US Army Corps of Engineers®
Los Angeles District

Prado Basin Ecosystem Restoration and Water Conservation Study

APPENDIX P

Economics

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US Army Corps of Engineers

PRADO BASIN, CA

FEASIBILITY REPORT

Economic Appendix

October 2018

U.S. Army Corps of Engineers

Los Angeles District

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1 Introduction

1.1 Study Overview

This feasibility study investigates alternatives to restore environmental resources and conserve water within Prado Basin and downstream of the Prado Dam, within the Santa Ana River (SAR). Thus the study objectives are ecosystem restoration and water conservation. The Federal objective of ecosystem restoration is to contribute to National Ecosystem Restoration (NER). NER contributions include increases in the net quantity and/or quality of desired ecosystem resources. The Federal objective of water and related land resources project planning is to contribute to National Economic Development (NED). NED contributions include increases in the net value of the national output of goods and services, expressed in monetary units. An array of ecosystem restoration measures were analyzed for cost effectiveness, combined in to alternatives, and evaluated for incremental cost and habitat output. A single alternative to re-operate Prado Basin's maximum water storage elevation to increase downstream water conservation was also evaluated.

Prado Basin is located within the Santa Ana River watershed. The Santa Ana River drainage area above Prado Dam encompasses about 2,650 square miles (686,347 hectares), making it the largest watershed in southern California. The Prado Dam flood control reservoir, operated by the USACE, was constructed for flood control operations for downstream urban areas in Orange County. The study area encompasses Prado Basin to elevation 566', the Orange County Water District (OCWD) service area, and each of the four major watercourses to the approximate area where the channels change physical characteristics or are adjacent to another project. It is approximately 50 square miles within which all storm water and groundwater flows drain into the Prado Basin. Additionally, the Orange County Water District (OCWD) service area extends over 350 miles across Orange County (Figure 1-1).

1.2 Purpose

1.2.1 Ecosystem Restoration

The ecosystem restoration purpose of the study is to determine the feasibility of restoring critical habitat up and downstream of Prado Dam. The objective is restoring aquatic, wetland and riparian habitats for endangered and other significant species. This report presents the existing and future with and without project conditions cost effectiveness and incremental cost analysis established by the *Planning Guidance Notebook*.[1]

1.2.2 Water Conservation

This water conservation purpose of the study is to determine the feasibility of re-operating Prado Reservoir to provide additional water conservation storage during the flood season. Conserved water would be used by the Orange County Water District (OCWD) and its member agencies. This report presents the existing and future with and without-project conditions cost-benefit analysis following the methodology established by the *Planning Guidance Notebook*.[2]

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[1] Engineering Regulation 1105-2-100 dated 22 April 2000

[2] Ibid

1.3 Study Area

1.3.1 Ecosystem Restoration

The ecosystem restoration study area encompasses Prado Basin to elevation 566' and each of the four major watercourses to the approximate area where the channels change physical characteristics or are adjacent to another project. This includes approximately 8 miles immediately downstream of the dam ending at Weir Canyon Road, which is a relatively natural channel with riparian and aquatic habitat as the river meanders within the banks. The study area evaluated for ecosystem restoration is approximately 50 square miles within which all storm water and groundwater flows drain into the Prado Basin.

1.3.2 Water Conservation

The water conservation study area is defined as the Prado Dam and reservoir, and the extended study area is defined as the OCWD present and future service area. The service area extends to the northwestern half of Orange County as shown in Figure 1-1, covers more than 350 square miles, and includes Orange County's vast groundwater basin. The basin provides water supply to over 20 municipal water agencies and special districts that serve about 2.4 million people. The District owns 1,600 acres in and near the Santa Ana River in Anaheim to capture flows and recharge the basin, and 2,150 acres above Prado Dam for conservation and water quality improvement.

Prado Dam was constructed in 1941 for the purpose of providing flood control in the Santa Ana River Basin. The Santa Ana River watershed comprises 2,450 square miles, 92 percent of which is located upstream of Prado Dam. The dam is located on the lower Santa Ana River in Riverside County, California, approximately 30.5 miles upstream of the Pacific Ocean. The Prado Flood Control Basin is situated within both Riverside and San Bernardino Counties at the confluence of the Santa Ana River, Chino Creek, Cucamonga Creek, and Temescal Wash.

1.4 Existing Water Conservation Operation

The 2004 Prado Basin Water Conservation Feasibility Study identified the NED and recommended plan as reoperation of the Prado Dam for water conservation during flood season from the maximum water surface elevation of 494 feet to 498 feet and during the non-flood season to a maximum elevation of 505 feet. The Consolidated Appropriations Act of 2005 (Public Law 108-447) directed the Corps to enter into a Memorandum of Agreement with OCWD for operation at a minimum of 498 (flood season) and 505 (non-flood season), consistent with the study recommendation. The MOA was executed in 2006. There was no previous Ecosystem Restoration Feasibility Study.

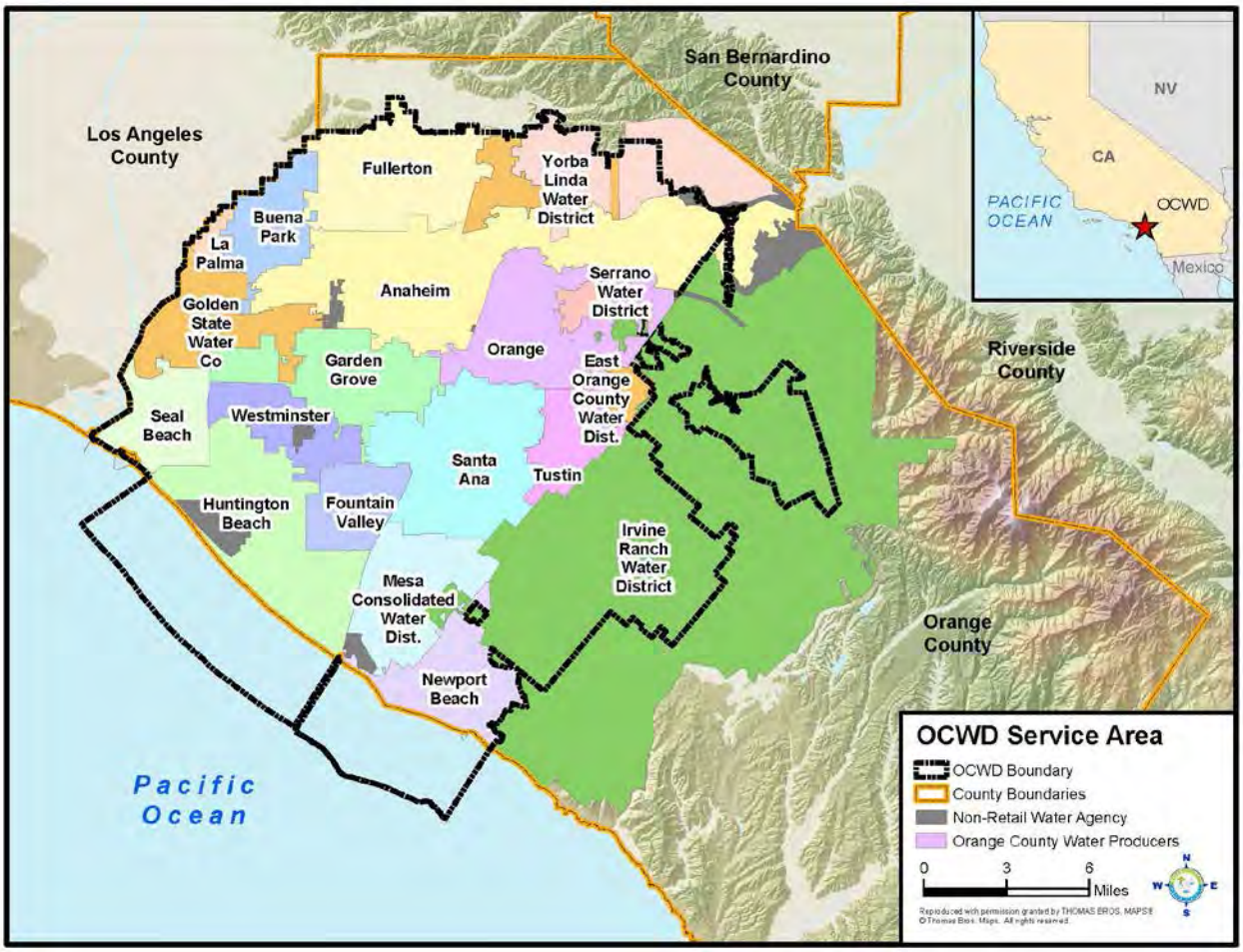

Figure 1-1 Orange County Water District Service Area

1.5 Study Methodology

This report has been completed in conformance with the Planning Guidance Notebook, ER 1105-2-100. Average annual costs are calculated over a 50-year period of analysis with a base year of 2026. Ecosystem restoration and water conservation benefits and costs are presented at 2017 price levels and the fiscal year 2017 discount rate of 2.875% in the plan formulation and evaluation sections of the report. Benefits and costs for the Final Array plans were updated to October 2017 price levels and the FY18 discount rate of 2.75%. Benefits and costs for the Recommended Plan will be updated to current price levels for the Final Feasibility Report.

1.5.1 Ecosystem Restoration

Ecosystem values and restoration benefits are measured in habitat units using a CHAP analysis. The procedure for CHAP analysis is described in the main report and environmental appendix. Briefly, different features and increments of features were evaluated across the study area for habitat benefit. This habitat benefit is quantified in habitat output units. IWR Planning Suite software was used to evaluate combinations of features in order to determine cost effective plans for a given level of output. Incremental cost analysis was applied to determine the tradeoff between additional cost and additional output to help identify the National Ecosystem Restoration (NER) plan.

Sediment removal is one feature analyzed for environmental restoration. Sediment removal can also increase the water storage capacity of Prado Basin creating water conservation benefits.

1.5.2 Water Conservation

Analysis was conducted on water conservation with reoperation of the basin at the maximum water surface elevation of 505 feet during the flood season. The average annual cost of municipal and industrial water with and without proposed water conservation plans was calculated. Additional water conserved at Prado with-project would be used to replenish the lower Santa Ana River groundwater basin, reducing the need to utilize more costly imported or reclaimed water. This difference in cost of water with and without project represents the project benefits for each alternative.

Water demand was forecast and compared to available local groundwater supply under without and with-project conditions. Water supply sources in the study area include local surface water, recycled water, and imported water provided by Metropolitan Water District of Southern California (MWD of Southern California or MWDSC). The cost per acre-foot from these sources was identified. Additional costs were applied as needed to reflect the economic cost to produce water of similar quality to the groundwater in the study area. Benefits from additional water supply due to reoperation at Prado Dam were then compared to economic costs. Economic costs include environmental mitigation costs, recreation impacts, operations and maintenance costs, and flood risks. Economic costs result primarily from increased probability, duration and elevations of inundation within the basin as a result of reoperation to 505 feet during the flood season.

2 Demographic and Land Use Analysis[3]

2.1 Demographics

Population Projections for Orange County show limited growth throughout the study period. Census data recorded over 3.17 million people living in Orange County as of 2016. By 2020, the population is projected to increase to approximately 3.26 million, an increase of about 2.8%. The population growth is expected to decrease considerably, with a total increase of about 357,000 or 10.9% between 2020 and 2060. Since per capita water consumption is not projected to grow substantively during the study period, future OCWD residential water consumption is expected to be driven primarily by the population increases shown in Table 2.1-1 as well as some secondary factors identified later in this document.

Table 2.1-1 Population Projections

	US Census	Projections[4]				
	2016	2020	2030	2040	2050	2060
California	39,250,017	40,719,999	44,019,846	46,884,801	49,158,401	51,056,510
Orange County	3,172,532	3,260,659	3,434,157	3,558,718	3,616,582	3,617,223

The population of the Orange County Water District service area can be approximated by aggregating the population from 22 cities wholly or partially within its boundaries.[5] By this measure about 2.31 million

[3] Limited socioeconomic data is available specifically for the study area so descriptions of regional socioeconomics are based on Orange County data unless otherwise indicated.

[4] California Department of Finance Demographics Division

[5] The 22 cities are Anaheim, Buena Park, Costa Mesa, Fountain Valley, Fullerton, Garden Grove, Huntington Beach, Irvine, La Palma, Lake Forest, Los Alamitos, Newport Beach, Orange, Placentia, Rossmoor, Santa Ana, Seal Beach, Stanton, Tustin, Villa Park, Westminster, and Yorba Linda

people currently live in the OCWD service area, which is an increase of over 146,000 since the census was taken in 2010.

Table 2.1-2 shows the population of Orange County grew rapidly following World War II until the early 1970s. Most of that growth was the result of migration within the United States. Domestic migration slowed in the 1970s while international migration rose. That trend has increased the foreign-born population from 6% in 1970 to about 30% today. However by the 1990s most growth in Orange County was being caused by natural increases (births exceeding deaths). Since 2000 migration has reversed and more people emigrate from Orange County than immigrate to it as shown in Figure 2-1; yet, overall the population continues to grow, although slowly, from natural increases. The population projections shown in Table 2.1-1 are consistent with this slowing growth trend and also consistent with moderate water demand growth during the study period.

Table 2.1-2 Orange County Growth Rates and Components of Growth

Decade	Population (start of decade)	Annual Growth Rate (avg)	Major Component of Growth[6]
1950s	216,224	22%	Domestic migration
1960s	703,925	10%	Domestic Migration
1970s	1,431,900	3.1%	International Migration
1980s	1,944,800	2.2%	International Migration, Natural Increase
1990s	2,411,976	1.7%	Natural Increase
2000s	2,853,893	0.6%	Natural Increase
2010-2011	3,017,327	0.9%	Natural Increase

The most recent year components of population change are available is 2010-2011, which is not included in Figure 2-1. During that period net migration switched from an outflow to an inflow of 18,017 while natural increases added 21,256 residents. Long-range projections suggest this pattern will continue, with natural increases continuing to be the primary contributor to growth.[7]

[6] Orange County Community Indicators 2012, Orange County Government
[7] Orange County Community Indicators 2012, Orange County Government

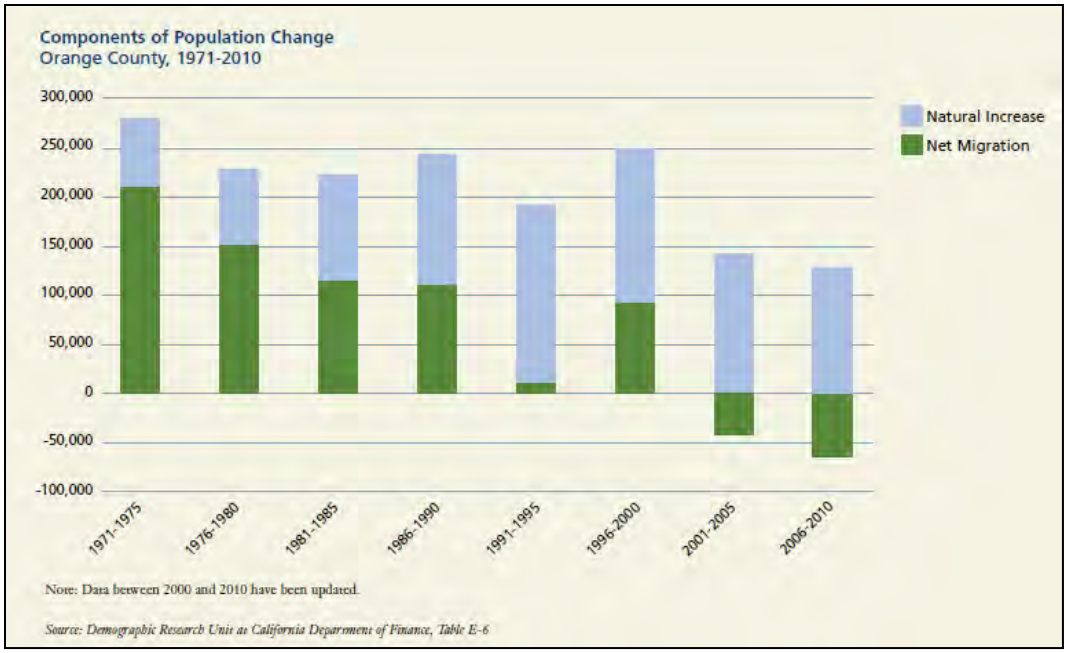

Figure 2-1 Orange County Components of Population Change

Orange County has significant tourism and financial sectors that made its economy especially sensitive to the broader downturn around 2008. The more recent upturn in population growth rate and net immigration relates closely to the improved economic activity following the 2007-2008 financial crisis. Presently, the median housing price exceeds $695,000, which is about 7.9 times the median household income. Income and housing price increases, plus gains in economic activity since 2009 support the conclusion that net migration inflow is a short term trend but longer term population growth will come from natural increases as projected by the Orange County government and California Department of Finance Demographics Unit.

The ethnic makeup of the OCWD service area as defined by the US Census Bureau is shown in Table 2.1-3. The primary ethnic groups are White, Hispanic/Latino, and Asian. A majority of residents are White but excluding Hispanics self-identifying as White reduces that to a plurality. Thirty-eight percent fall under this definition of White while 37% identify as Hispanic/Latino alone. Asians make up 20% of the population. This is higher than the state-wide average of 13%. In contrast, African Americans make up less than 2% in Orange County compared to over 6% across California.

Table 2.1-3 Ethnic Distribution in OCWD Service Area

Ethnicity, 2010 US Census	Share of OCWD Service Area[8]	Share of California
White	56.50%	57.60%
Black or African American	1.80%	6.20%
American Indian and Alaska Native	0.64%	1.00%
Asian	20.00%	13.00%
Native Hawaiian and Other Pacific Islander	0.35%	0.40%
Two or More Races	4.25%	4.90%
Hispanic or Latino	37.21%	37.60%
White alone, not Hispanic or Latino	38.48%	40.10%

Median household income in Orange County is significantly higher than national and state income levels. In 2015, median household income in nominal dollars was $61,818 in California and $53,889 nationally. In Orange County the median household income was $76,509.

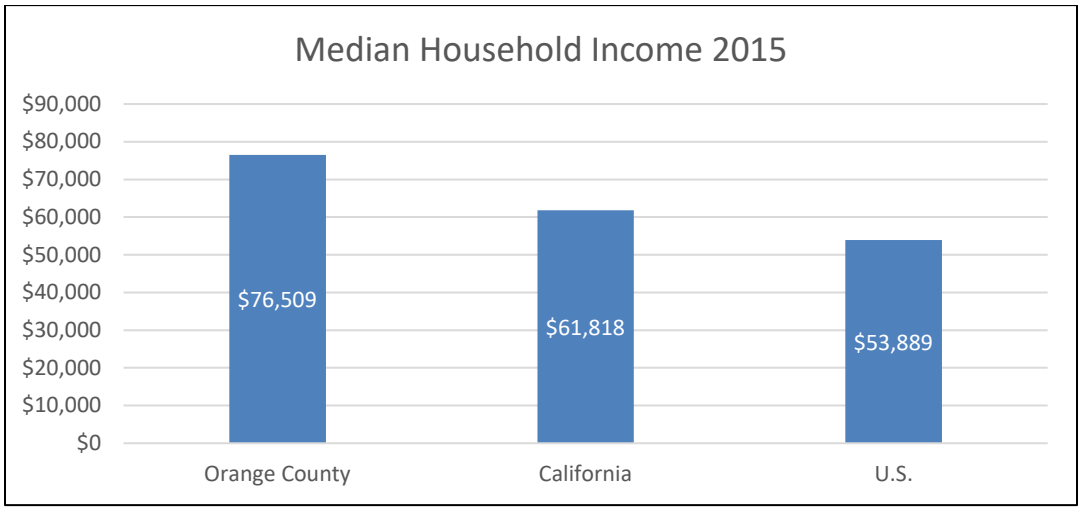

Figure 2-2 Median Household Income

Unemployment rates in Orange County have been consistently below state-wide rates. As of July 2017 unemployment rates were 4.8% in California, 4.3% nationally, and 4.2% in Orange County. Unemployment has fallen back to 2006-2007 levels due to increases in consumer sentiment, air travel, vehicle registration, office occupancy rates, and other regional economic indicators.[9] Lower unemployment rates than neighboring regions due to improving economic activity typically draw in new residents. This is consistent with the switch from net migration outflow in Orange County as recently as 2009 to net migration inflow in 2010-2011, (see Figure 2-1). This suggests the population should growth should be slower in the longer term due to the continued gains in economic activity across California since the recession which is

[8] More than one category may apply to respondents so total does not add to 100%
[9] Orange County Workforce Investment Board August 2013 Metrics

consistent with the declining growth projections generated by the California Department of Finance and Orange County governments and used to model future water demand for this study.

