


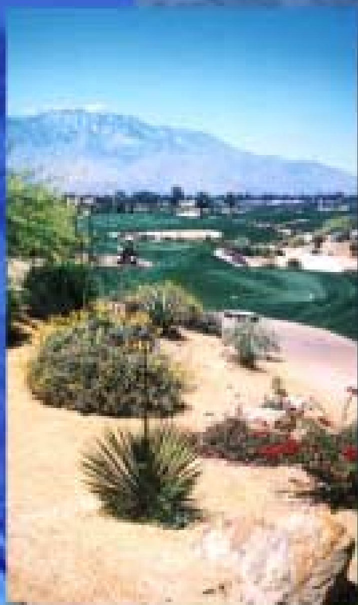

Coachella Valley Draft Water Management Plan

November 2000

Coachella Valley Water District

Water Consult

MONTGOMERY WATSON

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COACHELLA VALLEY WATER MANAGEMENT PLAN

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FOREWORD

Water. No single resource has been as vital to the development and economic well-being of the Coachella Valley as an abundant supply of high-quality, reasonably priced water. The Coachella Valley Water District (District) was formed in 1918 to protect the Coachella Valley's groundwater and to seek sources of imported water to supplement the Valley's water supplies. The District's efforts have resulted in the delivery of Colorado River water through the Coachella Branch of the All American Canal. The District and Desert Water Agency were also instrumental in obtaining the Valley's allotment of State Water Project water. This water is delivered through an exchange agreement with the Metropolitan Water District of Southern California. Imported water recharges the Valley's groundwater supply in the Upper Valley, and supports the Valley's multi-billion dollar economy that is based on the agriculture, resort/recreation, and golf industries.

The successes of past water management activities, however, will not guarantee the Valley's future well being. In 1995, the District began looking to the twenty-first century. Understanding that water uses are constantly changing due to changing land uses, cultural practices, and farming methods, the District embarked on developing a Water Management Plan (Plan) to outline the means of meeting water needs through 2035. Several alternatives for meeting those needs were studied, and a preferred alternative is recommended. The preferred alternative is a comprehensive, conjunctive use approach that incorporates conservation, additional sources of supply, and local resources. It insures a long-term reliable supply of high-quality water at the lowest possible cost to our customers.

The role of the District will continue to change from being a provider of water to being a regional manager of water resources. The availability of water will be a major factor affecting the way the valley grows and its quality of life. Implementing the preferred alternative will allow the Valley to move into the future with a reliable, stable water supply.

The Plan sets goals for improving all areas of water management, including conserving urban, golf course, and agricultural water, controlling the continuing overdraft of our groundwater basin, maintaining water quality, and searching for firm supplies of imported water. Plan implementation will be a collaborative effort by all in the Valley. The Plan sets benchmarks against which progress and success can be measured. Although the Plan sets out a new direction, the path is not fixed. The Plan will be adjusted to meet new circumstances as the planning horizon is extended into the future.

The District's board of directors is asking for public input on the Plan. That input will be used to define a final Plan for the District that will serve as our road map well into the twenty-first century. There will be bumps on the road and detours along the way. However, the District has embarked on a path that will ensure the future viability of the Coachella Valley's water supply. If everyone works together to use water wisely, the Coachella Valley will continue to sustain its vibrant economy.

We wish to thank the many individuals who participated in the development of the Plan. Their hard work is appreciated and acknowledged. The Coachella Valley Water District will continue to lead the way to ensure that the water needs of the Coachella Valley are met well into the foreseeable future.

Tellis Codekas

Tellis Codekas
President of the Board

Tom Levy

Tom Levy
General Manager-Chief Engineer

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INTRODUCTION

Water resources management in the arid west involves many challenges. Droughts, limited supplies, increasing demands, water quality degradation - all of these factors must be taken into consideration to provide a safe and reliable water supply for the Coachella Valley. The Coachella Valley Water District (CVWD or District) is developing a comprehensive Water Management Plan (Plan) that will assure adequate quantities of safe, high-quality water supply for the Coachella Valley well into this century.

As part of the planning process, alternatives have been formulated, and a preferred alternative has been identified. Public comment will be solicited on the Plan in the form of public forums and workshops which will invite input from the general public, taxpayers, water users, local governments, tribal interests, federal and state agencies, and other Colorado River water users.

The Coachella Valley

For purposes of this Water Management Plan, the Coachella Valley is divided into the Upper Valley and the Lower Valley. Generally, the Upper Valley is a resort/recreation-based economy developed on groundwater while the Lower Valley is an agricultural-based economy with access to Colorado River water imported via the Coachella Canal. Geographically, the Lower Valley is southeast of a line extending from Washington Street and Point Happy northeast to the Indio Hills near Jefferson Street, and the Upper Valley is northwest of this line (Figure A).

The Coachella Valley's groundwater basin can be described as a giant tilted bathtub full of sand, with the high end at the northwest edge of the valley near Whitewater and the low end at the Salton Sea. Water placed on the ground surface in the Upper Valley will percolate through the sand directly into the groundwater aquifer. However in the Lower Valley, several impervious clay layers lie between the ground surface and the main groundwater aquifer. Water applied to the surface in the Lower Valley does not easily reach the lower groundwater aquifers due to these impervious clay layers. The only natural outlet for water in the Coachella Valley is through subsurface outflow to the Salton Sea. A profile of the Coachella Valley groundwater basin in provided in Figure B.

Historical Water Management

Water management in the Coachella Valley began as early as 1915 when, with groundwater levels falling, the need for a supplemental water source was recognized in order for the Coachella Valley to continue to flourish. The Coachella Valley Stormwater District was formed in 1915 followed by formation of CVWD in January 1918. In 1918, a contract had been awarded for construction of spreading facilities in the Whitewater River northwest of Palm Springs.

During the next 16 years, District activities focused on obtaining imported Colorado River water. In 1934, negotiations with the federal government were completed, and plans were in place for the construction of the Coachella Branch of the All American Canal. Construction of the Canal began in 1938, was interrupted by World War II, and was finally completed with the first deliveries of imported Colorado River water to area growers in 1949. The impact of imported water on the Coachella Valley was almost immediate. By the early 1960s, water levels in the Lower Valley had returned to their historical highs.

Although groundwater levels in the Lower Valley had stabilized, water levels in the Upper Valley continued to decline. In 1963, the District and Desert Water Agency (DWA) entered into contracts with the State of California for entitlements to State Water Project (SWP) water. To avoid the estimated $150 million cost of constructing an aqueduct to bring SWP water directly to the Coachella Valley, the District and the DWA entered into an agreement with The Metropolitan Water District of Southern California (Metropolitan) to exchange Colorado River water for SWP water.

Starting in 1973, the District and DWA began exchanging their annual SWP entitlement of 61,200 acre-ft with Metropolitan to recharge Upper Valley groundwater supplies at the Whitewater Spreading Facility. CVWD, DWA, and Metropolitan also signed an advance delivery agreement in 1984 that allows Metropolitan to store additional SWP water in wet years. By 1999, the spreading facility had percolated in excess of 1.7 million acre-ft of Colorado River water exchanged for SWP water.

Water levels in the Lower Valley remained relatively stable until the 1980s when they once again began to decline. Groundwater demand had once again exceeded supply, resulting in groundwater level decreases of 60 feet or more in some parts of the Lower Valley. Because groundwater recharge in the Lower Valley is complicated by the existence of relatively impervious clay layers in the Valley floor, the District began looking for sites sufficiently far away from the main clay layer to allow groundwater recharge. In 1995, the District began operating the Dike No. 4 pilot recharge facility (located on the west side of the Lower Valley), which has successfully demonstrated that Lower Valley groundwater recharge is possible. The facility was expanded in 1998 in order to determine the ultimate recharge capacity of a facility at this location. Assuming favorable results, it may be possible to recharge as much as 30,000 to 60,000 acre-ft/yr at this location.

Recycled water has been a priority water management practice in the Coachella Valley for many years. The first permit to use recycled water for golf course irrigation in the Coachella Valley was issued by the Regional Water Quality Control Board to the Palm Desert Country Club in 1965. Today, the District and the DWA provide more than 8,000 acre-ft of recycled water each year for golf course and greenbelt irrigation purposes from four wastewater treatment facilities.

Water conservation is also a key ingredient for managing water demands in the Coachella Valley. Water efficient methods such as drip irrigation have changed the face of farming in the Coachella Valley. The District continually educates Valley residents in water-efficient landscaping techniques, works with local farmers to ensure reasonable beneficial use of irrigation water, and provides in-school visits to more than 21,000 children a year, educating them about water conservation, water value, and aquatic safety.

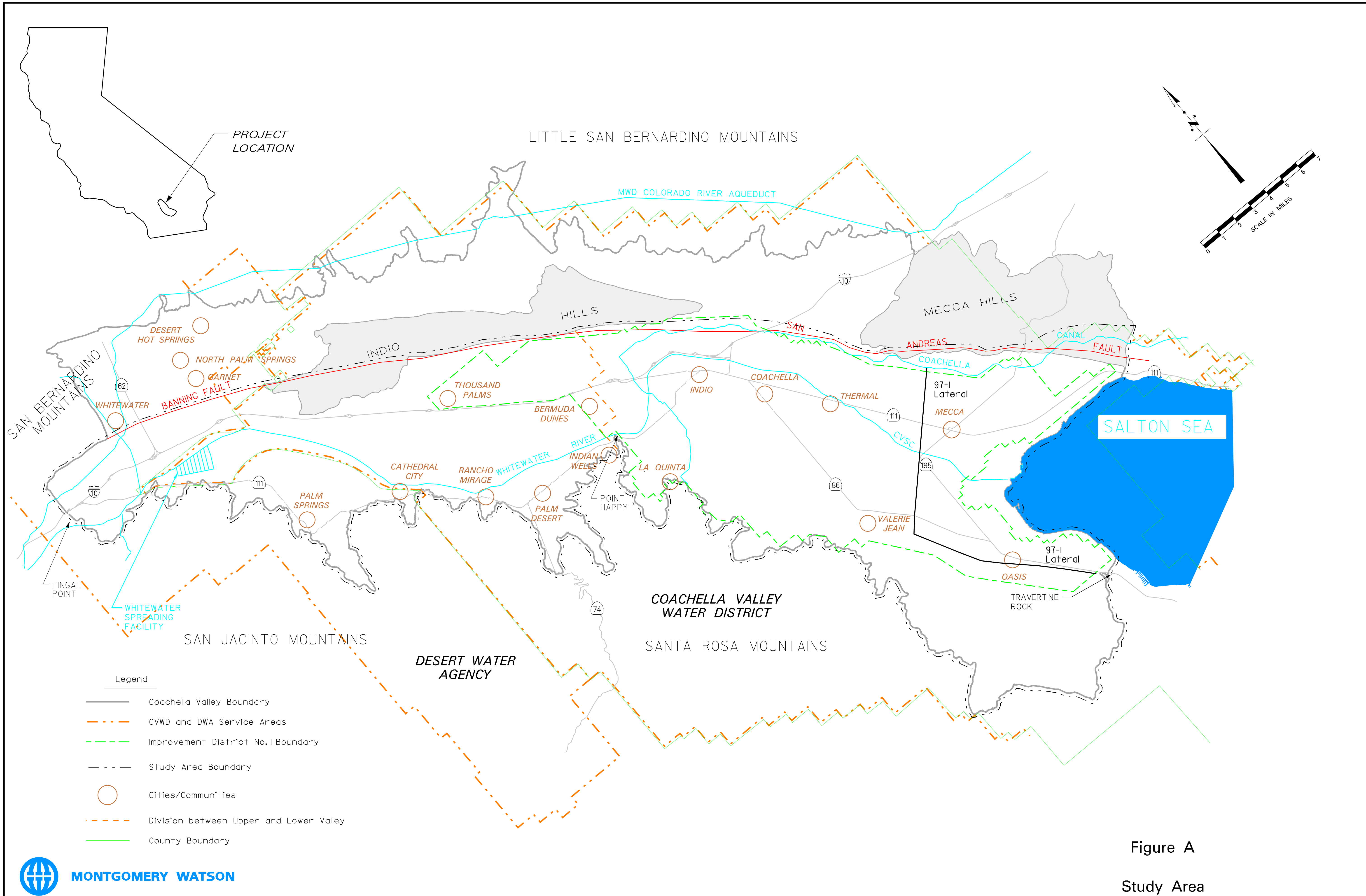

Figure A

Study Area

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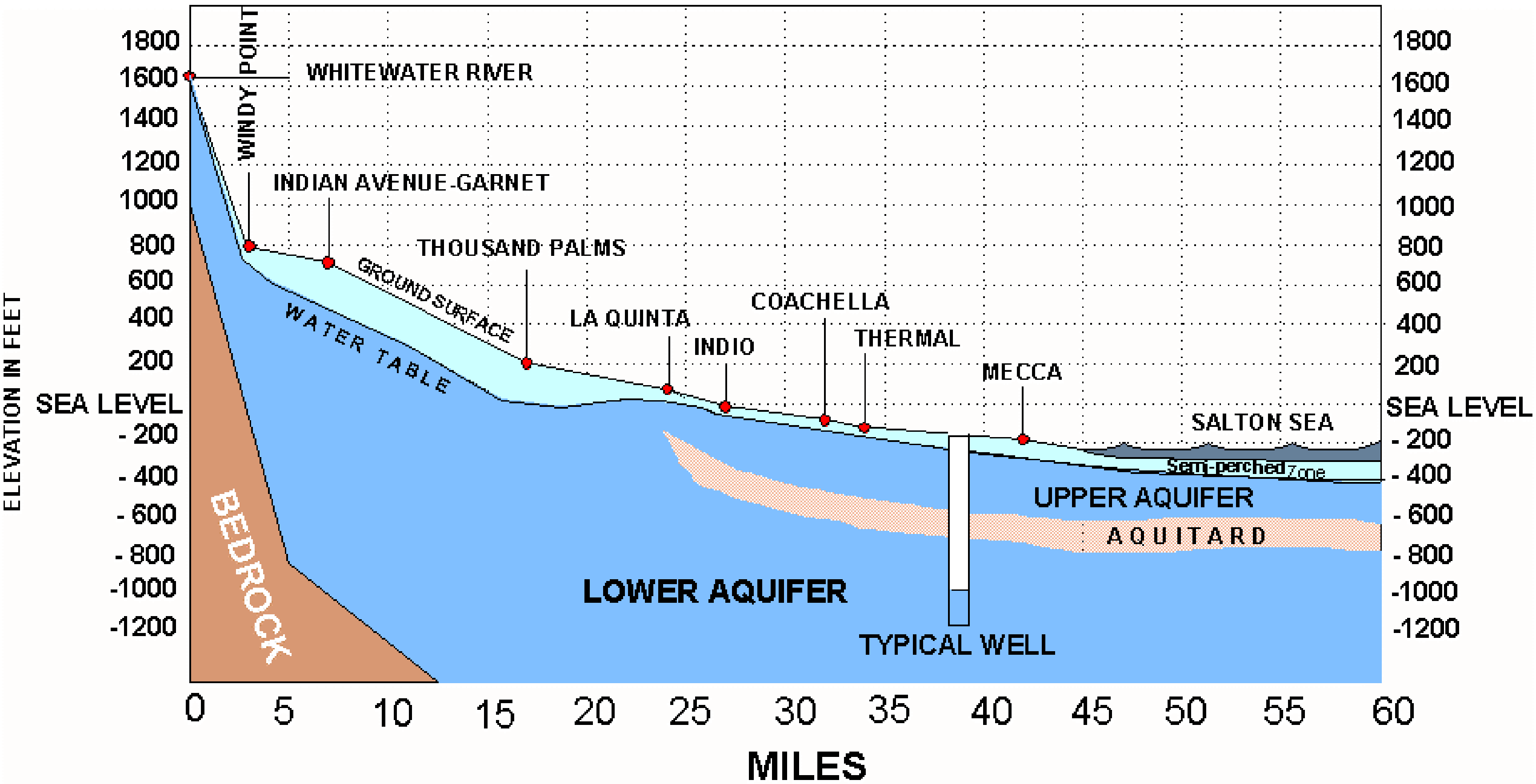


Figure B Coachella Valley Groundwater Basin Profile

Sources of Water Supply

Water in the Upper Valley is supplied by several sources including groundwater, surface water (local streams), Canal water, and recycled water (see Figure C). Lower Valley sources consist primarily of canal water and groundwater with a very small amount of recycled fish farm effluent for agricultural uses (see Figure D). Canal water refers to Colorado River water supplied via the Coachella Branch of the All American Canal. The service area for canal water delivery under the District's contract with the U.S. Bureau of Reclamation is defined as Improvement District No. 1 (ID-1).

