

The use of treatment wetlands has gained acceptance over the past three decades as a low-cost, low-maintenance and environmentally beneficial technology for reducing pollutants in wastewater and stormwater (Kadlec and Knight, 1996). Treatment wetlands can be important habitats for wildlife and can be designed as highly valued recreational facilities for the public. Phosphorus removal in treatment wetlands is largely through; 1) uptake and subsequent burial in plant and microbial biomass, 2) chemical precipitation and sorption, and 3) physical settling of organic and inorganic matter. Phosphorus removed through these three mechanisms is primarily stored in anaerobic wetland sediments.

Wetland phosphorus removal is influenced by hydraulic loading rate, hydraulic residence time, and inflow phosphorus concentration, with higher phosphorus removal rates being achieved in treatment wetlands with low hydraulic loading rates, longer residence time, and higher inflow phosphorus concentrations (Kadlec, 1999). Low hydraulic loading rates and longer residence times allow greater time for contact, removal, and processing of phosphorus within the wetland sediments and biota. Higher inflow concentrations increase biological activity and associated assimilation, and influence precipitation and sorption equilibrium. Because the littoral and Back Basin alternatives both involve creation of surface flow wetlands, expected water quality performance on a per acre basis is the same for both alternatives, assuming that system operation and hydraulic and mass loadings are consistent.

Advantages

The use of treatment wetlands as a natural treatment system for phosphorus removal has several advantages compared to biological and physical - chemical treatment technologies. Those advantages are:

- Low energy requirements for operation (potentially offset where significant pumping is required).
- No chemical costs if the wetlands are not managed.
- Comparatively low maintenance costs.
- No waste residuals or byproducts for offsite disposal.
- Creation of wildlife habitat.
- Multiple community benefits including greenspace preservation and opportunities for passive recreation and environmental educational facilities for the public.

Disadvantages

As a combined natural ecosystem and treatment system, treatment wetlands have unique construction and operational issues or constraints that must be evaluated and weighed against the potential benefits outlined above. These constraints include:

- Relatively large land area. Because wetlands are shallow water bodies (about 1 to 2 feet deep) and their treatment processes require long residence times, the most important constraint is the relatively large land area requirement for a treatment wetland to provide significant treatment.
- Water losses through evaporation and infiltration, which can be critical in arid regions, such as Southern California and the Lake Elsinore area. Water needs to be available to sufficiently hydrate and sustain the ecosystem, particularly through the dry season. In the arid West of the United States, this constraint may dictate that the treatment wetland may be smaller than preferred, and therefore, impact potential treatment performance.
- Relatively high capital cost of construction, through grading and installation of hydraulic control structures.
- Nuisance species control (e.g., herbivorous animals, such as geese, deer, and muskrats, where they occur, and pathogen vectors, such as mosquitoes).
- Regulatory feasibility, subject to local, state, and federal policy and rules.

Conceptual Wetland Design and Configuration

For both the littoral and Back Basin treatment wetland alternatives, surface-flow wetlands would be created. Surface-flow treatment wetlands mimic natural wetlands in that water principally flows above the ground surface, as a shallow sheet, through a more or less dense growth of plants. This type of wetland generally consists of an excavated or bermed area with a surface layer of topsoil to serve as rooting media. Appropriate inlet and outlet structures are provided to control the flow of water through the wetlands. The wetland can be planted with a variety of aquatic vegetation species, or allowed to seed and colonize naturally. The water depth in vegetated portions of surface-flow wetlands can range from a few inches to more than 2.5 feet, depending on the desired function of the wetland. An operating depth of about one foot for emergent marsh areas is typical. Figure 4-1 shows a typical treatment wetland surface flow layout. In addition to the emergent marsh areas, the surface flow wetlands often include open water areas that are typically 4 to 5 feet deep to provide wildlife habitat and hydraulic benefits.

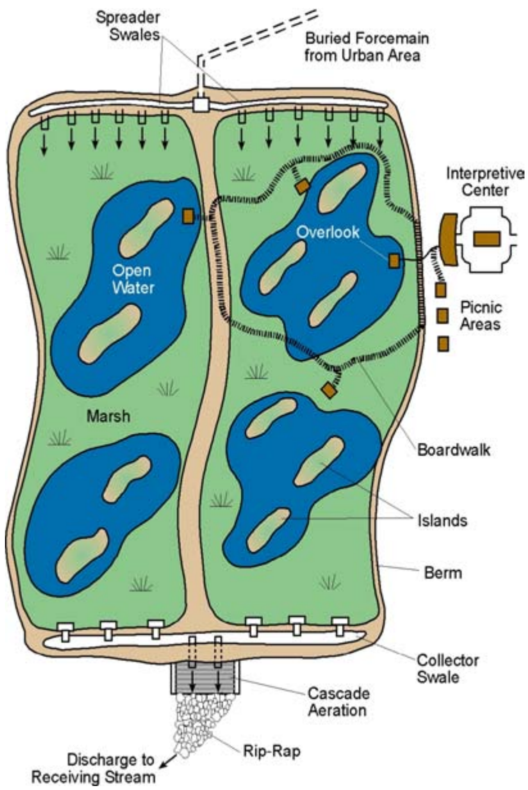


FIGURE 4-1
Conceptual Wetland Configuration, with Possible Recreational Features Included.
Shallow marsh areas generally operate with depths of about 1 foot and deeper pools with depths of about 4 to 5 feet.

Conceptually, a treatment wetland in the Back Basin area could include two parallel flow paths, each consisting of multiple wetland cells. Water supplied to the wetlands would be spilt between the two flow paths and allowed to flow by gravity through the wetland to the outlet. Creating two parallel flow paths provides operational flexibility for the system. Inflow rates can be varied between the flow paths to test water quality performance over a range of hydraulic loading rates. A single flow path can be taken “offline” for maintenance activities, while the other remains operational. Overall, this operational flexibility allows adjustments to be made to the system to optimize phosphorus removal.

The littoral wetlands alternative would include a series of wetland cells located along suitable portions of the Lake Elsinore shoreline. One possible area for siting a littoral wetland would be adjacent to Rome Hill, which is situated in the southeastern portion of the lake. The wetlands would be diked on the lake side, discharging from a single outlet point for each wetland cell. In general, broad areas of gradually sloping shoreline below the high water elevation, where adjacent land uses would be compatible with wetland creation. Water would be supplied to the wetlands and split among a number of cells. Creating multiple smaller littoral wetland cells provides operational flexibility to optimize treatment performance and facilitates maintenance activities.

The littoral wetland configuration offers an advantage over a conventional treatment wetland in that its water loss due to evaporation would be accounted for in the lake evaporation loss, and the littoral wetland water loss would therefore be negligible. Also, infiltration losses are likely to be low because the wetland would necessarily be operated within the range of normal lake water level fluctuation, and on average would need to be operated slightly above the mean lake elevation. A significant disadvantage to the development of littoral wetlands is the amount of shoreline that is available to construct the wetland. The feasibility of this approach will require further analysis of available shoreline and compatible land uses, topographic suitability, and system hydraulic requirements.

The project objective of supplying supplemental water to offset deficiencies in natural runoff reaching Lake Elsinore necessitates a thorough evaluation of the wetland water balance. The estimated average long-term and worst-case supplemental water requirements are 8,000 acre-feet per year and 13,800 acre-feet per year, respectively. Allowing for the 5,000 acre-feet per year groundwater production from the Island Wells, between 3,000 and 8,800 acre-feet per year of supplemental water would have to be treated through a treatment wetland. The wetland outflow volume is estimated as the balance of water gains (inflow and precipitation) and losses (evapotranspiration and infiltration). A preliminary analysis of the wetland water balance for a 350-acre and 600-acre treatment wetland was performed for this study. The results of that analysis are provided in Appendix A to this report

Wetland Phosphorus Removal Performance Assessment

Treatment wetland phosphorus removal performance can be estimated using a water quality model that accounts for water gains (inflows and precipitation) and losses (evapotranspiration and infiltration). This model, developed by Kadlec and Knight (1996), is referred to as the "first-order, area-based model." Based upon a simplified mass balance approach, the model estimates wetland effluent concentrations using inflow and outflow concentrations, hydraulic loading rates (i.e., the volume of water applied to the area of the wetland), and site-specific hydrologic gains and losses. Tracer studies of actual treatment wetlands have shown that they can be characterized hydraulically as a series of continuously stirred tanks, and the model is formulated to reflect this "tanks-in-series" type of operation. A wetland with multiple cells and with no significant hydraulic problems (e.g., short-circuiting) may typically be found to have a number of tanks-in-series. Because a low level, or background, concentration of a water quality constituent can result from the subtle interaction between wetland sediments and the overlying water, particularly for phosphorus, the tanks-in-series model can be corrected by introducing a second parameter (C^*) that represents the lowest achievable or irreducible concentration that will occur in a treatment wetland. Details for treatment wetlands water quality model are provided in Appendix B to this report.

Using the water quality model typically requires compiling data from a variety of sources and carefully considering those assumptions that have the most influence on model performance. Sources of data for this modeling analysis include the following:

- When performing conceptual planning and preliminary wetland design, values for the climatic variables T, ET, and P are typically developed from appropriate long-term local climate data, where available. The local precipitation, ET, and temperature data for the Lake Elsinore area were used in the model evaluations.
- Site-specific infiltration data are not usually available to estimate I. A relatively conservative (i.e., high) infiltration rate of 0.19 inches per day (0.5×10^{6} cm/sec) was selected for the Lake Elsinore application, based upon available analyses of water balances for other existing treatment wetlands, and the expectation that (a) infiltration would not be zero, (b) the long-term accumulation of fine-particle sediments and organic

residue within the wetlands would ultimately reduce the hydraulic conductivity of the wetland soils, and (3) the restored lake levels would minimize the hydraulic gradient between the wetland and the lake.

- Values of the wetland influent phosphorus concentration, C_i, were set to be 3.0 mg/L for those scenarios modeling the wetland treatment of reclaimed water based on effluent quality data for both locals RWRFs, and 0.2 mg/L for scenarios modeling the wetland treatment of recycled lake water based on lake water quality data.
- The hydraulic loading rate values are calculated by dividing the water inflow rate by the total area of the wetland, and is commonly reported as cm/d or in/d.
- The number of tanks-in-series was assumed to be three.
- Estimates of k_{20}, C^*, and θ are based upon prior analysis of influent and effluent concentration data and average inflow rates for operational wetland systems. These parameters are typically calculated based upon at least monthly, quarterly, or annual average data. Representative values were drawn from an analysis of wetland water quality performance using data summarized in the North American Wetland Database (CH2MHILL, 1995). Using these and other wetland data sets, Kadlec and Knight (1996) calculated first-order model coefficients (k_{20}, C^*, and θ) for phosphorus, indicating a median k_{20} value of 12 m/yr, a representative θ value of 1.0, and a C* value of 0.02 mg/L.

Where data exists, it is preferable to base the selection of an appropriate removal rate constant from local data sets consistent with the geology, climate, vegetation community composition, and background water quality of the area. A review of available information on treatment wetlands in California and the arid southwestern United States indicated limited data is available of sufficient length and consistency to estimate k. Phosphorus data from regional treatment wetlands at Hemet-San Jacinto, Hidden Valley, Prado, and the San Joaquin marshes were either not existent, not available, or too infrequent to be of much help for setting this parameter. When other California wetland data were reviewed, the available published information on one of the best documented wetland treatment systems, the Sacramento Regional Wetland Demonstration Project, indicated a relatively low phosphorus removal performance of 22 percent (SCRSD, 1999). Preliminary analyses of the available phosphorus removal data and a discussion of the known operational requirements and hydraulic characteristics of this system with Dr. Robert Kadlec, a consultant to this study, led to concerns about the general applicability of this data set.

For this study, an average value of 10 meters per year and low value of 5 meters per year for the first-order removal rates were selected to bracket a conservative range of wetland performance. The 10 meter per year removal rate represents the central tendency, and the 5 meter per year rate represents the lower percentile of the distribution for operational systems. This lower range was evaluated to acknowledge treatment penalties associated with the relatively poor phosphorus removal performance of the Sacramento Regional Wetlands Demonstration Project. The C* of 0.02 mg/L and θ of 1.00 were used as recommended by Kadlec and Knight (1996).

The removal rate constant, k, is a term that aggregates the various biological, physical, and chemical removal and recycling processes affecting phosphorus concentrations in wetlands. Various factors that can be mitigated during design and operation of a wetland will influence this net removal rate. A wetland with channelized flow paths (i.e., "short-circuits"), excessive pond area, or excessive hydraulic loading rates will likely have a low removal rate simply because the water will not be in sufficient contact with wetland sediments and accumulated detritus. A system with poor or inappropriate vegetative cover or density may affect performance by resulting in a low biomass accrual rate. Soils with intrinsic or artificially high phosphorus contents may contribute phosphorus to the water column and influence the apparent net removal rate. All of these factors, as well as others, will need to be addressed in the follow on planning for the wetland through site-specific soil sampling, appropriate vegetation selection and maintenance during establishment and operation, and careful attention to the hydraulic characteristics of the wetland during design to prevent short-circuiting from occurring.

Treatment Wetland Modeling Analysis

Table 4-1 summarizes the model runs conducted for this study to estimate treatment wetlands phosphorus removal capabilities, and the expected discharge concentrations under different assumed configurations and phosphorus loading conditions. Each model run assumed a unique combination of removal rate constant, hydraulic loading rate, area, and water source, all meant to be representative of the following range of conditions:

- First-order removal rate constants of 5 meters per year or 10 meters per year, which represent conservative to average levels of phosphorus removal performance.
- Hydraulic loading rates adequate to deliver 3,000 and 8,800 acre-feet of water from the wetland to Lake Elsinore as described in Appendix A. More water must be delivered to the wetlands to account for net evapotranspiration and seepage losses. The range of inflows (6,365-14,398 acre-feet) required to equal these outflow rates varied with wetland size and resulted in hydraulic loading rates that ranged between 0.5 to 1.1 inches per day, depending upon model scenario. These values correspond with the range of flows normally associated with moderate levels of phosphorus removal in treatment wetlands.
- The choice in area of 350 or 600 acres, which represents the conversion of the Back Basin Wetland within its existing area, and expansion to a larger treatment wetlands. The expected water quality performance for a littoral treatment wetland would be expected to be the same, assuming that the acreage, system operation, and hydraulic and mass loading rates are consistent.
- Water sources reflect the reclaimed water that can be used for augmentation of the lake, and recycled lake water for phosphorus removal within the lake to address algae growth and lake eutrophication.

Model run results are grouped and discussed below according to influent water source.

TABLE 4-1
Treatment Wetland Performance Model Run Scenarios

Water Source	Area (ac)	Wetland Influent Phosphorus Concentration (mg/L)	Wetland Inflow Rate (ac-ft/yr)	Wetland Outflow Rate (ac-ft/yr)	Hydraulic Loading Rate (in/d)	Removal Rate Constant (m/yr)	Model Run
Reclaimed Water	350	3.0	6,365	3,100	0.6	5	1A
						10	1B
		3.0	12,065	8,800	1.1	5	1C
						10	1D
	600	3.0	8,698	3,100	0.5	5	2A
						10	2B
		3.0	14,398	8,800	0.8	5	2C
						10	2D
Recycled Lake Water	350	0.2	6,365	3,100	0.6	5	3A
						10	3B
		0.2	12,065	8,800	1.1	5	3C
						10	3D
	600	0.2	8,698	3,100	0.5	5	4A
						10	4B
		0.2	14,398	8,800	0.8	5	4C
						10	4D

Reclaimed Water Source

Table 4-2 summarizes estimated monthly hydrologic inflow and outflow water volumes, nominal hydraulic residence time, wetland influent and effluent phosphorus concentrations and total mass of phosphorus removed for Model Runs 1 (A-D) and 2 (A-D). Monthly comparisons of these results are provided as Appendix A to this report.

Where the conservative (5 meter per year) first-order removal rate was used for model predictions (Model Runs 1A, 1C, 2A, and 2C), only run 2A produced a wetland effluent phosphorus concentration consistent with the near-term target phosphours loading goal of 1.0 mg/L, or less, for Lake Elsinore. Run 2A conservatively predicts that a 600-acre wetland could polish approximately 8,700 acre-feet of reclaimed water annually, producing 3,100 acre-feet of polished effluent with a phosphorus concentration of 1.0 mg/L to replace evaporative losses from Lake Elsinore.

TABLE 4-2
Treatment Wetland Reclaimed Water Model Runs: Average Annual Phosphorus Removal Performance

Model Run	Wetland Size (ac)	Inflow (ac-ft)	Outflow (ac-ft)	HRT (d)	Influent Phosphorus (mg/L)	Effluent (mg/L)		Total Mass Removed (kg)	
						(k=5 m/yr)	(k=10 m/yr)	(k=5 m/yr)	(k=10 m/yr)
						1A	**1B**	**1A**	**1B**
[a]1A and 1B	350	6,365	3,100	46	3.0	1.26	0.61	18,785	21,203
						1C	**1D**	**1C**	**1D**
[b]1C and 1D	350	12,065	8,800	21	3.0	1.93	1.27	23,777	30,880
						2A	**2B**	**2A**	**2B**
[c]2A and 2B	600	8,698	3,100	64	3.0	0.98	0.41	28,478	30,566
						2C	**2D**	**2C**	**2D**
[d]2C and 2D	600	14,398	8,800	32	3.0	1.57	0.89	36,286	43,643

[a]Phosphorus mass loading rate = 0.46 kg/ha/d

[b]Phosphorus mass loading rate = 0.86 kg/ha/d

[c]Phosphorus mass loading rate = 0.36 kg/ha/d

[d]Phosphorus mass loading rate = 0.60 kg/ha/d

Where the average (10 meter per year) first-order removal rate was used for model predictions (Model Runs 1B, 1D, 2B, and 2D), all model runs, excluding Run 1D, produced a wetland effluent phosphorus concentration consistent with the near-term phosphorus loading goal of 1.0 mg/L, or less, for Lake Elsinore. Run 2B, consisting of a 600-acre treatment wetland, showed that approximately 8,700 acre-feet of reclaimed water per year could be treated in the treatmeent wetland, and would produce the lowest phosphorus concentration at 0.41 mg/L. That low phosphorus concentration in the wetlands effluent is achieved because the wetland has the largest area and a low hydraulic loading rate. As shown for Run 2A, if a lower average phosphorus removal rate constant is assumed, then phosphorus concentrations in the discharge from the wetland would be greater.

All wetland configurations modeled would incur water losses through infiltration and evapotranspiration, with the 350-acre treatment wetland losing about 3,300 acre feet, and the 600-acre treatment wetland losing about 5,600 acre feet.

Recycled Lake Water Source

Table 4-3 summarizes estimated monthly hydrologic inflow and outflow water volumes, nominal hydraulic residence time, wetland influent and effluent phosphorus concentrations and total mass of phosphorus removed for Model Run 3 (A-D) and Run 4 (A-D). Monthly comparisons of these results are provided as Appendix A to this report.

TABLE 4-3
Treatment Wetland Recycled Lake Water Model Runs: Average Annual Phosphorus Removal Performance

Model Run	Wetland Size (ac)	Inflow (ac-ft)	Outflow (ac-ft)	HRT (d)	Influent Phosphorus(mg/L)	Effluent (mg/L)		Total Mass Removed (kg)	
						(k=5 m/yr)	(k=10 m/yr)	(k=5 m/yr)	(k=10 m/yr)
						3A	**3B**	**3A**	**3B**
[a]3A and 3B	350	6,365	3,100	46	0.2	0.10	0.06	1,207	1,354
						3C	**3D**	**3C**	**3D**
[b]3C and 3D	350	12,065	8,800	21	0.2	0.14	0.10	1,506	1,936
						4A	**4B**	**4A**	**4B**
[c]4A and 4B	600	8,698	3,100	64	0.2	0.08	0.04	1,847	1,975
						4C	**4D**	**4C**	**4D**
[d]4C and 4D	600	14,398	8,800	32	0.2	0.11	0.07	2,314	2,760

[a]Phosphorus mass loading rate = 0.03 kg/ha/d

[b]Phosphorus mass loading rate = 0.06 kg/ha/d

[c]Phosphorus mass loading rate = 0.02 kg/ha/d

[d]Phosphorus mass loading rate = 0.04 kg/ha/d

Where the conservative (5 meters per year) first-order removal rate was used for model predictions (Model Runs 3A, 3C, 4A, and 4C), only Run 4A produced a wetland effluent phosphorus concentration most consistent with the long-term target phosphorus loading goal of 0.1 mg/L, or less. Run 4A conservatively predicts that a 600-acre treatment wetland could polish approximately 8,700 acre-feet of recycled lake water annually, producing 3,100 acre-feet of effluent with a phosphorus concentration of 0.08 mg/L.

Where the average (10 meters per year) first-order removal rate was used for model predictions (Model Runs 3B, 3D, 4B, and 4D), all model runs produced a wetland effluent phosphorus concentration consistent with the long-term target phosphorus loading goal of 0.1 mg/L, or less. Run 4B predicts that a 600-acre treatment wetland could polish approximately 8,700 acre-feet of recycled lake water annually, producing the lowest discharge phosphorus concentration of 0.04 mg/L). That low phosphorus concentration was achieved because the treatment wetland has the largest area and a low hydraulic loading rate.

All wetland configurations modeled would incur water losses through infiltration and evapotranspiration, with the 350-acre treatment wetland losing 3,300 acre feet and the 600-acre treatment wetland losing 5,600 acre feet.

Discussion of Treatment Wetland Alternatives

The modeling analysis performed for this evaluation indicates that wetlands would be capable of removing and storing significant amounts of phosphorus from the inflow water source, whether reclaimed water or recycled lake water. Treating reclaimed water with an average phosphorus concentration of 3.0 mg/L, none of the treatment wetland options modeled appear to be capable of achieving the long-term phosphorus loading criteria of

0.50 mg/L. Only a 600-acre treatment wetland would be able to consistently meet the near-term phosphorus nutrient loading criteria of 1.0 mg/L. For a 350-acre treatment wetland to meet the near-term phosphorus loading criteria of 1.0 mg/L, supplemental phosphorus treatment would be required upstream of the wetlands, or as a polishing treatment step downstream of the wetlands. Likewise, a 600-acre treatment wetland would require supplemental phosphorus treatment to achieve the study long-term phosphorus loading criteria of 0.50 mg/L.

Recycling of the lake water through a treatment wetland would remove a relatively small fraction of the phosphorus in the lake water, but over the long term, this approach would result in a net decrease in "in-lake" phosphorus concentrations. An example of where a treatment wetland has been used to remove nutrients from a hypertrophic lake can be found in the Lake Apopka flow-way marsh in Florida (Coveney et al., 2002). In that project, water from the hypertrophic lake was diverted through a 490-acre constructed wetland. The inflow to the wetlands contains 80 µg/L to 380 µg/L total phosphorus that is mostly particulate organic phosphorus. SRP was low in the lake, but increased through the wetland due to release from wetland soils. SRP in the outflow decreased with time. Particulate phosphorus was enriched in the outflow relative to the inflow. Mass total phosphorus removal efficiencies obtained in the wetland ranged from 30 percent to 67 percent. About 80 percent of the removed phosphorus was found in wetland sediments. The first order removal efficiency for total phosphorus calculated for that project was 63 meters per year, which is substantially greater than the conservative values of 5 to 10 meters per year assumed for the Lake Elsinore treatment wetland.

Filtration Treatment Technologies

Phosphorus can be removed from reclaimed water by the addition of a chemical to form a precipitate, with the removal of the formed precipitate in a physical separation process, such as the filtration process. Either conventional granular media filtration or membranes can be used to filter the formed precipitates. Ultrafiltration membranes, with smaller pore openings, have better particulate removal characteristics than microfiltration membranes, and are often the preferred membrane technology for this application.

Both the granular media filtration process and ultrafiltration membrane process, combined with chemical addition, have demonstrated their ability to achieve extremely low phosphorus concentrations. Both treatment technologies will be capable of producing treated water that has phosphorus concentrations below the near-term and long-term phosphorus loading criteria adopted for the study.

Granular media filtration or membrane filtration are the most appropriate treatment technologies for remote treatment at Lake Elsinore. A filtration facility with chemical addition sited near the lake could serve as the primary means of phosphorus removal for the reclaimed water supplemental water source, or as a polishing process combined with a treatment wetland. In addition, a remote filtration facility could provide a means to treat in-lake water during periods when reclaimed water is not being added to the lake. In light of these flexible treatment capabilities, the following discussions will focus on a remote filtration treatment facility near Lake Elsinore.

Figure 4-2 presents a block diagram for a remote treatment system that will remove phosphorus from reclaimed water. As shown, the influent to the filtration facility will be a blend of tertiary effluent from the Eastern MWD's RRWS and the Elsinore Valley MWD's RWRF.

Table 4-5 presents a summary of the preliminary criteria used to develop conceptual-level alternatives for remote granular media filtration and membrane filtration treatment systems near Lake Elsinore. The remote treatment systems discussed will treat reclaimed water with an average total phosphorus concentration of 3.0 mg/L, and will produce a treated water for discharge to lake Elsinore with a phosphorus concentration of 0.5 mg/L, or less.

TABLE 4-5
Preliminary Design Criteria and Water Quality Goals for Remote Filtration Treatment Facility at Lake Elsinore

Parameter	Design Criteria
Temperature	> 20 degrees Celsius
Total Suspended Solids	5 mg/L
Turbidity	2 NTU (24-hr average) 5 NTU (maximum)
Initial Total Phosphorus	3 mg/L
Filtration Rate (gpm/sq. ft)	3.5 gpm/sf
Alum Feed (Filtration option)	5 - 15 mg/L
Membrane Design Flux (i.e., Zenon)	15 - 20 gfd
Membrane Loading Rate (i.e., US Filter, Ionix, Pall, etc.)	0.3- 0.4 gpm/sq. meter

mgd = million gallons per day
mg/L = milligrams per liter

To achieve the phosphorus removal performance needed to produce a treated water with a total phosphorus concentration of 0.5 mg/L, or less, the filtration process will consist of chemical precipitation followed by filtration. Phosphorus precipitation generally requires the addition of a coagulant and coagulant aid. Coagulants typically used for phosphorus precipitation are lime, alum sulfate, sodium aluminate, ferric chloride, and ferrous sulfate. Polymers are typically used as the coagulant aid. For this study, alum Sulfate will be considered the coagulant. Alum is widely used in the water filtration industry and is commercially available by numerous suppliers.

As alum reacts with the phosphate in the reclaimed water, the sulfate ion remains in solution, pH is depressed, and alkalinity is consumed. The weight ratio of alum to phosphorus is 9.6:1; however, more alum is typically required because of side reactions

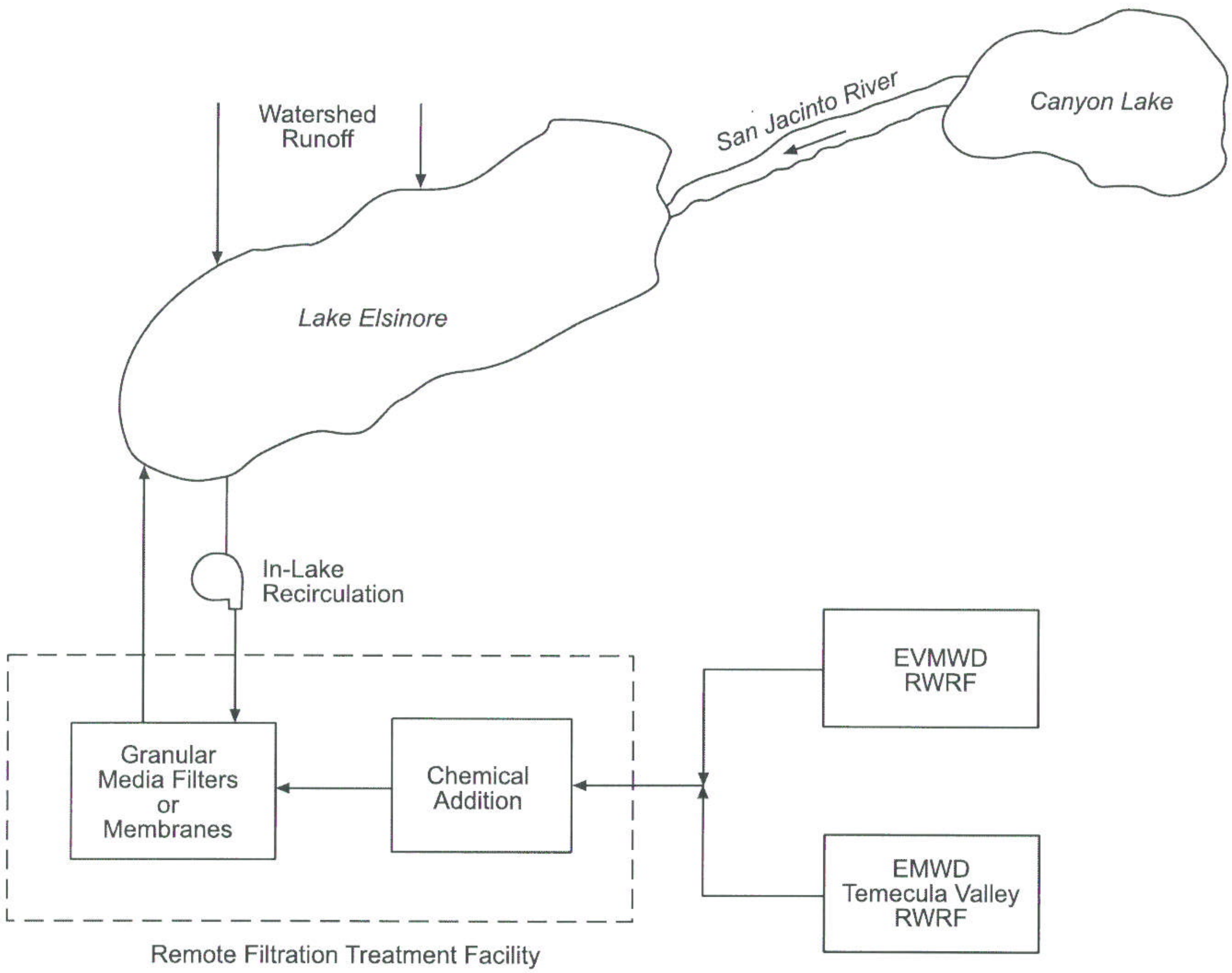


Figure 4-2
Remote Filtration Treatment Facility
Lake Elsinore Nutrient
Removal Alternatives Study

CH2MHILL

involving alkalinity and organic matter. The solubility of the aluminum phosphate also produced during this reaction is a function of pH, with the most efficient chemical usage being attained at a process pH in the range of 5.5 to 6.5. Sometimes excess alum is required to depress the pH sufficiently to reach the optimal pH range for phosphate removal. Based on the operational experience at other facilities providing phosphorus nutrient removal, the alum feed rate generally ranges from 5 mg/L to 15 mg/L.

Granular Media Filtration

Granular media filtration has been used to treat municipal wastewater in a variety of applications. Granular media filters may be classified according to the direction of flow, media type, driving force, and method of flow control. Most wastewater granular media filters are downflow units. However, there are some proprietary systems that are upflow units such as the Parkson Corporation DynaSand® Filter.

Phosphorous removal through granular media filtration may be achieved to various extents through a variety of filter configurations including dual media, single media, gravity, and pressure systems. However, most filter installations are not provided strictly for phosphorous removal. Limited data and operational experience is available for the granular media filtration process for phosphorus removal, with the exception of the DynaSand® filtration system. Thus, the discussion of the granular media filtration process will concentrate on the DynaSand® granular media filtration system, recognizing that other filters may also provide phosphorous removal.

The DynaSand® filter is a continuous-backwash, upflow, deep-bed, sand-media filter. These filters are installed at numerous wastewater plants throughout the United States, and several installations have been specifically designed for phosphorus removal. Those installations are unique in that they use dual-stage filtration units in series to accomplish the phosphorus removal treatment. The filtration media used in each stage of the filtration process has different size gradations. Combined with chemical addition pretreatment, this filtration technology has proven highly effective in achieving very low treated water phosphorus concentrations.

For phosphorus removal applications, the DynaSand® process employs continuous, contact filtration where coagulation, flocculation, and separation are performed directly within the sand bed thus eliminating the need for external flocculators and clarifiers. Based on the manufacturer’s published literature, the resultant savings in equipment costs for the DynaSand® process can be as much as 85 percent when compared to conventional filtration process equipment costs, and 50 percent when compared to direct filtration process equipment costs. In most cases, since only small floc is required for filtration, chemical dosage requirements are reduced by 20 to 30 percent compared to conventional filtration treatment. Furthermore, phosphorus removal efficiencies of 90 percent, or greater, are achievable using chemical addition followed by the dual-stage DynaSand® continuous contact filtration process.

The DynaSand® filter media is continuously cleaned by recycling the sand internally through an airlift pipe and sand washer. The cleansed sand is redistributed on top of the sand bed, allowing for continuous, uninterrupted flow of filtrate and reject (backwash) water. Since all filter beds are continuously cleaned, the pressure drop remains low and equal among the filters, assuring even inlet distribution to each filter without the need for flow control valves, splitter boxes, or backwash controls. Figure 4-3 presents a process flow schematic for the DynaSand® filtration system.

The reclaimed water will be introduced at the top of the filter and will then flow downward through an opening between the feed pipe and the airlift housing located in the center of the filter. The feed exits the bottom of the filter through a series of radials. As the influent flows upward through the moving sand bed, the solids are removed. The filtrate, or treated effluent, exits at the top of the filter via an overflow weir. Simultaneously, the sand bed, along with accumulated solids, is drawn downward into the airlift pipe. Compressed air is introduced at the bottom of the airlift, which draws sand into the airlift and scours it as it rises in the airlift. The reject slurry spills over into a central reject compartment and the sand is returned to the top of the sand bed through a washer/separator. Thus, the sand bed is continuously cleaned while a continuous flow of filtrate and reject is produced.

The construction costs for a dual-stage granular filtration treatment system generally range from $0.3 to $0.4 per gallon treated.

Major advantages and disadvantages of the DynaSand® filtration system are:

Advantages

- Achieves more efficient use of the filtration area.
- Low maintenance requirements.
- Simple operation, requiring minimal operator attention.
- More energy efficient due to low headloss across the process (less than 24 inches).
- No flow control valves, splitter boxes, or backwash controls.
- No backwash pumps and holding tanks.

Disadvantages

- Requires compressed air.
- Typically requires a filter aid, such as polymer, to enhance filterability.
- May have difficulty achieving extremely low target phosphorus levels (i.e., 0.05 mg/L).
- Hydraulic loading (filtration rate) can be limited by solids loading.
- Airlift mechanism wear and replacement are required after extended use.

Membrane Filtration Technology

There are several proprietary systems that employ membranes for tertiary wastewater treatment that have been successfully used to achieve effluent phosphorus concentrations as low as 0.04 mg/L, with the use of addition of alum. Membrane systems manufactured by US Filter, Pall, Ionics and Zenon Environmental require different systems configuration including operating pressure, cleaning, and installation requirements.

Membrane systems produce a high-quality treated water by either drawing or forcing feedwater through the membranes, which serve as the filter elements. As an example, Zenon's ZeeWeed® ultrafiltration membranes are hollow-fiber membranes with a nominal pore size of 0.035 microns, which ensures that particulate matter greater than 1 micron will not end up in the treated water. For phosphorus removal, the flow stream is pretreated with a coagulant, such as alum, and the aluminum phosphate precipitate is removed from the flow stream by the membrane fibers.

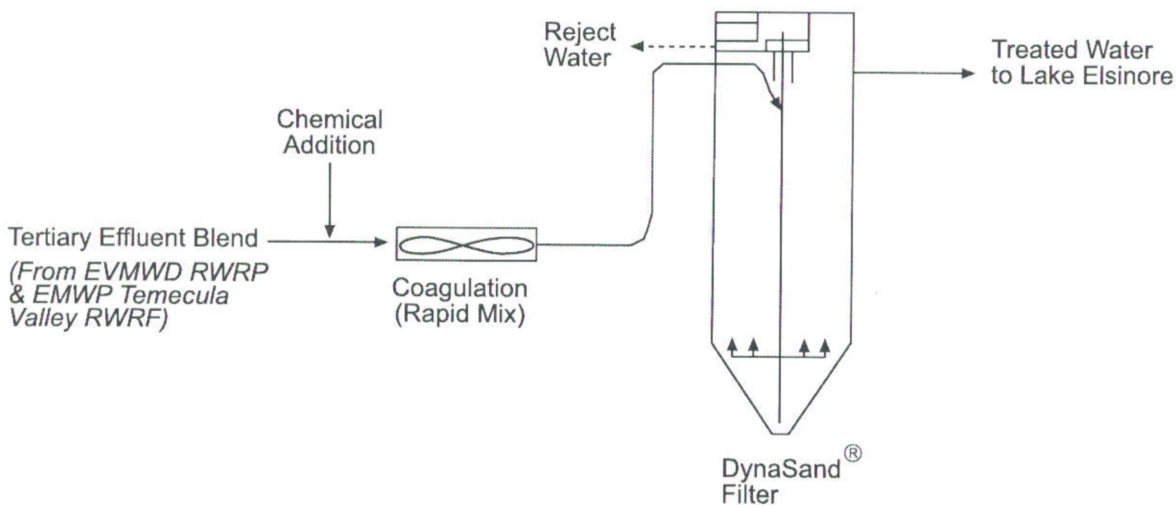


Figure 4-3
Dynasand® Process Schematic

For the ZeeWeed® system, the membranes operate under a slight vacuum created within the hollow membrane fibers using a permeate pump. This vacuum draws from the outside of the membrane to the inside of the membrane, hence the term "outside-in" membranes. The permeate pump then pumps the treated water to the desired location. Air flow is introduced at the bottom of the membrane modules to create turbulence, which scours the outside of the membrane fibers. The aeration also oxidizes organic compounds, resulting in treated water quality that is better than that provided by ultrafiltration or microfiltration membrane processes.

US Filter, Pall, and Ionics membranes operate as medium pressure systems requiring approximately 35-45 PSI inlet pressure to force the water through the membrane fibers.

Membrane treatment systems can tolerate a high concentration of solids. Depending upon the formulation of the membrane fibers they are tolerant to free chlorine or chloramines. Membranes formulated from polyvinyl chloride compounds are tolerant to free chlorine, and can be easily cleaned even if heavy fouling occurs. The chemical-cleaning frequency depends on the degree of fouling.

Major advantages and disadvantages of membrane filtration systems are:

Advantages

- Ability to operate in a high solids environment.
- Stable and low effluent particle count.
- Durable materials of construction.
- Modular expandability.
- Operational flexibility.
- Low maintenance requirements.
- System reliability even with hydraulic and solids load variations.
- Easily automated processes that reduce operator requirements.

Disadvantages

- Higher capital cost.
- Requires an operator with instrumentation and controls skills.
- Requires cleaning system.
- Requires ancillary equipment such as pumps, chemical feed systems, and chemical storage facilities.

Calcium-Sulfate Addition

Dr. Michael Anderson of the University of California Riverside completed a study that evaluated the phosphorous loading issues of Lake Elsinore titled "Evaluation of Calcium Treatment for Control of Phosphorous in Lake Elsinore." In this report he compares, in laboratory experiments, the effects Calcium Chloride ($CaCl_2$), Calcium Oxide (CaO), and Calcium Hydroxide, ($Ca[OH]_2$), agricultural gypsum and rock gypsum have on the containment of phosphorous by absorption and the suppression of phosphorous in the soils. Alkalinity and pH were also closely monitored throughout the experiments. Chemical changes attributed to the addition of a recycled water stream from the Elsinore Valley MWD regional treatment plant that would offset the evaporation of the lake were also quantified.

The series of experiments performed for the study demonstrated the capability of calcium to sorb phosphorous. The five calcium source compounds were tested for changes in pH, alkalinity, electrical conductance, dissolved Ca^{2+}, soluble-reactive phosphorus (SRP), total phosphorous and total nitrogen. Initially, the kinetic and equilibrium of the chemical reactions were tested to develop the appropriate calcium dosage and equilibrium water chemistry. Phosphorous sorption in addition to SRP flux from the lake sediments was also tested. It was found that adding Ca^{2+} to the waters of Lake Elsinore can create a dramatic change in the water chemistry. The effect varies with the five calcium source compounds. Neutral salts lowered pH and alkalinity, while leaving residual Ca^{2+}. Not surprisingly, basic salts did not have a great effect on the water's pH or alkalinity and because of this showed little promise for phosphorous treatment in Lake Elsinore. Concentrations of Ca^{2+}, regardless of source, lowered the total phosphorous and chlorophyll levels, although a Ca^{2+} dose of 200 mg/L was required to obtain 0.08 mg of phosphorous per liter and 35 micrograms (µg) of chlorophyll per liter. $CaCO_3$ provided little protection from rising levels of SRP released over time. Neither aeration nor reduced oxygen levels by nitrogen purging increased control over SRP release over time either. It is Dr. Michael Anderson's opinion that from the information obtained from the series of experiments conducted for the study, the use of calcium as a method of in-lake water treatment for phosphorous removal is not recommended.

However, there may be a benefit to adding Ca^{2+} to reclaimed water discharged to the lake to lower the total phosphorus concentration and sequester the phosphorus to minimize its release in the lake environment. Further evaluation of this application of Ca^{2+} is warranted based on the study results.

The candidate chemicals for Ca^{2+} treatment include gypsum ($CaSO_4.24H_20$), anhydrous calcium sulfate ($CaSO_4$), and lime ($Ca(OH)_2$). Approximate costs for adding gypsum to the reclaimed water at the lake site is approximately $300 per million gallon of water being treated. Lime treatment is an alternative as well, which is highly effective. However, lime treatment would require subsequent pH adjustment. Lime treatment of the reclaimed water can be categorized under chemical phosphorus removal and is best accomplished at the water reclamation facilities.

In discussions with Dr. Anderson it was asked if there are existing examples of calcium treatment in other locations. Dr. Anderson responded that he was not familiar with any and that there had been only preliminary discussion on methods of implementation by slurry at this time.

Dr. Ellie Prepas, the Canada Research Chair in Sustainable Water Management Faculty of Forestry and the Forest Environment Lakehead University has also reviewed Dr. Anderson's work. In her draft "Report on Evaluation of Potential of Calcium Treatment to Enhance Water Quality in Lake Elsinore," Prepas agrees that gypsum would provide the most appropriate source of Ca^{2+}, although she has reservations concerning the quantity of phosphorous precipitation with calcite. Her emphasis is that the phosphorous levels in the sediments should not be increased because the phosphorous in the sediments over time become increasingly more difficult to remove or suppress. Prepas also expressed concerns on the real life application of the technology without further study than laboratory experiments.

Major advantages and disadvantages of using Ca^{2+} are:

Advantages

- Effective treatment during periods of high SRP concentrations.

Disadvantages

- Water quality goals are not meet despite any of the Ca^{2+} sources tested.
- Chlorophyll removal is not significant enough to clear algae or the turbidity of the lake.
- With 30 percent recycled water, agricultural gypsum only reduced the SRP from 0.698 to 0.061 mg/L, which is still higher than the original lake level of 0.005 mg/L.
- The process appears to be able to achieve at least 90 percent removal of phosphorus in the source water. At that removal rate, the process would be capable of achieving the long-term phosphorus loading rate of 0.5 mg/L established for the study.
- More research would be required to apply this technology in a real world application than the jar testing performed in Dr. Anderson's study.

Biological Phosphorus Removal

Biological removal of phosphorus is accomplished by the luxury uptake of phosphorus by phosphorus-accumulating organisms (PAO) in excess of their synthesis requirements, when exposed to an anaerobic environment initially and to an aerobic environment subsequently. Under anaerobic conditions, the PAO transport soluble organic matter, especially volatile fatty acids (VFA) fermented by facultative bacteria, across their cell membranes and store it inside their cells, as shown in Figure 4-4. The PAO are able to do this using energy released by breaking the "high energy" bond in the polyphosphate stored in their cells and releasing soluble phosphate. When the PAO subsequently pass into the aerobic zone, oxygen is provided to allow aerobic metabolism. The PAO then oxidize the stored organic matter and generate energy that is used to take up soluble phosphate from the solution and store it as polyphosphate. The excess phosphate accumulated by these organisms is subsequently removed from the liquid treatment train through the waste activated sludge (WAS).

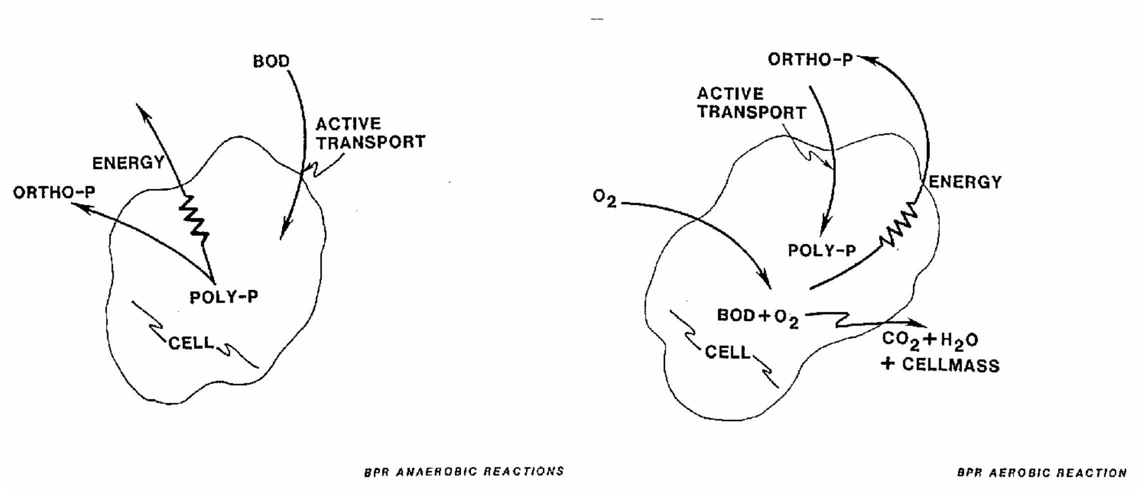


Figure 4-4
Phosphorus and Organic Matter Cycling in a Biological Phosphorus Removal System

The biological removal of phosphorus in its simplest form is an A/O™ (Anaerobic/Oxic) process, which implements the above concept as shown in Figure 4-5. The A/O™ process is a high-rate process, and is quite effective when nitrification is not required or desired.

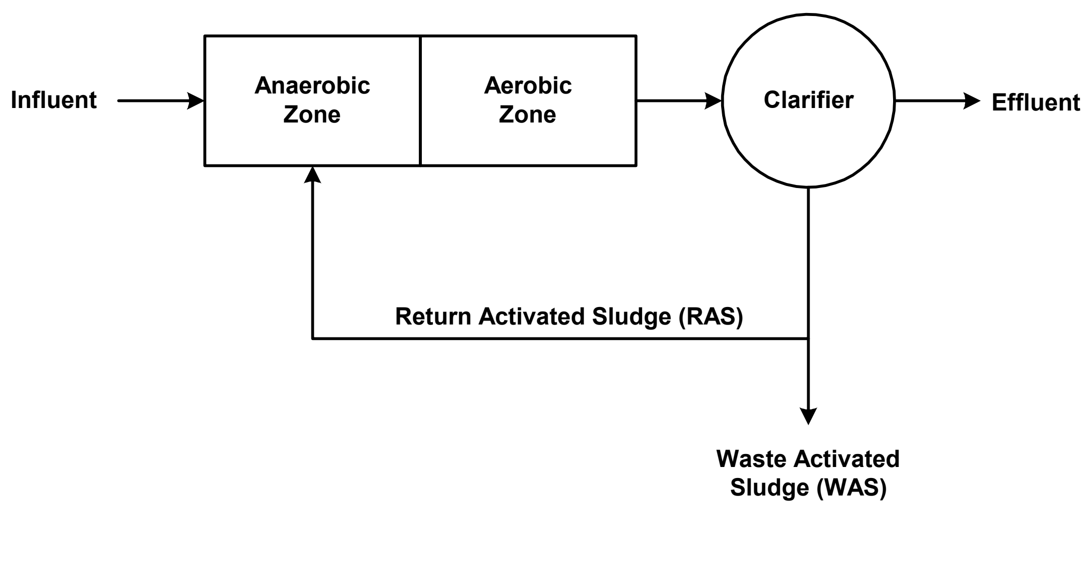


Figure 4-5
The A/O™ Biological Phosphorus Removal Process

Factors that can affect the phosphorus removal efficiency in a biological system are as follows:

- Environmental factors, such as temperature, dissolved oxygen, and pH.
- Substrate availability, especially the concentrations of VFA, as fermented by the facultative bacteria. The VFA production is directly influenced by the influent biochemical oxygen demand (BOD)/P ratio. Typically, in systems with short solids residence time (SRT), a BOD/P ratio of 20 will ensure an effluent phosphorus concentration of 1 mg/L. A BOD/P ratio of 22, or greater, may produce effluent with total phosphorus concentrations less than 1 mg/L, at treatment plants with properly operating post-secondary liquid-solid separation units. The presence of nitrate in the recycle stream has an inhibitory effect on strict anaerobes, which have to compete with the denitrifiers for the VFA in the waste stream. This hinders the efficiency of phosphorus removal in a biological system.
- Design parameters, such as system SRT, anaerobic zone detention time, and aerobic zone detention time. The minimum SRT required for phosphorus removal is approximately 1.5 and 4.3 days at 10 and 20 degrees Celsius, respectively. An anaerobic detention time of 1 to 2 hours is recommended for VFA uptake. Too high of an anaerobic detention time will result in a secondary release of phosphate, which can cause an increase in soluble phosphate in the effluent.

Existing RWRF Biological Phosphorus Removal Capabilities

The two reclaimed water supplemental water sources for Lake Elsinore are reclaimed water from the Elsinore Valley MWD RWRF and the Eastern MWD Temecula Valley RWRF. If LESJWA needs supplemental reclaimed water beyond what is produced by the Elsinore Valley MWD RWRF to maintain the lake operating water level, it will have to purchase the reclaimed water from Eastern MWD. The cost of any treatment process upgrades at the Eastern MWD Temecula Valley RWRF will be included in the reclaimed water purchase price. Because of that, the discussion of biological phosphorus removal upgrades will concentrate on only those upgrades needed at the Elsinore Valley MWD to meet the adopted study nutrient loading targets.

The Elsinore Valley MWD RWRF has two liquid treatment trains; existing Treatment Train A and new Treatment Train B. The new Treatment Train B has utilizes the Kruger BioDenipho™ process for biological phosphorus removal. Treatment Train A currently does not have biological phosphorus removal capabilities, but the District is currently favoring the installation of anaerobic zones in Train A to achieve biological phosphorus removal. The Kruger BioDenipho™ process includes an anaerobic basin followed by an oxidation ditch. Air is turned on and off alternately for nitrification and denitrification. Because, the Kruger BioDenipho™ process is a combined nitrogen and phosphorus removal process, the effectiveness of phosphorus removal is slightly compromised for the following reasons:

- Nitrate and dissolved oxygen recycled to the anaerobic zone through the returned activated sludge in the anaerobic zone.
- Longer SRT of the oxidation ditches resulting in poor phosphorus removal kinetics.

- Reduced sludge wasting due to the extended aeration process of the oxidation ditch.

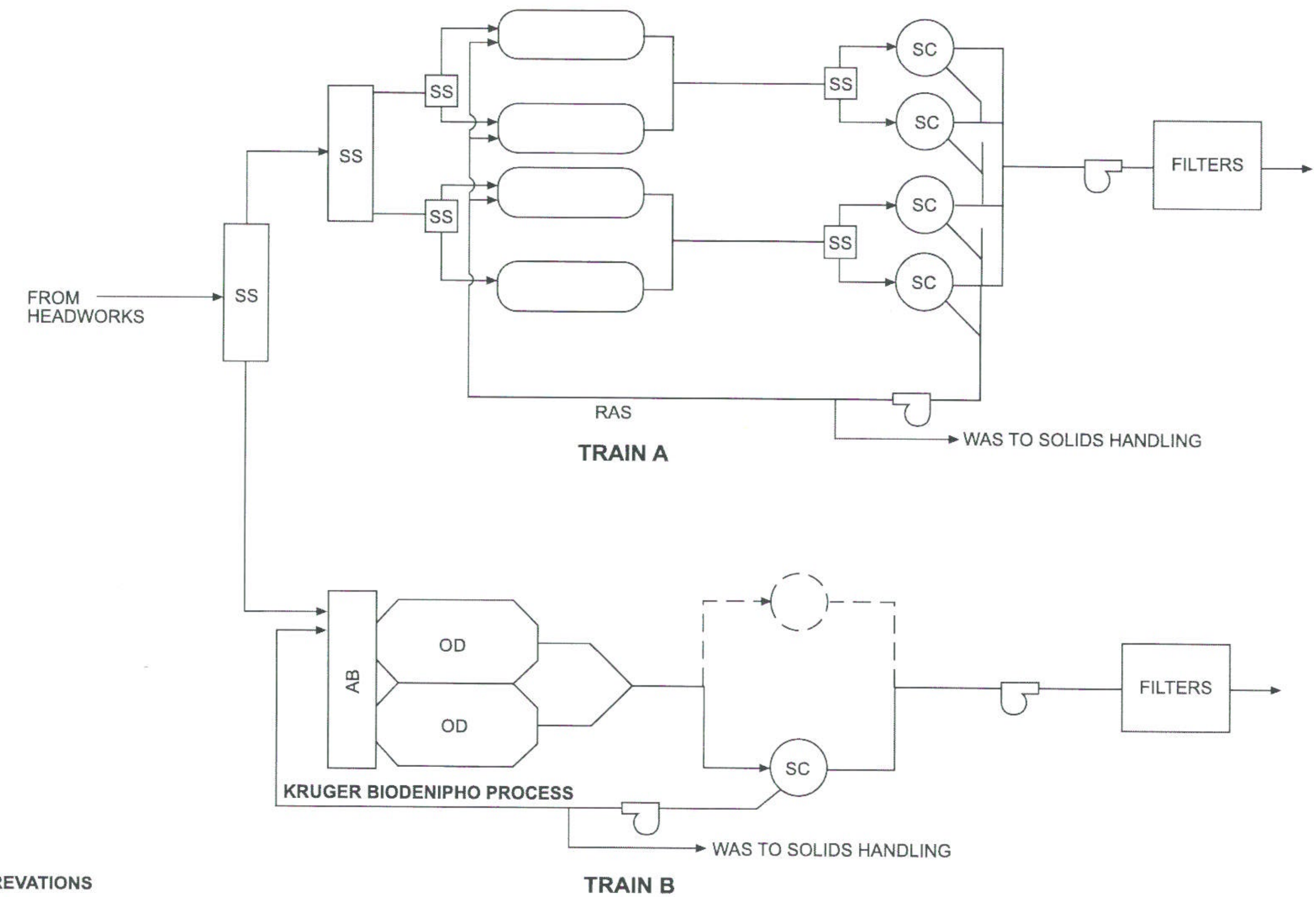
The phosphorus nutrient loading of 0.5 mg/L is achievable with a properly designed and operated biological phosphorus removal system and favorable wastewater characteristics. The process may have difficulty achieving the 0.5 mg/L nutrient loading for phosphorus established for this study if the influent wastewater to the process is highly variable. Therefore, a 1.0 mg/L phosphorus nutrient loading is more reasonable and achievable for a well-designed and well-operated biological phosphorus removal system. A realistic target for effluent phosphorus concentration will be 1 to 2 mg/L for Train B, as demonstrated by the historical operating data available for that treatment train.

Elsinore Valley MWD RWRF Biological Phosphorus Removal Improvements

The Elsinore Valley MWD RWRF is a tertiary water reclamation facility and uses oxidation ditches with phased isolation for secondary treatment and nitrogen removal. As discussed before, the RWRF has two treatment trains. New Treatment Train B utilizes the Kruger BioDenipho™ process described earlier for nutrient removal. The original Treatment Train A does not have anaerobic basins, and thus does not have nutrient removal capabilities in excess of the amount required for biomass growth. A schematic of the Elsinore Valley MWD RWRF treatment process is shown in Figure 4-6. Neither treatment train has primary clarifiers. Both treatment trains have tertiary filters. The following is a discussion of the upgrade improvements that will be required for biological phosphorus removal at the Elsinore Valley RWRF.