2.2 Land Use - OCWD Service Area

The OCWD service area is highly urbanized with few undeveloped areas. As a result land use is not expected to change substantively during the period of analysis. Current land use in Orange County is distributed 27% to residential, 24% to government/public, 19% uncommitted/unknown, and around 10% each to commercial/industrial, transportation, and agricultural. See Figure 2-3.

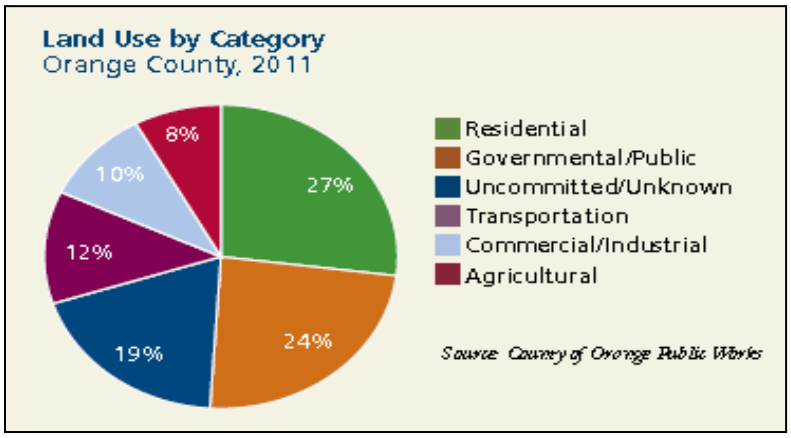

Figure 2-3 Land Use by Category for Orange County

Residential development in the lower Santa Ana River watershed, which approximates the OCWD service area, peaked between 1960 and 1980. Between 2000 and 2004 growth fell below 4% and since 2004 growth has fallen below 2%.[10] Data on commercial, industrial, and public lands was not available but is expected to follow this same trend.

The Orange County economy has a large service sector and 20 out of 25 major employers listed by the California Employment Development Department are from the service sector. To illustrate this Figure 2-4 clusters employment by economic sector. Six out of the ten largest employment clusters are in service-related sectors and four out of the five largest clusters. Some of the largest service sector employers are Walt Disney Parks & Resorts, UC Irvine Healthcare, First American Title Insurance, and Knott's Berry Farm Amusement Park. Industrial employment tends to focus on light industrial activities such as laboratory equipment, cleaning agents, and solid state memory device manufacturing. The current mix and level of commercial and industrial activity is expected to persist during the study period. Thus, it is not expected to significantly change future water demand.

[10] Lower Santa Ana Economic Reevaluation Report, USACE 2013

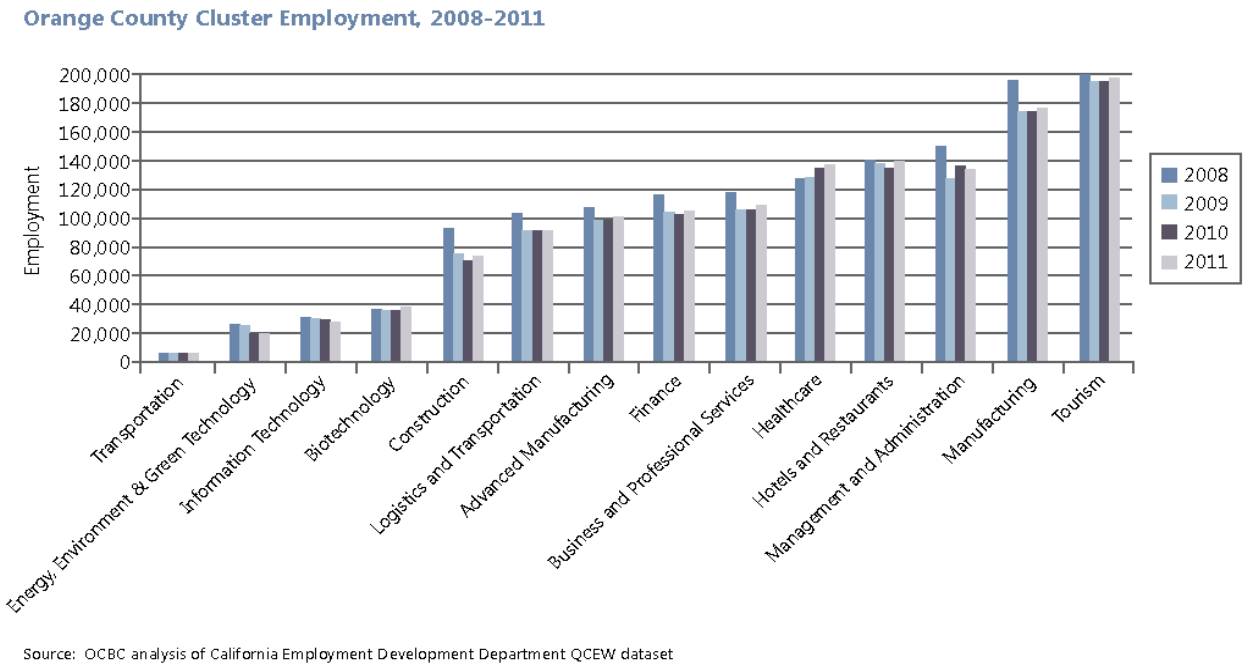

Figure 2-4 Orange County Employment Clusters

Although only 27% of land use is zoned residential (see Figure 2-3), Table 2.2-1 shows that over 9 in 10 structures in the study area are residential. Eighty-three percent are single family residential while 5% are multi-family residential and 3% are mobile homes. The remaining 9% are industrial, commercial, or public. A small share of parcels, less than 1%, are vacant supporting the conclusion that the study area is built out and population growth will need to be accommodated through redevelopment and intensification.

Table 2.2-1 Structure Use by Category for Study Area[11]

	Share of All Structures	Share of **Residential** Structures
Residential	91%	100%
Single Family	83%	91.2%
Multi Family	5%	5.5%
Mobile Home	3%	3.3%
Commercial	2%	
Industrial	4%	
Public	3%	
Agricultural	0%	
Vacant/Undeveloped	1%	
Total	100%	

The recent trend of slow growth in residential housing stock and limited population growth along with visual inspections of the OCWD service area suggest there is little available room for future development. Thus, any future development is generally assumed to be the result of slower incremental land use

[11] OCWD service area approximated by the Lower Santa Ana watershed as presented in the Lower Santa Ana Economic Reevaluation Report, USACE 2013

through intensification and redevelopment. Water demand during the study period has been projected to increase gradually following this and other trends outlined in the following sections.

2.3 Land Use - Prado Basin

Land use within the Prado Basin Study Area up to 566 feet of elevation was also evaluated, which is distinct from the OCWD service area that makes up the study area. The primary use for each parcel was identified. Parcels with commercial, industrial, public, or residential structures were labeled accordingly. Parcels primarily used for agriculture were coded for agricultural use. Parcels without visible development were labeled undeveloped. The Prado Basin Study Area is approximately 16.1 square miles and consists of 1,123 parcels. Most of the area is undeveloped; however, substantial area is also used for commercial activity as shown in Figure 2-5. Although about 100 parcels are used for agricultural purposes such as crops and dairy farms most are smaller parcels. Public parcels include Prado Dam and a small water treatment facility. Many residential structures border the Prado Basin Study Area but only 77 single family residences are below 566 feet of elevation as shown in Figure 2-5. None of these residential structures would incur additional inundation risk from re-operating Prado Basin.

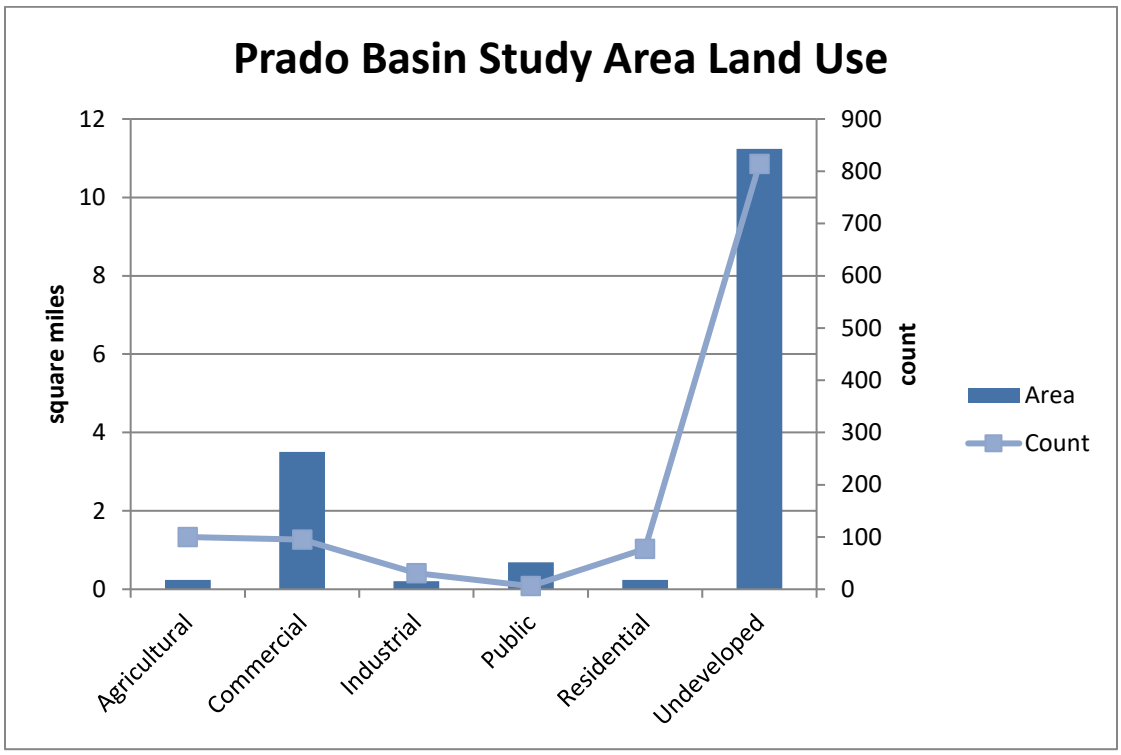

Figure 2-5 Prado Basin Study Area Land Use

Figure **2-6** shows land use in the Prado Basin Study Area based on aerial surveys. This figure highlights that most land is undeveloped but there are commercial and agricultural activities concentrated in the northern portion of the basin (red and tan), an airport is present in the southeast portion of the basin (red), and a golf course and mobile home park are present downstream (red). Prado Dam parcels are colored blue. Additional flood risk is concentrated in several recreation businesses operating roughly in the center of the basin and the golf course and RV park downstream of Prado Dam. Flood risk is discussed and analyzed extensively later in this document.

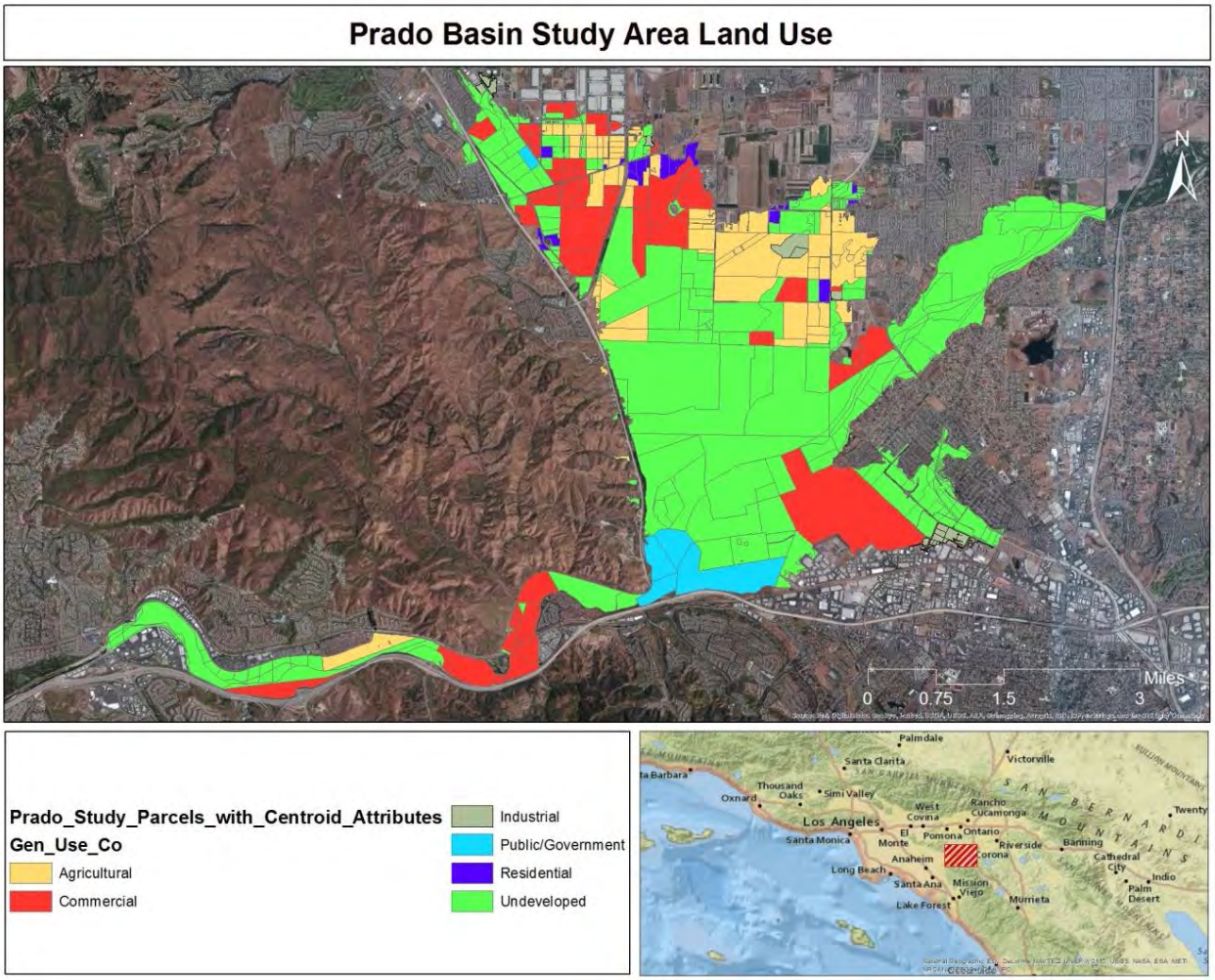

Figure 2-6 Prado Basin Study Area Land Use

3 Water Conservation Analysis

3.1 Water Demand

3.1.1 Water Demand & Future Use

Water demand is driven primarily by 1) the mix of users, 2) the number and characteristics of those users, 3) economic activity, and 4) water service prices. Changes to any of these four factors should alter future water demand. Since Orange County is built out and relatively affluent with a large and stable service sector, the share of municipal versus industrial users is not expected to change substantively during the study period. A second factor that influences demand is the number and characteristics of those users. The number of municipal users is tied to population. Population forecasts by the California Department of Finance Demographics Division show steady, slow growth in Orange County (see Table 2.1-1), which indicates municipal water demand will only grow modestly because of new residential users. However, the characteristics of municipal users are changing. Key characteristics like the number and type of housing units are expected to change while household size and income are expected to remain the same. The number of housing units should continue to rise to accommodate the gradual increase in projected population—roughly one unit for every three new people, which is the current and projected average

household size. While the average household size is not expected to change, the share of multi-family housing structures should rise from the existing low share because there is little room for future development except through intensification and redevelopment (see Table 2.2-1). Multi-family housing units should require less water for landscaping and other outdoor uses per capita than single family units, modestly reducing per capita water demand but not overall demand because the population continues to grow.

The third factor is economic activity. Water demand is linked with economic activity through changes to employment, business sector mixes, and intensity of activity. The unemployment rate in Orange County has been consistently lower than the state of California for the past decade. From 2002 to 2008 the rate remained at or below 5%. In the past several years the rate has dropped significantly following a spike in unemployment after the 2007-2008 financial crisis. Naturally, this coincides with improving business indicators.[12] As a result in the short-term economic activity should remain strong. Over the longer-term activity is expected to grow modestly because income levels are relatively high, the area is built out, and population growth is expected to be much slower than in preceding decades. Overall, this factor should cause moderate growth in water demand during the study period.

The final factor is the price of water service for end consumers. It varies across the 19 retail water agencies within the OCWD service area from $960 to $1600 per acre-foot but is strongly related in the medium and long-term cost that retail water agencies incur importing water or pumping & replenishing groundwater, the two largest sources of water supply in the study area. In 2003 the cost of imported water purchased from the Metropolitan Water District of Southern California (MWDSC), the sole source for imported water from the Colorado River Watershed and State Water Project, was $454 per acre-foot. By 2017 the cost more than doubled to $1,077 per acre-foot—a 137% increase in 14 years. As a result end consumer prices have trended upward, which is expected to slow the per capita growth in demand. Primary reasons for the price increases for imported water include significant increases in infrastructure development and maintenance costs, environmental related costs, and energy costs, along with changes in water demands.

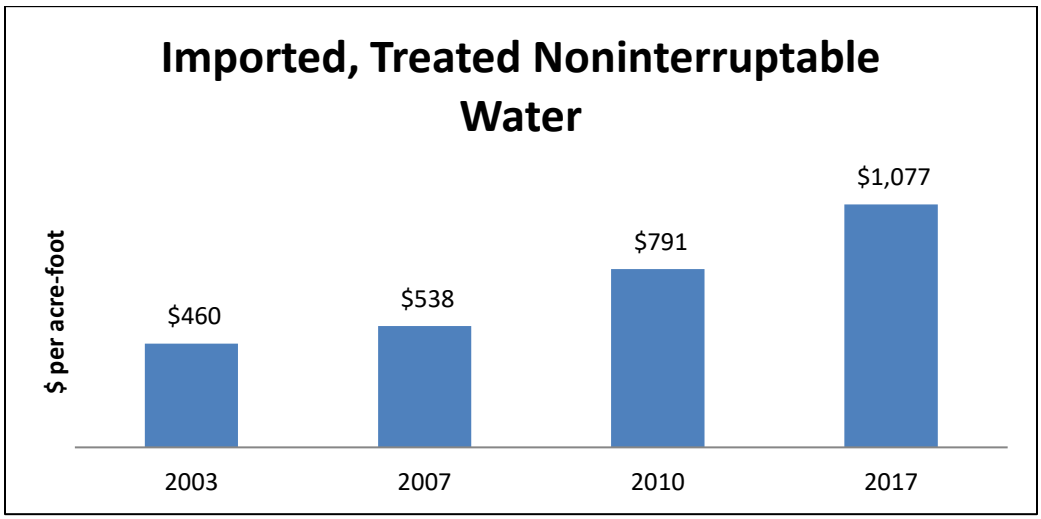

Figure 3-1 Trends in Retail Water Cost

Table 3.1-1 summarizes these factors and their influences on water demand. Of the factors identified only increased economic activity, population growth, and the corresponding increase in housing units should raise water demand during the study period. At the same time land redevelopment and intensification

[12] Orange County Workforce Investment Board August 2013 Metrics

should lower per capita water demand for new residents compared to existing residents primarily housed in single family units. Retail water costs, which are expected to stabilize in real terms after rising rapidly the preceding decade, are at a level that should also slow growth to per capita demand throughout the study period. Overall these factors suggest that water demand will increase more in the short term corresponding with increased economic activity but grow slower in the long-term in line with population projections.