Figure C
Upper Valley Supplies

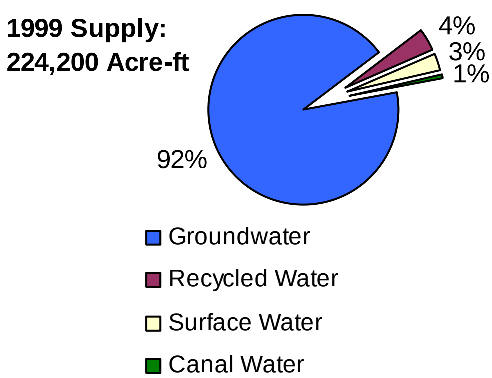
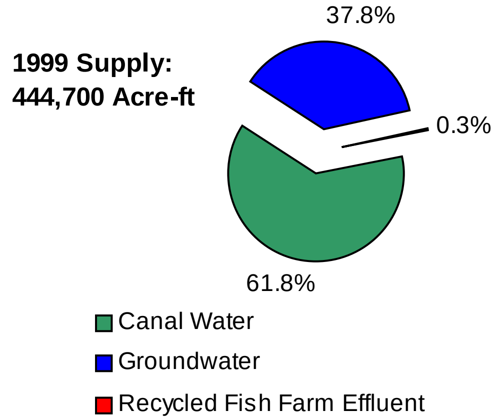


Figure D
Lower Valley Supplies



Growing Demands

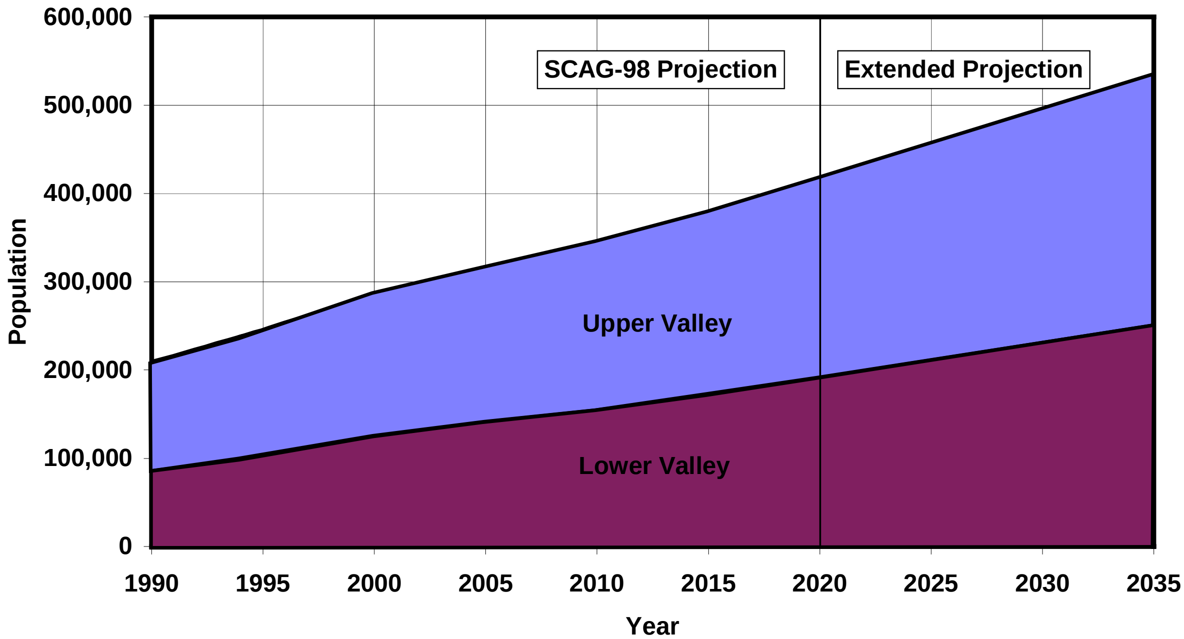
Demands for water in the Coachella Valley are divided between urban uses (municipal and domestic, industrial, and golf courses) and agricultural uses (crop irrigation, fish farming, greenhouses, and duck clubs). Municipal and domestic demands are expected to increase at a faster rate than agricultural demands primarily due to population growth. Coachella Valley's population within the study area is projected to increase from 285,000 in 2000 to 414,000 in 2020, and to 529,000 in 2035, a growth of 31 percent and 46 percent, respectively (see Figure E). Growth will be more rapid in the Lower Valley, where population is projected to nearly double by 2035. Population growth in the Upper Valley is expected to be 76 percent.

The total water demand in 1999 was approximately 669,000 acre-ft/yr, of which 310,000 acre-ft/yr (46 percent) was for urban uses and 359,000 acre-ft/yr (54 percent) was for agricultural uses. By the year 2035, the total demand is anticipated to be approximately 891,000 acre-ft/yr, an increase of 25 percent. Urban uses represent about 514,000 acre-ft/yr (58 percent) of the future demand while agricultural uses represent the remaining 377,000 acre-ft/yr (41 percent).

Upper Valley Demands

Upper Valley demand is projected to increase 36 percent from 224,200 acre-ft/yr in 1999 to 352,300 acre-ft/yr in 2035 (see Figure F) due to population growth and increased golf course use.

Figure E
Coachella Valley Population



Lower Valley Demands

Lower Valley demand is projected to increase 17 percent from 444,700 acre-ft/yr in 1999 to 538,300 acre-ft/yr in 2035 (see Figure F) due to population growth and increased golf course use as well as some additional agricultural use.

Current Condition of Coachella Valley Groundwater Basin

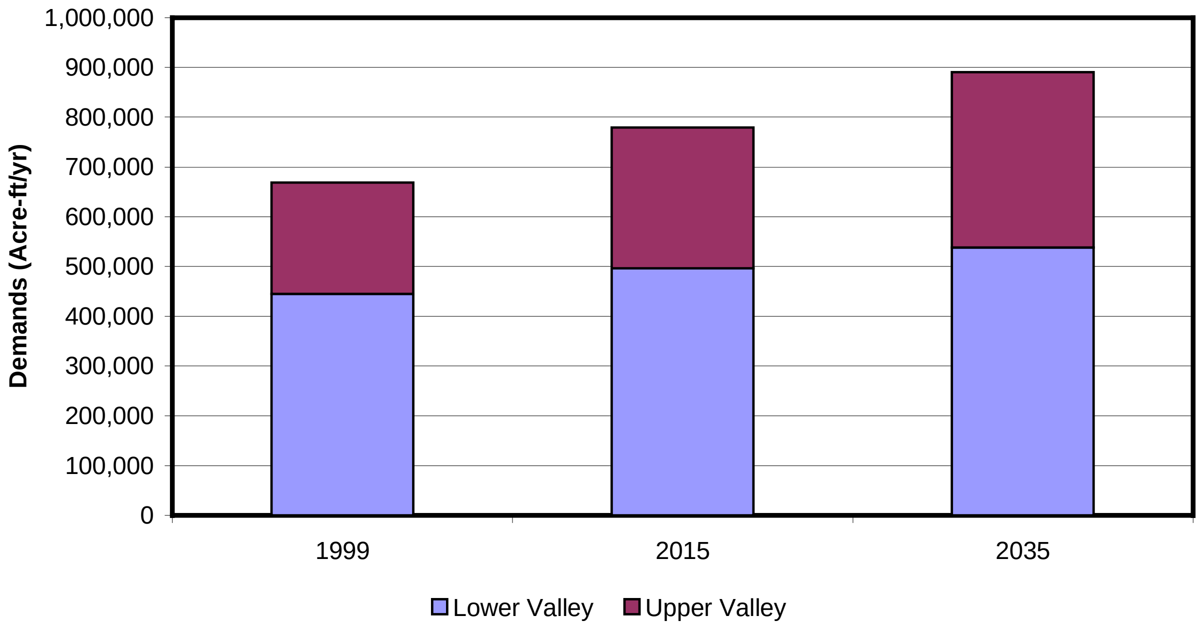
Since the early part of this century, the Coachella Valley has been dependent on groundwater as a source of supply. The demand for groundwater has annually exceeded the limited natural recharge of the groundwater basin. The condition of a groundwater basin in which the outflows (demands) exceed the inflows (supplies) to the groundwater basin is called "*overdraft*".

The State of California Department of Water Resources Bulletin 160-93 describes *overdraft* as follows:

> "Where the groundwater extraction is in excess of inflow to the groundwater basin over a period of time, the difference provides an estimate of overdraft. Such a period of time must be long enough to produce a record that, when averaged, approximates the long-term average hydrologic conditions for the basin."

Bulletin 118-80 defines "overdraft as the condition of a groundwater basin where the amount of water extracted exceeds the amount of groundwater recharging the basin over a period of time." It also defines "critical condition of overdraft" as water management practices that "would probably result in significant adverse overdraft-related environmental, social, or economic effect." Water quality degradation and land subsidence are given examples of two such adverse effects.

Figure F
Coachella Valley Demands



This overdraft condition or "mining" of the groundwater has caused groundwater levels to decrease more than 60 feet in portions of the Lower Valley and raised concerns about water quality degradation and land subsidence. Groundwater levels in the Upper Valley have also decreased substantially, except in the areas near the Whitewater Spreading Facility where artificial recharge has successfully raised water levels.

Continued overdraft will have serious consequences for the Coachella Valley. The immediate and direct effect will be increased groundwater pumping costs for all water users. Wells will have to be deepened, larger pumps will have to be installed, and energy costs will increase as the pump lifts increase. Eventually, the need for deeper wells and larger pumps will have an adverse impact on agriculture and will increase the cost of water for municipalities, resorts, homes, and businesses. Continued decline of groundwater levels could result in a substantial and possibly irreversible degradation of water quality in the groundwater basin.

Continued overdraft also increases the possibility of land subsidence within the Valley. As groundwater is removed, the dewatered soil begins to compress from the weight of the ground above, causing subsidence. Subsidence can cause ground fissures and damage to buildings, homes, sidewalks, streets, and buried pipelines - all of the structures that make the Valley livable. Recent studies indicate that as much as 7 centimeters of subsidence occurred in the Palm Desert area between 1996 and 1998.

The calculation of an annual value of overdraft that accounts for all of the components of overdraft is difficult. One method of estimating the overdraft is to look at the net annual change in freshwater storage in the basin. Change in freshwater storage is the difference between the inflows and outflows of the basin, excluding the inflows of poor-quality water (irrigation return flows and Salton Sea water) which are induced by the overdraft. By excluding these inflows, a more accurate approximation of actual annual overdraft is possible. In 1999, the change in freshwater storage in the Coachella Valley is estimated to be 136,700 acre-ft/yr. The cumulative change in freshwater storage from 1936 to 1999 is estimated to be nearly 4.8 million acre-ft i.e., 4.8 million acre-ft of freshwater was withdrawn from the basin and not replaced. Using freshwater storage as an indicator of overdraft does not account for all aspects of overdraft such as subsidence and other water quality, environmental, social, and economic effects.

Action Required by Coachella Valley Water District

It is clear that the continued decline of groundwater levels and overdraft is unacceptable. The District is charged with providing a reliable, safe water supply to its area of the Valley now and in the future. In order to fulfill its obligations to Valley residents, the District must take action to prevent continuing decline of groundwater levels and degradation of water quality. A comprehensive water management plan will guide the District in its efforts to prevent groundwater level decline, protect water quality, prevent subsidence, and expand its water conservation programs.

WATER MANAGEMENT PLAN PROCESS

To meet its responsibilities for ensuring that there are adequate water supplies in the future, the District initiated a planning process in the early 1990s. The process initially addressed the Lower Valley, but was expanded to include the entire Coachella Valley in 1995. This Plan is the product of that process.

Goals and Objectives

The goal of the Water Management Plan is to assure adequate quantities of safe, high-quality water at the lowest cost to Coachella Valley water users. To meet this goal, four objectives have been identified:

1. eliminate groundwater overdraft and its associated adverse impacts, including:
   - groundwater storage reductions,
   - declining groundwater levels,
   - land subsidence, and
   - water quality degradation,
2. maximize conjunctive use opportunities,
3. minimize adverse economic impacts to Coachella Valley water users, and
4. minimize environmental impacts.

Formulation of Plan Alternatives

The District staff and consultants conducted several brainstorming sessions to identify potential water management elements for inclusion in the Plan. Potential elements were considered without regard to cost, potential environmental impact, technical feasibility, or other considerations. Additional input was obtained through public meetings with local Indian tribes, state and federal agencies, regional and local governments, other interested and affected parties, and the public at large resulting in additional potential management elements for consideration. A detailed description of the element screening and alternative formulation process is contained in Appendix B.

Potential management elements were subsequently organized into six categories: pumping restrictions, demand reduction , local water sources, imported water sources, water management actions, and water quality approaches. Each of the potential management elements was rated based on the element's ability to reduce overdraft, technical feasibility, potential environmental impacts, costs, legal and regulatory factors, and regional economic impacts. Based on these ratings, numerous potential elements were eliminated from further consideration.

The remaining "short-listed" elements were organized into the following conceptual management alternatives:

- No Project,
- Pumping Restrictions,
- Demand Management,
- Groundwater Recharge,
- Source Substitution, and
- Combinations of the above.

With the exception of the No Project alternative, which is required under the California Environmental Quality Act (CEQA), a preliminary evaluation of each alternative was performed to determine which alternatives should be formally considered and evaluated in the Plan. The evaluation process involved technical analyses coupled with professional judgement and experience. The following four proposed alternative management scenarios were selected for evaluation within the Plan.

Alternative 1 – No Project

The No Project Alternative, would involve continuation of current water management actions by the District which include:

- groundwater recharge in the Upper Valley at historical average rates (approximately 50,000 acre-ft/yr),
- supplying Canal water to existing golf courses and agricultural users,
- supplying Canal water to all new agricultural users and new golf courses within ID-1,

- supplying excess recycled wastewater effluent beyond percolation capacity from the Palm Springs Wastewater Reclamation Plant (WRP-10) to area golf courses, and
- domestic, golf course, and agricultural water conservation at current levels.

Alternative 2 – Pumping Restriction by Adjudication

Alternative 2 assumes court-ordered restrictions imposed through a process in which the water rights of the basin are allotted to individual groundwater pumpers. Court-ordered restrictions would likely require groundwater pumping be reduced throughout the Coachella Valley to the point where basin inflows and outflows balance. This balance point, also known as perennial yield, is the amount of groundwater that can be pumped each year without adversely depleting the basin, lowering long-term groundwater levels, or degrading water quality. The exact limit of individual well pumpage is determined in the adjudication process.

Since overdraft exists in both the Upper and Lower Valleys, any adjudication will necessarily apply to both areas. The overdrafts in the Upper and Lower Valleys are different; thus the pumping reductions associated with the adjudication could be computed separately for each portion of the Valley. In order to accommodate the perennial yield of the basin, Upper Valley pumping would have to be reduced by approximately 35 percent while in the Lower Valley pumping would have to be reduced by approximately 75 percent.

Alternative 3 – Management of Demand and Maximization of Local Resources

Alternative 3 focuses on maximizing the use of available local water resources and managing water demand while maintaining imported water usage at approximately current levels. Demand would be managed, to the extent practical, by maximizing water conservation for both urban and agricultural uses. Local resources would be maximized by the increased use of recycled water. The primary features of Alternative 3 include:

- implementation of extensive water conservation measures for urban water use,
- reduction of non-agricultural irrigation demand through mandatory xeriscaping for new residential, commercial, and golf course properties,
- increased conservation by agricultural water users through the use of more efficient irrigation technology and application methods,
- increasing recycled water use by Upper and Lower Valley golf courses, homeowner associations, and agricultural users, and
- fixing imported water supplies at historical levels.