To achieve biological phosphorus removal, anaerobic basins will be have to be added prior to the Treatment Train A oxidation ditches. The RAS recycle will have to be rerouted to the anaerobic basins. The biological processes in both treatment trains will be able to lower the phosphorus levels to a range of 1 mg/L to 2 mg/L on a consistent basis. However, to achieve a total phosphorus concentration of 1 mg/L, or less, in the treated effluent, supplemental chemical treatment should be considered as a polishing step. In addition, provisions may need to be made to add metal salts as a standby option for phosphorus removal to meet the nutrient loading criteria established for the study during biological process upsets.

A potential method for enhancing the biological phosphorus removal is fermentation of primary sludge to generate VFA. The VFA-rich supernatant is pumped to the anaerobic basin to enhance phosphate release from the PAOs. However, the current facilities do not have provisions for primary sludge collection and disposal. This upgrade option would be very expensive. Therefore, this option should be considered for a future upgrade of the RWRF, when and if primary clarification and primary sludge-handling facilities are incorporated into the treatment process. As an alternative, the mixers in the anaerobic basins could be cycled on and off. This will help the anaerobic reactors act as settlers during the “mixer-off cycle” and generate VFA to enhance the biological removal of phosphorus. This is an inexpensive but very effective method to achieve the level of phosphorus removal needed to achieve the nutrient loading goal of the study.



ABBREVATIONS

AB - Anaerobic Basins

RAS - Return Activated Sludge

WAS - Waste Activated Sludge

CCT - Chlorine Contact Tank

OD - Oxidation Ditches

SS - Splitting Structure

SC - Secondary Clarifier

NOTE: PROCESS RELEVANT TO PHOSPHORUS REMOVAL SHOWN ONLY

Figure 4-6
Elsinore Valley MWD RWRF
Existing Plant Liquid
Treatment System Schematic

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Table 4-6 presents the sizing criteria for the required biological treatment improvements at the Elsinore Valley MWD RWRF to meet the phosphorus removal objectives. Figure 4-7 shows the location of the recommended phosphorus removal upgrades at the Elsinore Valley MWD RWRF. Because of a lack of sufficient wastewater characterization, the design criteria in Table 4-6 should be considered conceptual at this stage in the planning process, and the criteria needs further refinement as LESJWA moves forward with the recommended upgrade improvements.

Table 4-7 presents the design criteria for chemical feed facilities required to serve as standby to the biological phosphorus removal process at the Elsinore valley MWD RWRF. The criteria presented in the table is based on the use of ferric chloride for the supplemental chemical precipitation of phosphorus.

Major advantages and disadvantages of biological phosphorus removal are:

Advantages

- Inexpensive to operate.
- Simpler process control.
- Much less sludge is generated compared to chemical treatment.

Disadvantages

- Biological process alone cannot achieve an effluent phosphorus concentration of 0.5 mg/L consistently, and a post-secondary chemical polishing step needs to be provided.
- Biological processes are prone to process upsets due to variability in influent wastewater strengths. Supplemental chemical addition capability is required to ensure effluent quality goals.

TABLE 4-6
Plant Influent Characteristics and Recommended Improvements to Elsinore Valley MWD RWRF Biological Facilities (Conceptual)

Parameter Description	Elsinore Valley MWD RWRF	
	Treatment Train A	**Treatment Train B**
Flow (mgd):		
Average	4.0	4.0
Max Month (1.1 peaking factor)	4.4	4.4
Peak Hour	6.0	6.0
Influent Phosphorus Concentration (mg/L):		
Average	6.4	
90^{th} Percentile	9	
95^{th} Percentile	13	
Design Max	15	
Other Relevant Parameters:		
Average BOD_5	179	
90^{th} Percentile BOD	259	
TSS	47	
90^{th} Percentile TSS	24	
NH_3-N	20	
90^{th} Percentile NH_3-N	24	
TKN	42	
90^{th} Percentile TKN	47	
Average BOD_5/P Ratio	28	
Target Effluent Concentrations (mg/L):		
Total P short-term	1.0	
Total P long-term	0.5	
Recommended Improvements		No upgrade required
Anaerobic Basins		
Size (million gallons)	0.425	
Detention Time (Hours)	1.5	
Mixers (Days)	3	

Note: All values in the table are based on the report “Elsinore Valley Municipal Water District – Site Plan Update for Regional Wastewater facilities (August 1996)” by Montgomery Watson.

Abbreviations:

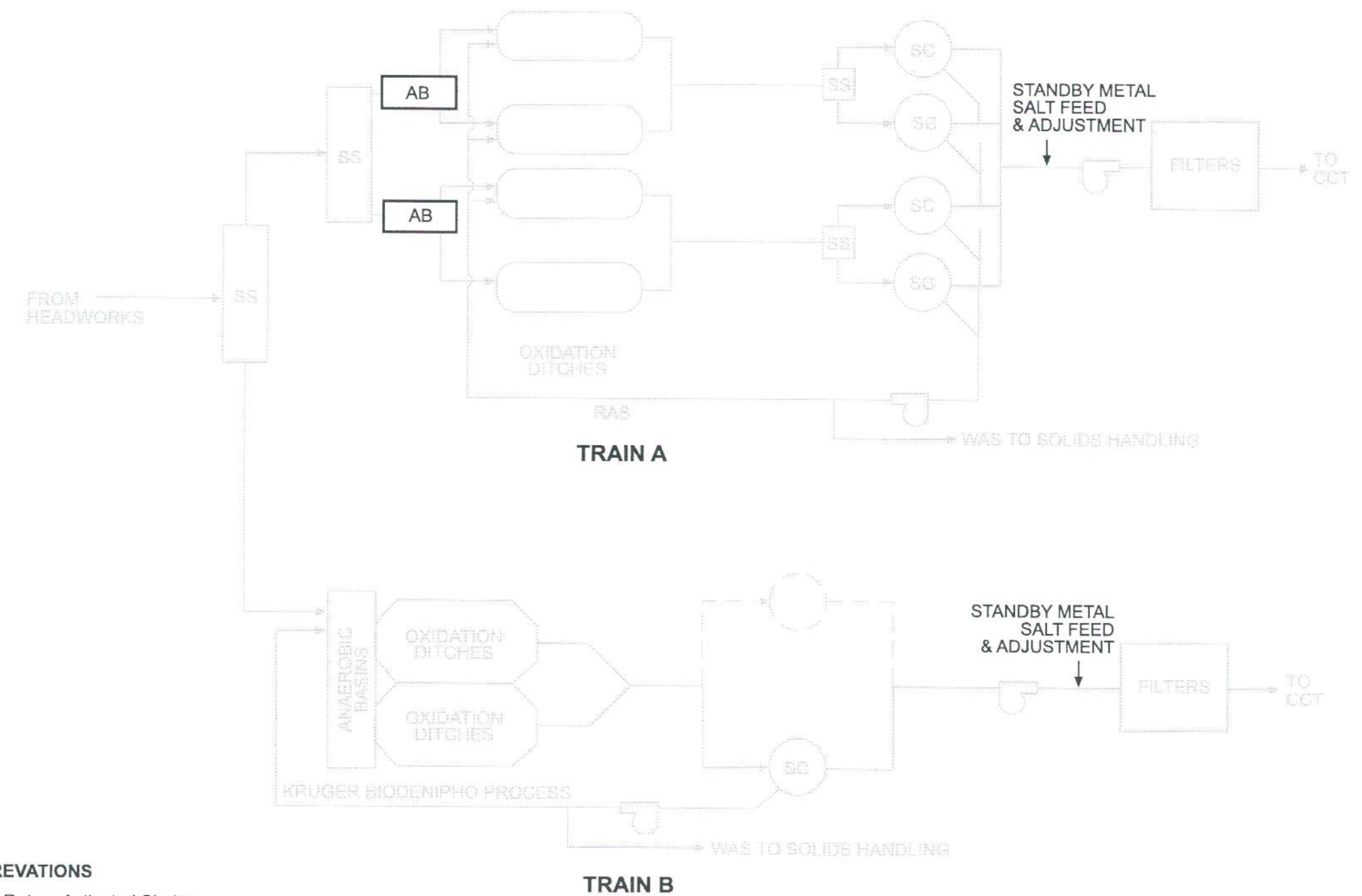
mgd = million gallons per day

mg/L = milligrams per liter

BOD = biochemical oxygen demand

TSS = total suspended solids

P = phosphorus.



ABBREVATIONS

RAS - Return Activated Sludge
WAS - Waste Activated Sludge
CCT - Chlorine Contact Tank
SS - Splitting Structure
SC - Secondary Clarifier
AB - Anaerobic Basins

Figure 4-7
Elsinore Valley MWD RWRF
Biological Phosphorus
Removal Improvements

NOTE: PROCESS RELEVANT TO PHOSPHORUS REMOVAL SHOWN ONLY

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TABLE 4-7
Design Criteria for Elsinore Valley MWD RWRF Chemical Feed Facilities

Parameter	Elsinore Valley MWD RWRF	
	Train A	**Train B**
Chemical Requirements		
Chemical	Ferric Chloride	Ferric Chloride
Solution Strength; Percent	34	34
Chemical Dosage; mg/L	5.5	5.5
Average Usage; gpd	46	46
Maximum Usage; gpd	68	68
Chemical Solids Quantity; lb/d		
Average Flow	107	107
Peak Flow	160	160
Chemical Feed Facility		
Number of Storage Tanks	1	
Capacity (each); gal	6,500	
Average Storage;d	3014	
Number of Metering Pumps	4 duty; 2 standby	

Abbreviations:

mg/L = milligrams per liter

gpd = gallons per day

gph = gallons per hour

gal = gallons d = days

Chemical Phosphorus Removal

The use of chemical treatment as a stand alone alternative for the removal of phosphorus from the wastewater at the Elsinore Valley MWD RWRF is a treatment technology that also needs to be evaluated in the study.

Phosphorus in the wastewater can be removed chemically by the addition of metal salts or lime. The primary metal salts used are aluminum-based and iron-based salts, which react with soluble orthophosphate to form an insoluble precipitate that is then removed by clarification and/or filtration. Metal salts effectively remove phosphorus within the neutral pH range, which makes this treatment method compatible with biological phosphorus removal for polishing purposes.

The most common aluminum-based salt that is used for phosphorus removal is aluminum sulfate, or alum. Sodium aluminate is sometimes used, especially in the case of low-alkaline wastewater in which use of alum can cause excessive depression of pH. Aluminum chlorohydrate and polyaluminum chloride are also used.

Iron-based salts that are typically used for chemical phosphorus treatment are ferric chloride, ferric sulfate, ferrous chloride, and ferrous sulfate. The ferrous salts are also available as a by-product of steelmaking waste pickle liquor operations. Although fairly inexpensive, the disadvantage with waste pickle liquor is that it contains large quantities of hydrochloric and sulfuric acid, which can destroy alkalinity and depress pH. Iron salts are also corrosive to plant equipment.

Lime treatment is used when a very low level of phosphorus, less than 0.2 mg/L, is desired. However, lime treatment boosts the wastewater pH significantly and requires pH control, typically through carbonation after lime treatment. Lime treatment is typically not recommended, except to achieve very low phosphorus limits, because of high maintenance requirements, high capital and operating costs, and a higher amount of sludge production.

Phosphorus levels can be reduced to 0.5 mg/L by the stoichiometric addition of chemicals. The typical dosage ratio is 1 to 5 moles of metal salts per mole of phosphorus being removed (*Wastewater Engineering Treatment and Reuse, Metcalf & Eddy*). In order to lower phosphate concentrations below 0.5 mg/L, the dosage of metal salts relative to phosphorus removal increases significantly (*Wastewater Engineering Treatment and Reuse, Metcalf & Eddy*), as several competing reactions takes place and phosphate precipitation becomes a matter of equilibrium with other metal hydroxides.

Metal salts can be added at the following locations: before primaries, at the start or end of the activated sludge basin, before secondary clarifiers, or upstream of the tertiary filters. Because, soluble orthophosphates are removed readily compared to organic or polyphosphate, chemical precipitation of phosphate after secondary treatment as a polishing step is highly effective. Typically, multiple points of addition accompanied by tertiary filtration is recommended when phosphorus concentration below 0.5 mg/L is the treatment objective. Multiple points of addition has the advantage of mass removal of phosphate at the primary clarifiers followed by effective polishing after secondary treatment.

Because the addition of metal salts depresses pH, sodium hydroxide addition as a post-treatment process for pH control is typically provided, especially in applications such as nitrification, where the alkalinity is consumed during biological reactions and the active microorganisms are sensitive to decreases in pH.

Chemical feed is typically operated proportional to the plant flow once an adequate dosage is determined. In cases where online orthophosphate monitoring is not provided, chemical dosing becomes difficult, and typically, it is dosed to neutralize the maximum anticipated phosphorus concentrations in the plant influent. This results in chemical wastage, and periodic influent sampling is recommended to minimize chemical costs. At plants where online monitoring is provided, diurnal fluctuations in influent phosphate can be better managed resulting in significant chemical savings and lower sludge processing costs.

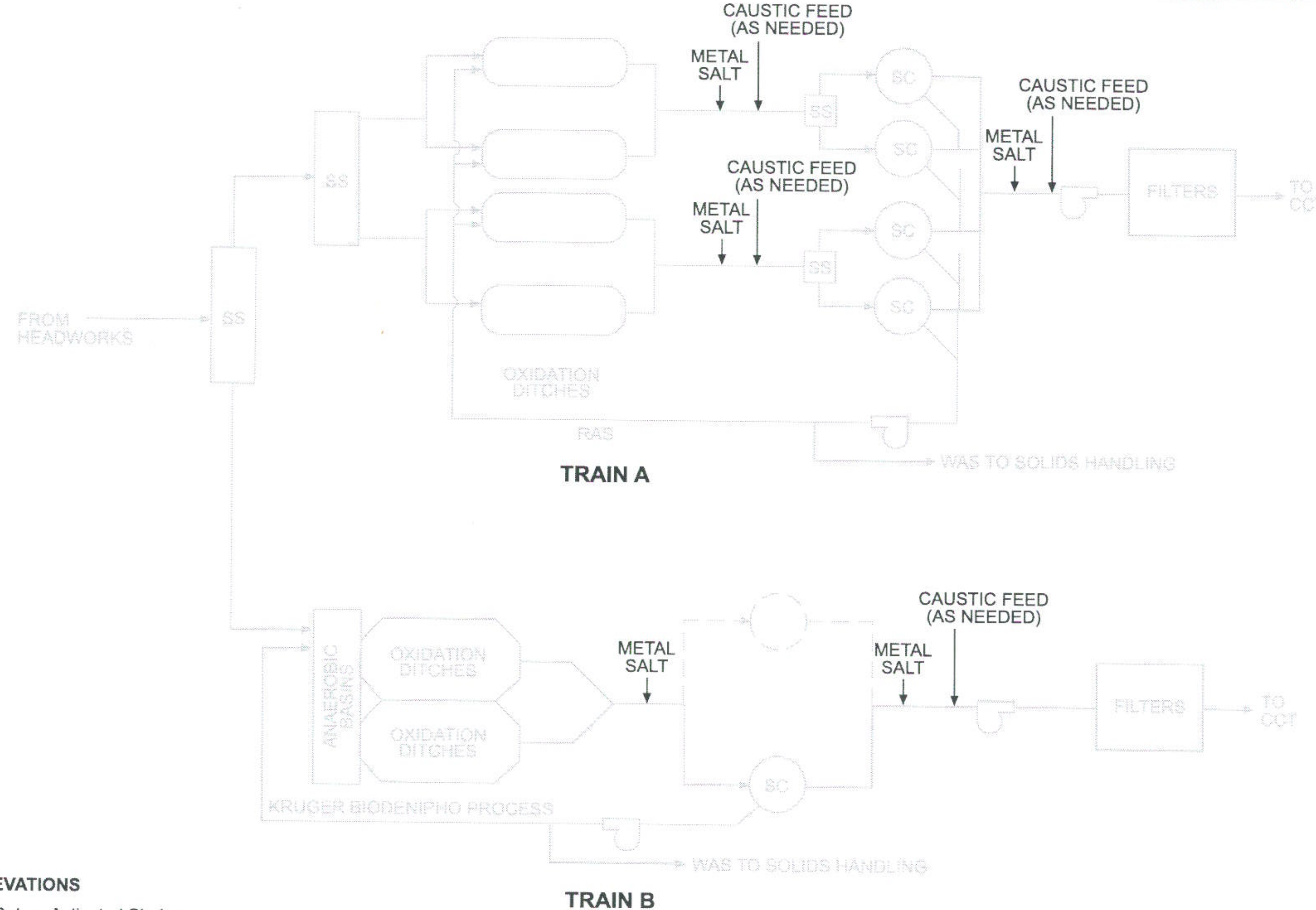
Elsinore Valley MWD RWRF Chemical Precipitation Improvements for Phosphorus Removal

A description of the treatment system at the Elsinore Valley MWD RWRF was presented in the Biological Phosphorus Removal discussion in this section. Treatment Train B has in the Elsinore Valley MWD RWRF, has biological phosphorus removal capabilities in place, with the ability to lower the effluent phosphorus to 1 to 2 mg/L. Treatment Train A currently does not have biological phosphorus removal capabilities. Elsinore Valley MWD currently favors the installation of biological phosphorus treatment for Treatment Train A to match the capabilities of Treatment Train B. An evaluation of the improvements required to implement chemical phosphorus removal to augment the existing and planned biological phosphorus removal facilities is needed.

Because the target effluent phosphorus concentration is 0.5 mg/L, multiple points of metal salts addition with tertiary filtration will be required. It is proposed that the metal salts be added both prior to and after the secondary clarifiers as shown in Figure 4-8. The addition of metal salts upstream of the biological process is not recommended because such a chemical addition can precipitate some soluble BOD and other nutrients prematurely, affecting system performance. To make a firm recommendation of the type of metal salts to be used for chemical treatment, a more detailed evaluation than this study should be considered. For this study, conceptual design criteria has been developed using ferric chloride as the metal salt, which is one of the most commonly used chemicals for phosphorus removal. The addition of sodium hydroxide for post-treatment pH control will be required.

Design Criteria

Table 4-8 presents the sizing criteria for chemical phosphorus removal facilities at the Elsinore Valley MWD RWRF. The table criteria presumes that Treatment Train A will not upgraded to provide biological phosphorus removal, and phosphorus removal will be accomplished solely through chemical addition. Accordingly, for Treatment Train A ferric chloride will be added upstream of the secondary clarification process as the primary phosphorus removal step. Ferric chloride will then be added post-secondary clarification upstream of the tertiary filters as a phosphorus removal polishing step in both Treatment Trains A and B. If biological phosphorus is added to Treatment Train A, then ferric chloride would be added post-secondary clarification in both treatment trains as described in Table 4-7.



ABBREVATIONS

RAS - Return Activated Sludge
WAS - Waste Activated Sludge
CCT - Chlorine Contact Tank
SS - Splitting Structure
SC - Secondary Clarifier

Figure 4-8
Elsinore Valley MWD RWRF
Chemical Phosphorous
Removal Improvements

NOTE: PROCESS RELEVANT TO PHOSPHORUS REMOVAL SHOWN ONLY

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TABLE 4-8
Elsinore Valley MWD RWRF Conceptual Design Criteria for Chemical Phosphorus Removal

Parameter	Elsinore Valley MWD RWRF	
	Train A	**Train B**
Flow (mgd)		
Average	4	4
Max Month (1.1 peaking factor)	4.4	4.4
Peak Hour	6	6
Influent Phosphorus Concentration (mg/L)		
Average	6.4	
90^{th} Percentile	9	
95^{th} Percentile	13	
Design Max	15	
Secondary Chemical Requirements		
Chemical	Ferric Chloride	Not Needed
Solution Strength: Percent	34	
Chemical Dosage; mg/L	26	
Average Usage; gpd	228	
Maximum Usage; gpd	19.3	
Chemical Sludge Quantity; lb/d		
Average Flow	534	
Peak Flow	801	
Post-Secondary Chemical Addition		
Chemical	Ferric Chloride	Ferric Chloride
Solution Strength; Percent	34	34
Chemical Dosage; mg/L	5.5	5.5
Average Usage; gpd	46	46
Maximum Usage; gpd	68	68
Chemical Solids Quantity; lb/d		
Average Flow	107	107
Peak Flow	160	160
Chemical Feed Facilities		
Number of Storage Tanks	2	
Capacity (each); gal	6,500	
Average Storage; d	30	
Number of Metering Pumps	2 duty; 1 standby	
Sodium Hydroxide Feed Facilities (pH Control)		
Number of Storage Tanks	1	
Number of Metering Pumps	2	

Abbreviations:

mg/L = milligrams per liter

gph = gallons per hour

d = day gal = gallons

Major advantages and disadvantages of chemical phosphorus removal are:

Advantages

- Reliable, well-documented phosphorus removal technique. Most popular process used in the United States.
- Chemical costs can be reduced substantially if waste pickle liquors are available and can be used, and online phosphate monitoring is implemented.
- Controls required for phosphorus removal are fairly simple and straight forward.
- Relatively easy and inexpensive to install at existing facilities.
- Can easily be coupled with biological phosphorus removal process to polish effluent phosphorus levels or ensure compliance during periods of process upset.
- Iron addition can also reduce hydrogen sulfide levels in raw sewage and in anaerobic digesters.
- Can achieve low-effluent phosphorus concentrations, especially below 0.5 mg/L.

Disadvantages

- Chemical costs are higher than for biological phosphorus removal systems, which use chemical treatment only as a standby/backup system.
- Significantly more chemical sludge will be produced compared to that for a biological phosphorus removal alternative. May overload existing liquid sludge handling facilities. Higher sludge treatment and disposal costs.
- Sludge produced generally does not dewater as well or as easily as conventional wastewater sludges.
- Chemicals used can be corrosive to process equipment and structures.

Treatment Technology Cost Comparison

Table 4-9 presents a summary of the expected range of capital costs and annual O&M costs for the treatment technologies discussed for phosphorus removal. The costs presented in the table represent general costs that reflect a wide variety of installations and treatment applications, and are not specific to this project application. The next step in the study is to evaluate treatment alternatives, which will define the facility requirements in greater detail and refine the costs. The capital costs include construction costs, engineering costs and project administration and financing costs. The annual O&M costs include labor, chemicals, power, equipment replacement costs and incidental costs.

TABLE 4-9
Treatment Technology Capital and Annual O&M Cost Summary

Treatment Technology	Capital Cost ($/Gal/Day)	Annual O&M Cost ($/1000 Gal)
Treatment or Littoral Wetlands	$2.50 - $6.35	$0.10 - $0.35
Remote Granular Media Filtration	$0.35 - $0.60	$0.05 - $0.15
Remote Membrane Filtration	$0.55 - $0.85	$0.15 - $0.30
Calcium Treatment	$0.10 - $0.20	$0.20 - $0.50
Chemical Phosphorus Treatment at Local RWRF	$0.05 - $0.15	$0.15 - $0.35
Biological Phosphorus Treatment at Local RWRF	$0.25 - $0.50	$0.10 -$0.20

PROJECT ALTERNATIVES

Section 5: Project Alternatives

Introduction

The phosphorus removal treatment system information developed in Section 4 served as the basis for the development of the project alternatives described in this section of the report. A total of eight project alternatives were developed for evaluation, with five of those alternatives having sub alternatives. Alternative 1, involving phosphorus treatment at the Elsinore Valley MWD RWRF and the Eastern MWD RWRF, has Alternative 1A and Alternative 1B that evaluate chemical and biological phosphorus treatment upgrades at the two RWRFs, respectively. Alternative 2 has two sub alternatives. Alternative 2A evaluates the use of the chemical phosphorus upgrades at the Elsinore Valley MWD RWRF, treatment wetland and remote granular media filtration to treat reclaimed water and lake water recycled through the remote treatment system. Alternative 2B evaluates the use of chemical phosphorus upgrades at the Elsinore Valley MWD RWRF and treatment wetland to treat the reclaimed water, with the treatment wetland treating the recycled lake water. Alternative 3 has two sub alternatives. Alternative 3A evaluates the use of a 600-acre treatment wetland to treat reclaimed water from the two sources, and recycled lake water. Alternative 3B evaluates the use of chemical phosphorus upgrades at the Elsinore Valley MWD RWRF and the 600-acre treatment wetland to treat the reclaimed water, with the treatment wetland treating the recycled lake water. Alternative 5 is composed of two sub alternatives that evaluate chemical coagulation and filtration for phosphorus removal treatment. Alternative 5A evaluates a remote dual-stage granular media filtration system sited at the Elsinore Valley MWD RWRF. Alternative 5B evaluates a remote membrane treatment system sited in the vicinity of Lake Elsinore. Alternative 8 also has two sub alternatives that include wetland treatment of the lake water and chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF. Alternative 8A includes an additional remote granular media filtration system in the vicinity of Wasson Sill to treat reclaimed water from the Eastern MWD RRWS. Alternative 8B includes the purchase of imported water in lieu of constructing the remote treatment system at the Wasson Sill. Overall, a total of thirteen project alternatives and sub alternatives (alternatives) were developed for evaluation.

The phosphorus treatment and supplemental water components and supplemental water requirements of each of the project alternatives and sub alternatives will first be described. Following that, the conceptual layout of the facilities required for each of the alternatives will be described, including facility siting locations and pipeline alignments. The section will conclude with estimates of the phosphorus removed annually by each alternative, as well as estimates of the annual phosphorus load to Lake Elsinore, based on available water quality data.

Project Alternatives

A total of thirteen project alternatives have been developed for evaluation, involving the different combinations of the treatment technologies being considered to achieve the study phosphorus nutrient loading criteria. Table 5-1 presents a list of the study alternatives.

Project Alternative Treatment Technologies and Supplemental Water Requirements

The following are descriptions of the supplemental water components and supplemental water requirements for each of the study alternatives for the long-term average and worst-case drought supplemental water conditions described in Section 3.

TABLE 5-1
Project Alternative List

Alternative 1A:	Chemical Phosphorus Treatment at RWRFs (Elsinore Valley MWD RWRF and Eastern MWD RWRF)
Alternative 1B:	Biological Phosphorus Treatment at RWRFs (Elsinore Valley MWD RWRF and Eastern MWD RWRF)
Alternative 2A:	350-Acre Back Basin Treatment Wetland
Alternative 2B:	Elsinore Valley MWD RWRF Chemical Phosphorus Treatment and 350-Acre Back Basin Treatment Wetland
Alternative 3A:	600-Acre Back Basin Treatment Wetland
Alternative 3B:	Elsinore Valley MWD RWRF Chemical Phosphorus Treatment and 600-Acre Back Basin Treatment Wetland
Alternative 4:	350-Acre Littoral Treatment Wetland
Alternative 5A:	Remote Treatment at Elsinore Valley MWD RWRF
Alternative 5B:	Remote Treatment at Lake Elsinore
Alternative 6:	Calcium Treatment at Lake Elsinore
Alternative 7:	Imported Water
Alternative 8A:	Chemical Phosphorus Treatment at Elsinore Valley MWD RWRF, Imported Water and 107-Acre Treatment Wetland
Alternative 8B:	Chemical Phosphorus Treatment at Elsinore Valley MWD RWRF, Remote Granular Filtration and 107-Acre Treatment Wetland

Alternative 1A: Chemical Phosphorus Treatment at RWRFs

Figure 5-1 presents the flow schematic for Alternative 1A. Phosphorus removal treatment for this alternative will be achieved through the construction of new chemical phosphorus removal upgrades at the Elsinore Valley MWD RWRF. If additional reclaimed water is needed beyond the amount of reclaimed water produced by the Elsinore Valley MWD RWRF, it will be purchased from Eastern MWD. The reclaimed water for this alternative from Eastern MWD will be produced by their Temecula Valley RWRF and delivered through their planned Temescal Valley RWRF Effluent Pipeline. The Temescal Valley RWRF will be upgraded by Eastern MWD to achieve the short-term and long-term phosphorus loading targets of 1.0 mg/L and 0.5 mg/L, respectively. The costs (amortized

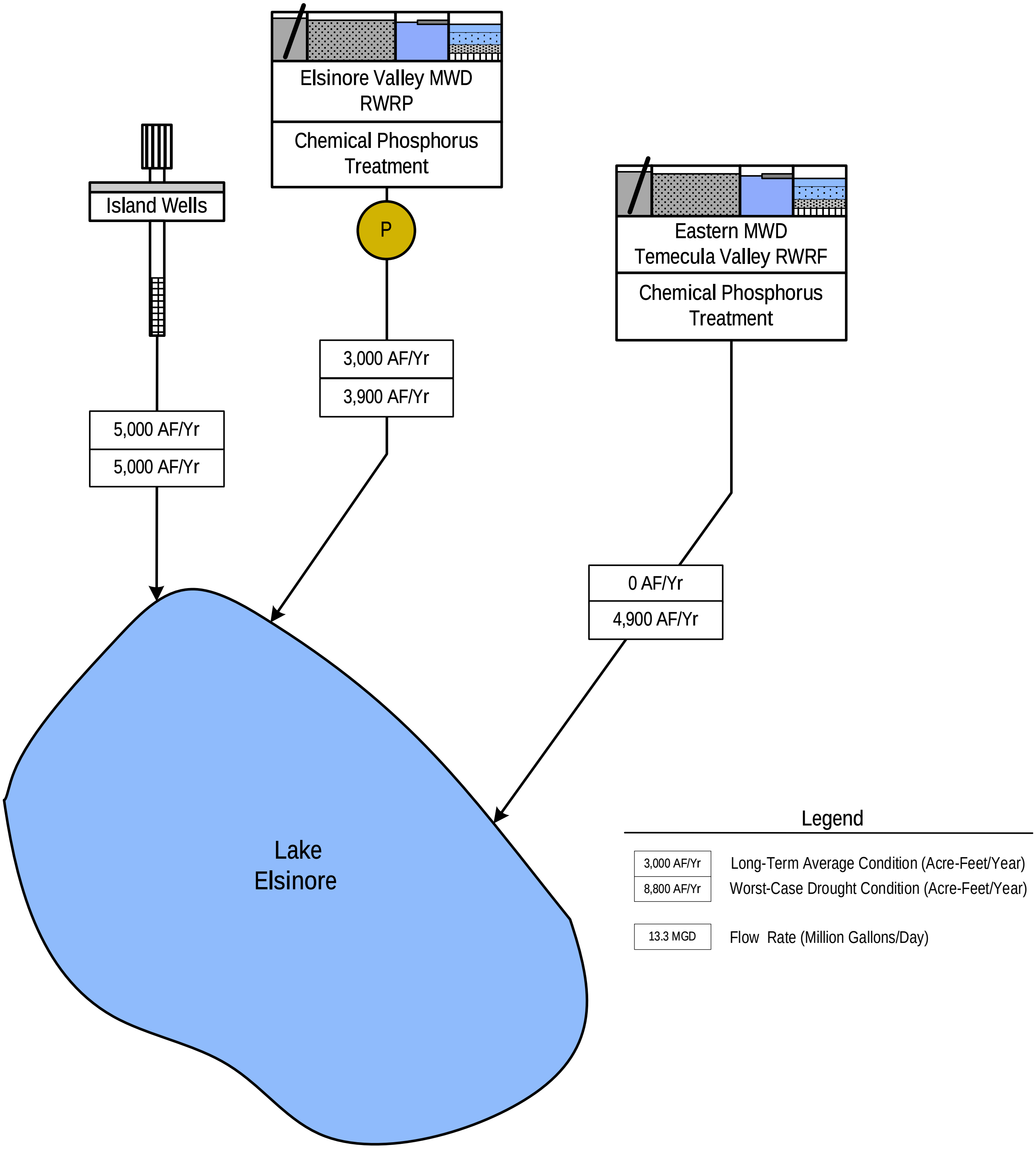

Figure 5-1
Alternative 1A Flow Schematic

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capital and annual O&M costs) for the Temescal Valley RWRF treatment process upgrades will be borne by Eastern MWD, and will be recovered by Eastern MWD through the purchase price for their reclaimed water.

For the long-term average supplemental water condition, 5,000 acre-feet of local groundwater will be pumped from the three existing Island Wells from the Lake Elsinore Basin that underlies Lake Elsinore. The extracted high-quality groundwater will not require treatment, and will be discharged directly into the lake. The Elsinore Valley MWD RWRF has a treatment capacity of 8.0 mgd, or 8,960 acre-feet per year. At this time, the service area produces about 4.0 mgd of reclaimed water (treated effluent), or 4,480 acre-feet per year of reclaimed water. Of that current annual reclaimed water production, about 0.5 mgd, or 580 acre-feet per year, is dedicated to other discharges. The remainder of the Elsinore Valley MWD RWRF annual reclaimed water production of 3,900 acre-feet per year is therefore available as a supplemental water source for Lake Elsinore. Three thousand acre-feet of reclaimed water from Elsinore Valley MWD's RWRF will be sufficient to make up the balance of the 8,000 acre-feet of supplemental water needed each year for the long-term average supplemental water condition. No additional reclaimed water will be needed from the Eastern MWD RRWS.

For the worst-case drought condition, 5,000 acre-feet of local groundwater from the three Island Wells will be pumped and discharged into Lake Elsinore. In addition, the total current reclaimed water production from the Elsinore Valley MWD RWRF of 3,900 acre-feet per year will be conveyed to the lake. An additional 4,900 acre-feet per year of reclaimed water will have to be obtained from the Eastern MWD Temecula Valley RWRF when it is available during the five-month winter period to provide the remainder of the required 13,800 acre-feet per year of supplemental water. At the current Temecula Valley RWRF wastewater flow rates only about 4,030 acre-feet of reclaimed water would be available as a supplemental water source. An additional 870 acre-feet of reclaimed water will have to be obtained from the Eastern MWD RRWS. Since that reclaimed water will not receive the same level of phosphorus removal treatment, supplemental water from Eastern MWD's RRWS should only be obtained when it is absolutely necessary to maintain the lake operating water elevation within the desired elevation range.

Alternative 1B: Biological Phosphorus Treatment at RWRFs

Figure 5-2 presents the flow schematic for Alternative 1B. Phosphorus treatment for this alternative will be achieved through construction of new biological phosphorus treatment upgrades at the Elsinore Valley MWD RWRF. If additional reclaimed water is required, it will be purchased from the Eastern MWD. Like in Alternative A, Eastern MWD will recover the costs associated with biological treatment upgrades at their Temecula Valley RWRF through the purchase price of the reclaimed water. It is assumed that the reclaimed water from the Eastern MWD system will be produced by the Temecula Valley RWRF, and will be delivered to Lake Elsinore through their new Temecula Valley Pipeline.

The supplemental water source requirements for this alternative for the long-term average and worst-case drought supplemental water conditions will be the same as those previously described for Alternative 1A.

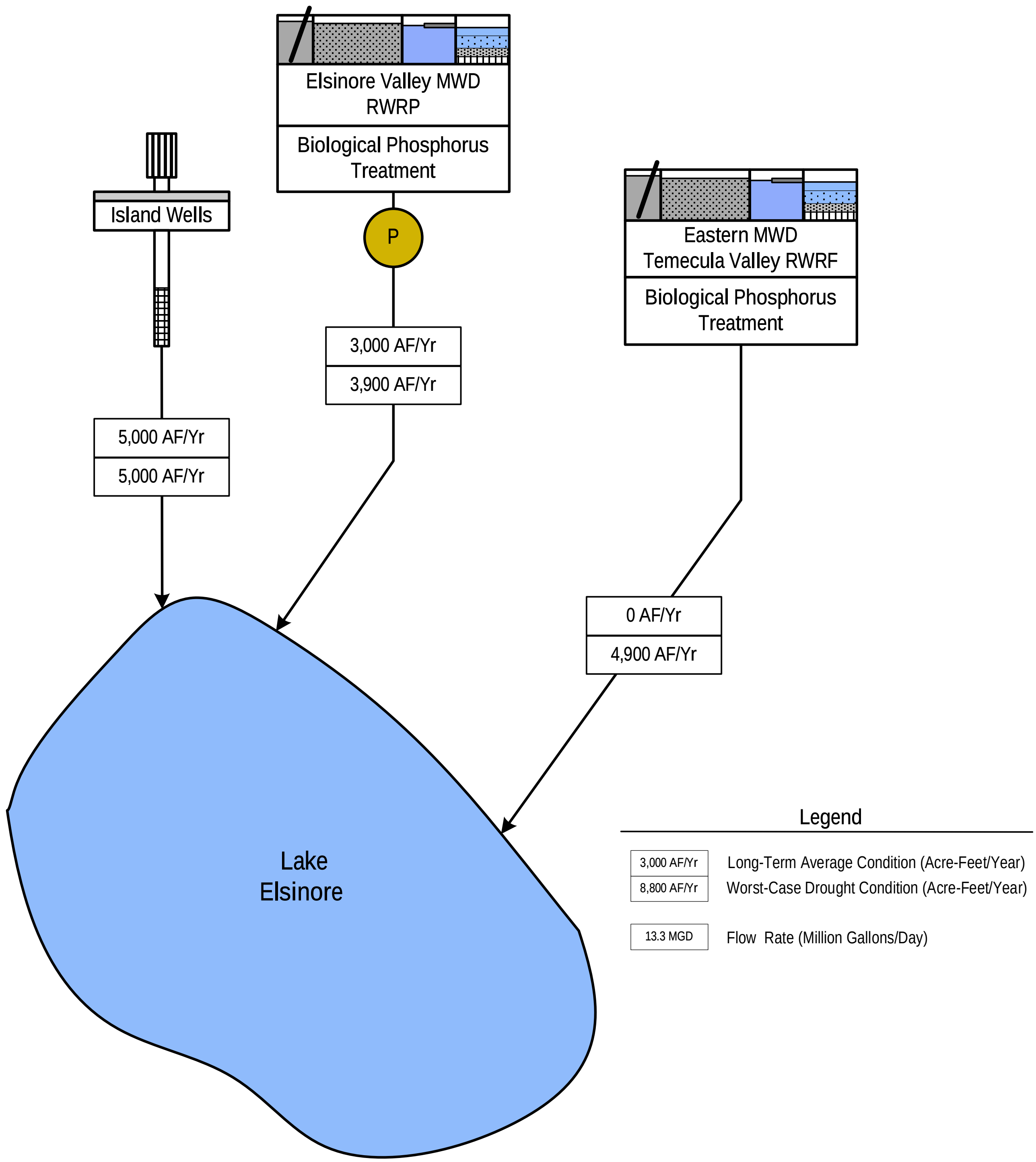

Figure 5-2
Alternative 1B Flow Schematic

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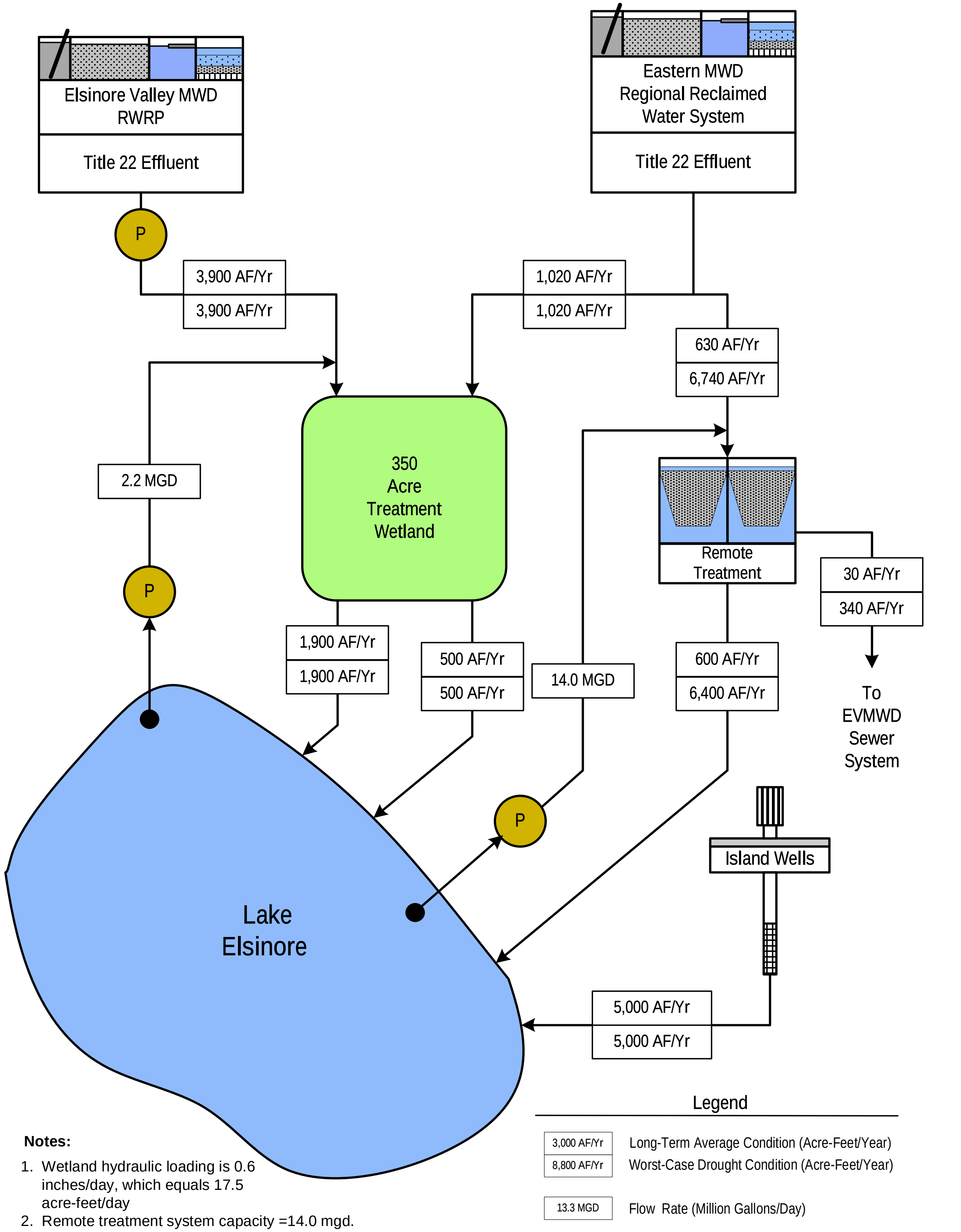
Alternative 2A: 350-Back Basin Treatment Wetland

Figure 5-3 presents the flow schematic for Alternative 2A. The existing 356-acre Back Basin Wetland will be converted into a 350-acre treatment wetland that will serve as the primary phosphorus treatment system for this alternative. The natural removal of phosphorus in the wetland will be through biological uptake and recycling by plants and microbial communities within the wetland, chemical adsorption to sediments, precipitation from the water column, and physical settling, burial and decomposition of organic and inorganic matter within the wetland sediments. This natural approach to removing phosphorus from the reclaimed water for lake level maintenance will enhance the existing natural habitat within the vicinity of the Lake Elsinore and provide a significant community amenity for passive outdoor recreation and environmental education.

Under the long-term average supplemental water condition, the wetland will treat reclaimed water from two sources; the Elsinore Valley MWD RWRF (3,900 acre-feet per year) and the Eastern MWD RRWS (1,020 acre-feet per year). The Elsinore Valley MWD reclaimed water will be supplied at a consistent rate of 10.7 acre-feet per day throughout the entire year, while the Eastern MWD reclaimed water will be available at a consistent rate of 6.8 acre-feet per day during the period from November through March. Due to this seasonal availability of reclaimed water and high evaporative losses during the hot and dry summer months, a lake water recycle system with a minimum pumping capacity of 2.2 mgd (6.8 acre-feet per day) will be needed to keep the wetland in an optimum operating condition, while providing additional water quality improvement of the lake water.

Table 5-2 summarizes the monthly reclaimed water flows to the treatment wetland, and the expected phosphorus removal performance at the indicated hydraulic and mass loading rates. The phosphorus removal performance is based on an average phosphorus removal rate of 10 m/yr, hydraulic loading rate of 0.6 inches per day (17.5 acre-feet per day), and influent phosphorus concentration of 3.0 mg/L for reclaimed water and 0.2 mg/L for recycled lake water. The estimated total mass of phosphorus removal from all flows applied to the treatment wetland will be about 15,990 kilograms, or about 35,000 pounds per year.



Notes:

1. Wetland hydraulic loading is 0.6 inches/day, which equals 17.5 acre-feet/day
2. Remote treatment system capacity =14.0 mgd.

Figure 5-3
Alternative 2A Flow Schematic

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TABLE 5-2
350-Acre Wetland Phosphorous Removal for WWTP Effluent and Recycled Lake Water

Month	[a]EVMWD Inflow (ac-ft)	[a]EMWD Inflow (ac-ft)	[b]Lake Recycle (ac-ft)	Influent (mg TP/L)	Mass Loading (kg/ha/d)	[c]Outflow (ac-ft)	HLR (in/d)	HRT (d)	[d]Effluent (mg TP/L)	Mass Removal (kg TP)
Jan	331	209	0	3.0	0.46	430	0.6	38	0.7	1,644
Feb	299	189	0	3.0	0.46	376	0.6	39	0.6	1,530
Mar	331	209	0	3.0	0.46	377	0.6	40	0.7	1,688
Apr	321	0	203	1.9	0.29	297	0.6	44	0.4	1,083
May	331	0	209	1.9	0.29	280	0.6	45	0.4	1,127
Jun	321	0	203	1.9	0.29	237	0.6	47	0.4	1,115
Jul	331	0	209	1.9	0.29	238	0.6	48	0.4	1,152
Aug	331	0	209	1.9	0.29	245	0.6	47	0.4	1,148
Sep	321	0	203	1.9	0.29	279	0.6	45	0.4	1,092
Oct	331	0	209	1.9	0.29	326	0.6	43	0.4	1,100
Nov	321	203	0	3.0	0.46	360	0.6	41	0.7	1,646
Dec	331	209	0	3.0	0.46	401	0.6	39	0.7	1,665
Annual	3,900	1,020	1,445			3,845				15,991

[a]Influent = 3.0 mg TP/L
[b]Influent = 0.2 mg TP/L
[c]Infiltration Rate = 3.4E-06 cm/s
[d]First-order removal rate (k) = 10 m/yr

EVMWD = Elsinore Valley Municipal Water District
EMWD = Eastern Municipal Water District
HLR = Hydraulic Loading Rate
HRT = Hydraulic Residence Time

Phosphorus removal within the treatment wetland is a function of the hydraulic loading rate, or the amount of water added to the wetland each day, and the inflow concentration or mass loading. With an estimated average phosphorus removal rate of 10 meters per year, a hydraulic loading rate of 0.6 inches per day (17.5 acre-feet per day), and an influent phosphorus concentration of 3 mg/L for reclaimed water and 0.2 mg/L for lake water, treatment wetland performance models predicted an effluent phosphorus concentration of about 0.7 mg/L during the winter months and 0.4 mg/L during the summer months, as shown in the table. Those predicted effluent phosphorus concentrations are less than the near-term phosphorus loading objective for Lake Elsinore that has been adopted for the study of 1.0 mg/L, a the long-term phosphorus loading objective of 0.5 mg/L during the summer months. The annual application of reclaimed water to the wetland will total 4,920 acre-feet per year for the worst-case drought supplemental water condition. Because of water loss by evapotranspiration and infiltration, the maximum treated effluent flow from the wetland will be limited to about 2,400 acre-feet, or about 49 percent of the influent flow into the wetland.

The long-term average supplemental water requirement for Lake Elsinore is established at 8,000 acre-feet per year. To achieve this requirement under this alternative, 5,000 acre-feet of local groundwater will be pumped by the three Island Wells and discharged directly into Lake Elsinore, and 2,400 acre-feet of treated water discharged from the 350-acre wetland into Lake Elsinore. Based on the conservative water loss (evapotranspiration and infiltration) assumptions used in the wetland modeling, an additional 600 acre-feet per year of reclaimed water will have to be discharged into the lake to achieve the required 8,000 acre-feet per year for the long-term average supplemental water condition. However, actual water losses from the constructed wetland may be less, and the treatment wetland water quality performance may exceed the model predictions, thereby allowing additional reclaimed water to be applied to the wetland.

As an alternate method to make up the supplemental water deficiency of 600 acre-feet per year, a remote treatment system will be needed in parallel with the treatment wetland to provide the required supplemental water volume. The remote treatment system will consist of chemical addition, followed by granular-media filtration. For the purpose of the study, it has been assumed that the granular filtration process will be a two-stage granular media filtration process, similar to the DynaSand® process. An additional 630 acre-feet per year of reclaimed water from the Eastern MWD RRWS will receive treatment in the remote treatment system to yield the 600 acre-feet of treated water needed. The 30 acre-foot per year water loss represents a five percent waste backwash loss that has been assumed for the two-stage granular media filtration process. The waste backwash water will be discharged to the Elsinore Valley MWD sewer system for treatment and disposal.

The worst-case drought condition supplemental water requirement for Lake Elsinore is 13,800 acre-feet per year. Five-thousand (5,000) acre-feet of local groundwater will be pumped from the three Island Wells and discharged directly to Lake Elsinore. In addition to local groundwater, 4,920 acre-feet per year of reclaimed water will be obtained from the Elsinore Valley MWD and Eastern MWD systems and will be conveyed to the treatment wetland for treatment, which will produce 2,400 acre-feet of treated effluent. Up to 6,740 acre-feet per year of reclaimed water will be obtained from the Eastern MWD RRWS, and will be conveyed to the remote treatment system for treatment, resulting in 6,400 acre-feet per year of treated effluent. The waste backwash water loss of up to 340 acre-feet per year from the filtration process will be discharged to the Elsinore Valley MWD sewer system for treatment and disposal.

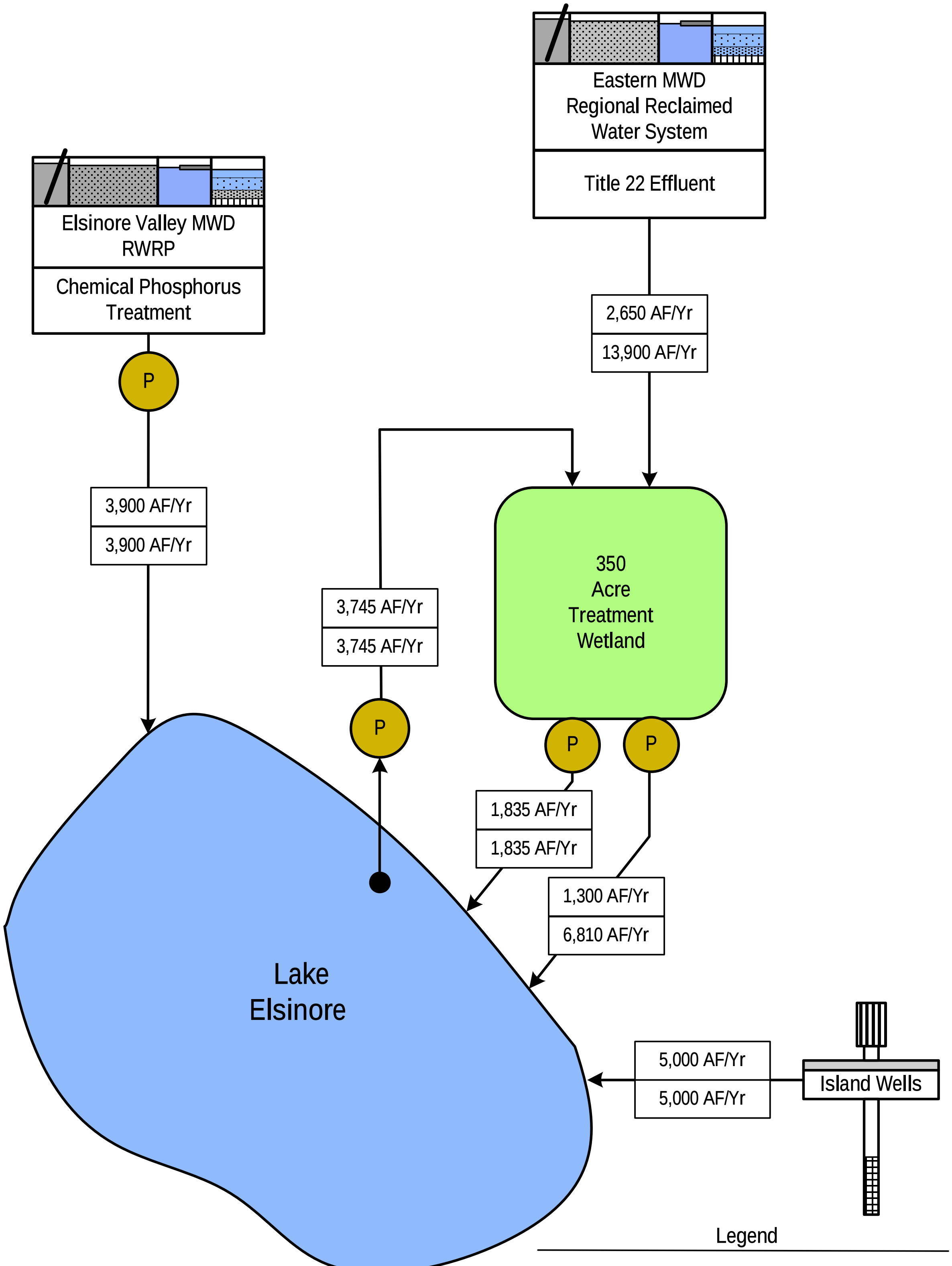
The remote treatment system has been sized to handle the reclaimed water flows for the worst-case drought condition as outlined above. The remote treatment system therefore, has a maximum treatment capacity of 14.0 mgd, or 42.9 acre-feet per day. The remote treatment system thus has the capability to produce more than the 6,400 acre-feet per year of treated water within the 151 day five-month winter period (November through March) to achieve the worst-case drought supplemental water condition. Since the remote treatment system will be primarily used to treat reclaimed water from the Eastern MWD RRWS, the total facility treatment capacity will be available during most the remaining seven month period to treat lake water recycled through the system.

Alternative 2B: Elsinore Valley MWD RWRF Chemical Phosphorus Treatment and 350-Acre Back Basin Treatment Wetland

The flow schematic for Alternative 2B is shown in Figure 5-4. Phosphorus treatment for this alternative will be provided by the construction of new chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF, and conversion of the existing Back Basin Wetland to a 350-acre treatment wetland.

For the long-term average supplemental water condition, up to 5,000 acre-feet per year of local groundwater will be pumped from the three existing Island Wells and discharged directly into Lake Elsinore. The new chemical addition upgrades at the Elsinore Valley MWD RWRF will provide phosphorus treatment, and will produce up to 3,900 acre-feet per year of supplemental water that will be discharged directly to Lake Elsinore for the long-term average supplemental water condition. Under long-term average supplemental water conditions, the treatment wetlands will be used to treat Lake Elsinore water since the supplemental water requirement can be satisfied by groundwater production from the Island Wells and reclaimed water production from the Elsinore Valley MWD RWRF. The treatment wetland will be operated at a hydraulic loading rate of 0.6 inches per day. Phosphorus removal performance will thus be the same as that predicted for Alternative 2A. To achieve that hydraulic loading objective, up to 3,745 acre-feet of lake water will be circulated through the treatment wetland, and up to 2,650 acre-feet of reclaimed water from the Eastern MWD RRWS will be treated through the treatment wetland, which will add 1,300 acre-feet of supplemental water to the lake. That volume of supplemental water will be more than adequate to offset the treatment wetland water losses. The lake water will be circulated through the treatment wetland during the 214 days when reclaimed water is not available from Eastern MWD. The reclaimed water from Eastern MWD will be treated through the treatment wetlands during the 151-day period during the winter months when it will be available for purchase. The lake water recycle pump station pumping capacity will be 5.7 mgd (17.5 acre-feet per day) to keep the wetland in an optimum operating condition, while providing additional water quality improvement of the lake water.

For the worst-case supplemental water condition, again up to 5,000 acre-feet of local groundwater will be pumped from the three existing Island Wells and discharged directly into the lake. Up to 3,900 acre-feet of treated effluent will be produced by the Elsinore Valley MWD RWRF, and discharged directly into Lake Elsinore. Up to 13,900 acre-feet of reclaimed water from the Eastern MWD RRWS will be treated in the treatment wetland, which will produce a discharge of 6,810 acre-feet per year into the lake over the 151 day period when the reclaimed water will be available from Eastern MWD. The 5.7 mgd lake water recycle system will be used to keep the wetland in an optimum operating condition, while providing additional water quality improvement of the lake water during the 214 days that reclaimed water is not available from Eastern MWD.