Table 3.1-1 Factors Influencing Water Demand

			Demand Factors
	OCWD, Current	OCWD, 2035	Influence on Demand
Retail Water Cost	$1,077	unchanged, 2017 dollars	Costs have more than doubled since 2003; although expected to stabilize, the recent higher price levels should slow growth per capita in demand.
Median Household Income	$76,509	not projected	Generally affluent; median income has grown modestly since 2008 and is expected to follow that trend during study period. Thus no change to future demand from this factor.
Number of Housing Units	800,000 (est.)	855,000[13]	Population growth generally accommodated through intensification/redevelopment. Increased water demand overall but negligible per capita growth due to intensification.
Type of Housing Units	91% Single Family 6% Multi Family 3% Mobile Home	increased multi-family dwellings	In general, intensification rather than new development to meet future housing needs. Lower than average per capita consumption for new residents.
Household Size, avg.	2.97	unchanged	Household size is not expected to change noticeably during the study period. Thus no change to future demand from this factor.
Commercial-Industrial Mix	Dominated by large service sector, some light manufacturing	unchanged	The area is generally affluent and highly developed. The commercial-industrial level and mix is not expected to significantly change during the study period. Thus no change to future demand from this factor.
Economic Activity	Exceeding pre-2007 levels	continued modest increase	Economic activity rebounded after the recession. Future growth is expected to be gradual in line with population projections. Modest increase to future water demand from this factor.
Population Growth	0.6% (est.)	0.3%	Population growth rate declines during the study period. Moderate increase to future water demand.

[13] California Department of Finance projects the population of Orange County will increase approximately 332,000 by 2035. The assumption is half (166,000) move to the OCWD service area and require about 55,000 additional housing units.

3.1.2 Future Use Uncertainty

Currently residential customers are the largest water consumers in the study area. They consume 62% of water followed by commercial, industrial, and institutional consumers that collectively use 37% of the water. Agricultural use is negligible and accounts for about 1% of all consumption. Given that the study area is built out, generally affluent with a large service sector, and projected population growth is modest, these usage patterns are expected to persist throughout the period of analysis. Thus, municipal-industrial consumption mix should not be a significant source of uncertainty for future demand projections.

Forecasting future water demand requires projections of future changes in economic activity, future population growth, a gradual increase in the share of multi-family housing units, and potential though unexpected changes in the real cost of water throughout the study period. Economic activity has trending upward. Since this continued growth should occur in the short to medium-term and is relatively certain to happen, demand projections based on economic conditions are not a significant source of uncertainty. However, economic activity beyond the next several years is less certain and this study's assumption that activity will grow modestly in line with population growth may under or overestimate the level of activity. Over time even small differences in projected and actual economic growth rates can accumulate to substantial differences in the level of economic activity. Furthermore, increased economic activity is in part a result of population growth and vice versa. This reverse causality creates the potential for double counting when creating a demand forecast, which complicates modeling and can contribute to error or uncertainty.

Since population growth and economic activity are related, uncertainty in one factor spills over in to uncertainty for the other factor. If economic projections are too high, for instance, then population growth projections are probably also too high. Fortunately this is less of a problem for Orange County because most future population growth is expected to come from natural increase (birth rate exceeding death rate) from the established population, which seems less sensitive to fluctuations in economic activity.

Overall, the factors summarized in Table 3.1-1 suggest a limited range for future demand. The study area is mostly built out, has a relatively high and steady level of economic prosperity, appears to have a stable commercial-industrial mix with a large service sector, and has experienced low population growth rates.

3.1.3 Water Demand Analysis

Water demand for the OCWD service area (study area) is based on aggregated projections made by each water retailer as described in the water retailer's Urban Water Management Plans. Methodologies vary across retailers, which means the projections have the advantage of being tailored to local conditions within each water district but may not be consistent in fundamental assumptions such as demographic changes and regional economic growth. For comparison MWD of Southern California and MWD of Orange County were approached for regional demand models but neither had models developed for the study area.

The aggregated projections made by water retailers continue to 2035. Forecasting beyond 2035 is held at the county-wide population growth rate projection made by the California Department of Finance Demographics Unit. Although the amount of developable land is very limited within the OCWD service area, population growth within the service area has been similar to county-level growth rates over the past decade. Future growth in the service area is also anticipated to be similar to county-level rates, especially over the long term, as there is very little land available for development at the county level. This is reflected in population growth projections. The aggregated water demand projections comport well to expectations developed and summarized in Table 3.1-1, specifically stable economic activity, number of households, industrial-commercial mix, and population. Figure 3-2 compares one of these factors, projected population for Orange County, with the projected demand for this study.

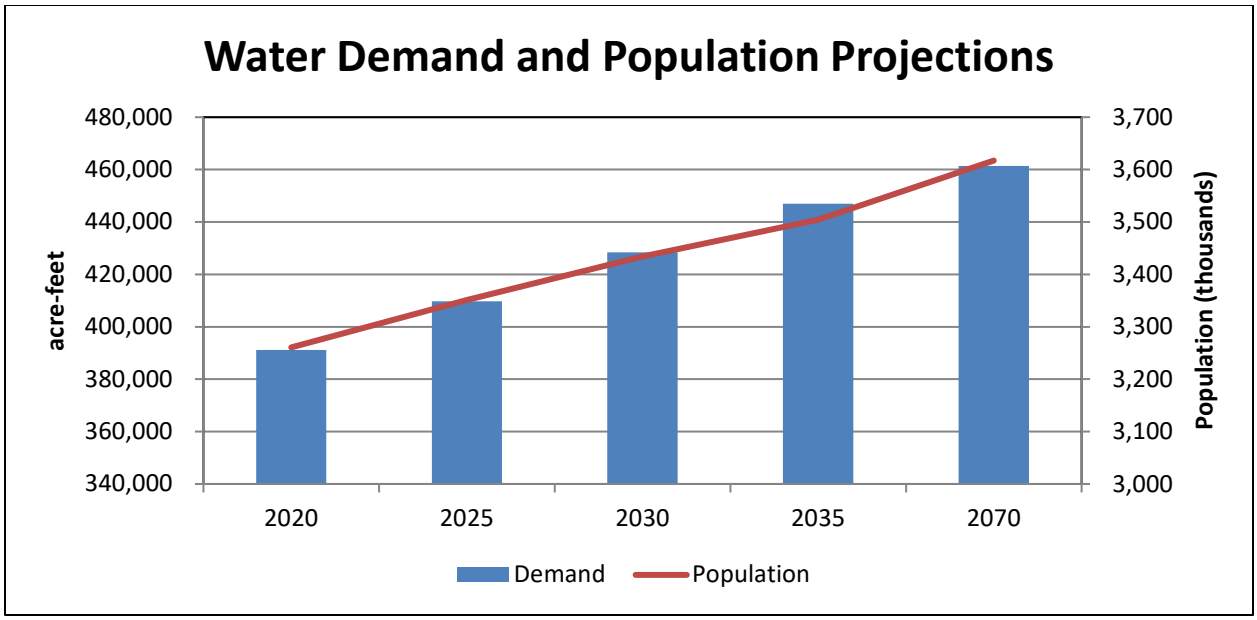

Figure 3-2 Water Demand and Population Projections

3.2 Water Supply

3.2.1 Water Supply Impact Area

Orange County Water District service area covers more than 350 square miles, and includes Orange County's vast groundwater basin. OCWD is responsible for managing the groundwater basin that provides over 70% of northern and central Orange County's drinking water presently. To manage groundwater supply, OCWD maintains aquifer recharge systems to replace the water that is pumped from about 400 wells belonging to local water agencies, cities and other groundwater users. The District owns 1,600 acres in and near the Santa Ana River in Anaheim, which it uses to capture flows and recharge the basin. The District also owns 2,150 acres above Prado Dam, which it uses for conservation and water quality improvement. The area above Prado Dam and the recharge basins would be directly impacted by reoperation of the dam to increase water conservation and supply. Reoperation would lead to increased capture above the dam, more gradual discharge, and increased recharge in the groundwater basin.

The recharge stations are concentrated in a six-mile section of the Santa Ana River owned by OCWD, from Imperial Highway to Ball Road in Anaheim. Over the years it has further expanded its recharge system, which now includes over two dozen separate facilities that cover over 1,000 acres. A number of these facilities are recharge basins that range in depth from 5 to 150 feet. The recharge basins are located in the cities of Anaheim and Orange due to sandy and coarse-grained soils, which allow water to easily percolate into the deep aquifers. OCWD has increased the water supply available for recharge, and thereby increased the sustainable groundwater yield, as recently as 2008 by constructing a 13-mile pipeline to transfer treated recycled water to recharge basins.[14] This was done to lower dependence on outside sources such as the Colorado River and State Water Project.

3.2.2 Water Supply Sources

Current end-user water supply types are 1) groundwater, 2) imported treated water, 3) local surface water, and 4) recycled water.

[14] Portions taken from Orange County Water District website www.ocwd.com

Table 3.2-1 presents a distribution of water supply by source for recent years, which corresponds with a somewhat greater demand than is forecast over the next few years, but provides a representative distribution. The single largest source continues to be groundwater which has ranged from about 228,000 AF to about 366,000 AF since 1990. Groundwater typically provides over 70% of the total water supply in the OCWD service area. Groundwater production is sustained by recharge from the Santa Ana River, imported untreated water, treated recycled water, and storm water. About 45% of groundwater supplies come from Santa Ana River recharge and about 31% comes from the ground water replenishment system, which recharges treated and treated recycled water. The next largest source is incidental recharge, primarily from storm water flows. The remainder comes from recharging untreated water from the Colorado River or California State Water Project. Imported treated water accounts for about 15% of the total supply at approximately 60,000 acre-feet annually (based upon OCWD purchases over the past 20 years) while local surface water and direct-use recycled water make up the remaining supply sources. See the table below. Imported water sources are colored blue.

Table 3.2-1 Water Supply Sources

Water Supply Type	Water Supply Source	Primary Agency	Average Annual Water Supply Volume & Share (afy)		Retail Water Agency Cost[15]
Groundwater	Recharge from Santa Ana River (storm and base flow)	OCWD	150,000	36%	$202[16]
	Recharge of imported interruptible untreated water[17]	MWD of Southern California	18,000	4%	$594
	Recharge from Groundwater Replenishment System[18]	OCWD	102,000	25%	$850
	Incidental recharge[19]	OCWD	60,000	14%	$202
Total Groundwater			330,000	79%	
Imported Treated Water	Uninterruptible from Colorado River Watershed, State Water Project[20]	MWD of Southern California	60,000	15%	$1,077
Local Surface Water	Santiago Creek and Irvine Lake	Serrano Water District, IRWD	10,000	2%	$316.50
Direct Use of recycled water for Irrigation and Industrial Uses	Tertiary treated water provided by OCWD and IRWD	IRWD, OCWD, retailers	15,000	4%	Not Assessed
Total			415,000	100%	

In contrast to the water supply type from the end users perspective, all water in the study area is sourced from either: 1) the Santa Ana River; 2) recycling; 3) incidental sources (natural groundwater percolation); 4) surface water; or 5) imports. See the second column of

[15] Actual or average cost charged by OCWD to member retail water agencies
[16] Cost of groundwater extraction: For energy, depreciated capital stock, and operation and maintenance from OCWD Engineer's Report 2015-2016 Table 7, page 28
[17] "Replenishment" water.
[18] Treated, recycled water that is recharged in to the aquifer
[19] Natural inflow to the basin, deep percolation of rainfall and irrigation water, and other unmeasured recharge; same cost basis as pumping groundwater sourced from the Santa Ana River
[20] "Full Service"

Table 3.2-1. These sources are used to derive the water supply benefits.

Imported water is either treated or untreated. Untreated water is interruptible and percolated in to the aquifer through recharge basins maintained by OCWD (also referred to as "replenishment water"). Treated water is delivered as an uninterruptable supply with a higher cost than untreated water (also referred to as "full service water"). All sources of imported water, which are from the Colorado River, State Water Project, and regional sources, and conveyed by MWD of Southern California, are expected to be available during the study period. Shortfalls in groundwater recharge can be accommodated by additional imports or by pumping in excess of the amount recharged temporarily. However, OCWD has a basin management objective to maintain the aquifer within a 500,000 acre-foot range (from a full aquifer to a 500,000 acre-foot deficit). To accommodate these needs OCWD has increased the amount of groundwater recharge over time by improving recharge facilities and generating new sources that can be recharged like treated recycled water. However, these improvements do not fully offset the expected decrease in non-storm flow in the Santa Ana River in the future as more municipalities upstream begin recycling water rather than discharging it in to the Santa Ana River. See Figure 3-3.

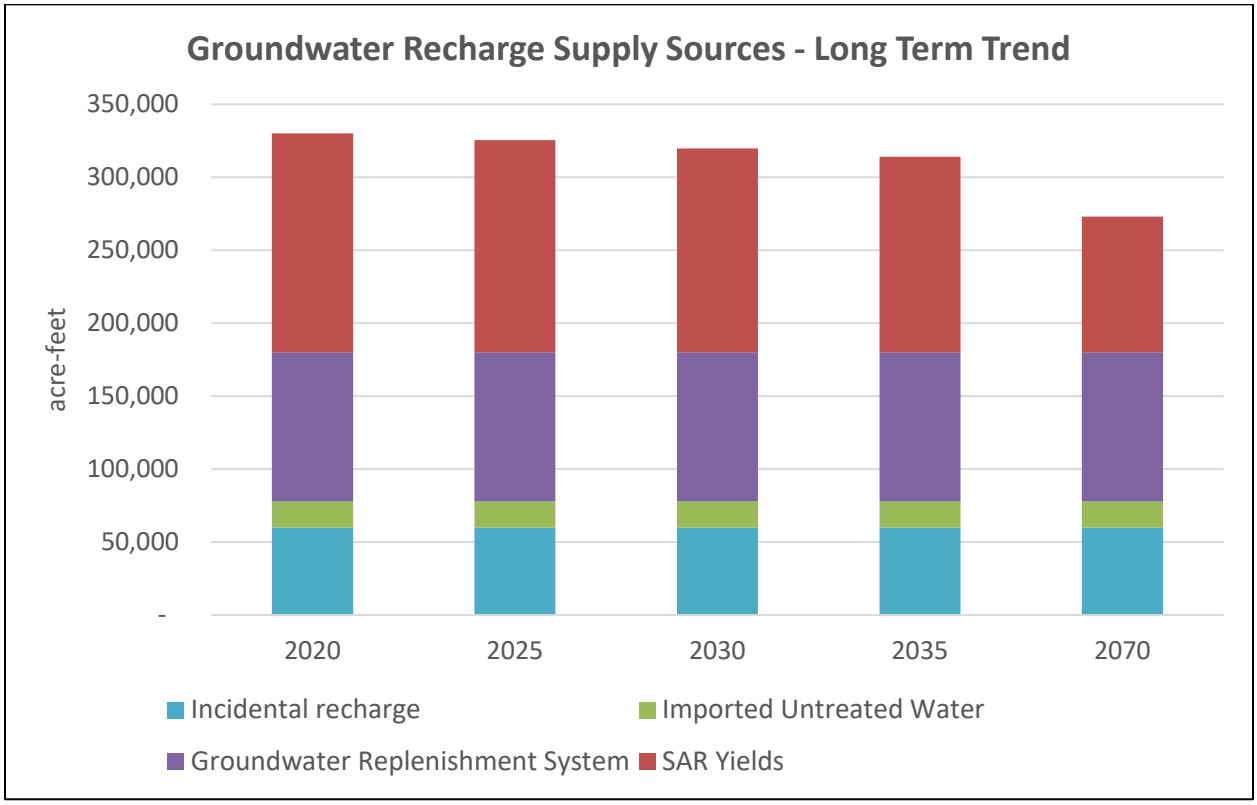

Figure 3-3 Groundwater Recharge Supply Sources

Several supply sources are not injected in to the aquifer before extraction and consumption. These include surface water, direct use of recycled water, conservation, and treated imports. When these sources are included the result is a complete picture for water supply in the study area. The impact of planned active and passive conservation measures are accounted for in demand projections. This complete supply outlook is presented in Figure 3-4 and Figure 3-5. Both figures show all supply sources except imports are expected to have a stable trend throughout the study period. The only source that is expected to increase long-term is imported water to meet the expected growth in demand, which is also shown in the tables below. Figure 3-4 projects Santa Ana River (SAR) water yields assuming that the prevailing conditions in

the base year (2026) continue throughout the study period. Figure 3-5 assumes the conditions in the future year (2075) prevail. In contrast Figure 3-3 above projects a gradual drop in SAR yields due to decreased non-storm flows, which means upstream water treatment facilities would begin recycling more water rather treating recycled water and releasing it in to the river. The base year and future year projections in Figure 3-4 and Figure 3-5 below are essentially the beginning and end points of this gradual reduction in SAR non-storm flows. The projections below in Figure 3-4 and Figure 3-5 are also the basis for calculating project benefits, which is explained in a later section.