Alternative 4 – Combination Alternative

Alternative 4 engages elements within three basic water management categories: conservation, groundwater recharge, and source substitution. The most feasible and cost effective management elements are combined to form an alternative that incorporates the following:

- urban, golf course, and agricultural conservation measures.
- groundwater recharge in the Upper and Lower Valleys.
- numerous source substitution elements including
  - Canal water to agricultural groundwater users within ID-1,
  - Canal water for golf course irrigation within ID-1,
  - additional recycled water to Upper Valley golf courses,
  - desalted agricultural drain water for agricultural irrigation outside ID-1,
  - recycled water for agricultural irrigation in Lower Valley,
  - treated Canal water for urban uses within ID-1,
  - direct delivery of SWP exchange water for Upper Valley golf course irrigation.

EVALUATION OF ALTERNATIVES

Each proposed alternative was evaluated against a set of specific criteria based on the goals and objectives of the Plan. The evaluation criteria are the foundation of the overall evaluation process used to select the preferred alternative. The evaluation process and criteria are described below.

Evaluation Process

The evaluation process involved technical analyses, application of the evaluation criteria, professional judgment, and experience. To assist in the evaluation process, the District developed a three-dimensional groundwater model (model) for the Coachella Valley. The model provides a consistent, scientific basis for identifying the impacts of the proposed management alternatives on groundwater basin storage, groundwater levels, land subsidence, and water quality. A brief description of the model is provided in Appendix C.

Another important technical evaluation tool was an economic evaluation of the four management alternatives. The purpose of this evaluation was to provide a comparative economic and financial evaluation among the four alternatives within the Coachella Valley as a whole. The evaluation provided a reconnaissance level, order of magnitude comparison of the economic and financial effects of each alternative. In general, the evaluation of economic and financial effects focused on year 2015, to provide an assessment of near-term impacts, and 2035, to allow assessment of longer-term impacts.

Evaluation Criteria

The following criteria, reflecting the goals and objectives of the Plan, were used to evaluate each alternative:

1. The ability to eliminate groundwater overdraft and associated adverse impacts, including:
   - decreasing groundwater basin storage,
   - declining groundwater levels,
   - land subsidence,
   - water quality degradation,

2. The ability to maximize conjunctive use opportunities.
3. The ability to minimize adverse economic impacts to Coachella Valley water users.
4. The ability to minimize environmental impacts.

A brief description of the specific methodology used with each evaluation criterion is discussed below.

Criterion 1: Eliminate Overdraft and Associated Adverse Impacts

The elimination of the groundwater basin overdraft and the associated adverse impacts are primary goals of the Plan. The inflows to the groundwater basin must meet or exceed the outflows (an increase in groundwater storage) in order to eliminate the overdraft. Groundwater levels must be stabilized at levels that will prevent land subsidence and water quality degradation.

Changes in Groundwater Basin Storage. Change in groundwater basin storage is evaluated in terms of the change in total storage and the change in freshwater storage. For each alternative, the model-predicted future (2035) groundwater inflows and outflows for both the Upper and Lower Valley are compared. The changes in both total and freshwater storage are then determined using these estimates. For Alternative 2, the change in total storage is used to represent the perennial yield of the groundwater basin. The change in freshwater storage is used to estimate the groundwater overdraft.

Groundwater Levels. As groundwater levels decline due to reductions in groundwater storage, the potential for associated adverse impacts such as land subsidence and water quality degradation increases significantly. The changes in Upper and Lower Valley groundwater levels from 1999 to 2035, as predicted by the model, are compared.

Land Subsidence. A recent USGS study of land subsidence in the Lower Valley indicated that land subsidence resulting from groundwater pumping may have occurred since the early 1990s, when groundwater levels began declining below previously recorded lows in 1949. To evaluate the potential for land subsidence, the model-predicted 2035 groundwater levels for each alternative are compared to the 1949 groundwater levels. If the 2035 groundwater levels are below the 1949 levels, the potential for land subsidence is likely to increase. Conversely, if the 2035 groundwater levels are above the 1949 levels, the potential for land subsidence is reduced.

Water Quality Degradation. Water quality degradation is a serious adverse impact of overdraft. In particular, declining water levels and decreased drain flows allow the migration of poor-quality water into the underlying aquifer units of the basin and prevent the removal of applied salts from leaving the basin through the drains. To evaluate the potential for water quality degradation, the projected salt balance in 2015 and 2035 is compared to current conditions.

Criterion 2: Maximize Conjunctive Use Opportunities

Each alternative is evaluated based on the alternative's ability to maximize conjunctive use opportunities. Conjunctive use of surface and groundwater may be defined as an integrated plan that capitalizes on the combination of available surface and groundwater resources in order to achieve a reliable long-term water supply. When surface water i.e., SWP exchange water, Canal water, recycled water, or surplus Colorado River water, is available, surface water is utilized to the maximum extent possible. Surface water not used directly is also recharged to augment groundwater storage. Conversely, when surface supplies are limited, surface water resources may be supplemented by pumping groundwater.

The conjunctive use potential of each alternative is evaluated based on its ability to:

1. store available surface water supplies,
2. extract stored water, and
3. utilize alternate sources of supply in-lieu of groundwater.

Criterion 3: Minimize Economic Impacts

This criterion provides a comparative evaluation of the economic and financial impacts associated with the Plan alternatives. The evaluation is based on a reconnaissance-level economic and financial analysis. The economic impact analysis of each alternative considers six economic factors:

- economic sustainability,
- economic development,
- regional economic activity measures,
- economic and financial risks,
- direct costs, and
- indirect costs or savings.

Economic sustainability, economic development, and regional economic impact assessments are made by comparing the projected economic conditions in the Coachella Valley and conditions that could occur under each Plan alternative.

Criterion 4: Minimize Environmental Impacts

The District has prepared a Program Environmental Impact Report (PEIR) to fully assess the potential environmental impacts of each alternative and to develop feasible mitigation measures to minimize those effects. The PEIR summarizes the results of technical and environmental analyses and stakeholder input regarding the Plan alternatives. In addition to the criteria on groundwater effects and water supply, the PEIR evaluates the following factors:

- surface water impacts (Coachella Canal, Coachella Valley Stormwater Channel, drains, and Salton Sea),
- energy use (pumping),
- land use (crop patterns, water use patterns, golf course operations, etc.),
- population/housing
- geology/soils/seismicity,

- aesthetics and recreation,
- air quality
- cultural resources (archaeological and historic), and
- sensitive aquatic, riparian, and terrestrial species and habitats (drains, uplands, Salton Sea, and Coachella Canal).

Evaluation Results

The evaluation results relative to each criterion are discussed below.

Criterion 1: Eliminate Overdraft and Associated Adverse Impacts

Changes in Groundwater Basin Storage. With respect to the change in total groundwater basin storage in 2035, Alternatives 2 and 4 would result in positive changes in 2035. However, Alternative 4 is the only alternative that would result in a cumulative increase in total storage over the planning period (1999 to 2035). With respect to the change in freshwater storage in 2035, only Alternative 4 will completely eliminate the overdraft throughout the Valley. Additional pumping restrictions under Alternative 2 would be necessary to eliminate the overdraft in the Lower Valley.

Declining Groundwater Levels. Within the Upper Valley, Alternative 4 would minimize the decline in groundwater levels from 1999 to 2035. Alternatives 2 and 4 would increase groundwater levels throughout the Lower Valley with Alternative 4 resulting in the greatest overall increase.

Land Subsidence. Subsidence normally occurs in aquifers with thick clay layers that can compress when dewatered. The Upper Valley consists predominantly of sandy soils with relatively thin clay layers. There appears to be minimal increased potential for land subsidence in the Upper Valley because the aquitard separating the Upper and Lower Aquifers is thin or absent in much of the Upper Valley (such as Palm Springs and North Palm Springs). With the exception of Indio, the model-predicted 2035 groundwater levels under Alternatives 2 and 4 throughout the Lower Valley are higher than the 1949 levels. Therefore, Alternatives 2 and 4 would best minimize the potential for land subsidence.

Water Quality Degradation. The current net salt addition in the Coachella Valley is 265,000 tons per year. By 2035, Alternative 1 would result in the highest rate of salt addition to the Coachella Valley of 504,000 tons per year—a dramatic increase compared to 1999 conditions. The net salt addition in 2035 would decrease compared to current conditions under Alternative 2 (68,000 tons per year) and Alternative 4 (155,000 tons per year) with Alternative 2 best minimizing the water quality degradation.

Criterion 2: Maximize Conjunctive Use Opportunities

With regards to the ability to store and extract surface water supplies, all four alternatives received "excellent" rankings in the Upper Valley due to the presence of the Whitewater

Spreading Facility and continued use of wells for water supply. In the Lower Valley, Alternative 4 received a "good" ranking regarding the ability to store and extract water while Alternatives 1, 2, and 3 each received “poor” rankings due to the lack of groundwater recharge under these alternatives.

The ability to utilize alternate supply sources evaluated in-lieu use and direct recharge use. Three primary alternate sources of supply for in-lieu use are recycled water, Canal water, and SWP exchange water. Due to the ability to utilize each of these three alternate sources, Alternative 4 received an “excellent” ranking for recycled in-lieu use. Alternative 4 received a similar “excellent” ranking regarding the in-lieu use of Canal water as an alternate supply source. In-lieu use of Canal water under the other alternatives is minimal. SWP exchange water is utilized as an alternate supply source only under Alternative 4, where exchange water would be delivered to Upper Valley golf courses in-lieu of groundwater. Alternative 4 received an “excellent” ranking regarding the use of SWP exchange water.

Under Alternatives 1, 2, and 3, the ability to utilize alternate sources of supply for direct recharge use is limited to the continuation of Upper Valley recharge at the Whitewater River spreading facility. These alternatives received rankings of “fair” since no increased Upper Valley recharge is included. Only Alternative 4 would utilize Canal water as an alternate supply source for direct recharge in the Lower Valley and, therefore, received an “excellent” ranking.

Overall, Alternative 4 received the highest ranking regarding the ability to maximize conjunctive use opportunities.

Criterion 3: Minimize Economic Impacts

By 2035, reductions in groundwater supplies available for crop production and golf courses under Alternative 2 would likely diminish crop revenues and visitor spending in the Coachella Valley by more than $200 million per year compared to 2000 demand levels, more than $500 million per year compare to 2015 demand projections, and by more than $700 million compared to 2035 demand projections. About 3,000 jobs linked to agriculture and tourism would be lost compared to 2000, more than 6,600 would be lost compared to 2015, and more than 8,200 jobs could be lost compared to 2035 projections. In addition, reductions in groundwater supplies for municipal and domestic use would support 89,000 fewer permanent residents in 2000 and 32,000 fewer seasonal residents than live in the Valley today.

Long-term water quality degradation under Alternatives 1 and 3 also has adverse economic consequences. Higher plumbing and equipment replacement costs, lower crop yields, and the expense of various treatment or filtering devices would be incurred due to degradation of water quality.

Alternative 4 would provide overall economic sustainability, maintain currently projected economic development, minimize impacts to the regional economy, and would not result in increased economic and financial risks to the Valley. Alternative 4 would best minimize the economic impacts to Valley water users due to lower net costs.

Criterion 4: Minimize Environmental Impacts

Based upon a comparison of Plan alternatives with respect to several environmental factors, Alternative 4 would have the greatest beneficial effect on Coachella Valley water supplies and is the overall environmentally superior alternative. Alternative 4 best meets project objectives by combining environmental benefits and minimizing impacts. Alternative 4 eliminates overdraft, creating stable water levels in the Upper Valley and increasing water levels in the Lower Valley. Subsidence potential halts and energy use for groundwater pumping is also minimized. In addition, Alternative 4 also provides the least adverse impacts to surface water, groundwater, biological and human resources.

Selection of Preferred Alternative

As previously stated, the goal of the Water Management Plan is to assure adequate quantities of safe, high-quality water at the lowest cost to Coachella Valley water users. Implementation of Alternatives 1, 2, and 3 would result in significant adverse economic impacts to the Coachella Valley. These alternatives would not sustain long-term economic viability, they would add considerable financial risk, they would curtail economic development, and they would not sustain the economy of the Coachella Valley. When the economic costs of these impacts are considered, the net costs of Alternatives 1, 2, and 3 would be extremely high. The social, economic, and environmental impacts of these alternatives would also make them undesirable.

Alternative 2 shows positive impacts in terms of change in groundwater storage, increased groundwater levels, and decreased potential for land subsidence and water quality degradation. However, the near-term economic consequences of Alternative 2 would be severe. The benefits of Alternative 2 would be equally achievable under Alternative 4 without the severe adverse economic impacts to the Valley. From among Alternatives 1, 2, 3, and 4, the alternative(s) that best meets each evaluation criterion are summarized in Table 1.

The evaluation results indicate that Alternative 4 would best:

- maximize the increase in total storage,
- eliminate groundwater overdraft throughout the Valley,
- minimize the decline of groundwater levels in the Upper Valley while increasing groundwater levels throughout the Lower Valley,
- minimize the potential for land subsidence,
- maximize conjunctive use opportunities,
- minimize the economic impacts to Valley water users, and
- minimize the environmental impacts.

Based on these results, Alternative 4 best meets the objectives of the Plan.

Table 1
Summary of Evaluation Results – Alternatives 1, 2, 3, and 4

EVALUATION CRITERIA	PREFERRED ALTERNATIVE(S)			
	1	**2**	**3**	**4**
1.0 Eliminate overdraft				●
1.a Change in groundwater storage				
Total change in storage				●
Change in freshwater storage				●
1.b Declining groundwater levels		●		●
1.c Land subsidence		●		●
1.d. Water quality degradation		●		
2.0 Maximize Conjunctive Use Opportunities				●
3.0 Minimize Economic Impacts				
Economic sustainability, economic development, economic and financial risk, and regional economy				●
Net cost				●
4.0 Minimize Environmental Impacts				●

"●" denotes a relatively superior alternative - multiple dots denote equally superior alternatives

IMPLEMENTATION OF THE PREFERRED ALTERNATIVE

The preferred alternative includes water conservation, groundwater recharge, and source substitution management elements. Implementation of the preferred alternative will require numerous decisions regarding the priorities for implementation, the financing mechanisms for various elements of the plan, potential cooperative agreements with other agencies, and balancing needs with available resources. A significant activity in decision-making and implementation is coordination and consultation with other governing agencies and tribal interests. The District cannot, nor should it, attempt to unilaterally implement water management activities that are within the purview of local or other governments. This coordinating effort will be a major focus of implementation. Detailed implementation plans will be developed by the District for each water management category following completion of the Water Management Plan. The preferred alternative includes water conservation, groundwater recharge, and source substitution management elements. The general locations of these elements are shown in Figure G. The implementation strategies within each water management category are discussed below.

Water Conservation

Conservation measures can be applied to all water uses; however, in the Coachella Valley, the primary focus of water conservation is on municipal, agricultural irrigation, golf course irrigation and fish farm uses. As shown in Table 2, water conservation measures are expected to decrease total water demand by approximately seven percent by 2015.