Notes:

1. Lake recycle flow rates are based on a wetland hydraulic loading of 0.6 inches/day, which equals 17.5 acre-feet/day
2. Long-term average lake recycle is for 356 days per year.
3. Worst-case drought lake recycle is for 214 days for the period from April through October.

Figure 5-4
Alternative 2B Flow Schematic

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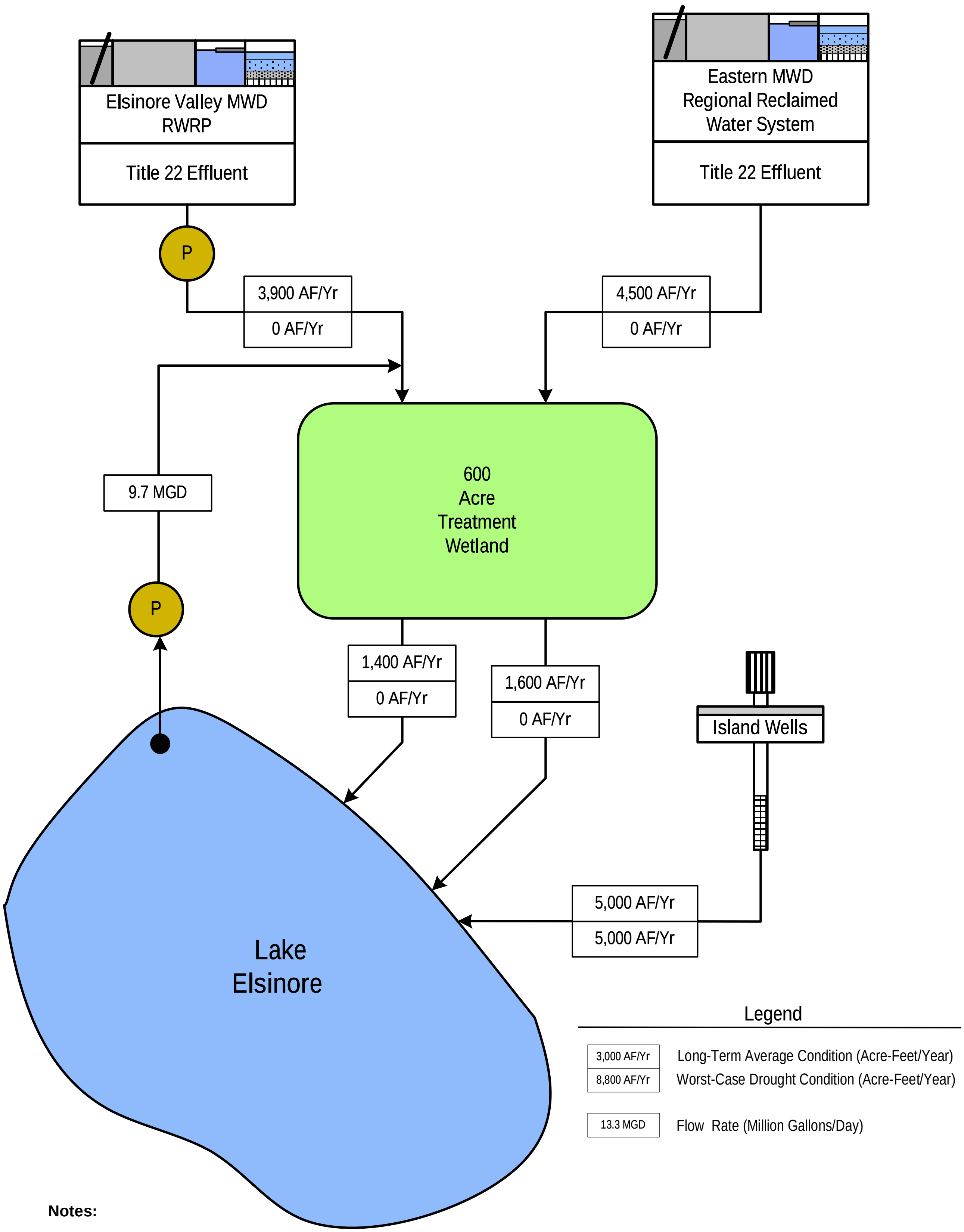
Alternative 3A: 600-Acre Back Basin Treatment Wetland

The flow schematic for Alternative 3A is shown in Figure 5-5. Phosphorus treatment for this alternative will be provided by an expanded treatment wetland covering a total area of 600-acres that will be located in the vicinity of the existing Back Basin Wetland. The wetland will treat reclaimed water from the Elsinore Valley MWD RWRF (3,900 acre-feet per year) and the Eastern MWD RRWS (4,500 acre-feet per year). The Elsinore Valley MWD reclaimed water will be supplied at a consistent rate of about 10.7 acre-feet per day throughout the entire year. The Eastern MWD reclaimed water will be supplied at a consistent rate of about 29.8 acre-feet per day during the 151 day five-month winter period (November through March). Due to this seasonal availability of reclaimed water and the high evaporative losses during the hot and dry summer months, a lake water recycle system with a pumping capacity of 9.7 mgd (29.8 acre-feet per day) will be required to keep the wetland in an optimum operating condition, while providing additional water quality improvement of the lake water. Table 5-3 summarizes the monthly reclaimed water flows to the treatment wetland, and the expected phosphorus removal performance at the indicated hydraulic and mass loading rates.

With an estimated average phosphorus removal rate of 10 m/yr, a hydraulic loading rate of 0.8 inches per day (40.0 acre-feet per day), and influent phosphorus concentrations of 3 mg/L for reclaimed water and 0.2 mg/L for recycled lake water, the treatment wetland performance is expected to produce effluent phosphorus concentrations of about 0.9 mg/L during the winter months and 0.3 mg/L during the summer months. Those predicted effluent phosphorus concentrations are less than the near-term phosphorus loading objective for Lake Elsinore that has been adopted for the study of 1.0 mg/L, a the long-term phosphorus loading objective of 0.5 mg/L during the summer months. The estimated annual total mass of phosphorus removed from all flows applied to the treatment wetland will be about 25,800 kilograms, or about 57,000 pounds per year. Annual application of recycled water to the wetland will total 8,400 acre-feet per year. Because of water loss by evapotranspiration and infiltration, about 3,000 acre-feet , or about 30 percent of the influent flow to the treatment wetland, will be discharged to Lake Elsinore as treated effluent.

The long-term average supplemental water requirement for Lake Elsinore is 8,000 acre-feet per year. To achieve that supplemental requirement under this alternative 5,000 acre-feet of local groundwater will be pumped by the three Island Wells and discharged directly into Lake Elsinore, and 3,000 acre-feet of treated effluent will have to be produced by the treatment wetland. Because of the large evapotranspiration and infiltration loss from the 600-acre treatment wetland, the expanded treatment wetland is only considered to be an effective treatment system for the long-term average supplemental water needs of the lake.



Notes:

1. Wetland hydraulic loading is 0.8 inches/day, which equals 40.0 acre-feet/day.

Figure 5-5
Alternative 3A Flow Schematic

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TABLE 5-3
600-Acre Wetland Phosphorous Removal for WWTP Effluent and Recycled Lake Water

Month	[a]EVMWD Inflow (ac-ft)	[a]EMWD Inflow (ac-ft)	[b]Lake Recycle (ac-ft)	Influent (mg TP/L)	Mass Loading (kg/ha/d)	[c]Outflow (ac-ft)	HLR (in/d)	HRT (d)	[d]Effluent (mg TP/L)	Mass Removal (kg TP)
Jan	331	924	0	3.0	0.62	973	2.1	29	0.9	3,539
Feb	299	834	0	3.0	0.62	857	0.8	29	0.8	3,312
Mar	331	924	0	3.0	0.62	882	0.8	30	0.9	3,634
Apr	321	0	884	0.9	0.19	728	0.8	32	0.3	1,140
May	331	0	913	0.9	0.19	706	0.8	33	0.3	1,184
Jun	321	0	884	0.9	0.19	626	0.8	34	0.3	1,176
Jul	331	0	913	0.9	0.19	634	0.8	34	0.3	1,212
Aug	331	0	913	0.9	0.19	646	0.8	34	0.3	1,208
Sep	321	0	884	0.9	0.19	697	0.8	32	0.3	1,150
Oct	331	0	913	0.9	0.19	786	0.8	31	0.3	1,154
Nov	321	894	0	3.0	0.62	846	0.8	30	0.9	3,546
Dec	331	924	0	3.0	0.62	923	0.8	29	0.9	3,583
Annual	3,900	4,500	6,305			9,305				25,838

[a]Influent = 3.0 mg TP/L

[b]Influent = 0.2 mg TP/L

[c]Infiltration Rate = 5.2E-06 cm/s

[d]First-order removal rate (k) = 10 m/yr

EVMWD = Elsinore Valley Municipal Water District

EMWD = Eastern Municipal Water District

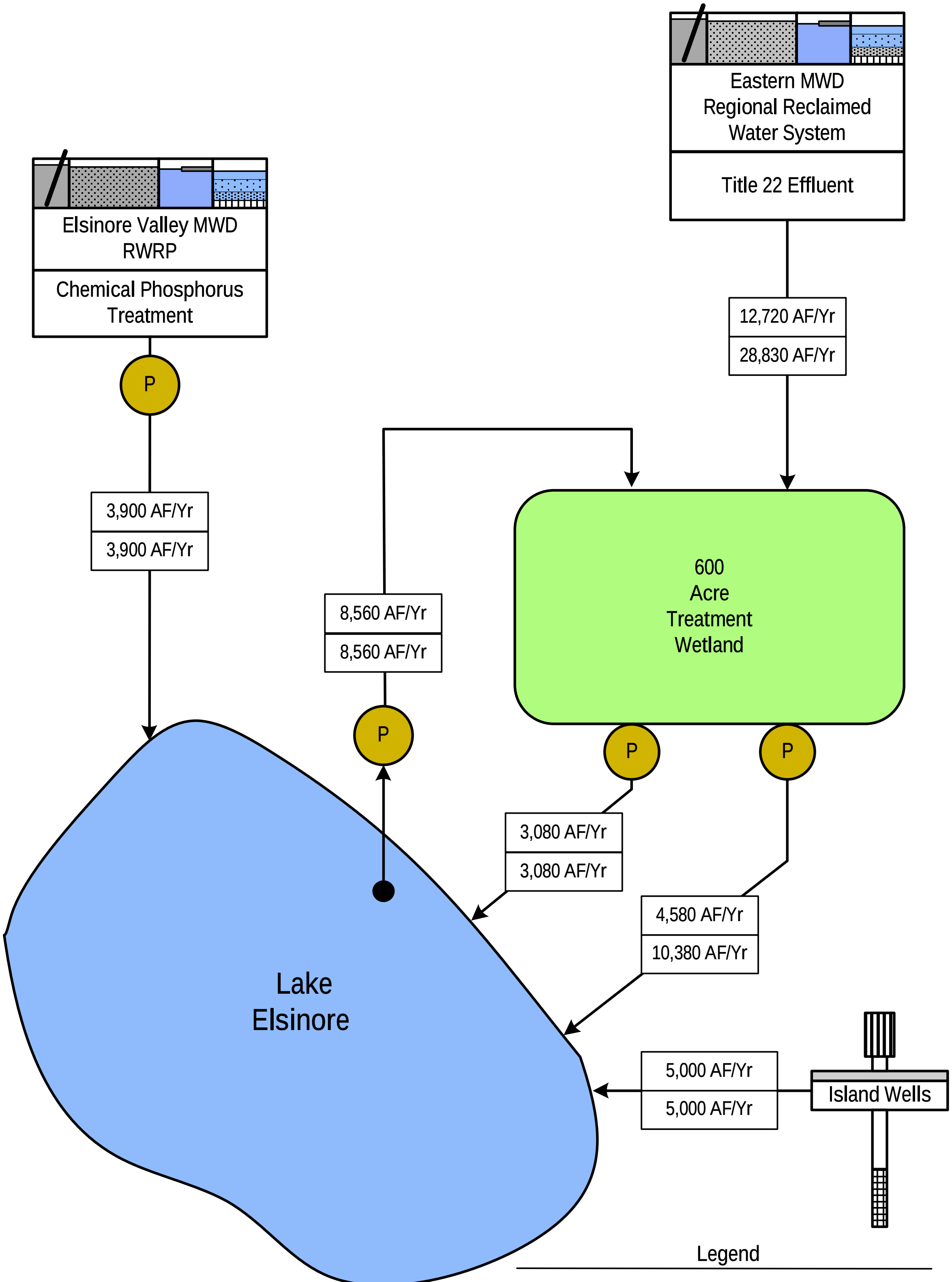
HLR = Hydraulic Loading Rate

HRT = Hydraulic Residence Time

Alternative 3B: Elsinore Valley MWD RWRF Chemical Phosphorus Treatment and 600-Acre Back Basin Treatment Wetland

Figure 5-6 presents the flow schematic for Alternative 3B. Phosphorus treatment for this alternative will be provided by the construction of new chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF and conversion and expansion of the existing Back Basin Wetland into a 600-acre treatment wetland.

For the long-term average supplemental water condition, up to 5,000 acre-feet per year of local groundwater will be pumped from the three existing Island Wells and discharged directly into the lake. In addition, the entire current treated water production from the Elsinore Valley MWD RWRF of 3,900 acre-feet per year will be discharged directly into Lake Elsinore. Since the treatment wetland will not be needed to produce supplemental water during long-term average conditions, a lake water recycle system will be needed to keep the wetland in an optimum operating condition. The lake water recycle system will also



Notes:

1. Lake recycle flow rates are based on a wetland hydraulic loading of 0.8 inches/day, which equals 40.0 acre-feet/day
2. Long-term average lake recycle is for 356 days per year.
3. Worst-case drought lake recycle is for 214 days for the period from April through October.

Legend

3,000 AF/Yr	Long-Term Average Condition (Acre-Feet/Year)
8,800 AF/Yr	Worst-Case Drought Condition (Acre-Feet/Year)
13.3 MGD	Flow Rate (Million Gallons/Day)

Figure 5-6
Alternative 3B Flow Schematic

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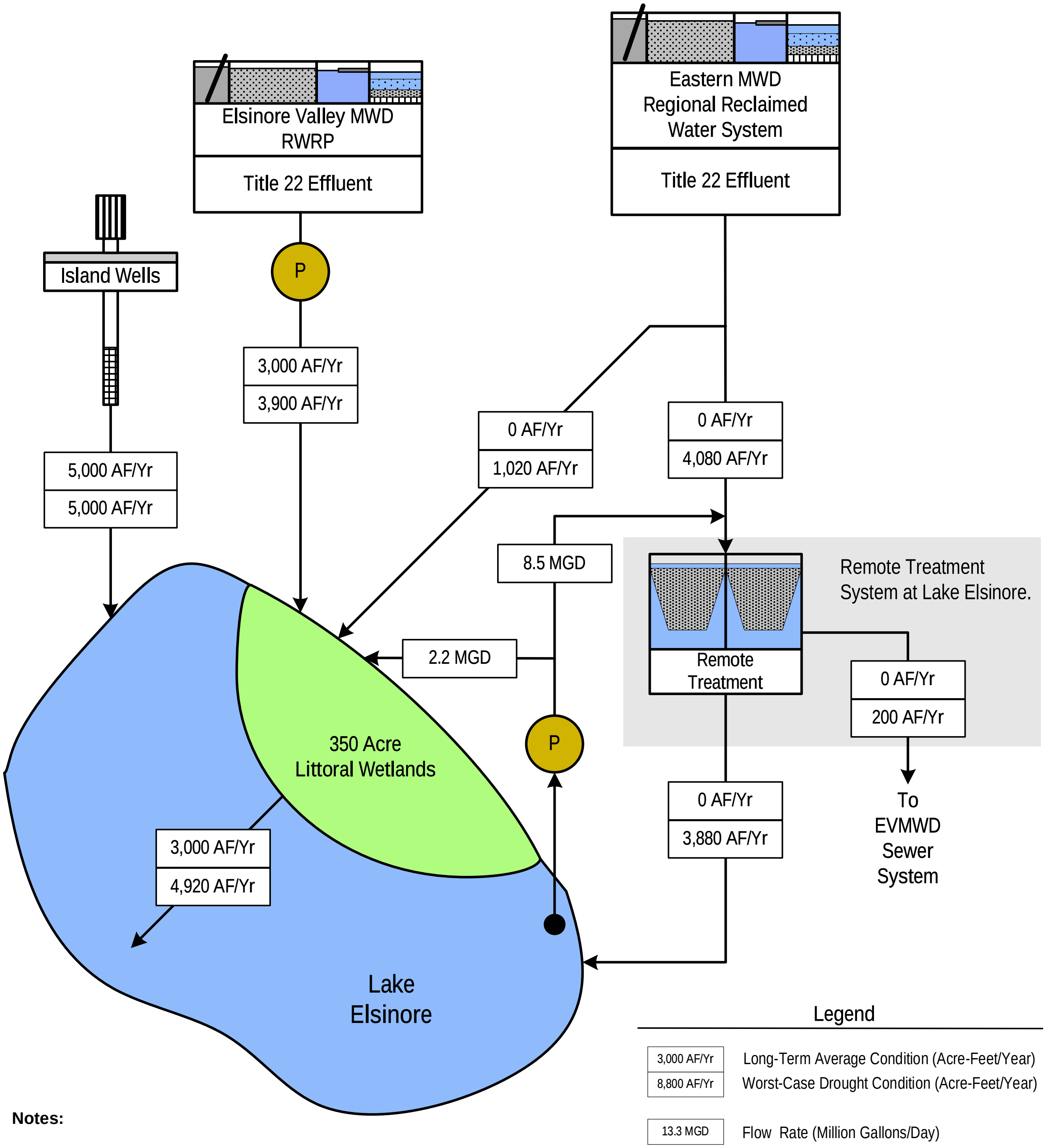
provide additional water quality improvement of the lake water. The lake water recycle system has been sized to operate the 214 days each year that reclaimed water will not be available from Eastern MWD. At a wetland hydraulic loading rate of 0.8 inches per day (40 acre-feet per day), a pumping capacity of 13.0 mgd that will circulate up to 8,560 acre-feet over the 214-day period will be required. The annual water loss in the treatment wetland over the 214 day operational period is estimated to be 5,480 acre-feet. That evaporative loss will be made up by treating Eastern MWD reclaimed water over the 151-day winter period when that water is available. Up to 15,220 acre-feet of reclaimed water from Eastern MWD will be needed to provide the makeup water and the wetland operating water losses. The treatment wetland hydraulic loading rate for the 151-day period will be 2.0 inches per day, which is substantially higher than the normal hydraulic loading rate of 0.8 inches per day. The phosphorus removal performance of the treatment wetland at that higher hydraulic loading rate can be expected to be less than that estimated for the lower rate. The treatment wetland will however still provide a high degree of phosphorus treatment. The treatment wetland hydraulic loading rate during that 151-day period equates to a flow rate of 32.9 mgd (about 100.8 acre-feet per day). That much reclaimed water may not be available from Eastern MWD; therefore, the feasibility of this alternative is questionable.

For the worst-case supplemental water condition, again up to 5,000 acre-feet of local groundwater will be pumped from the three existing Island Wells and discharged directly into the lake. Up to 3,900 acre-feet of treated effluent will be produced by the Elsinore Valley MWD RWRF, and discharged directly into Lake Elsinore. A supplemental water deficiency of 4,900 acre-feet per year, under the worst-case drought condition, may have to be made up by treating Eastern MWD reclaimed water through the treatment wetland. A recycle system, with a pumping capacity of 13.0 mgd, will be needed to circulate lake water through the treatment wetland when reclaimed water is not available from eastern MWD to keep the wetland in an optimum operating condition. The lake water recycle system will also provide additional water quality improvement of the lake water. That lake water recycle system will lose up to 5,480 acre-feet per year from evaporation, vegetative uptake and infiltration losses in the treatment wetland. Accordingly, up to 10,380 acre-feet per year of treated water from the treatment wetland may have to be provided to make up the supplemental water deficiency and wetland operating losses. To provide that volume of treated water from the 600-acre treatment wetland, up to 28,830 acre-feet of reclaimed water may have to be purchased from Eastern MWD during the 151 day winter period. That volume of reclaimed water equates to a daily flow of 190.9 acre-feet per day, or about 62.2 mgd. The Eastern MWD reclaimed water system does not have the capacity to produce that volume of flow on a daily basis as a supplemental water source for Lake Elsinore, which makes this alternative infeasible under worst-case drought conditions.

Alternative 4: 350-Acre Littoral Wetlands

Figure 5-7 presents the flow schematic for Alternative 4. Phosphorus treatment for this alternative will be provided by a 350-acre littoral wetland that will be constructed within the existing shoreline of Lake Elsinore. For the long-term average supplemental water condition, up to 3,000 acre-feet of reclaimed water from the Elsinore Valley MWD RWRF will be conveyed to the wetland for treatment at a consistent rate of about 8.2 acre-feet per day throughout the entire year. Due to the relatively low hydraulic loading rate, a lake



Notes:

1. Wetland hydraulic loading is 0.6 inches/day, which equals 17.5 acre-feet/day
2. Remote treatment system capacity = 8.5 mgd.

Figure 5-7
Alternative 4 Flow Schematic

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water recycle system with a maximum pumping capacity of 2.2 mgd (6.8 acre-feet per day) will be needed to keep the wetland in an optimum operating condition, while providing additional lake water quality improvement. Table 5-4 summarizes the monthly reclaimed water flows to the treatment wetland, and the expected phosphorus removal performance at the indicated hydraulic and mass loading rates. The phosphorus removal performance is based on and average phosphorus removal rate of 10 m/yr, hydraulic loading rate of 0.5 inches per day (14.6 acre-feet per day), and influent phosphorus concentrations of 3 mg/L for reclaimed water and 0.2 mg/L for recycled lake water. The estimated annual total mass of phosphorus removed from all flows applied to the treatment wetland will be about 10,900 kilograms, or about 24,000 pounds per year.

TABLE 5-4
350-Acre Littoral Wetland Phosphorous Removal for WWTP Effluent and Recycled Lake Water

Month	[a]EVMWD Inflow (ac-ft)	[a]EMWD Inflow (ac-ft)	[b]Lake Recycle (ac-ft)	Influent (mg TP/L)	Mass Loading (kg/ha/d)	[c]Outflow (ac-ft)	HLR (in/d)	HRT (d)	[d]Effluent (mg TP/L)	Mass Removal (kg TP)
Jan	255	0	209	1.7	0.23	290	0.5	49	0.3	886
Feb	230	0	189	1.7	0.23	249	0.5	50	0.3	817
Mar	255	0	209	1.7	0.23	237	0.5	53	0.3	908
Apr	247	0	203	1.7	0.23	162	0.5	59	0.3	907
May	255	0	209	1.7	0.23	140	0.5	61	0.3	945
Jun	247	0	203	1.7	0.23	102	0.5	65	0.3	929
Jul	255	0	209	1.7	0.23	98	0.5	66	0.3	961
Aug	255	0	209	1.7	0.23	105	0.5	65	0.3	959
Sep	247	0	203	1.7	0.23	144	0.5	61	0.3	914
Oct	255	0	209	1.7	0.23	187	0.5	57	0.3	926
Nov	247	0	203	1.7	0.23	225	0.5	53	0.3	883
Dec	255	0	209	1.7	0.23	261	0.5	51	0.3	897
Annual	3,000	0	2,464			2,199				10,932

[a]Influent = 3.0 mg TP/L
[b]Influent = 0.2 mg TP/L
[c]Infiltration Rate = 5.5E-06 cm/s
[d]First-order removal rate (k) = 10 m/yr

EVMWD = Elsinore Valley Municipal Water District
EMWD = Eastern Municipal Water District
HLR = Hydraulic Loading Rate
HRT = Hydraulic Residence Time

With an estimated average phosphorus removal rate of 10 m/yr, a hydraulic loading rate of 0.5 inches per day (14.6 acre-feet per day), and influent phosphorus concentrations of 3 mg/L for reclaimed water and 0.2 mg/L for lake water, the treatment wetland performance models predicted an average effluent phosphorus concentration of about 0.3 mg/L. That predicted effluent phosphorus concentration is less than the near-term phosphorus loading objective for the lake study of 1.0 mg/L, and the long-term phosphorus loading objective of 0.5 mg/L. Since the water losses for the littoral wetland are already accounted for in the

Lake Elsinore evaporation losses, the application of 3,000 acre-feet per year of reclaimed water to the wetland, combined with the 5,000 acre-feet of local groundwater pumped from the three Island Wells, will provide all of the water needed to achieve the long-term supplemental water requirement of 8,000 acre-feet per year.

For the worst-case drought supplemental water condition, the reclaimed water supply to the littoral wetland will be the same as that described for Alternative 2, and will include 3,900 acre-feet per year of reclaimed water from Elsinore Valley MWD's RWRF, and 1,020 acre-feet per year of reclaimed water from Eastern MWD's RRWS. The Elsinore Valley MWD reclaimed water will be supplied at a consistent rate about 10.7 acre-feet per day throughout the entire year. The Eastern MWD reclaimed water will be supplied at a consistent rate of about 6.8 acre-feet per day during the 151 day five-month winter period when surplus water will be available from that agency

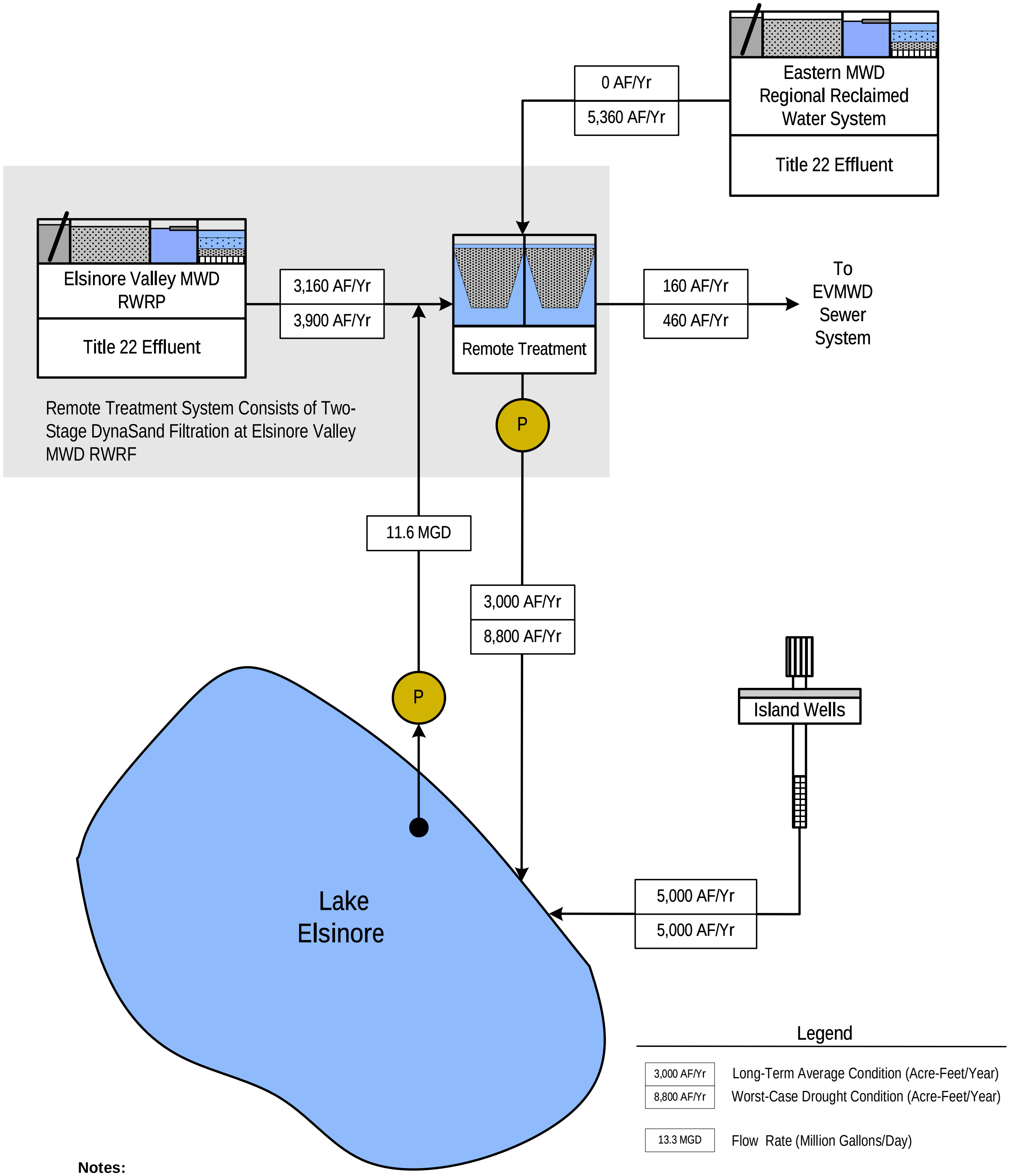
The phosphorus removal performance of the littoral wetlands under the worst-case drought supplemental water condition will be the same as the treatment wetland described in Alternative 2A, because the assumptions of wetland area, hydraulic loading rate, and influent phosphorus concentrations are the same.

The worst-case drought condition supplemental water requirement for Lake Elsinore is 13,800 acre-feet per year, and will require remote phosphorus treatment in addition to the littoral wetland. The supplemental water for this condition will include 5,000 acre-feet of local groundwater pumped from the three Island Wells and discharged directly into the lake, combined with 4,920 acre-feet per year of reclaimed water obtained from the Elsinore Valley MWD RWRF and Eastern MWD RRWS that will be conveyed to the wetland for treatment. Under this alternative, 4,080 acre-feet per year of reclaimed water from the Eastern MWD RRWS will be conveyed to the remote treatment system for treatment. The reclaimed water influent flows to the littoral wetland and the remote treatment system will yield the 8,800 acre-feet per year of supplemental water required for this supplemental water condition. The waste backwash water loss of up to 200 acre-feet per year from the remote treatment system represents the waste backwash water loss that will be discharged to the Elsinore Valley MWD sewer system for treatment and disposal.

The remote treatment system has been sized to handle the reclaimed water flows for the worst-case supplemental water condition. The remote treatment system will therefore, be capable of producing up to 3,880 acre-feet within the 151 day five-month winter period (November through March), which corresponds to a maximum treatment capacity of 8.5 mgd. Since the remote treatment system will be used primarily to treat reclaimed water from the Eastern MWD RRWS, the facility's treatment capacity will be available to treat recycled lake water during the remaining seven months of the year. A lake water recycle system with an 8.5 mgd pumping capacity has been provided to take advantage of that surplus treatment capacity.

Alternative 5A: Remote Treatment at Elsinore Valley MWD RWRF

Figure 5-8 presents the flow schematic for Alternative 5A. Construction of remote treatment facilities at the Elsinore Valley MWD RWRF and the Elsinore Valley MWD RWRF will provide the phosphorus treatment for this alternative. The remote treatment system will consist of coagulant addition followed by a two-stage granular media filtration process.



Notes:

1. Remote treatment system capacity = 14.5 mgd.

Figure 5-8
Alternative 5A Flow Schematic

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For the long-term average supplemental water condition, 5,000 acre-feet of local groundwater will be pumped from the three Island Wells, and will be discharged directly into Lake Elsinore. In addition, 3,160 acre-feet of reclaimed water from the Elsinore Valley MWD RWRF will be treated in the remote treatment system located at that facility. The treatment system will produce the 3,000 additional acre-feet per year of supplemental water needed for the long-term average supplemental water condition. One hundred sixty acre-feet per year will be lost as waste backwash water from the two-stage filtration process, which will be recycled to the RWRF treatment system for treatment and disposal.

For the worst-case drought supplemental water condition, 5,000 acre-feet of local groundwater will be pumped by the three Island Wells, and discharged directly into Lake Elsinore. Three thousand nine hundred acre-feet per year of reclaimed water from the Elsinore Valley MWD RWRF, and up to 5,360 acre-feet per year of reclaimed water obtained from the Eastern MWD RRWS, will be treated by the remote treatment system to produce the 8,800 acre-feet of treated water needed for this supplemental water condition. The remote treatment system will produce up to 460 acre-feet per year of waste backwash water that will be recycled back to the RWRF treatment system for treatment and disposal.

A treatment remote treatment system with a maximum treatment capacity of 15.5 mgd has been provided to handle the reclaimed wastewater flows from the Elsinore Valley MWD RWRF (3.5 mgd) and the Eastern MWD Temecula Valley RWRF (up to 11.6 mgd). Up to 12.0 mgd of the remote treatment system capacity will be available during the seven non-winter months, when Eastern MWD reclaimed water is not available, to treat recycled lake water. A lake water recycle system with a 12.0 mgd pumping capacity has been provided for this alternative to allow treatment of Lake Elsinore water.

Alternative 5B: Remote Treatment at Lake Elsinore

Figure 5-9 presents the flow schematic for Alternative 5B. Phosphorus treatment for this alternative will be provided by a remote treatment system that will be sited near Lake Elsinore. The remote treatment system will be a membrane treatment system that can be fully-automated to allow unmanned operation.

For the long-term average supplemental water condition, 5,000 acre-feet of local groundwater will be pumped by the three Island Wells, and discharged directly into Lake Elsinore. In addition, 3,160 acre-feet of reclaimed water from the Elsinore Valley MWD RWRF will be conveyed to the remote treatment system for phosphorus treatment, which will produce the 3,000 additional acre-feet per year of supplemental water needed for the long-term average supplemental water condition. One hundred sixty acre-feet per year will be lost as waste backwash water from the membrane process, which will be recycled to the Elsinore Valley MWD sewer system for treatment and disposal.

Under the worst-case drought supplemental water condition, 5,000 acre-feet of local groundwater will be pumped by the three Island Wells, and discharged directly into Lake Elsinore. Three thousand nine hundred acre-feet per year of reclaimed water from the Elsinore Valley MWD RWRF, and up to 5,360 acre-feet per year of reclaimed water obtained from the Eastern MWD's RRWS, will be treated by the remote treatment system to produce the 8,800 acre-feet of treated water needed for this supplemental water condition. The remote treatment system will produce up to 460 acre-feet per year of waste backwash water

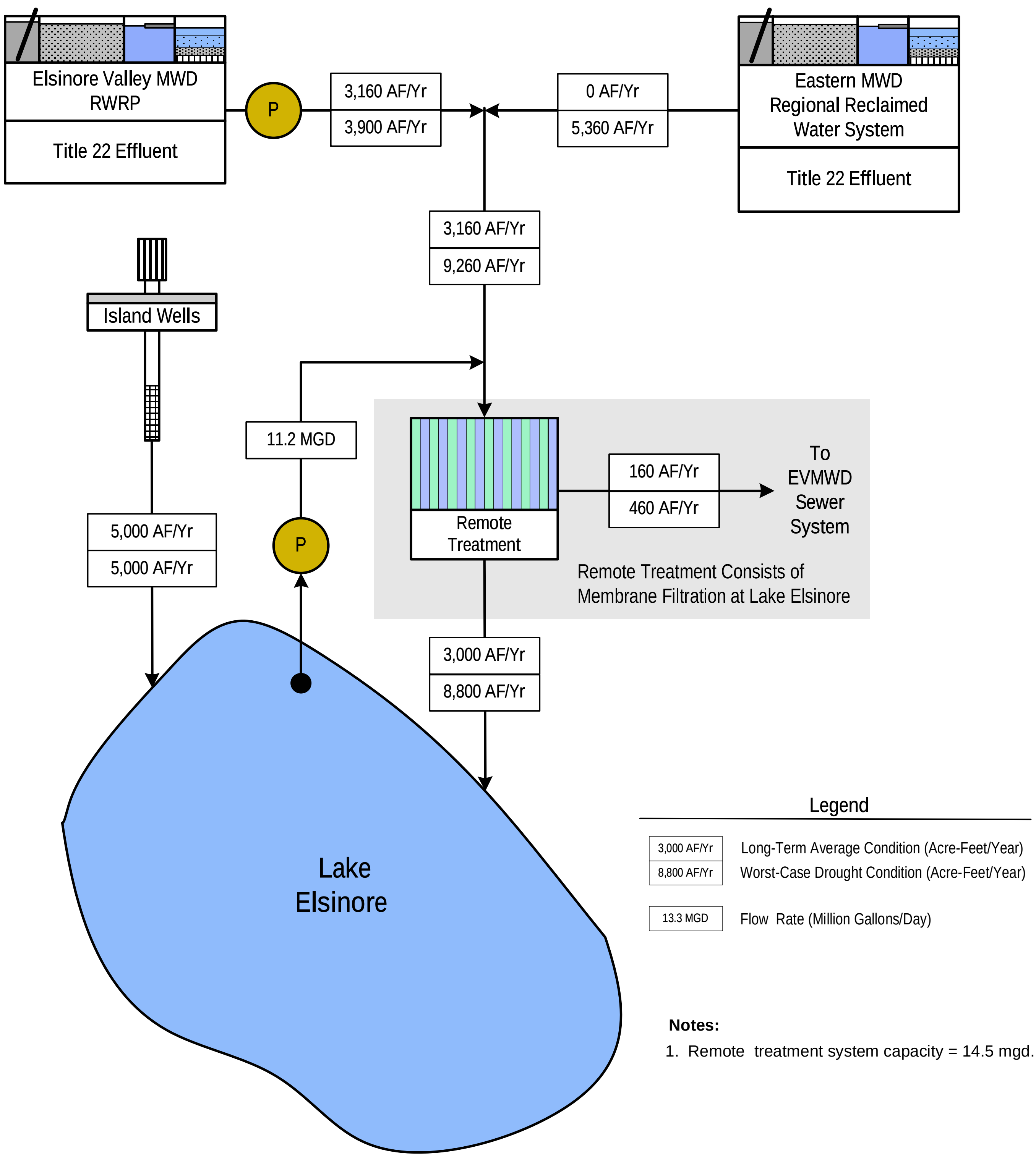

Figure 5-9
Alternative 5B Flow Schematic

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that will be discharged to the Elsinore Valley MWD sewer system for treatment and disposal.

The remote treatment system treatment capacity will be 15.5 mgd. A lake water recycle system with the same sizing as Alternative 5A will be provided for this alternative to allow the recycle of lake water for treatment in the remote treatment system.

Alternative 6: Calcium Treatment at Lake Elsinore

Figure 5-10 presents the flow schematic for Alternative 6. Phosphorus treatment will be provided by a remote treatment system consisting of calcium addition to a blended flow of reclaimed water (70 percent) and lake water (30 percent). The chemically treated blended water (reclaimed water and lake water) will then be discharged directly into Lake Elsinore where the phosphorus-hydroxide precipitate will settle out in the lake. A blend ratio of about 70 percent reclaimed water to 30 percent lake water is needed to achieve the most phosphorus removal, based on Dr. Anderson's most recent testing.

For the long-term average supplemental water condition, 1,285 acre-feet per year of recycled lake water will be blended with 3,000 acre-feet of reclaimed water to produce the 3,000 acre-feet per year of needed supplemental water. A total of 4,285 acre-feet per year of water will be returned to the lake.

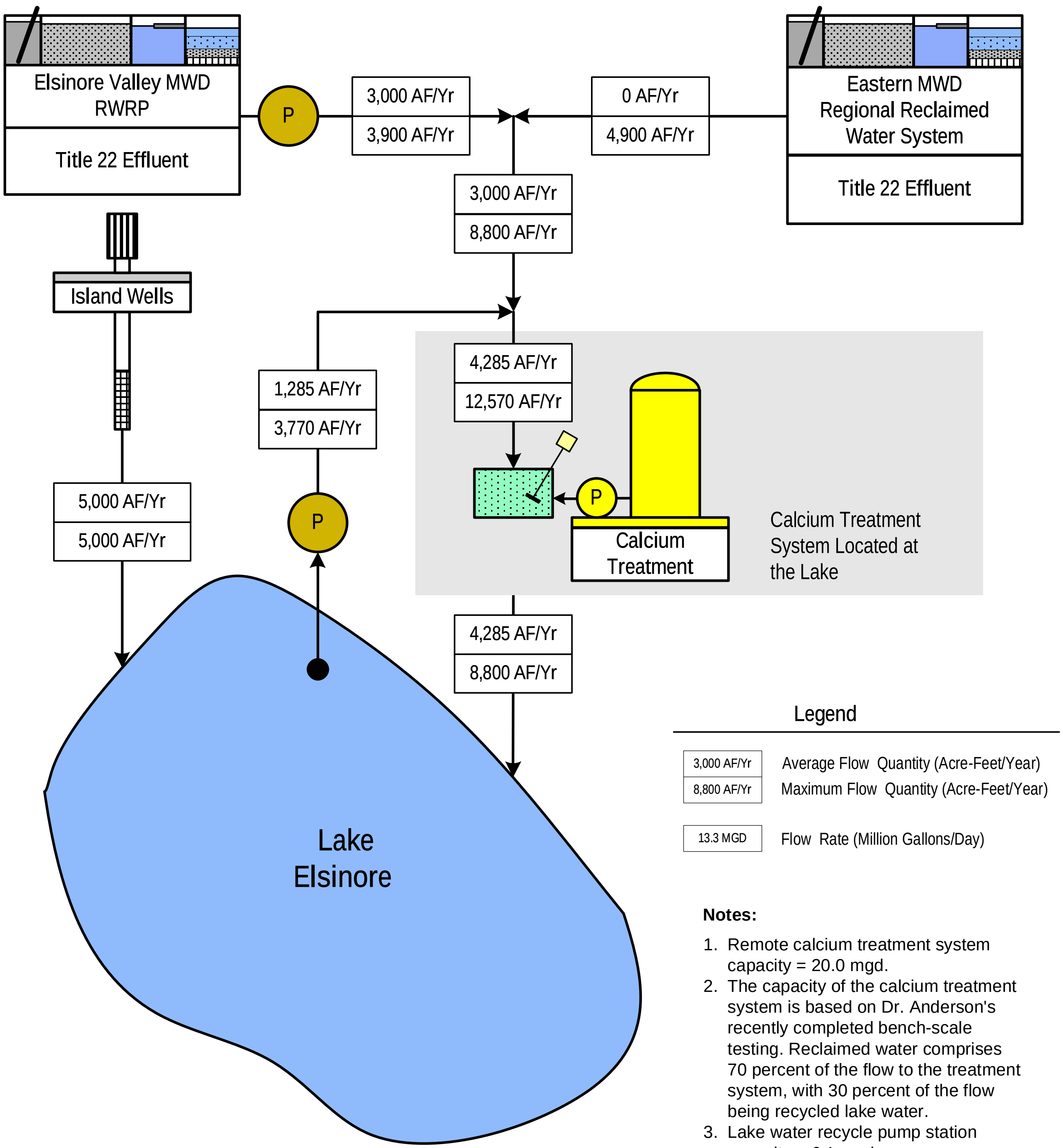
For the worst-case drought supplemental condition, 3,770 acre-feet per year of lake water will be recycled and blended with 8,800 acre-feet per year of reclaimed water from the two reclaimed water sources to produce the required supplemental water volume. A total of 12,570 acre-feet per year of water will be returned to the lake.

The remote treatment system will have a treatment capacity of 20.0 mgd. A lake water recycle system will also be provided for this alternative, and the system will have a 6.1 mgd pumping capacity.

Alternative 7: Imported Water

Figure 5-11 presents the flow schematic for Alternative 7. In this alternative all of the supplemental water for Lake Elsinore will be imported water purchased from the Metropolitan. The imported water will be untreated Colorado River Water obtained through Elsinore Valley MWD's WR-18b turnout on Metropolitan's Colorado River Aqueduct. The turnout discharges into the San Jacinto River approximately 12 miles upstream of Canyon Lake. The diverted imported water will flow down the San Jacinto River until it reaches Canyon Lake, where it will be released through the Canyon Lake dam outlet piping or will discharge over the dam spillway. From Canyon Lake, the imported water will continue to flow down the San Jacinto River to Lake Elsinore. A 10-percent imported water loss has been assumed in this study for the evaporation and infiltration losses in the San Jacinto River and Canyon Lake from the Metropolitan turnout to Lake Elsinore.

The supplemental water source for this alternative will not receive any treatment. Accordingly, the imported water will pick up phosphorus as it is diluted with the water in Canyon Lake. The Santa Ana RWQCB initiated water quality monitoring in Lake Elsinore



Notes:

1. Remote calcium treatment system capacity = 20.0 mgd.
2. The capacity of the calcium treatment system is based on Dr. Anderson's recently completed bench-scale testing. Reclaimed water comprises 70 percent of the flow to the treatment system, with 30 percent of the flow being recycled lake water.
3. Lake water recycle pump station capacity = 6.1 mgd.

Figure 5-10
Alternative 6 Flow Schematic

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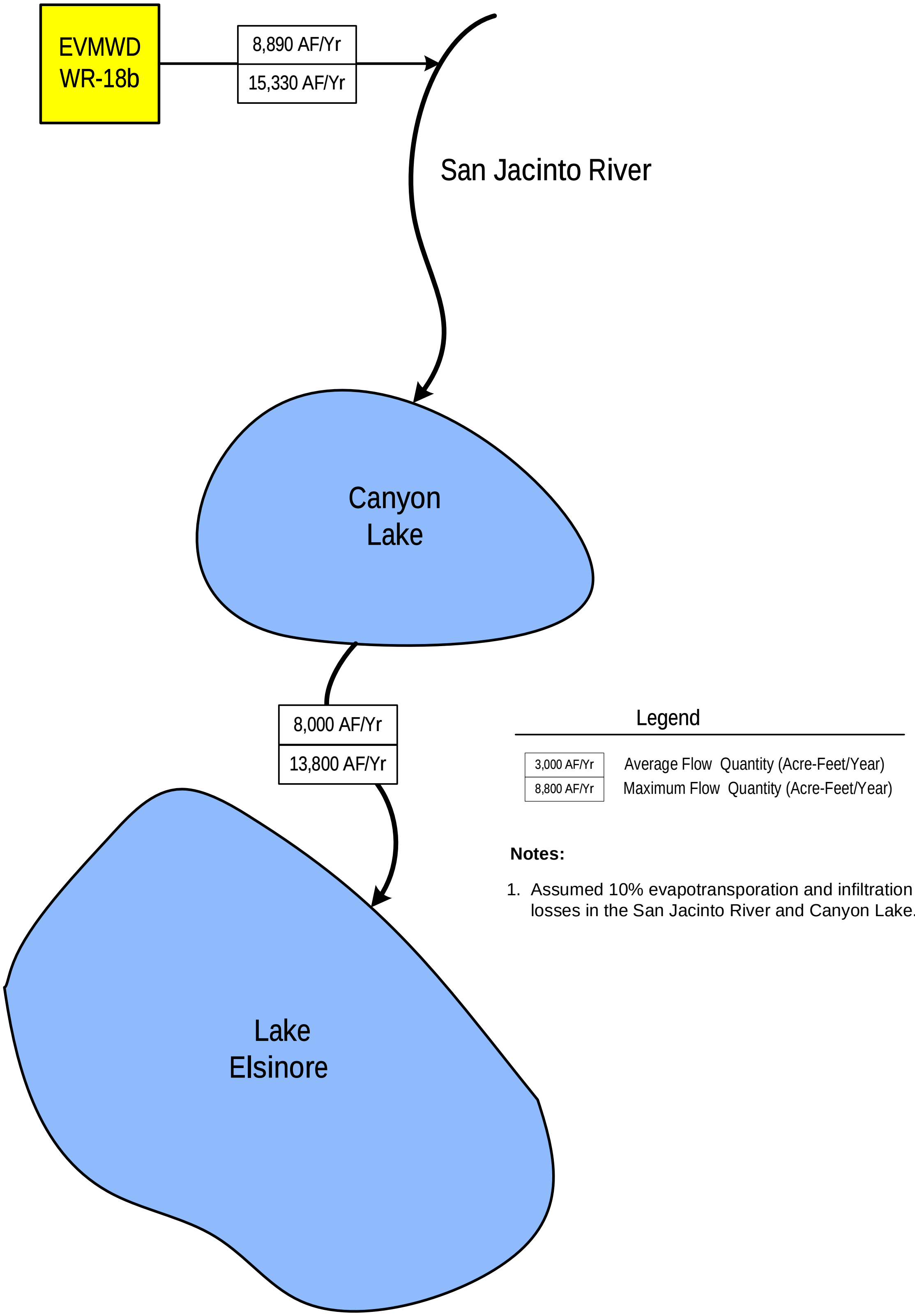

Notes:

1. Assumed 10% evapotransporation and infiltration losses in the San Jacinto River and Canyon Lake.

Figure 5-11
Alternative 7 Flow Schematic

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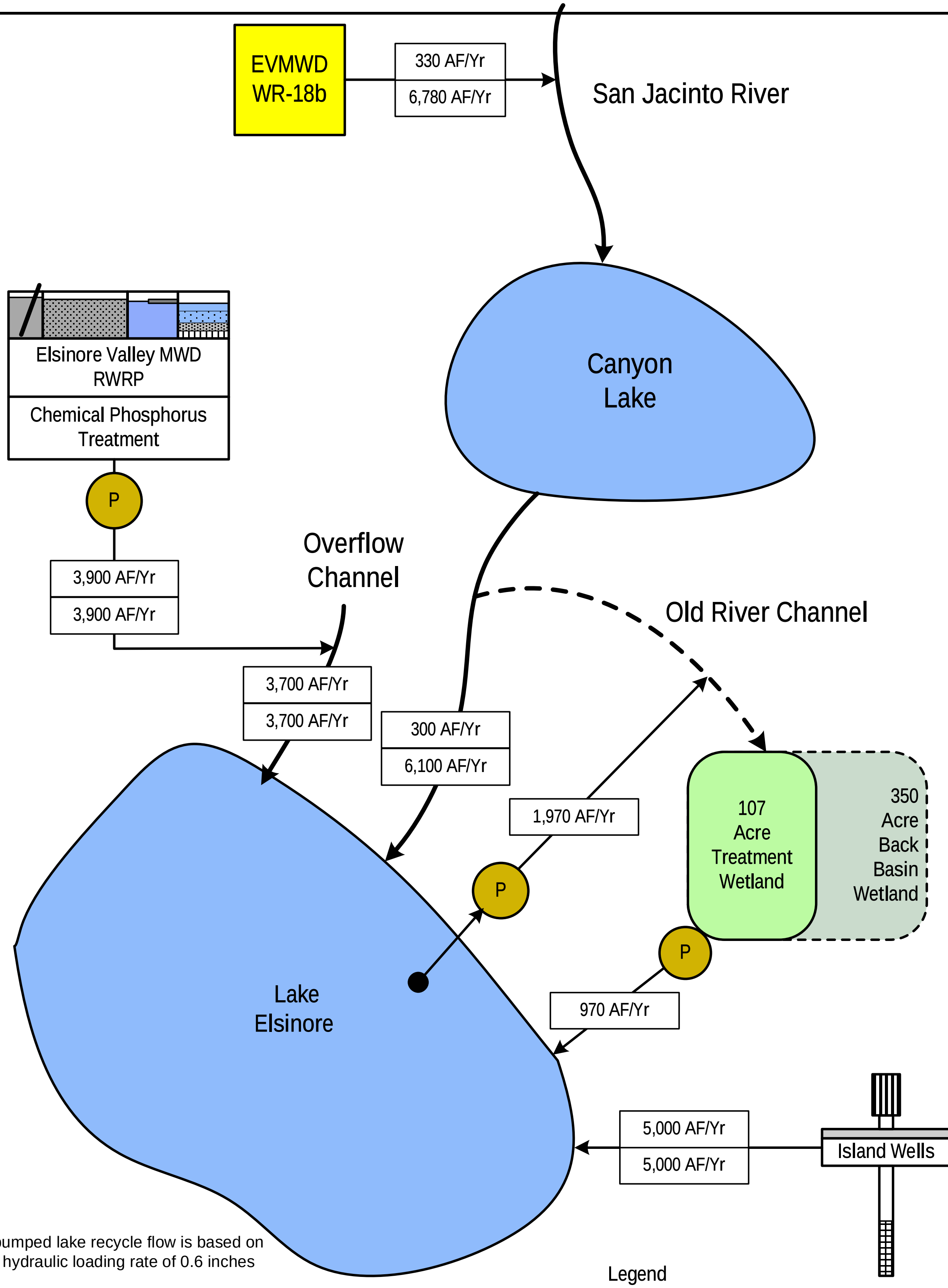
and Canyon Lake in June 2000. The water quality monitoring program is an ongoing program that is focusing on the nutrients (nitrogen and phosphorus), algal biomass and dissolved oxygen in both lakes. Based on the water quality data collected through May 2001, the median total phosphorus concentration in Canyon Lake and Lake Elsinore are 0.25 mg/L and 0.12 mg/L, respectively. It can reasonably be expected that the imported water released from Canyon Lake will have a median total phosphorus concentration of 0.25 mg/L, which is both higher than the source water and Lake Elsinore water.

For the long-term average supplemental water condition, 8,890 acre-feet per year of imported water will have to be purchased from Metropolitan. For the worst-case drought condition, up to 15,330 acre-feet per year of supplemental water may have to be purchased from Metropolitan.

Alternative 8A: Chemical Phosphorus at Elsinore Valley MWD RWRF, Imported Water and 107-Acre Treatment Wetland

Figure 5-12 presents the flow schematic for Alternative 8A. Phosphorus treatment for this alternative will be provided by the construction of chemical phosphorus treatment facilities at the Elsinore Valley MWD RWRF. In addition, this alternative will also include the conversion of up to 107 acres of the southeast portion of the existing Back Basin Wetland into a treatment wetland. The remainder of the existing Back Basin Wetland will remain in its current configuration. Lake water will be circulated through the new treatment wetland on a year-round basis to remove phosphorus and improve the quality of the lake water. The lake water will be pumped to the Old San Jacinto River Channel that will be relined and used to convey the lake water to the converted treatment wetland. The evaporation, vegetation uptake and infiltration water losses in the existing Back Basin Wetland is estimated to be about 1,000 acre-feet per year. The area of the treatment wetland was limited to 107 acres so that the evaporation, vegetation uptake and infiltration losses in the Old San Jacinto River Channel and the treatment wetland does not exceed the existing wetland losses. Up to 1,970 acre-feet of lake water will be pumped to the treatment wetland, with up to 970 acre-feet per year of treated water being returned to the lake. The treatment wetland estimated operational water loss is based on treatment wetland model with an optimized hydraulic loading rate of 0.6 inches per day for phosphorus removal.

Table 5-5 summarizes the monthly inflows to the 107-acre treatment wetland, and the expected phosphorus removal performance at the indicated hydraulic and mass loading rates. The phosphorus removal performance is based on an average phosphorus removal rate of 10 m/yr, hydraulic loading rate of 0.6 inches per day (5.8 acre-feet per day), and influent phosphorus concentration of 0.2 mg/L for the recycled lake water. The treatment wetland effluent discharge phosphorus concentration is projected to be 0.06 mg/L, representing a 71 percent reduction. The estimated annual total mass of phosphorus removed from all flows applied to the treatment wetland will be about 418 kilograms, or about 1,100 pounds per year.



Notes:

1. Wetlands pumped lake recycle flow is based on a wetlands hydraulic loading rate of 0.6 inches per day.
2. Assumed 10% water loss in the San Jacinto River and Canyon Lake.
3. Assumed 5% water loss in the Lake Elsinore Overflow Channel.
4. 107 acre treatment wetland water loss is estimated to be 1,000 acre-feet/year which is equal to current Back Basin Wetland annual water loss.