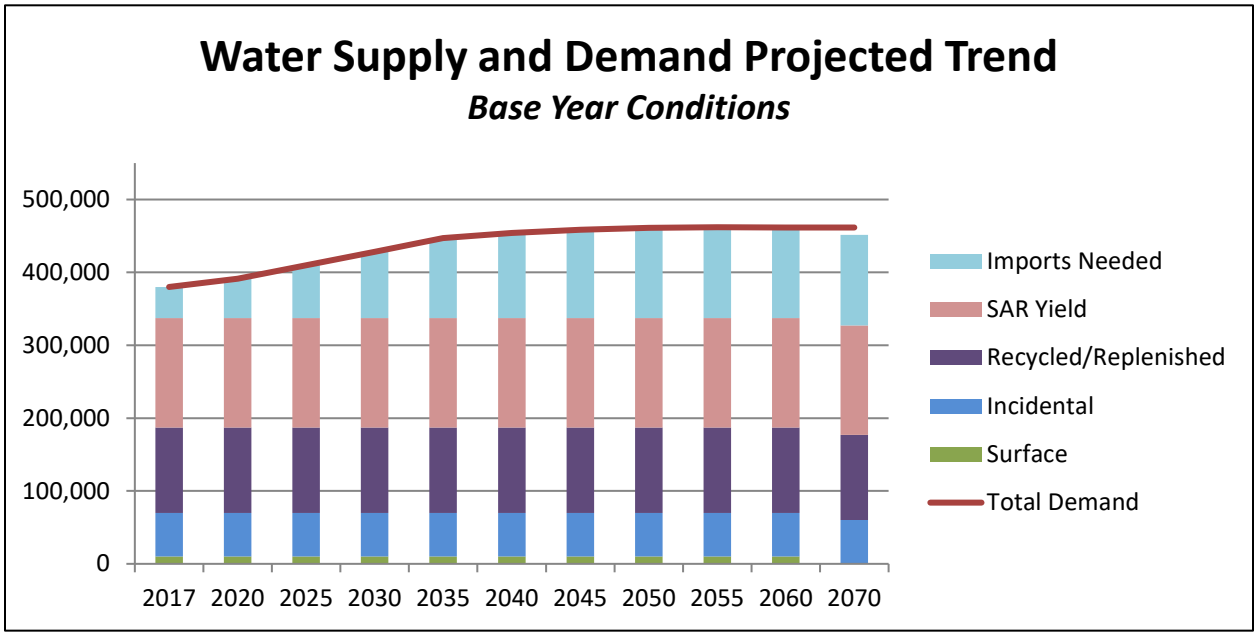

Figure 3-4 Projected Water Supply by Source under Base Year SAR Yield Conditions

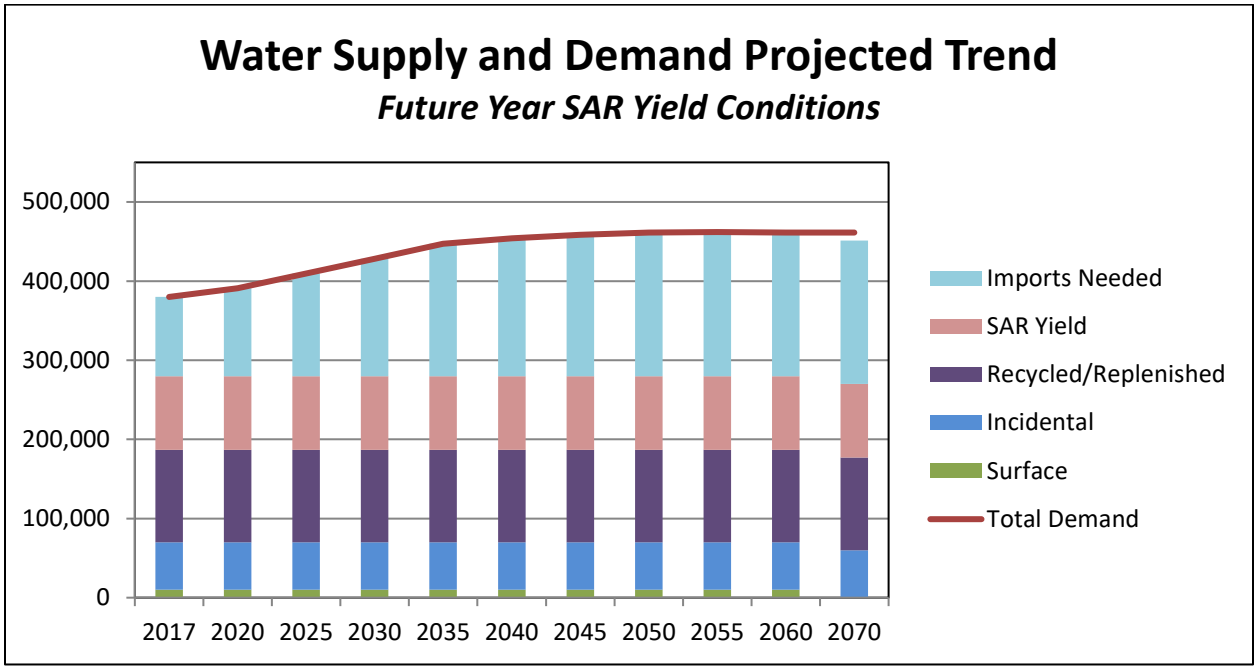

Figure 3-5 Projected Water Supply by Source under Future Year SAR Yield Conditions

3.2.3 Conservation

California law requires all of California's retail urban water suppliers serving more than 3,000 acre-feet per year or 3,000 service connections to achieve a 20% reduction in per capita consumption from a historical baseline by 2020. Due to the region's past and ongoing water use efficiency and recycled water efforts in the past decade, retail agencies are on their way to meeting the required reduction. Water retailers in Orange County have established an Orange County regional alliance to assist in reducing the region's water demand and meet the 20% reduction by 2020. Consequently, water demand projections developed by the retail agencies already include allowance for both passive and active conservation. MWD of Orange County estimates that 3,246 acre-feet of water were saved as a result of active water use efficiency programs in year 2017 within the North Orange County Watershed Management Area, which is similar to the OCWD boundary. MWD of Orange County staff indicated that passive water use efficiency accounts for about 2/3 of total water use efficiency and active water use efficiency programs account for 1/3 of the total.[21] This equates to 9,738 acre-feet of combined active and passive conservation in 2017—6,492 acre-feet from passive and 3,246 acre-feet from active conservation. Table 3.2-2 shows representative projections throughout the study period. It is assumed that the impact of these conservation measures has been accounted for in OCWD service area demand projections.

Table 3.2-2 Active and Passive Conservation Projections

Conservation in acre-feet					
	2020	2025	2030	2035	…2070
Passive	6,563	6,683	6,805	6,930	7,838
Active	3,281	3,341	3,403	3,465	3,919
Total	9,844	10,024	10,208	10,394	11,757

3.2.4 Reliability and Uncertainty

In the OCWD service area demand consistently exceeds local supply. One primary source offsets these local supply shortages. OCWD arranges for additional water supplies from the Metropolitan Water District of Southern California (MWD), which imports water from the California State Water Project (SWP), Colorado River, and its own regional network of supply sources. These purchases are made through the Municipal Water District of Orange County (MWDOC). The SWP is the world's largest publicly built and operated water and power development and conveyance system. It collects water from northern California watersheds. Water from the Colorado River travels along a 242-mile water conveyance beginning at Parker Dam near Lake Havasu City, Arizona. OCWD contracts with MWD for treated and untreated water that is either non-interruptible or interruptible. OCWD primarily relies on treated interruptible water and untreated interruptible water from MWD to meet water demand in excess of local groundwater supply and other local sources. Treated water essentially bypasses OCWD and goes directly to its member agencies because it is distributed directly to retail water agencies for municipal and industrial purposes. In 2015-2016 the OCWD service area has imported 67,735 acre-feet of treated water, which constituted approximately 18% of the total water supply during the water year. Untreated water is interruptible and used by OCWD for groundwater replenishment. The availability and amount of untreated replenishment water is impacted by dry years and drought conditions. About 45,000 acre-feet or 12% of total supply was untreated interruptible water used for recharge in water year 2015-2016. Total

[21] Passive water use efficiency is actions taken by water users separate and apart from water agency funded water use efficiency programs. See 'Orange County Water Use Efficiency Master Plan', prepared by MWDOC, 2013.

imports are expected to grow to approximately 124,000 acre-feet if present conditions prevail or 181,000 acre-feet if future conditions prevail as shown in Figure 3-4 and Figure 3-5.

Although MWD is the sole source for imported water deliveries to the study area, imports to the study area are highly reliable. This is because of how MWD gets its supplies. It has three largely independent "macro watersheds" in Northern California, the Colorado River system, and in the Los Angeles region. These are each huge geographic areas to draw water supplies. In addition MWD has substantial water storage facilities.[22] According to the *Metropolitan Water District of Sothern California 2010 Regional Water Plan*, "Metropolitan has supply capabilities that would be sufficient to meet expected demands from 2015 through 2035 under the single dry-year and multiple dry-year conditions…" In addition, "Metropolitan has comprehensive plans for stages of actions it would undertake to address up to 50 percent reduction in its water supplies and a catastrophic interruption in water supplies through its Water Surplus and Drought Management and Water Supply Allocation Plans." MWD's analysis shows that water deliveries can be met even under consecutive periods of drought through 2035, the final year of analysis. As a result water imports to the study area have near certain reliability through 2035 under all but catastrophic scenarios. Beyond 2035 there is no analysis available to address the reliability of MWD deliveries. However, presuming the same reliability level beyond the final year of analysis in the MWD report, 2035, seems reasonable and forms the most likely outcome used in this study's analysis.

To address any remaining uncertainty about the reliability of imported water over the fifty-year period of analysis for this water conservation study, alternative water supply scenarios were also analyzed. Operating under the assumption MWD supplies may not be as reliable beyond 2035, three likely alternative sources were analyzed. Those alternative sources are desalination, additional conservation, and additional water recycling facilities. Each source has past precedence in the Southern California region and identifiable costs. Results from this analysis are presented in a later section.

Local water sources have been monitored closely for decades by OCWD. All supplies in existence today are expected to continue throughout the study period. Furthermore, future supplies have been held at prevailing, expected levels determined by OCWD. Santa Ana River yields, which were developed by hydrologic and hydraulic modeling, follow prevailing conditions in 2026 or 2075. A discussion of the reliability of each local source follows.

- Surface water collects in several local reservoirs in the study area at a prevailing rate of approximately 10,000 acre-feet annually. This source is less that 3% of the current water supply. Weather conditions could reduce or increase this water source compared to its expected amount. This uncertainty, which is the predominant method utilized in this study to quantify reliability, has been modeled.
- Incidental water naturally percolates in to the aquifer at the average rate of 60,000 acre-feet annually. Substantial variance from this amount has been observed in the past decade that corresponds with wet and dry years. Since the area is predominantly built out, this same relationship is expected to continue in the future. This uncertainty has been modeled.
- Recycled water for direct irrigation or groundwater recharge is regulated by the capacity to process incoming recycled water. It is highly reliable because the source is local recycled water and the amount available is certain because it is capacity constrained by the current and projected infrastructure. It has been held constant throughout the study period.
- Existing conservation measures have reduced use by about 10,000 acre-feet. As noted, conservation has not been accounted for as a supply source, since assumptions regarding the

[22] MWD exclusively owns 1,036,000 acre-feet or 338 billion gallons of surface storage capacity. Its member agencies own an additional 736,700 acre-feet.

impact of active and passive conservations measures have been accounted for in OCWD water demand projections.

- Santa Ana River water captured and recharged represents roughly 40% of current water supply. These yields were developed by hydrologic and hydraulic engineers based in historical weather patterns and prevailing conditions in either 2026 or 2075. The yields were provided in a 39-year series but the starting point in the series is randomly selected for the economic modeling. This random selection is repeated several thousand times to generate results. Thus year-to-year dependencies are retained while still accounting for uncertainty in the amount available in any given year.

Since our modeling has shown that demand will continue to exceed local supply sources under all reasonable ranges of uncertainty and projections for reliability, the order of precedence for local sources does not affect the economic benefits or local supply deficits. Furthermore, the additional SAR yield from reoperating Prado Dam does not exceed 13,000 acre-feet in any given year and averages about 6,300 acre-feet under Base Year conditions, which is a small fraction of total imports. Thus, from the perspective of economic benefits reliability only meaningfully affects results when applied to MWD imports. Hypothetically, if MWD imports are unable to reliably meet the remaining demand, then alternative sources (desalination, additional conservation, and additional recycling) would, which is specifically addressed by several scenario analyses later in this report.

3.3 Project Benefits for Water Conservation

3.3.1 Method

To determine water conservation benefits, all water supplies were modeled with and without re-operating Prado Basin. Any reduction in the cost of those water supplies under with project conditions are the project benefits. Since re-operating Prado Basin to increase Santa Ana River groundwater recharge must displace another water source in equal measure, the benefits for water conservation come from displacing another source of water that has a higher opportunity cost (price). Conceptually, in the absence of water pricing at marginal cost "…the benefits from a water supply plan are measured instead by the resource cost of the alternative most likely to be implemented in the absence of that plan."[23] The most likely water source to be utilized in the absence of re-operating Prado Basin to increase SAR groundwater is treated, uninterruptable imported water. This water has similar quality and arguably greater reliability than recharged and extracted Santa Ana River water. The Department of Engineering and Local Resources at OCWD has also indicated this is the only water supply source that would be displaced by additional SAR groundwater. Conceptually, this is a reasonable expectation. Imported treated water accounts for approximately 60,000 acre-feet annually and is expected to grow over time. The project alternative being studied could result in up to 13,000 additional acre-feet of water being recharged on any given year but on average approximately 6,300 acre-feet would be recharged annually under Base Year conditions, which would displace only a small portion of the treated water imported annually. Modeling all water sources and demand with uncertainty confirms that SAR yields would only displace treated, uninterruptible water imports under nearly all predicted outcomes.[24] In the highly unlikely scenario that treated water does not need to be imported at any time throughout the year due to the consistent confluence of unusually low demand and significantly above normal local water supplies, untreated rather than treated water imports

[23] ER 1105-2-100, E-203

[24] This statement is based on findings from the water conservation modeling using Monte Carlo simulation. In this way different water sources are allowed to vary above and below normal levels to create thousands of possible combinations. Results show conclusively that treated imported water will always be needed every year of the study period under all but a small number of possible outcomes.

become displaced by SAR groundwater in the model. In this manner all realistic possibilities for SAR groundwater to displace supply sources have been accounted for when calculating with and without project supply costs.

The cost per acre-foot for treated uninterruptible water is currently $1,077 and is expected to maintain this cost in current dollars throughout the study period. The components of this cost are shown in Table 3.3-1 and taken directly from OCWD's publically available *Engineer's Report*.

Table 3.3-1 Imported Non-Interruptible Treated Water Cost Components 2017

Firm Deliveries	Imported Uninterruptable Treated Water
MWD Supply Rate (MWDOC Melded Rate)	205.00
MWD System Access Rate	294.00
MWD System Power Rate	128.00
MWD Water Stewardship Rate	53.50
MWD Treatment Surcharge	316.50
MWD RTS and Capacity Charges[2]	80.00
Total	1,077.00

Since OCWD has a large groundwater basin, deficit pumping was also evaluated to determine if such activity should alter how water supplies are utilized and ultimately how project benefits are calculated. OCWD's basin management objective is to operate the groundwater basin within no more than a cumulative deficit of 500,000 acre-feet. Thus, OCWD has the ability to allow pumping beyond the sustainable annual level in a dry year to defer some import costs but in practice there are several constraints. Over-pumping in the past has led to salt water intrusion and has raised groundwater extraction costs among other problems. As a result today OCWD generally balances extraction and recharge rates through a basin equity assessment that more than triples the price to pump groundwater in the study area.[25] This discourages over pumping by municipalities and provides funds for OCWD to purchase water to recharge the basin. Recently OCWD has been reducing the cumulative groundwater deficit. In addition to these constraints on deficit pumping and a pattern of sustainable pumping in practice, the fact that deficit pumping defers costs only in the near-term tends to marginalize any overall cost savings. Finally, since demand has been consistently greater than local supplies and this is expected to grow in the future, deficit pumping would need to exceed approximately 90,000 acre-feet on average early in the study period and substantially more later before groundwater pumping could displace imported water as the most likely alternative source for calculating benefits. Such an occurrence seems highly unlikely. Therefore, benefits were determined assuming that deficit pumping does not occur. This is a simplification for modeling purposes that almost certainly has no impact on the calculation of benefits for the reasons given above.

In addition to stochastic modeling for local water supplies and costs, water conservation benefits were evaluated under several scenarios to account for uncertainty meeting local water supply deficits during the fifty-year study period. The most likely scenario is that the current source for meeting these local supply deficits will continue to be available throughout the study period. That source is treated water provided by MWD of Southern California, which has concluded through its own analysis that all water delivery obligations to member agencies including those in the study area can be met even under multiple

[25] This assessment more than triples the average energy and infrastructure costs to pump groundwater from $202 per acre-foot to a total cost with replenishment fee of $647, which is 3.2 times the average extraction only cost in the study area. The fee is determined by a formula to compensate for historical over pumping so it increases when deficit pumping increases, further dampening demand.

periods of drought. However, MWD does not have reliability projections beyond 2035 and the study period continues beyond 2070. Due to this mismatch uncertainty in MWD imports was evaluated under a most likely scenario where MWD is able to meet all local supply deficits and three reliability scenarios that incorporate alternative sources if MWD imports can no longer consistently meet local deficits beyond 2035.

3.3.2 Results under Most Likely Scenario

The most likely scenario is that MWD imports continue to meet all local supply deficits throughout the study period. Implicitly, in this scenario additional SAR groundwater recharge is displacing treated, uninterruptable water imports from MWD. The reliability report produced by MWD concludes it can meet all water deliveries to the study area under a multi-period drought scenario through 2035, which is the final year projections were made. As previously discussed and elaborated upon, the most likely outcome is that MWD imports will continue to be available to meet all local supply deficits in beyond 2035 until the final year of the study period, 2075. Equivalent annual water conservation benefit for the most likely scenario is $7.08 million. The table below displays with and without project water supply costs in the base year and future year, and project benefits, which is the difference.

Table 3.3-2 Project Benefits under the Most Likely Scenario ($1,000s) FY 2017 Price Levels, 2.875% Discount Rate

	Expected Value – Base Year	Expected Value – Future Year	Equivalent Annual Value
Without Reoperation Supply Cost	$260,882	$307,305	$278,680
With Reoperation Supply Cost	$255,660	$297,238	$271,600
Project Benefits	$5,222	$10,067	$7,080

3.3.3 Results under Reliability Scenarios

Since the reliability of imported water could not be established conclusively after 2035 due to a lack of analysis carried out beyond this period, several separate reliability scenarios were established. Implicitly, in these scenarios additional SAR groundwater recharge is displacing treated imports until 2035 and the alternative sources in whole or in part beyond 2035. Utilizing these alternative sources is a potential but less likely outcomes beyond 2035 compared with relying solely on MWD treated water in the most likely scenario above. The alternative supply sources are desalination, additional recycling, and additional conservation. Additional conservation is the only short-term source available because desalination and recycling require additional planning, permitting, and infrastructure. Once operational, desalination and recycling facilities would be in use regardless of any short-term demand and supply fluctuations. Determining when a short-term supply gap becomes a longer-term deficit that triggers construction of these facilities is beyond the scope of this study. Instead the approach taken is to address uncertainty beyond 2035 by allowing the shortfall in imports to be filled with a combination of these alternative sources. What these scenarios show is how benefits change with different percentages of import shortfalls and different shares of the three alternatives sources meeting those shortfalls.

To account for uncertainty beyond 2035, three reliability scenarios were developed using alternative water supply sources. In all scenarios the local supply deficit is met by MWD imports until 2035. The first reliability scenario assumes that MWD can meet half of the local supply deficit in the study area beyond 2035 and the other half is met through 20% mandated conservation measures, 40% desalination, and 40%

additional recycling. The second scenario projects that beyond 2035 the entire local supply deficit is met through these alternatives sources with the same percentages as the first scenario. The third scenario projects that beyond 2035 the entire local supply deficit is met through 20% mandatory conservation and 80% desalination.

Table 3.3-3 Project Benefits under Reliability Scenarios ($1,000s) FY 2017 Price Levels, 2.875% Discount Rate

Scenario	Annual Expected Benefit – Base Year	Annual Expected Benefit – Future Year	Equivalent Annual Benefit
Expected Value	$5,222	$10,067	$7,080
Scenario 1	$6,869	$13,242	$9,312
Scenario 2	$8,517	$16,419	$11,546
Scenario 3	$9,658	$18,620	$13,094

3.3.4 Incidental Ecosystem/Habitat Benefits

Section 4.0 describes the results of the ecosystem restoration analysis, including an assessment of without project habitat values and increases in habitat values for various ecosystem restoration measures and alternatives. An evaluation was also conducted to determine the impacts on habitat values within the Study Area with implementation of the water conservation alternative. This analysis showed that implementation of the 505' water conservation alternative results in substantial habitat benefits. The increase in average annual habitat units over the period of analysis was estimated 6,219. These benefits are an incidental byproduct of the water conservation alternative. It should also be noted that the benefits are even higher if the water conservation alternative is implemented in conjunction with certain ecosystem restoration measures (specifically, a sediment management system on the Santa Ana River upstream and downstream of Prado Dam). If combined with an ecosystem restoration plan that includes the sediment management system measure, water conservation is expected to generate 8,208 average annual habitat units.