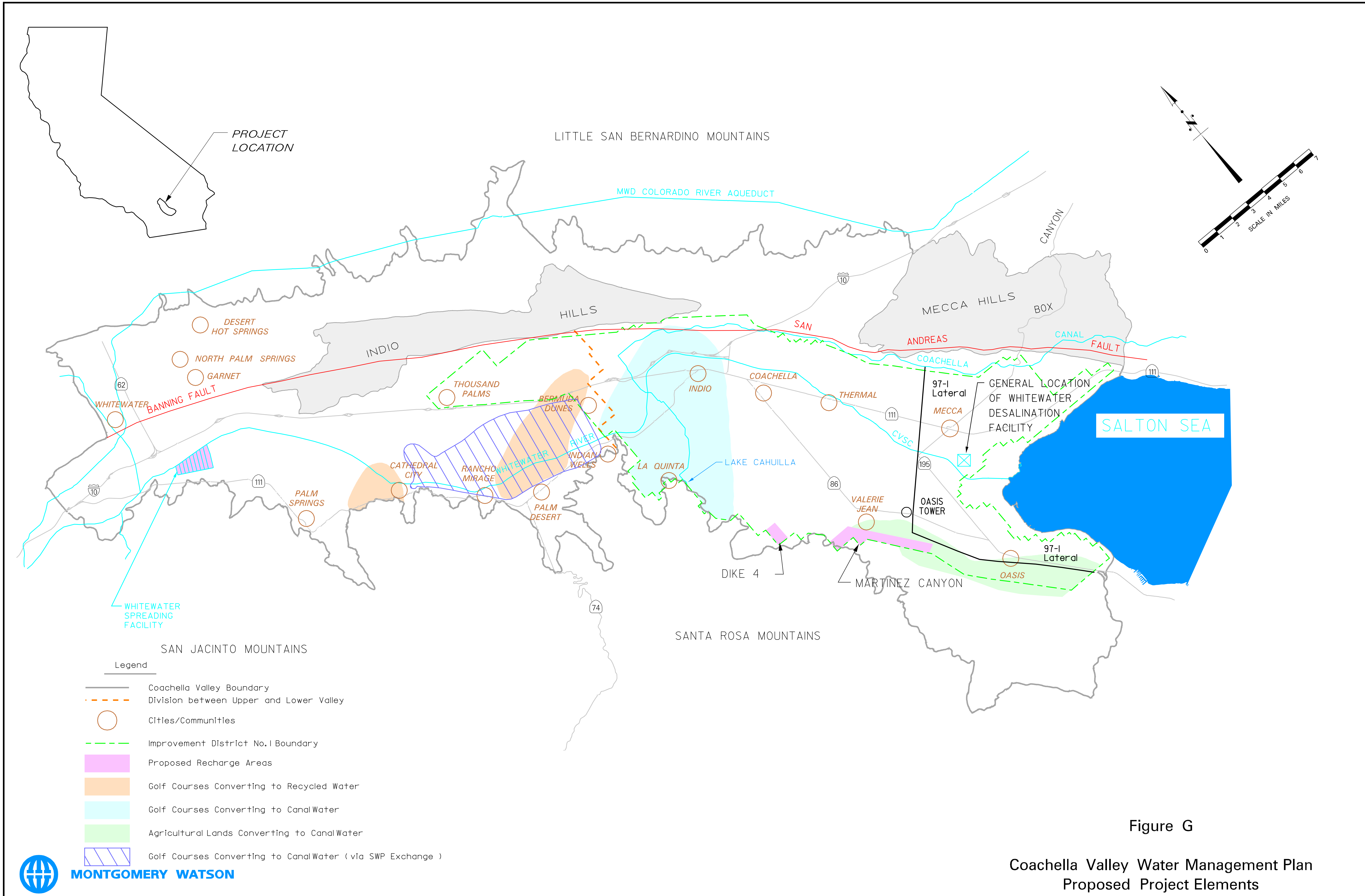


Figure G

Coachella Valley Water Management Plan
Proposed Project Elements

This level of reduction will be maintained through the remainder of the planning period. By 2035, water conservation is expected to further reduce demands.

Table 2
Minimum Water Conservation Assumptions for the Preferred Alternative

Water Use Category	Minimum Conservation Goal (Reduction from No Project Demand)
Municipal	10 percent by 2010
Golf Courses	
Existing in 1999	5 percent by 2010
Built after 1999 [1]	Case-by-Case
Industrial	Case-by-Case
Crop Irrigation	7 percent by 2015
Fish Farms	Case-by-Case
Duck Clubs	Case-by-Case
Greenhouses	Case-by-Case
Total Demand	7 percent

[1] Future golf courses are assumed to implement water conservation measures under No Project

Municipal Conservation

Under the preferred alternative, the District will revise and update the urban water management plan submitted to the California Department of Water Resources (DWR). The goal will be to further reduce urban water demand by a minimum of 10 percent by 2010 and maintain this level of reduction throughout the planning period without producing dramatic lifestyle changes on the part of those conserving. In the future, as total demand increases, the volume of water conserved will increase.

During revision of the urban water management plan, various existing and new water conservation measures will be evaluated including:

- Water Efficient Landscaping-maintaining water-efficient urban and residential landscaping and irrigation systems, optimizing existing systems, improving the overall efficiency of local water use, developing and enforcing water efficient landscape ordinances.
- Water Efficient Plumbing-retrofitting indoor plumbing with ultra-low flush toilets and low-flow showerheads, encouraging development of local ordinances requiring retrofitting as a condition of sale of a property, installing water efficient plumbing in all new buildings.

- Tiered or Seasonal Water Pricing-revising the District's water pricing structure to a tiered or increased block-rate structure that will encourage water conservation by increasing the price of water either year-around or seasonally as usage increases.
- Public information and education programs-promoting the importance of water conservation efforts within the schools and to the general public.
- Alternate Water Supplies-requiring the use of alternate water supplies (such as recycled or Canal water) for urban irrigation purposes where available.
- Municipal Development Policies-working with municipalities, counties, and other agencies to incorporate specific policies regarding water conservation measures into future general plan updates and development policies.
- Conservation Coordinator-designating a full-time position and support staff as required to coordinate and develop water conservation plans.
- Maximum Allowable Water Allowance-establish new and enforce existing annual Maximum Applied Water Allowances for parks, playgrounds, sports fields, school yards, and other recreational areas.

Agricultural Conservation

As presented in Table 2, the goal is to reduce agricultural demand for crop irrigation by approximately 7 percent by 2015. This corresponds to an increase in irrigation efficiency from 70 to 75 percent. Conservation would be maintained at this level for the remainder of the planning period. The District will prepare an agricultural water conservation plan to develop and evaluate specific existing and new agricultural conservation measures including:

- Efficient Irrigation Practices-working with Valley growers to ensure that the most up-to-date irrigation practices are being employed, converting from furrow irrigation to drip irrigation, refining existing drip irrigation management and design to improve distribution uniformity such as buried drip systems, installation of pressure compensating emitters, and including more emitters per line.
- On-farm Water Audits-reviewing individual grower's water use practices on a field-by-field basis and evaluating the unique characteristics of each field and crop type. Confidential reports will be made to each grower indicating the general efficiency of each field and containing recommendations for improved efficiency.

Golf Course Conservation

Golf course conservation is expected to reduce the water demand of existing golf courses by at least 5 percent by 2010 and maintain that level throughout the planning period. The District will prepare a golf course water conservation plan to develop and evaluate specific existing and new golf course conservation measures including:

- Efficient Irrigation Practices-promoting the use of more efficient irrigation techniques, such as improved sprinkler layouts, computer-based irrigation systems and ET-based irrigation scheduling.

- Golf Course Turf Restrictions-establishing criteria in a local ordinance to specify the maximum allowable irrigated area for golf courses. Such an ordinance would restrict the placement of turf grass on the tees, greens, and small portions of the fairways.
- Maximum Allowable Water Allowance-enforce existing annual Maximum Applied Water Allowances for newly installed and rehabilitated landscapes. Establish annual Maximum Applied Water Allowances for golf courses.

District Operating Policies

In addition, the District is in the process of reviewing its operating policies. The purpose of this review is to identify CVWD operating policies that (1) result in additional water savings or (2) make the use of Canal water more attractive to groundwater users.

Evaluation of Water Conservation Programs

The District's water conservation programs will be evaluated to determine the effectiveness of voluntary programs with recommendations for improvement in specific areas, such as public education, ordinances, etc. Based on the evaluation results, additional conservation measures will be considered.

Additional Water Supplies

In addition to water conservation, the District and DWA will need to obtain additional water supplies to eliminate current and future overdraft. Evaluation of many potential alternative supplies has identified four sources that will be augmented as part of the preferred alternative. These sources are the Colorado River, State Water Project, Whitewater River and recycled water. The steps to be taken to augment these supplies are discussed below.

Colorado River Water

In October 1999, CVWD, IID and Metropolitan reached agreement on the "key terms" that will be necessary elements in a formal Quantification Settlement Agreement (QSA) regarding a division and quantification of their respective shares of Colorado River water. The detailed QSA document is being prepared for review and, pending completion of all required environmental reviews, formal approval by the three agencies' Boards. The intent of this agreement is to quantify the rights of each agency and allow the transfer of water between willing buyers and sellers. The Quantification Settlement includes:

- Capping IID and CVWD Priority 3 water,
- Modification to the 1988 IID/Metropolitan Water Conservation Agreement,
- Amendment to the 1989 Metropolitan/IID/CVWD/PVID Approval Agreement and transferring 20,000 acre-ft/yr to CVWD,
- Conservation and transfer of 200,000 acre-ft/yr from IID to SDCWA,
- Exchange Agreement between SDCWA and Metropolitan,
- Conservation and transfer of 100,000 acre-ft/yr from IID to CVWD,

- Lining the All-American Canal and the Coachella Canal and transfer of conserved water to Metropolitan less 16,000 acre-ft/yr for the San Luis Rey Indian Water Rights Settlement,
- Sharing obligations to provide 14,500 acre-ft/yr from IID and CVWD for miscellaneous present perfected rights,
- Transferring 35,000 acre-ft/yr of SWP water from Metropolitan to CVWD,
- Quantification of surplus water available under Priority 6 and 7,
- Various conditions precedents for approval of the final agreement,

Under the settlement agreement, CVWD's entitlement under its share of the Priority 3 allotment is capped at 330,000 acre-ft/yr at Imperial Dam less 26,000 acre-ft/yr of conserved water made available by lining the Coachella Canal. Metropolitan will provide 20,000 acre-ft/yr to CVWD at Imperial Dam under the 1989 Approval Agreement for the 1988 Metropolitan/IID Water Conservation Agreement. CVWD has the option to purchase water from IID in two phases of 50,000 acre-ft/yr each. This water would be made available by the implementation of water conservation measures by IID which are financed by the payments for water by CVWD. The first phase would be available beginning in 2007 and the second phase would be available beginning in 2017. Under the terms of the settlement agreement, CVWD may acquire the water in increments of 5,000 acre-ft/yr, reaching full entitlement by 2033. CVWD may acquire the water at rates of 3,000 acre-ft/yr and 4,000 acre-ft/yr given one year's notice to IID. Metropolitan will transfer 35,000 acre-ft/yr of its SWP entitlement to CVWD on a permanent basis. CVWD, IID and Metropolitan have agreed to provide 16,000 acre-ft/yr of water from the lining of the All-American and Coachella Canals as part of the San Luis Rey settlement. During wet years, CVWD will also have access to 119,000 acre-ft/yr of Priority 6 water after Metropolitan and IID have received 38,000 acre-ft/yr and 63,000 acre-ft/yr, respectively. When all water transfers have been completed, CVWD will have a total diversion of 456,000 acre-ft/yr at Imperial Dam as shown in Table 3. After deducting conveyance losses, about 441,000 acre-ft/yr will be available for use in the Valley. The build-up curve for Colorado River water to CVWD under the agreement will impact the timing of the various projects to be implemented under the Water Management Plan. The term of the settlement agreement is 75 years.

Table 3
CVWD Deliveries Under Quantification Settlement Agreement

Component	Amount – acre-ft/yr
Base Allotment	330,000
1988 MWD/IID Approval Agreement	20,000
Coachella Canal Lining (to Metropolitan)	-26,000
To Miscellaneous/Indian PPRs	-3,000
IID/CVWD First Transfer	50,000
IID/CVWD Second Transfer	50,000
Metropolitan SWP Transfer	35,000
Total Diversion at Imperial Dam	456,000
Less Conveyance Losses[1]	-15,000
Total Deliveries to CVWD	**441,000**

The preferred alternative includes delivery of 441,000 acre-ft/yr of Canal water provided under the Quantification Settlement Agreement by 2033 and remaining at that level through 2035. Approximately 361,000 acre-ft/yr of this amount will be supplied directly to existing and future users in the Valley. Of this amount, about 83,000 acre-ft/yr will replace groundwater pumping (source substitution). The remaining 80,000 acre-ft/yr will be used for groundwater recharge. The Quantification Settlement provides the mechanism for obtaining the additional Colorado River supply needed to implement the Water Management Plan. The projects required to use Canal water are discussed later in this section.

Although the Water Management Plan has been designed to coincide with the terms of the Quantification Settlement, CVWD intends to proceed with the Plan regardless of the outcome of quantification. If the Settlement Agreement is not executed, CVWD would seek other sources of water to eliminate overdraft and to meet the needs of the Valley. Since the District would be constrained by the existing Colorado River allocations, its use of Colorado River water would be within the 3.85 million acre-ft/yr allocation to the first three priorities. The District would attempt to obtain some or all of the water required through transfer of conserved water from IID.

SWP Exchange Water

CVWD and DWA currently have contracts with the State of California for a combined entitlement of 61,200 acre-ft/yr of SWP water. Reliability studies performed by DWR indicate this SWP entitlement can provide an average supply of about 50,000 acre-ft/yr. In 1996, CVWD and DWA recognized the need for additional imported water in order to eliminate groundwater overdraft. Since then, the two districts have purchased additional Pool A, Pool B, and interruptible water from the SWP resulting in average deliveries of 119,000 acre-ft/yr. These additional supplies are not expected to be available in the future and cannot be relied upon to provide a reliable long-term source of water to the Coachella Valley.

The preferred alternative identifies the need for average deliveries of 140,000 acre-ft/yr of SWP exchange water; 103,000 acre-ft/yr for recharge at the Whitewater Spreading facility and 37,000 acre-ft/yr for direct use on mid-Valley golf courses. Assuming average deliveries of 80 percent of entitlement, CVWD and DWA need to obtain firm combined SWP entitlements of approximately 175,000 acre-ft/yr. To the extent possible, additional long-term entitlements would be obtained from other SWP contractors. If adequate long-term entitlements cannot be obtained, surplus SWP water will continue to be purchased on a year-to-year basis as needed and as available.

SWP exchange water obtained from Metropolitan under the Quantification Settlement will be delivered via the Coachella Canal for agricultural irrigation purposes in the Lower Valley.

Recycled Water

Treated Municipal Effluent. There are seven wastewater plants located in the Coachella Valley. The cities of Coachella and Palm Springs and the Valley Sanitary District (VSD) each operate water reclamation plants (WRP). CVWD operated four plants designated WRP-4, WRP-

7, WRP-9 and WRP-10. Water is recycled from each plant except for the Coachella and WRP-4 facilities. These three plants (VSD, Coachella, and WRP-4 discharge effluent to the CVSC. The other facilities discharge to percolation ponds when the demand for recycled water is low in winter months. Use of recycled water effluent is assumed to increase by about 14,000 acre-ft/yr in the absence of the Water Management Plan as growth occurs in the Valley.

The use of recycled water will increase an additional 16,000 acre-ft/yr compared to No Project conditions. The proposed uses for recycled water are discussed in the following section.

Desalinated Agricultural Drain Water. In 1997, the District filed an application with the State Water Resources Control Board to appropriate all waters in the CVSC (up to a maximum of 150 cfs) draining from lands irrigated in ID-1. The application was submitted with the intent to retain local control of local water resources. Initial diversions must take place by 2013, building up to full diversion in 2063.

Up to 11,000 acre-ft/yr of agricultural drain water will be desalted to a quality equivalent to Canal water and delivered for irrigation use. Approximately 13.6 million gallons per day (mgd) of drain water would be diverted and filtered prior to desalination. The desalination facility would have a 10-mgd capacity that will produce about 7.5-mgd of product water. Approximately 3.5 mgd of the flow would be bypassed and blended with the product water to produce the desired quality. Delivery of this water would begin at a rate of about 4,000 acre-ft/yr and reaches 11,000 acre-ft/yr in approximately fifteen years. The preferred alternative does not identify specific users for this water since the product water would be delivered to the District's Canal water distribution system. Because the CVSC contains water of wastewater origin, this supply is not suitable for potable uses even if treated. Therefore, it will be likely be delivered to the 97-1 Lateral, where the downstream demand is for agricultural irrigation. Since this water is non-federal, it is not subject to the contractual restrictions regarding use of Canal water within the ID-1 service area. The District anticipates that an equal amount of Canal water can be delivered to golf courses or the portion of the Oasis system outside ID-1. Preliminary discussion with USBR officials indicated that such an exchange of water might be feasible. No specific location for the plant has been identified.