Figure 5-12
Alternative 8A Flow Schematic

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TABLE 5-5
107-Acre Recycled Lake Water Treatment Wetland Phosphorous Removal

Month	[a]EVMWD Inflow (ac-ft)	[a]EMWD Inflow (ac-ft)	[b]Lake Recycle (ac-ft)	Influent (mg TP/L)	Mass Loading (kg/ha/d)	[c]Outflow (ac-ft)	HLR (in/d)	HRT (d)	[d]Effluent (mg TP/L)	Mass Removal (kg TP)
Jan	0	0	167	0.2	0.031	114	0.6	40	0.06	33
Feb	0	0	151	0.2	0.031	99	0.6	41	0.05	31
Mar	0	0	167	0.2	0.031	98	0.6	43	0.06	34
Apr	0	0	162	0.2	0.031	74	0.6	47	0.06	35
May	0	0	167	0.2	0.031	68	0.6	48	0.06	36
Jun	0	0	162	0.2	0.031	56	0.6	50	0.06	36
Jul	0	0	167	0.2	0.031	56	0.6	51	0.06	37
Aug	0	0	167	0.2	0.031	58	0.6	50	0.06	37
Sep	0	0	162	0.2	0.031	69	0.6	48	0.06	35
Oct	0	0	167	0.2	0.031	82	0.6	45	0.06	35
Nov	0	0	162	0.2	0.031	93	0.6	43	0.06	33
Dec	0	0	167	0.2	0.031	105	0.6	42	0.06	34
Annual	0	0	1970		486	972				418

[a]Influent = 3.0 mg TP/L

[b]Influent = 0.2 mg TP/L

[c]Infiltration Rate = 5.5E-06 cm/s

[d]First-order removal rate (k) = 10 m/yr

EVMWD = Elsinore Valley Municipal Water District

EMWD = Eastern Municipal Water District

HLR = Hydraulic Loading Rate

HRT = Hydraulic Residence Time

For the long-term supplemental water condition up to 5,000 acre-feet per year of local groundwater will be pumped directly into Lake Elsinore from the existing Island Wells. The current treated effluent production from the Elsinore valley MWD RWRF of 3,900 acre-feet per year will be discharged to the Lake Elsinore Outlet Channel for conveyance to the lake. Allowing for evaporation and infiltration losses in the channel, it is estimated that 3,700 acre-feet of treated effluent will reach the lake. That leaves a deficiency of about 300 acre-feet per year, under long-term average supplemental water conditions, that will have to be made up by purchasing imported water from Metropolitan. The imported water will be obtained through Elsinore Valley MWD's existing WR-18b turnout on the Colorado River Aqueduct. Allowing for evaporation and infiltration losses along the San Jacinto River and in Canyon Lake, 330 acre-feet per year of imported water will have to be purchased from Metropolitan.

For the worst-case drought supplemental water condition, 5,000 acre-feet per year of local groundwater will be pumped from the existing Island Wells and discharged directly into the lake. In addition, the current treated effluent production from the Elsinore Valley MWD

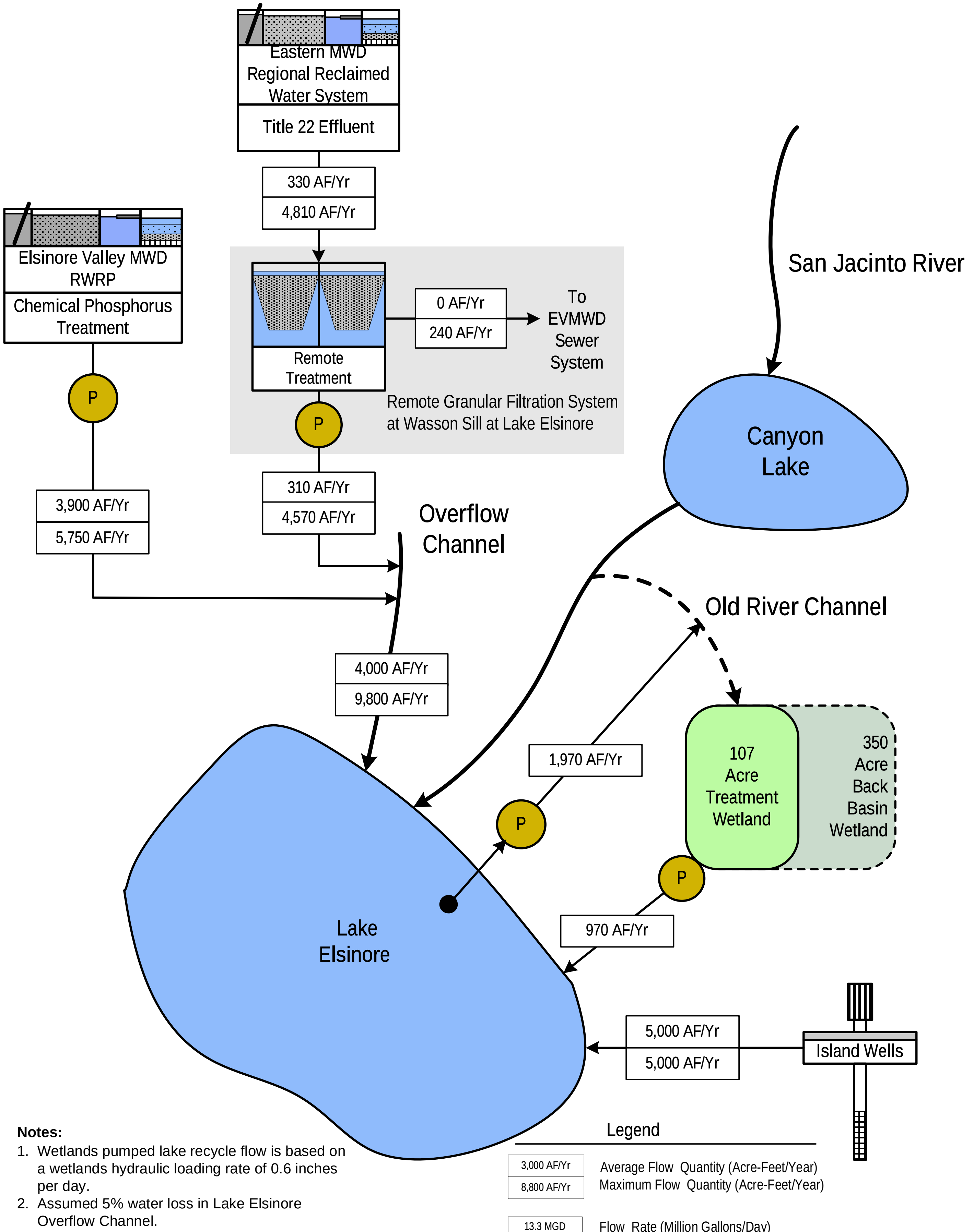
RWRF of 3,900 care-feet per year will be discharged to the lake Outlet Channel, which will yield a discharge to the lake of about 3,700 acre-feet per year. The supplemental water deficiency of 6,100 acre-feet per year, including the 1,000 acre-foot per year treatment wetland operating losses, will be made up by imported water purchased from Metropolitan. The imported water will be delivered to Lake Elsinore through Elsinore Valley MWD's WR-18b turnout, the San Jacinto River and Canyon Lake.

Alternative 8B: Chemical Phosphorus Treatment at Elsinore Valley MWD RWRF, Remote Granular Filtration and 107-Acre Treatment Wetland

Figure 5-13 presents the flow schematic for Alternative 8B. Phosphorous treatment for this alternative will be provided by the construction of chemical phosphorus facilities at the Elsinore Valley MWD RWRF, and construction of a remote granular media filtration system in the vicinity of the Wasson Sill to treat reclaimed water from the Eastern MWD RRWS. This alternative includes the same 107 acre treatment wetland conversion as described for Alternative 8A that will treat lake water circulated through the treatment wetland. Up to 1,970 acre-feet per year of lake water will be pumped to the relined Old San Jacinto River Channel that will be used to convey the lake water to the treatment wetlands. An estimated return flow to lake Elsinore of 970 acre-feet per year is based on modeling of the performance of the treatment wetland at an optimized hydraulic loading rate for phosphorus removal of 0.6 inches per day. Operating losses for the treatment wetland is estimated to be about 1,000 acre-feet per year. The phosphorus removal performance for the treatment wetland treating recycled lake water will be the same as that summarized in Table 5-5 for Alternative 8A.

For the long-term supplemental water condition up to 5,000 acre-feet per year of local groundwater will be pumped directly into Lake Elsinore from the existing Island Wells. Effluent production from the Elsinore Valley MWD RWRF, with chemical phosphorus treatment, will be discharged to Lake Elsinore via the lake Outlet Channel. An evaporation and infiltration loss of 5 percent has been assumed for the Outlet Channel from the vicinity of Wasson Sill to the lake. Up to 4,000 acre-feet per year of supplemental water will have to be added to the lake for the long-term supplemental water condition in addition to the Island Well production. That supplemental water will be treated effluent produced from the Elsinore Valley MWD RWRF. An annual treated water effluent production of up to 4,210 acre-feet per year will be required, with up to 3,900 acre-feet per year being provided by the Elsinore Valley MWD service area and the purchase of 310 acre-feet per year of reclaimed water from Eastern MWD. The Elsinore Valley RWRF will have sufficient surplus capacity to treat the reclaimed water purchased from Eastern MWD.

For the worst-case drought supplemental condition, up to 5,000 acre-feet per year of local groundwater will be pumped from the existing Island Wells, and will be discharged directly into Lake Elsinore. A total of 6,660 acre-feet per year of reclaimed water will be purchased from the Eastern RRWS. Up to 1,850 acre-feet per year of the purchased reclaimed water will be treated through the Elsinore Valley MWD RWRF utilizing the existing plant's current surplus treatment capacity of 4.0 mgd. The remainder of the purchased reclaimed water, or about 4,810 acre-feet per year, will be treated through the remote granular media filtration system that will be constructed in the vicinity of the Wasson Sill. The treated



Notes:
1. Wetlands pumped lake recycle flow is based on a wetlands hydraulic loading rate of 0.6 inches per day.
2. Assumed 5% water loss in Lake Elsinore Overflow Channel.
3. 107 acre treatment wetland water loss is estimated to be 1,000 acre-feet/year which is equal to current Back Basin Wetland annual water loss.
4. Remote treatment system capacity = 14.5 mgd.

Figure 5-13
Alternative 8B Flow Schematic

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effluent flow from the Elsinore Valley MWD RWRF (5,750 acre-feet per year) and the remote granular filtration system (4,570 acre-feet per year) will be discharged to the Lake Elsinore Overflow Channel for conveyance to the lake. Accounting for evaporation and infiltration losses in the Overflow Channel, it is estimated that about 9,800 acre-feet per year of supplemental water will reach the lake. The remote granular filtration system will produce a waste backwash water flow of about 240 acre-feet per year. That flow will be discharged to the Elsinore Valley MWD sewer system for conveyance to their RWRF for treatment.

Project Alternative Facility Sizing Criteria

The following criteria has been used to size the facilities for each of the project alternatives:

- Pipeline diameters are based on the maximum flow rate for the pipeline and a maximum flow velocity of five feet per second.
- Pump station total dynamic pumping head (TDH) includes the maximum static elevation difference along the pipeline alignment, friction loss for the total pipeline length, and an allowance of 20 percent to account for fitting and miscellaneous losses.
- The pipeline friction loss component of the TDH calculation is based on a friction coefficient value of 130, representative of C-900 and C-905 polyvinyl chloride (PVC) pressure pipe.
- Horsepower calculations for vertical turbine pump installations are based on a maximum pump bowl efficiency of 80 percent and motor efficiency of 90 percent for an overall efficiency of 72 percent.
- Horsepower calculations for submersible pump installations are based on a maximum pump bowl efficiency of 70 percent and motor efficiency of 90 percent for an overall efficiency of 63 percent.

Project Facility Conceptual Features

Several of the component facilities are common to most, or all, of the project alternatives. The following are descriptions of the conceptual features for those facilities that have been used in this evaluation:

- The remote treatment system and recycled lake water pump station when they are sited along the lake shoreline will be located at or above elevation 1,265 feet, which is above the 100-year float elevation of 1,263.3 feet.
- The reclaimed water pipeline from the Elsinore Valley MWD RWRF has been sized to ultimately be able to convey up to 7.5 mgd of flow. That flow rate is based on the expanded capacity of 8.0 mgd, with the continuation of other existing reclaimed water uses that require up to 0.5 mgd of the plant treatment capacity. This approach to sizing the pipeline was used to allow more reclaimed water to be pumped through the pipeline as the wastewater flows to the RWRF increase in the future and the Eastern MWD reclaimed water purchases decrease.
- For those alternatives involving the pumping of reclaimed water from the Elsinore Valley MWD RWRF, the pump station structure will be sized to allow expansion for the ultimate future reclaimed water flows from the plant. The pump station will initially be

equipped with pumping equipment with sufficient pumping capacity for the initial capacity condition indicated in the respective alternative flow schematics.

- The recycle water systems with two pump stations will have a common inlet structure and common pipeline to convey the lake water to each pump station.
- The recycled water intake in the lake will consist of a submerged pre-cast concrete vault structure with integral top and bottom. The vault structure will be installed on the bottom of the lake about 300 feet from the shoreline to make sure it is properly submerged. The structure will be square, and will have openings on each of its four horizontal sides. The openings will be screened to keep fish from being sucked into the system. The total area of the structure openings has been sized so that the flow velocity through the screened openings is within the 0.2 to 0.3 foot per second. The outlet pipeline will enter the structure through the bottom. The structure for the Alternative 2A remote treatment system pump station, and the pump stations for Alternatives 3B and 5A will be 4 feet high and 15 feet on each side, with a total opening area of 100 square feet. The structure for the wetland recycle pump station in Alternative 2A, and the pump stations for Alternatives 2B, 3A, 4, 5B, 6, 8A and 8B will be 4 feet high and 11 feet on each side, with a total opening area of 60 square feet.
- A dilution model was used to model the lake currents to determine the minimum distance between the treated water discharge point and the lake water recycle intake to minimize short-circuiting of flows between both points. The lake water recycle intake was modeled up current from the discharge point. The distance between the recycled lake water intake and the treated water discharge into the lake has been set at 2,000 feet to provide a minimum dilution factor of ten, based on the modeling results. The dilution model assumed a 100-foot diffuser section on the discharge pipeline that would start 200 feet from shore.
- The treated water discharge pipeline into the lake will extend into the lake 300 feet. The initial 200 feet of the pipeline will be constructed beneath the lake bottom. The final 100 feet of the pipeline will be a diffuser section constructed along the lake bottom. The diffuser section will have a series of drilled openings along the top of the pipe to avoid disturbing the lake bottom sediments.
- The recycled water pump station will be a submersible centrifugal pump installation, with two primary pumps and one stand-by pump unit. The wet well will be constructed of vertical concrete pipe sections, with concrete base and cover. The wet well will be constructed below grade. The pump station will include a new electrical service
- The treated water and reclaimed water pump station at the Elsinore Valley MWD RWRF will consist of a cast-in-place concrete wet well structure with vertical turbine pumps suspended into the wet well. The pump station will have two primary pumps, and one stand-by pump unit. The pump station will collect the reclaimed water downstream of the chlorine contact basins, and will collect treated water from the project remote treatment system when it is located at the RWRF.
- The turnout on the existing Eastern MWD Temescal Valley Pipeline for all of the alternatives, except for Alternatives 1A and 1B, will consist of a vault structure that will contain a flow meter and motor-operated flow control valve. The turnout structure for

Alternatives 1A and 1B will contain a flow meter, motor-operated flow control valve and pressure regulation valving.

- For those alternatives that have a combined reclaimed water conveyance pipeline to the remote treatment system, a pressure regulating station will be constructed on the Eastern MWD reclaimed water pipeline, upstream of the point-of-connection. The pressure regulating station is required to balance the pipeline operating pressure so that it matches the operating pressure of the other pipeline. The pressure regulating station will consist of a pre-cast concrete vault structure containing pressure regulation valving.
- All materials of construction of all project pipelines will be C-900 and C-905 PVC pressure pipe, with polyurethane lined ductile iron fittings. The pipe pressure rating will be 150 psi.

Project Alternative Facilities

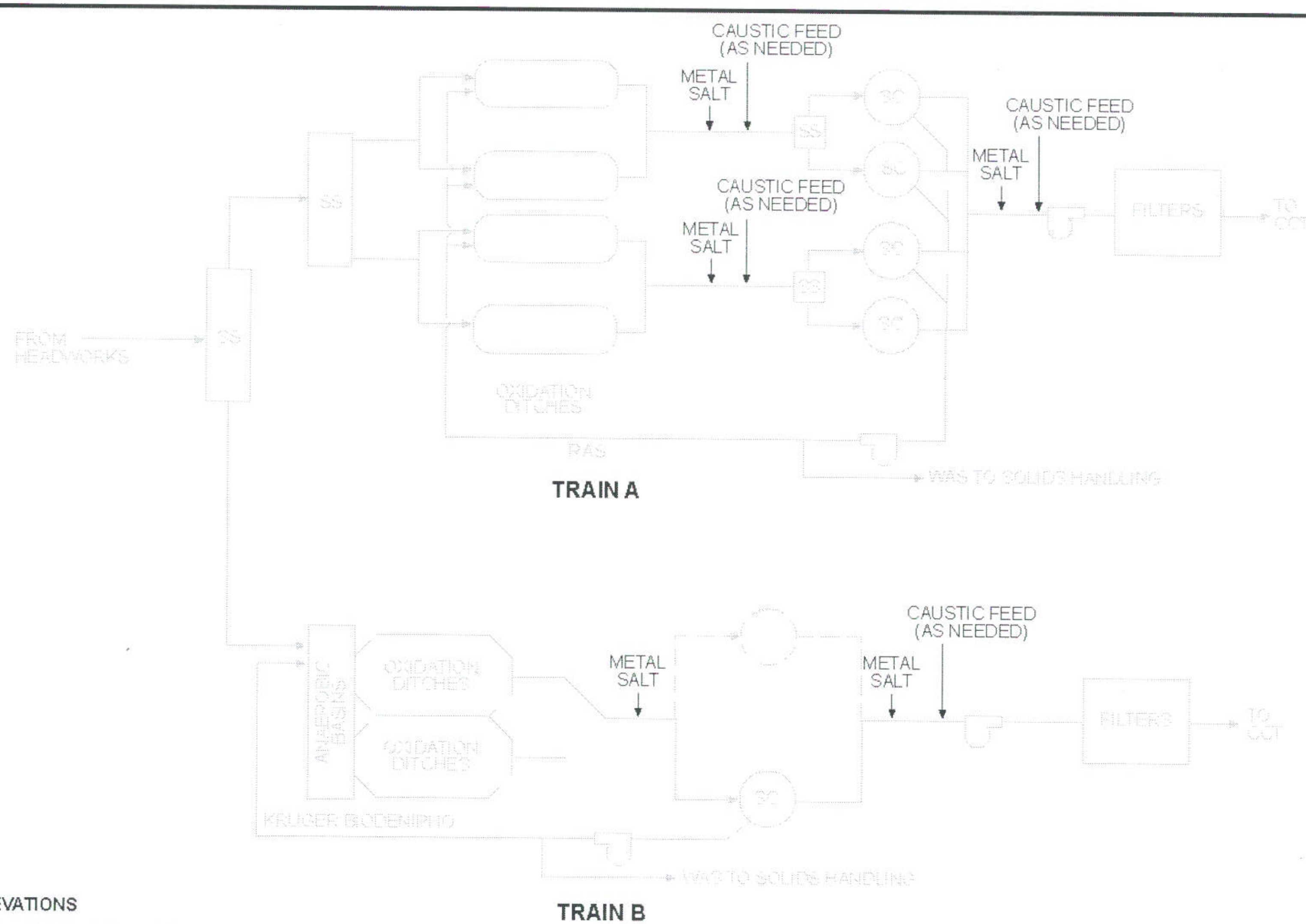
The facilities associated with each of the thirteen project alternatives and sub alternatives are described in the following sections. The facility descriptions will first describe the treatment systems and treatment technologies to be employed to remove phosphorus from the reclaimed water sources and lake water, then will describe the other ancillary facilities required for each alternative. LESJWA is rehabilitating the existing Island Wells. All of the project alternatives assume that the Island Wells after their rehabilitated will continue to be operated by Elsinore Valley MWD to meet their supplemental water commitment for Lake Elsinore. No additional improvements are planned for the Island Wells in any of the project alternatives.

Alternative 1A: Chemical Phosphorus Treatment at RWRFs

Treatment System

Phosphorus treatment will be accomplished at the Elsinore Valley MWD RWRF through the construction of new chemical addition facilities. Ferric chloride will be the coagulant added to the treatment system to accomplish the phosphorus removal required to achieve the study phosphorus nutrient loading objectives to the lake. If additional reclaimed water is needed beyond the production capability of the Elsinore Valley MWD RWRF, it will be purchased from Eastern MWD. This alternative assumes the Elsinore Valley MWD Temecula Valley RWRF treatment system will be upgraded with chemical phosphorus removal facilities to produce effluent that meets the short-term and long-term phosphorus nutrient loading concentrations of 1.0 mg/L and 0.5 mg/L, respectively. The costs for those treatment system upgrades will be recovered through the purchase price of the Eastern MWD reclaimed water. The Temecula Valley RWRF treated effluent will be delivered to Lake Elsinore through Eastern MWD's new Temecula Valley RWRF Effluent Pipeline.

At the Elsinore Valley MWD RWRF, ferric chloride injection points will be located both prior to and after the secondary clarifiers as shown in Figure 5-14. The injection point prior to the secondary clarifier is the primary injection point and the injection point after the secondary clarifier is used as a polishing step when necessary. One additional one meter gravity belt thickener will be added to the existing solids thickening process train to account for the additional solids generated by the ferric chloride addition. It is assumed in this evaluation that the secondary clarifiers and digesters have sufficient capacity to handle the additional solids generated from the ferric chloride addition. Since the ferric chloride



ABBREVATIONS

RAS - Return Activated Sludge
WAS - Waste Activated Sludge
CCT - Chlorine Contact Tank
SS - Splitting Structure

Figure 5-14
Elsinore Valley MWD RWRF
Chemical Precipitation
Phosphorus Removal Improvements

NOTE: ONLY PROCESS RELEVANT TO PHOSPHORUS REMOVAL SHOWN

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injection point is primarily used as a polishing step, if needed, it is also assumed that the impact on the filters is minimal. Further analysis of this alternative is recommended to evaluate the feasibility of the recommended chemical injection locations and to obtain a more detailed cost estimate. Two 6,500-gallon fiberglass-reinforced plastic (FRP) chemical storage tanks will be provided for the storage of the 30 percent ferric chloride solution. Each storage tank is sized to hold one 5,000-gallon tanker load of ferric chloride. Assuming an average ferric chloride dosage of about 25 mg/L, the two tanks will provide approximately 25 days of chemical storage. Three 70 gallon per hour (gph), 0.5 horsepower chemical metering pumps will be provided. One pump will be dedicated to each plant treatment train. The third pump will serve as a stand-by pump for both of the primary chemical metering pumps.

The addition of ferric chloride will cause a decrease in the pH of the liquid stream. Because of that lowering of the liquid stream pH, sodium hydroxide (caustic soda) may have to be added to increase the pH of the liquid stream to make it non-corrosive. One 6,500-gallon caustic soda storage tank will be provided to allow for pH control, if it is needed. The tank is sized to hold one tanker delivery load of caustic soda. The caustic soda injection location will be located downstream of the ferric chloride injection points. Two 0.5 horsepower chemical metering pumps will be provided.

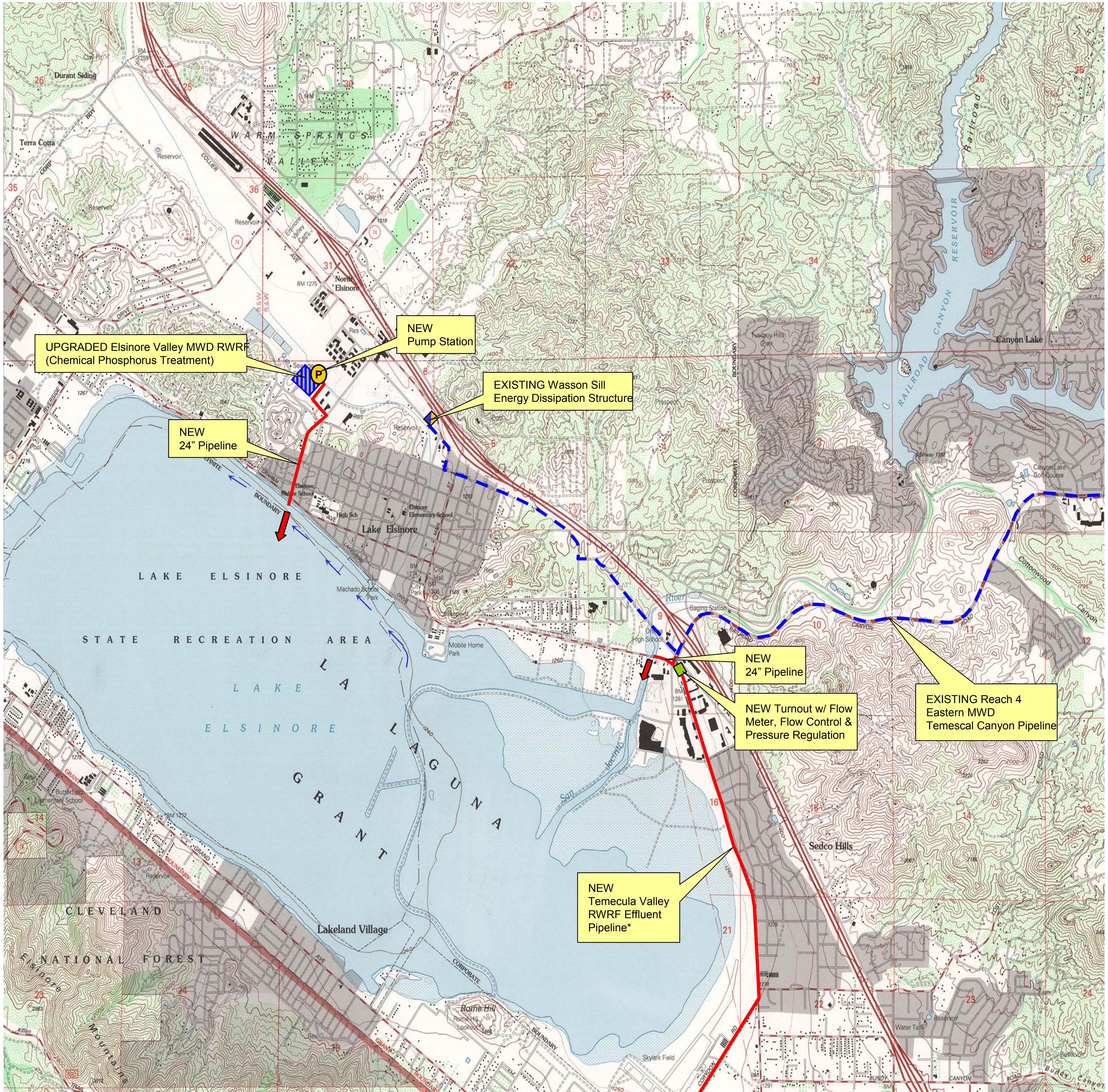
The chemical storage and feed facilities will be sited together as close as possible to the chemical dosage points. The chemical storage tanks and metering pumps will be installed within a concrete containment area with perimeter concrete walls and cover structure over the entire area. Electrical and instrumentation equipment will be housed in weather-proof outdoor panels.

The treated effluent from the Eastern MWD Temecula Valley RWRF will be diverted at a new turnout constructed on the new Temecula Valley RWRF Effluent Pipeline near the intersection of Casino Drive and Diamond Drive. The reclaimed water will be conveyed to Lake Elsinore through the new 24-inch pipeline. The pipeline will run south along Diamond Drive to East Lakeshore Drive, then continue west along East Lakeshore Drive to the San Jacinto River where the treated effluent will be discharged into the Lake Elsinore Inlet Channel. The pipeline will have an overall length of approximately 900 feet.

Ancillary Facilities

The treated effluent from the Elsinore Valley RWRF and Eastern MWD RRWS will be conveyed to Lake Elsinore through separate facilities, as shown in Figure 5-15. The treated effluent from the Elsinore Valley MWD RWRF will be conveyed through a new pump station and pipeline to the lake. The treated effluent from the Eastern MWD Temecula Valley RWRF will be conveyed through the new Temecula Valley RWRF Effluent Pipeline to Lake Elsinore. At Lake Elsinore, a turnout will be constructed on the new pipeline, and a new pipeline constructed to convey the Eastern MWD reclaimed water to the Lake Elsinore Inlet Channel. Residual pressure in the pipeline will be used to convey the treated effluent from the pipeline turnout to the discharge point at the upper end of the lake inlet channel near the ballpark.

The treated effluent from the upgraded Elsinore Valley MWD RWRF will be pumped to Lake Elsinore through a new 24-inch pipeline. The pump station will be located at the RWRF, and will have a pumping capacity of 8.0 mgd at a TDH of about 77 feet. The total



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LEGEND

- Existing Reclaimed Water Pipeline
- New Reclaimed Water Pipeline
- New Treated Water Pipeline
- New Recycled Water Pipeline
- Pump Station
- Treated Water Discharge
- Lake Water Intake
- Wasson Sill Energy Dissipation Structure
- Remote Treatment System
- Pressure Regulating Station
- Assumed Lake Current Direction (based on 2-D depth finite element simulations & ADCP measurements).
- Pipeline Turnout

* Pipeline alignment shown in "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" report, dated October, 2000

Figure 5-15
Alternative 1A
Facilities

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installed pump motor capacity will be 300 horsepower. As shown in the figure, the pipeline will exit the RWRF site, and will run southeast in Trevelen Avenue to Chaney Street, then south along Chaney Avenue to Townsend Street. The pipeline will continue south along Townsend Street to West Lakeshore Drive, then over land to the lake. The pipeline will extend into the lake about 300 feet to allow diffusion of the treated water flows. The pipeline will have an overall length of about 5,500 feet.

The treated effluent from the Eastern MWD Temecula Valley RWRF will be diverted at a new turnout constructed on the new Temecula Valley RWRF Effluent Pipeline near the intersection of Casino Drive and Diamond Drive. The reclaimed water will be conveyed to Lake Elsinore through the new 24-inch pipeline. The pipeline will run south along Diamond Drive to East Lakeshore Drive, then continue west along East Lakeshore Drive to the San Jacinto River where the treated effluent will be discharged into the Lake Elsinore Inlet Channel. The pipeline will have an overall length of approximately 900 feet.

Alternative 1B: Biological Phosphorus Treatment at RWRFs

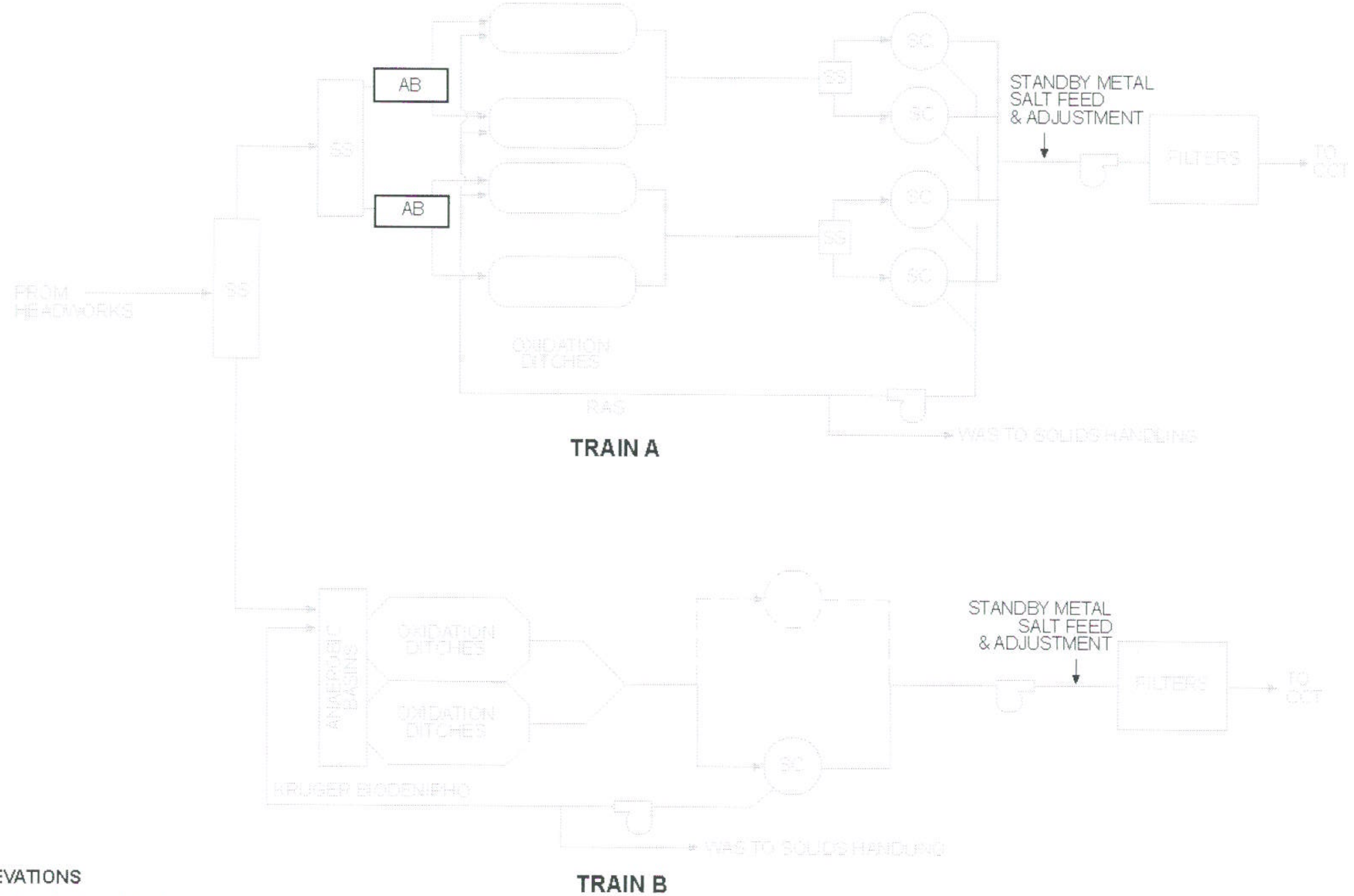
Treatment System

Phosphorus treatment will be accomplished at the Elsinore Valley MWD RWRF through the construction of new biological treatment processes. If additional reclaimed water is needed beyond the production capability of the Elsinore Valley MWD RWRF, it will be purchased from Eastern MWD. This alternative assumes the Elsinore Valley MWD Temecula Valley RWRF treatment system will be upgraded with biological phosphorus removal facilities to produce effluent that meets the short-term and long-term phosphorus nutrient loading concentrations of 1.0 mg/L and 0.5 mg/L, respectively. The costs for those treatment system upgrades will be recovered through the purchase price of the Eastern MWD reclaimed water. The treated water will be delivered to Lake Elsinore through Eastern MWD's new Temecula Valley RWRF Effluent Pipeline. The new biological treatment processes will be supplemented with chemical feed facilities to serve as a standby and polishing step. It has been assumed that ferric chloride will be the metal salt used for phosphorous removal.

The Elsinore Valley MWD RWRF has two treatment trains. Train A, the older treatment train, consists of oxidation ditches, followed by secondary clarifiers, and the final tertiary filters. Train B, the newer treatment train, uses the Kruger BioDenipho process, which is followed by tertiary filters. The Kruger BioDenipho process is a combined nitrogen and phosphorous removal process; hence, Train B will not need any additional biological processes for phosphorous removal.

To achieve biological phosphorus removal in Train A, two 425,000-gallon anaerobic basins will be needed upstream of the oxidation ditches. As shown in Figure 5-16, flow will be diverted to the two new anaerobic basins following the splitting structure. The tanks will provide approximately 1.5 hours of detention time for the flow. Three, 7.5 horsepower mixers will be needed to keep the solids suspend in solution. RAS recycle will be diverted and rerouted from the oxidation ditches to the new anaerobic basins.

One additional 1 meter gravity belt thickener will be added to the existing solids thickening process train to account for the additional solids generated in Train A. It is assumed in this evaluation that the secondary clarifiers and digesters had sufficient capacity to handle the



ABBREVATIONS

RAS - Return Activated Sludge
WAS - Waste Activated Sludge
CCT - Chlorine Contact Tank
SS - Splitting Structure
SC - Secondary Clarifier

Figure 5-16
Elsinore Valley MWD RWRF
Biological Phosphorus Removal Improvements

NOTE: PROCESS RELEVANT TO PHOSPHORUS REMOVAL SHOWN ONLY

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additional solids generated. An additional sludge disposal cost is included in the O&M costs. Since the ferric chloride injection point is primarily used as a polishing step if needed, it is also assumed that the impact on the filters is minimal.

One 3,000-gallon FRP chemical storage tank will be provided for the storage of the ferric chloride solution. The two ferric chloride addition points will be located downstream of the secondary clarifiers in both Trains A and B. Assuming an average ferric chloride dosage of about 5 mg/L, the two tanks will provide approximately 30 days of chemical storage. Three 70 gph, 0.5 horsepower chemical metering pumps will be provided. Two chemical metering pumps will serve as the primary chemical metering pumps for the primary chemical dosage points.

The third pump will serve as a stand-by pumping unit for the two primary chemical metering pumps. The chemical addition facility is designed to supplement the biological processes, but it will also allow each RWRF to meet the effluent limits during periods of biological process upsets.

The chemical storage and feed facilities will be sited together as close as possible to the chemical dosage points at each RWRF. The chemical storage tanks and metering pumps will be installed within a concrete containment area with perimeter concrete walls and cover structure over the entire area. Electrical and instrumentation equipment will be housed in weather-proof outdoor panels.

Ancillary Facilities

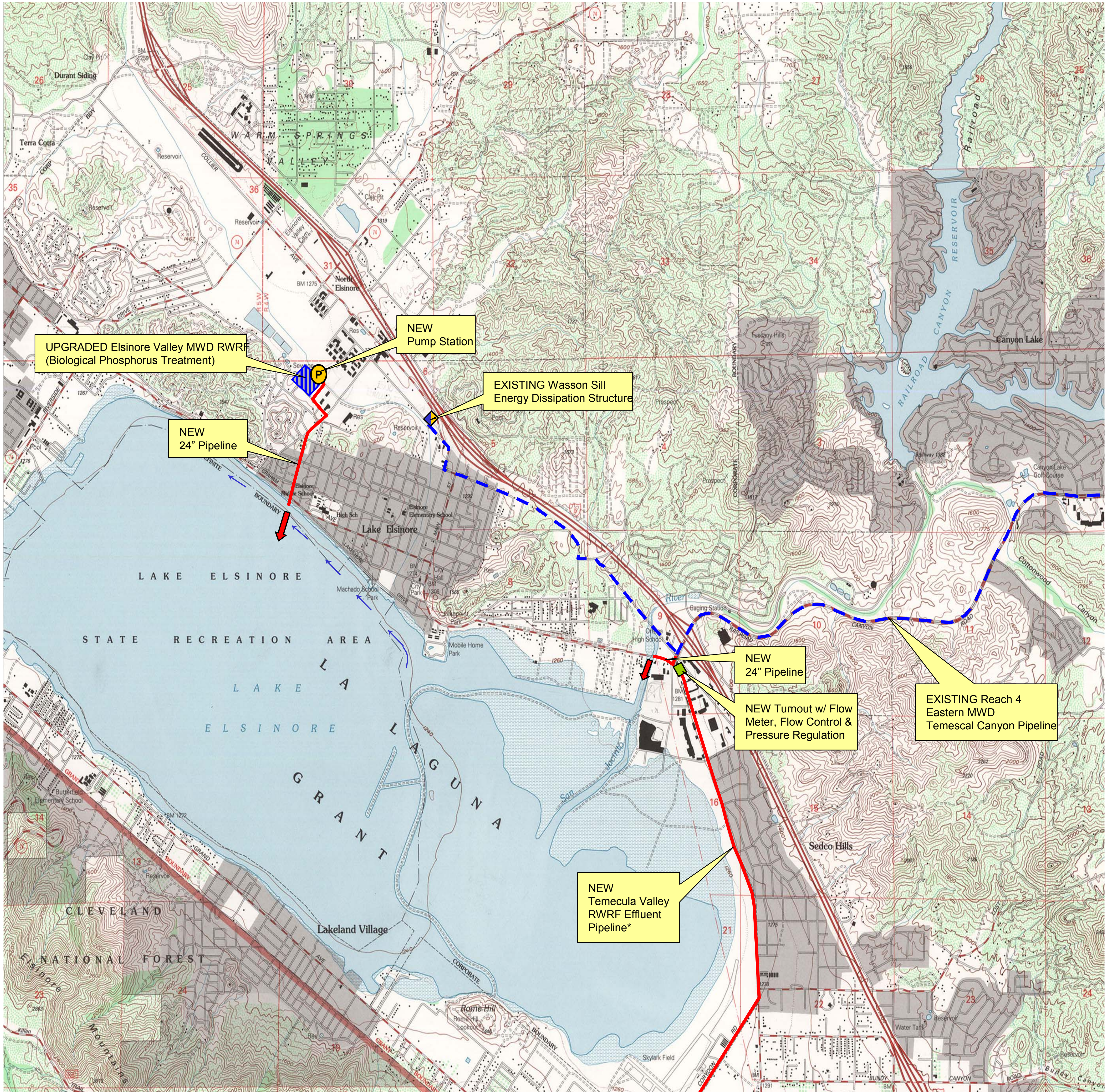
The treated effluent from each of the RWRFs will be conveyed to Lake Elsinore through the separate facilities shown in Figure 5-17. The treated effluent from the Elsinore Valley MWD RWRF will be conveyed through a new pump station and pipeline to Lake Elsinore. The treated effluent from the Eastern MWD Temecula Valley RWRF will be conveyed through the planned new Temecula Valley RWRF Effluent Pipeline. Residual pressure in the pipeline will be used to convey the treated effluent from the pipeline turnout to the point of discharge into the lake inlet channel near the ballpark. The treated effluent conveyance facilities are the same as those described for Alternative 1A.

Alternative 2A: 350-Acre Back Basin Treatment Wetland

Treatment System

The existing 356-acre Back Basin wetland will be converted into 350 acres of surface flow treatment wetland, consisting of shallow marshes interspersed with deep, open-water zones. The treatment wetland will be divided into three parallel flow paths, each consisting of two individual cells operated in series. Effluent from the three parallel flow paths will be combined and routed to the polishing wetland, that will consist of two cells operated in parallel. Figure 5-18 shows the conceptual layout for the 350-acre Back Basin treatment wetland for Alternative 2A.

The creation of multiple parallel flow paths within the 350-acre wetland system will create operational flexibility to optimize water quality performance, and allow individual flow paths or wetland cells to be taken out of service for maintenance. Each wetland cell will include a single inflow and outflow structure centrally located at the influent and effluent edge of the cell. The inflow and outflow structures of each cell will be surrounded by deep



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LEGEND

- Existing Reclaimed Water Pipeline
- New Reclaimed Water Pipeline
- New Treated Water Pipeline
- New Recycled Water Pipeline
- Pump Station
- Treated Water Discharge
- Lake Water Intake
- Wasson Sill Energy Dissipation Structure
- Remote Treatment System
- Pressure Regulating Station
- Assumed Lake Current Direction (based on 2-D depth finite element simulations & ADCP measurements).
- Pipeline Turnout

* Pipeline alignment shown in "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" report, dated October, 2000

Figure 5-17
Alternative 1B Facilities

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Figure 5-18
350-Acre Treatment Wetland Conceptual Layout
Alternative 2A

flow zones to distribute flow, increase hydraulic residence time, settle out particulate matter, and create a greater diversity of habitats. Similar deep zones situated perpendicular to flow will be evenly spaced along the length of the cells. For this conceptual layout, a ratio of marsh area to deep area is targeted to be about 80:20. Planning depths are one foot for marsh areas and five feet for deep zones. An operating depth of five feet for the deep zones should be sufficient to prevent colonization by emergent wetland plants.

The marsh areas could be planted or allowed to colonize naturally, depending upon cost and source of suitable wetland seed sources within the lake watershed. A broad variety of aquatic species exist that are tolerant of continuous flooding could be considered for this wetland alternative. A sample list of wetland plant species includes broadleaf arrowhead (*Sagittaria latifolia*), California bulrush (*Scirpus californicus*), iris-leaved rush (*Juncus xiphioides*), big bulrush (*Scirpus robustus*), common rush (*Juncus effusus*), panicled bulrush (*Scirpus microcarpus*), wire rush (*Juncus balticus*), common tule (*Scirpus acutus*), three-square bulrush (*Scirpus pungens*), and common cattail (*Typha latifolia*). Plants to be planted in the wetland can be obtained from local native plant nurseries or from permitted donor sites. Emergent species would be planted on 3 to 5 foot centers to achieve a robust plant cover.

Reclaimed water from Elsinore Valley MWD and Eastern MWD, and recycled lake water, will be pumped to the wetland, which will then flow by gravity through the wetland to the effluent pump station. The effluent pump station will pump the treated wetland effluent into the Lake Elsinore. Careful control of water levels within each wetland cell and operational flexibility would be key to successful operation and maintenance of the surface wetland system. Adjustable inlet structures (v-notch weirs or stop logs) would allow either full or partial flows to the cells, or complete bypass of individual flow paths.

For the purpose of this study, it is assumed that the marsh invert elevation of the new treatment wetland would be 1,233 feet, which is the same elevation as the existing Back Basin wetland. Operating water depths for the marsh areas could range from 0.5 to 2 feet, but the target operating water depth would be one foot. At a one-foot water depth, the operating water level of the wetland will be at an elevation of 1,234 feet, which is below the desired operating water level range for Lake Elsinore. The wetland treated effluent would be pumped from the wetland to the lake using the existing wet well at the west end of the Back Basin wetland. There is currently no pumping equipment installed in the existing wet well, new submersible pumps and 200 feet of 14-inch discharge pipe through the main levee separating the Back Basin from the lake would be installed. Two primary pumps and one stand-by pump unit would be installed for a combined capacity of 2.8 mgd (3,136 acre-feet per day). The total pump motor capacity would be 75 horsepower. Additionally, the existing 48-inch pipe section through the main levee that is designed to provide connectivity and additional shallow fish habitat in the Back Basin Wetland would be removed to prevent the back flow of lake water into the treatment wetlands.

To provide ancillary environmental benefits, the treatment wetland design could incorporate public use and educational facilities. The existing Back Basin wetlands currently support some recreational use from walkers, joggers, fishermen, and birdwatchers. The treatment wetlands would expand these options by incorporating a boardwalk, gazebo, picnic tables, and educational signage to encourage public use and education about water resources and the benefits of wetlands, such as water quality improvement and habitat creation. The boardwalk could traverse various marsh, deep zone, and transitional habitats, and lead to an observation overlook and gazebo. The educational signage would help educate visitors on areas such as water treatment processes, ecology, wetlands use and management, biology, and the wildlife likely to be observed in and around the wetlands. The boardwalks and overlooks would be used for the general public to observe treatment wetland function, wetlands plant life, and wildlife at close range.

The 350-acre treatment wetland will not have enough treatment capacity to supply all of the long-term average and worst-case drought supplemental water that may be needed to manage the lake operating water elevation and water quality. Accordingly, a remote treatment system will have to be provided to supply the required supplemental water for Lake Elsinore that the wetland cannot supply. The remote treatment system will be located at the lake, near the Diamond Baseball Park, and will have a treatment capacity of 14.0 mgd. The remote treatment system will consist of chemical coagulation and filtration to achieve the required phosphorus removal.

Ferric chloride will be injected into the reclaimed water conveyance pipeline upstream of the remote treatment system through an in-line mixer. Two 6,500-gallon FRP chemical storage tanks will be provided at the remote treatment system site for the storage of the 30 percent ferric chloride solution. Each tank is sized to hold one 5,000-gallon tanker delivery load of ferric chloride. Assuming an average ferric chloride dosage of about 21 mg/L, the two tanks will provide approximately 14 days of chemical storage. Two 30 gph, 0.5 horsepower chemical metering pumps will be provided. The second pump will serve as a stand-by pump. A supported cover will be provided over the chemical storage tank and metering pump area.

The remote treatment system will consist of 20 DynaSand® filter cells in concrete tanks. Each filter cell contains six DSF 50 DBTF DynaSand® filter modules, which provides 50 square feet of filtration area per module. Each cell contains 300 square feet of filtration area. The cells will be installed as dual-stage filtration units in series, and will contain sand media of different size gradations. The filter plant dimensions will be approximately 50 feet in length by 160 feet in width by 20 feet in height. The filtration system has an air compressor system. The process air compressor system, electrical and instrumentation panels will be housed in a climate-controlled engineered metal building.

Ancillary Facilities

The ancillary facilities for Alternative 2A are shown in Figure 5-19. The treated effluent from the Elsinore Valley MWD RWRF will be pumped through a new 24-inch pipeline to the point where the reclaimed water conveyance pipeline from the Eastern MWD system will connect to the pipeline. The point-of-connection will be at the intersection of West Lakeshore Drive and Diamond Drive. The pipeline will increase in size downstream of the connection point to a 36-inch pipeline to the remote treatment system, where the pipeline will then decrease in size to 18-inches from that location to the treatment wetland. The pump station at the Elsinore Valley MWD RWRF will have a pumping capacity of 8.0 mgd at a TDH of about 116 feet. The total installed pump motor capacity will be 225 horsepower.

The pipeline will have an overall length of approximately 29,200 feet from the Elsinore Valley MWD RWRF to the treatment wetland. Table 5-6 breaks the total Elsinore Valley RWRF treated water pipeline length down into the pipeline length for each pipe diameter.

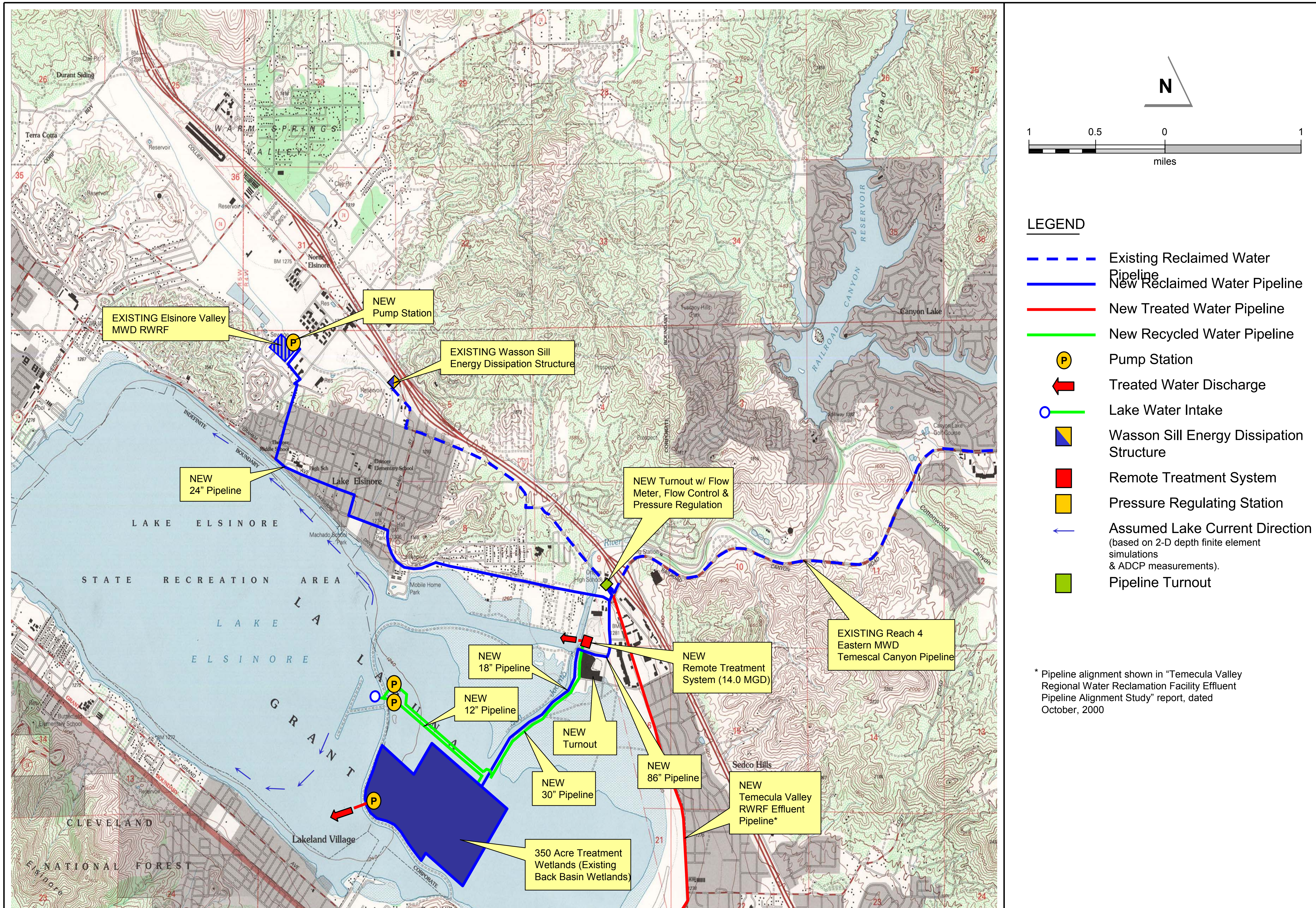

Figure 5-19
Alternative 2A Facilities

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TABLE 5-6
Elsinore Valley MWD RWRF Pipeline Component Lengths

Pipeline Diameter (in)	Pipeline Length (feet)
24	20,200
36	2,600
18	6,400
Totals:	29,200

As shown in the figure, the 24-inch pipeline will exit the RWRF site, then run southeast along Trevelen Avenue to Chaney Street, then run south in Chaney Street to West Flint Street. The pipeline will run east along West Flint Street to Davis Street, then south along Davis Street to West Lakeshore Drive. The pipeline will then follow along West Lakeshore Drive to West Graham Avenue, then east along West Graham Avenue to South Poe Street, the south along South Poe Street to West Limited Street. From that point, the pipeline will continue east in West Limited Street to South Main Street, then south along South Main Street to East Lakeshore Drive, then east along East Lakeshore Drive to the point of connection of the 36-inch Eastern MWD reclaimed water pipeline. From that point, the 36-inch portion of the pipeline will continue south in Diamond Drive to Pete Lehr Drive to the remote treatment system location. From the remote treatment system location, the 18-inch pipeline will continue west in Pete Lehr Drive to Diamond Circle, then south in Diamond Circle to the City of Lake Elsinore easement adjacent to the San Jacinto River. The pipeline will continue within the City easement to the treatment wetland.

The new remote treatment system will be sited along Diamond Circle, adjacent to the San Jacinto River. A turnout will be provided on the 36-inch pipeline to divert reclaimed water flows to the remote treatment system. The turnout will be a concrete vault structure equipped with a flow meter, flow control valve and pressure regulation valving. The treated water from the remote treatment system will be discharged to the San Jacinto River through a short 30-inch pipeline. The waste backwash water from the remote treatment will be discharged through a 12-inch gravity sewer to the Elsinore Valley MWD sewer system. The sewer is not shown in the figure. A pipeline length of 1,500 feet has been allowed for the discharge sewer.

A lake water recycle system has been included in this alternative. The recycle system will have a combined pumping capacity of 16.2 mgd. The pumping capacity of the recycle system was established to take full advantage of the surplus capacity available in the remote treatment system and treatment wetland during the seven month period when reclaimed water is not be available from the Eastern MWD RRWS. The lake water recycle system will collect water from the lake from the area north of the peninsula leading to the Island Wells. That location was selected to provide separation between the treatment wetland treated water discharge point and the lake water collection point to maximize dilution and minimize short-circuiting of the flows. A submerged pre-cast concrete vault with screened inlets will be installed on the bottom of the lake to collect the lake water. A common pipeline will be installed under the lake bottom from the collection vault to the pump station location. Two separate pump stations will be provided. Each pump station will consist of a wet well constructed out of vertical pre-cast concrete pipe sections, with multiple submersible pumps. The pumping capacities and installed pump motor horsepower for each of the pump stations is presented in Table 5-7.