3.4 Project Costs for Water Conservation

3.4.1 Environmental Impacts

Implementing water conservation would require mitigation for environmental impacts, in the absence of an ecosystem restoration plan. Please refer to the Main Report for detailed summary of impacts and costs. The total first cost for mitigation features were estimated at $2.7 million at FY 2017 price levels. Average annual costs, including interest during construction and operation and maintenance costs, were estimated at $124,100 at a discount rate of 2.875%. These costs are included in the separable benefit/cost analysis for water conservation.

As will be described later in this report, ecosystem restoration plans in the vicinity of Prado Basin that include a sediment management system will mitigate for any impacts from allowing Prado Basin water levels up to 505 feet year round as opposed to during the non-flood season only. Thus, no additional mitigation cost would be incurred from dam reoperation if implemented in conjunction with an ecosystem restoration plan that includes a sediment management system.

3.4.2 Operation and Maintenance

Additional operations and maintenance (O&M) costs to Prado Dam and basin from reoperation were evaluated and estimated. The O&M costs include:

- Periodic Inspections - engineering inspection of the integrity of the dam and equipment within; occurring every five years
- Surveying - surveys performed every five years in conjunction with period inspections to monitor settlement of the dam
- Dam Tenders - USCOE dam operators
- Maintenance - annual maintenance due to water conservation such as mowing or vegetation removal
- Engineering - time spent by the reservoir operation section on operation of the reservoir, specifically gate change schedules
- Equipment Rentals - additional equipment needed, such as pressure washers and crane scissors lifts, due to water conservation to accomplish necessary maintenance
- Dump Fees - fees necessary to disposal of material collected during necessary maintenance

Table 3.4-1 Operation and Maintenence Cost for Reoperation

O&M Category	Impact	Additional Cost annually
Periodic Inspections	N/A	N/A
Surveying	N/A	N/A
Dam Tenders	N/A	N/A
Maintenance	10 employees at $7,000 per day for 10 additional days annually	$70,000
Engineering	Additional Reservoir Operations coordination with Orange County Water District, Dam Tenders, other Agencies, and Public, some cases daily or hourly contact depending on water and weather, extra 0.5 hours on average during flood season (60 workdays *0.5 hrs * $100/hr)	$3,000
Equipment Rentals	SARI line drain, manhole inspection, drain pool down to lower elevation	$30,000
Dump Fees	No dump fees, chip/mulch in downstream area.	N/A
Total per year (avg)		**$103,000**

The additional costs from reoperation (with project conditions) include maintenance, engineering, and equipment rental costs as described in the table above. Total additional annual O&M costs are expected to be approximately $103,000.

3.4.3 Flood Risk

3.4.3.1 Prado Basin Inventory

There are a number of businesses operating within or near Prado Basin. Most would be impacted by water elevations above 520 feet. Hydrologic analysis showed that reoperation of Prado Dam would have a negligible effect on the duration of flooding at elevations above 520 feet. Most of the business identified in the basin operate above 520 feet and therefore would not be impacted. The businesses identified in the basin are listed below along with an explanation of whether there would be impacts.

Based on aerial mapping and visual inspection the Corona Municipal Airport facilities become partially inundated by water elevations of 520 feet. Damages above 520 feet of elevation could be substantial and may involve cleanup costs to the runway and about half of the facilities, primarily hangers. Since analysis

has shown there would be no added flood risk above 520 feet and the airport authorities would undertake measures to limit damages when the basin level is near 520 feet such as relocating airplanes to the higher portions of the airport, emptying lower-lying hangers, and employing sand bags or other temporary measures, there would be no material change in flood risks to the airport.

Prado Olympic Shooting Park would be inundated at 515 feet elevation and above. Next door is Oranco Bowman Archery Range, which would also need to temporarily close at elevations of 515 feet and above.

Prado Airpark is a model airplane park with a few small structures and one runway. Inundation occurs to the runway only at 540 feet of elevation and above. Since this is above 520 feet, the airpark has been left out of the analysis.

Firearms Training Associates would most likely experience full closure when flood levels reach 525 feet elevation but no impacts below 525 feet of elevation. Thus, it would not be impacted.

SC Village Paintball Park would experience at least partial closure at approximately 520 feet of elevation and full closure by 530 feet. Thus, it would not be impacted.

Riverside Flyaway Foundation was identified in the 2005 feasibility study. It operated recreation and hunting activities below 520 feet at that time but no longer operates today.

El Prado Golf Course would have minor inundation to 1-2 holes at 520 feet elevation, 2-3 holes at 525 feet, 5-7 holes at 530 feet, and major inundation to 8-10 holes at 540 feet. However, since damages occur starting at 520 feet, there is no additional flood risk.

Prado Recreation Dog Park, formerly Richardson's Dog Training, provides dog training, competition, boarding, and a substantial dog park. The facility logs about 20,000 visitor-days of use annually. The facility operates under a concession agreement with the Corps of Engineers' lessee, San Bernardino County. The facility leases approximately 535 acres, of which 269 acres are in active use. The facility is situated in the central northwestern portion of the Basin southeast of Euclid Avenue, at elevations ranging from 490 feet to 504 feet. The dog boarding facilities are located at approximately elevation 554 feet and are well above the seasonal pool and not impacted by conservation measures. The field area is situated at a lower elevation and approximately 103 acres, or 74 percent of the area, is inundated by the current conservation pool. Most of the land used for the dog park is inundated at the impoundment elevation 505 feet and would experience additional flood risk. The access road to the dog kennel was relocated in 1988 on a new alignment above elevation 516 feet and most likely would most not experience additional flood risk. According to San Bernardino County, this concession operates year round, and current water conservation operations impact some dog training activities. It is partially inundated with restricted road access when elevations reach about 510 feet and fully nonoperational at 530 feet and above.

Recreation values have not been applied for Prado Recreation Dog Park; however, because it is believed that lost recreation use at this location would be made up at alternative locations or later dates. Therefore, no economic loss from lost use is assigned to this operation.

Commuters using River Road Bridge would experience travel delays from inundation at 530 feet and above. Thus, the additional impacts would be negligible and do not warrant further analysis.

Raahauge Shooting Enterprises consists of public upland fowl hunting, a sports clays operation, and other facilities for firearms practice and training. Most facilities are located north of the water quality enhancement ponds in the northern portions of the Prado Basin at elevations above 520 feet. Its clubhouse is situated at 611 feet. OCWD leases the property to Raahauge in a renewable agreement. The operation includes duck hunting at elevations from 495 to 515 feet and pheasant hunting above elevation

520 feet. Annual visitation for pheasant hunting is about 5,000 visitor-days and 900 visitor-days for duck hunting.

3.4.3.2 Recreation Loss

Damage functions estimate the percent of use lost when water surface elevation is at the midpoint of each elevation increment. These functions depend on the information provided by the businesses and topographic information from aerial imagery and mapping.

Table 3.4-2 shows the share of use lost at selected elevations and recreation value per user-day, which is based on the current daily price for duck and pheasant hunting at this business--$100.[26] The estimated total amount of use in a year without any high water was estimated from information provided by the businesses for the 2004 Prado Basin Feasibility Study because the affected businesses and areas have not changed substantively since then. In addition to hunting each operation offers wildlife viewing and socializing and there are no other bird hunting or similar outdoor facilities elsewhere in the vicinity. Thus, minimal transfers are likely to occur. The inundation-duration, share of recreation disrupted, value of lost recreation, and use data are used to estimate the recreation losses. Recreation user-days was held constant throughout the study period because there is no objective basis to raise them and, if they were raised, the result would be immaterial to this study.

[26] ER 1105-2-100 Appendix E: Benefits for projects (or project features) that increase supply are measured as the willingness to pay for each increment of supply. Benefits for projects (or project features) that alter willingness to pay (e.g., through quality changes) are measured as the difference between the without and with project willingness to pay. Willingness to pay includes entry and use fees actually paid for site use plus any unpaid value (surplus) enjoyed by consumers.

Table 3.4-2 Percent Recreation Loss at Various Impoundment Levels in Prado Basin[27]

	Measurable Difference to Flood Risk from Reoperation					NO Measurable Difference to Flood Risk			
Elevation	494	498	505	510		520	530	user days	UDV
Transportation Infrastructure					limit for evaluation				
Corona Municipal Airport						modest	major	n/a	n/a
River Road Bridge							major	n/a	n/a
Recreation-centered Businesses									
El Prado Golf Course						20%	50%	n/a	n/a
Prado Olympic Shooting Park						80%	100%	n/a	n/a
Oranco Bowman Archery Range						80%	100%	n/a	n/a
Prado Airpark								n/a	n/a
Firearms Training Associates							100%	n/a	n/a
SC Village Paintball Park						50%	100%	n/a	n/a
Prado Recreation Dog Park				30%		40%	100%	19,600	n/a[28]
Raahauge, duck hunting	15%	25%	35%	55%		85%	100%	850	$100[29]
Raahauge, pheasant hunting						90%	100%	5,000	$100

The inundation-duration data from the hydrologic analysis is provided for the present and future conditions. From this information and the percent of use lost at each elevation (shown for selected elevations in Table 3.4-2), the daily recreation loss by water elevation can be calculated. The daily recreation loss by user is adjusted by the probability of its respective frequency event shown in Table 3.4-3. For instance, a 2-year frequency event has a 50% probability of occurring in any given year; therefore, at elevation 490 there would be 25 days of additional duration with a 50% chance of occurring. Multiplying 25 days by 50% gives the expected days of duration—12.5. This is done for all the durations given in Table 3.4-3 and combined with the recreation value, user-days, and share lost by elevation in Table 3.4-2.

Table 3.4-2 shows that in the future year the number of days of inundation decreases because upstream inflow is lower. Lower future year inflow results from conservation and recycling measures that are expected to be taken by upstream communities that currently release treated waste water into the river.

[27] Additional duration at elevations 520 feet and above found to be essentially zero. Share of recreation disrupted at each elevation assumed to be the same as determined in the 2005 Feasibility Study

[28] No recreation loss expected because dog owners are able to use alternate recreation sites or simply defer recreation.

[29] Based on the advertised price for one day of duck or pheasant hunting on the property. Actual willingness to pay is unknown but would be at least this much.

Table 3.4-3 Additional Days of Inundation at Prado Basin

	BASE YEAR							FUTURE YEAR					
Frequency	490	*494*	*498*	500	*505*	*510*		490	*494*	*498*	500	*505*	*510*
2	25	*5*	*5*	5	*0*	*0*		0	*1*	*7*	25	*8*	*0*
5	15	*60*	*55*	45	*5*	*0*		10	*10*	*5*	5	*3*	*0*
10	5	*10*	*10*	35	*5*	*0*		-5	*0*	*0*	10	*-6*	*0*
25	0	*0*	*5*	15	*10*	*3*		-5	*0*	*0*	5	*-1*	*0*
50	25	*25*	*20*	35	*20*	*4*		15	*15*	*25*	30	*3*	*0*
100	30	*45*	*50*	60	*15*	*10*		15	*15*	*55*	60	*40*	*7*

The result of those calculations is shown in Table 3.4-4. The results confirm there is little recreation loss from inundation below 495 feet because the hunting areas are only partially impacted. The additional impacts increase from 498 to 500 feet as more recreation is disrupted; however, after 500 feet the additional impacts quickly fall off because the additional days of inundation drop and when inundation does occur it's only from much rarer events.

Table 3.4-4 Expected Annual Recreation Loss – Duck Hunting (FY 2017 Price Levels, 2.875% Discount Rate)

Expected Annual Recreation Losses by Elevation	*490*	*494*	*498*	*500*	*505*	*510*
Base Year	$-	$ 575	$908	$1,063	$200	$38
Future Year	$-	$103	$323	$1,000	$360	$9

By linearly interpolating between the future and base year expected values and discounting, the average annual recreation loss is $2,400 when rounded.

3.4.3.3 Cleanup and Repair

While damage requiring cleanup and repair would occur to many businesses when water elevations approach or exceed 520 feet of elevation, hydrologic analysis showed that reoperation of Prado Dam would have a negligible effect on the duration of flooding at elevations of 520 feet and above. Thus, reoperation is not expected to cause additional expected damages to most businesses. However, Raahauge Shooting Enterprises and the Prado Recreation Dog Park have operations below 520 feet of elevation and would be negatively impacted as described in the previous section on recreation losses. Raahauge Shooting Enterprises maintains ponds with pathways and open fields for duck hunting. Prado Recreation Dog Park maintains open fields with trails for recreating.

Table 3.4-5 Inundation Area by Elevation (acres)

Elevation	500	505	510
Prado Recreation Dog Park	4	12	14
Raahauge Shooting Enterprises	11.8	24.2	36

Analysis of cleanup and repair cost performed for the 2005 study was validated by analyzing inundation layers and aerial imagery generated for the current study. Table 3.4-5 presents the estimated number of acres impacted when water levels reach elevations from 500 to 510 feet. The 2005 study determined that impacts would begin to occur once inundation reached approximately 500 feet of elevation, which is consistent with the current findings. Inundation above 510 feet is not included in damage estimates because there is essentially no additional flood risk from reoperation at 520 feet and above (see

explanation in previous section). Since the two businesses operating in this range of elevations have not substantively altered operations or infrastructure after the 2005 study was concluded and impacted areas have been validated, previous damage estimates were inflated to the current price level using the construction price index from EM 1110-2-1304 to be applied in this study. Results are presented below.

Table 3.4-6 Cleanup & Repair from Inundation at Several Elevations

Elevation	500ft	505ft	510ft
Prado Recreation Dog Park	$14,600	$20,750	$26,900
Raahauge Shooting Enterprises, duck hunting	$2,600	$15,550	$28,500

Increased expected annual damages were estimated based upon increased probabilities of inundation at the different elevations between 500 feet to 510 feet, consistent with the methodology applied in the 2005 study. The results are shown below. As shown, increases in expected annual cleanup and repair costs are minimal (approximately $1,900).

Table 3.4-7 Expected and Average Annual Cleanup & Repair Costs (FY 2017 Price Levels, 2.875% Discount Rate)

	Base Year	Future Year	Average Annual Damage
Prado Recreation Dog Park	$ 1,311	$ 1,894	$ 1,518
Raahauge Shooting Enterprises	$ 291	$ 728	$ 428
Total	$ 1,602	$ 2,622	$ 1,946

3.4.3.4 Downstream Flood Risk

According to hydrologic and hydraulic engineering analysis, the probability of flooding downstream of Prado Dam would not increase for the larger releases that could cause damage. The damage threshold for flooding was determined by evaluating current flood inundation mapping and aerial photography for the three significant downstream developments—Green River Golf Club, Canyon RV Park, and River View Golf Club. Each would begin to sustain flood damages from flows greater than 5-8,000 cfs. This threshold accounts for recent construction to reduce flood risks downstream of Prado Dam by the US Army Corps of Engineers in the area referred to as SARM Reach 9 Phase 2A. The current Prado Dam operation is to keep water level at 498 feet during the flood season and raised to elevation 505 feet for the non-flood season. The project alternative is a maximum water storage level of 505 feet year round. This would increase the potential storage in support of water conservation from approximately 9,300 acre-feet to approximately 19,800 acre-feet, an increase of approximately 10,500 acre-feet. Note that this increase is less than 3% of the total spillway crest capacity of 351,700 acre-feet.

Whenever there is a forecast of inclement weather, the reservoir will be drawn down to make space for the anticipated inflow volume, ensuring there is always adequate storage available for flood control operations. It would take approximately 2 days to release 10,500 acre-feet at a maximum of flow rate of 5000 cfs. This additional release time would have negligible and insignificant impact downstream. Thus, there is no additional downstream flood risk.

3.4.4 Summary of Project Costs

Table 3.4-8 summarizes the project costs identified and analyzed for this study. The largest cost categories are Environmental Mitigation for sedimentation impacts and Operation and Maintenance with average

annual damages/costs of $124,100 and $103,000, respectively. The other economic costs are relatively minor.

Table 3.4-8 Cost Summary for Reoperation (FY 2017 Price Levels, 2.875% Discount Rate)

Damage/Cost Category	Average Annual Damage
Environmental Sediment Mitigation	$124,100
Operation and Maintenance	$103,000
Flood Risk	
Recreation Loss	$2,400
Cleanup & Repair	$1,900
Total	**$231,400**

3.5 Project Net Benefits for Water Conservation

3.5.1 Most Likely Scenario & Reliability Scenarios

The most likely scenario is that MWD imports continue to meet all local supply deficits throughout the study period. Equivalent annual water conservation benefits for the most likely scenario are $7.08 million. To account for uncertainty in MWD imports beyond 2035, three reliability scenarios were developed using alternative water supply sources. In all scenarios the local supply deficit is met by MWD imports until 2035. *Reliability Scenario 1* assumes that MWD can meet half of the local supply deficit in the study area beyond 2035 and the other half is met through 20% mandated conservation measures, 40% desalination, and 40% additional recycling. *Scenario 2* projects that beyond 2035 the entire local supply deficit is met through these alternatives sources with the same percentages as the first scenario. *Scenario 3* projects that beyond 2035 the entire local supply deficit is met through 20% mandatory conservation and 80% desalination. The table below displays project benefits, costs, net benefits, and benefit-to-cost ratios. Net benefits are positive under all reliability scenarios. Thus, the conclusion that investment in this water conservation project is economically justified remains valid under a range of scenarios that address how local supply deficits are met and how project benefits are calculated.

Table 3.5-1 Net Benefits under Most Likely Benefit Scenario & Alternative Benefit Scenarios ($1,000s) FY 2017 Price Levels

	Most Likely	Scenario 1	Scenario 2	Scenario 3
Equivalent Annual Benefits	$7,080	$9,312	$11,546	$13,094
Equivalent Annual Costs	$231	$231	$231	$231
Net Benefits	$6,848	$9,081	$11,315	$12,863
Benefit/Cost Ratio	30.6	40.2	49.9	56.6

3.6 Water Conservation Modeling Parameters

Table 3.6-1 Water Conservation Modeling Parameters

Water Supply Source	Cost[30]	Cost Distribution: N(μ,σ)	Supply with Uncertainty Range	Dependency
Surface	$316.50	$316.50 , 5%	10,000 ac-ft, -5%/+25% (Dry yr: μ-5%, μ+ 25%) (Non-Dry yr: μ +/-5%)	Weather: up to 25% above mean during dry yrs, +/-5% during non dry yrs
Incidental	$202	$202 , 5%	60,000 ac-ft, +/-60% (Dry yr: μ, μ - 60%) (Wet yr: μ, μ + 60%)	Weather: up to 60% below mean during dry yrs, up to 60% above during wet yrs
SAR Yield	$202	$202 , 5%	random selection of sequence	n/a
Recycled/Replenished	$850	$850 , 5%	117,000 ac-ft, fixed	Independent
Untreated Imported MWD Water	$594	$594 , 5%	18,000 ac-ft, +/-25% (Dry yr: zero value) (Non-Dry yr: μ +/-25%)	Weather: not available during dry yrs, 25% variability during non dry yrs
MWD Treated Imports	$1,077	$1,077 , 5%	local supply gap	Reliability; evaluated through scenarios
Desalination	$2,290	$2290 , 5%	local supply gap	Reliability; evaluated through scenarios
Additional Recycling	$1,650	$1,650 , 5%	local supply gap	Reliability; evaluated through scenarios
Additional Conservation	$1,200	$1200 , 5%	local supply gap	Reliability; evaluated through scenarios

[30] Cost to bring water supply sources to comparable quality to groundwater

4 Ecosystem Restoration Analysis

4.1 Procedure

The procedure for ecosystem restoration analysis is the same as other project purposes: 1. Identify Problems and Opportunities; 2. Inventory and Forecast; 3. Formulate Alternative Plans; 4. Evaluate Effects of Alternative Plans; 5. Compare Alternative Plans; and 6. Plan Selection.