The treatment process would produce about 2.6 mgd of filter backwash and brine waste. Preliminary studies have considered both on-site and off-site evaporation ponds for brine disposal. On-site evaporation ponds would require about 530 acres of surface area due to the relatively low TDS of the brine. Alternatively, the brine could be conveyed to the Salton Sea either in the CVSC or a parallel brine outfall. Evaporation ponds located near the sea could remove an equivalent amount of salt by evaporating Salton Sea water. Approximately 110 acres of ponds would be required in this case. Decisions on the method of brine disposal will be addressed as project implementation proceeds.

Fish Farm Effluent. Recycled fish farm effluent from fish farms in the Lower Valley is currently reused for fish farms, duck clubs and agricultural irrigation. This reuse is projected to continue into the future.

Source Substitution

Source substitution is the delivery of an alternate source of water to users currently pumping groundwater. This approach is frequently referred to as *in-lieu* delivery where other water sources are delivered in place (or *in-lieu*) of groundwater use. The substitution of an alternate water source reduces groundwater extraction and allows the groundwater to remain in storage, thus reducing overdraft. Alternative sources of water include: recycled water from WRP-7, WRP-9, WRP-10 or City of Palm Springs WRP; Canal water, desalinated agricultural drainage water, or SWP Exchange water delivered through the Coachella Canal.

Source substitution projects under the preferred alternative include the following:

- Conversion of existing and future golf courses in the Lower Valley from groundwater to Canal water,
- Conversion of existing and future golf courses in the Upper Valley from groundwater to recycled water,
- Conversion of existing and future golf courses in the Upper Valley from groundwater to SWP Exchange water,
- Conversion of agricultural irrigation from groundwater to Canal water, primarily in the Oasis area, and
- Conversion of municipal use from groundwater to treated Canal water in Id-1

Specific details on each of these projects are presented below. The timing for the various projects is dependent on the available water supplies and the economics of the various projects. Therefore, the implementation schedules presented are generalized.

Conversion of Lower Valley Golf Courses

Canal water use will be expanded to serve additional golf courses within ID-1. Existing golf courses within ID-1 that use groundwater will be supplied with Canal water. The District will develop a program to convert existing courses from groundwater to Canal water. Many of the existing golf courses within ID-1 have Canal water connections but are not making full use of the water. The District will also work with the courses currently using both groundwater and Canal water to maximize their Canal water use. Because of the availability of desalinated Whitewater River water, the preferred alternative also includes conversion of several Lower Valley golf courses that are located outside ID-1.

The facilities required to serve golf courses located inside ID-1 are generally expected to be minimal as the Canal water distribution system is currently in place. Some new pipelines and pumping facilities may be required to convey desalinated Whitewater River water that is exchanged for Canal water to courses located outside ID-1. Conversion of golf courses is expected to reduce groundwater pumping by about 14,000 acre-ft/yr by 2035.

Upper Valley Golf Course Conversion to Recycled Water

Water from wastewater treatment plants in the Upper Valley is currently either recycled for golf courses or municipal irrigation or disposed by percolation/evaporation ponds located at each facility. Use of nitrogen-rich recycled water for irrigation lowers the amount of inorganic fertilizers needed on golf courses and other landscaped areas, thus reducing the nitrogen loading on the entire basin. One difficulty in recycling sewage effluent for irrigation purposes involves fluctuations in supply and demand. Flows to Valley treatment plants are generally higher in the winter months when irrigation demands are at their lowest, and flows are conversely lower when demand is highest.

In the Upper Valley, recycled water use for golf course and park irrigation will be expanded in areas adjacent to treatment plants where it is most cost-effective. The preferred alternative anticipates about 8,000 acre-ft/yr more recycled water use than the No Project conditions. The facilities required to expand the recycled water systems are expected to include pipelines and pump stations.

Conversion of Upper Valley Golf Courses to SWP Exchange Water

There are a number of golf courses in the Rancho Mirage-Palm Desert-Indian Wells area that pump groundwater for irrigation. This area has experienced a steady decline in groundwater levels over the past 50 years or more. Recent information indicates that there is an increased risk of land subsidence if water levels continue to decline. Therefore, conversion of the golf courses in this area to imported or recycled water is a high priority for the District.

Since this area is outside the ID-1 service area, it is not eligible for Canal water delivery. However, the District could redirect a portion of its SWP entitlement to this area. Conveyance options include the construction of over 20 miles of pipelines from the Whitewater turnouts, over 12 miles of pipelines from the Metropolitan aqueduct at Fan Canyon (east of Dillon Road) or by taking delivery through the Coachella Canal. The latter option would be similar to the proposed conveyance of desalinated Whitewater River water in the Canal delivery system. The Coachella Canal conveyance option was chosen as it involves the least amount of conveyance facilities to bring imported water to the Rancho Mirage-Palm Desert-Indian Wells area.

This project will require construction of over 30 miles of pipelines, two major pumping stations and delivery connections to each course. The project to convert the Upper Valley golf courses is expected to be implemented in phases beginning in the late 2000s and finishing in the mid 2010s. A total of 37,000 acre-ft/yr of groundwater pumping would be eliminated by this project.

Conversion of Existing Lower Valley Agriculture

Agricultural users of groundwater within the ID-1 service area will also be converted to Canal water. The Plan anticipates converting most of the groundwater pumping within the currently served portion of ID-1 to Canal water by the mid-2010s. Because most of these users have connections to the District's Canal water distribution system, these conversions will require minimal infrastructure modifications.

Agricultural uses located in the unserved area of ID-1 other than the Oasis area are also proposed to convert from groundwater to Canal water in the late-2020s. Since these users do not currently have connections to the distribution system, some new conveyance facilities will be required. The extent of these new facilities will be determined prior to any project-specific environmental documentation. Delivery of Canal water to agricultural users within ID-1 is expected to decrease future (2035) groundwater pumping by 30,000 acre-ft/yr.

Oasis Area Agricultural Conversion

The preferred alternative proposes the extension of the Canal water distribution system to serve all acreage in the Oasis area. Studies conducted for CVWD indicate this project could supply Canal water to about 6,700 acres of land located within ID-1 and about 2,200 acres outside ID-1 (Summers Engineering, 1996). The Oasis Conversion Project involves construction of over 20 miles of pipelines, two pumping stations, two small regulating reservoirs and miscellaneous facilities to convey Canal water to this area from the vicinity of the 97-1 Lateral.

Since portions of the Oasis area are outside ID-1, only non-federal water could be served to these users. CVWD proposes to develop agricultural drainage water for this use. The District would track the amount of desalinated agricultural drainage water conveyed in the system and serve a like amount to users outside ID-1. Facilities to serve water to this portion of the Oasis area are expected to include two pumping stations, about six miles of pipeline and other appurtenant facilities.

The ID-1 portion of the Oasis area is expected to convert to Canal water by the mid-2020s. The portion of the Oasis area outside ID-1 will be completed in the late-2020s. Because detailed engineering studies have not been conducted, separate environmental documents will be prepared for this project prior to its implementation.

Conversion of Municipal Use to Canal Water

Approximately 30 percent of the municipal demand in the Lower Valley would receive Canal water. The facilities required for this conversion would include the construction of one or more potable water treatment plants having a total capacity of at least 30 mgd. Other facilities would include pipelines to convey water from the Canal to the filtration plants, pipelines, pumping stations and reservoirs to deliver water from the filtration plants to the existing municipal water systems. Total municipal usage of treated Canal water is estimated to be about 32,000 acre-ft/yr. These facilities are projected to be phased in during the late 2020s and early 2030s.

Groundwater Recharge

Groundwater recharge is an important management element. Overall, groundwater recharge under the preferred alternative will increase above No Project. Recharge activities in the Upper and Lower Valley are described below.

Upper Valley

CVWD and DWA would recharge up to an average of 103,000 acre-ft/yr of SWP water at the Whitewater Spreading Facility. As with the current operation, SWP water would be exchanged for Colorado River water with Metropolitan. No capital improvements would be required at the Whitewater facility.

Lower Valley

Under the preferred alternative, approximately 80,000 acre-ft/yr of Coachella Canal water will be recharged in the Lower Valley. This amount will be phased in over time at recharge facilities anticipated to be near Dike No. 4 and in the Martinez Canyon area.

Dike No. 4: Although it may be possible to recharge in the range of 30,000 to 60,000 acre-ft/yr at the Dike No. 4 location, the Plan assumes an average recharge rate of approximately 40,000 acre-ft/yr. The Dike No. 4 recharge facility would be constructed within three to four years. The facility would include approximately 240 acres of recharge ponds along with a pumping station and over two miles of pipeline to convey water from Lake Cahuilla to the site. This recharge project will be subjected to separate environmental review when the project is more thoroughly defined.

Martinez Canyon: CVWD has evaluated other potential recharge sites in the Lower Valley including the Martinez Canyon area along the western margin the Valley. The Martinez Canyon recharge facility is expected to be operational by the mid-2010s and would be at full capacity by the mid-2020s. The basins could be constructed in phases to match the availability of Canal water. An average recharge rate of approximately 40,000 acre-ft/yr is assumed. The facility is expected to include approximately 240 acres of recharge basins, a pumping station and about three miles of pipeline to convey water from the Oasis Tower to the site. This recharge project will be subjected to separate environmental review when the project is more thoroughly defined. The District plans to conduct a demonstration recharge study on District-owned land on the alluvial fan to determine the feasibility of a large scale facility.

Groundwater Monitoring Program

As the Plan is implemented, the District's ongoing groundwater monitoring program will play an integral role in the District's understanding of the basin's response to different plan elements. The effectiveness of the Plan will be measured against its impacts on groundwater levels, water quality, and subsidence potential. In addition to continuation of the CVWD/USGS land subsidence studies, additional monitoring wells will be constructed as part of the program. Data collected through the monitoring program will enable the District to accurately assess individual plan elements and their effectiveness in meeting the goals of the Plan.

Cooperative Agreements with Other Agencies

The District, DWA, and Metropolitan have historically worked together on programs which are mutually beneficial to all three agencies. The exchange program at the Whitewater Spreading Facility and the advance delivery program are two such examples. Several other programs, which would provide benefits to both the Coachella Valley and to Metropolitan, are currently being studied. These programs are designed to provide the Coachella Valley with a firm long-term water supply and to provide Metropolitan with the dry-year supplies needed to serve its member agencies. Projects currently under consideration include:

- transfer of a portion of Metropolitan's SWP entitlement to DWA and the District and
- implementation of a conjunctive use program with Metropolitan to store surplus water in the Valley's groundwater basin during wet periods to be recovered during drought periods.

Implementation Costs

Each management category-conservation, groundwater recharge, and source substitution-will have specific implementation costs in addition to the baseline costs associated with the No Project alternative. The baseline costs include existing water conservation activities, existing delivery of recycled water to Upper Valley golf courses, and the continued purchase of existing SWP entitlements for Upper Valley groundwater recharge. In order to spread these implementation costs over the entire planning period, assumptions were made regarding the initiation of certain management elements within each category. Conservation activities primarily involve costs associated with additional manpower, which are included as an operation and maintenance (O&M) cost. The costs associated with groundwater recharge and source substitution activities include both capital and O&M costs.

The average annual implementation costs for the preferred alternative throughout the planning period are illustrated in Figure H. The total capital cost associated with groundwater recharge and source substitution elements in the preferred alternative is estimated at $180 million. The average annual costs for each category include capital costs, depreciation of the capital investment over time, and O&M costs (fixed and variable).

Financing Mechanisms

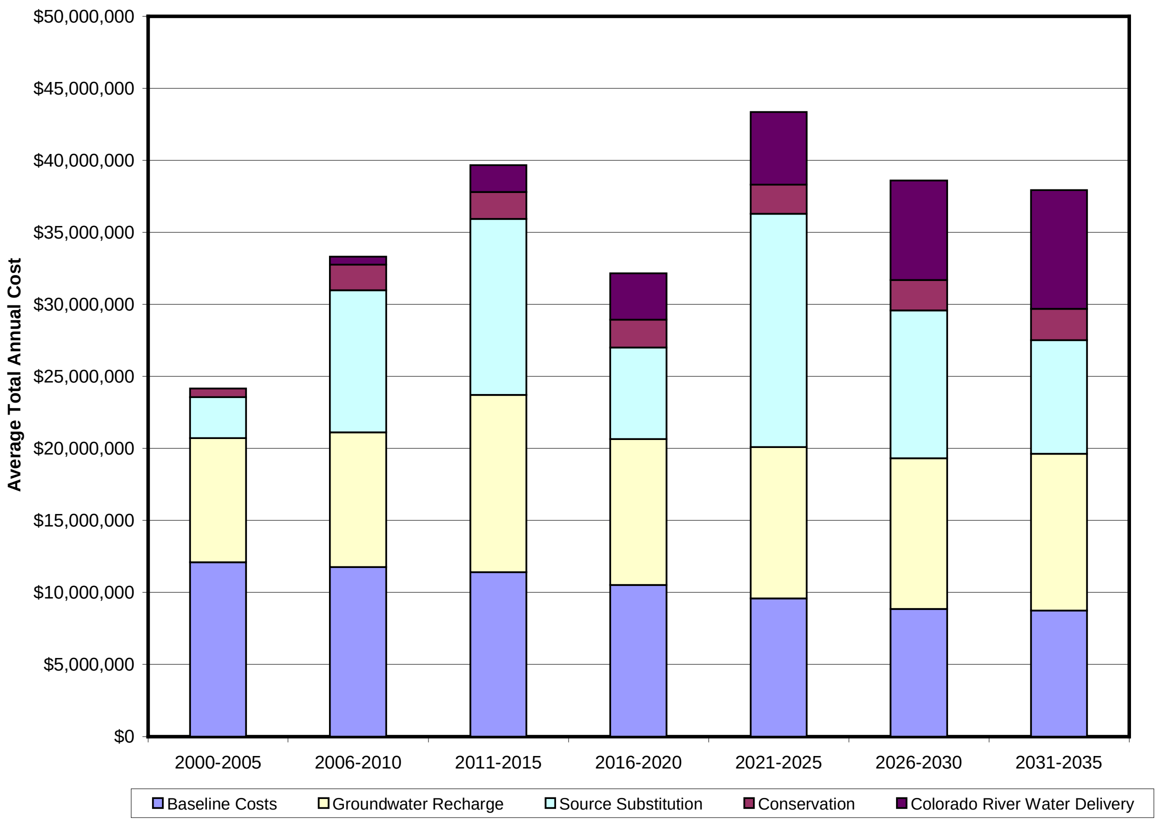
Several financing mechanisms are available to provide funding for the Plan including:

- water rates,
- replenishment assessments,
- assessment districts,
- general property taxes,

- financing by agencies outside the District,
- grants, and
- developer fees.

It is not possible at this time to predict the specific financing mechanisms that will be applied to each of the elements of the preferred alternative. Funding will likely be through a combination of mechanisms that best meet the needs of the Valley's water users. As appropriate, public input regarding financing options may be sought as specific items are proposed or constructed.

Figure H
Estimated Total Annual Implementation Cost for the Preferred Alternative



Effects on Water User Groups

Until such time as specific financing mechanisms are determined, it is not possible to determine the exact economic impact on different types of user groups. Table 4 shows the possible economic effects on several different types of user groups within the Coachella Valley.

CONCLUSIONS

The Coachella Valley Water Management Plan's goal is to assure adequate quantities of safe, high-quality water at the lowest cost to District water users. If the Plan is to succeed, it must be a living document that is flexible and can be adapted to meet the changing needs of the Coachella Valley. As management elements are set in place, and results of implementation strategies are quantified, the Plan will be periodically evaluated to determine how well it is meeting the needs of the Valley, to consider new information and opportunities, and if needed to make appropriate adjustments. Along with the Plan, a Programmatic Environmental Impact Report has been prepared that fully discusses the social and environmental impacts of the preferred alternative.