TABLE 5-7
Alternative 2A Recycle Pump Station Pumping and Pump Motor Capacities

Pump Station	Pumping Capacity (mgd)	Total Installed Pump Motor Capacity (Hp)
Treatment Wetland Lake Water Recycle	2.2	75
Remote Treatment Lake Water Recycle	14.0	375
Total:	16.2	

The discharge pipeline for the treatment wetland recycle pump station will run to the treatment wetland inlet as shown in the figure. The 12-inch pipeline will have an overall length of approximately 5,300 feet. The remote treatment system recycle pipeline will run next to the other recycle pipeline to the City of Lake Elsinore's San Jacinto River easement, and will then run north along that easement to remote treatment system. The 30-inch pipeline will have an overall length of approximately 11,700 feet.

Alternative 2B: Elsinore Valley MWD RWRF Chemical Phosphorus Treatment and 350-Acre Back Basin Treatment Wetland

Treatment System

Phosphorus treatment for Alternative 2B will be provided by the construction of new chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF, and by conversion of the existing Back basin Wetland to a 350-acre treatment wetland.

The chemical system treatment upgrades at the Elsinore Valley MWD RWRF will consist of new chemical system, consisting of chemical storage and feed equipment. The new chemical system will have a treatment capacity of 8.0 mgd, which is the current treatment capacity of the RWRF. The treatment system upgrades will also include solids dewatering equipment (one meter belt press) and building. The chemical system components will be identical to those described for Alternative 1A.

The converted 350-acre treatment wetland will be used most of the time to treat Lake Elsinore water circulated through the treatment wetland. The treatment wetland will only have to be used treat reclaimed water from the Eastern MWD RRWS to meet worst-case drought condition supplemental water requirements. The treatment wetland will be configured similar to the Alternative 2A treatment wetland, and will have the same phosphorus removal capabilities.

Ancillary Facilities

The ancillary facilities for Alternative 2B are shown in Figure 5-20. The treated effluent from the upgraded Elsinore Valley MWD RWRF will be pumped through a new 24-inch pipeline from the RWRF to Lake Elsinore. The pump station will be located at the RWRF, and will have a pumping capacity of 8.0 mgd at a TDH of about 80 feet. The total installed pump motor capacity will be 300 horsepower. As shown in the figure, the pipeline will exit the RWRF site, and will run southeast in Treleven Avenue to Chaney Street, then southwest in Chaney Street to Townsend Street, then southwest in Townsend Street to West Lakeshore Drive, then overland to Lake Elsinore. The pipeline will extend into the lake about 300 feet to allow diffusion of the flows. The pipeline will have an overall length of 5,500 feet.

Reclaimed water from the Eastern MWD RRWS will be diverted at a new turnout constructed on the existing Temescal Valley Pipeline near the intersection of Railroad Canyon Road and Casino Drive. The turnout will have flow meter, flow control and pressure regulating facilities. The reclaimed water from Eastern MWD will be conveyed to the treatment wetland through a new 42-inch pipeline. From that intersection, the pipeline will run south in Diamond Drive to Pete Lehr Drive, then west along Pete Lehr Drive to Diamond Circle, then south along Diamond Circle to the City of Lake Elsinore easement along the Old San Jacinto River Channel, then along the easement to the treatment wetland. The total length of the pipeline is about 9,700 feet.

A new lake water intake structure, pump station and pipeline will be constructed to recirculate Lake Elsinore water through the treatment wetland during that portion of the year when reclaimed water may not be available from the Eastern MWD RRWS. The lake water intake structure and pump station will be located in the vicinity of the Island Wells. The pump station will have a 5.75 mgd capacity at a TDH of about 38 feet. The total pump station installed pump motor capacity will be 150 horsepower. The pump station 18-inch discharge pipeline will run southeasterly through the Back Basin area to the new treatment wetland inlet in the vicinity of the Old San Jacinto River Channel. The total length of the pipeline will be about 4,400 feet. A new treatment wetland treated water pump station and discharge pipeline will be needed to convey the treated water to Lake Elsinore. The new pump station will have a pumping capacity of 15.0 mgd to handle the Eastern MWD reclaimed water flows under worst-case drought conditions, at a pumping TDH of about 40 feet. The total installed pump motor capacity will be 300 horsepower.

Alternative 3A: 600-Acre Back Basin Treatment Wetland

Treatment System

In Alternative 3A, the existing Back Basin Wetland will be expanded to the southeast and converted into a 600 acre surface flow treatment wetland, consisting of shallow marshes interspersed with deep, open-water zones. The treatment wetland will be divided into three parallel flow paths, each consisting of four individual cells operated in series. Effluent from the initial three parallel flow paths will be combined and routed to the polishing wetland, consisting of two cells operated in parallel. Figure 5-21 shows the conceptual layout for the 600-acre treatment wetland.

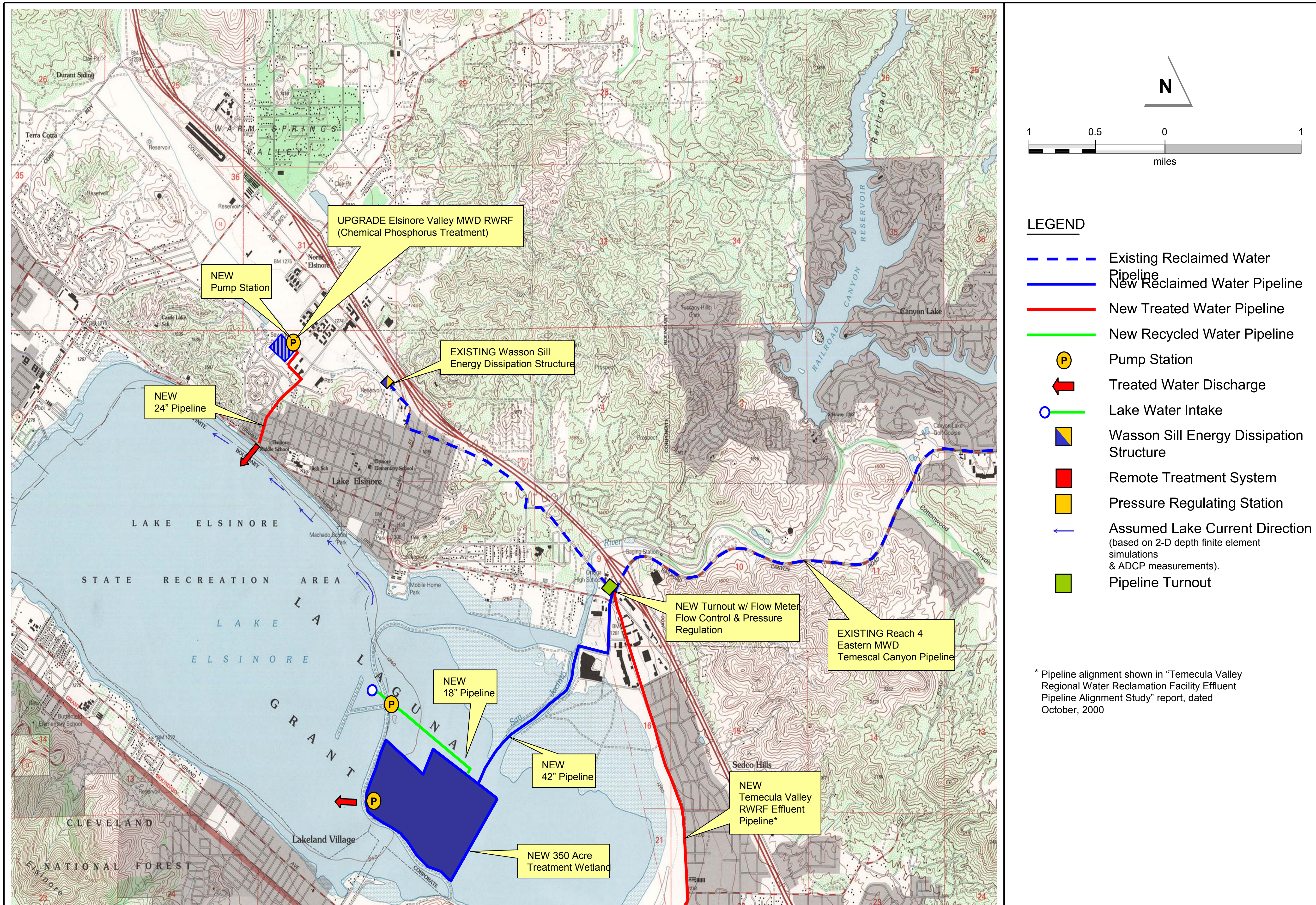

Figure 5-20
Alternative 2B Facilities

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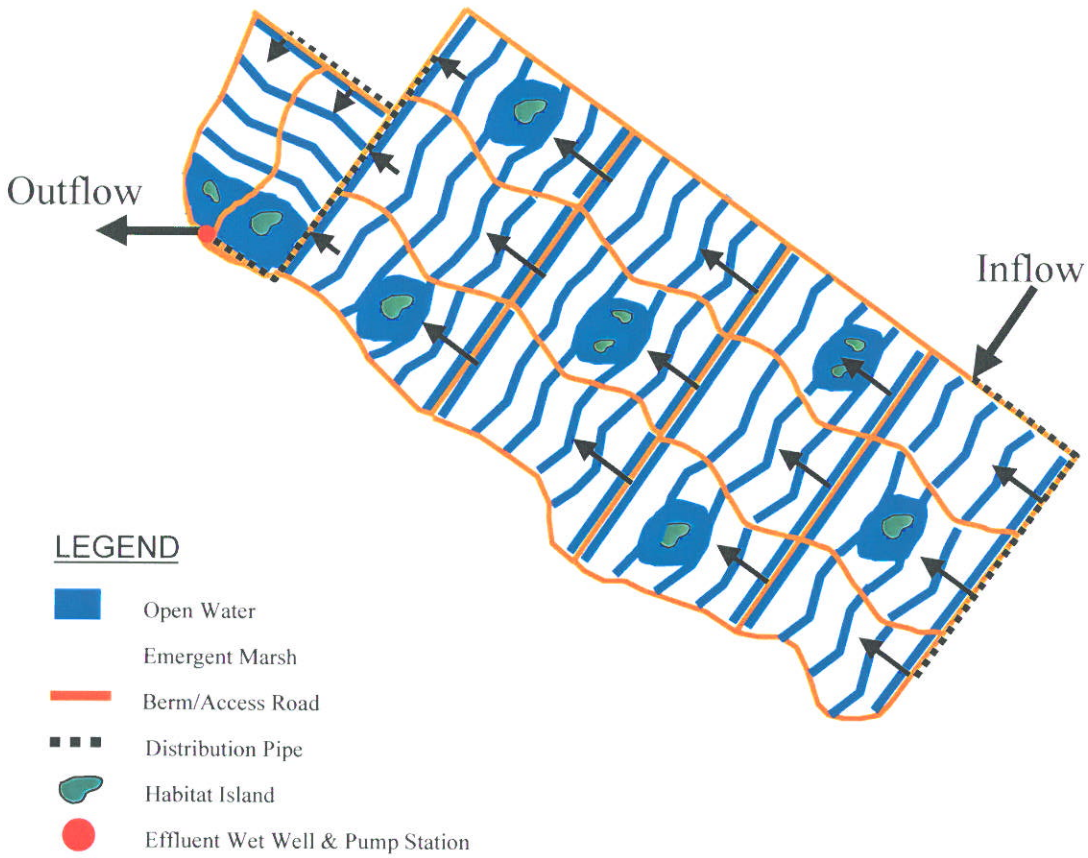


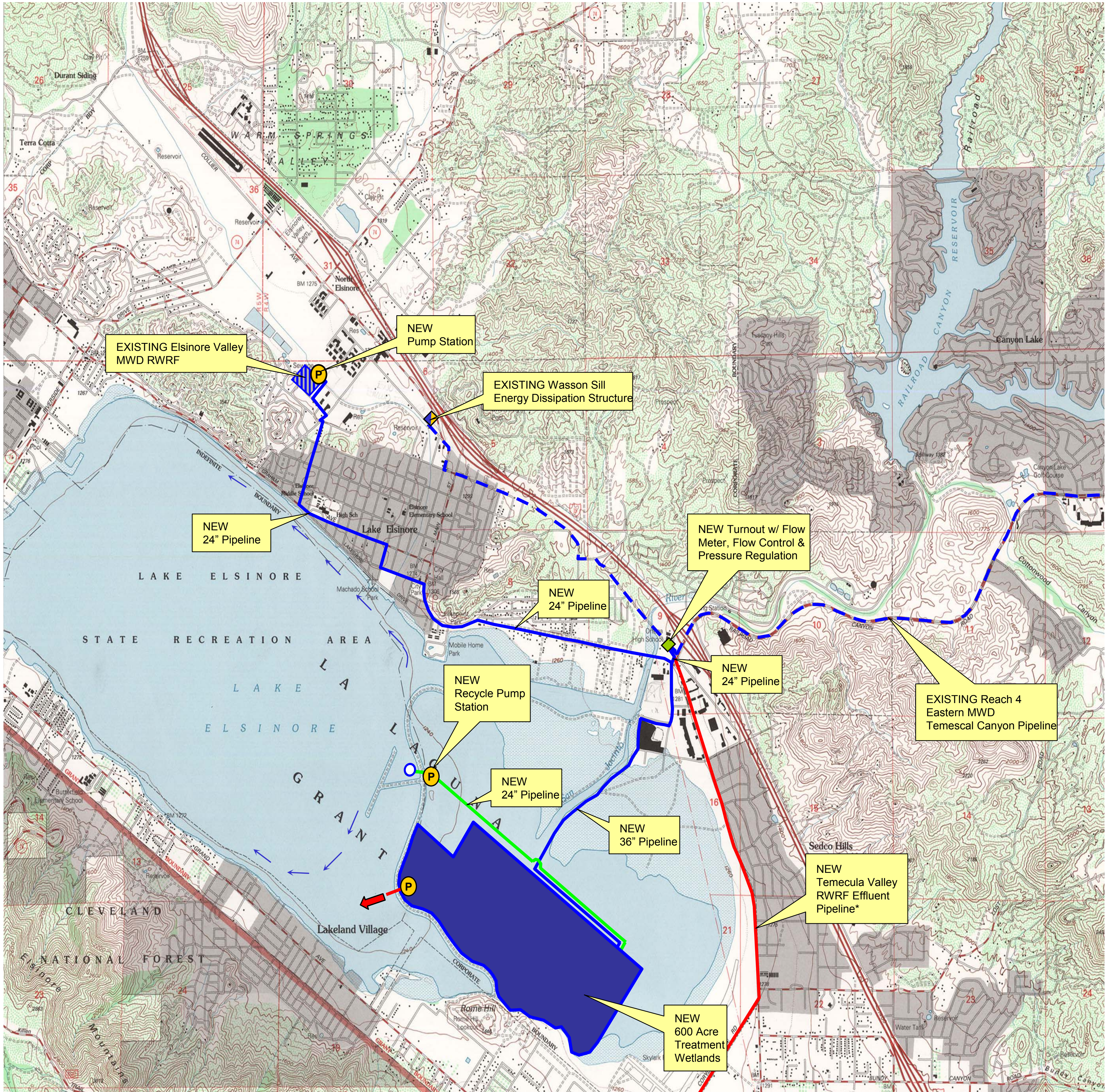
Figure 5-21
600-Acre Treatment Wetland Conceptual Layout
Alternative 3A

Reclaimed water from Elsinore Valley MWD and Eastern MWD and Lake Elsinore water will be conveyed to the wetland for treatment, and will and flow by gravity through the wetland cells to the final effluent pump station, where treated effluent would be pumped into the Lake. For the purpose of this study, it is assumed that the marsh invert elevation of the new treatment wetland will be at elevation 1,233 feet, or the same elevation as the existing Back Basin Wetland. Operating water depths for the marsh areas can be expected to range from 0.5 to 2 feet, with the target operating water depth being about one foot, corresponding to an elevation of 1,234 feet, which is below the desired operating water level range for Lake Elsinore. Treated effluent will be pumped from the wetland to the lake using the existing wet well at the west end of the Back Basin Wetland. There is currently no pumping equipment installed in the existing wet well. New submersible pumps and 200 feet of 18-inch discharge pipe through the main levee separating the Back Basin Wetland from the lake will be installed. Two primary pumps and one stand-by pump unit will be installed for a combined pumping capacity of 4.8 mgd. The total pump motor capacity will be 75 horsepower. Additionally, the existing 48-inch pipe section through the main levee that is designed to provide connectivity and additional shallow fish habitat in the existing Back Basin Wetland will be removed to prevent the back flow of lake water into the treatment wetland.

The Alternative 3A wetland will incorporate public use and educational facilities similar to those described for Alternative 2A. A boardwalk, gazebo, picnic tables, and educational signage to encourage public use and education about water resources and the benefits of a treatment wetland, such as water quality improvement and habitat creation. The creation of multiple parallel flow paths within the 600-acre wetland system will provide operational flexibility to optimize water quality performance and allow for maintenance activities by permitting individual flow paths or wetland cells to be taken offline as needed. Inflow and outflow structures and the creation and distribution of deep zones and marsh areas will be similar to those described for Alternative 2A. The marsh areas will be planted with a diverse mixture of emergent wetland plants.

Ancillary Facilities

Figure 5-22 shows the facilities for Alternative 3A. Reclaimed water from the Elsinore Valley MWD RWRF will be pumped through a new 24-inch pipeline to a point located near the intersection of East Lakeshore Drive and Diamond Drive. At that location, the pipeline will connect with a new Eastern MWD reclaimed water pipeline from their Temescal Canyon Pipeline. From that point of connection, a common 36-inch pipeline will continue to the treatment wetland. The pump station at the Elsinore Valley MWD RWRF will have a pumping capacity of 8.0 mgd at a TDH of about 126 feet. The pump station is sized to match the existing treatment capacity of the RWRF, which will allow future increases treated effluent to be pumped to the wetland for treatment. The total installed pump motor capacity of the pump station will be 450 horsepower. The 24-inch pipeline will have an overall length of about 20,200 feet from the Elsinore Valley MWD RWRF to the point where it connects to the 24-inch Eastern MWD reclaimed water pipeline. As shown in the figure, the pipeline will exit the RWRF site, then run southeast along Trevelen Avenue to Chaney Street, then south along Cheney Street to West Flint Street. The pipeline will run east along West Flint Street to Davis Street, then south along Davis Street to West Lakeshore Drive.



LEGEND

- Existing Reclaimed Water Pipeline
- New Reclaimed Water Pipeline
- New Treated Water Pipeline
- New Recycled Water Pipeline
- Pump Station
- Treated Water Discharge
- Lake Water Intake
- Wasson Sill Energy Dissipation Structure
- Remote Treatment System
- Pressure Regulating Station
- Assumed Lake Current Direction (based on 2-D depth finite element simulations & ADCP measurements).
- Pipeline Turnout

* Pipeline alignment shown in "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" report, dated October, 2000

Figure 5-22
Alternative 3A Facilities

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The pipeline will then follow along West Lakeshore Drive to West Graham Avenue, then east along West Graham Avenue to South Poe Street, the south along South Poe Street to West Limited Street. From that point, the pipeline will continue east in West Limited Street to South Main Street, then south along South Main Street to East Lakeshore Drive, then east along East Lakeshore Drive to the point of connection to the 24-inch Eastern MWD reclaimed water pipeline. At that location, the pipeline diameter will be increased to 36 inches to handle the reclaimed water flows from both sources. A turnout will be constructed on the existing Eastern MWD Temescal Valley Pipeline to divert the reclaimed water flows. The turnout facility will have a flow meter, flow control valve and pressure regulating valving. A 24-inch pipeline segment, about 900 feet in length, will run from the turnout structure to the connection with the Elsinore Valley MWD reclaimed water pipeline. The 36-inch pipeline will continue from the intersection of East Lakeshore Drive and Diamond Avenue south in Diamond Drive to Pete Lehr Drive, then run west along Pete Lehr Drive to Diamond Circle. The pipeline will then run south along Diamond Circle to the City of Lake Elsinore's easement along the Old San Jacinto River Channel to the treatment wetland. The 36-inch pipeline will have a total length of approximately 11,900 feet.

A lake water recycle system has been provided for this alternative to allow utilization of the surplus wetland treatment capacity during the seven months of the year that reclaimed water may not be available from the Eastern MWD RRWS. The lake water recycle system will have a capacity of 9.7 mgd, at a TDH of about 63 feet. The total installed pump motor capacity will be 300 horsepower. The lake water recycle system will collect water from the area of the lake located north of the peninsula leading to the Island Wells. That location was selected to provide separation between the treatment wetland treated water discharge point and the point where the lake water is collected to maximize dilution and minimize short-circuiting of the flows. A 24-inch pipeline will be installed under the lake bottom from the collection vault to the pump station. A 24-inch recycle pipeline will extend from the pump station location southeasterly through the Back Basin area to the treatment wetland inlet, as shown in the figure. The 24-inch pipeline will have a total length of approximately 8,800 feet.

Alternative 3B: Elsinore Valley MWD RWRF Chemical Phosphorus Treatment and 600-Acre Back Basin Treatment Wetland

Treatment System

Phosphorus removal for Alternative 3B will be provided by new chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF, and an expanded 600-acre treatment wetland.

The chemical phosphorus treatment system upgrades at the Elsinore Valley MWD RWRF will consist of a new chemical system, consisting of chemical storage and feed equipment. The new chemical system will be sized to handle the current 8.0 mgd treatment capacity of the RWRF. The treatment system upgrades will also include solids dewatering equipment (one meter belt press) and building. The chemical system components will be identical to those described for Alternative 1A.

The treatment wetland will function similar to the Alternative 2B treatment wetland. The treatment wetland will only be needed to treat reclaimed water from the Eastern MWD

RRWS during worst-case drought conditions to meet lake supplemental water requirements. The remainder of the time, the wetlands will be used to treat lake water circulated through the treatment wetland. The treatment wetland will be configured similar to the Alternative 3A treatment wetland, and will have the same phosphorus removal capabilities.

Ancillary Facilities

The facilities for Alternative 3B are shown in Figure 5-23. A new pump station and 24-inch treated water pipeline will be constructed to convey treated effluent from the Elsinore Valley MWD RWRF to Lake Elsinore. The pump station will be sited at the RWRF, and will have a pumping capacity of 8.0 mgd at a TDH of about 88 feet. The pump station installed pump motor capacity will be 300 horsepower. The treated water pipeline will exit the

RWRF site and will run southwest along Treleven Avenue to Chaney Street, then south in Chaney Street to Townsend Street. The pipeline will continue south in Townsend Street to West Lakeshore Drive then overland to the lake. The pipeline will extend about 300 feet into the lake to allow diffusion of the flows. The total length of the pipeline is 5,500 feet.

A turnout facility on the Eastern MWD Temescal Valley Pipeline and new pipeline will be constructed to convey reclaimed water from the Eastern MWD RRWS to the treatment wetland. The turnout facility will be located downstream of the point where the Temecula Valley Pipeline connects to the pipeline, along Auto Center Drive just west of Diamond Drive. The turnout facility will contain a flow meter, flow control valve and pressure regulating valving. The new 60-inch pipeline will run from the turnout facility south in Diamond Drive to Pete Lehr Drive, then west along Pete Lehr Drive to Diamond Circle. The pipeline will then continue south along Diamond Circle to the City of Lake Elsinore's easement that runs along the Old San Jacinto River Channel, then in the easement to the treatment wetland. The total length of the pipeline is about 13,200 feet.

The intake structure for the lake water recycle pump station will be located north of the peninsula that leads to the Island Wells. A 36-inch pipeline will be run beneath the lake bottom from the intake structure to the pump station that will be situated on the levee that separates the current Back Basin Wetland from the lake. A 36-inch pump station discharge pipeline will run southeasterly through the Back Basin area to the treatment wetland inlet as shown in the figure. The total length of the pipeline is about 8,600 feet. A new treated effluent pump station will also be constructed. The pump station will have a pumping capacity of 22.5 mgd at a THD of about 39 feet. The installed pump motor capacity is 450 horsepower.

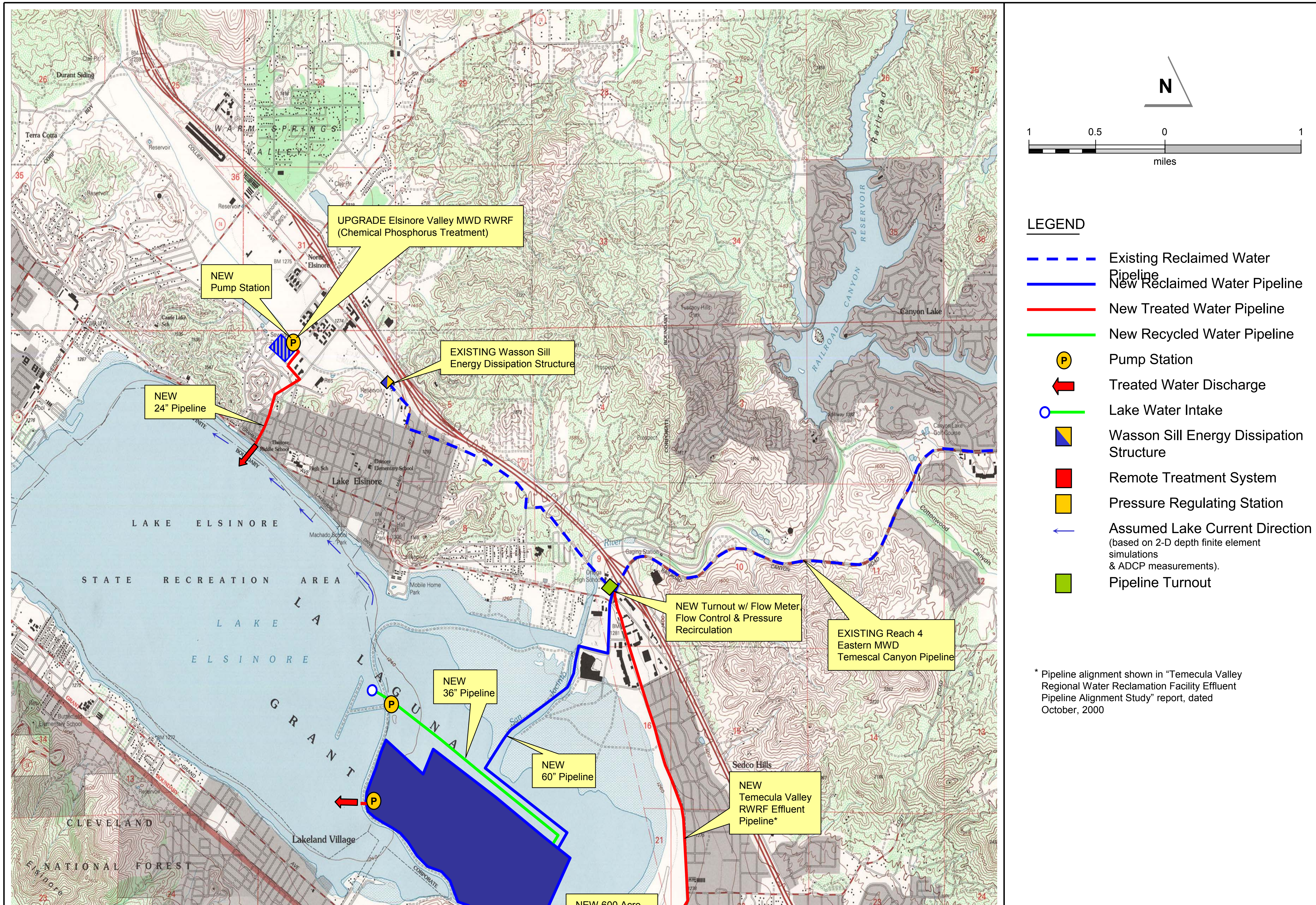

Figure 5-23
Alternative 3B Facilities

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Alternative 4: 350-Acre Littoral Wetland

Treatment System

A 350-acre littoral surface flow wetland consisting shallow marshes interspersed with deep, open-water zones will be constructed within the existing Lake Elsinore shoreline, along the southern periphery of the lake near Rome Hill. The treatment wetland will be divided into two parallel flow paths, one consisting of three individual cells operated in series and the other consisting of one cell with a sinuous flow path. A new lake-side levee will be constructed as an extension of the peninsula where the three Island Wells are located. Figure 5-24 shows the conceptual layout for the 350-acre littoral wetlands.

Reclaimed water from Elsinore Valley MWD and Eastern MWD will be conveyed to the littoral wetland for treatment, and will flow by gravity through the wetland cells to the effluent pump station where the treated effluent will be pumped over the exterior levee into Lake Elsinore. A lake water recycle system will also be provided to allow the circulation of lake water through the littoral wetland when there is surplus treatment capacity. For the purpose of this study, it is assumed that the marsh invert elevation of the new treatment wetland will be at the same elevation as the existing Back Basin Wetland (1,233 feet). Alternative 4 will require construction of a new main levee to separate the wetland from the lake. The new main levee will be constructed to an elevation of 1,264 feet, which is the same elevation as the existing levee separating the back Basin area from the lake. Operating water depths for the marsh areas could range from 0.5 to 2 feet, but the target operating water depth will be about one foot, corresponding to an elevation of 1,234 feet which is below the desired operating water level range for Lake Elsinore. A new pump station will therefore have to be constructed to pump the wetland effluent over the main levee to the Lake. The pump station will be a duplex submersible pump installation with a pumping capacity of 5.7 mgd (6,385 acre-feet per day) at a TDH of about 39 feet. The total installed pump motor capacity will be 150 horsepower.

Alternative 4 will incorporate public use and educational facilities similar to those described for Alternative 2A. A boardwalk, gazebo, picnic tables, and educational signage to encourage public use and education about water resources and the benefits of the wetland, such as water quality improvement and habitat creation are envisioned for the wetland. The creation of parallel flow paths within the 350-acre wetland system would create operational flexibility to optimize water quality performance and allow for maintenance activities; individual flow paths could be taken offline as needed. Inflow and outflow structures and the creation and distribution of deep zones and marsh areas will be similar to those described for Alternative 2A. The marsh areas will be planted with a diverse mixture of emergent wetland plants.

A remote treatment system will be needed for this alternative to provide the supplemental water required for the worst-case drought supplemental water condition. The remote treatment system will consist of chemical coagulation followed by two-stage filtration, and will have a treatment capacity of 8.5 mgd. The remote treatment system will be capable of producing the 3,880 acre-feet per year of supplemental water during the five-month period when surplus reclaimed water will be available from Eastern MWD RRWS. The remote treatment system will be located adjacent to the lake perimeter levee near the location of the existing Back Basin Wetland. The remote treatment system will consist of chemical pretreatment and a two-stage filtration process similar to the two-stage DynaSand® process.

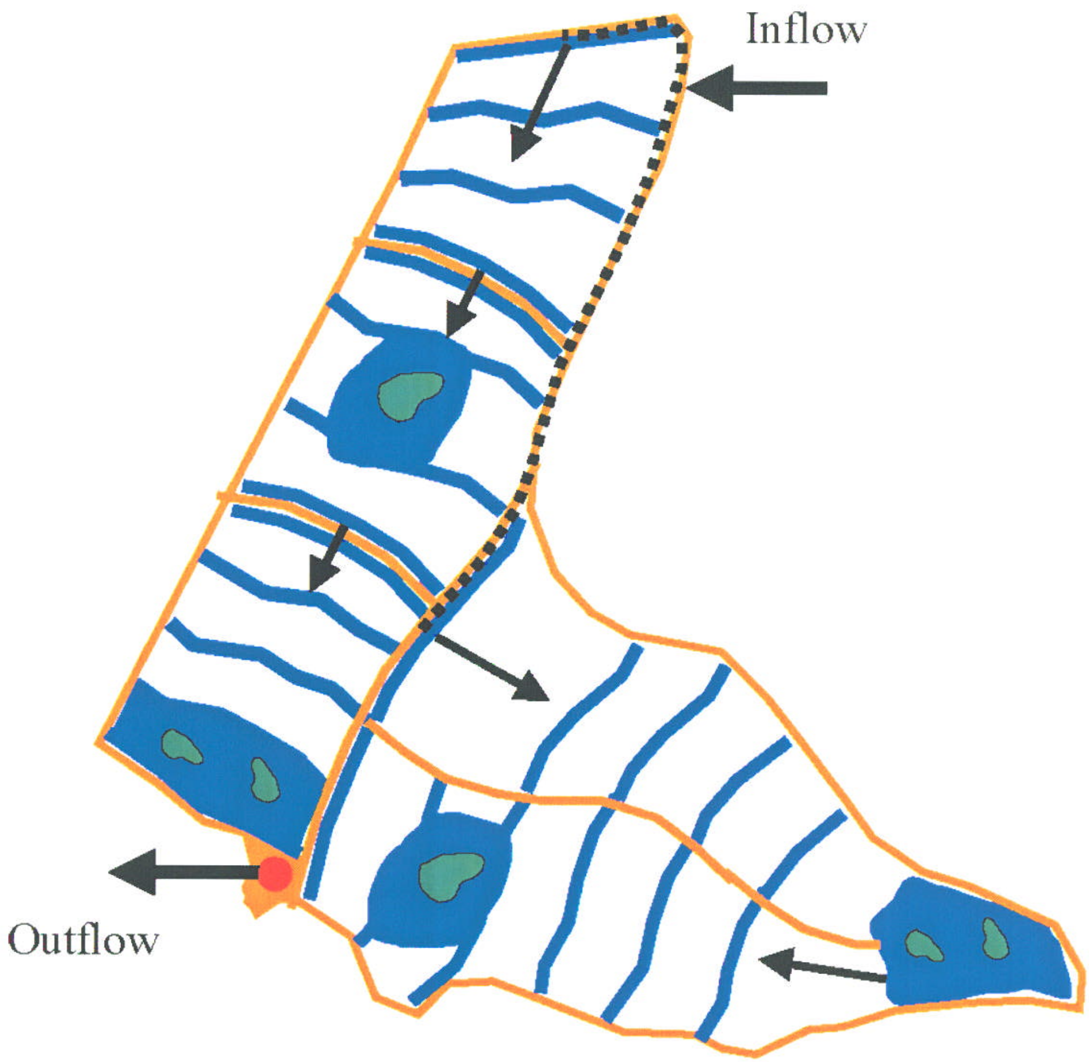

Figure 5-24
350-Acre Littoral Wetland Conceptual Layout
Alternative 4

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A two-stage filtration process is being used because of its better phosphorus removal characteristics.

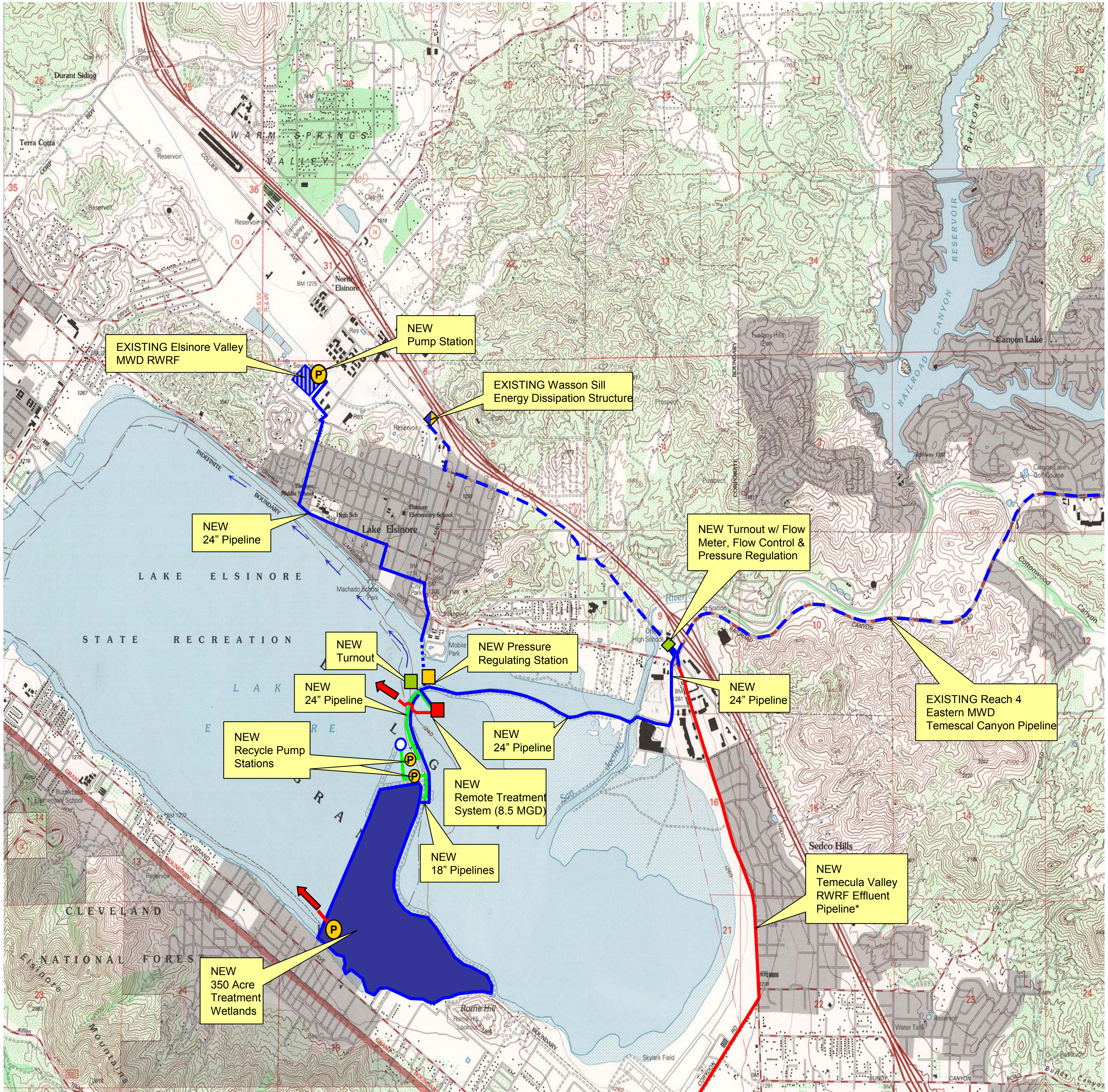
Ferric chloride will be used as the primary coagulant, and will be injected into the reclaimed water conveyance pipeline upstream of the remote treatment system through an in-line mixer. One 6,500-gallon FRP chemical storage tank will be provided at the remote treatment plant site for the storage of the 30 percent ferric chloride solution. Assuming an average ferric chloride dosage of about 21 mg/L, the tank will provide approximately 14 days of chemical storage. Two 20 gph, 0.5 horsepower chemical metering pumps will be provided. The second pump will serve as a stand-by pump. A supported cover will be provided over the chemical storage tank and metering pump area.

The remote treatment system will consist of 12 DynaSand® filter cells in concrete tanks. Each filter cell contains six DSF 50 DBTF DynaSand® filter modules, which provide 50 square feet of filtration area per module. Each cell has a filtration area of 300 square feet. The cells will be installed as dual-stage filtration units in series, and will contain sand media of different size graduations. The filtration process dimensions will be approximately 50 feet in length by 100 feet in width by 20 feet in height. A supported cover will be constructed over the filters. The filtration system has an air compressor system. The process air compressor system, electrical and instrumentation panels will be housed in a climate-controlled engineered metal building.

Ancillary Facilities

The treated effluent from the Elsinore Valley MWD RWRF will be pumped through a new 24-inch pipeline. The pipeline will run from the RWRF to a point, located on the southeast shoreline of Lake Elsinore, where the pipeline will connect to the pipeline conveying the reclaimed water from the Eastern MWD Temescal Canyon Pipeline. The pump station at the Elsinore Valley MWD RWRF will have a pumping capacity of 8.0 mgd at a total TDH of about 154 feet. The total installed pump motor capacity will be 525 horsepower. The 24-inch pipeline will have an overall length of about 13,000 feet from the Elsinore Valley MWD RWRF to the point where the pipeline connects to the Eastern MWD reclaimed water pipeline. The pipeline alignment, as shown in Figure 5-25, will exit the RWRF site, then run southeast along Trevelen Avenue to Chaney Street. The pipeline will then run south in Chaney Street to West Flint Street, then east in West Flint Street to Davis Street, then south in Davis Street to West Lakeshore Drive. The pipeline will then run southeast along West Lakeshore Drive to West Graham Avenue, then east along West Graham Avenue to South Poe Street, then south in South Poe Street to West Limited Street. The pipeline will then run east in West Limited Street to South Main Street, then south along South Main Street to East Lakeshore Drive, then overland along the western boundary of Lakepoint Park to the lake shoreline. The 24-inch pipeline will then be jacked across the Lake Elsinore Inlet Channel to the south side of the lake. The jacked pipeline length is about 1,500 feet. The pipeline will then join with the 24-inch Eastern MWD reclaimed water pipeline upstream of the remote treatment system, as shown inn the figure.

The 24-inch pipeline for the Eastern MWD reclaimed water will originate at a turnout constructed on the existing Temescal Valley Pipeline. The turnout facility will consist of a concrete vault structure that will contain a flow meter and motor-operated flow control valve. The pipeline will run from the turnout facility, near the intersection of Diamond



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LEGEND

- Existing Reclaimed Water Pipeline
- New Reclaimed Water Pipeline
- New Treated Water Pipeline
- New Recycled Water Pipeline
- Pump Station
- Treated Water Discharge
- Lake Water Intake
- Wasson Sill Energy Dissipation Structure
- Remote Treatment System
- Pressure Regulating Station
- Assumed Lake Current Direction (based on 2-D depth finite element simulations & ADCP measurements).
- Pipeline Turnout
- New Jacked Reclaimed Water Pipeline

* Pipeline alignment shown in "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" report, dated October, 2000

Figure 5-25
Alternative 4 Facilities

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Drive and casino Drive, south along Diamond Drive to Pete Lehr Drive, then west along Pete Lehr Drive to Diamond Circle, then south in Diamond Circle to the Lake Elsinore Inlet Channel levee. The pipeline will then run along the levee to a point upstream of the remote treatment system site, where the pipeline will tie into the Elsinore Valley MWD reclaimed water pipeline. At that location, the pipeline diameter will be increased to 30 inches. A pressure regulating station will be provided on the Eastern MWD reclaimed water pipeline upstream of the point-of-connection to the Elsinore Valley MWD pipeline to balance the operating pressures between the two pipelines. The total length of the 24-inch Eastern MWD reclaimed water pipeline will be about 11,200 feet.

A turnout will be provided in the common 30-inch pipeline at the remote treatment system to allow diversion of reclaimed water for treatment. The turnout will be a concrete vault structure with flow meter, motor-operated flow control valve and pressure regulating valving. The 30-inch pipeline from the point-of-connection of the two pipelines to the remote treatment system will have a length of about 200 feet. The combined reclaimed water pipeline will decrease in size to 18 inches at the remote treatment system turnout structure. The 18-inch pipeline will extend from the turnout structure to the littoral wetland, a total length of about 10,100 feet.

A lake water recycle system has been provided for this alternative. The lake water recycle pump station will be located on the lake levee, just north of the peninsula leading to the Island Wells. Two separate pump stations will be provided to recycle lake water to the remote treatment system and the littoral wetland. A common lake water inlet and 30-inch suction pipeline will provide water to the two pump stations. Each of the two pump stations will consist of a precast concrete pipe wet-well and submersible pumps in a two primary pump and one standby pump configuration. The pumping capacities and total installed pump motor horsepower for each of the pump stations is presented in Table 5-8.

TABLE 5-8
Alternative 4 Recycle Pump Station Pumping and Total Installed Pump Motor Capacities

Pump Station	Pumping Capacity (mgd)	Total Installed Pump Motor Capacity (Hp)
Treatment Wetland Lake Water Recycle	2.2	150
Remote Treatment Lake Water Recycle	8.5	150
Totals:	10.7	300

The 12-inch recycle pipeline for the littoral wetland recycle pump station will run to the inlet end of the littoral wetland, as shown in Figure 5-27. The pipeline will have an overall length of approximately 800 feet. The 24-inch recycle pipeline for the remote treatment system will run along the lake levee from the pump station location to the remote treatment system. The pipeline will have an overall length of about 2,200 feet.

Alternative 5A: Remote Treatment at Elsinore Valley MWD RWRF

Treatment System

A remote treatment system will provide the phosphorus treatment for this alternative. The remote treatment system will be sited at the Elsinore Valley MWD RWRF, and will have a treatment capacity of 14.5 mgd. The reclaimed water from the Elsinore Valley MWD RWRF will be diverted to the remote treatment system downstream of the chlorine contact basins. For the purpose of this study, it has been assumed that a pump station will be required to pump the diverted reclaimed water to the remote treatment process. The reclaimed water from the Eastern MWD RRWS will be diverted from the Temescal Valley Pipeline and will be conveyed to the Elsinore Valley MWD RWRF for treatment. It has been assumed that there is sufficient residual pressure in the pipeline to convey the reclaimed water flows to the remote treatment system.

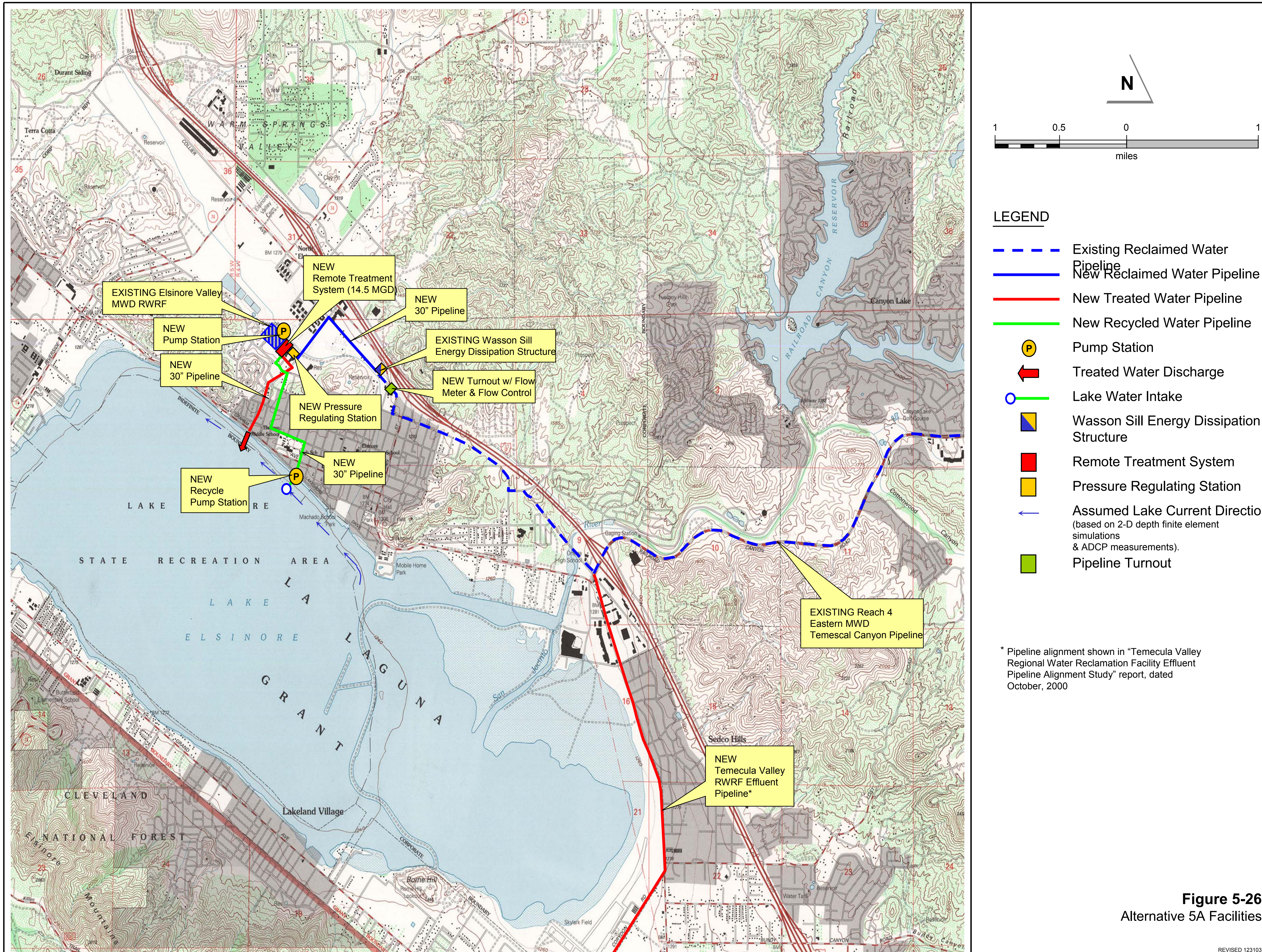
Two 6,500-gallon FRP chemical storage tanks will be provided at the Elsinore Valley MWD RWRF for the storage of the 30 percent ferric chloride solution. The ferric chloride will be injected into the pipeline upstream of the remote treatment system through an in-line mixer. Assuming an average ferric chloride dosage of about 21 mg/L, the two tanks will provide approximately 14 days of chemical storage. Two 30 gph, 0.5 horsepower chemical metering pumps will be provided. The second pump will serve as a stand-by pump. The chemical storage and feed facilities will be sited together at the RWRF. The chemical storage tanks and metering pumps will be installed within a concrete containment area, with perimeter concrete walls and cover structure over the entire area. Electrical and instrumentation equipment will be housed in outdoor weatherproof panels.

The remote treatment system will be a two-stage filtration process, consisting of 20 DynaSand® filter cells in concrete tanks. Each filter cell contains six DSF 50 DBTF DynaSand® filter modules and provides 50 square feet of filtration area per module. Each cell thus contains a filtration area of 300 square feet. The cells will be installed as dual-stage filtration units in series and will contain sand media with different size gradations. The filtration process dimensions will be approximately 50 feet in length by 160 feet in width by 20 feet in height. The filtration system will have an air compressor system. The process air compressor system, electrical and instrumentation panels will be housed in a climate-controlled engineered metal building.

Ancillary Facilities

A turnout will be constructed on the existing Eastern MWD Temescal Valley Pipeline upstream of the Wasson Sill energy dissipation structure. From the turnout, a new 30-inch pipeline will be constructed to convey the diverted reclaimed water flows to the Elsinore Valley MWD RWRF for treatment, as shown in Figure 5-26. The pipeline will run northwest along West Minthorn Street to Chaney Street, then southwest along Chaney Street to Temescal Creek, then northwest along the creek easement to the Elsinore Valley MWD RWRF and the remote treatment system. A pressure regulating station, consisting of a concrete vault structure with pressure regulating valving, will be provided in the pipeline upstream of the point-of-discharge to the remote treatment system. The total length of the 30-inch Eastern MWD reclaimed water pipeline will be about 6,000 feet.

The treated water from the remote treatment system at the Elsinore Valley MWD RWRF will be pumped through a new 30-inch pipeline to Lake Elsinore. The pump station at the Elsinore Valley MWD RWRF will collect the treated effluent from the remote treatment system, and will have a pumping capacity of 14.5 mgd at a TDH of about 77 feet. The total installed pump motor capacity will be 450 horsepower. The treated water pipeline will exit the Elsinore Valley MWD RWRF site and will run east in Treleven Avenue to Chaney Street, then proceed south in Chaney Street to Townsend Street. The pipeline will then run south



* Pipeline alignment shown in "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" report, dated October, 2000

Figure 5-26
Alternative 5A Facilities

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along Townsend Street to West Lakeshore Drive, then overland to the lake. The pipeline will extend into the lake approximately 300 feet to allow diffusion of the treated water flows into the lake water. The pipeline will have an overall length of about 5,500 feet.

A lake water recycle system has been provided for this alternative. The recycle pump station will have a pumping capacity of 11.6 mgd, with a pumping TDH of 113 feet. The total installed pump motor capacity will be 600 horsepower. A 30-inch recycle pipeline will extend from the pump station to the Elsinore Valley MWD RWRF. The pump station will be located along the lake shoreline in the vicinity of North Lewis Street. The pipeline will run overland from the lake shoreline to West Lakeshore Drive, then run northwest in North Lewis Street to West Heald Street, then west in West Heald Street to Davis Street. The pipeline will run north in Davis Street West Flint Street, then west in West Flint Street to Chaney Street, then north in Chaney Street to Treleven Avenue, then northwest in Treleven Avenue to the Elsinore Valley MWD RWRF site. The pipeline will have a total length of approximately 7,500 feet.

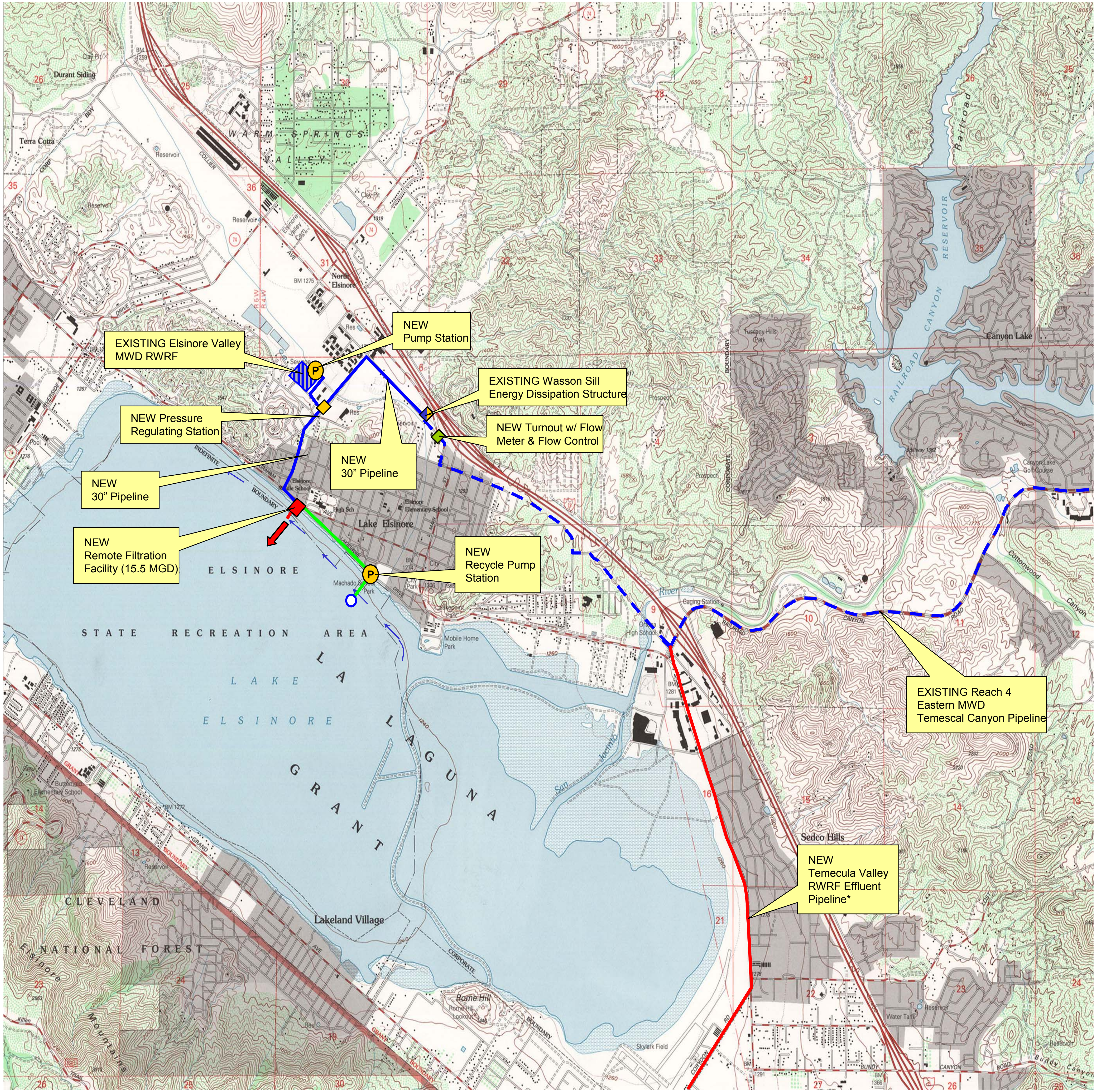
Alternative 5B: Remote Treatment at Lake Elsinore

Treatment System

A remote treatment system situated along the lake shoreline will provide the phosphorus treatment for Alternative 5B. The remote treatment system will be located within the City-owned public fishing beach along Acacia Drive, east of Davis Street, as shown in Figure 5-27. The remote treatment system will have a treatment capacity of 14.5 mgd, and will consist of coagulant addition upstream of a membrane filtration process. The remote treatment system will be a low-pressure membrane system, similar to a Pall microfiltration membrane system.