See Section 1.2.1 for an outline of the study problems and opportunities, which are further defined and elaborated in the Main Report. The economic analysis is described starting with the inventory and forecast of without-project conditions and concluding with a comparison of alternatives that constitute the final array. Plan selection for ecosystem restoration purposes, which involves considerations of quantitative and qualitative tradeoffs among cost effective/efficient plans, is not addressed in this appendix. Instead, metrics useful for plan selection such as total cost, total acres, total habitat units (HU), average & incremental cost per HU, and cost per acre are provided to aid in selection of the tentatively selected plan.

4.2 Inventory and Forecast

The habitat restoration outputs for without project conditions and proposed management measures were forecasted over the period of analysis using the Combined Habitat Assessment Protocols (CHAP) model. Please refer to the Main Report for a detailed description of the management measures formulated to address ecosystem restoration objectives, as well as the CHAP model and model results. Base, year 5, year 25, and year 50 forecasts were developed for with and without project conditions habit units. The change in habitat units across these years as well as average habitat value, which is calculated by linear interpolation between the four forecast years, is shown in the table below. Average annual costs, which include construction, adaptive management, and operation & maintenance are also shown.

Table 4.2-1 Ecosystem Restoration Measures, Costs and Output (FY 2017 Price Levels, 2.875% Discount Rate)

Measure Name	First Cost ($1,000s)	AAC ($1,000s)	Base Year HUs	Year 5 HUs	Year 25 HUs	Year 50 HUs	AAHUs
SARM Upstream Measures							
Upstream sediment management system	$75,006,895	$7,836,008	754	6,034	11,732	13,810	10,278
Invasive plant management	$5,544,814	$558,989	6,095	15,707	27,150	31,976	24,443
Riparian edge management	$1,675,095	$84,969	-170	619	1,185	1,411	1,032
Instream habitat features	$3,593,347	$139,066	207	217	138	138	161
Non-native aquatics management	$749,240	$110,510	508	475	301	395	378
Native plantings	$1,614,776	$79,931	94	467	642	763	601
SARM Downstream Measures							
Instream habitat features	$6,028,326	$231,762	2,065	6,754	11,089	13,320	10,111
Invasive plant management	$3,509,249	$185,065	2,796	5,274	7,907	8,566	7,158
Non-native aquatics management	$899,088	$132,611	212	164	154	342	206
Chino Creek Measures							
Invasive plant management	$1,985,710	$282,558	513	1,048	1,591	1,483	1,374
Raise existing invert and cut new channel	$7,214,093	$331,000	1,088	1,798	2,595	2,799	2,371
Raise existing invert and encourage braided channels	$7,106,309	$326,856	794	1,737	2,528	2,820	2,317
Instream habitat features	$572,184	$30,651	4	4	2	2	3
Non-native aquatics management	$524,468	$77,357	26	26	25	24	25
Native plantings	$2,855,695	$127,979	699	1,011	1,253	1,350	1,189
Mill Creek Measures							
Invasive plant management	$1,686,427	$86,778	523	999	1,389	1,586	1,298
Non-native aquatics management	$374,620	$55,255	36	36	35	34	35
Native plantings	$769,939	$38,101	58	219	292	296	263
SARM Upstream, Chino Creek & Mill Creek - Measures							
Feral pigs management	$1,695,146	$250,026	349	322	278	246	285
Cowbird trapping	$1,489,115	$219,638	117	108	94	93	98

- Average Annual Costs include Interest During Construction and O&M costs for each measure.

4.3 Formulation of Alternative Plans

Plan formulation requires formulation of alternatives from management measures by focal area, which are referred to as features. The three steps to this process are: 1) identify outputs and costs of each feature; 2) identify management measure relationships; and 3) add costs and outputs of combinations. To accomplish these steps each feature is separately assessed for habitat output then assessed for combinability with other features, dependency on other features, and synergy from combining features. When two or more management measures are dependent, that relationship entered into IWR Plan and retained in plan formulation. When management measures are not combinable, that relationship is specified in IWR Plan. In this manner only mutually exclusive and independent alternatives are formulated, which is a requirement of plan formulation.[31] These criteria were entered in to IWR Plan to establish all possible combinations of features and associated habitat outputs and costs. These combinations established by the criteria entered in to IWR Plan become the alternative plans. Dependency, combinability, and synergy have been developed by biologists and retained in the environmental appendix. See that source for additional details on determining habitat outputs and establishing relationships among features. The table below shows the dependencies and non-combinable measures.

[31] IWR 95-R-1 page 29

Although the CEICA analysis was focused on identifying best buy ecosystem restoration plans, implementation of the proposed water conservation plan of reoperating the dam at a target elevation of 505' year round for water conservation purposes is anticipated to provide substantial positive ecosystem restoration outputs. Restoration benefits associated with water conservation were not included in the CEICA, since there are no specific restoration related costs associated with the water conservation alternative. The restoration benefits associated with water conservation increase if implemented in conjunction with the Sediment Management System along the Santa Ana River Mainstem relative to the benefits achieved with implementation of water conservation as a stand-alone plan.

Table 4.3-1 CEICA Combinabilities & Dependencies

Solution	Not Combinable with:		Solution	Dependent on:
Raise Invert & New Cut Channel	Raise invert & Braided Channel		Riparian Edge Mgmt	SARM Sediment Management System
			Instream Habitat Features (upstream & downstream SARM)	SARM Sediment Management System

The CEICA analysis was performed in a three step process because the number of features, 20, exceeded the number of the computational capabilities of IWR Plan. To get around this limitation CEICA analysis was first performed on the features located in SARM upstream and downstream. A CEICA model was then run for features within Chino and Mill Creek. Chino/Mill Creek did not contain any measures with dependencies. This kept all measures with dependencies and the corresponding dependent measures within the SARM grouping. Non-combinable measure pairings also did not extend beyond either SARM or Chino/Mill Creek ensuring that all non-combinable measures are accounted for.

The Best Buy Plans resulting from the CEICA analyses for Chino/Mill Creek and SARM (upstream and downstream) were then evaluated in a third CEICA analysis to determine the overall Best Buy Plans for the study area. This method allowed the IWR Planning Suite programming limitations to be overcome while still being able to identify cost effective and efficient plans for the overall study area as described in the next section.

4.4 Evaluation of Alternative Plans

4.4.1 Cost Effectiveness and Efficiency

Once IWR Plan combines measures to formulate possible plans, these plans are then evaluated for cost effectiveness. The criterion for cost effectiveness ensures that for a given level of ecosystem output (habitat units) only the alternative that costs the least remains. In addition, to meet efficiency criterion no alternative that costs more for less output remains or, put another way, only alternatives that can produce more habitat units for the same or less cost remain. The end result is only cost effective and efficient alternatives are retained for the next step of analysis. The next two figures show the cost effective plans resulting from the CEICA runs for SARM as well as for Chino/Mill Creeks.

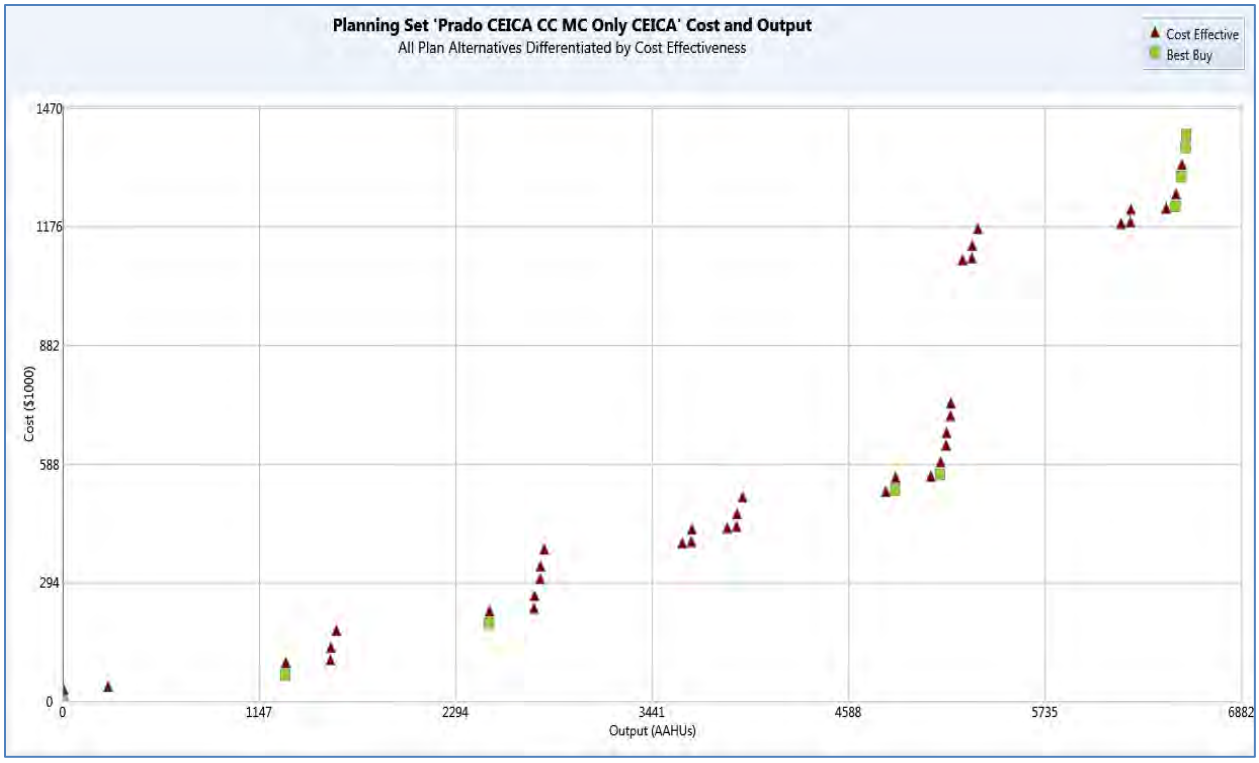

Figure 6 Chino and Mill Creek Cost Effective and Efficient Plans

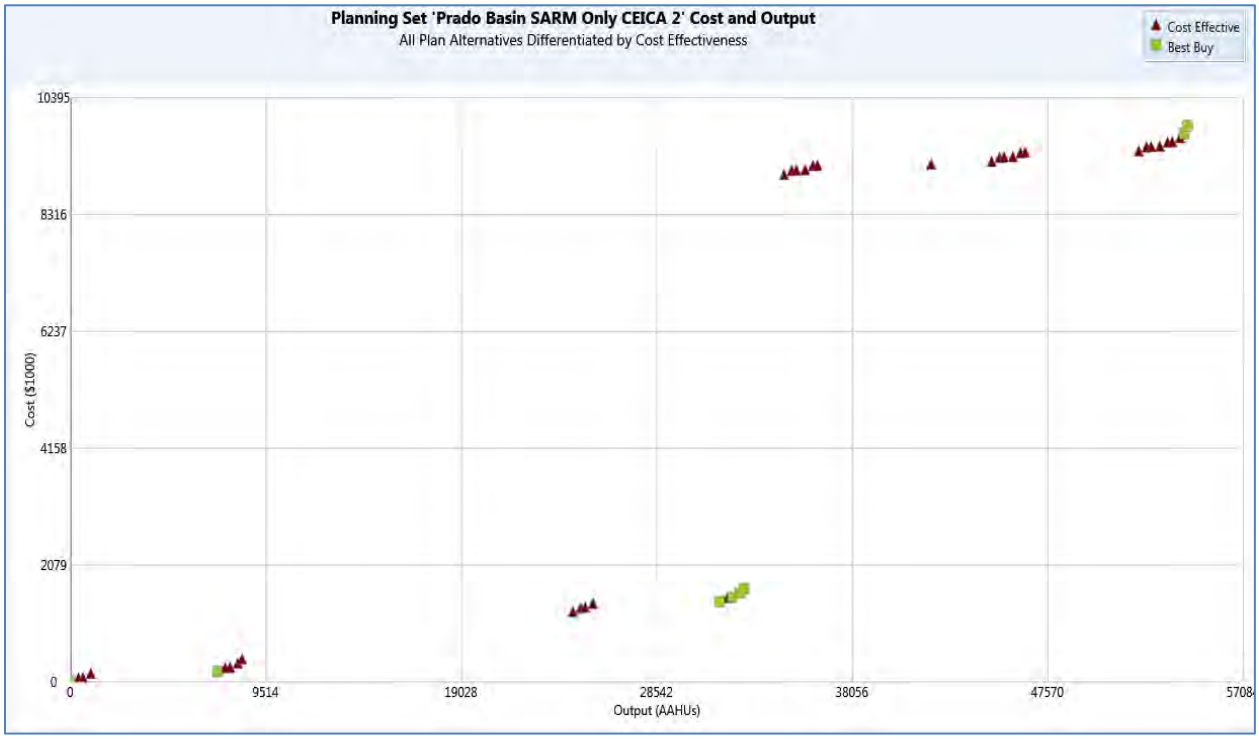

Figure 7 SARM Cost Effective and Efficient Plans

4.5 Comparison of Alternative Plans

4.5.1 Incremental Cost Analysis

At this stage only cost effective plans were evaluated further. Irregular, non-continuously increasing cost changes were removed by first identifying the lowest average cost alternative. The remaining alternatives were evaluated for the lowest average cost for additional output, which are alternatives that have the lowest cost increase per additional unit of habitat output (lowest slope). After this screening incremental costs and outputs were calculated and "best buy" plans displayed by successive level of incremental cost and output. This last step is performed to determine if additional environmental output is worth its added cost.

The CE/ICA output results ("best buys") are displayed below for SARM and Chino/Mill Creek.

Table 4.5-1 Chino and Mill Creek Best Buys (FY 2017 Price Levels, 2.875% Discount Rate)

BB Plan	Adds Measure(s)	In Location	AAC	AAHU	Incr. AAC	Incr. AAHU	Incr.AAC/AAHU
1	No Action						
2	Invasive plant management	Mill Creek	$87,000	1,298	$87,000	1,298	$67
3	Native plantings	Chino Creek	$215,000	2,487	$128,000	1,189	$108
4	Raise existing invert and cut new channel	Chino Creek	$546,000	4,858	$331,000	2,371	$140
5	Native plantings	Mill Creek	$584,000	5,121	$38,000	263	$144
6	Invasive plant management	Chino Creek	$867,000	6,495	$283,000	1,374	$206
7	Non-native aquatics management	Mill Creek	$922,000	6,530	$55,000	35	$1,571
8	Non-native aquatics management	Chino Creek	$999,000	6,555	$77,000	25	$3,080
9	Instream habitat features	Chino Creek	$1,030,000	6,558	$31,000	3	$10,333

Table 4.5-2 SARM Best Buys (FY 2017 Price Levels, 2.875% Discount Rate)

BB Plan	Adds Measure(s)	In Location	AAC	AAHU	Incr. AAC	Incr. AAHU	Incr.AAC/AAHU
1	No Action						
2	Invasive plant management	SARM Upstream	$559,000	24,443	$559,000	24,443	$23
3	Invasive plant management	SARM Downstream	$744,000	31,601	$185,000	7,158	$26
4	Native plantings	SARM Upstream	$824,000	32,202	$80,000	601	$133
5	Non-native aquatics management	SARM Upstream	$935,000	32,580	$111,000	378	$294
6	Sediment Mgt. System + Riparian Edge Mgt. (US) + Instream Habitat Features (DS)	Both	$9,088,000	54,001	$8,153,000	21,421	$381
7	Non-native aquatics management	SARM Downstream	$9,221,000	54,207	$133,000	206	$646
8	Instream habitat features	SARM Upstream	$9,360,000	54,368	$139,000	161	$863

These results form the inputs used to determine the overall best buy plans. Best buy plans from SARM and Chino/Mill Creek were combined across focal areas that cover the entire study area. These plans were screened using CE/CIA to identify overall Best Buys.

4.5.2 Overall Best Buys

The overall Best Buy plans are shown below in tabular and graphical formats. Note that Figure 16 does not include the largest Best Buy Plan (BB Plan 18), for graphical display purposes given the very large incremental cost per output for that plan.