Table 4
Economic Effects on Water User Groups

Water User Group	Range of Effects
Domestic Water Users (District Wide)	\$0.05 to \$0.20 per hundred cubic feet
Canal Water Users (Lower Valley only)	\$0 to \$5 per acre foot
Lower Valley Groundwater Users	\$10 to \$40 per acre foot
Upper Valley Groundwater Users	\$0 to \$25 per acre foot
Property Owners	\$0 to \$0.02 per \$100 taxable value
Developer Fees	\$0 to \$2,000 per unit

The next step is a public review of the Plan. Public forums and workshops will invite input from the general public, taxpayers, water users, local governments, tribal interests, federal and state agencies, and other Colorado River water users. Public review may result in modifications to the proposed preferred alternative. It is anticipated that the Plan will be recommended to the District Board of Directors for adoption near the end of 2000.

Actions needed to ensure that the preferred alternative meets the objectives of the Plan require commitment, consensus, and cooperation from all water users in the Valley. The success of past water management efforts, coupled with implementation of the recommendations in the Coachella Valley Water Management Plan, will allow the Coachella Valley to sustain its vibrant economy and move into the new century with a reliable, affordable, and stable water supply.

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Section 1
Introduction

PURPOSE OF AND NEED FOR A WATER MANAGEMENT PLAN

Background

Over thousands of years, freshwater inflows from rainfall and snow melt left millions of acre-feet of high-quality water in the Coachella Valley groundwater basins. As the Valley developed, this precious resource was tapped to quench the growing thirst of agriculture, golf courses, and ever-increasing urban demands. Demands quickly increased and for several decades have annually exceeded the limited natural supplies. This mining of groundwater has resulted in declining groundwater levels and raised concerns about possible water quality impacts and land subsidence.

In the early part of the century, farming in the Lower Valley (from Indio to the Salton Sea) boomed because of the Valley's warm climate and its seemingly infinite supply of flowing artesian groundwater. Early settlers soon learned, however, that the supply of high-quality groundwater was indeed finite. As demand on the groundwater basin increased, groundwater levels began dropping and artesian wells ceased flowing. The Coachella Valley Water District (CVWD or District) was formed in 1918 in response to concerns about protecting the Valley's water supplies.

The groundwater table in the Lower Valley continued to drop until Colorado River water was introduced to the Coachella Valley in 1949. Groundwater levels began to rise soon after the first application of Colorado River water and quickly returned to levels that had existed prior to agricultural development. The water table remained fairly stable through the early 1980s but then began to decrease sharply. Groundwater demand had once again exceeded supply, resulting in decreases in groundwater levels of more than 60 feet in some portions of the Lower Valley.

Development of the Upper Valley (Palm Springs to Indio) has occurred primarily because of the golf and destination resort industry, which dominates the Upper Valley economy. Around 80 of the Valley's approximately 100 golf courses lie in the Upper Valley. In 1925, when the Coachella Valley's first golf course was constructed, Palm Springs was a sleepy getaway for the rich and famous. The cities of Rancho Mirage, Palm Desert, and Indian Wells were not even wide spots in the road. Today, all of these cities are world-renowned destination resorts.

As golf courses, resorts, and the corresponding population grew, so did the demand on the Upper Valley's groundwater. In 1963, the District and the Desert Water Agency (DWA) entered into agreements to purchase water from the California State Water Project (SWP) to alleviate declining water tables in the Upper Valley. To avoid the estimated $150 million cost of constructing a pipeline to bring SWP water to the Coachella Valley, the District and DWA entered into an exchange agreement with the Metropolitan Water District of Southern California (Metropolitan) to deliver water to the Valley. Metropolitan takes CVWD and DWA SWP entitlements while delivering an equivalent amount of Colorado River water to the Coachella Valley. The exchanged Colorado River water is percolated into the ground at the District's Whitewater River Spreading Facility to replenish the Upper Valley's groundwater aquifer.

Averaging approximately 50,000 acre-feet per year (acre-ft/yr), more than 1.7 million acre-ft of Colorado River water has been delivered to the Upper Valley through this exchange since 1973. An advanced delivery agreement also allows Metropolitan to store excess Colorado River water in the Upper Valley's groundwater aquifer. During periods of shortages, Metropolitan uses CVWD and DWA's SWP entitlement while CVWD and DWA use the water stored by Metropolitan in the groundwater basin. Even with this additional supply of water to the Upper Valley, groundwater levels continue to decline.

Because the amount of groundwater being pumped from the Valley's groundwater basins exceeds the amount replenished, the aquifers have been in overdraft for a significant portion of the last century. Overdraft is a condition of a groundwater basin in which the amount of water extracted exceeds the amount of water recharging the basin over a period of time (California Department of Water Resources Bulletin 160-93). The bulletin also defines "the critical condition of overdraft" as water management practices that would probably result in significant adverse overdraft-related environmental, social, or economic effects. Water quality degradation and land subsidence are two examples of such effects.

Effects of Continued Groundwater Overdraft

Continued overdraft will have serious consequences for the Coachella Valley. The immediate and direct effect will be increased groundwater pumping costs for all water users. Wells will have to be deepened, larger pumps will have to be installed, and energy costs will increase as pump lifts increase. Eventually, the need for deeper wells and larger pumps will begin to have an adverse impact on agriculture, as well as on the cost of water for municipalities, resorts, homes, and businesses. However, these will not be the most serious effects in the long term.

Continued decline of groundwater levels could result in a substantial and possibly irreversible degradation of water quality in the groundwater basins. Until now, the Coachella Valley groundwater basin has provided high-quality water supplies for municipal and agricultural use. Poor-quality water may come from two sources: (1) downward flow from the degraded upper aquifers in the Lower Valley and (2) intrusion of highly saline Salton Sea water into the Lower Valley aquifer. In the Lower Valley, historically high groundwater levels in the Lower Aquifer have prevented leakage of poor-quality water from the upper aquifers by maintaining an upward pressure gradient. Rather than leak into the lower aquifers, the degraded water flows into man-made drains to the Salton Sea. However, reduction of water levels in the lower aquifers allows for downward leakage of this water and subsequent degradation of water quality.

Located immediately south of Coachella Valley, the Salton Sea has salinity levels 25 percent higher than that of ocean water. This water is too salty to grow crops, to irrigate golf courses or lawns, or to drink. Having no outlet, Salton Sea water evaporates, leaving more concentrated salt water. Historically, groundwater pressure levels in the lower aquifers have been high enough to keep denser Salton Sea water from displacing the high-quality waters in adjacent freshwater aquifers. Continued decline of groundwater levels may cause high-quality water to be displaced by salt water. As displacement occurs, wells near the Salton Sea, and eventually large areas in the Lower Valley, may become unusable, as they pump saline water. Once saltwater intrusion occurs, it is extremely expensive, if not impossible, to remove salts from the groundwater basins. Groundwater currently accounts for about 63 percent of the Coachella

Valley's total water supply. Saltwater intrusion would result in loss of the groundwater resource, seriously affecting the Coachella Valley economy.

Continued overdraft also increases the possibility of land subsidence within the Lower Valley. As groundwater is removed from the lower Coachella Valley groundwater aquifers, the soil begins to compress from the weight of the ground above, causing subsidence. Subsidence can cause ground fissures and can damage buildings, homes, sidewalks, streets, and buried pipelines — all of the structures that make the valley livable. Within the Lower Valley, subsidence may have occurred in the late 1940s after a significant decline in groundwater over a 30-year period (Ikehara et al. 1997). If groundwater levels continue to decline in the Lower Valley, the potential for subsidence will increase dramatically.

Action Required by Coachella Valley Water District

It is clear that the continued decline of groundwater levels is unacceptable. The District is charged with providing a reliable, safe water supply to its area of the Valley now and in the future. In order to fulfill its obligations to Valley residents, the District must take action to prevent continuing decline of groundwater levels and degradation of water quality. A comprehensive water management plan will guide the District in its efforts to prevent groundwater level decline, protect water quality, prevent subsidence, and expand its water conservation programs.

WATER MANAGEMENT PLAN PROCESS

To meet its responsibilities for ensuring that there are adequate water supplies in the future, the District initiated a planning process in the early 1990s. The process initially addressed the Lower Valley. In 1995, it was expanded to include the entire Coachella Valley. The resulting Water Management Plan (Plan) is the product of that process.

Goals and Objectives of Water Management Plan

The District's overall goal is to assure adequate quantities of safe, high-quality water at the lowest cost to Coachella Valley water users. In order to meet this goal, four objectives have been identified for the Water Management Plan:

- eliminate groundwater overdraft and its associated adverse impacts, including:
  - decreasing groundwater basin storage,
  - declining groundwater levels,
  - land subsidence, and
  - water quality degradation,
- maximize conjunctive use opportunities,
- minimize adverse economic impacts to Coachella Valley water users, and
- minimize environmental impacts.

These objectives provide the basis for evaluating various management alternatives.

Formulation of Plan Alternatives

The District staff and consultants conducted several brainstorming sessions to identify potential water management elements for inclusion in the Plan. Potential elements were considered without regard to cost, potential environmental impact, technical feasibility, or other considerations. Additional input was obtained through public meetings with local Indian tribes, state and federal agencies, regional and local governments, and other interested and affected parties, and the public at large resulting in additional potential management elements for consideration.

Potential management elements were subsequently organized into four categories: pumping restrictions, demand management, source augmentation, and source substitution. Each of the potential management elements was rated based on the element's ability to reduce overdraft, technical feasibility, potential environmental impacts, costs, legal and regulatory factors, and regional economic impacts. The elements then underwent a screening process in order to determine which elements would be included in the Plan alternatives described in Section 5. An expanded description of the element screening and alternative formulation process is contained in Appendix B.

Ultimately, four alternative management scenarios were developed.

- **Alternative 1 – No Project:** required by CEQA regulations.
- **Alternative 2 – Pumping Restrictions by Adjudication:** court ordered restrictions imposed through a process in which water rights of the basin are allotted to individual groundwater pumpers.
- **Alternative 3 – Management of Demand and Maximization of Local Resources:** manages demand through aggressive water conservation measures and maximizes the use of local water resources.
- **Alternative 4 – Combination Alternative:** a combination of the most feasible and cost effective elements identified at the conclusion of the potential management alternative screening process.

Evaluation of Alternatives

Each alternative was evaluated based on its ability to meet the stated goals and objectives of the Plan. To assist in evaluating the alternative plans, the District developed a computerized three-dimensional groundwater flow model for the Coachella Valley. The model was subjected to a scientific peer-review by leading groundwater experts to verify its formulation and operation. Appendix C contains additional information on the groundwater model. The evaluation process, which is described in Section 6, indicated that Alternative 4 best meets the Plan's goals and objectives and has been selected as the preferred alternative.

Public Review and Environmental Considerations

The Plan is subject to review under the California Environmental Quality Act (CEQA). To comply with CEQA, the District has prepared a Programmatic Environmental Impact Report (PEIR) to evaluate the environmental impacts of the Plan and to identify environmental mitigation, as appropriate. The PEIR evaluates a series of actions that are part of one large project and are related either geographically or as parts of a chain of contemplated actions.

There are several advantages to a PEIR. First, it can provide a more detailed consideration of overall effects and alternatives than would be practical for an environmental impact report (EIR) on an individual action. Second, it ensures consideration of cumulative impacts that might be slighted in a project-level EIR. Next, it avoids duplicate consideration of basic policy issues. Fourth, it allows the District to assess broad policy alternatives and program-wide mitigation measures at the beginning of the program, when the District has greater flexibility to deal with basic problems or cumulative impacts.

Subsequent activities that are implemented as part of the Plan will be examined in the light of the PEIR to determine whether additional environmental documentation must be prepared. If a future activity has effects that were not examined in the PEIR, a new initial study will be prepared leading to either a project-specific EIR or a negative declaration. If the District finds that no new effects occur or no new mitigation measures will be required, the District can approve the activity as being within the scope of the project covered by the PEIR, and no new environmental document would be required. If a subsequent EIR or negative declaration is required, the PEIR can be incorporated by reference, and the later document will focus solely on any new effects which had not been considered before.

The draft PEIR will be released to all interested public agencies and individuals for review and comment. The draft PEIR, along with the Plan, will have a 45-day review period. As part of the public review process, the District will hold a public meeting in the Valley to solicit citizen and agency input. Agencies responsible for environmental permitting are expected to use the PEIR in their decision-making process for the consideration of permits or approvals within their jurisdictions. All agencies and interested individuals are expected to review the PEIR. Initial contacts with these agencies were made through the Notice of Preparation (NOP) process outlined in the state CEQA guidelines. Recipients of the NOP were notified that a PEIR is being prepared for the proposed project and were given an opportunity to express their concerns and to identify issues to be addressed in the PEIR. The NOP and responses to it are included in an appendix to the PEIR. A public scoping meeting was held to receive oral comments from the public on the contents and level of detail of the PEIR.

Financing

The District is committed to providing value to its customers. There are substantial long-term costs to the community of not managing and meeting future water needs including water quality degradation and subsidence. To prevent these adverse effects, the entire community should share in the costs of prevention.

Although no specific policies regarding financing of Plan elements have been determined, the District is committed to meeting customer needs in an efficient, effective, and equitable manner. Long-range plans for infrastructure improvements will be balanced against the ability to finance the improvements. Equity is also key to financing Plan elements. No user group should underwrite the costs of other groups.

Water rates are one possible source of funding for many elements of the Plan. Other potential sources include replenishment assessments on groundwater pumpers, formation of local assessment districts, general property taxes, agencies outside the District via cooperative water development and management programs, and grants. All potential sources of funding will be considered for each Plan element while maintaining balance among 1) least costs, 2) the customers willingness to pay for a particular element, and 3) equity among user groups.

PARALLEL PROCESS REGARDING WATER SUPPLY

At the same time that the Coachella Valley Water Management Plan was being developed, negotiations were underway between California water agencies to develop a plan to determine how California will reduce its use of Colorado River water from over 5.0 million acre-ft/yr to the 4.4 million acre-ft/yr that is the basic California entitlement.

California's Colorado Water Use Plan

An integral part of California's Colorado Water Use Plan involves transfer of Colorado River water from agricultural to urban agencies (Colorado River Board of California, 2000). Such transfers, in turn, will require quantification of the entitlements of the agricultural agencies proposing to make such transfers in order to establish a baseline from which the amount of transfers can be measured. Currently, the California agricultural agencies' entitlements are prioritized but are not quantified in terms of actual amounts or volumes.

Under the 1931 Seven Party Agreement, which divides California's share of Colorado River water among seven California agencies, the agricultural agencies are collectively entitled to the first 3.85 million acre-ft of California's 4.4 million acre-ft annual Colorado River entitlement. Palo Verde Irrigation District has the first priority for the amount needed to irrigate 104,500 acres in the Palo Verde Valley, the Yuma Project has the second priority for water to irrigate up to 25,000 acres, and the third priority is held by the Imperial Irrigation District and the Coachella Valley Water District (and Palo Verde Irrigation District for its Mesa lands) for the irrigation of lands in the Imperial and Coachella Valleys.

Thus, CVWD shares the third priority with IID, but, by reason of a 1934 Agreement between the two agencies, IID has the first option to take as much third priority water as it can put to reasonable and beneficial use within its service area, a senior right which put CVWD's Colorado River water supply at risk.

Quantification Settlement Agreement

A tentative agreement reached between CVWD, IID, and Metropolitan would quantify IID's share of the third priority at 3.1 million acre-ft and Coachella's share at 330,000 acre-ft. The tentative agreement further provides additional Colorado River water to Coachella from shares of IID and Metropolitan. The total ultimately available to CVWD would be an average of 456,000 acre-ft/yr during the lifetime of the agreement known as the "Quantification Settlement Agreement." Under the Quantification Settlement Agreement, Coachella's share of Colorado River water would be a reliable supply rather than one that could be at risk.