The coagulant system will consist of chemical storage tanks and metering pumps. Two 6,500-gallon FRP chemical storage tanks will be provided for the storage of ferric chloride solution. The ferric chloride will be injected into a mixing basin upstream of the membrane process. The mixing basin will provide approximately 10 minutes of contact time to allow the mixing of the chemical with the reclaimed water prior to treatment. Assuming an average ferric chloride dosage of about 21 mg/L, the two tanks will provide approximately 14 days of chemical storage. Two 30 gph, 0.5 horsepower chemical metering pumps will be provided. The second pump will serve as a stand-by pump. The chemical storage and feed facilities will be sited together. The chemical storage tanks and metering pumps will be installed within a concrete containment area, with perimeter concrete walls and cover structure over the entire area. Electrical and instrumentation equipment will be housed in outdoor weatherproof panels.

The membrane treatment system will consist of eight operating membrane blocks. Each membrane block will consist of approximately 80 hollow fine-fiber microfiltration modules. The module dimensions are approximately 6 feet in length and 5 inches in diameter. The membrane material will be polyvinylidene fluoride (PVDF). The membrane process dimensions will be 90 feet in length by 70 feet in width by 15 feet in height. The membrane treatment system will consist of the membrane blocks, a chemical clean-in-place system, a neutralization tank, a compressed air system, and a local control panel. The membrane system and auxiliary equipment will be housed in a climatically-controlled engineered metal building.



* Pipeline alignment shown in "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" report, dated October, 2000

Figure 5-27
Alternative 5B Facilities

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Ancillary Facilities

The reclaimed water from the Eastern MWD RRWS will be diverted from the Temescal Valley Pipeline upstream of the Wasson Sill energy dissipation structure. From the turnout, a new 30-inch pipeline will be constructed to convey the diverted reclaimed water flows to the intersection of Chaney Street and Treleven Avenue, where the pipeline will connect with the Elsinore Valley MWD RWRF pipeline. The pipeline will run northwest in West Minthorn Street to Chaney Street, then south in Chaney Street to Treleven Avenue. A pressure regulation station will be provided in the pipeline upstream of the point-of-connection with the Elsinore Valley MWD pipeline to balance the hydraulic gradeline between the two pipelines. The total length of the Eastern MWD 30-inch reclaimed water pipeline is about 5,100 feet. From the point-of-connection, a combined 30-inch pipeline will convey the reclaimed water from both sources to the remote treatment system. The pipeline, from the intersection of Chaney Street and Treleven Avenue, will continue south in Chaney Street to Townsend Street, then south along Townsend Street to West Lakeshore Drive. The pipeline will then continue southeast along West Lakeshore Drive to Davis Street, then overland to the remote treatment system. The total length of the combined 30-inch reclaimed water pipeline is about 3,800 feet.

The reclaimed water from the Elsinore Valley MWD RWRF will be pumped through a new 24-inch pipeline and the combined 30-inch pipeline. The 24-inch pipeline will run east from the RWRF in Treleven Avenue the point of connection of the Eastern MWD pipeline at the intersection of Treleven Avenue and Chaney Street. The pump station at the Elsinore Valley MWD RWRF will have a pumping capacity of 8.0 mgd at a TDH of 88 feet. The total installed pump motor capacity will be 300 horsepower.

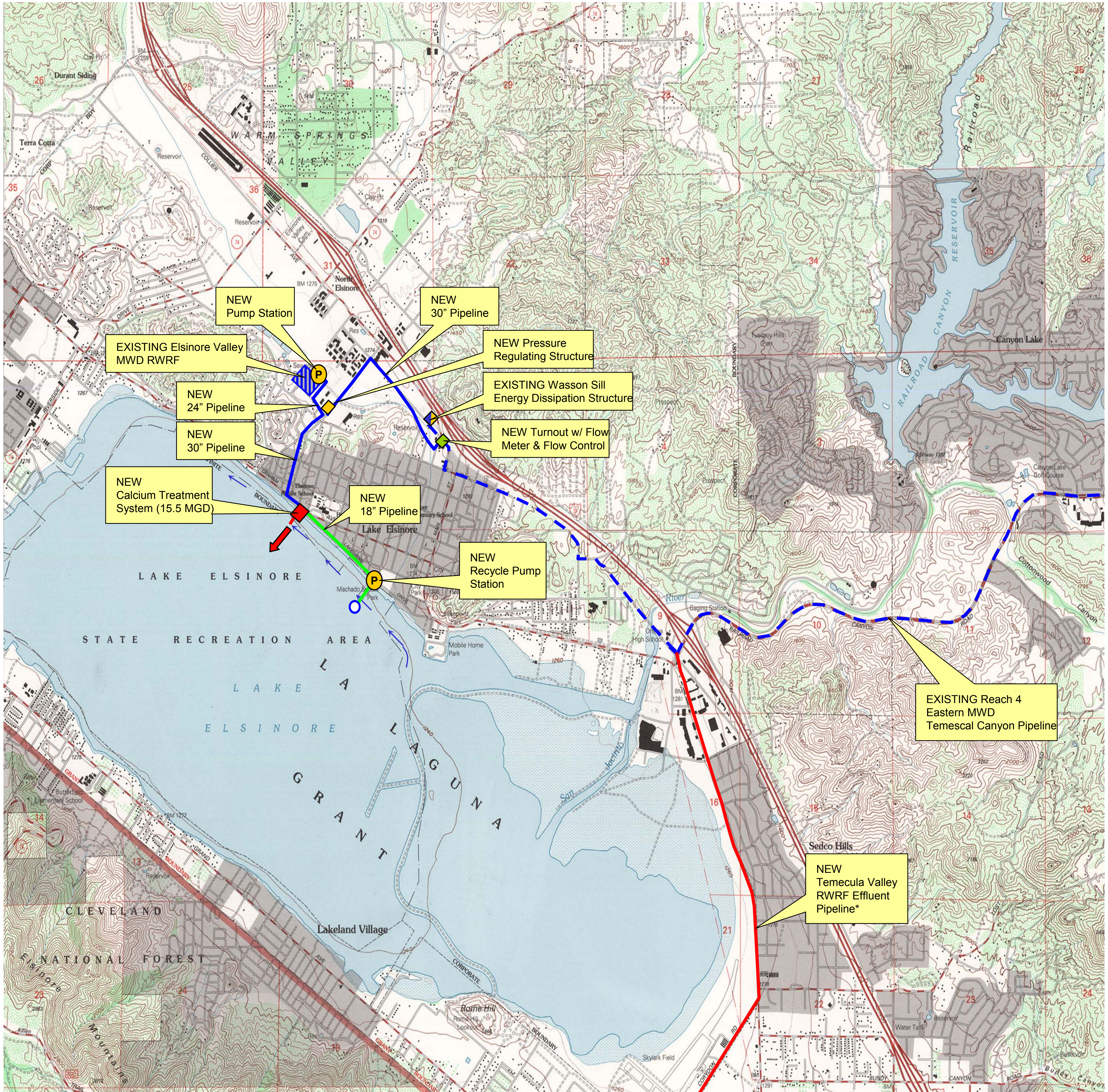
The remote treatment system will require a discharge pipe into the lake. A 30-inch treated water pipeline will be constructed about 300 feet into the lake to allow diffusion of the treated water with the lake water.

A lake water recycle system has been provided for this alternative. A 30-inch pipeline will be installed under the lake bottom from the lake water intake structure to the pump station that will be located along the lake shoreline just west of the Swick and Matich Park. The lake water recycle pump station will be a submersible pump installation, with precast concrete pipe wet-well and submersible pumps in a two duty and one standby configuration. The pump station will have a pumping capacity of 11.2 mgd at a TDH of about 52 feet. The total installed pump motor capacity will be 300 horsepower. A 30-inch recycle pipeline will run west along West Lakeshore Drive from the pump station location to Davis Street, then overland to the remote treatment system. The pipeline will have a total length of approximately 4,200 feet.

Alternative 6: Calcium Treatment at Lake Elsinore

Treatment System

Calcium chemical treatment of a blended flow of reclaimed water from both sources and recycled lake water will accomplish the phosphorus treatment for Alternative 6. The remote treatment system will be located along Acacia Drive, east of Davis Street, within the City-owned fishing beach as shown in Figure 5-28.



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LEGEND

- Existing Reclaimed Water Pipeline
- New Reclaimed Water Pipeline
- New Treated Water Pipeline
- New Recycled Water Pipeline
- Pump Station
- Treated Water Discharge
- Lake Water Intake
- Wasson Sill Energy Dissipation Structure
- Remote Treatment System
- Pressure Regulating Station
- Assumed Lake Current Direction (based on 2-D depth finite element simulations & ADCP measurements).
- Pipeline Turnout

* Pipeline alignment shown in "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" report, dated October, 2000

Figure 5-28
Alternative 6 Facilities

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Dr. Anderson recently completed bench-scale testing to better quantify the amount of SRP removal that could be achieved by calcium amendment. Previous preliminary research conducted by Dr. Anderson in 2002 documented the capacity for removal of phosphorus from recycled water with calcium amendment via in situ calcium carbonate precipitation in Lake Elsinore. In that study, about 90 percent of the SRP in the reclaimed water was removed from solution when the reclaimed water was amended with agricultural gypsum (calcium sulfate) at a concentration of 200 mg/L calcium. The reclaimed water was then mixed with lake water at a ratio of 30 percent reclaimed water to lake water. The rate of the SRP removal was not assessed in that previous research.

The results of Dr. Anderson's current bench-scale testing program demonstrated that calcium hydroxide addition to reclaimed water prior to discharge into Lake Elsinore can achieve a reduction in the SRP levels. Since the rate of calcium carbonate formation and SRP removal increases with increasing degree of supersaturation, high pH and high dissolved calcium concentrations will maximize the reaction under the flow-mixing regime of the reclaimed water-lake water reactor. The maximum amount of SRP removal observed in the bench-scale testing was achieved at a calcium dose between 100 mg/L to 200 mg/L, with calcium hydroxide being the source of calcium. The maximum observed SRP removal was achieved with a blend of 70 percent reclaimed water to 30 percent lake water. The testing program results also showed that most of the SRP removal was achieved within five minutes of the calcium addition to the blended flow (reclaimed water and lake water).

The remote treatment system will have a maximum treatment capacity of 20.0 mgd. The calcium hydroxide source will be in powdered form as either slaked or hydrated lime. The treatment system will be composed of a lime chemical system, consisting of a bulk lime storage silo, gravimetric feeder/slaker, and centrifugal chemical feed pumps. An in-line mixer will be used to mix the lime slurry feed with the blended reclaimed water and lake water flow. Following the chemical addition, a contact pipe section will be needed to provide the five-minute chemical reaction time before the chemically treated water is discharged into the lake. The 300-foot discharge pipeline and diffuser into the lake will provide one minute of the required hydraulic contact time. The contact pipe section will therefore have to provide a minimum of four minutes of hydraulic contact time. A 400-foot, 60-inch contact pipeline section will be required to provide the 4 minutes of contact time at the maximum 20 mgd capacity of the treatment system.

Ancillary Facilities

The reclaimed water from the Eastern MWD RRWS will be diverted from the Temescal Valley Pipeline upstream of the Wasson Sill energy dissipation structure. From the turnout, a new 30-inch pipeline will be constructed to convey the diverted reclaimed water flows to the intersection of Chaney Street and Treleven Avenue, where the pipeline will connect with the Elsinore Valley MWD RWRF pipeline. From the turnout, the pipeline will run northwest in West Minthorn Street to Chaney Street, then south in Chaney Street to Treleven Avenue. The total length of the 30-inch pipeline will be about 5,100 feet. A pressure regulation station will be provided on the pipeline upstream of the point of connection with the other pipeline to match the hydraulic gradeline in the other pipeline. Downstream of the point-of-connection of the two pipelines, a 30-inch pipeline will convey the reclaimed water from the two sources to the remote treatment system. The pipeline alignment will continue south in Chaney Street to Townsend Street, then south in Townsend Street to West Lakeshore Drive, the east in West Lakeshore Drive to the remote treatment system. The total length of the 30-inch pipeline conveying the reclaimed waters from both sources is about 3,800 feet.

The reclaimed water from the Elsinore Valley MWD RWRF will be pumped through a new 24-inch pipeline. The pipeline will run east from the RWRF in Treleven Avenue the point of connection of the Eastern MWD pipeline. The total length of the 24-inch pipeline is approximately 1,300 feet. The pump station at the Elsinore Valley MWD RWRF will have a pumping capacity of 8.0 mgd at a TDH of 74 feet. The total installed pump motor capacity will be 150 horsepower.

A 30-inch discharge pipeline will be required for the treated water discharge into Lake Elsinore, and will extend into the lake about 300 feet to allow diffusion of the flows with lake water.

This alternative includes a lake water recycle system to maintain the reclaimed water-to-lake water ratio of 70 percent needed to optimize the phosphorus removal in the blended flow. The pump station will be a submersible pump installation, with precast concrete pipe wet-well and submersible pumps in a two duty and one standby configuration. The pump station will have a maximum pumping capacity of 6.1 mgd at a TDH of 54 feet. The total installed pump motor capacity will be 150 horsepower. An 18-inch pipeline will be installed beneath the lake bottom from the lake water intake structure to the pump station, that will be located along the lake shoreline on the west side of the Swick and Matich Park. An 18-inch lake water recycle pipeline run west along West Lakeshore Drive to the remote treatment system. The 18-inch pipeline will have a total length of approximately 4,200 feet.

Alternative 7: Imported Water

Treatment System

The source of supplemental water for Alternative 7 is imported water, which will be obtained through Elsinore Valley MWD's WR-18b turnout that discharges into the San Jacinto River about 12 miles upstream of Canyon Lake. That turnout has been used by Elsinore Valley MWD over the years to add water to Canyon Lake. The imported water is Colorado River Water, which is a low phosphorus water source that does not require treatment, at its source, to meet the study nutrient water quality objectives. The imported water will be conveyed to Lake Elsinore via the San Jacinto River and Canyon Lake, and as a result of that transport, the imported water will pick up nutrients (phosphorus and nitrogen) as it commingles with the water in the river and lake. The Santa Ana RWQCB has been conducting nutrient water quality monitoring in Canyon Lake since June 2000. Based on the water quality data collected by that monitoring program through 2001 to date, the observed median phosphorus concentration in Canyon Lake water and Lake Elsinore water were 0.45 mg/L and 0.12 mg/L, respectively. The phosphorus concentration of the imported water source can therefore be expected to be greater than the phosphorus concentration in Lake Elsinore by the time it reaches the lake. This alternative, even though it can provide the required amount of water for both the long-term average and worst-case drought supplemental water conditions, may result in water with higher phosphorus concentrations being discharged into Lake Elsinore.

Ancillary Facilities

Alternative 7 will utilize existing facilities to acquire the imported water and convey the imported water to Lake Elsinore. The WR-18b turnout has adequate capacity to discharge the volumes of water required for both the long-term average and worst-case drought supplemental water conditions. Likewise, the San Jacinto River and Canyon Lake also have sufficient capacity to handle the supplemental water flows. This alternative can therefore be considered the study "no project" alternative because of the source of the supplemental water and the fact that no new facilities will be required to convey the water to Lake Elsinore.

The supplemental water for this alternative will be released from Canyon Lake either by discharge through the existing two-gated 48-inch pipes that extend through the dam, or by flow over the dam spillway. The invert of the two dam discharge pipes is at elevation 1,319-feet. The Canyon Lake water level will therefore have to be above the discharge pipe invert elevation in order to release water downstream to Lake Elsinore. That operating constraint may limit the ability of this alternative to convey an adequate amount of supplemental water to Lake Elsinore under either supplemental water condition. The situation may be more critical during drought conditions, when a greater amount of supplemental water needs to be delivered to Lake Elsinore, and the Canyon Lake operating water level would also be at a low level, possibly below the elevation of the dam discharge pipe.

Alternative 8A: Chemical Phosphorus Treatment at Elsinore Valley MWD RWRF, Imported Water and 107-Acre Treatment Wetland

Treatment System

For Alternative 8A, phosphorus treatment of reclaimed water will be provided by new chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF, and the treatment of Lake Elsinore water by the circulation of the lake water through a converted 107-acre treatment wetland. Additional supplemental water will be provided, as needed, for this alternative through the purchase of imported Colorado River Water from Metropolitan, which will be obtained through Elsinore Valley MWD's WR-18b turnout.

The chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF will consist of new chemical system, consisting of chemical storage and feed equipment. The new chemical system will have sufficient capacity for the existing 8.0 mgd treatment capacity of the RWRF. The chemical phosphorus treatment upgrades will also include solids dewatering equipment (one meter belt press) and building. The chemical system components will be identical to those described for Alternative 1A.

The southeastern portion of the existing Back Basin Wetland will be converted into a 107-acre treatment wetland that will be dedicated to the removal of phosphorus from Lake Elsinore water. The size of the treatment wetland has been limited to 107 acres to keep the water losses equivalent to the water losses from the existing Back Basin Wetland. Lake Elsinore water will be circulated through the wetland on a year-round basis, at a hydraulic loading rate of 0.6 inches per day (5.35 acre-feet per day). At that hydraulic loading rate, the phosphorus removal performance of the treatment wetland can be expected to be the same as the 350-acre treatment wetlands in Alternatives 2A and 2B, and the 350 acre littoral wetland in Alternative 4.

During those years when the treated effluent produced by the Elsinore Valley MWD RWRF and the groundwater from the Island Wells is not sufficient to meet the supplemental water needs of Lake Elsinore, imported Colorado River Water will be obtained from Metropolitan and conveyed to Lake Elsinore via the San Jacinto River and Canyon Lake. The imported water is a high quality water source that has a low phosphorus concentration and does not need treatment as a supplemental water source.

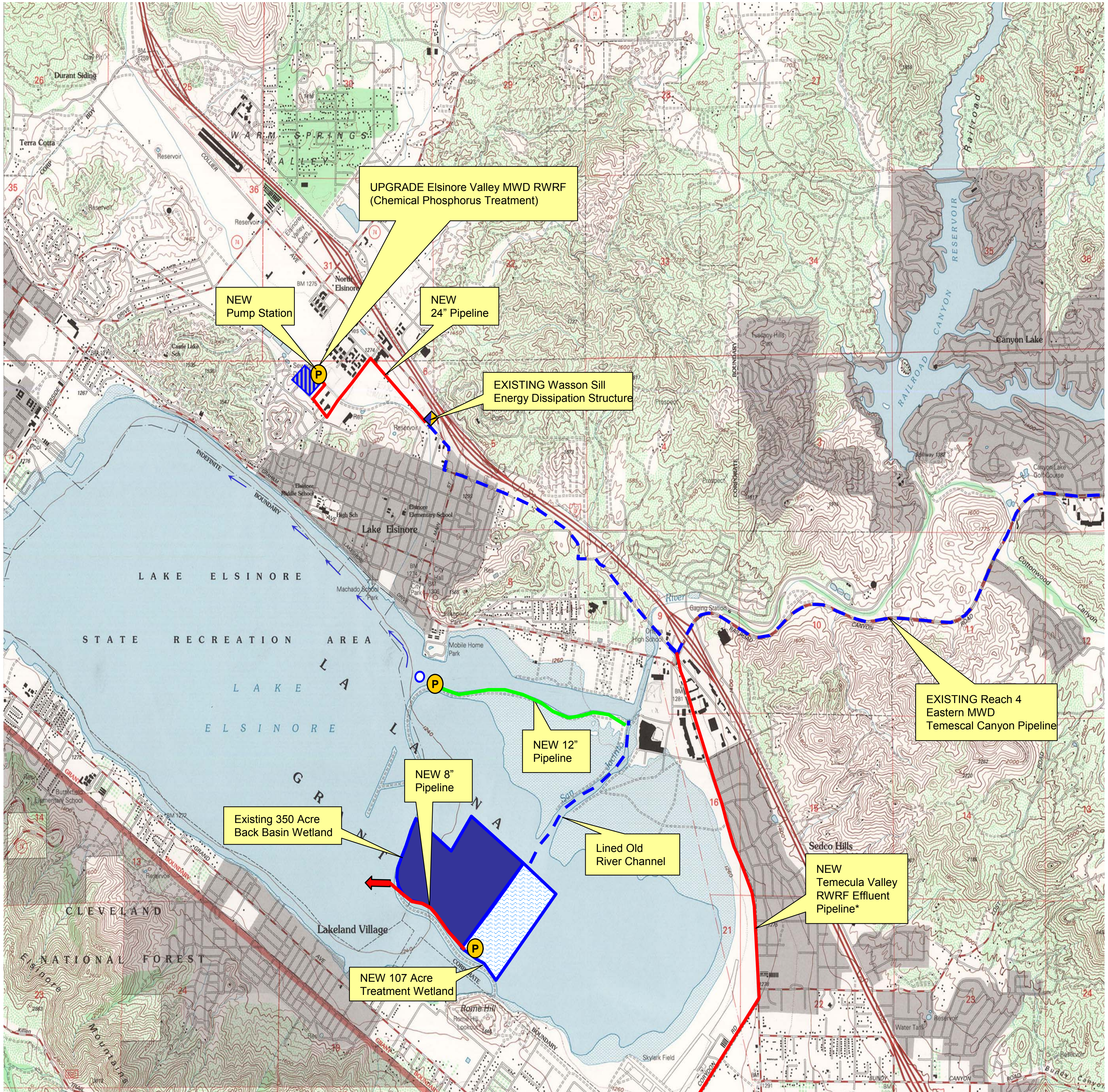
Ancillary Facilities

The facilities required for Alternative 8A are shown in Figure 5-29. Treated water from the Elsinore Valley MWD RWRF will be pumped through a new 24-inch pipeline from the RWRF to the vicinity of Wasson Sill, where the treated water will be discharged into the Lake Elsinore Overflow Channel for conveyance to the lake. After exiting the RWRF site,the pipeline will run southeast along Treleven Street to Chaney Street, then northeast along Chaney Street to West Minthorn Street, then southeast along West Minthorn Street to the vicinity of Wasson Sill. The total length of the pipeline is about 6,800 feet. The pipeline will discharge into the Lake Elsinore Overflow Channel at that location. A berm will have to be constructed at the point of discharge into the channel to force the flow of water towards the lake. The pump station will be sited at the RWRF, and will have a pumping capacity of 8.0 mgd at a TDH of about 41 feet. The total installed pump motor capacity will be 150 horsepower.

A lake water recycle system will be needed to circulate the lake water through the treatment wetland and back to the lake. The system will consist of a recycle pump station, recycled water pipeline and treatment wetland effluent pump station. The lake water intake and pump station will be located near the mouth of the Lake Elsinore Inlet Channel, as shown in the figure. The lake water will be collected through a concrete intake structure installed on the lake bottom. An 18-inch pipeline will be installed beneath the lake bottom to convey the collected lake water to the pump station. The pump station will be a submersible pump installation, consisting of precast concrete pipe wet-well with two primary duty pumps and one standby pump. The pump station will have a pumping capacity of 2.0 mgd at a TDH of about 49 feet. The total installed pump motor capacity will be 75 horsepower. The recycled lake water pipeline will run along the San Jacinto River levee from the pump station to the vicinity of the ballpark, where the water will be discharged into the Old San Jacinto River channel. The Old San Jacinto River Channel will be relined, and will be used to convey the lake water by gravity to the treatment wetland.

The intake and pump station were placed near the mouth of the lake inlet channel to make sure there was an adequate supply of lake water. The City of Lake Elsinore has expressed an interest in desilting the Lake Elsinore Inlet Channel to its original bottom elevation of 1,230feet. If the City were to move forward with the desilting of the inlet channel, the intake structure and pump station could be relocated to a location nearer the ballpark. That facility relocation will substantially shorten the length of the pump station discharge pipeline and its construction and capital costs. If the City moves forward with that facility relocation, the remaining capital cost for the pipeline could serve as a LESJWA funding commitment that could be applied towards the cost of desilting the Lake Elsinore Inlet Channel. Relocating the intake structure and pump station will only be possible if the future maintenance of the inlet channel (sediment removal) is assumed by the City of Lake Elsinore.

The treated effluent from the treatment wetland will have to be pumped back to Lake Elsinore. The pump station will be a submersible pump installation, consisting of precast concrete pipe wet-well with two primary duty pumps and one standby pump. The pump station will have a pumping capacity of 1.0 mgd at a TDH of about 40 feet. The total installed pump motor capacity will be 45 horsepower.



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LEGEND

- Existing Reclaimed Water Pipeline
- New Reclaimed Water Pipeline
- New Treated Water Pipeline
- New Recycled Water Pipeline
- Pump Station
- Treated Water Discharge
- Lake Water Intake
- Wasson Sill Energy Dissipation Structure
- Remote Treatment System
- Pressure Regulating Station
- Assumed Lake Current Direction (based on 2-D depth finite element simulations & ADCP measurements).
- Pipeline Turnout

* Pipeline alignment shown in "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" report, dated October, 2000

Figure 5-29
Alternative 8A Facilities

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Alternative 8B: Chemical Phosphorus Treatment at Elsinore Valley MWD RWRF, Remote Granular Filtration and 107-Acre Treatment Wetland

Treatment System

Phosphorus treatment of reclaimed water for Alternative 8B will be provided by new chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF and the construction of a remote treatment system at Wasson Sill. In addition, Lake Elsinore water will receive phosphorus treatment by the circulation of the lake water through a converted 107-acre treatment wetland.

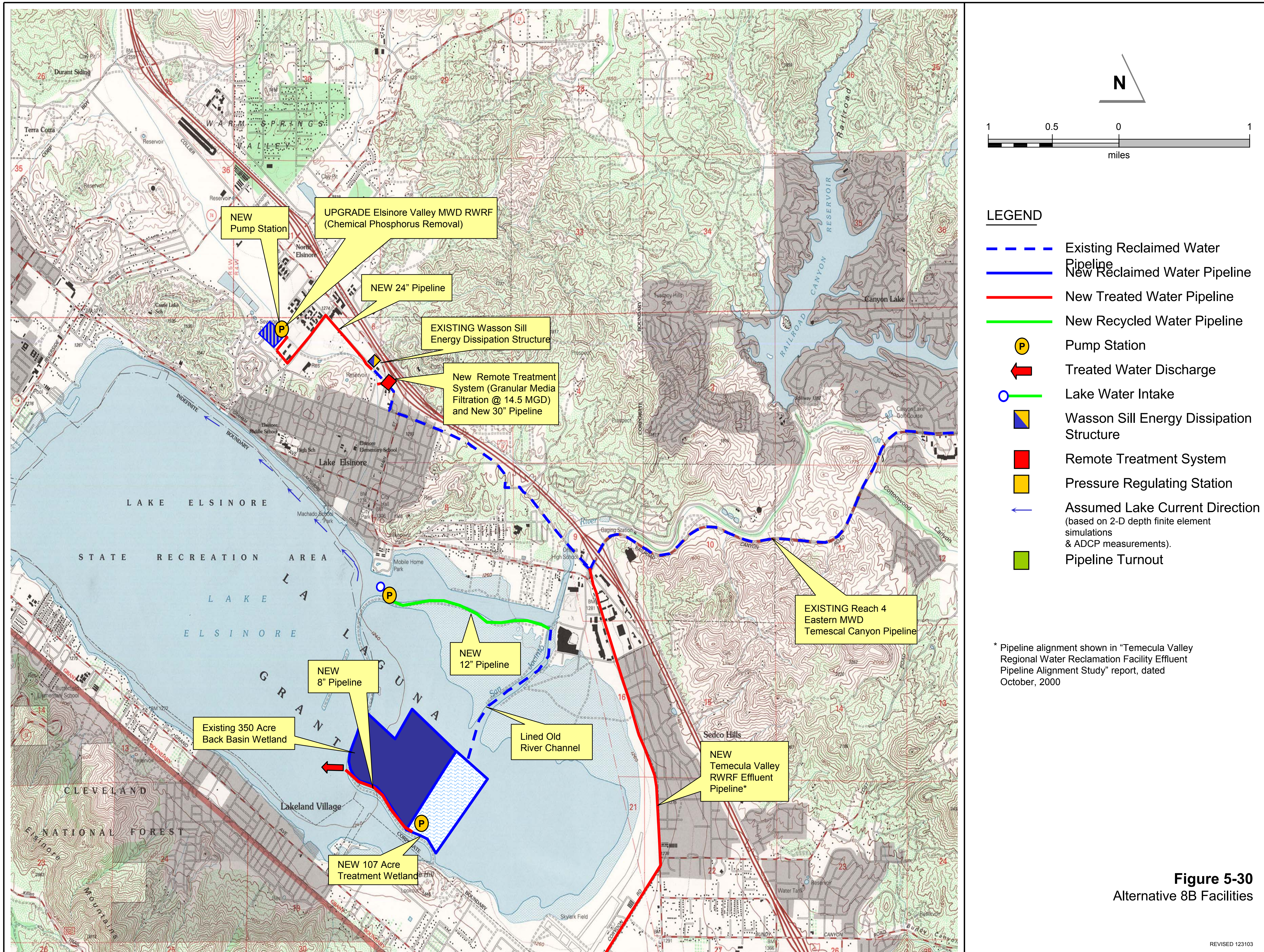
The chemical phosphorus treatment upgrades at the Elsinore Valley MWD RWRF will consist of new chemical system, consisting of chemical storage and feed equipment. The new chemical system will have sufficient capacity for the existing 8.0 mgd treatment capacity of the RWRF. The chemical phosphorus treatment upgrades will also include solids dewatering equipment (one meter belt press) and building. The chemical system components will be identical to those described for Alternative 1A.

A granular media filtration system, consisting of chemical coagulation pretreatment followed by two-stage filtration will be constructed in the vicinity of the Wasson Sill. The two-stage granular media filtration process will be a process similar to the DynaSand® process. The remote treatment system will have a treatment capacity of 10.0 mgd. Treated water from the remote treatment system will be discharged to the Lake Elsinore Overflow Channel, which will be used to convey the flows to Lake Elsinore. The remote treatment system facilities will be similar to those described for the Alternative 4 system.

The southeastern portion of the existing Back Basin Wetland will be converted into a 107-acre treatment wetland that will be dedicated to the removal of phosphorus from Lake Elsinore water. The size of the treatment wetland has been limited to 107 acres to keep the water losses equivalent to the water losses from the existing Back Basin Wetland. Lake Elsinore water will be circulated through the wetland on a year-round basis, at a hydraulic loading rate of 0.6 inches per day (5.35 acre-feet per day). At that hydraulic loading rate, the phosphorus removal performance of the treatment wetland can be expected to be the same as the 350-acre treatment wetlands in Alternatives 2A and 2B, and the 350 acre littoral wetland in Alternative 4.

Ancillary Facilities

Figure 5-30 shows the Alternative 8B facilities. Treated water from the Elsinore Valley MWD RWRF will be pumped through a new 24-inch pipeline from the RWRF to the vicinity of Wasson Sill, where the treated water will be discharged into the Lake Elsinore Overflow Channel for conveyance to the lake. After exiting the RWRF site, the pipeline will run southeast along Treleven Street to Chaney Street, then northeast along Chaney Street to West Minthorn Street, then southeast along West Minthorn Street to the vicinity of Wasson Sill. The total length of the pipeline is 6,800 feet. The pipeline will discharge into the Lake Elsinore Overflow Channel at that location. A berm will have to be constructed at the point of discharge to the channel to force the flow of water towards the lake. The pump station will be sited at the RWRF, and will have a pumping capacity of 8.0 mgd at a TDH of about 41 feet. The total installed pump motor capacity will be 150 horsepower.



* Pipeline alignment shown in "Temecula Valley Regional Water Reclamation Facility Effluent Pipeline Alignment Study" report, dated October, 2000

Figure 5-30
Alternative 8B Facilities

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Reclaimed water from the Eastern MWD RRWS will be conveyed to the Elsinore Valley MWD RWRF and the remote treatment system for treatment. A turnout will be constructed on the Eastern MWD Temescal Valley Pipeline just upstream of the Wasson Sill energy dissipation facility. The turnout will consist of a concrete vault structure with flow meter and flow control valve. A short 30-inch pipeline segment will be constructed to a second turnout structure that will control the amount of reclaimed water divert to the remote treatment system. Downstream of the second turnout structure, a new 24-inch pipeline Eastern MWD reclaimed water pipeline will be constructed to the Elsinore Valley MWD RWRF. The pipeline has been sized to utilize the current 4.0 mgd surplus treatment capacity in the RWRF. The pipeline, from the turnout structure, will run northwest along West Minthorn Street to Chaney Street, then southwest in Chaney Street to a point just south of the Temescal Wash, where the pipeline will run overland to the RWRF. A pressure regulating facility will be provided at the end of the pipeline before it discharges into the RWRF treatment system. The total length of the pipeline is about 5,800 feet. The second turnout will be constructed on the 30-inch reclaimed water pipeline, just downstream of the main Temescal Valley Pipeline turnout. The turnout will be a concrete vault structure containing flow meter, flow control valve and pressure regulation valving. A 30-inch reclaimed water pipeline will run from the turnout structure to the remote treatment system. The total pipeline length of 1,100 feet has been allowed for the 30-inch reclaimed water pipeline. A 30-inch treated water pipeline will be needed to convey the remote treatment system treated water to the Wasson sill for discharge to the Lake Elsinore Overflow Channel. A total pipeline length of 1,100 feet has been allowed for the 30-inch treated water pipeline.

A lake water recycle system will be needed to circulate the lake water through the treatment wetland and back to the lake. The system will consist of a recycle pump station, recycled water pipeline and treatment wetland effluent pump station. The lake water intake and pump station will be located near the mouth of the lake inlet channel, as shown in the figure. The lake water will be collected through a concrete intake structure installed on the lake bottom. An 18-inch pipeline will be installed beneath the lake bottom to convey the collected lake water to the pump station. The pump station will be a submersible pump installation, consisting of precast concrete pipe wet-well with two primary duty pumps and one standby pump. The pump station will have a pumping capacity of 2.0 mgd at a TDH of about 49 feet. The total installed pump motor capacity will be 75 horsepower. The recycled lake water pipeline will run along the San Jacinto River levee from the pump station to the vicinity of the ballpark, where the water will be discharged into the Old San Jacinto River channel. The Old San Jacinto River Channel will be relined, and will be used to convey the lake water by gravity to the treatment wetland. The treated effluent from the treatment wetland will have to be pumped back to Lake Elsinore. The pump station will be a submersible pump installation, consisting of precast concrete pipe wet-well with two primary duty pumps and one standby pump. The pump station will have a pumping capacity of 1.0 mgd at a TDH of about 40 feet. The total installed pump motor capacity will be 45 horsepower.

The intake and pump station were placed near the mouth of the lake inlet channel to make sure there is an adequate supply of lake water to the pump station. As with Alternative 8A, the City of Lake Elsinore has expressed an interest in desilting the Lake Elsinore Inlet Channel to its original bottom elevation of 1,230feet. If the City were to move forward with the desilting of the inlet channel, the intake structure and pump station could be relocated to a location nearer the ballpark. That facility relocation will substantially shorten the length of the pump station discharge pipeline and its construction and capital costs. If the City moves forward with that facility relocation, the remaining capital cost for the pipeline could serve as a LESJWA funding commitment that could be applied towards the cost of desilting the Lake Elsinore Inlet Channel. Relocating the intake structure and pump station will only be possible if the future maintenance of the inlet channel (sediment removal) is assumed by the City of Lake Elsinore.

Estimated Alternative Annual Phosphorus Removal Amounts

Table 5-9 presents an estimate of the total amount of phosphorus that will be removed by the project alternative treatment systems. The phosphorus removal amounts presented in the table represent the amount of phosphorus removed from the reclaimed water used to supplement the natural runoff into Lake Elsinore, and the treatment of recycled lake water. The phosphorus removal estimates are based on the long-term average supplemental water condition, and an average phosphorus concentration of 3.0 mg/L for the two reclaimed water sources and 0.2 mg/L for the recycled lake water.

The treatment system performance criteria used to estimate the phosphorus removal amounts is as follows:

- Chemical addition and biological upgrades at the Elsinore Valley MWD RWRF and Eastern MWD Temecula Valley RWRF will produce an effluent reclaimed water phosphorus concentration of 0.5 mg/L.
- 350-acre treatment wetland with a maximum hydraulic loading rate of 0.6 inch per day, which yields an average effluent phosphorus concentration of about 0.52 mg/L for the treatment of reclaimed water. The same hydraulic loading rate will yield an average effluent phosphorus concentration of about 0.05 mg/L for the treatment of lake water.
- 600-acre treatment wetland with a maximum hydraulic loading of 0.8 inch per day, which yields an average effluent reclaimed water effluent phosphorus concentration of about 0.54 mg/L for the treatment of reclaimed water. The same hydraulic loading rate will yield an average effluent phosphorus concentration of about 0.05 mg/L for the treatment of lake water.
- 350-acre littoral wetland with a maximum hydraulic loading rate of 0.5 inch per day, which yields an average effluent phosphorus concentration of about 0.30 mg/L for the treatment of reclaimed water. The same hydraulic loading rate will yield an average effluent phosphorus concentration of about 0.05 mg/L for the treatment of lake water.
- Two-stage granular media filtration process with coagulant and coagulant addition can achieve a minimum 90 percent phosphorus removal, with a reclaimed water effluent phosphorus concentration of 0.5 mg/L and recycled lake water effluent concentration of 0.04 mg/L.

- Membrane filtration process with coagulant addition can achieve a reclaimed water effluent phosphorus concentration of 0.1 mg/L and recycled lake water effluent phosphorus concentration of 0.02 mg/L.

The treatment and littoral wetland phosphorus removal performance is based on the study modeling results. The two-stage granular media filtration process and membrane filtration process phosphorus removal performance assessments are based on manufacturer-furnished performance data for similar systems treating phosphorus. The treatment system phosphorus removal rates represent average performance conditions.

TABLE 5-9
Alternative Total Annual Phosphorus Removed Estimates

Alternative	Estimated Phosphorus Removed (lbs/yr)				Total Estimated Removed Phosphorus (lbs/yr)
	Wetlands		Remote Treatment		
	Reclaimed Water	Lake Recycle	Reclaimed Water	Lake Recycle	
1A	0	0	20,400	0	20,400
1B	0	0	20,400	0	20,400
2A	16,200	300	4,100	3,800	24,700
2B	8,800	700	26,500	0	36,000
3A	20,100	2,500	0	0	22,600
3B	30,600	1,300	26,500	0	58,400
4	22,000	1,000	0	3,700	26,700
5A	0	0	20,400	5,000	25,400
5B	0	0	23,700	5,800	29,500
6	0	0	22,000	500	22,500
7	0	0	0	0	0
8A	0	400	25,100	0	25,500
8B	0	400	27,100	0	27,500

Estimated Annual Phosphorus Loads

Table 5-10 presents estimates of the annual phosphorus loads to Lake Elsinore that will result from the addition of reclaimed water and imported water as supplemental water sources. For the imported water source, it was assumed that the water released from Canyon Lake will have a median phosphorus concentration for the lake water of 0.12 mg/L, based on the observed results of the Santa Ana RWQCB water quality monitoring program through 2002. The annual phosphorus loads presented in the table are based on the long-term average supplemental water condition.

TABLE 5-10
Estimated Annual Phosphorus Loads to Lake Elsinore from Reclaimed Water and Imported Water Sources

Alternative	Estimated Annual Phosphorus Load (lbs/yr)
1A	4,100
1B	4,100
2A	5,200
2B	7,300
3A	5,200
3B	12,400
4	3,900
5A	5,800
5B	1,400
6	2,600
7	2,600
8A	5,100
8B	5,500

ESTIMATED ALTERNATIVE CONSTRUCTION, CAPITAL, AND ANNUAL OPERATION AND MAINTENANCE COSTS

Section 6: Estimated Alternative Construction, Capital, and Annual Operation and Maintenance Costs

Estimated Alternative Construction and Capital Costs

The estimated construction costs for the project alternatives represent order of magnitude estimates, as defined by the American Association of Cost Engineers, since they represent approximate estimates that have been made without detailed engineering data. The estimated construction costs are based on cost curves, scale-up and scale-down of similar project costs, published project cost data and equipment manufacturer estimates. As such, the estimated facility construction costs can be expected to have an accuracy of plus 50 percent to minus 30 percent.

The following criteria were used to develop the facility construction cost estimates for the study alternatives:

- The costs to construct chemical and biological phosphorus removal upgrades at the Elsinore Valley MWD RWRF have been based on manufacturer price information, and cost information from other projects and sources. The costs for the chemical and biological phosphorus removal upgrades for the Eastern MWD Temecula Valley RWRF have not been included in the alternative construction cost estimates for Alternatives 1A and 1B. Those costs, along with the annual O&M costs for nutrient removal treatment, will be recovered through the price to purchase reclaimed water from Eastern MWD.

- Pump station cost data for vertical turbine and submersible pump installations similar to those planned for the alternatives were used to estimate the pump station construction costs. A cost curve representative of new pump station construction of average complexity involving single stage construction was used to calculate the pump station construction costs. The cost curve is represented by the following formula:

  $$\$/Hp = 15{,}570\ (TIHP)^{-.42}$$

  Where:

  \$/Hp = Dollars per installed horsepower.

  TIHP = Total installed horsepower, including standby pumping units.

- A unit construction cost of $7.50 per diameter-inch per lineal foot was used for pipelines constructed within paved roadways. The unit construction cost includes pavement removal, pipe trenching, shoring, pipe materials and installation, air/vacuum and blow-off valves, compacted backfill, pavement replacement, traffic detours and control and testing.

- A unit construction cost of $3.50 per diameter-inch per lineal foot was used for pipelines constructed outside paved roadways, or overland. The unit construction cost includes pipe trenching, shoring, pipe materials and installation, air/vacuum and blow-off valves, compacted backfill and testing.
- The pipeline unit construction costs are representative of a pipeline installation that follows the ground contour, with the pipeline trench depth ranging from five to ten feet in depth.
- A unit construction cost of $17.00 per diameter-inch per lineal foot was used for the jacked 24-inch pipeline segment in Alternative 4. A carrier pipe with a diameter of 36 inches was assumed for the jacked pipe segment. The unit construction cost was applied to the carrier pipe diameter. The unit construction cost includes construction of the jacking and receiving pits, jacking the 36-inch carrier pipe, installation of the 24-inch pipeline inside the carrier pipe and placement of concrete grout in the annular space between both pipes.
- A unit construction cost of $10.00 per diameter-inch per lineal foot was used for the discharge piping extending into the lake and the lake water collection piping within the lake. The same unit cost was used for both the portion of the pipeline installed beneath the lake bottom, and the discharge pipeline diffuser section that will be installed on the bottom of the lake.

The estimated alternative construction costs are broken down by major facility components. The alternative construction cost estimates presented in the tables include a 15 percent contingency to account for estimating inaccuracies and unknown factors at this feasibility stage of the project. The alternative capital costs were calculated by adding 25 percent to the estimated total facility construction cost. The markup includes the costs for design and construction engineering, assumed to be 15 percent, and LESJWA project management and financing costs, assumed to be 10 percent. The estimated facility construction costs for the alternatives represent March 2003 costs, and have been referenced to an Engineering News-Record CCI of 7,275 for the greater Los Angeles area.

The estimated construction and capital costs for Alternatives 1A and 1B are presented in Table 6-1. Alternative 1A involves construction of phosphorus chemical treatment upgrades at the Elsinore Valley MWD RWRF and the Eastern MWD Temecula Valley RWRF to provide supplemental water for Lake Elsinore and treatment of those reclaimed water sources to achieve the study phosphorus removal objectives. Alternative 1A differs from Alternative 1B in that the latter alternative involves the construction of biological treatment upgrades at both RWRFs. The estimated facility construction and capital costs for Alternative 1A are $3,534,000 and $4,418,000, respectively. The estimated facility construction and capital costs for Alternative 1B are $8,877,000 and $11,096,000, respectively. Both of these alternatives require the construction of the planned Temecula Valley RWRF Effluent Pipeline by Eastern MWD to be feasible. The construction cost for the pipeline has not been included in the construction cost estimates for the two alternatives. Based on discussions with Eastern MWD staff, the pipeline costs and Temecula Valley RWRF reclaimed water treatment costs will be recovered in the cost LESJWA will have to pay for the reclaimed water obtained from the Eastern MWD RRWS.

TABLE 6-1
Alternatives 1A and 1B Estimated Facility Construction and Capital Costs

Facility Description	Estimated Costs	
	Alternative 1A	**Alternative 1B**
EVMWD RWRF Upgrades	$950,000	$5,596,000
EVMWD RWRF Treated Water Pump Station	$599,000	$599,000
24-Inch EVMWD Treated Water Pipeline	$990,000	$990,000
24-Inch Lake Discharge & Diffuser Piping	$101,000	$101,000
24-Inch EMWD Temescal Canyon Pipeline Turnout	$271,000	$271,000
24-Inch EMWD Treated Water Pipeline	$162,000	$162,000
Construction Cost Subtotals:	$3,073,000	$7,719,000
Contingency	$461,000	$1,158,000
Construction Cost Totals:	$3,534,000	$8,877,000
Capital Cost Markup	$884,000	$2,219,000
Capital Cost Totals:	$4,418,000	$11,096,000

EVMWD = Elsinore Valley MWD

EMWD = Eastern MWD

The estimated construction and capital costs for Alternative 2A are presented in Table 6-2. Alternative 2A involves the conversion of the existing Back Basin Wetland to a 350-acre treatment wetland and construction of a new remote treatment system to provide supplemental water for Lake Elsinore, and to provide treatment of the reclaimed water to achieve the study phosphorus removal objectives. The estimated construction costs for the treatment wetland component of this alternative, and the other treatment wetland alternatives, include an allowance for the modest public recreational facilities, including short access trails, gazebo, and interpretive signage. The estimated facility construction and capital costs for Alternative 2A are $19,621,000 and $24,526,000, respectively.

The estimated construction and capital costs for Alternative 2B are presented in Table 6-3. Alternative 2B involves the construction of phosphorus chemical treatment upgrades at the Elsinore Valley MWD RWRF to further treat the wastewater being treated at the RWRF to the study phosphorus water quality objectives. The RWRF treatment upgrades are sized for the current 8.0 mgd treatment capacity of the RWRF, and include solids dewatering equipment and a building to house the solids dewatering equipment. Alternative 2B also includes the conversion of the existing Back Basin Wetland to a treatment wetland to treat lake water circulated through the wetland. The estimated facility construction and capital costs for Alternative 2B are $12,180,000 and $15,225,000, respectively.

TABLE 6-2
Alternative 2A Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Pump Station	$757,000
24-Inch EVMWD Reclaimed Water Pipeline	$3,636,000
350-Acre Treatment Wetland	$3,814,000
Treatment Effluent Wetland Effluent Pump Station	$239,000
24-Inch EMWD Temescal Valley Pipeline Turnout	$271,000
24-Inch EMWD Reclaimed Water Pipeline	$162,000
30-Inch Combined Reclaimed Water Pipeline	$585,000
18-Inch Combined Reclaimed Water Pipeline	$469,000
Recycle Intake Structure & Pipeline	$154,000
Treatment Wetland Recycle Pump Station	$368,000
Remote Treatment System Recycle Pump Station	$937,000
Remote Treatment System	$4,215,000
12-Inch Treatment Wetland Recycle Pipeline	$223,000
30-Inch Remote Treatment System Recycle Pipeline	$1,232,000
Construction Cost Subtotal:	$17,062,000
Contingency	$2,559,000
Construction Cost Total:	$19,621,000
Capital Cost Markup	$4,905,000
Capital Cost Total:	$24,526,000

EVMWD = Elsinore Valley MWD
EMWD = Eastern MWD

TABLE 6-3
Alternative 2B Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Phosphorus Treatment Upgrades	$950,000
EVMWD RWRF Pump Station	$895,000
24-Inch EVMWD Treated Water Pipeline	$990,000
24-Inch Lake Discharge	$101,000
350-Acre Treatment Wetland	$3,814,000
Treatment Effluent Wetland Effluent Pump Station	$535,000
42-Inch EMWD Temescal Valley Pipeline Turnout	$326,000
42-Inch EMWD Reclaimed Water Pipeline	$2,014,000
Recycle Intake Structure & Pipeline	$114,000
Treatment Wetland Recycle Pump Station	$550,000
18-Inch Treatment Wetland Recycle Pipeline	$302,000
Construction Cost Subtotal:	$10,591,000
Contingency	$1,589,000
Construction Cost Total:	$12,180,000
Capital Cost Markup	$3,045,000
Capital Cost Total:	$15,225,000

The estimated construction and capital costs for Alternative 3A are presented in Table 6-4. Alternative 3A involves the construction of an expanded 600-acre treatment wetland in the vicinity of the existing Back Basin Wetland to provide supplemental water for Lake Elsinore, and treatment of the reclaimed water from the Elsinore Valley MWD RWRF and the Eastern MWD RRWS to achieve the study phosphorus water quality objectives. The estimated facility construction and capital costs for Alternative 3 are $18,169,000 and $22,711,000, respectively.

The estimated construction and capital costs for Alternative 3B are presented in Table 6-5. Alternative 3B involves the construction of phosphorus chemical treatment upgrades at the Elsinore Valley MWD RWRF to further treat the wastewater being treated at the RWRF to the study phosphorus water quality objectives. The RWRF treatment upgrades are sized for the current 8.0 mgd treatment capacity of the RWRF, and include solids dewatering equipment and a building to house the solids dewatering equipment. Alternative 3B also includes the conversion of the existing Back Basin Wetland to a 600-acre treatment wetland to treat lake water circulated through the wetland and reclaimed water purchased from

Eastern MWD. The estimated facility construction and capital costs for Alternative 2B are $20,997,000 and $26,246,000, respectively.

TABLE 6-4
Alternative 3A Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Pump Station	$1,132,000
24-Inch EVMWD Reclaimed Water Pipeline	$3,636,000
24-Inch EMWD Temescal Valley Pipeline Turnout	$271,000
24-Inch EMWD Reclaimed Water Pipeline	$162,000
36-Inch Combined Reclaimed Water Pipeline	$2,003,000
600-Acre Expanded Treatment Wetland	$6,671,000
Recycle Intake Structure & Pipeline	$123,000
Treatment Wetland Effluent Pump Station	$239,000
Treatment Wetland Recycle Pump Station	$823,000
24-Inch Treatment Wetland Recycle Pipeline	$739,000
Construction Cost Subtotal:	$15,799,000
Contingency	$2,370,000
Construction Cost Total:	$18,169,000
Capital Cost Markup	$4,542,000
Capital Cost Total:	$22,711,000

EVMWD = Elsinore Valley MWD
EMWD = Eastern MWD

TABLE 6-5
Alternative 3B Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Phosphorus Treatment Upgrades	$950,000
EVMWD RWRF Treated Water Pump Station	$895,000
24-Inch EVMWD Treated Water Pipeline	$756,000
24-Inch Lake Discharge	$101,000
600-Acre Treatment Wetland	$6,671,000
Treatment Wetland Effluent Pump Station	$676,000
60-Inch EMWD Temescal Valley Pipeline Turnout	$542,000
60-Inch EMWD Reclaimed Water Pipeline	$5,715,000
Recycle Intake Structure & Pipeline	$172,000
Treatment Wetland Recycle Pump Station	$696,000
36-Inch Treatment Wetland Recycle Pipeline	$1,084,000
Construction Cost Subtotal:	$18,258,000
Contingency	$2,739,000
Construction Cost Total:	$20,997,000
Capital Cost Markup	$5,249,000
Capital Cost Total:	$26,246,000

The estimated construction and capital costs for Alternative 4 are presented in Table 6-6. Alternative 4 involves the construction of a new 350-acre littoral wetland in the southeast portion of Lake Elsinore near Rome Hill to treat reclaimed water from the Elsinore Valley MWD RWRF and Eastern MWD RRWS to achieve the study phosphorus water quality objectives. The littoral wetland will require the construction of a new levee to separate the wetland from the lake, that will extend south along an extension of the existing Island Well peninsula to the lake shoreline. The length of the levee will be approximately 4,100 feet. Alternative 4 also includes the construction of a new remote treatment system near Lake Elsinore to treat reclaimed water from the Eastern MWD RRWS. A lake water recycle system will circulate water through the treatment wetland during the portion of the year that reclaimed water will not be available from the Eastern MWD RRWS. The estimated facility construction and capital costs for Alternative 4 are $18,622,000 and $23,278,000, respectively.

TABLE 6-6
Alternative 4 Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Pump Station	$1,238,000
24-Inch EVMWD Reclaimed Water Pipeline	$2,902,000
24-Inch EMWD Temescal Valley Pipeline Turnout	$236,000
24-Inch EMWD Reclaimed Water Pipeline	$1,238,000
24-Inch EMWD Pressure Regulating Station	$144,000
30-Inch Combined Reclaimed Water Pipeline	$21,000
Remote Treatment System Turnout	$80,000
Remote Treatment System	$2,638,000
24-Inch Treated Water Discharge Pipeline	$101,000
18-Inch Combined Reclaimed Water Pipeline	$636,000
350-Acre Littoral Wetland	$4,854,000
Littoral Wetland Effluent Pump Station	$550,000
Recycle Intake Structure & Pipeline	$123,000
Littoral Wetland Recycle Pump Station	$550,000
Remote Treatment System Recycle Pump Station	$550,000
24-Inch Remote Treatment System Recycle Pipeline	$185,000
12-Inch Littoral Wetland Recycle Pipeline	$147,000
Construction Cost Subtotal:	$16,193,000
Contingency	$2,429,000
Construction Cost Total:	$18,622,000
Capital Cost Markup	$4,656,000
Capital Cost Total:	$23,278,000

EVMWD = Elsinore Valley MWD
EMWD = Eastern MWD

The estimated construction and capital costs for Alternative 5A are presented in Table 6-7. Alternative 5A involves the construction of a remote treatment system at the Elsinore Valley MWD RWRF to treat reclaimed water produced from both the Elsinore Valley MWD RWRF and the Eastern MWD RRWS. The remote treatment system will provide supplemental water for Lake Elsinore and treatment of the reclaimed water to achieve the study phosphorus water quality objectives. The estimated facility construction and capital costs for Alternative 5A are $12,779,000 and $15,974,000, respectively.

TABLE 6-7
Alternative 5A Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Remote Treatment System	$4,191,000
EVMWD Treated Water Pump Station	$1,132,000
30-Inch Treated Water Pipeline	$995,000
30-Inch Lake Discharge Pipeline & Diffuser	$126,000
30-Inch EMWD Temescal Valley Pipeline Turnout	$297,000
30-Inch EMWD Reclaimed Water Pipeline	$1,243,000
30-Inch EMWD Pressure Regulating Station	$176,000
Recycle Intake Structure & Pipeline	$141,000
Remote Treatment System Recycle Pump Station	$1,231,000
30-Inch Remote Treatment System Recycle Pipeline	$1,580,000
Construction Cost Subtotal:	$11,112,000
Contingency	$1,667,000
Construction Cost Total:	$12,779,000
Capital Cost Markup	$3,195,000
Capital Cost Total:	$15,974,000

EVMWD = Elsinore Valley MWD
EMWD = Eastern MWD

The estimated construction and capital costs for Alternative 5B are presented in Table 6-8. Alternative 5B involves the construction of a remote treatment system at Lake Elsinore to treat reclaimed water produced from both the Elsinore Valley MWD and Eastern MWD systems. The remote treatment system will provide supplemental water for Lake Elsinore and treatment of the reclaimed water to achieve the study phosphorus water quality objectives. The estimated facility construction and capital costs for Alternative 5B are $19,985,000 and $24,981,000, respectively.

The estimated construction and capital costs for Alternative 6 are presented in Table 6-9. Alternative 6 involves the construction of a remote calcium treatment system at Lake Elsinore to treat reclaimed water produced from both the Elsinore Valley MWD and Eastern MWD systems. The remote treatment system will provide supplemental water for Lake Elsinore and treatment of the reclaimed water to achieve the study phosphorus removal objectives. The estimated facility construction and capital costs for Alternative 6 are $8,084,000 and $10,105,000, respectively.