Table 4.5-3 Overall Best Buy Plans (FY 2017 Price Levels, 2.875% Discount Rate)

BB Plan	Adds Measure(s)	In Location	First Cost	AAC	AAHU	Incr. AAC	Incr. AAHU	Incr.AAC/AAHU
1	No Action							
2	Invasive plant management	SARM US	$5,544,814	$559,000	24,443	$559,000	24,443	$23
3	Invasive plant management	SARM DS	$9,054,063	$744,000	31,601	$185,000	7,158	$26
4	Invasive plant management	Mill Creek	$10,740,489	$831,000	32,899	$87,000	1,298	$67
5	Native plantings	Chino Creek	$13,596,184	$959,000	34,088	$128,000	1,189	$108
6	Native plantings	SARM US	$15,210,960	$1,039,000	34,689	$80,000	601	$133
7	Raise existing invert and cut new channel	Chino Creek	$22,425,054	$1,370,000	37,060	$331,000	2,371	$140
8	Native plantings	Mill Creek	$23,194,993	$1,408,000	37,323	$38,000	263	$144
9	Invasive plant management	Chino Creek	$25,180,703	$1,691,000	38,697	$283,000	1,374	$206
10	Non-native aquatics management	SARM US	$25,929,943	$1,802,000	39,075	$111,000	378	$294
11	Sediment Management System US/DS + Riparian edge management US + Instream Habitat Features (DS)	SARM US/DS	$108,640,259	$9,955,000	60,496	$8,153,000	21,421	$381
12	Non-native aquatics management	SARM DS	$109,539,347	$10,088,000	60,702	$133,000	206	$646
13	Instream habitat features	SARM US	$113,132,694	$10,227,000	60,863	$139,000	161	$863
14	Feral Pig Management	All	$114,827,841	$10,477,000	61,148	$250,000	285	$877
15	Non-native aquatics management	Mill Creek	$115,202,461	$10,532,000	61,183	$55,000	35	$1,571
16	Cowbird Trapping	All	$116,691,575	$10,752,000	61,281	$220,000	98	$2,245
17	Non-native aquatics management	Chino Creek	$117,216,043	$10,829,000	61,306	$77,000	25	$3,080
18	Instream habitat features	Chino Creek	$117,788,227	$10,860,000	61,309	$31,000	3	$10,333

- *Feral Pig Mangement and Cowbird Trapping measures located in SARM Upstream, Chino Creek and Mill Creek*

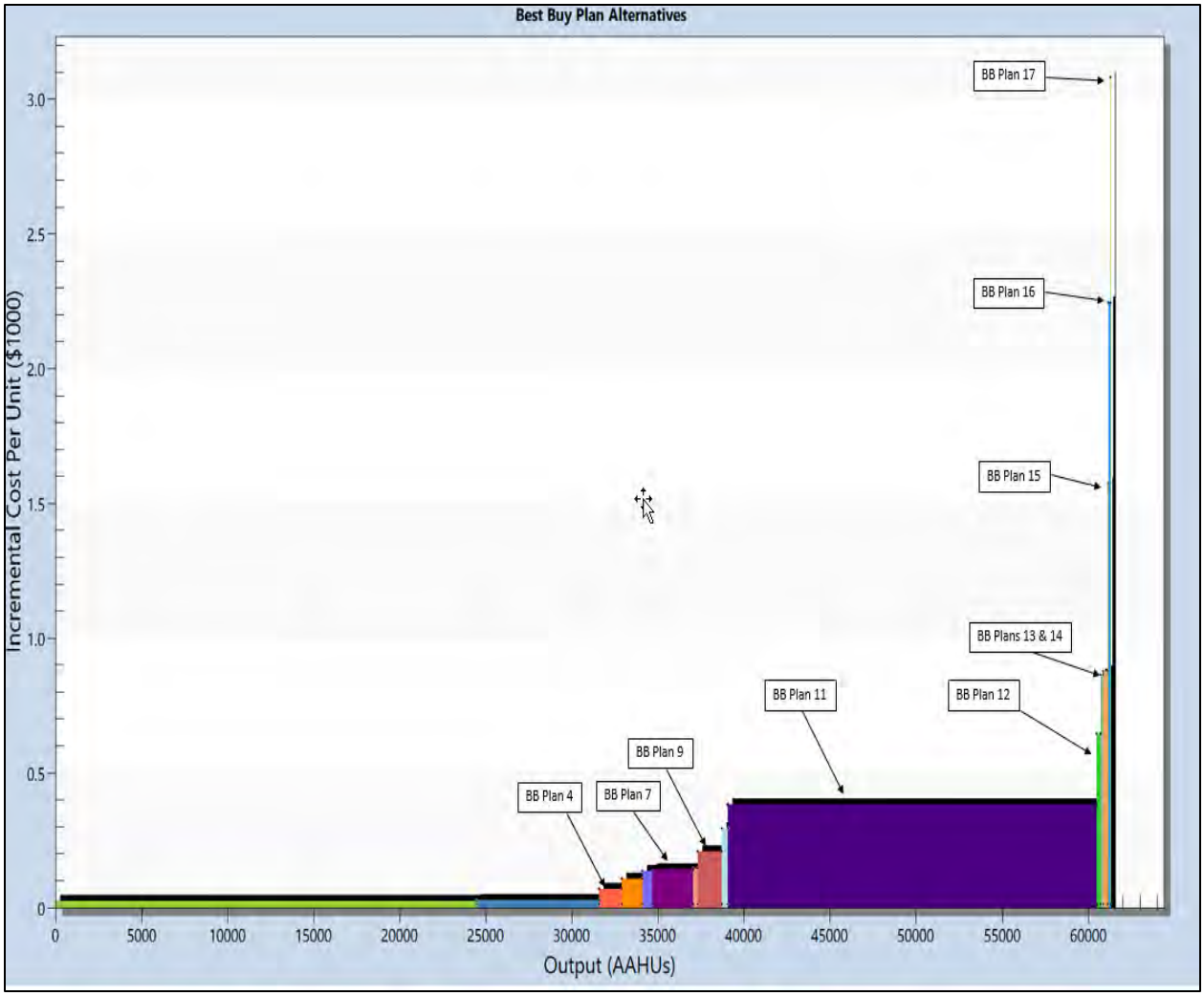

Figure 8 Overall Best Buy Plans with Incremental Cost[32]

[32] Incremental costs/HU above $3,000 removed for ease of presentation

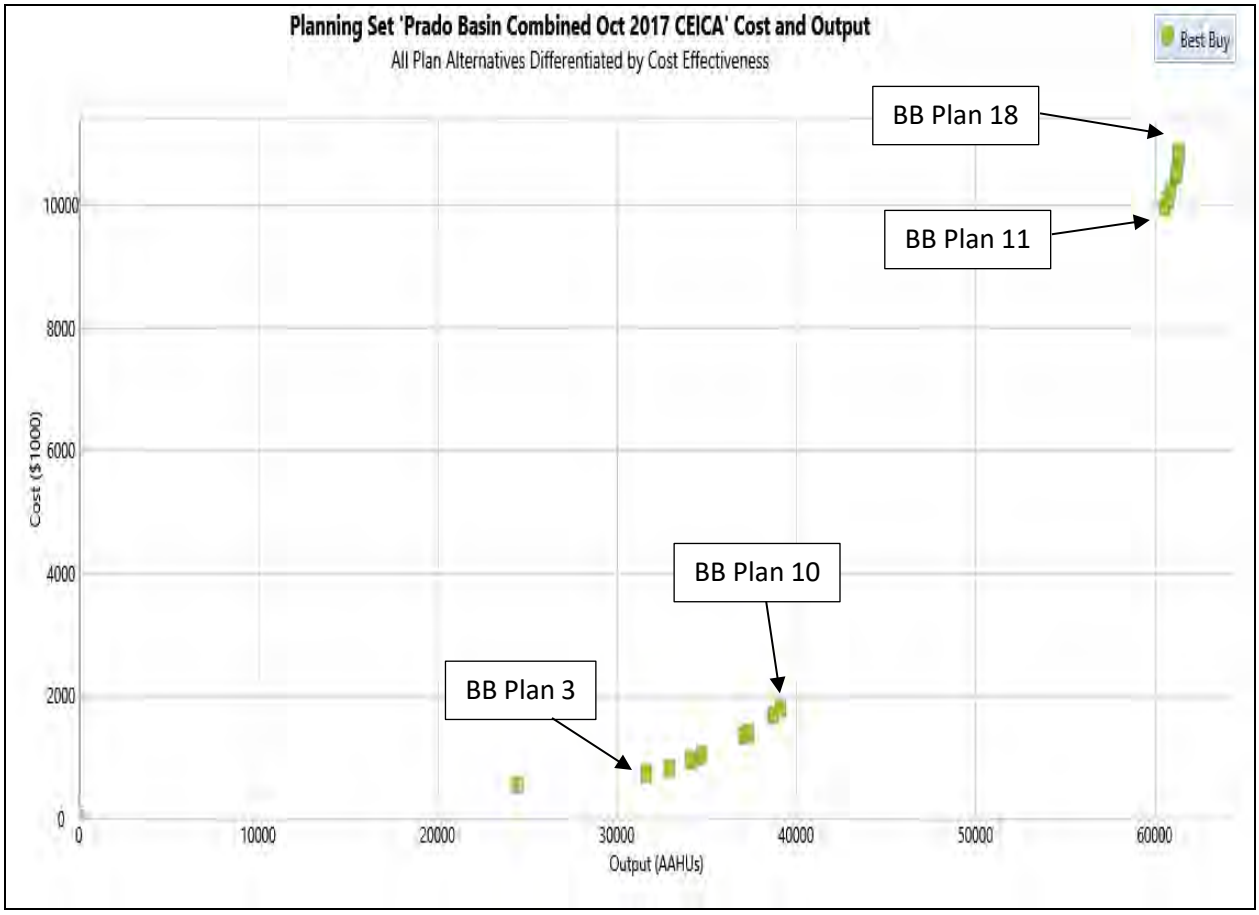

Figure 9 Overall Best Buy Plans with Total Avg Annual Cost ($1,000s)

While incremental cost analysis cannot provide a single plan to recommend, it does account for tradeoffs between incurring additional cost and receiving additional ecosystem restoration benefit. Plans that produce more habitat units require additional resources. The incremental costs per habitat unit to achieve a larger plan is shown in the last column, which will help answer the question "Is it worth it?"

4.5.3 Criteria for Comparison

While cost effectiveness and incremental cost analysis are important criteria for establishing economically rational alternatives, other decision guidelines need to be applied to determine the NER Plan.[33]

- Output targets
- Output thresholds
- Cost limits
- Breakpoints in incremental cost/output graph
- Unintended consequences

These and other criteria or metrics can be used to determine the Final Array Plans to carry forward and the Tentatively Selected Plan.

[33] USACE Cost Effectiveness/Incremental Cost Analysis Workshop 9-May-2014

4.5.4 Final Array Plans

Based upon the criteria outlined in Section 4.5.3 and as further described in Chapter 3 of the Main IFR, four of the Best Buy Plans (including the No Action Plan) were selected to carry forward into the Final Array for ecosystem restoration. These plans are Best Buy Plans 1 (No Action), 9, 11, and 14. The table below summarizes the features of the Final Array Plans. Note that the Cowbird Trapping measure was added to each of the Final Array Action Plans. The justification for including this measure in the Final Array plans can be found in Chapter 3 of the Main IFR.

Table 4.5-4 Final Array Plan Features

BB Plan	Adds Measure(s)	In Location
1	No Action	
9	- Invasive Plant Mgt.	All Locations
	- Native Plantings	SARM US, MC, CC
	- Raise Invert/Cut New Channel	CC
	- *Cowbird Trapping* *	SARM US, MC, CC
11	- Non-Native Aquatics Mgt.	SARM US
	- Sediment Mgt. System	SARM US/DS
	- Riparian Edge Mgt.	SARM US
	- Instream Habitat Features	SARM DS
14	- Non-Native Aquatics Mgt.	SARM DS
	- Feral Pig Management	SARM US, MC, CC
	- Instream Habitat Features	SARM US

Project cost estimates for the Final Array plans were refined and updated to FY 2018 price levels, with contingencies reflecting the results of an abbreviated cost risk analysis. Average annual costs were recomputed based upon the FY 2018 discount rate of 2.75%. The following table shows the updated costs and benefits for the Final Array Plans.

Table 4.5-5 Final Array Plan Summary (FY 2018 price levels, 2.75% Discount Rate)

	BB Plan 9	BB Plan 11	BB Plan 14
Construction	$20,492,543	$96,715,632	$102,800,088
PED/S&A	$5,287,668	$24,011,459	$25,275,153
Monitoring & Adaptive Mgt.	$8,682,943	$13,857,527	$14,621,329
LERRD	$2,382,029	$3,200,725	$3,450,725
Total First Cost	**$36,845,000**	**$137,785,000**	**$146,147,000**
IDC	$2,571,225	$9,615,313	$10,198,855
Investment Cost	$39,416,225	$147,400,313	$156,345,855
Annualized Investment Cost	$1,460,000	$5,460,000	$5,791,000
OMRR&R	$522,000	$7,735,000	$8,012,000
Total Annual Cost	**$1,982,000**	**$13,195,000**	**$13,803,000**
AAHU	38,795	60,594	61,246
AAC/AAHU	$51	$218	$225
Incremental AAC	$1,982,000	$11,213,000	$608,000
Incremental AAHU	38,795	21,799	652
Incremental AAC/AAHU	$51	$514	$933

Best Buy Plan 9– This plan was the plan determined to minimally meet planning objectives. It provides 38,795 AAHUs. The total first cost is approximately $36.8 million, with an average annual cost of about $2.0 million. Relative to the No Action Plan, the incremental AAC/AAHU of Best Buy Plan 9 is about $51. The plan features invasive plant management and native plantings throughout the project areas, which are the most cost effective restoration measures, and also includes raising the invert and cutting a new channel through Chino Creek. Cowbird trapping was determined to be a critical feature for all Final Array action plans, based upon output that was not captured in the CHAP results.

Best Buy Plan 11 – This plan provides a substantial increase in output, generating 60,594 AAHUs. The total first cost is approximately $137.8 million, with an average annual cost of about $13.2 million. Relative to Best Buy Plan 9, the incremental AAC/AAHU is about $514. This plan is the first to feature the sediment management system along the Santa Ana River Mainstem (SARM), as well as in-stream habitat features in the SARM downstream area and riparian edge management features upstream, which are both dependent upon implementation of the sediment management system. This plan also adds non-native aquatics management in the SARM upstream area. These additional features raise the cost considerably – the first cost is about $101 million higher than Best Buy Plan 9, and average annual costs are approximately 6.7 times higher than the annual costs for Best Buy Plan 9. However, the increase in output of 21,799 AAHUs results in a low incremental cost per AAHU. The incremental AAC/AAHU for this best buy plan is substantially lower than larger scale best buy plans.

Best Buy Plan 14 – This is the largest plan carried forward to the Final Array, and is projected to generate 61,246 AAHUs. This represents an increase of 652 AAHUs relative to Best Buy Plan 11. The total first cost of Best Buy Plan 14 is approximately $146.1 million, with an average annual cost of about $13.8 million. The incremental first cost and annual cost of Best Buy Plan 14 relative to Best Buy Plan 11 are about $8.4

million and $608,000, respectively. This plan adds non-native aquatics management in the SARM downstream area, in-stream habitat features in the SARM upstream area, and feral pig management in the SARM Upstream, Chino Creek and Mill Creek project areas. These measures, while not adding a significant amount of output based upon the CHAP analysis, do provide important restoration benefits. The feral pig management measure in particular was identified as an important to help achieve restoration success throughout the project areas. Relative to Best Buy Plan 11, the incremental AAC/AAHU of this plan is about $933. While the incremental AAC/AAHU for this final array plan is larger than smaller scale plans, it is still lower than larger scale best buy plans.

4.5.5 National Ecosystem Restoration Plan

NER Plan Definition & Criteria

Based upon the Planning Guidance Notebook (PGN) (ER 1105-2-100) –

- *For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost effective and justified to achieve the desired level of output.*
- *The recommended plan should be the justified alternative and scale having the maximum excess of monetary and non-monetary beneficial effects over monetary and nonmonetary costs. This plan occurs where the incremental beneficial effects just equal the incremental costs, or alternatively stated, where the extra environmental value is just worth the extra costs. This plan should be called the NER plan. In making these value and cost comparisons it is assumed that each plan and scale is the minimum cost way of achieving that level of output; i.e., that an appropriate least cost or cost effectiveness algorithm was used in their development. Deviations from the NER Plan requires justification.*
- *In all but the most unusual cases, the NER Plan should be derived from the final set of Best Buy solutions. Other solutions, identified as non-cost effective in cost effectiveness analysis; as well as cost effective plans identified as relatively less efficient in production ("non-Best Buys") in incremental analysis, may continue to be considered for selection. In some cases, the economic and environmental models used to estimate the effects of ecosystem restoration plans are not capable of capturing the full range of such effects, or considerable uncertainty may accompany the estimates of such effects. Other evaluation criteria, such as environmental significance, acceptability, completeness, and effectiveness also impact the decision process.*
- *Selecting the NER plan requires careful consideration of the plan that meets planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness. Additional factors to consider include the following items.*
    - *Partnership Context. Restoration projects that were planned in cooperation with other Federal resource agencies, and where those agencies also have a significant role in implementing the project, using their authorities and funding, should receive higher priority than those that do not, assuming they also satisfy the other criteria. Similarly, restoration projects that make a significant contribution to regional or national interagency programs (e.g., North American Waterfowl Management Plan, Coastal America, Marine Fish Habitat Creation and Restoration Program, Chesapeake Bay Program, etc.) should also receive priority.*
    - *Reasonableness of Costs. All costs associated with a plan should be considered. Even after tests of cost effectiveness and incremental cost analysis have been satisfied, the decision maker must ascertain that the benefits to be realized are really worth the costs. This will*

almost always be a subjective decision and ultimately must rely on experience, reasonableness and common sense.

- *Rarely will the NER plan not be among the best buy plans identified during the cost effectiveness and incremental cost analyses. If the recommend plan is not the NER plan its selection must be justified. The reasons for such a selection should be clearly explained in the supporting documentation as well as the potential implications for cost sharing.*

Identification of NER Plan

Best Buy Plan 11 has been identified as the NER Plan for the following reasons:

1) Efficiency: It is a Best Buy Plan per the CE/ICA analysis. All of the plan features are cost effective and efficient.
2) The slight modification to Best Buy Plan 11 includes the addition of the Cowbird Trapping measure. This measure is included in larger scale Best Buy Plans (16-18), so it is considered cost effective and efficient. Further, the benefits for this measure are not fully captured in the CHAP ecosystem output model, and therefore the efficiency of this measure is greater than indicated in the CE/ICA analysis.
3) The incremental AAC/AAHU of this plan is low compared to larger scale best buy plans and is not significantly higher than smaller best buy plans.
4) This plan includes the Sediment Management System measure – a key restoration measure that provides more habitat benefits than any other measure – especially when combined with other measures that depend on it (e.g., riparian edge management and in-stream habitat features). This plan generates 21,421 more AAHUs than Best Buy Plan 10, and 21,799 more AAHUs than Best Buy Plan 9.
5) Effectiveness: This plan meets ecosystem restoration objectives and achieves nearly 99% of the restoration outputs of the largest best buy plan.
6) Based upon the criteria of effectiveness and efficiency described above, it has been determined that this plan maximizes ecosystem restoration benefits relative to costs. As described in the Main Report, this plan also meets the criteria for acceptability and completeness, and is therefore identified as the NER Plan.

As shown on Table 4.5-5, the NER Plan generates 21,799 AAHUs at a total project first cost of about $137.8 million and an average annual cost of about $13.2 million.

5 Tentatively Selected Plan

5.1 Combined Plan Analysis

As described in the PGN -

Projects which produce both National Economic Development (NED) benefits and National Ecosystem Restoration (NER) benefits will result in a "best" recommended plan so that no alternative plan or scale has a higher excess of NED benefits plus NER benefits over total project costs. This plan shall attempt to maximize the sum of net NED and NER benefits, and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects will be based on a combination of NED benefit-cost analysis, and NER benefits analysis, including cost effectiveness and incremental cost analysis.

As described in the previous sections, the NED Plan for water conservation is identified as water conservation to elevation 505', while the NER Plan is identified as Best Buy Plan 11. There are no tradeoffs required to implement both of these plans as a Combined Plan. There are, however, incidental benefits from combining the plans. These are outlines as follows:

- The incidental ecosystem restoration outputs associated with the NED water conservation plan are higher if implemented in conjunction with the NER Plan. Specifically, under the NED water conservation plan, the increase in average annual habitat units over the period of analysis is estimated at 6,219. If the water conservation alternative is implemented in conjunction with the sediment management system on the Santa Ana River upstream and downstream of Prado Dam (a key component of the NER Plan), the incidental benefits increase to 8,208 average annual habitat units.
- If the NED and NER Plans are combined and implemented concurrently, the sediment mitigation requirements for the NED water conservation plan are not required. This reduces the total first costs corresponding with the NED Plan by about $2.86 million (at FY 2018 price levels), and average annual costs by about $130,700.

The following table summarizes the total benefits and costs for the Combined Plan. Note that all benefits and costs are presented at FY 2018 price levels and the FY 18 federal discount rate of 2.75%.