As mentioned above, the Quantification Settlement Agreement is a necessary part of the California's Colorado River Water Use Plan, which is literally required by law to be implemented. For that reason, the preferred alternative assumes that CVWD's entitlement to Colorado River water will be realized in the amounts and according to the build-up schedule set out in the Key Terms for Quantification Settlement.

With ultimate build-up of Colorado River water entitlement occurring under the Quantification Settlement Agreement in 2033, the planning period in the Water Management Plan looks at near term (through 2015) and long-term (2015 through 2035) time frames. The emphasis of the Plan is on the near term since a new set of circumstances may exist beyond 2015 with respect to economics, population growth, water demands, potential water supply sources, and other factors affecting the Valley's future. As necessary, a significant change in circumstances will be evaluated and incorporated into Plan updates.

PLAN CONTENTS

In addition to this introductory section, the Plan includes the following sections:

Section 2 - The Coachella Valley

This section provides a general description of the Coachella Valley, the Coachella Valley Water District, and the environmental resources of the Coachella Valley.

Section 3 - Historic Water Management

This section provides a discussion of the historic water management activities in the Coachella Valley and the impacts on groundwater overdraft, water quality, subsidence, and saltwater intrusion.

Section 4 - Baseline Conditions - No Project

This section provides a detailed description of the water management activities associated with Alternative 1, the No Project alternative. This section includes demand and supply projections and subsequent impacts on groundwater overdraft, water quality, subsidence, and saltwater intrusion if a water management plan is not adopted.

Section 5 - Water Management Plan Alternatives

This section presents descriptions of the alternative water management strategies developed to meet the objectives of the Plan. The alternatives look at water management from different conceptual viewpoints with the intent of achieving the goals of the Plan in a timely, cost-effective, and environmentally responsible manner.

Section 6 - Evaluation of Alternatives

This section outlines the process, criteria, and results associated with the evaluation and selection of the preferred alternative.

Section 7 - Implementation of Preferred Alternative

This section describes the strategy for implementation of the preferred alternative.

Section 2
The Coachella Valley

The Coachella Valley lies in the northwestern portion of a great valley, the Salton Trough, which extends from the Gulf of California in Mexico northwesterly to the Cabazon area. The Colorado River intersects this trough about midway, and its delta has formed a barrier between the Gulf of California and the Coachella and Imperial valleys. The Coachella Valley is ringed with mountains on three sides. On the north and west sides are the San Bernardino Mountains, San Jacinto, and Santa Rosa, which rise more than 10,000 feet above mean sea level (MSL). To the northeast and east are the Little San Bernardino Mountains, which attain elevations of 5,500 feet above MSL (see Figure 2-A).

The Plan study area is defined as the Coachella Valley floor, from the surface water divide near the northwest end of the Valley (San Gorgonio Pass) to the Salton Sea at the southeastern end. The Banning and San Andreas faults bound the area to the north and east, backed by the Indio Hills and Little San Bernardino Mountains. The Desert Hot Springs area overlies the Mission Creek subbasin that is northeast of the Banning Fault. Although somewhat hydrologically connected to the Plan study area, the Mission Creek subbasin is being studied separately in a joint effort by CVWD, DWA, and Mission Springs Water District.

For purposes of the Plan, the Coachella Valley is divided into the Upper Valley and Lower Valley. Geographically, the Lower Valley is southeast of a line extending from Washington Street and Point Happy northeast to the Indio Hills near Jefferson Street, and the Upper Valley is northwest of this line (Figure 2-A).

DEVELOPMENT OF THE COACHELLA VALLEY

The principal economic base of the Upper Valley is resort development associated with golf courses, which began in 1926. The economic base for the Lower Valley is dominated by agriculture. These two economic sectors also drive water demands and the need for water supply management in both the Upper and Lower Valleys.

Upper Valley

The Upper Valley, largely undeveloped prior to World War II, now includes open space, urban areas, and extensive resort development. The Upper Valley includes the cities of Palm Springs, Cathedral City, Rancho Mirage, Palm Desert, Indian Wells, and Desert Hot Springs, along with the unincorporated communities of Thousand Palms, Garnet, North Palm Springs, and Whitewater. These communities include major resort destinations with hotels, restaurants, shopping areas, major residential developments, celebrity homes, and approximately 80 golf courses. In 1994, the last time the economic contributions of tourism were calculated by local agencies, approximately 3.6 million visitors to the Upper Valley contributed more than $1.1 billion to the regional economy (Source: Palm Springs Resort and Convention Bureau). Portions of the Upper Valley lands are Indian-owned and contain several reservations. Casinos on Indian land are located near Cabazon and Palm Springs.

Lower Valley

The economic base of the Lower Valley was established in the late 19th century by mining and railroading. The development of deep-well drilling techniques advanced the settlement of the Lower Valley, which includes the cities of La Quinta, Indio, and Coachella; and three unincorporated communities, Thermal, Bermuda Dunes, and Mecca. Economical well-drilling methods and pumping machinery reduced the cost of water supply, and farming activities in the Lower Valley expanded rapidly.

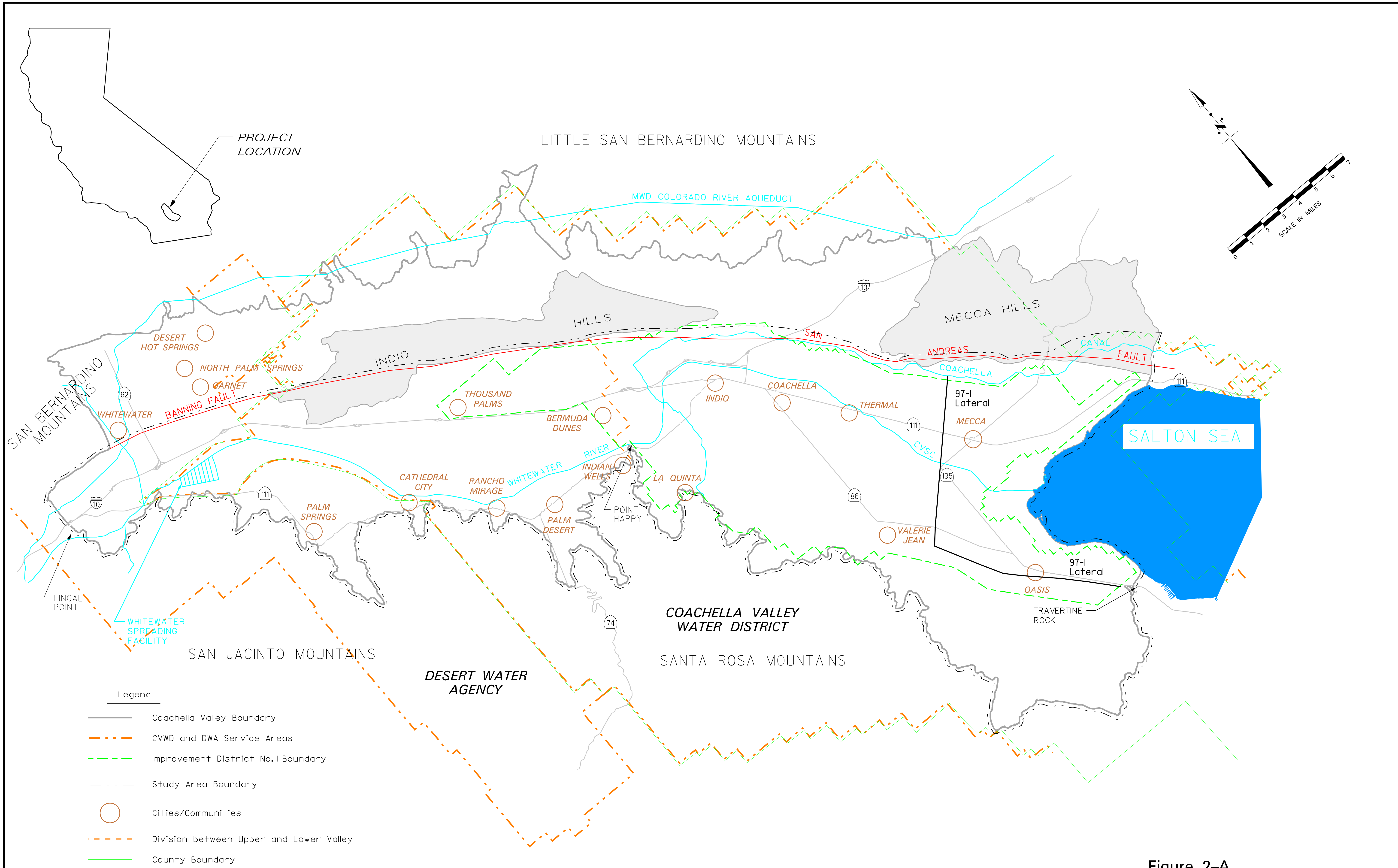
Completion of the Coachella Canal by the U.S. Bureau of Reclamation (Reclamation) in 1949 resulted in further expansion of irrigated farming. In 1948, about 23,000 acres were under irrigation. By 1964, irrigated acreage exceeded 50,000 acres (Department of Water Resources 1964), and, in 1999, there were 72,800 irrigated acres (CVWD 1999). Principal fruit crops are dates, table grapes, grapefruit, lemons and limes, oranges and tangerines, and watermelons. Corn, lettuce, carrots, broccoli, beans, onions, bell peppers, and squash are the principal vegetables. The Lower Valley also has fish farms and greenhouses, which have located there because warm groundwater in a geothermal area is beneficial to their operations. Agriculture is now the mainstay of the economy in the Lower Valley. In calendar year 1999, the District delivered Coachella Canal water to 72,800 acres with a value of product of $570 million or $7,832 per acre (CVWD 1999). Most of this production was in the Lower Valley.

In 1992, the gross value per irrigated acre of the Coachella Valley ranked fourth among all projects in the western United States being supplied irrigation water by Reclamation. Comparisons of the average gross value per acre with other areas in California and the western United States are provided below.

Table 2-1
Comparison of Gross Crop Values for Selected Areas in the Western United States

Project	Gross Crop Value per Irrigated Acre
Top four irrigation projects:	
Traction Ranch - Casper (California)	$11,475
Centerville - Duell Creek (Utah)	$11,250
Greater Wenatchee Division (Washington)	$ 9,075
Coachella Valley	$ 6,286
Other projects:	
Yuma Project, Arizona - California	$3,345
Welton Mohawk, Arizona	$1,803
Salt River Project, Arizona	$1,787
Imperial Irrigation District	$1,036
Central Arizona Project	$ 868

1992 Summary Statistics, Water, Land, and Related Data; U.S. Bureau of Reclamation



MONTGOMERY WATSON

Figure 2–A

Study Area

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In addition to the agricultural economy, urban development is increasing in the Lower Valley. Golf courses in the northern portion of the Lower Valley have expanded dramatically in recent years and are projected to continue growing in the future. In addition, two Indian-owned casinos, located near Indio, also contribute to the Lower Valley economy.

Demographic Overview

There are approximately 330,000 permanent residents living in over 107,000 households in the Coachella Valley. About 75 percent of Valley residents lived in one of the nine incorporated cities, while the other 25 percent lived in unincorporated portions of the Valley. Palm Springs and Indio were the two largest cities, each with a population exceeding 48,000 residents. Table 2-2 summarizes the 2000 population distribution in the Valley according to projections prepared by the Southern California Association of Government's and used by the Coachella Valley Association of Governments.

Table 2-2
Coachella Valley Resident Population, 2000

Communities	Population
Cathedral City	38,844
Coachella	22,925
Desert Hot Springs	18,158
Indian Wells	3,540
Indio	48,535
La Quinta	21,489
Palm Desert	32,349
Palm Springs	48,257
Rancho Mirage	12,846
Unincorporated	82,594
Total	**329,537**

Source: SCAG, 1998.

A portion of the population shown in Table 2-2, including all of Desert Hot Springs and portions of other Upper Valley areas, lives outside the study area for the Water Management Plan. Based on analysis of population distribution by census tract, the year 2000 population within the study area is estimated at about 284,700 residents.

In addition to the permanent population, the Coachella Valley is also home to a large number of seasonal residents who own second homes in the area. The seasonal resident population has been estimated at approximately 117,000 (*Economic Overview of the Coachella Valley*, Wheeler's, 2000). BBC Research and Consulting (2000) estimates that there are roughly 52,000 second homes in the Coachella Valley.

The Coachella Valley is expected to continue to experience substantial population growth during the planning period. Projections produced by the Coachella Valley Association of Governments and the Southern California Association of Governments indicate that by year 2020 the Valley's population is expected to grow to nearly 490,000 permanent residents. The projected average annual growth rate between 2000 and 2020 is nearly 2.0 percent, with the most rapid growth expected to take place in the Lower Valley. Continued growth in seasonal residences is also likely.

For purposes of the Water Management Plan, the CVAG population growth projections have been extended from 2020 to 2035 based on the average annual population increase projected between 2015 and 2020. Table 2-3 summarizes demographic conditions in the Coachella Valley in 2000, 2020 and 2035.

Table 2-3
Demographic Conditions in the Coachella Valley

	2000	**2020**	**2035**
Permanent Population (entire Valley)	329,500	490,000	634,000
Permanent Population (study area)	284,700	414,200	528,800
Households	107,100	164,000	213,000
Seasonal Population	117,000	174,000	225,000
Seasonal Residences	52,000	77,000	100,000

Source: SCAG, 1998; Wheelers, Montgomery Watson and BBC estimates, 2000.

Employment

There are currently between 135,000 and 140,000 jobs located in the Coachella Valley (CVAG, 1998). CVAG projects that employment in the Valley will increase to about 200,000 jobs by 2020. Like the demographic estimates described previously, estimates of employment in the Valley are approximations, since sub-county economic and demographic statistics are not regularly compiled by state or federal sources.

The Palm Springs Department of Economic Development has produced an estimate of the number of Coachella Valley jobs by industrial classification. This estimate is depicted and compared with the average composition of employment throughout Riverside County and the state of California in Table 2-4.

Compared with the state as a whole, the Coachella Valley economy has a substantially larger proportion of jobs in agriculture, construction, retail trade and services and a comparatively small proportion of jobs in manufacturing, wholesale trade and government. These differences are consistent with an economy in the Coachella Valley that is largely driven by tourism and agriculture and that also is experiencing robust growth in both permanent and seasonal housing.

Indian Trust Assets

Most lands within the Coachella Valley are either private lands or public lands administered by the U.S. Bureau of Land Management (BLM). Indian trust assets are interests held in trust by the United States for Indian individuals and tribes.

Table 2-4
Estimated Distribution of Coachella Valley Employment by Sector

Component	Coachella Valley (%)	Riverside County (%)	California Average (%)
Agriculture & Mining	7.1	5.8	4.0
Construction	6.6	7.8	4.7
Manufacturing	3.1	8.8	11.2
Transportation, Communication	4.4	3.1	4.5
Wholesale Trade	3.1	3.1	4.5
Retail Trade	21.2	18.8	15.9
Fire	7.1	6.9	8.0
Services	40.7	30.9	33.7
Government	6.6	14.8	13.3
TOTAL	99.9*	100.0	99.8*

*Sum does not equal 100 due to rounding. Source: Coachella Valley Economic Partnership, Regional Economic Information System, 1997 data.

A number of Indian land reservations are located within the Coachella Valley. Major Indian reservation lands include Torres Martinez Indian Reservation, Cabazon Indian Reservation, Augustine Indian Reservation, Agua-Caliente Indian Reservation, and 29 Palms Reservation. For this Plan, no distinctions are made among Indian trust assets and other lands within District boundaries. Table 2-5 indicates the approximate acreage of reservation lands within the study area.