TABLE 6-8
Alternative 5B Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Reclaimed Water Pump Station	$895,000
24-Inch EVMWD Reclaimed Water Pipeline	$234,000
30-Inch EMWD Temescal Valley Pipeline Turnout	$297,000
30-Inch EMWD Reclaimed Water Pipeline	$1,283,000
30-Inch Combined Reclaimed Water Pipeline	$928,000
30-Inch EMWD Pressure Regulating Station	$176,000
Remote Treatment System	$11,637,000
30-Inch Lake Discharge Pipeline & Diffuser	$126,000
Recycle Intake Structure & Pipeline	$141,000
Remote Treatment System Recycle Pump Station	$823,000
30-Inch Remote Treatment System Recycle Pipeline	$838,000
Construction Cost Subtotal:	$17,378,000
Contingency	$2,607,000
Construction Cost Total:	$19,985,000
Capital Cost Markup	$4,996,000
Capital Cost Total:	$24,981,000

EVMWD = Elsinore Valley MWD
EMWD = Eastern MWD

TABLE 6-9
Alternative 6 Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Reclaimed Water Pump Station	$599,000
24-Inch EVMWD Reclaimed Water Pipeline	$234,000
30-Inch EMWD Temescal Valley Pipeline Turnout	$297,000
30-Inch EMWD Reclaimed Water Pipeline	$1,283,000
EMWD Pressure Regulating Station	$176,000
30-Inch Combined Reclaimed Water Pipeline	$928,000
Remote Calcium Treatment System	$1,260,000
60-Inch Treated Water Contact Pipe Section	$84,000
36-Inch Lake Discharge Pipeline & Diffuser	$152,000
Recycle Intake Structure & Pipeline	$96,000
Remote Treatment System Recycle Pump Station	$550,000
30-Inch Remote Treatment System Recycle Pipeline	$838,000
Construction Cost Subtotal:	$6,497,000
Contingency	$975,000
Construction Cost Total:	$8,084,000
Capital Cost Markup	$2,021,000
Capital Cost Total:	$10,105,000

EVMWD = Elsinore Valley MWD
EMWD = Eastern MWD

Alternative 7 involves the purchase of imported water from Metropolitan. The imported water for this alternative will be Colorado River Water obtained through Elsinore Valley MWD's WR-18b turnout, which is located along the San Jacinto River about 12 miles upstream of Canyon Lake. The imported water will be conveyed to Lake Elsinore via the San Jacinto River and Canyon Lake. Since this alternative utilizes existing facilities, no new facilities will be needed. The estimated construction and capital costs for this Alternative 7 are therefore zero.

The estimated construction and capital costs for Alternative 8A are presented in Table 6-10. Alternative 8A involves the construction of new phosphorus chemical treatment system upgrades at the Elsinore Valley MWD RWRF to provide additional phosphorus removal treatment of the wastewater treated at the facility to meet the study phosphorus water quality objectives. The alternative also includes the conversion of 107 acres of the existing Back Basin Wetland into a treatment wetland to treat lake water circulated through the wetland. Supplemental water deficiencies for both the long-term average and worst-case drought conditions will be made up by purchasing imported water from Metropolitan that will be obtained through Elsinore Valley MWD's WR-18b turnout along the San Jacinto River. The estimated facility construction and capital costs for Alternative 8A are $6,749,000 and $8,436,000, respectively.

TABLE 6-10
Alternative 8A Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Phosphorus Treatment Upgrades	$950,000
EVMWD RWRF Treated Water Pump Station	$599,000
24-Inch EVMWD Treated Water Pipeline	$1,224,000
107-Acre Treatment Wetland	$1,183,000
Treatment Wetland Effluent Pump Station	$178,000
Recycle Intake Structure & Pipeline	$114,000
Treatment Wetland Recycle Pump Station	$368,000
12-Inch Treatment Wetland Recycle Pipeline	$332,000
San Jacinto River Old Channel Lining	$921,000
Construction Cost Subtotal:	$5,869,000
Contingency	$880,000
Construction Cost Total:	$6,749,000
Capital Cost Markup	$1,687,000
Capital Cost Total:	$8,436,000

The estimated construction and capital costs for Alternative 8B are presented in Table 6-11. Alternative 8B involves the construction of phosphorus chemical treatment upgrades at the Elsinore Valley MWD RWRF to provide additional treatment to the wastewater being treated at the RWRF to meet the study phosphorus water quality objectives. A remote treatment system, consisting of two-stage granular media filtration, will be constructed in the vicinity of Wasson Sill to provide additional phosphorus treatment to the reclaimed water purchased from the Eastern MWD RRWS to meet the study phosphorus water quality objectives. In addition, 107 acres of the existing Back Basin Wetland will be converted to a treatment wetland to treat lake water circulated through the wetland. The estimated facility construction and capital costs for Alternative 8A are $12,296,000 and $15,370,000, respectively.

TABLE 6-11
Alternative 8B Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EVMWD RWRF Phosphorus Treatment Upgrades	$950,000
EVMWD RWRF Treated Water Pump Station	$599,000
24-Inch EVMWD Reclaimed Water Pipeline	$1,224,000
107-Acre Treatment Wetland	$1,183,000
Recycle Intake Structure & Pipeline	$114,000
Treatment Wetland Recycle Pump Station	$368,000
12-Inch Recycle Water Pipeline	$118,000
Treatment Wetland Effluent Pump Station	$178,000
Remote Treatment System	$4,191,000
Remote Treatment System TW Pump Station	$599,000
30-Inch Remote Treatment System TW Pipeline	$247,000
San Jacinto River Old Channel Lining	$921,000
Construction Cost Subtotal:	$10,692,000
Contingency	$1,604,000
Construction Cost Total:	$12,296,000
Capital Cost Markup	$3,074,000
Capital Cost Total:	$15,370,000

Estimated Alternative Annual Operation and Maintenance Costs

The annual O&M costs have been estimated for each of the study alternatives. The annual O&M costs for the alternatives are based on the long-term average supplemental water requirements. The annual O&M costs were estimated using the following criteria:

- The treatment system annual O&M costs include operation and maintenance labor, treatment chemical costs, power and incidentals. The component costs were estimated from published data, information from other similar operating installations and manufacturer-furnished data.
- Elsinore Valley MWD has negotiated a reclaimed water purchase price with Eastern MWD for Lake Elsinore supplemental water. The current purchase price is $175 per acre-foot. The purchase agreement has a cost escalation clause that increases the reclaimed water purchase price by the Consumer Price Index plus 4.3 percent. That

rate has averaged about 6 percent over the last several years. It was assumed that the 6 percent escalation rate will continue into the future. In addition, it was assumed that it will take thirteen years to reach the mid-point of the project life span (3 year implementation period plus one-half of project 20 year life span). Those assumptions yield a reclaimed water purchase price of $373 per acre-foot, which was used in the annual O&M cost estimates for the project alternatives.

- The $373 per acre-foot purchase price for Eastern MWD reclaimed water does not include the recovery costs for chemical and biological treatment upgrades at their Temecula Valley RWRF. It is estimated that the phosphorus chemical and biological upgrade costs would add an additional $77 per acre-foot and $29 per acre-foot to the reclaimed water purchase price, respectively, for Alternative 1A and 1B. Those additional phosphorus treatment costs are based on Alternative 2-1 costs (chemical phosphorus treatment) and Alternative 2-2 costs (biological Phosphorus treatment) as presented in the "Temecula Valley RWRF Live Stream Discharge Alternatives Analysis" report, dated March 2001.
- A water purchase price of $663 per acre-foot was used for the purchase of Metropolitan imported water for those alternatives requiring the purchase of supplemental imported water. The water purchase rate reflects Metropolitan's current future price projection, as of October 2003, for non-interruptable untreated Tier 2 water, which was projected to the mid-point of the study project life assuming a 4 percent per year escalation.
- The investment and annual O&M costs for the Eastern MWD Temecula Valley RWRF process upgrades for Alternatives 1A and 1B have been considered included in the purchase price for the Eastern MWD reclaimed water.
- The treatment chemical costs for Alternative 6 are based on the recommended calcium dosage rate of 200 mg/L from bench-scale testing conducted by Dr. Anderson, and his report to LESJWA entitled "Removal of Dissolved Phosphorus Using Calcium Amendment," dated April 27, 2003.
- Treatment system labor costs are based on an average hourly rate of $40 per hour, including fringe benefits.
- Power costs are based on an average unit cost of $0.10 per kilowatt.
- The pump station annual O&M costs include power costs other operation and maintenance costs. The power costs are based on the long-term average flow conditions for the various alternatives. The other O&M costs were estimated as 1.25 percent of the pump station construction cost.
- Pipeline annual O&M costs were estimated at 0.5 percent of the pipeline construction cost.
- Routine wetlands O&M activities typically include maintenance checks of the system hydraulics, effluent pump station maintenance, routine water quality monitoring, berm maintenance, vegetation management, and wetland planting management. These wetland O&M activities are typically handled by a full-time staff person with

periodic contributions from an organizational labor pool. This level of wetland maintenance has been assumed as the basis for estimating wetland O&M costs.

- Specialized wetland maintenance and management activities can include specialized monitoring, herbivore control, vector control, non-native or nuisance plant control, vegetation removal and replacement, if warranted, berm and structural maintenance in response to seasonal storms. These costs will be incurred on an occasional basis, and will not typically be expected as part of the routine O&M maintenance activities. A special allowance has been included in the O&M estimates provided below to account for these periodic or contingent activities.
- An annual water quality monitoring cost of $100,000 per year has been included in the annual O&M cost estimates for all of the alternatives.
- For those alternatives with lake water recycle pump stations located within the Lake Elsinore Inlet Channel, an annual dredging cost of $100,000 per year has been included in the annual O&M cost calculations. The annual dredging cost allowance has been included in case the inlet structure and pump station are relocated to the vicinity of the ballpark to shorten the length of the pump station discharge pipeline.

The estimated annual O&M costs for each of the study alternatives are presented in Table 6-12 through Table 6-24.

TABLE 6-12
Alternative 1A Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Elsinore Valley MWD RWRF Chemical Treatment Upgrades		$170,000
O&M Labor	$45,000	
Treatment Chemicals	$95,000	
Power	$3,000	
Sludge Disposal	$27,000	
Elsinore Valley MWD RWRF Treated Water Pump Station		$35,000
Power	$28,000	
Operation & Maintenance	$7,000	
Pipeline Operation & Maintenance Costs		$6,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchase		$0
Total Estimated Annual O&M Cost:		$311,000

TABLE 6-13
Alternative 1B Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Elsinore Valley MWD RWRF Biological Treatment Upgrades		$154,000
O&M Labor	$71,000	
Treatment Chemicals	$33,000	
Power	$40,000	
Sludge Disposal	$10,000	
Elsinore Valley MWD RWRF Treated Water Pump Station		$35,000
Power	$28,000	
Operation & Maintenance	$7,000	
Pipeline Operation & Maintenance Costs		$6,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchase		$0
Total Estimated Annual O&M Cost:		$295,000

TABLE 6-14
Alternative 2A Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
350-Acre Treatment Wetland		$200,000
Facility Maintenance	$100,000	
Plant Maintenance	$100,000	
Treatment Wetland Effluent Pump Station		$19,000
Power	$17,000	
Operation & Maintenance	$2,000	
Remote Treatment System		$381,000
O&M Labor	$63,000	
Treatment Chemicals	$288,000	
Power	$30,000	
Elsinore Valley MWD RWRF Reclaimed Water Pump Station		$55,000
Power	$49,000	
Operation & Maintenance	$6,000	
Treatment Wetland Recycle Pump Station		$18,000
Power	$15,000	
Operation & Maintenance	$3,000	
Remote Treatment System Recycle Pump Station		$90,000
Power	$83,000	
Operation & Maintenance	$7,000	
Pipeline Operation & Maintenance Costs		$32,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchase		$615,000
Total Estimated Annual O&M Cost:		$1,510,000

Eastern MWD Reclaimed Water = 1,650 AF @ $373/AF

TABLE 6-15
Alternative 2B Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Elsinore Valley MWD RWRF Chemical Treatment Upgrades		$197,000
O&M Labor	$38,000	
Treatment Chemicals	$121,000	
Power	$4,000	
Sludge Disposal	$34,000	
Elsinore Valley MWD RWRF Treated Water Pump Station		$55,000
Power	$44,000	
Operation & Maintenance	$11,000	
300-Acre Treatment Wetland		$200,000
Facility Maintenance	$100,000	
Plant Maintenance	$100,000	
Lake Water Recycle Pump Station		
Power	$36,000	$43,000
Operation & Maintenance	$7,000	
Treatment Wetlands Effluent Pump Station		
Power	$32,000	$39,000
Operation & Maintenance	$7,000	
Pipeline Operation & Maintenance Costs		$18,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchases		$988,000
Total Estimated Annual O&M Cost:		$1,640,000

Eastern MWD Reclaimed Water 2,650 AF @ $373/AF

TABLE 6-16
Alternative 3A Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
600-Acre Treatment Wetland		$275,000
Facility Maintenance	$100,000	
Plant Maintenance	$175,000	
Treatment Wetland Effluent Pump Station		$33,000
Power	$31,000	
Operation & Maintenance	$2,000	
Elsinore Valley MWD RWRF Reclaimed Water Pump Station		$57,000
Power	$49,000	
Operation & Maintenance	$8,000	
Treatment Wetland Recycle Pump Station		$66,000
Power	$60,000	
Operation & Maintenance	$6,000	
Pipeline Operation & Maintenance Costs		$33,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchase		$1,679,000
Total Estimated Annual O&M Cost:		$2,243,000

EMWD Reclaimed Water 4,500 AF @ $373/AF

TABLE 6-17
Alternative 3B Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Elsinore Valley MWD RWRF Chemical Treatment Upgrades		$197,000
O&M Labor	$38,000	
Treatment Chemicals	$121,000	
Power	$4,000	
Sludge Disposal	$34,000	
Elsinore Valley MWD RWRF Treated Water Pump Station		$55,000
Power	$44,000	
Operation & Maintenance	$11,000	
600-Acre Treatment Wetland		$275,000
Facility Maintenance	$100,000	
Plant Maintenance	$175,000	
Lake Water Recycle Pump Station		$84,000
Power	$75,000	
Operation & Maintenance	$9,000	
Treatment Wetlands Effluent Pump Station		$86,000
Power	$78,000	
Operation & Maintenance	$8,000	
Pipeline Operation & Maintenance Costs		$39,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchases		$4,745,000
Total Estimated Annual O&M Cost:		$5,581,000

Eastern MWD Reclaimed Water = 12,720 AF @ $373/AF

TABLE 6-18
Alternative 4 Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
350-Acre Littoral Wetland		$225,000
Facility Maintenance	$100,000	
Plant Maintenance	$125,000	
Remote Treatment System		$230,000
O&M Labor	$38,000	
Treatment Chemicals	$174,000	
Power	$18,000	
Littoral Wetland Effluent Pump Station		$42,000
Power	$38,000	
Operation & Maintenance	$4,000	
Elsinore Valley MWD RWRF Reclaimed Water Pump Station		$40,000
Power	$31,000	
Operation & Maintenance	$9,000	
Treatment Wetland Recycle Pump Station		$12,000
Power	$8,000	
Operation & Maintenance	$4,000	
Remote Treatment System Recycle Pump Station		$35,000
Power	$31,000	
Operation & Maintenance	$4,000	
Pipeline Operation & Maintenance Costs		$26,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchase		$0
Total Estimated Annual O&M Cost:		$710,000

TABLE 6-19
Alternative 5A Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Remote Treatment System		$244,000
O&M Labor	$42,000	
Treatment Chemicals	$176,000	
Power	$26,000	
Elsinore Valley MWD RWRF Treated Water Pump Station		$62,000
Power	$54,000	
Operation & Maintenance	$8,000	
Remote Treatment System Recycle Pump Station		$129,000
Power	$120,000	
Operation & Maintenance	$9,000	
Pipeline Operation & Maintenance Costs		$18,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchase		$0
Total Estimated Annual O&M Cost:		$553,000

TABLE 6-20
Alternative 5B Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Remote Treatment System		$384,000
O&M Labor	$15,000	
Treatment Chemicals	$206,000	
Power	$163,000	
Elsinore Valley MWD RWRF Treated Water Pump Station		$36,000
Power	$29,000	
Operation & Maintenance	$7,000	
Remote Treatment System Recycle Pump Station		$63,000
Power	$57,000	
Operation & Maintenance	$6,000	
Pipeline Operation & Maintenance Costs		$15,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchase		$0
Total Estimated Annual O&M Cost:		$598,000

TABLE 6-21
Alternative 6 Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Remote Calcium Treatment System		$204,000
O&M Labor	$25,000	
Treatment Chemicals	$134,000	
Power	$45,000	
Elsinore Valley MWD RWRF Reclaimed Water Pump Station		$36,000
Power	$32,000	
Operation & Maintenance	$4,000	
Remote Treatment System Recycle Pump Station		$7,000
Power	$4,000	
Operation & Maintenance	$3,000	
Pipeline Operation & Maintenance Costs		$15,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchase		$0
Total Estimated Annual O&M Cost:		$362,000

TABLE 6-22
Alternative 7 Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Metropolitan Imported Water Purchases		$5,894,000
Water Quality Monitoring		$100,000
Eastern MWD Reclaimed Water Purchase		$0
Total Estimated Annual O&M Cost:		$5,994,000

Metropolitan Imported Water = 8,890 AF @ $663/AF

TABLE 6-23
Alternative 8A Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Elsinore Valley MWD RWRF Chemical Treatment Upgrades		$197,000
O&M Labor	$38,000	
Treatment Chemicals	$121,000	
Power	$4,000	
Sludge Disposal	$34,000	
Elsinore Valley MWD RWRF Treated Water Pump Station		$44,000
Power	$37,000	
Operation & Maintenance	$7,000	
107-Acre Treatment Wetland		
Facility Maintenance	$30,000	$80,000
Plant Maintenance	$50,000	
Lake Water Recycle Pump Station		
Power	$6,000	$11,000
Operation & Maintenance	$5,000	
Treatment Wetlands Effluent Pump Station		$8,000
Power	$6,000	
Operation & Maintenance	$2,000	
Pipeline Operation & Maintenance Costs		$8,000
Water Quality Monitoring		$100,000
Lake Inlet Channel Dredging		$100,000
Metropolitan Imported Water Purchases		$219,000
Eastern MWD Reclaimed Water Purchase		$0
Total Estimated Annual O&M Cost:		$767,000

Metropolitan Imported Water = 330 AF @ $663/AF

TABLE 6-24
Alternative 8B Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Elsinore Valley MWD RWRF Chemical Treatment Upgrades		$197,000
O&M Labor	$38,000	
Treatment Chemicals	$121,000	
Power	$4,000	
Sludge Disposal	$34,000	
Elsinore Valley MWD RWRF Treated Water Pump Station		$30,000
Power	$23,000	
Operation & Maintenance	$7,000	
Remote Treatment System		$177,000
O&M Labor	$50,000	
Treatment Chemicals	$115,000	
Power	$12,000	
Remote Treatment System Treated Water Pump Station		$8,000
Power	$1,000	
Operation & Maintenance	$7,000	
107-Acre Treatment Wetland		$80,000
Facility Maintenance	$30,000	
Plant Maintenance	$50,000	
Lake Water Recycle Pump Station		$14,000
Power	$9,000	
Operation & Maintenance	$5,000	
Treatment Wetlands Effluent Pump Station		$8,000
Power	$6,000	
Operation & Maintenance	$2,000	
Pipeline Operation & Maintenance Costs		$13,000
Water Quality Monitoring		$100,000
Lake Inlet Channel Dredging		$100,000
Eastern MWD Reclaimed Water Purchases		$123,000
Total Estimated Annual O&M Cost:		$850,000

Eastern MWD Reclaimed Water = 330 AF @ $373/AF

PROJECT ALTERNATIVES DECISION ANALYSIS

Section 7: Project Alternatives Decision Analysis

Introduction

This section of the report describes the decision analysis process used to evaluate the 13 project alternatives and subalternatives to identify a preferred project alternative based on the estimated capital and annual O&M costs for the alternatives and subalternatives and the evaluation criteria adopted by the study stakeholders. The section will conclude with a presentation of results of the study decision analysis.

Evaluation Criteria and Weightings

Once all the project alternatives had been developed, and the construction cost, capital cost, and annual O&M cost for each alternative estimated, an initial workshop was conducted with the project stakeholders to develop the evaluation criteria categories, and assign weighting criteria to each of the evaluation criteria categories. Primary evaluation criteria categories were first developed. Once all of the primary evaluation criteria categories had been selected, then secondary evaluation criteria categories were developed for each primary evaluation criteria category. The workshop concluded with the project stakeholders assigning weighting criteria first to the primary evaluation criteria categories, then to the secondary evaluation criteria categories. A weighting range of 0 percent to 100 percent was adopted for the study decision analysis.

Table 7-1 presents the primary and secondary evaluation criteria selected by the project stakeholders for the study decision analysis. The table also shows the weightings assigned to each of the evaluation criteria categories. A total of eight primary evaluation criteria categories and twenty-eight secondary evaluation criteria categories were established for the analysis.

For the financial impact primary category initially three secondary evaluation criteria categories were selected. Those secondary categories included Capital Cost, Annual O&M Cost and Other Funding Sources. The Capital Cost and Annual O&M Cost categories turned out to be redundant categories that are already accounted for in the Decision Analysis Model Cost/Benefit calculation. Accordingly, those two secondary categories were dropped from the decision analysis benefit value computation to avoid a double counting of those criteria in the analysis.

TABLE 7-1
Primary and Secondary Evaluation Criteria Categories and Weightings

Primary Evaluation Category	Percentage	Secondary Evaluation Category	Percentage
Water Quality/Treatment	80	Ability to Achieve L-T Phosphorus Goal	90
		Compliance w/ RWQCB TMDL Objective - Lake Elsinore	90
		Amount of Phosphorus Removed	25
Water Quantity	100	Availability of Adequate Supply	100
		Amount of Water Losses (wetlands/outflow)	75
Environmental Considerations	50	Noise	20
		Visual Impacts/Aesthetics	75
		Traffic Impacts	50
		Footprint	25
		Loss of Active lake Area	10
Operational Considerations	65	Operational Difficulty (Operator Skill Level)	25
		Ability to Treat Changing Recycled Water Qualities	80
		Process Automation (Unattended Operation)	75
		Energy usage	80
		Public Safety (Emissions & Chemical Spills)	80
		Disposal of Residuals	80
Flexibility	80	Staging Potential (Construct Facilities to Match Funding)	90
		Implementation Time	80
Financial	100	Other funding Sources	90
Community Benefits	60	Recreational Value	50
		Compatibility with Back Basin Development	40
		Compatibility w/ Surrounding Land Uses	40
		Compatibility w/ Lake Uses	50
Institutional Constraints	100	SWRCB Approval	100
		Inter-agency Agreements	90
		Agency willingness to upgrade WWTP	90
		Permitting	100
		CEQA	100

Evaluation Criteria Rankings

After the evaluation criteria and weightings were finalized, the next step was to rank each of the 13 project alternatives and subalternatives against the secondary evaluation criteria categories. A ranking system, with one representing the lowest rank and five representing the highest rank, was used to rank the project alternatives. The ranking of the projects against each of the secondary evaluation criteria was done with LESJWA staff. The project alternative ranking results are presented in Table 7-2. The project stakeholders evaluated and accepted the rankings of the projects at a workshop held on November 12, 2003.

Decision Analysis Model

A decision matrix model developed by CH2M HILL, consisting of two linked software modules, was used for the study decision analysis. The DecisionPlus Criterium® program is one of the software modules, and was used to calculate the benefit score of each project alternative and subalternative, based on the primary and secondary evaluation criteria and the ranking of the project alternatives and subalternatives against the secondary evaluation criteria. The Excel® spreadsheet program is the other software module, which calculates the present value of the project alternatives and subalternatives, and also calculates the cost/benefit score and generates the results output graphic.

The present value of the project alternative and subalternative annual O&M costs were calculated using an interest rate of 6 percent and a project life span of 20 years. The alternative and subalternative total present value is the sum of the capital cost plus the present value of the annual O&M costs. The cost/benefit value for each alternative and subalternative is calculated as the total present value divided by the total benefit score.

Decision Analysis Results

The result of the decision analysis model cost/benefit analysis is presented in Figure 7-1. As shown in the figure, the benefit scores for the 13 project alternatives and subalternatives ranged from 0.45 and 0.72, with the lowest score belonging to Alternative 6 and the highest score belonging to Alternative 1A. The benefit scores for each of the alternatives are shown graphically as a compilation of the individual evaluation criteria benefits selected by the stakeholders as being important to the implementation of the project alternatives.

The line graphs at the top of the figure present the capital costs, present value of the annual O&M costs, total present value and the model-calculated cost/benefit values for each of the project alternatives. A smaller cost/benefit value would be indicative of a favorable alternative, costing less per each unit of benefit score. Conversely, a larger cost/benefit value would be indicative of a less favorable alternative, since it would cost more per unit of benefit score. For the study analysis, the least favorable alternative appears to be Alternative 3B with a benefit/cost value of $166,377,199, while the most favorable alternative appears to be Alternative 1A with a cost/benefit value of $11,168,036.

TABLE 7-2
Project Alternative Rankings Versus Secondary Evaluation Criteria

Primary Evaluation Category	Secondary Evaluation Category	Project Alternatives Ranking												
		1A	1B	2A	2B	3A	3B	4	5A	5B	6	7	8A	8B
Water Quality/Treatment	Ability to Achieve L-T Phosphorus Goal	4	4	2	3	2	3	2	4	5	3	1	2	3
	Compliance w/ RWQCB TMDL Objective - Lake Elsinore	4	4	2	3	2	3	2	4	5	2	1	2	3
	Amount of Phosphorus Removed	2	2	2	4	2	5	3	3	3	2	1	3	4
Water Quantity	Availability of Adequate Supply	4	4	4	2	2	1	4	3	3	3	5	4	3
	Amount of Water Losses (wetlands/outflow)	5	5	2	2	1	1	4	4	4	5	2	3	3
Environmental Considerations	Noise	5	5	4	5	5	5	3	4	3	3	5	4	4
	Visual Impacts/Aesthetics	5	5	3	3	4	4	2	4	3	2	5	4	3
	Traffic Impacts	4	4	2	2	3	3	2	4	2	1	5	4	3
	Footprint	4	4	3	3	1	1	3	4	3	3	5	4	3
	Loss of Active Lake Area	5	5	5	5	5	5	1	5	5	5	5	5	5
Operational Considerations	Operational Difficulty (Operator Skill Level)	3	3	3	4	4	4	3	3	2	3	5	4	3
	Ability to Treat Changing Recycled Water Qualities	4	3	2	1	1	1	2	4	5	2	5	2	3
	Process Automation (Unattended Operation)	3	4	2	2	5	5	2	3	5	2	5	5	2
	Energy usage	4	4	2	3	3	2	3	2	1	3	5	3	3
	Public Safety (Emissions & Chemical Spills)	4	4	2	3	5	5	2	4	1	1	5	5	3
	Disposal of Residuals	3	3	2	2	4	4	2	3	2	5	5	4	2
Flexibility	Staging Potential (Construct Facilities to Match Funding)	5	5	2	4	2	3	2	2	2	2	5	4	3
	Implementation Time	4	3	2	2	2	3	1	4	3	3	5	4	3
Financial	Capital Costs	4	3	1	3	2	1	2	3	1	4	5	3	1
	Annual O&M Costs	5	5	4	4	3	2	5	5	5	5	1	3	4
	Other Funding Sources	3	3	4	4	4	4	4	2	2	2	2	5	5
Community Benefits	Recreational Value	2	2	4	4	4	4	3	2	2	2	1	5	5
	Compatibility with Back Basin Development	1	1	5	5	2	2	3	1	1	1	1	5	5
	Compatibility w/ Surrounding Land Uses	5	5	3	2	2	2	1	4	1	1	5	4	3
	Compatibility w/ Lake Uses	5	5	4	4	4	4	1	3	2	2	5	3	3
Institutional Constraints	SWRCB Approval	4	4	5	5	5	5	4	4	4	4	1	5	5
	Inter-Agency Agreements	4	4	3	3	3	3	3	4	4	4	5	1	3
	Agency Willingness to Upgrade WWTP	1	1	5	5	5	5	5	5	5	5	5	5	5
	Permitting	4	4	4	3	5	4	3	5	5	5	5	3	2
	CEQA	5	5	2	4	2	3	1	4	3	3	5	4	4

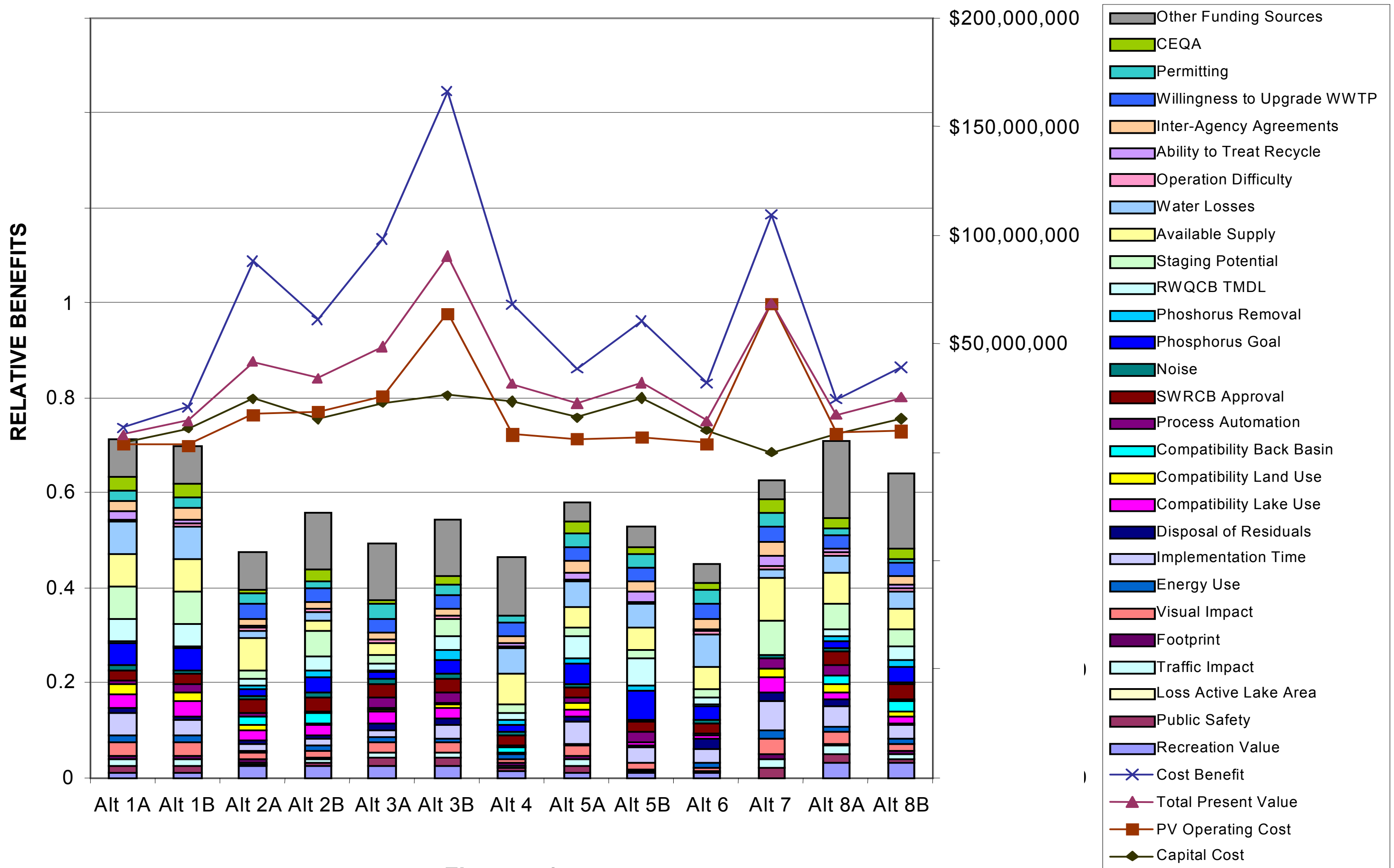


Figure 7-1
Decision Matrix Cost/Benefit Analysis Results

Table 7-3 lists each of the project alternatives, and the corresponding cost/benefit values calculated by the decision matrix model. The table lists the project alternatives in an ascending order, from most favorable to least favorable.

The decision matrix model calculates benefit scores for each of the project alternatives, as the product of the individual evaluation criteria weighting percentages (primary and secondary categories) and the project alternative rankings for the evaluation criteria. The individual benefit scores for the project alternatives are presented in Table 7-4 to show how the project alternatives would be ranked if only the benefits of each alternative are considered. As with the cost/benefit ranking, Alternative 1A is the most favorable alternative with a calculated benefit score of 0.72. The second and third best alternatives are Alternative 8A and Alternative 1B, with benefit scores of 0.71 and 0.70, respectively. The benefit scores of Alternative 1A, Alternative 8A, and Alternative 1B are so close that any of those alternatives could be considered equivalent if benefit scores are only taken into consideration.

TABLE 7-3
Project Alternative Calculated Cost/Benefit Values Ranked in Descending Order From Most Favorable to Least Favorable

Alternative	Cost/Benefit Value ($)
Alt 1A	$11,168,036
Alt 1B	$20,685,181
Alt 8A	$24,358,204
Alt 6	$31,682,470
Alt 5A	$38,643,925
Alt 8B	$39,096,394
Alt 5B	$60,360,214
Alt 2B	$61,050,531
Alt 4	$67,938,690
Alt 2A	$88,095,960
Alt 3A	$98,351,337
Alt 7	$109,562,881
Alt 3B	$166,377,199

TABLE 7-4
Project Alternative Benefit Scores Ranked in Descending Order From Most Favorable to Least Favorable

Alternative	Benefit Score
Alt 1A	0.72
Alt 8A	0.71
Alt 1B	0.70
Alt 8B	0.64
Alt 7	0.63
Alt 5A	0.58
Alt 2B	0.56
Alt 3B	0.54
Alt 5B	0.53
Alt 3A	0.49
Alt 2A	0.48
Alt 4	0.46
Alt 6	0.45

PREFERRED PROJECT ALTERNATIVE

Section 8: Preferred Project Alternative

Introduction

The previous report section described the decision analysis procedure used to identify the best project alternative to provide the required supplemental water volumes for the long-term average and worst-case drought conditions, and meet the study water quality objectives. The decision analysis procedure utilized a decision matrix software program that calculated the benefit scores for the 13 study alternatives, based on the evaluation criteria and their weightings and alternative rankings established by the study stakeholders. The decision matrix software program also calculated the cost/benefit values for the study alternatives. The results of the decision analysis process identified Alternative 1A and Alternative 8A as the alternatives with the highest benefit rankings with benefit scores of 0.72 and 0.71, respectively. Alternative 1B was the third highest ranked alternative with a benefit score of 0.70. The benefit scores for those three alternatives are so close that they can be considered equivalent. Alternative 1A was also the highest ranked project alternative from a cost/benefit perspective, with a calculated cost/benefit value of $11,120,000. Alternative 8B ranked second, with a calculated cost/benefit value of $20,636,000. Alternative 8A ranked third, with a calculated cost/benefit value of $23,471,000.

Alternative 1A will have a fatal flaw if the Eastern MWD Temecula Valley Pipeline conveys treated effluent from any other wastewater treatment plants than their Temecula Valley RWRF. The combined treated effluent flows in the pipeline would not receive the same amount of phosphorus treatment, and the phosphorus concentration in the flow will most likely be greater than the goal established for the study. Accordingly, the study stakeholders decided to develop a Preferred Project Alternative (PPA) that has the best attributes from Alternative 1A, Alternative 8A and Alternative 8B. The various elements of the PPA will then be implemented by LESJWA as funding is available to construct the various facility elements of the PPA. The components of the PPA are described in this section of the report, along with the estimated construction, capital and annual O&M costs for the PPA.

Preferred Project Alternative Facility Elements

The following facility elements comprise the PPA:

- Use of existing three Island Wells, as needed.
- Conversion of the south one-third of the existing Back Basin Wetland (350 acres) to a 107 acre treatment wetland, with the remainder of the Back Basin Wetland staying in its current configuration.
- Construction of lake water recycle pump station and pipeline to convey lake water to the Old San Jacinto Channel, and subsequent conveyance in the Old San Jacinto River Channel to the new treatment wetland.
- Lining of the Old San Jacinto River Channel from the vicinity of the ballpark to the new treatment wetland to convey lake water recycle flows.

- Construction of a new Title 22 effluent pipeline from the Eastern MWD Temescal Pipeline at Wasson Sill to convey purchased Title 22 effluent to the Elsinore Valley MWD RWRF, including turnout facility at the Temescal Valley Pipeline and pressure regulating facilities at the RWRF.
- Construction of chemical phosphorus treatment facilities at the Elsinore Valley MWD RWRF up to the 8.0 mgd existing treatment capacity of the plant.
- Construction of a remote granular media filtration facility at the Elsinore Valley MWD RWRF to treat Title 22 effluent purchased from Eastern MWD.
- Construction of a new treated water pump station at the Elsinore Valley MWD RWRF and treated water pipeline to the Lake Elsinore Outlet Channel near the Wasson Sill to convey treated effluent to lake Elsinore via the lake outlet channel.

The construction of the chemical phosphorus treatment facilities at the Elsinore Valley MWD RWRF up to the existing treatment capacity of the plant will allow the use of surplus plant treatment capacity to treat Title 22 effluent purchased from Eastern MWD. This feature of the PPA would allow the construction of the granular media facility at the Elsinore Valley MWD RWRF to be delayed to a later date, or may negate the need to construct that facility depending upon the supplemental water requirements for Lake Elsinore.

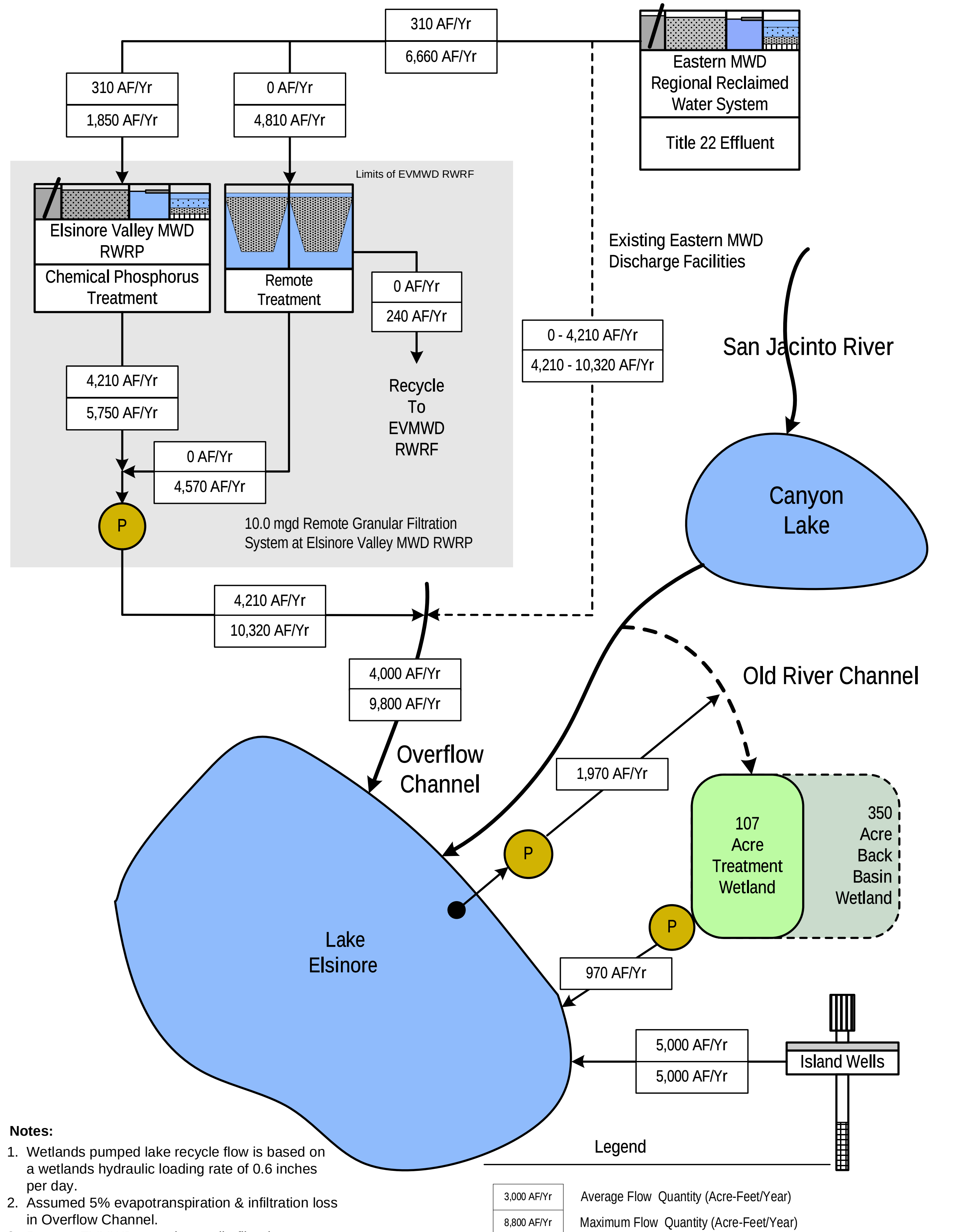
The PPA will also utilize the existing Eastern MWD turnout and pipeline facilities at Wasson Sill to discharge reclaimed water directly into Lake Elsinore via the Lake Elsinore Outlet Channel. The Lake Elsinore Outlet Channel will have to be bermed at the point of discharge to direct the reclaimed water towards the lake.

Preferred Project Alternative Supplemental Requirements

Figure 8-1 presents the flow schematic for the PPA. The figure shows the supplemental water requirements for the long-term average condition of 8,000 acre-feet per year, as well as the supplemental water requirements for the worst-case drought condition of 13,800 acre-feet per year that has been adopted for the study.

The treatment wetland will be used to treat lake water recycled through the wetland. The treatment wetland area was limited to 107 acres to keep the evaporation and infiltration losses in the Old San Jacinto River Channel and the treatment wetland to 1,000 acre-feet per year, or less, which is equivalent to the current water losses from the existing Back Basin Wetland. The wetland evaporation and infiltration water losses will be made up through supplemental water production through the Elsinore Valley MWD RWRF, or direct discharge of Title 22 effluent purchased from Eastern MWD to the lake via the overflow channel.

Table 8-1 summarizes the monthly inflows to the PPA 107-acre treatment wetland, and the expected phosphorus removal performance at the indicated hydraulic and mass loading rates. The phosphorus removal performance is based on an average phosphorus removal rate of 10 m/yr, hydraulic loading rate of 0.6 inches per day (5.8 acre-feet per day), and influent phosphorus concentration of 0.2 mg/L for the recycled lake water. The treatment wetland effluent discharge phosphorus concentration is projected to be 0.06 mg/L, representing a 71 percent reduction. The estimated annual total mass of phosphorus



Notes:

1. Wetlands pumped lake recycle flow is based on a wetlands hydraulic loading rate of 0.6 inches per day.
2. Assumed 5% evapotranspiration & infiltration loss in Overflow Channel.
3. Remote EVMWD granular media filtration system capacity =10.0 mgd.
4. EVMWD RWRF capacity = 8.0 mgd, of which 0.5 mgd is dedicated for environmental discharge.

Figure 8-1
Preferred Project Alternative Flow Schematic

CH2MHILL

removed from all flows applied to the treatment wetland will be about 418 kilograms, or about 1,100 pounds per year.

TABLE 8-1
Preferred Project Alternative 107-Acre Recycled Lake Water Treatment Wetland Phosphorous Removal

Month	[a]EVMWD Inflow (ac-ft)	[a]EMWD Inflow (ac-ft)	[b]Lake Recycle (ac-ft)	Influent (mg TP/L)	Mass Loading (kg/ha/d)	[c]Outflow (ac-ft)	HLR (in/d)	HRT (d)	[d]Effluent (mg TP/L)	Mass Removal (kg TP)
Jan	0	0	167	0.2	0.031	114	0.6	40	0.06	33
Feb	0	0	151	0.2	0.031	99	0.6	41	0.05	31
Mar	0	0	167	0.2	0.031	98	0.6	43	0.06	34
Apr	0	0	162	0.2	0.031	74	0.6	47	0.06	35
May	0	0	167	0.2	0.031	68	0.6	48	0.06	36
Jun	0	0	162	0.2	0.031	56	0.6	50	0.06	36
Jul	0	0	167	0.2	0.031	56	0.6	51	0.06	37
Aug	0	0	167	0.2	0.031	58	0.6	50	0.06	37
Sep	0	0	162	0.2	0.031	69	0.6	48	0.06	35
Oct	0	0	167	0.2	0.031	82	0.6	45	0.06	35
Nov	0	0	162	0.2	0.031	93	0.6	43	0.06	33
Dec	0	0	167	0.2	0.031	105	0.6	42	0.06	34
Annual	0	0	1970		486	972				418

[a]Influent = 3.0 mg TP/L

[b]Influent = 0.2 mg TP/L

[c]Infiltration Rate = 5.5E-06 cm/s

[d]First-order removal rate (k) = 10 m/yr

EVMWD = Elsinore Valley Municipal Water District

EMWD = Eastern Municipal Water District

HLR = Hydraulic Loading Rate

HRT = Hydraulic Residence Time

The existing three Island Wells will provide up to 5,000 acre-feet per year of local groundwater as a supplemental water source for Lake Elsinore. This source of supplemental water will only be used as needed.

With the Island Well production, up to 4,000 acre-feet per year of water may have to be added to Lake Elsinore each year for the long-term average supplemental water condition. Up to 9,800 acre-feet per year may have to be added to Lake Elsinore for the worst-case drought supplemental water condition. Those two supplemental water volumes include the 1,000 acre-feet per year of evaporation and infiltration losses for the converted 107-acre treatment wetland. This supplemental water requirement will be satisfied by Elsinore Valley RWRF treated water and reclaimed water purchased from Eastern MWD that will be treated at the Elsinore Valley RWRF that is discharged to the Lake Elsinore Overflow Channel. If those two sources of water are not enough to satisfy the lake supplemental water requirement, then additional reclaimed water can be purchased from Eastern MWD, discharged directly to the lake via the overflow channel. A five percent evaporation and infiltration loss has been assumed for the Lake Elsinore Overflow Channel.

Chemical phosphorus treatment facilities will be constructed at the Elsinore Valley MWD RWRF to meet the phosphorus removal objectives of the study, and will have a capacity of 8.0 mgd that matches the existing treatment capacity of the plant. The Elsinore Valley MWD RWRF will initially produce up to 4,210 acre-feet per year of supplemental water for Lake Elsinore, which includes the current Title 22 effluent production from the plant plus the treatment of Title 22 effluent purchased from Eastern MWD. The surplus plant treatment capacity will be used in the future to increase the supplemental water deliveries to Lake Elsinore as wastewater flows from the Elsinore Valley MWD service area increase, or through the treatment of Eastern MWD reclaimed water. During the initial years of the project, up to an additional 310 acre-feet per year of water may be needed from Eastern MWD for the long-term average supplemental water condition, and up to 6,660 acre-feet per year of water for the worst-case drought condition.

One of the facility elements of the PPA is the construction of granular media filtration facilities at the Elsinore Valley MWD RWRF. Those facilities have been sized so that they will be capable of producing up to 4,570 acre-feet of supplemental water under the worst-case drought supplemental water condition. That volume of supplemental water will have to be treated within the 151-day winter period, when Eastern MWD has indicated that reclaimed water from their system would be available for purchase as a supplemental water source for Lake Elsinore. The granular media filtration facilities will therefore have a treatment capacity of 10.0 mgd to produce the 4,570 acre-feet of supplemental water within that 151 day period. The granular media filtration process will produce waste backwash water that is estimated to be up to 240 acre-feet per year for the worst-case drought condition. Those waste backwash water flows will be recycled to the Elsinore Valley MWD RWRF for treatment via the agency's sewer system.

Preferred Project Alternative Facilities

Figure 8-2 shows the PPA component facilities, which include the following:

1. Turnout facility at the Wasson Sill terminus of the Eastern MWD Temescal Pipeline, and 6,200 feet of 30-inch pipeline to convey reclaimed water from the turnout facility to the Elsinore Valley MWD RWRF. The turnout facility will contain an isolation valve, flow meter and rate-of-flow control valve. A pressure reduction facility will be constructed immediately upstream of the discharge point to the Elsinore Valley MWD RWRF treatment system, or granular media filtration process.

2. Chemical phosphorus treatment facilities at the existing Elsinore Valley MWD RWRF, consisting of chemical storage and feed system, solids dewatering equipment and building. The chemical phosphorus treatment facilities will have a treatment capacity of 8.0 mgd to match the current RWRF treatment capacity.

3. A 10.0 mgd remote treatment granular media filtration process at the Elsinore Valley MWD RWRF to treat reclaimed water purchased from the Eastern MWD. The filtration process will be a two-stage Dynasand® filtration process.

4. Treated water pump station with a 17.0 mgd pumping capacity located at the Elsinore Valley MWD RWRF, and 6,200 feet of 36-inch pipeline to convey reclaimed water from the Elsinore Valley MWD RWRF to the vicinity of the Wasson Sill for discharge into the Lake Elsinore Overflow Channel and the lake.

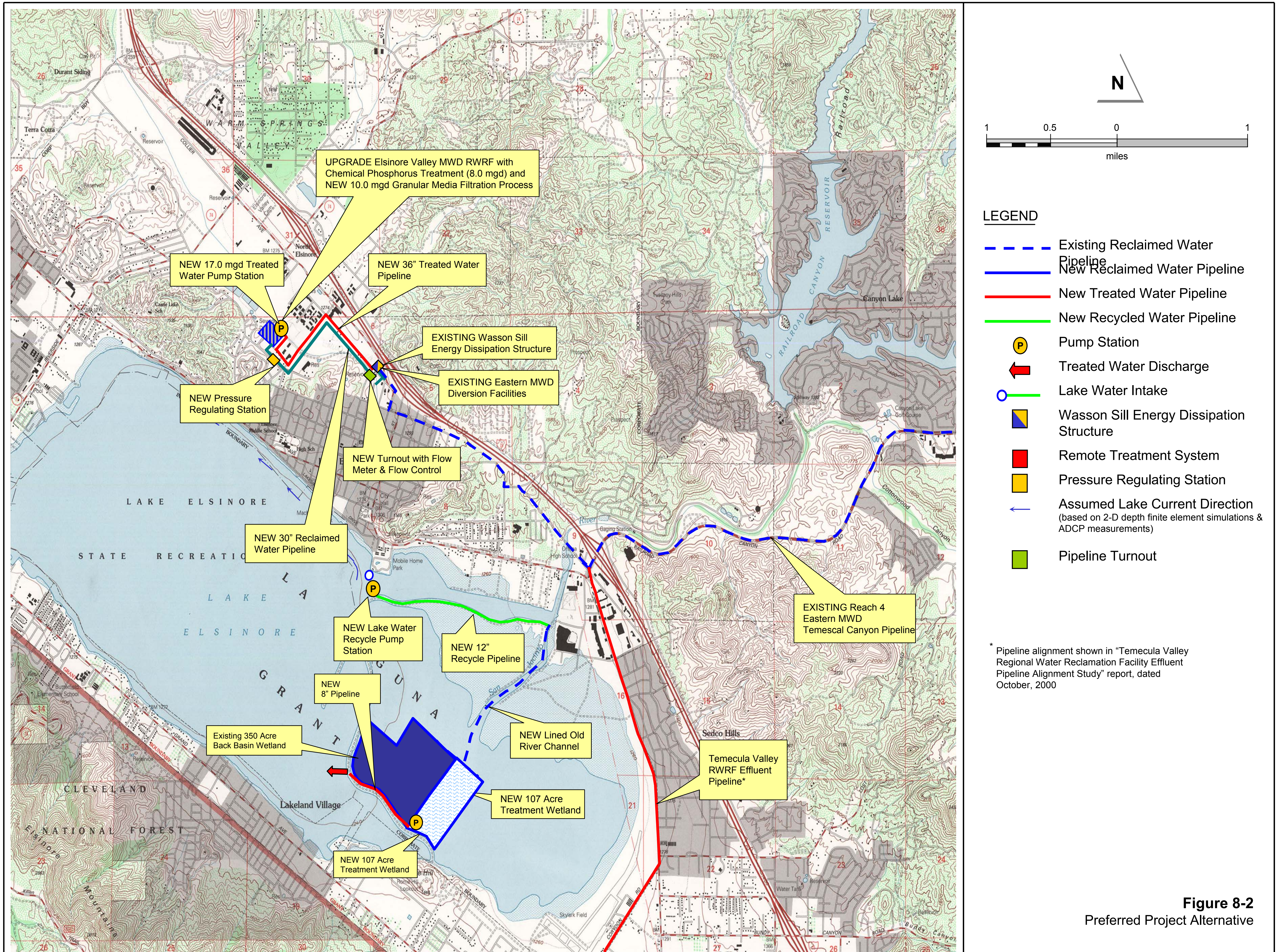


Figure 8-2
Preferred Project Alternative

5. Lake intake structure, 2.0 mgd (1,970 acre-feet per year) capacity lake water recycle pump station, 7,400 feet of 12-inch pipeline to convey lake water to the Old San Jacinto River Channel in the vicinity of the ballpark, and relining of the Old san Jacinto River Channel. The Old San Jacinto River Channel will be used to convey lake water via the channel to the existing back basin Wetland, or a converted treatment wetland.
6. Conversion of the southern portion of the existing Back Basin Wetland to a 107-acre treatment wetland, including 1.0 mgd treatment wetland effluent pump station and 3,200 feet of 8-inch discharge pipeline to Lake Elsinore.
7. Use of the existing Eastern MWD turnout and pipeline facilities at the Wasson Sill to discharge reclaimed water via the Outlet Channel to Lake Elsinore.

Preferred Project Alternative Construction, Capital and Annual O&M Costs

Table 8-2 presents the estimated construction cost and capital cost of the component elements of the PPA. The estimated construction cost includes a contingency of 15 percent. The capital cost for the PPA was calculated by applying a 25 percent markup of the construction cost to account for engineering costs, and LESJWA administrative and financing costs. The estimated cost for the lining of the Old San Jacinto River Channel takes into consideration LESJWA's $400,000 grant. The estimated construction and capital costs reflect March 2003 costs, and have been referenced to an Engineering News-Record CCI of 7,570 for the greater Los Angeles area.

Table 8-3 presents the estimated annual O&M costs for the PPA. The annual O&M costs are based on the long-term average supplemental water requirements presented in Figure 8-1. The annual O&M cost factors are the same as those described in Section 6 of this report.

TABLE 8-2
Preferred Project Alternative Estimated Construction and Capital Costs

Facility Description	Estimated Cost
EMWD Pipeline Turnout Structure	$220,000
30-Inch EMWD Title 22 Effluent Pipeline	$1,004,000
EMWD Pressure Regulating Station	$176,000
EVMWD RWRF Phosphorus Treatment Upgrades	$950,000
EVMWD RWRF Granular Media Filtration Process	$3,143,000
EVMWD Treated Water Pump Station	$895,000
36-Inch EVMWD Treated Water Pipeline	$1,469,000
Recycle Intake Structure & Pipeline	$114,000
Treatment Wetland Recycle Pump Station	$368,000
12-Inch Treatment Wetland Recycle Pipeline	$340,000
107-Acre Treatment Wetland	$1,183,000
Treatment Wetland Effluent Pump Station	$195,000
8-Inch Treatment Wetland Treated Water Pipeline	$98,000
San Jacinto River Old Channel Lining	$921,000
Construction Cost Subtotal:	$11,076,000
Contingency	$1,661,000
Estimated Total Construction Cost:	$12,737,000
Capital Cost Markup	$3,184,000
Estimated Total Capital Cost:	$15,921,000

Notes:
1. San Jacinto River Relining Cost of $921,000 = $1,321,000 - $400,000 (grant).

Table 8-3 presents the estimated annual O&M costs for the PPA. The annual O&M costs are based on the long-term average supplemental water requirements presented in Figure 8-1. The annual O&M cost factors are the same as those described in Section 6 of this report.