Table 5.1-1 Combined Plan Summary of Benefits and Costs (FY 2018 Price Levels, 2.75% Discount Rate)

	NER Plan	NED Plan	Total
NED/NER Costs			
Construction	$96,715,632	$0	$96,715,632
PED/S&A	$24,011,459	$0	$24,011,459
Monitoring & Adaptive Mgt.	$13,857,527	$0	$13,857,527
LERRD	$3,200,725	$0	$3,200,725
Total First Cost (Rounded)	$137,785,000	$0	$137,785,000
IDC	$9,615,313	$0	$9,615,313
Investment Cost	$147,400,313	$0	$147,400,313
Annualized Investment Cost (Rounded)	$5,460,000	$0	$5,460,000
OMRR&R	$7,735,000	$100,000	$7,835,000
NED Losses (Rec & Cleanup)	$0	$4,400	$4,400
Total Annual Cost	$13,195,000	$104,400	$13,299,400
NER Benefits			
AAHU (NER Plan)	60,594	0	60,594
AAHU (Incidental - NED Plan)	0	8,208	8,208
Total AAHUs	60,594	8,208	68,802
AAC/AAHU	$218		$193
NED Benefit/Cost Analysis			
Average Annual Benefits	$0	$7,370,000	$7,370,000
Average Annual Costs	$0	$104,400	$104,400
Net Benefits	$0	$7,265,600	$7,265,600
Benefit/Cost Ratio	NA	71	71

As shown in the table above, the Combined Plan has a total first cost of about $137.8 million (all related to ecosystem restoration features), an annual cost of about $13.3 million (including NER and NED costs). Note again that the NED costs for the water conservation plan are reduced, since mitigation costs are not required when the plan is implemented in conjunction with the sediment management system component of the NER Plan.

Including incidental NER outputs associated with the NED Plan, total AAHUs are estimated at about 68,802, with an average annual cost per AAHU of about $193 (based upon total annual costs for the Combined Plan).

The NED water conservation plan generates $7.37 million in annual benefits, with only about $104,400 in annual costs, resulting in net benefits of about $7.27 million and a benefit/cost ratio of about 71.

5.2 Tentatively Selected Plan

The Combined Plan, as described in Section 4.5.6 above, is the Tentatively Selected Plan. The non-Federal Sponsor has not expressed a desire for a Locally Preferred Plan.

5.3 Regional Economic Development Analysis

5.3.1 Purpose

"The regional economic development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output and population."[34] The RED account displays information not analyzed in other accounts in the feasibility report that could have a "material bearing on the decision-making process."[35]

The RED account is born out of the difference in perspectives between the Federal government and local communities directly impacted by water resource planning. The Federal objective in water resource planning is contributing to national economic development and the Federal perspective is the nation as a whole. Local communities and regions directly impacted by water resource planning may consider impacts at the state, regional, or local level a more relevant measure. From the Federal perspective transferring employment opportunities and resources from one region of the nation to another to construct a water resource project does not in itself constitute national economic development and therefore regional economic impacts may not be fully captured in the national economic development (NED) account. However, from a regional or local perspective the transfer of employment opportunities and resources to construct a project in that region, as opposed to some other region of the United States, can be a significant benefit to the local economy in terms of more local employment, more local spending, and more local production. This is why the different perspectives between the Federal government and local communities impacted by water resource projects are addressed in different accounts. The Federal perspective is addressed principally in the NED account while the regional or local perspective is addressed principally in the RED account.

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[34] *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies*, 1983
[35] Ibid

5.3.2 Process

To perform an economic analysis from the regional perspective (RED account), several different impacts from constructing the water resource project have to be analyzed. These impacts are termed direct, indirect, and induced effects.

i) *Direct effects* are "immediate effects associated with the change in total sales for a particular industry. In other words…the proportion of the expenditure in each industry that flows to material and service providers in that region."[36] Stated simply, these are the direct impacts to employment and income due to the demand for goods and services to complete construction (e.g. construction equipment and labor). The region is typically defined by political rather than economic or geographic boundaries. Political boundaries are broken down to state and county or metropolitan area for analysis.

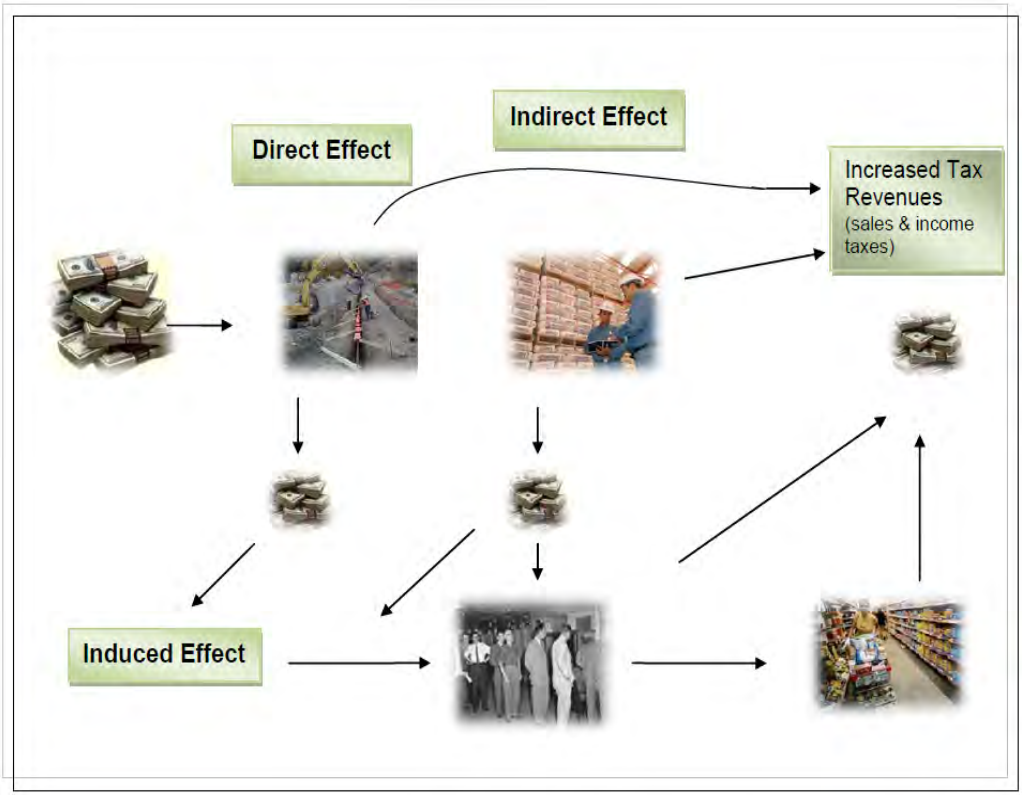
ii) *Indirect Effects* are changes in inter-industry purchases in response to new demand from the directly affected industries. In other words the supply of materials and services to meet the needs of the companies or individuals directly engaged in constructing the project (e.g. concrete suppliers).

iii) *Induced effects* are "changes in spending patterns [from] increases in income to directly and indirectly affected industries."[37] Stated simply, this is the increased spending on local goods and services such as restaurants, grocery stores, hotels, and gas stations due to the direct and indirect effects of the project.

The impact from spending to construct the project is shown in Figure 10. First the direct effects from hiring a construction firm to complete the project are experienced, then that firm purchases supplies and services from other firms to complete the project causing indirect effects.

[36] *Regional Economic Development (RED) Procedures Handbook* 2011-RPT-01, March 2011
[37] Ibid

Figure 10 Process to Evaluate Regional Economic Development



Finally, both direct and indirect effects contribute to induced spending at local retailers, restaurants, convenience stores, etc. This leads local retailers, restaurants, convenience stores, and so on to purchase more goods and services and perhaps hire additional workers. At the same time all this cycling of dollars also leads to increased tax revenue. This cycle continues until the additional dollars are no longer in circulation in the regional economy due to leakages. Leakages occur when goods and services with value added outside of the region are purchased (e.g. purchased clothing that was manufactured in Asia or consulting services from a firm located and engaged in business activity primarily outside the region). The graphic below illustrates the concepts of direct, indirect, and induced effects

The direct, indirect, and induced effects are estimated through multipliers, which can be thought of, figuratively, as money multiplying throughout the regional economy. A portion of the money spent on construction equipment and labor (direct effect) gets re-spent on construction supplies (indirect effect) and a portion of the money from both is re-spent on local restaurants and gas stations (induced effect). Economists have used regression analysis on historical spending data to estimate how much spending and re-spending varies when there is an economic stimulus to the region through various construction projects. This produces the "multipliers" that are applied to the initial construction spending (i.e. cost of constructing the project) to estimate the direct, indirect, and induced effects of the project studied in this feasibility report.

In addition to the regional benefits from direct, indirect, and induced spending on constructing the project there are also benefits from increased recreation demand from non-locals and tax benefits to the local and state economy from preserving property tax receipts since episodic erosion events causing property loss would be markedly reduced once the project is constructed. These are called forward linkages since they link the construction project to the regional "consumers" of the outputs from this coastal storm

damage reduction project, which are decreased land loss resulting in the preservation of property tax receipts as well as increased recreational opportunities resulting in more tourist spending. This contrasts with backward linkages from the construction firm to its suppliers captured in the "money multipliers" described earlier and analyzed in this section.

5.3.3 Analysis

The RECONS model was used to estimate the direct, indirect, and induced effects of the TSP based on construction cost and OMRR&R cost estimates. This model generates regional construction multipliers based on the USACE business lines (navigation, flood mitigation, water storage & supply, etc). Each business line is subdivided into numerous work activities, which improves the accuracy of the estimates for regional and national job creation, and retention and other economic measures such as income, value added, and sales. For the RED analysis for construction expenditures, the business line selected was Environmental Stewardship and the work activity selected was construction of ecosystem and habitat improvement. The most significant costs for the TSP are associated with the sediment management system, including grading, clearing, grubbing, placement of sheetpile and stone/rip-rap, pipes, and a temporary irrigation system. Other higher cost features of the TSP include native plantings and invasive plant management. These activities most closely align with the model inputs selected for the analysis. Table 5.1-1 shows that the total first cost of the TSP is approximately $137.8 million. However, excluding real estate costs, which are comprised primarily of crediting the non-federal sponsor for lands they already own, the direct expenditures for the project are about $134.6 million. Annual OMRR&R costs are estimated at about $7.835 million.

5.3.3.1 Results – Construction Expenditures

RED analysis results for the impact of construction expenditures are presented for the region, state, and nation. The region consists of Los Angeles, Orange County, Riverside and San Bernardino Counties which includes the Prado Basin study area. This means regional impacts that have been measured accrue within multi-county metropolitan region but not specifically in the Study Area. The state-level impacts are for California and the national impacts are for the contiguous United States.

Direct impacts (effects) to employment and income due to the demand for goods and services. These contribute to additional output, additional demand for jobs, and increased value-added to goods and services within region, the state of California, and the nation.

The direct impacts from construction expenditures for the TSP are expected to support about 1,296 full-time equivalent (FTE) jobs over the period of construction within the region. Over the estimated 5 year period of construction, this represents approximately 259 jobs supported each year on average. The TSP is projected to support an additional 906 FTE jobs during construction through the indirect and induced effects that support or compliment that construction effort. The regional capture rate, which is the region's direct output as a share of total spending, is very high (89% for planting activities and 100% for construction activities). Since much of the labor and equipment comes from within the region, we expect the capture rate to be high as shown.

Overall, construction of the TSP should lead to about $165 million in gross regional product (GRP) and about 2,202 additional jobs within the region during construction. The impact to the state would be of greater magnitude although less relative importance due to the large size of the California economy. Approximately $171 million in GRP and about 2,295 jobs would be supported state-wide over the period of construction.

Table 5.3-1 Regional Economic Development Impacts from Construction of the TSP

Impacts	Impact Areas	Regional	State	National
Total Spending		$134,584,000	$134,584,000	$134,584,000
Direct Impact				
	Output	$130,917,709	$133,556,092	$134,045,425
	Job	1,295.97	1,359.11	1,370.82
	Labor Income	$63,997,113	$66,054,585	$66,436,178
	GRP	$74,176,080	$76,189,660	$76,563,112
Total Impact				
	Output	$285,917,351	$295,910,763	$386,666,482
	Job	2,202.41	2,294.69	2,834.85
	Labor Income	$117,543,970	$121,538,872	$147,819,977
	GRP	$165,334,112	$170,984,508	$215,056,800

5.3.3.2 Results – OMRR&R Expenditures

The previous section described the RED impacts associated with construction of the TSP. These impacts are temporary, accruing during construction of the project. In addition, there are also ongoing OMRR&R costs for the TSP, which are estimated at $7.835 million. These expenditures would occur throughout the period of analysis after construction of the project. Most of the OMRR&R costs relate to the sediment management system, including earthwork (grading, downstream sediment removal). There are also OMRR&R costs associated with vegetation and species (feral pig and cowbird) removal.

It is expected that about 75 full-time equivalent (FTE) jobs will be supported annually from direct impacts from OMRR&R expenditures within the region. The TSP is projected to support an additional 53 FTE jobs annually through indirect and induced effects that support or compliment these OMRR&R activities.

Overall, OMRR&R expenditures for the TSP are projected to lead to about $9.6 million in gross regional product (GRP) and about 128 additional jobs annually within the region throughout the period of analysis. Approximately $10 million in GRP and about 134 jobs would be supported state-wide from annual OMRR&R expenditures.

Table 5.3-2 Regional Economic Development Impacts from OMRR&R Expenditures of the TSP

Impacts	Impact Areas	Regional	State	National
Total Spending		$7,835,000	$7,835,000	$7,835,000
Direct Impact				
	Output	$7,621,562	$7,775,159	$7,803,646
	Job	75.45	79.12	79.80
	Labor Income	$3,725,683	$3,845,462	$3,867,677
	GRP	$4,318,267	$4,435,490	$4,457,231
Total Impact				
	Output	$16,645,087	$17,226,868	$22,510,342
	Job	128.22	133.59	165.04
	Labor Income	$6,842,990	$7,075,559	$8,605,551
	GRP	$9,625,162	$9,954,108	$12,519,839

5.4 Other Social Effects Analysis

5.4.1 Overview of the OSE Account

Other Social Effects (OSE) include beneficial and adverse effects on social well-being. These effects reflect a highly complex set of relationships and interactions between inputs and outputs of a plan and the social and cultural setting in which these are received and acted upon. Effects included in the OSE account include urban and community impacts, life, health and safety factors, displacement, long-term productivity, and energy requirements and energy conservation. Beneficial OSE effects include contributions to the equitable distribution of real income and employment and to other social opportunities, while adverse effects of a plan have detrimental impacts on equitable distribution of income and employment or otherwise diminish or detract from the attainment of social opportunities.

5.4.2 OSE Impacts of the TSP

The TSP is primarily comprised of ecosystem restoration features within and along the Santa Ana River and Chino and Mill Creeks. The most significant restoration feature includes a sediment management system along the Santa Ana River, which, in addition to a large initial investment, will require substantial future operation and maintenance. The TSP also includes reoperation of Prado Dam to increase water conservation.

<u>Urban & Community Impacts</u>

Urban and community impacts address changes in the following categories.

- Effects on employment distribution, especially the share to minorities
- Effects on population distribution and composition
- Effects on the fiscal condition of the State and local sponsor

The TSP is not expected to have a significant urban and community impacts, either positive or negative. There will be increases in regional income and employment associated with the TSP, both during and after

construction (as addressed in the Regional Economic Development analysis). These income and employment impacts will be positive for the community, including minorities employed by these businesses. However, most of these employment impacts will be concentrated during the period of construction. The TSP will not impact population distribution and composition. The cost sharing requirements for the TSP are not anticipated to have a significant impact on the fiscal condition of the non-federal sponsor. The reduced cost of supplying water to the OCWD service area, while positive, is not expected to result in a significant change in the cost per customer or the amounts charged to customers.

Effects on educational, cultural and recreational opportunities

The TSP is expected to provide both positive and negative impacts to educational and recreation opportunities in the Study Area. As noted earlier in this report, increasing the target elevation for water conservation at Prado Dam is expected to result in increased inundation of areas behind the dam that have recreational uses, including a dog park and duck and pheasant hunting. However, there will also be positive recreational impacts for those visiting the area associated with the enhanced environmental setting resulting from the TSP ecosystem restoration features. These positive impacts are expected to be limited, since the TSP does not include any specific recreational features formulated to compliment the restoration plan.

Life, health and safety Impacts

The TSP is not expected to have any significant impacts on life, health and safety. Engineering analysis indicates that there will not be any increase in flood risk associated with the change in Prado Dam operations to implement increased water conservation.

Displacement effects (people, businesses)

The TSP is not anticipated to result in the displacement of people or businesses. As noted, it is expected that there will be some reduction in the days of availability for areas within the basin that are used for some recreational activities.

Other (e.g., social connectedness, long term productivity)

Beyond the impacts described above, the TSP is expected to result in positive OSE impacts, primarily in terms of the value placed by society on the creation/existence of a restored ecosystem. The impact of the TSP on other OSE factors, such as social connectedness, social vulnerability, community resilience, is expected to be minimal.

6 Summary & Conclusions

- The TSP is a Combined NED/NER Plan that includes increased water conservation and ecosystem restoration components.
- Under the TSP, water conservation benefits would be realized by re-operating Prado dam for water conservation during both the flood season and non-flood season to a maximum water surface elevation of 505'. Under current operations, the target elevation during the flood season is limited to 498'.
- Water conservation benefits for the TSP water conservation alternative were quantified by comparing the cost of supplying water within the OCWD service area both with and without reoperation of Prado Basin to increase Santa Ana River groundwater recharge. Additional water supply yields resulting

from reoperation will generally result in a reduction in purchases of imported non-interruptible, treated water, which has a much higher cost than groundwater supplies.

- Equivalent annual water conservation benefits at FY 2018 price levels are estimated at $7.37 million. Several additional scenarios were evaluated which assumed reduced availability of imported water, necessitating reliance of higher cost alternative sources. Equivalent annual benefits for these scenarios range from $9.5 million to $13.2 million.
- Average annual costs associated with the TSP water conservation plan are minimal. Total average annual costs are estimated at about $235,000 at FY 2018 price levels. This includes about $131,000 in environmental mitigation related costs that are not required if the TSP water conservation plan is implemented with the NER Plan as part of the Combined Plan. Excluding these costs, average annual costs for the TSP water conservation plan are estimated at about $104,000.
- The water conservation plan is well justified from an economic perspective. As part of the Combined Plan, the recommended water conservation plan generates net benefits of about $7.27 million and a benefit/cost ratio of about 71 under the most-likely scenario. Net benefits are greater under other scenarios that were evaluated.
- The ecosystem restoration component of the TSP is based upon the NER Plan. The NER Plan was identified as Best Buy Plan 11 from the cost effectiveness and incremental cost analysis. The NER Plan includes a sediment management system, in-stream habitat features, non-native aquatics management, and riparian edge management along the Santa Ana River, raising the invert and cutting a new channel on Chino Creek, and invasive plant management and native plantings along the Santa Ana River, Chino Creek and Mill creek. The plan also adds cowbird trapping, which is a best buy measure that is included in larger scale best buy plans.
- The NER Plan component of the TSP has a total first cost of $137.8 million, an average annual cost of $13.2 million, and generates 60,594 average annual habitat units (AAHUs). The TSP water conservation plan also generates incidental ecosystem restoration benefits, estimated at 8,208 AAHUs.
- The combined NED and NER features of the TSP have a total first cost of $137.8 million, an average annual cost of about $13.3 million, generate about $7.37 million in NED water conservation benefits (with a benefit/cost ratio of 71) and 68,802 AAHUs in ecosystem restoration benefits (or an AAC/AAHU of about $193).
- Construction of the TSP is expected to generate about $165 million in gross regional product (GRP) and about 2,202 additional jobs within the region during construction as a result of construction expenditures. In addition, OMRR&R expenditures for the TSP are projected to lead to about $9.6 million in gross regional product (GRP) and about 128 additional jobs annually within the region throughout the period of analysis.
- There are not expected to be any significant Other Social Effects impacts as a result of the TSP. Impacts are anticipated to be minor and mostly positive, associated with the provision of a lower cost source of water supply and the establishment of the restored ecosystem.