TABLE 8-3
Preferred Project Alternative Estimated Annual O&M Costs

Cost Description	Estimated Component O&M Cost	Total Estimated O&M Cost
Elsinore Valley MWD RWRF Chemical Treatment Upgrades		$197,000
O&M Labor	$38,000	
Treatment Chemicals	$121,000	
Power	$4,000	
Sludge Disposal	$34,000	
Elsinore Valley MWD RWRF Granular Media Filtration Process		$72,000
O&M Labor	$40,000	
Treatment Chemicals	$26,000	
Power	$6,000	
Elsinore Valley MWD RWRF Treated Water Pump Station		$26,000
Power	$15,000	
Operation & Maintenance	$11,000	
107-Acre Treatment Wetland		$80,000
Facility Maintenance	$30,000	
Plant Maintenance	$50,000	
Lake Water Recycle Pump Station		$13,000
Power	$8,000	
Operation & Maintenance	$5,000	
Treatment Wetlands Effluent Pump Station		$8,000
Power	$6,000	
Operation & Maintenance	$2,000	
Pipeline Operation & Maintenance Costs		$16,000
Water Quality Monitoring		$100,000
Lake Inlet Channel Dredging		$100,000
Eastern MWD Title 22 Effluent Purchase		$116,000
Total Estimated Annual O&M Cost:		$728,000

EMWD Reclaimed Water = 310 AF @ $373/AF

Preferred Project Alternative Estimated Annual Phosphorus Removal Rate and Phosphorus Loading

It is estimated that under the long-term average supplemental water condition, the Preferred Project Alternative will remove 27,600 pounds of phosphorus per year from the supplemental water added to Lake Elsinore. Of that total amount of phosphorus removed, it is estimated that 27,200 pounds of phosphorus will be removed each year from the reclaimed treated through the Elsinore Valley MWD RWRF, while 400 pounds each year will be removed from the lake water that is recycled through the treatment wetland.

The Preferred Project Alternative will add a total of 5,500 pounds of phosphorus to lake Elsinore each year under the long-term average supplemental condition. Up to 5,400 pounds per year will originate from the reclaimed water added to the lake, while about 100 pounds of phosphorus will be added to the lake through the return flow from the treatment wetland.

PREFERRED PROJECT ALTERNATIVE PHASING

Section 9: Preferred Project Alternative Phasing

Introduction

LESJWA has been successful in securing Proposition 13 funding for programs and projects associated with Lake Elsinore and its surrounding watersheds. Most of the Proposition 13 funds have already been allocated, and the remaining available funds are not sufficient to construct all of the PPA facilities. Because of that, a phasing approach is needed for the implementation of the PPA components that provides the best use of available funds, and also establishes a plan for the future funding of the remaining PPA facilities. A suggested PPA phasing approach is presented in this section of the report.

Preferred Project Alternative Elements

The project PPA is composed of the following elements:

1. Turnout facility at the Wasson Sill terminus of the Eastern MWD Temescal Pipeline, and 6,200 feet of 30-inch pipeline to convey reclaimed water from the turnout facility to the Elsinore Valley MWD RWRF. The turnout facility will contain an isolation valve, flow meter and rate-of-flow control valve. A pressure reduction facility will be constructed immediately upstream of the discharge point to the Elsinore Valley MWD RWRF treatment system, or granular media filtration process.

2. Chemical phosphorus treatment facilities at the existing Elsinore Valley MWD RWRF, consisting of chemical storage and feed system, solids dewatering equipment and building. The chemical phosphorus treatment facilities will have a treatment capacity of 8.0 mgd to match the current RWRF treatment capacity.

3. A 10.0 mgd remote treatment granular media filtration process at the Elsinore Valley MWD RWRF to treat reclaimed water purchased from Eastern MWD. The filtration process will be a two-stage Dynasand® filtration process.

4. Treated water pump station with a 17.0 mgd pumping capacity located at the Elsinore Valley MWD RWRF, and 6,200 feet of 36-inch pipeline to convey reclaimed water from the Elsinore Valley MWD RWRF to the vicinity of the Wasson Sill for discharge into the Lake Elsinore Overflow Channel and the lake.

5. Lake intake structure, 2.0 mgd (1,970 acre-feet per year) capacity lake water recycle pump station, 7,400 feet of 12-inch pipeline to convey lake water to the Old San Jacinto River Channel in the vicinity of the ballpark, and relining of the Old San Jacinto River Channel. The Old San Jacinto River Channel will be used to convey lake water via the channel to the existing Back Basin Wetland, or the converted treatment wetland.

6. Conversion of the southern portion of the existing Back Basin Wetland to a 107-acre treatment wetland, including 1.0 mgd treatment wetland effluent pump station and 3,200 feet of 8-inch discharge pipeline to Lake Elsinore.

In addition to the components listed above, the PPA may need to utilize existing or planned facilities until the various PPA components can be funded and implemented. Those existing and planned facilities include:

- Existing Eastern MWD turnout and pipeline facilities at the Wasson Sill terminus that can be used to convey reclaimed water from their RRWS directly to Lake Elsinore via the lakes Overflow Channel.
- Existing temporary Elsinore Valley MWD RWRF treated effluent pump station and pipeline that is currently being used to convey treated effluent from the RWRF to the Wasson Sill for discharge to Lake Elsinore via the Overflow Channel. These existing facilities will also include the turnout facilities that Elsinore Valley MWD is planning to construct in the future at the Wasson Sill discharge point to the Lake Elsinore Overflow Channel.
- Island Well discharge pipeline planned by Elsinore Valley MWD to convey pumped local groundwater to the existing Back Basin Wetland.

The existing Eastern MWD turnout and pipeline facilities can be utilized to add supplemental reclaimed water to Lake Elsinore when the water available from the Island Wells and Elsinore Valley MWD RWRF is not sufficient to maintain the desired lake operating water level between elevation 1,240 feet and 1,247 feet. The existing Eastern MWD facilities can also be used to add supplemental water to the lake under worst-case drought conditions until the granular media filtration facilities are constructed at the Elsinore Valley RWRF.

The temporary Elsinore Valley MWD RWRF pump station and pipeline facilities can only pump treated effluent from Train A to the lake, and the conveyance capacity of those facilities is limited to 2.0 to 2.5 mgd. Based on information provided by Elsinore Valley MWD staff, the planned turnout facility improvements at Wasson Sill will allow gravity flow conveyance of an additional 2.0 mgd of treated effluent from Train B. The total conveyance capacity of the Elsinore Valley MWD temporary facilities will be 4.0 mgd to 4.5 mgd after the turnout facilities are constructed. Those temporary facilities can be used to convey treated effluent to the Lake Elsinore Overflow Channel, and via the channel to the lake. Even though those facilities are temporary in nature, the PPA could utilize those facilities to convey treated effluent to Lake Elsinore until funding is available to construct the permanent Elsinore Valley MWD RWRF treated water pump station and pipeline facilities.

Elsinore Valley MWD is planning to construct the Island Well discharge pipeline to the existing Back Basin Wetland in the very near future. The primary purpose of the pipeline is to circulate local groundwater through the existing wetland to keep them wet in order to meet an existing commitment to the Corps of Engineers. The groundwater once it has flowed through the wetland will discharge into Lake Elsinore.

Available LESJWA Funding

LESJWA has been able to secure $15,000,000 in Proposition 13 funding for programs and projects associated with Lake Elsinore and its surrounding watersheds. Current contracts and projects have appropriated about $9,130,000 of that funding. In addition, planned projects and potential future projects could likely use another $4,087,000 of the existing Proposition 13 funding. That leaves a current funding balance of about $1,783,000 available to fund the components of the PPA. The total estimated capital cost for the PPA is $15,921,000, if all of the components are implemented. LESJWA will therefore have to find additional funding to implement most of the components of the PPA.

Proposed PPA Component Phasing

Table 9-1 presents the proposed phasing of the PPA components. The phasing approach presented in the table, by the phasing priority ranking of the project elements, prioritizes the project components to maximize the available lake supplemental water and lake water quality improvement benefits. The costs presented in the table have been broken down to show the estimated capital cost and annual O&M cost for each of the PPA components.

TABLE 9-1
PPA Component Phasing Approach

Phasing Priority	Component Description	Component Capital Cost	Annual O&M Cost
1	Chemical Phosphorus Upgrades at Elsinore Valley MWD RWRF	$1,366,000	$197,000
2	Construction of the Eastern MWD Reclaimed Water Pipeline and Associated Facilities, Treated Water Pump Station at Elsinore Valley MWD RWRF and Treated Water Pipeline	$5,410,000	$155,000
3	Construction of Lake Water PS, Discharge Pipeline & Relining the Old San Jacinto River Channel	$2,505,000	$15,000
4	Conversion of 107-Acre Treatment Wetland, Treated Water Pump Station and Discharge Pipeline	$2,122,000	$88,000
5	Construction of the Granular Media Filtration System at Elsinore Valley MWD RWRF	$4,518,000	$72,000

The annual O&M costs for water quality monitoring and Lake Elsinore inlet channel dredging amount to $200,000 per year, and are common to all of the project components. Those annual O&M costs have not been included in the table annual O&M costs. Under the long-term average supplemental water condition, up to 310 acre feet of reclaimed water may have to be purchased from Eastern MWD. The estimated annual O&M cost of that reclaimed water purchase has been included in the component that includes the construction of the Eastern MWD reclaimed water pipeline.

The PPA component ranked first is the construction of phosphorus treatment upgrades at the Elsinore Valley MWD RWRF. That component of the PPA was ranked first because it will provide an immediate water quality benefit to Lake Elsinore through the amount of low-phosphorus treated effluent that can be conveyed to the lake as a supplemental water source. Until the permanent Eastern MWD reclaimed water pipeline and RWRF treated water conveyance facilities can be constructed, the existing temporary treated effluent pump and pipeline facilities, and planned turnout improvements at Wasson Sill (when constructed by Elsinore Valley MWD) will be used to convey the supplemental water to the lake. Those existing and planned facilities will be able to convey up to 4.5 mgd of treated effluent until the permanent facilities can be constructed. This study has assumed that the treatment upgrade improvements at the Elsinore Valley MWD RWRF will be chemical phosphorus improvements, including solids dewatering equipment and building. Those improvements could also be biological treatment upgrades that may better fit into the treatment scheme at the plant. If that is the case, the estimated capital cost for that component of the PPA could serve as a LESJWA funding commitment that could be applied towards the cost of biological treatment upgrades at the Elsinore Valley MWD RWRF. The estimated capital cost for this component of the PPA is $1,366,000, which can be funded with the remaining available Proposition 13 funding. The estimated annual O&M cost for this project component is $197,000.

The PPA component ranked second for implementation involves the construction of the Eastern MWD reclaimed water pipeline and associated facilities, treated effluent pump station at the Elsinore Valley MWD RWRF and the treated water pipeline to Wasson Sill. Those project components were ranked second because their construction will allow full use of the Elsinore Valley MWD RWRF treatment capacity to produce up to 7.5 mgd of low-phosphorus supplemental water for Lake Elsinore. Allowing for evaporation and infiltration losses in the Lake Elsinore Overflow Channel, the 7.5 mgd treated effluent production from the plant will result in the discharge of about 7,980 acre-feet per year of low-phosphorus supplemental water to the lake. This PPA component will continue to use the Elsinore Valley MWD turnout facilities planned at Wasson Sill. The current temporary pumping and pipeline facilities will not be needed after these facilities are constructed. The estimated capital cost for this component of the PPA is $5,410,000. The estimated annual O&M cost is $155,000, which includes the purchase of up to 310 acre-feet per year of reclaimed water from the Eastern MWD RRWS.

The PPA component ranked third for implementation is the construction of the lake water recycle pump station, including intake structure and piping, discharge pipeline and the relining of the Old San Jacinto River Channel. The pipeline will discharge recycled lake water into the channel in the vicinity of the ballpark. The relined Old San Jacinto River Channel will be used to convey lake water to the existing Back Basin Wetland, and to the project treatment wetland when it is constructed. This project component has been prioritized ahead of the construction of the treatment wetland because it allows the recycling of lake water to keep the existing wetland wet instead of using higher quality local groundwater pumped from the Island Wells. The recycling of lake water through the existing wetland will provide some degree of phosphorus removal, and lake water quality enhancement. The estimated capital cost for this component of the PPA is $2,505,000, and includes a credit of $400,000 for the grant LESJWA has obtained for the relining of the Old San Jacinto River Channel. The estimated annual O&M costs is $15,000.

The City of Lake Elsinore has expressed an interest in desilting the inlet channel to its original bottom elevation of 1,230 feet. If the City were to move forward with the desilting of the channel, the PPA lake water intake structure and pump station could be relocated to a location in the vicinity of the ballpark. That facility relocation will substantially shorten the length of the pump station discharge pipeline that will be used to convey the lake water to the Old San Jacinto River Channel. If the City moves forward with that facility relocation, the estimated remaining capital cost for the pipeline component of the PPA could serve as a LESJWA funding commitment that could be applied towards the cost of desilting the inlet channel. Relocating the intake structure and piping is only possible if the future maintenance of the inlet channel (sediment removal) is assumed by the City of Lake Elsinore.

The PPA component ranked fourth for implementation is the conversion of up to 107 acres of the existing Back Basin Wetland into a treatment wetland to treat the recycled lake water. The treatment wetland will provide greater phosphorus removal than the existing Back Basin Wetland, and as a result greater water quality improvement benefit. The estimated capital cost for this PPA component is $2,122,000. The estimated annual O&M cost is $88,000. This PPA component may be combined with fisheries management improvements being considered for the Back Basin area, as part of the Lake Elsinore Fisheries Management Plan. The fishery management improvements are still being developed and have not been included in the nutrient removal planning scope but may be considered for funding by LESJWA.

The last PPA component for implementation is the construction of the granular media filtration facilities at the Elsinore Valley MWD RWRF. This component has been ranked last for implementation because the treatment facilities are needed to produce supplemental water for the lake during worst-case drought conditions. As such, the facilities may not be used for the majority of the time. The estimated capital cost for this PPA component is $4,518,000. The estimated annual O&M cost is $72,000.

The proposed project component phasing involves five separate facility packages. LESJWA can combine two or more of the project elements if adequate funding is obtained, and agreement can be reached by the LESJWA member agencies on the payment of the associated annual O&M costs. In addition, other lake improvements, such as the fishery management improvements, inlet channel desilting and other projects are under evaluation by LESJWA and are not necessarily included in the Lake Elsinore nutrient removal analysis. Including those other lake improvements may impact the recommended PPA phasing described herein.

APPENDIX A

Appendix A

Conceptual Wetland Water Balance

This appendix evaluates the conceptual water balance for two wetland systems (350 acres and 600 acres), for both the 3,000 and 8,800 wetland outflow objectives.

Long-term (50-year) average monthly precipitation data is available for Lake Elsinore through the Western Regional Climate Center. The California Irrigation Management Information System has calculated potential evapotranspiration rates based on 22 years of climate data for Temecula, California. Table A-1 summarizes this local precipitation and evapotranspiration data for Lake Elsinore.

The initial infiltration rate for wetland sites is a function of soil texture, with the highest rates observed for sandy soils and the lowest rates observed for clay soils. Long-term infiltration rates generally decrease due to the accumulation of fine-grained soil particles, such as clays, silts, fine sands, and organic materials, as well as the development of thin layers of algae, fungi, and bacteria at the interface between sediment and the overlying water. Along with other factors, this complex layer of organic materials and fine-soil particles can be a significant impediment to downward movement of water.

TABLE A-1
Average Precipitation and Evapotranspiration for Lake Elsinore

Month	Precipitation (in)[a]	Evapotranspiration (in)[b]
January	2.6	2.7
February	2.2	2.8
March	1.9	3.9
April	0.7	4.9
May	0.2	5.5
June	0.0	6.3
July	0.1	6.8
August	0.1	6.6
September	0.3	5.1
October	0.3	4.0
November	1.1	3.2
December	1.6	2.8
Annual	11.0	54.7

[a]Value for Elsinore, CA; 1948-2001 average (source: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?caelsi)

[b]Value for turf grass in Temecula, CA; 1987-2002 average (data source: http://wwwcimis.water.ca.gov/)

Because constructed wetlands are generally excavations or impoundments within or on top of native soils, there is the potential for water movement, variously termed infiltration or seepage, to change direction seasonally in response to relative changes in water elevation. For example, when the groundwater table is high relative to the wetland water-surface elevation, water will tend to move toward the wetland. Conversely, when the wetland water elevation is high relative to the water table, water will tend to move away from the wetland (and toward the water table). Given the inherent site variability for soil types and groundwater elevations, it is often beneficial to evaluate an expected minimum and maximum infiltration rate during planning activities. For the purpose of this analysis, the infiltration rate for the Back Basin site could range from a low of 1.0 to a high of 10.3 inches per month, but would likely remain consistent throughout the year.

In the arid West of the United States, wetland water losses through evapotranspiration and infiltration can far exceed water gains through precipitation, resulting in an overall water deficit for the wetlands. Table A-2 provides a summary of predicted annual water losses for wetlands of various sizes. These annual losses are presented for low, medium, and high infiltration rates. Even at the low infiltration rate, infiltration can account for more than 50 percent of the annual water loss. Increasing the infiltration rate from an average of 1.0 to 10 in/mo, may increase the annual water loss by a factor of 3. Subsequent analysis in this report assumes an average infiltration rate of 5.7 in/mo.

TABLE A-2
Annual Wetland Water Loss For Different Infiltration Rates

Wetland Area (ac)	Annual Water Loss (ac-ft)		
	Infiltration (1.0 in/mo)	Infiltration (5.7 in/mo)	Infiltration (10.3 in/mo)
0	0	0	0
50	230	470	700
100	470	930	1400
150	700	1400	2100
200	940	1870	2800
250	1,200	2,300	3,500
300	1,400	2,800	4,200
350	1,600	3,300	4,900
400	1,900	3,700	5,600
450	2,100	4,200	6,300
500	2,300	4,700	7,000
550	2,600	5,100	7,700
600	2,800	5,600	8,400

*Water loss equal to $P-(ET-I)$.

While infiltration rates for the Back Basin site will likely remain consistent throughout the year, both precipitation and evapotranspiration vary seasonally. The wetland water deficit is greatest during summer months when precipitation is low and evapotranspiration is high. Figure A-1 shows conceptual seasonal water losses for a 350-acre and 600-acre wetland system.

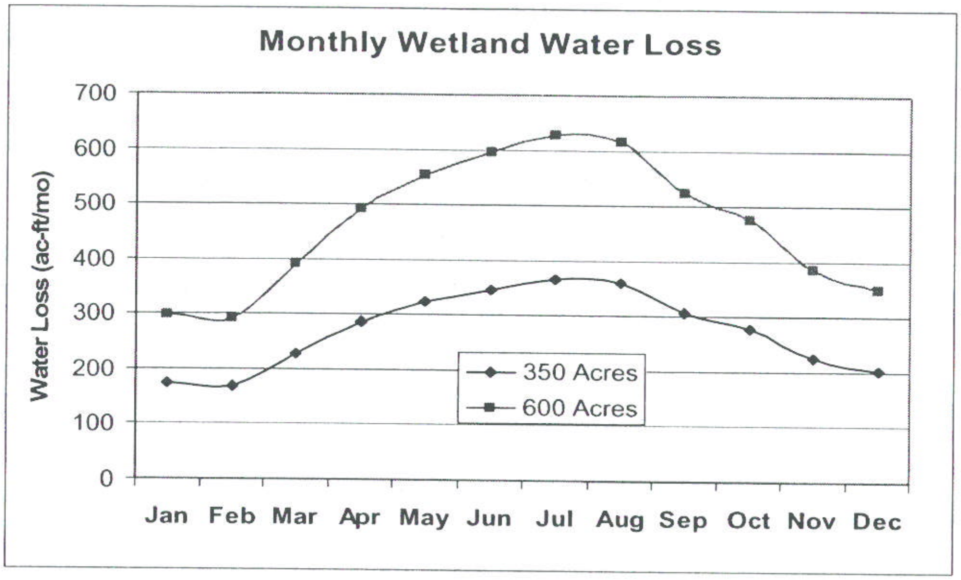


Figure A-1
Estimated Monthly Wetland Water Losses for a 350-acre and 600-acre Wetland

Treatment Wetland Water Quality Model

The first-order, area-based, tanks-in-series model is described mathematically by the following series of equations:

$$C_e = \frac{HLR_3 * C_{e2} + k_T * C^*}{HLR_4 + \beta + k_T}$$

where

$$C_{e2} = \frac{HLR_2 * C_{e1} + k_T * C^*}{HLR_3 + \beta + k_T}$$

and

$$C_{e1} = \frac{HLR_1 * C_i + k_T * C^*}{HLR_2 + \beta + k_T}$$

and

$$HLR_1 = 3 * \frac{Q_i}{A}$$
$$HLR_2 = HLR_1 + \alpha$$
$$HLR_3 = HLR_2 + \alpha$$
$$HLR_4 = HLR_3 + \alpha$$

and

$$\beta = I + 0.5ET$$
$$\alpha = P - ET - I$$

and

$$k_T = k_{20}(\Theta)^{(T-20)}$$

Specific terms and units are defined as the following:

C_e	= concentration in wetland effluent, milligrams per liter (mg/L)
C_i	= concentration in wetland influent, mg/L
C_{e1}	= concentration in tank 1 effluent, mg/L
C_{e2}	= concentration in tank 2 effluent, mg/L
HLR_1	= tank 1 influent hydraulic loading rate, meters per year (m/yr)
HLR_2	= tank 2 influent hydraulic loading rate, m/yr
HLR_3	= tank 3 influent hydraulic loading rate, m/yr
HLR_4	= tank 4? effluent hydraulic loading rate, m/yr
C^*	= background concentration, mg/L

k_T	= first-order areal reaction rate constant at T degrees Centigrade (°C), m/yr
k_{20}	= first-order areal reaction rate constant at 20°C, m/yr
Θ	= Arrhenius temperature factor, -
I	= infiltration, m/yr
P	= precipitation, m/yr
ET	= evapotranspiration, m/yr
Q_i	= influent water flow rate, cubic meters per year (m^3/yr)
A	= surface area, square meters (m^2)
T	= temperature, °C

Comparison of Reclaimed Model Runs

Model Runs 1A and 1B

Table A-3 summarizes the results of model runs 1A and 1B that assume a 350-acre wetland area the same size as the existing Back Basin wetland, low hydraulic loading rate (HLR)(0.6 in/d), and low (5 m/yr) and high (10 m/yr) removal rates. The nominal HRT of the wetland ranges from 41 to 52 days, which is relatively long for a treatment wetland. It is estimated that about 6,365 acre-feet of reclaimed water will be needed to provide 3,100 acre-feet of flow into Lake Elsinore, or about twice the amount of supplemental water needed to maintain lake water levels. The influent phosphorus concentration in the reclaimed water is 3.0 mg/L. Wetland discharge phosphorus concentrations are estimated to range between 1.2 mg/L for Run 1A and 0.6 mg/L for Run 1B. For each model run, differences in effluent phosphorus discharge concentrations vary by months, but total mass removals are greater in the summer than in the winter months. These results indicate that while high summer months evaporation rates tend to increase phosphorus removal rates in association with total water volume loss, the tendency for phosphorus to concentrate as water volumes are reduced is not sufficiently great to overcome wetland phosphorus assimilation rates.

For Run 1A, monthly outflow phosphorus (P)concentrations range from 1.1 mg/L to 1.3 mg/L, with the higher concentrations estimated during the summer. Annual outflow P concentration averages 1.2 mg/L, representing a 58 percent reduction from the assumed inflow concentration of 3.0 mg/L. Mass removals are greater in the summer, reflecting the evaporative loss of water from the system.

For Run 1B, monthly outflow P concentrations vary only slightly around 0.6 mg/L, with no apparent increase in outflow P concentrations during the summer. Annual outflow P 0.6 mg/L, representing an 80 percent reduction from the assumed inflow concentration of 3.0 mg/L. Mass removals are greater in the summer, reflecting the evaporative loss of water from the system.

The difference between model runs in average outflow P concentrations and seasonal performance is attributable to the difference in selected removal rate constants. For Run 1A, the low assumed removal rate of 5 m/yr allows the concentration effect of summer evaporative losses to be measured. For Run 1B, the removal rate of 10 m/yr is high enough to reduce the evaporation concentration effect.

TABLE A-3
Treatment Wetland Model Runs 1A and 1B: Estimated Phosphorus Removal Performance for 350-acre Reclaimed Water Treatment Wetland with Low Hydraulic Loading Rate

Model Run				1A (k=5 m/yr)	1B (k=10 m/yr)	1A (k=5 m/yr)	1B (k=10 m/yr)
Month	Inflow[a] (Ac-ft)	Outflow (Ac-ft)	HRT[b] (d)	Effluent (mg/L)		Total Mass Removed (kg)	
Jan	541	367	41	1.21	0.64	1,454	1,713
Feb	488	318	42	1.12	0.56	1,365	1,586
Mar	541	313	43	1.24	0.63	1,522	1,756
Apr	523	236	47	1.25	0.60	1,572	1,761
May	541	217	49	1.31	0.62	1,651	1,834
Jun	523	176	51	1.28	0.59	1,658	1,809
Jul	541	175	52	1.32	0.61	1,716	1,869
Aug	541	182	51	1.32	0.61	1,706	1,863
Sep	523	218	48	1.27	0.60	1,595	1,775
Oct	541	263	46	1.3	0.64	1,580	1,794
Nov	523	299	44	1.23	0.61	1,483	1,710
Dec	541	337	42	1.24	0.64	1,484	1,734
Annual	6,365	3,100	46	1.26	0.61	18,785	21,203

[a]Influent = 3.0 mg/L total phosphorus; Total phosphorus mass Loading rate = 0.46 kg/ha/d

[b]Hydraulic Loading Rate (HLR) = 0.6 in/d (1.5 cm/d)

Model Runs 1C and 1D

Table A-4 summarizes results of similar wetland simulations for Runs 1C and 1D. These runs are based upon the same conditions as Runs 1A and 1B, but higher HLR of 1.1 in/d has been assumed. Because hydraulic loading rates are twice as high, the nominal HRTs are reduced to between 20 and 22 days. Annual average wetland discharge P concentrations are therefore equal to or greater than Runs 1A and 1B, with 1.9 mg/L predicted for Run 1C and 1.3 mg/L for Run1D.

As for the previous model runs, differences in expected discharge concentrations vary between months, with the total mass removals being greater in the months than in the winter months, reflecting the evaporative loss of water from the system. For Run 1C, monthly outflow P concentrations range from 1.8 mg/L to 2.0 mg/L, with higher concentrations estimated during the summer. Annual outflow P concentration averages 1.9 mg/L, representing a 37 percent reduction from the inflow concentration of 3.0 mg/L.

For Run 1D, monthly outflow P concentrations range around 1.3 mg/L. Annual outflow P concentration average 1.3 mg/L, representing a 58 percent reduction from the assumed influent P concentration of 3.0 mg/L. As with the other model runs, greater summer evaporation losses contribute to greater phosphorus mass removals.

As before, the difference in average outflow P concentrations and seasonal performance is attributed to the difference in selected removal rate constant. For Run 1C, the removal rate of 5 m/yr is low , thereby allowing the concentration effect of summer evaporative losses to be measurable. For Run 1D, the removal rate of 10 m/yr is high enough to reduce the evaporation concentration effect.

Increasing the hydraulic loading rate from 0.6 in/d to 1.1 in/d reduced the amount of reclaimed water that will have to be added to the wetland to provide the desired supplemental water volume. It is estimated that the inflow into the wetland will have to be almost 37 percent more than the desired supplemental water volume.

TABLE A-4
Treatment Wetland Model Runs 1C and 1D: Estimated Phosphorus Removal Performance for 350-acre Reclaimed Water Treatment Wetland with High Hydraulic Loading Rate

Model Run				1C (k=5 m/yr)	1D (k=10 m/yr)	1C (k=5 m/yr)	1D (k=10 m/yr)
Month	Inflow[a] (Ac-ft)	Outflow (Ac-ft)	HRT[b] (d)	Effluent (mg/L)		Total Mass Removed (kg)	
Jan	1,025	851	20	1.84	1.25	1,856	2,480
Feb	926	756	20	1.77	1.16	1,772	2,344
Mar	1,025	797	20	1.89	1.27	1,933	2,545
Apr	992	704	21	1.93	1.26	1,993	2,573
May	1,025	701	22	1.99	1.31	2,071	2,662
Jun	992	644	22	1.99	1.28	2,090	2,652
Jul	1,025	659	22	2.02	1.31	2,150	2,724
Aug	1,025	666	22	2.02	1.31	2,137	2,714
Sep	992	686	21	1.95	1.27	2,016	2,594
Oct	1,025	747	21	1.96	1.3	1,986	2,595
Nov	992	767	20	1.88	1.25	1,887	2,489
Dec	1,025	821	20	1.88	1.27	1,885	2,508
Annual	12,065	8,800	21	1.93	1.27	23,777	30,880

[a]Influent = 3.0 mg/L total phosphorus; Total phosphorus mass loading rate = 0.86 kg/ha/d
[b]Hydraulic Loading Rate (HLR) = 1.1 in/d (2.9 cm/d)

Model Runs 2A and 2B

Table A-5 summarizes the results of the analyses for Runs 2A and 2B. These runs include the same conditions as Runs 1A and 1B, but assume a wetland area of 600 acres which is about double the area of the existing Back Basin wetland. Annual wetland discharge phosphorus concentrations average 1.0 mg/L for Scenario 2A and 0.4 mg/L for Scenario 2B.

For each model run, differences in expected discharge P concentrations vary between months, but total mass removals are greater in the summer months than in the winter months. For Run 2A, monthly outflow P concentrations are about 1.0 mg/L, with no discernible seasonality. Annual outflow P, concentration average 1.0 mg/L, representing a 66 percent reduction from the assumed inflow P concentration of 3.0 mg/L. Mass removals are greater in the summer, reflecting the evaporative loss of water from the system.

For Run 2B, monthly outflow P concentrations range from 0.37 mg/L to 0.46 mg/L. Outflow P concentrations are generally lower during the summer, which can be attributable to the reduction in hydraulic loading rate as water is evaporated as it moves through the wetland. Annual outflow P concentration average 0.4 mg/L, representing an 86 percent reduction from the assumed inflow P concentration of 3.0 mg/L. Mass removals are greater in the summer, reflecting the higher level of performance and evaporative loss of water from the system.

The difference in average outflow P concentrations and seasonal performance between the two model runs is attributed to the difference in selected removal rate constant. For Run 2A, the removal rate of 5 m/yr is low, thereby allowing the concentration effect of summer evaporative losses to be measurable. For Run 2B, the removal rate of 10 m/yr is high enough to reduce the evaporation concentration effect.

TABLE A-5
Treatment Wetland Model Runs 2A and 2B: Estimated Phosphorus Removal Performance for 600-acre Reclaimed Water Treatment Wetland with Low Hydraulic Loading Rate

Model Run				2A (k=5 m/yr)	2B (k=10 m/yr)	2A (k=5 m/yr)	2B (k=10 m/yr)
Month	Inflow[a] (Ac-ft)	Outflow (Ac-ft)	HRT[b] (d)	Effluent (mg/L)		Total Mass Removed (kg)	
Jan	739	440	54	0.97	0.46	2,209	2,486
Feb	667	376	55	0.88	0.39	2,060	2,287
Mar	739	349	58	0.98	0.44	2,312	2,543
Apr	715	222	66	0.97	0.40	2,381	2,535
May	739	184	69	1.01	0.41	2,505	2,640
Jun	715	120	74	0.96	0.37	2,503	2,590
Jul	739	112	75	0.99	0.39	2,596	2,680
Aug	739	123	74	1.00	0.39	2,582	2,674
Sep	715	192	68	0.97	0.40	2,415	2,552
Oct	739	263	64	1.02	0.44	2,404	2,592
Nov	715	330	59	0.97	0.43	2,251	2,471
Dec	739	390	56	0.99	0.45	2,258	2,515
Annual	8,698	3,100	64	0.98	0.41	28,478	30,566

[a]Influent = 3.0 mg/L total phosphorus; Total phosphorus mass loading rate = 0.36 kg/ha/d
[b]Hydraulic Loading Rate (HLR) = 0.5 in/d (1.2 cm/d)

Model Runs 2C and 2D

Table A-6 summarizes the results of model Runs 2C and 2D. These runs include the same conditions as Runs 1C and 1D but assume a larger wetland area of 600 acres. Nominal HRTs vary between 30 days and 35 days. Annual wetland discharge P concentrations average 1.6 mg/L for Scenario 2C and 0.9 mg/L for Scenario 2D.

For each model run, differences in expected discharge concentrations vary between months, but total mass removals are greater in the summer months than in the winter months. For Run 2C, monthly outflow P concentrations range from 1.4 mg/L to 1.6 mg/L during the summer months. The annual average outflow P concentration of 1.6 mg/L represents a 47 percent reduction from the assumed inflow concentration of 3.0 mg/L. Mass removals are greater in the summer, reflecting the evaporative loss of water from the system.

For Run 2D, monthly outflow P concentrations are about 0.9 mg/L. Outflow P concentrations show little variation during the year. Annual outflow P concentration averages 0.9 mg/L, representing a 70 percent reduction from the assumed inflow concentration of 3.0 mg/L. Mass removals are slightly greater in the summer, reflecting the higher level of performance and evaporative loss of water from the system.

The difference in average outflow P concentrations and seasonal performance between the two model runs is attributed to the difference in selected removal rate constant. For Run 2C, the removal rate of 5 m/yr is low, thereby allowing the concentration effect of summer evaporative losses to be measurable. For Run 2D, the removal rate of 10 m/yr is high enough to reduce the evaporation concentration effect.

TABLE A-6
Treatment Wetland Model Runs 2C and 2D: Estimated Phosphorus Removal Performance for 600-acre Reclaimed Water Treatment Wetland with High Hydraulic Loading Rate

Model Run				2C (k=5 m/yr)	2D (k=10 m/yr)	2C (k=5 m/yr)	2D (k=10 m/yr)
Month	Inflow[a] (Ac-ft)	Outflow (Ac-ft)	HRT[b] (d)	Effluent (mg/L)		Total Mass Removed (kg)	
Jan	1,223	924	30	1.50	0.89	2,814	3,510
Feb	1,104	813	30	1.42	0.81	2,664	3,279
Mar	1,223	833	31	1.54	0.90	2,941	3,603
Apr	1,183	690	33	1.57	0.88	3,039	3,631
May	1,223	668	34	1.64	0.91	3,178	3,773
Jun	1,183	588	35	1.62	0.88	3,202	3,740
Jul	1,223	596	35	1.66	0.91	3,304	3,856
Aug	1,223	607	35	1.66	0.91	3,285	3,843
Sep	1,183	660	33	1.59	0.88	3,081	3,661
Oct	1,223	747	32	1.61	0.92	3,041	3,681
Nov	1,183	798	31	1.53	0.88	2,869	3,515
Dec	1,223	874	30	1.54	0.90	2,867	3,553
Annual	14,398	8,800	32	1.57	0.89	36,286	43,643

[a]Influent = 3.0 mg/L total phosphorus; Total phosphorus mass loading rate = 0.60 kg/ha/d

[b]Hydraulic Loading Rate (HLR) = 0.8. in/d (2.0 cm/d)

Model Runs 3A and 3B

Table A-7 summarizes predicted phosphorus removal for a 350-acre wetland receiving recycled lake water with a low hydraulic loading rate. Monthly inflow and outflow water volumes and system hydraulic residence time (HRT) are estimated. Average phosphorus concentrations and monthly mass totals of phosphorus removed are estimated for an average removal rate of 10 m/yr.

Discharge P concentrations average 0.1 mg/L and 0.06 mg/L for the low and high removal rates respectively . Those removal rates represent a reduction in P concentration of between 50 percent and 72 percent.

TABLE A-7
Treatment Wetland Model Runs 3A and 3B: Estimated Phosphorus Removal Performance for 350-acre Recycled Lake Water Treatment Wetland with Low Hydraulic Loading Rate
Refer to text for details of model run characteristics.

Month	Inflow[a] ac-ft	Outflow ac-ft	HRT[b] d	Effluent (mg/L)		Mass Removed (kg)	
				[e]k=5 m/yr	[f]k=10 m/yr	[e]k=5 m/yr	[f]k=10 m/yr
Jan	541	367	41	0.09	0.06	92	108
Feb	488	318	42	0.09	0.05	87	100
Mar	541	313	43	0.09	0.06	97	111
Apr	523	236	47	0.10	0.06	101	113
May	541	217	49	0.10	0.06	107	118
Jun	523	176	51	0.10	0.06	108	117
Jul	541	175	52	0.10	0.06	112	121
Aug	541	182	51	0.10	0.06	111	121
Sep	523	218	48	0.10	0.06	103	114
Oct	541	263	46	0.10	0.06	101	115
Nov	523	299	44	0.09	0.06	95	108
Dec	541	337	42	0.09	0.06	94	110
Annual	6,365	3,100	46	0.10	0.06	1,207	1,354

[a]Influent = 0.2 mg/L TP; Total phosphorus mass loading = 0.03 kg/ha/d

[b]Hydraulic Loading Rate (HLR) = 0.6 in/d (1.5 cm/d)

Model Runs 3C and 3D

Table A-8 summarizes the predicted P removal for a 350-acre wetland receiving recycled lake water with a high hydraulic loading rate. Monthly inflow and outflow water volumes and system HRT are estimated. Average phosphorus concentrations and monthly mass totals of phosphorus removed are estimated for an average removal rate of 10 m/yr.

Discharge P concentrations average 0.14 mg/L and 0.1 mg/L for the low and high removal rates. Those removal rates represent a reduction in P concentration of between 32 percent and 50 percent, respectively.

TABLE A-8
Treatment Wetland Model Runs 3C and 3D: Estimated Phosphorus Removal Performance for 350-acre Recycled Lake Water Treatment Wetland with High Hydraulic Loading Rate

Month	Inflow[a] ac-ft	Outflow ac-ft	HRT[b] d	Effluent (mg/L)		Mass Removed (kg)	
				[c]k=5 m/yr	[f]k=10 m/yr	[c]k=5 m/yr	[f]k=10 m/yr
Jan	1,025	851	20	0.13	0.09	117	154
Feb	926	756	20	0.13	0.09	111	146
Mar	1,025	797	20	0.13	0.10	122	159
Apr	992	704	21	0.14	0.10	126	162
May	1,025	701	22	0.14	0.10	132	168
Jun	992	644	22	0.14	0.10	133	167
Jul	1,025	659	22	0.14	0.10	137	172
Aug	1,025	666	22	0.14	0.10	136	171
Sep	992	686	21	0.14	0.10	128	163
Oct	1,025	747	21	0.14	0.10	126	163
Nov	992	767	20	0.13	0.09	119	155
Dec	1,025	821	20	0.13	0.10	119	156
Annual	12,065	8,800	21	0.14	0.10	1,506	1,936

[a]Influent = 0.2 mg/L TP; Total phosphorus mass loading = 0.06 kg/ha/d
[b]Hydraulic Loading Rate (HLR) = 1.1 in/d (2.9 cm/d)

Model Runs 4A and 4B

Table A-9 summarizes the predicted P removal performance for a 600-acre wetland receiving recycled lake water with a low hydraulic loading rate. Monthly inflow and outflow water volumes and system HRT are estimated. Average phosphorus concentrations and monthly mass totals of phosphorus removed are estimated for low (5 m/yr) and average (10 m/yr) removal rates.

Discharge P concentrations average 0.08 mg/L and 0.04 mg/L for the low and high removal rates respectively. Those removal rates represent a reduction in P concentration of between 61 percent and 78 percent, respectively.

TABLE A-9
Treatment Wetland Model Runs 4A and 4B: Estimated Phosphorus Removal Performance for 600-acre Recycled Lake Water Treatment Wetland with Low Hydraulic Loading Rate

Month	Inflow[a] ac-ft	Outflow ac-ft	HRT[b] d	Effluent (mg/L)		Mass Removed (kg)	
				[e]k=5 m/yr	[f]k=10 m/yr	[e]k=5 m/yr	[f]k=10 m/yr
Jan	739	440	54	0.08	0.05	141	157
Feb	667	376	55	0.07	0.04	132	145
Mar	739	349	58	0.08	0.05	149	163
Apr	715	222	66	0.08	0.04	155	164
May	739	184	69	0.08	0.05	164	172
Jun	715	120	74	0.08	0.04	165	170
Jul	739	112	75	0.08	0.04	171	176
Aug	739	123	74	0.08	0.04	170	176
Sep	715	192	68	0.08	0.04	158	166
Oct	739	263	64	0.08	0.05	156	167
Nov	715	330	59	0.08	0.04	145	158
Dec	739	390	56	0.08	0.05	145	160
Annual	8,698	3,100	64	0.08	0.04	1,847	1,975

[a]Influent = 0.2 mg/L TP; Total phosphorus mass loading = 0.02 kg/ha/d

[b]Hydraulic Loading Rate (HLR) = 0.5 in/d (1.2 cm/d)

Model Runs 4C and 4D

Table A-10 summarizes the predicted P removal performance for a 600-acre wetland receiving recycled lake water with a high hydraulic loading rate. Monthly inflow and outflow water volumes and system HRT are estimated. Average phosphorus concentrations and monthly mass totals of phosphorus removed are estimated for low (5 m/yr) and average (10m/yr) removal rates.

Discharge P concentrations average 0.11 mg/L and 0.07 mg/L for the low and high removal rates, respectively. Those removal rates represent a reduction in P concentration between 43 percent and 63 percent.

TABLE A-10
Treatment Wetland Model Runs 4C and 4D: Estimated Phosphorus Removal Performance for 600-acre Recycled Lake Water Treatment Wetland with Low Hydraulic Loading Rate

Month	Inflow[a] ac-ft	Outflow ac-ft	HRT[b] d	Effluent (mg/L)		Mass Removed (kg)	
				[e]k=5 m/yr	[f]k=10 m/yr	[e]k=5 m/yr	[f]k=10 m/yr
Jan	1,223	924	30	0.11	0.07	178	219
Feb	1,104	813	30	0.10	0.07	168	205
Mar	1,223	833	31	0.11	0.07	187	227
Apr	1,183	690	33	0.11	0.07	194	230
May	1,223	668	34	0.12	0.08	204	240
Jun	1,183	588	35	0.12	0.07	206	239
Jul	1,223	596	35	0.12	0.08	213	246
Aug	1,223	607	35	0.12	0.08	211	245
Sep	1,183	660	33	0.12	0.07	197	232
Oct	1,223	747	32	0.12	0.07	194	233
Nov	1,183	798	31	0.11	0.07	182	221
Dec	1,223	874	30	0.11	0.07	181	223
Annual	14,398	8,800	32	0.11	0.07	2,314	2,760

[a]Influent = 0.2 mg/L TP; Total phosphorus mass loading = 0.04 kg/ha/d
[b]Hydraulic Loading Rate (HLR) = 0.8 in/d (2.0 cm/d)

APPENDIX B

LAKE ELSINORE AND SAN JACINTO WATERSHEDS AUTHORITY
LAKE ELSINORE NUTRIENT REMOVAL STUDY
SUPPLEMENTAL WATER SOURCE REQUIREMENTS

Year	Starting Elevation (ft)	Starting Area (acres)	USGS Inflow (af/yr)	USGS Inflow (ft)	Evap. Loss (ft)	Ending Elevation (ft)	Avg. Elevation (ft)	Target Elevation (ft)	Diff. (ft)	Make-Up Water (af/yr)	EVMWD Source (af/yr)	Remainder (af/yr)	Island Wells Source (af/yr	Remainder (af/yr)	EMWD Source (af/yr)	Lost Water (ft)	Lost Water Volume (af/yr)
1928	1,240.00	3,074	34	0.01	-4.60	1,235.41	1,237.71	1,240.00	4.59	13,574	3,900	9,674	5,000	4,674	4,674	0	0
1929	1,240.00	3,074	2	0.00	-4.60	1,235.40	1,237.70	1,240.00	4.60	13,605	4,061	9,544	5,000	4,544	4,544	0	0
1930	1,240.00	3,074	46	0.01	-4.60	1,235.41	1,237.71	1,240.00	4.59	13,563	4,228	9,335	5,000	4,335	4,335	0	0
1931	1,240.00	3,074	26	0.01	-4.60	1,235.41	1,237.70	1,240.00	4.59	13,582	4,402	9,180	5,000	4,180	4,180	0	0
1932	1,240.00	3,074	9,533	3.10	-4.60	1,238.50	1,239.25	1,240.00	1.50	4,526	4,526	0	0	0	0	0	0
1933	1,240.00	3,074	67	0.02	-4.60	1,235.42	1,237.71	1,240.00	4.58	13,542	4,772	8,770	5,000	3,770	3,770	0	0
1934	1,240.00	3,074	7	0.00	-4.60	1,235.40	1,237.70	1,240.00	4.60	13,600	4,968	8,632	5,000	3,632	3,632	0	0
1935	1,240.00	3,074	28	0.01	-4.60	1,235.41	1,237.70	1,240.00	4.59	13,580	5,173	8,407	5,000	3,407	3,407	0	0
1936	1,240.00	3,074	109	0.04	-4.60	1,235.44	1,237.72	1,240.00	4.56	13,502	5,386	8,116	5,000	3,116	3,116	0	0
1937	1,240.00	3,074	84,065	27.35	-4.60	1,255.00	1,247.50	1,240.00	0.00	0	0	0	0	0	0	7.75	27,936
1938	1,255.00	3,606	54,447	15.10	-4.60	1,255.00	1,255.00	1,240.00	0.00	0	0	0	0	0	0	10.50	37,859
1939	1,255.00	3,606	4,822	1.34	-4.60	1,251.74	1,253.37	1,240.00	0.00	0	0	0	0	0	0	0	0
1940	1,251.74	3,540	239	0.07	-4.60	1,247.20	1,249.47	1,240.00	0.00	0	0	0	0	0	0	0	0
1941	1,247.20	3,386	44,631	13.18	-4.60	1,255.00	1,251.10	1,240.00	0.00	0	0	0	0	0	0	0	0
1942	1,255.00	3,606	238	0.07	-4.60	1,250.47	1,252.73	1,240.00	0.00	0	0	0	0	0	0	0.79	2,833
1943	1,252.73	3,571	7,231	2.02	-4.60	1,250.15	1,251.44	1,240.00	0.00	0	0	0	0	0	0	0	0
1944	1,250.15	3,463	850	0.25	-4.60	1,245.80	1,247.97	1,240.00	0.00	0	0	0	0	0	0	0	0
1945	1,245.80	3,345	267	0.08	-4.60	1,241.28	1,243.54	1,240.00	0.00	0	0	0	0	0	0	0	0
1946	1,241.28	3,124	147	0.05	-4.60	1,236.73	1,239.00	1,240.00	3.27	9,884	8,064	1,821	1,821	0	0	0	0
1947	1,240.00	3,074	63	0.02	-4.60	1,235.42	1,237.71	1,240.00	4.58	13,546	8,397	5,149	5,000	149	149	0	0
1948	1,240.00	3,074	26	0.01	-4.60	1,235.41	1,237.70	1,240.00	4.59	13,582	8,397	5,185	5,000	185	185	0	0
1949	1,240.00	3,074	507	0.16	-4.60	1,235.56	1,237.78	1,240.00	4.44	13,119	8,397	4,722	4,722	0	0	0	0
1950	1,240.00	3,074	1	0.00	-4.60	1,235.40	1,237.70	1,240.00	4.60	13,606	8,397	5,209	5,000	209	209	0	0
1951	1,240.00	3,074	0	0.00	-4.60	1,235.40	1,237.70	1,240.00	4.60	13,607	8,397	5,210	5,000	210	210	0	0
1952	1,240.00	3,074	15,880	5.17	-4.60	1,240.57	1,240.28	1,240.00	0.00	0	0	0	0	0	0	0	0
1953	1,240.57	3,124	16	0.01	-4.60	1,235.98	1,238.27	1,240.00	4.02	11,906	8,397	3,509	3,509	0	0	0	0
1954	1,240.00	3,074	24	0.01	-4.60	1,235.41	1,237.70	1,240.00	4.59	13,584	8,397	5,187	5,000	187	187	0	0
1955	1,240.00	3,074	53	0.02	-4.60	1,235.42	1,237.71	1,240.00	4.58	13,556	8,397	5,159	5,000	159	159	0	0
1956	1,240.00	3,074	0	0.00	-4.60	1,235.40	1,237.70	1,240.00	4.60	13,607	8,397	5,210	5,000	210	210	0	0
1957	1,240.00	3,074	19	0.01	-4.60	1,235.41	1,237.70	1,240.00	4.59	13,589	8,397	5,192	5,000	192	192	0	0
1958	1,240.00	3,074	8,353	2.72	-4.60	1,238.12	1,239.06	1,240.00	1.88	5,686	5,686	0	0	0	0	0	0
1959	1,240.00	3,074	37	0.01	-4.60	1,235.41	1,237.71	1,240.00	4.59	13,571	8,397	5,174	5,000	174	174	0	0
1960	1,240.00	3,074	0	0.00	-4.60	1,235.40	1,237.70	1,240.00	4.60	13,607	8,397	5,210	5,000	210	210	0	0
1961	1,240.00	3,074	0	0.00	-4.60	1,235.40	1,237.70	1,240.00	4.60	13,607	8,397	5,210	5,000	210	210	0	0
1962	1,240.00	3,074	4	0.00	-4.60	1,235.40	1,237.70	1,240.00	4.60	13,603	8,397	5,206	5,000	206	206	0	0
1963	1,240.00	3,074	0	0.00	-4.60	1,235.40	1,237.70	1,240.00	4.60	13,607	8,397	5,210	5,000	210	210	0	0
1964	1,240.00	3,074	26,054	8.48	-4.60	1,243.88	1,241.94	1,240.00	0.00	0	0	0	0	0	0	0	0
1965	1,243.88	3,271	3,504	1.07	-4.60	1,240.35	1,242.12	1,240.00	0.00	0	0	0	0	0	0	0	0
1966	1,240.35	3,074	12,962	4.22	-4.60	1,239.97	1,240.16	1,240.00	0.03	102	102	0	0	0	0	0	0
1967	1,240.00	3,074	541	0.18	-4.60	1,235.58	1,237.79	1,240.00	4.42	13,086	8,397	4,689	4,689	0	0	0	0
1968	1,240.00	3,074	63	0.02	-4.60	1,235.42	1,237.71	1,240.00	4.58	13,546	8,397	5,149	5,000	149	149	0	0
1969	1,240.00	3,074	55,586	18.08	-4.60	1,253.48	1,246.74	1,240.00	0.00	0	0	0	0	0	0	0	0
1970	1,253.48	3,557	422	0.12	-4.60	1,249.00	1,251.24	1,240.00	0.00	0	0	0	0	0	0	0	0
1971	1,249.00	3,412	74	0.02	-4.60	1,244.42	1,246.71	1,240.00	0.00	0	0	0	0	0	0	0	0
1972	1,244.42	3,271	186	0.06	-4.60	1,239.88	1,242.15	1,240.00	0.12	391	391	0	0	0	0	0	0
1973	1,240.00	3,074	1,146	0.37	-4.60	1,235.77	1,237.89	1,240.00	4.23	12,504	8,397	4,107	4,107	0	0	0	0
1974	1,240.00	3,074	624	0.20	-4.60	1,235.60	1,237.80	1,240.00	4.40	13,006	8,397	4,609	4,609	0	0	0	0
1975	1,240.00	3,074	431	0.14	-4.60	1,235.54	1,237.77	1,240.00	4.46	13,192	8,397	4,795	4,795	0	0	0	0
1976	1,240.00	3,074	332	0.11	-4.60	1,235.51	1,237.75	1,240.00	4.49	13,287	8,397	4,890	4,890	0	0	0	0
1977	1,240.00	3,074	213	0.07	-4.60	1,235.47	1,237.73	1,240.00	4.53	13,402	8,397	5,005	5,000	5	5	0	0
1978	1,240.00	3,074	50,916	16.56	-4.60	1,251.96	1,245.98	1,240.00	0.00	0	0	0	0	0	0	0	0

LAKE ELSINORE AND SAN JACINTO WATERSHEDS AUTHORITY
LAKE ELSINORE NUTRIENT REMOVAL STUDY
SUPPLEMENTAL WATER SOURCE REQUIREMENTS

1979	1,251.96	3,540	22,185	6.27	-4.60	1,253.63	1,252.79	1,240.00	0.00	0	0	0	0	0	0	0	0
1980	1,253.63	3,571	161,147	45.13	-4.60	1,255.00	1,254.32	1,240.00	0.00	0	0	0	0	0	0	39.16	141,199
1981	1,255.00	3,606	737	0.20	-4.60	1,250.60	1,252.80	1,240.00	0.00	0	0	0	0	0	0	0	0
1982	1,250.60	3,469	2,101	0.61	-4.60	1,246.61	1,248.60	1,240.00	0.00	0	0	0	0	0	0	0	0
1983	1,246.61	3,386	68,570	20.25	-4.60	1,255.00	1,250.81	1,240.00	0.00	0	0	0	0	0	0	7.26	26,183
1984	1,255.00	3,606	563	0.16	-4.60	1,250.56	1,252.78	1,240.00	0.00	0	0	0	0	0	0	0	0
1985	1,250.56	3,469	370	0.11	-4.60	1,246.07	1,248.31	1,240.00	0.00	0	0	0	0	0	0	0	0
1986	1,246.07	3,345	393	0.12	-4.60	1,241.59	1,243.83	1,240.00	0.00	0	0	0	0	0	0	0	0
1987	1,241.59	3,175	436	0.14	-4.60	1,237.13	1,239.36	1,240.00	2.87	8,675	8,397	278	278	0	0	0	0
1988	1,240.00	3,074	483	0.16	-4.60	1,235.56	1,237.78	1,240.00	4.44	13,142	8,397	4,745	4,745	0	0	0	0
1989	1,240.00	3,074	481	0.16	-4.60	1,235.56	1,237.78	1,240.00	4.44	13,144	8,397	4,747	4,747	0	0	0	0
1990	1,240.00	3,074	528	0.17	-4.60	1,235.57	1,237.79	1,240.00	4.43	13,099	8,397	4,702	4,702	0	0	0	0
1991	1,240.00	3,074	9,765	3.18	-4.60	1,238.58	1,239.29	1,240.00	1.42	4,299	4,299	0	0	0	0	0	0
1992	1,240.00	3,074	7,182	2.34	-4.60	1,237.74	1,238.87	1,240.00	2.26	6,836	6,836	0	0	0	0	0	0
1993	1,240.00	3,074	102,260	33.27	-4.60	1,255.00	1,247.50	1,240.00	0.00	0	0	0	0	0	0	13.67	49,280
1994	1,255.00	3,606	2,142	0.59	-4.60	1,250.99	1,253.00	1,240.00	0.00	0	0	0	0	0	0	0	0
1995	1,250.99	3,469	34,409	9.92	-4.60	1,255.00	1,253.00	1,240.00	0.00	0	0	0	0	0	0	1.31	4,720
1996	1,255.00	3,606	527	0.15	-4.60	1,250.55	1,252.77	1,240.00	0.00	0	0	0	0	0	0	0	0
1997	1,250.55	3,469	3,170	0.91	-4.60	1,246.86	1,248.71	1,240.00	0.00	0	0	0	0	0	0	0	0
1998	1,246.86	3,386	16,374	4.84	-4.60	1,247.10	1,246.98	1,240.00	0.00	0	0	0	0	0	0	0	0
1999	1,247.10	3,386	370	0.11	-4.60	1,242.61	1,244.85	1,240.00	0.00	0	0	0	0	0	0	0	0
2000	1,242.61	3,218	387	0.12	-4.60	1,238.13	1,240.37	1,240.00	1.87	5,748	5,748	0	0	0	0	0	0
		Total Inflow:	819,406						Totals:	487,798	290,863		162,614		34,321		
		Lost to Overflow:	290,011						Percentage Breakdown:	100%	60%		33%		7%		
									Years of Record:	73	73		73		73		
									Average:	6,611	3,984		2,228		470		
									Long-Term Condition Allocation:	8,000	4,770		2,667		563		
									Years Source Make-Up Water Needed:	42	42		35		23		