Table 2-5
Approximate Indian Reservation Acreage

Tribe	Acres
Agua Caliente	23,200
Augustine	502
Cabazon	1,374
Torres Martinez	24,024
29 Palms	240
Total	**49,340**

COACHELLA VALLEY WATER DISTRICT

Early in this century, the Imperial Valley agricultural industry was growing and needed additional water. Imperial Valley farmers conceived a plan to tap the Whitewater River and export water from the Coachella Valley. Although the project did not materialize, the possibility of losing a valuable resource prompted the organization of the Coachella Valley County Water District to conserve and protect the water of the Coachella Valley and to develop a supplemental water source for irrigation. This supplemental source became Colorado River water delivered to the Lower Valley via the Coachella Branch of the All American Canal. Improvement District No. 1 (ID-1) was established to include the irrigable land provided with Colorado River water. The District's contract with Reclamation restricts Colorado River water use to beneficial uses for lands within ID-1.

The Coachella Valley Water District was formed in January 1918 under the California Water Code provisions of the County Water District Act. The Coachella Valley Stormwater District was formed in 1915. The two districts merged in 1937. The District now encompasses approximately 637,000 acres, mostly within Riverside County, but also extending into northern Imperial and San Diego Counties.

District Services

The water-related services provided by the District to most of the Coachella Valley include irrigation water delivery and conservation, domestic water delivery and conservation, wastewater reclamation and recycling, stormwater protection, agricultural drainage, water education, and groundwater recharge.

Irrigation Water Delivery and Conservation

The District's Colorado River irrigation distribution system was built to include conservation measures unheard of in the 1940s and rarely used elsewhere even today. Unique to that initial system was a pipeline distribution system, a pipeline drainage system, and metered deliveries to every farm. Of the Colorado River water reaching the Coachella Valley, 98.5 percent (or approximately 300,000 acre-ft/yr) is delivered to farmers. Several water conservation and management activities are incorporated into the District's irrigation distribution system.

- The Coachella Branch of the All American Canal was concrete-lined within the District's water service area.

- A network of nearly 500 miles of distribution system consists entirely of buried pipeline to eliminate seepage and evaporation losses.

- The District's system was designed to prevent tail water by eliminating a place for it to be collected. District drains are mostly buried, perforated pipelines that require water to penetrate the soil for collection.

- In 1968, the District built Lake Cahuilla to provide a place to store Colorado River water, to meet changing needs, and to avoid wasteful spills.

- In the mid-1960s, the District placed the canal system under telemetry control, allowing operators to monitor and control water delivery facilities throughout a 1,000-square-mile area around the clock from District headquarters. If more water is in a farm delivery system than can be used by the farmers on that system, an alarm sounds so the water can be cut back before significant waste occurs.

- Aquatic weeds clog canals which slow the water and increase losses through evapotranspiration and plugging meters and pipelines. The District has achieved complete control of aquatic vegetation through stocking of triploid grass carp in the Coachella Canal.

- Coachella Valley farmers have been at the forefront in the use of water-efficient irrigation techniques such as drip. This technique has shown water savings of up to 60 percent. More than 50 percent of the irrigated acreage in ID-1 is irrigated by drip systems. To facilitate irrigation, landowners have constructed more than 250 water-regulation reservoirs.

- The District has encouraged and supported the study of optimal irrigation and drainage techniques.

- In 1997, the District restructured its water-ordering procedures to allow water to be turned on and off at any time. Previous District procedures required orders to be placed well in advance and allowed for turn-ons and turn-offs only at certain times of the day. This procedure has increased operational flexibility for irrigators and increased efficiency.

Domestic Water Delivery and Conservation

The District provides domestic water for nearly 192,000 Coachella Valley residents (CVWD 1999). The distribution system includes 63 reservoirs, over 1,600 miles of pipelines, and 92 domestic wells.

- More than half of residential and commercial construction in the Coachella Valley is relatively recent and includes water-conserving plumbing.

- To demonstrate low-water-use plants, the District maintains a xeriscape demonstration garden at its headquarters and at the Palm Desert facility. These gardens of native plants employ the most water-efficient irrigation techniques available.

- An Internet Web page (www.cvwd.org) is maintained by the District. The District Web site provides frequently updated Coachella Valley weather conditions, a description of the Valley's water resources, information on the District's functions, and a guide to Coachella Valley landscaping, including the use of native plants.

- The District also provides water audits to farms, golf courses and homeowner associations. Significant savings on water use have been realized because of these audits. The audit brings wasteful water use to the attention of the user and provides recommendations for greater efficiency. The District provides landscape workshops for homeowners. Reviews of landscape plans for major housing and commercial developments are now a part of the subdivision review process in Coachella Valley cities.

- Homeowner associations have saved as much as 50 percent on water bills after updating and modifying their irrigation systems. The District has set aside $500,000 to issue loans to homeowner associations at 3 percent interest over a five-year loan period. The District requires only that the large-scale water users be audited to confirm that there is a potential for at least a 30 percent water savings.

Wastewater Reclamation and Recycling

Sanitation service became a District responsibility in 1968, when it acquired the Palm Desert Country Club Wastewater Reclamation Plant and domestic water system. Presently, this plant, along with similar facilities near Palm Desert, Thermal, North Shore, Bombay Beach, and Thousand Palms, allows the District to provide sanitation service to most of the areas that it serves with domestic water. The District's two largest wastewater reclamation plants (WRPs), Palm Desert and Mid-Valley, are projected to treat 20 million gallons per day by 2015. The Palm Desert Regional WRP serves the communities of Indian Wells, Palm Desert, and Rancho Mirage as well as a portion of Cathedral City. The other major facility, the Mid-Valley WRP (WRP-4) located near Thermal, became operational in 1986 and allows the District to serve communities from La Quinta to Mecca.

One golf course has been irrigated with recycled water from the Palm Desert Country Club WRP since the early 1960s. Today, the District recycles treated water from three WRPs to irrigate several golf courses and homeowner associations and is negotiating with others.

Stormwater Protection

The District provides regional flood protection for the portion of the Coachella Valley within the District's stormwater unit, extending from Cathedral City to Salton City. The stormwater unit includes 59 percent (375,658 acres) of the land within the general District boundary (637,634 acres). The annual budget (FY1999) for the stormwater unit is about $7,132,000, funded mostly by a general property tax (CVWD 1999).

The stormwater facilities operated and maintained by the District include:

- the Whitewater River Stormwater Channel,
- the Coachella Valley Stormwater Channel,
- the West side dike system,
- the East side dike system,
- 15 cove community channels from Rancho Mirage to La Quinta,
- Cove community basins,
- Lower Valley stormwater channels in the agricultural areas, and
- Detention channels that drain water impounded behind the dikes.

The District's Capital Improvement Program, which has annual expenditures in the millions, improves and adds to these facilities and provides protection for those areas that do not currently have standard flood protection.

The District reviews proposed developments in the unincorporated areas of the Valley regarding their flood risk and protection. Developments are reviewed for their impact on District facilities and may require installation of new flood-protection facilities. Facilities proposed by developers are reviewed for adequacy, and agreements for inclusion in the District-maintained system are negotiated. If development is proposed within Federal Emergency Management Agency flood zones, flood plain management reviews are conducted to ensure compliance with federal, state, and county laws, ordinances, and guidelines.

Agricultural Drainage

Supplemental water brought into the Lower Coachella Valley for irrigation has resulted in a high groundwater table within the semi-perched zone that could saturate the root zone of crops and stifle growth or eliminate crop production. The semi-perched zone lies above the Upper aquifer and extends to the ground surface (see Figure 2-E). Irrigation also concentrates salts in drainage waters as salts are leached from soils. Therefore, a drainage system is necessary for much of the Lower Valley.

The District operates and maintains a collector system of 166 miles of pipe ranging in size from 18 inches to 72 inches, along with 21 miles of open ditches, to serve as a drainage network for irrigated lands. All agricultural drains empty into the CVSC except those at the southern end of the Valley, which flow directly to the Salton Sea. This system serves nearly 38,000 acres and receives water from more than 2,293 miles of on-farm drain lines (CVWD 1999).

Water Education

The District's education efforts concentrate on water safety and outside water use. Two certified teachers on staff reach out to thousands of children annually with CVWD's "wise water use" message. A water management specialist on staff works with country clubs, cities, and major developers to encourage the use of water-efficient plants and water-conserving landscape irrigation techniques. District staff and Eric Johnson, one of California's leading desert landscape experts, developed *Lush and Efficient: A guide to Coachella Valley Landscaping* specifically to aid Coachella Valley residents. Newsletters and other printed material promoting the wise use of water are published regularly.

Groundwater Recharge

The District has been recharging the groundwater basin in the Upper Valley since 1919, first with local water and later with imported water. With the introduction of the SWP, the District became one of 29 contractors for Northern California water. The DWA, in the west end of the Valley, also is an SWP contractor. With no pipeline in place to get SWP water to the valley, the two local agencies worked out an agreement with Metropolitan to trade, on an acre-foot-for-acre-foot basis, Coachella Valley's SWP water for a like amount of Metropolitan's Colorado River water. Metropolitan's Colorado River Aqueduct is tapped where it crosses the Whitewater

River, and the exchange water is diverted to a series of 19 District ponds, where it percolates to replenish groundwater. In 1973, the District and DWA started spreading the water exchanged with Metropolitan. More than 1.7 million acre-ft of Colorado River water have been delivered through the SWP Exchange program since its inception in 1973.

In 1984, CVWD and DWA executed an advance delivery agreement with Metropolitan to recharge additional Colorado River supplies in the Upper Valley during periods of surplus water availability in the Colorado River Basin. These pre-deliveries, which also were released to the Whitewater River and recharged in the Upper Valley, amounted to over 650,000 acre-ft of exchange water released to the Whitewater River between 1985 through 1987. As of 1999, a total of about 290,300 acre-ft of Colorado River water was stored in the groundwater reservoir. Metropolitan will later use the banked supplies during periods of future water shortage in Southern California. When Metropolitan requires the stored water, it will take its Colorado supplies and CVWD's and DWA's SWP entitlements for as long as necessary, or until the banked quantity of the allotment is exhausted. CVWD and DWA, in turn, will pump the previously stored water from the basin. However, until the banked water is needed, CVWD and DWA benefit by higher groundwater levels and lower pumping costs. CVWD also has contracted with the U.S. Bureau of Reclamation (Reclamation) to take surplus Colorado River water, when available, for storage in the Upper Valley. In addition, the District purchases SWP water on the spot market as available. This water is also exchanged with Metropolitan for Colorado River water and used for Upper Valley groundwater recharge.

In 1995, the District began a pilot recharge program at a site west of Dike No. 4 and south of Lake Cahuilla in the Lower Valley. The objective of the program is to determine whether groundwater could be recharged at this site to the benefit of the Lower Valley. Most of the Lower Valley is underlain by a clay layer that limits the exchange of water between the Upper and Lower aquifers. The geologic information indicates that a recharge site at Dike No. 4 is sufficiently far away from the main clay layer to allow groundwater recharge to the Lower aquifer, which is the principal aquifer supplying agricultural water to the Lower Valley. Through June of 1998, approximately 1,800 acre-ft of water had been recharged experimentally at this site. This small amount of water has not had a measurable impact on groundwater levels. However, the pilot program indicates that recharge is feasible. In 1998, the District expanded the groundwater recharge project at Dike No. 4 to include two 3-acre ponds. This project is discussed in Section 5.

District Finances

CVWD finances its functions from six principal revenue sources: water sales, service charges, availability charges, taxes, interest, and other revenues. For the fiscal year ending June 30, 1999, CVWD had total revenues of over $89 million as shown in Figure 2-B.

Approximately 41 percent of total revenues are derived from water sales of which 87 percent is from domestic water sales with the remainder from Canal water sales. Property taxes represent the second largest source of income providing 22 percent of revenues. Service and availability charges together provide about 18 percent of revenues. Interest and other revenues provide about 19 percent of revenues. A large source of other revenues is Upper Valley groundwater replenishment assessment fees.

Figure 2-B
Total Revenues by Source – Fiscal Year 1998-99

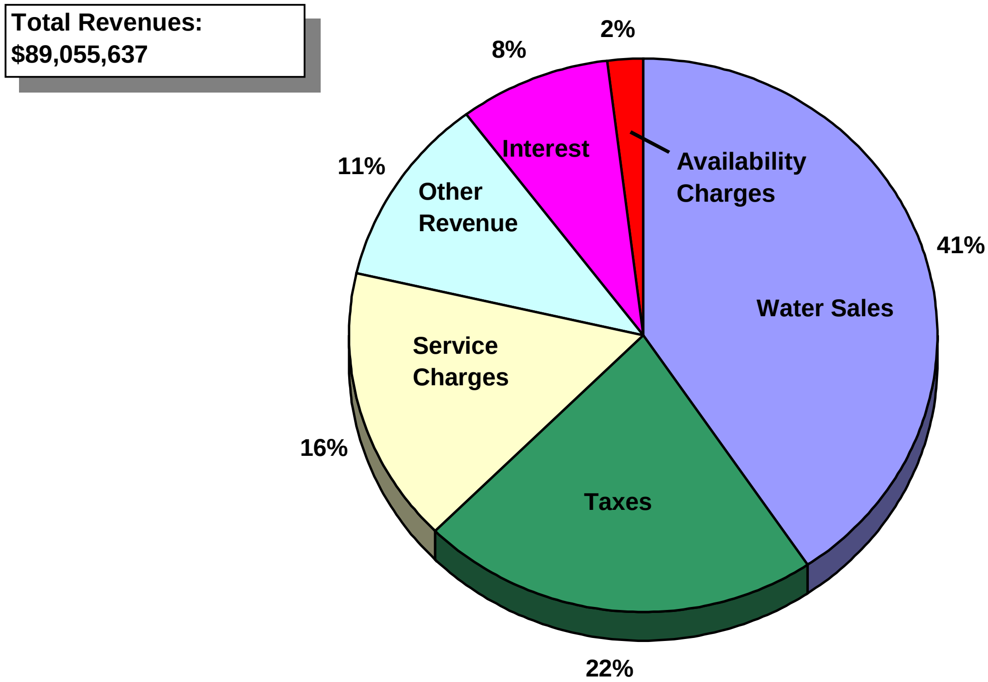
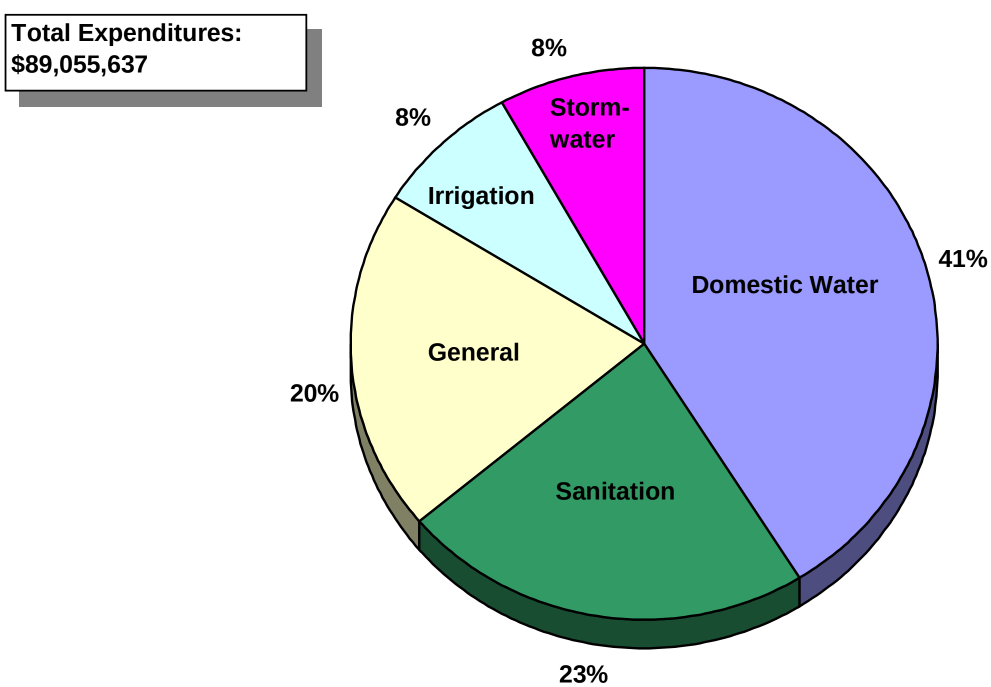


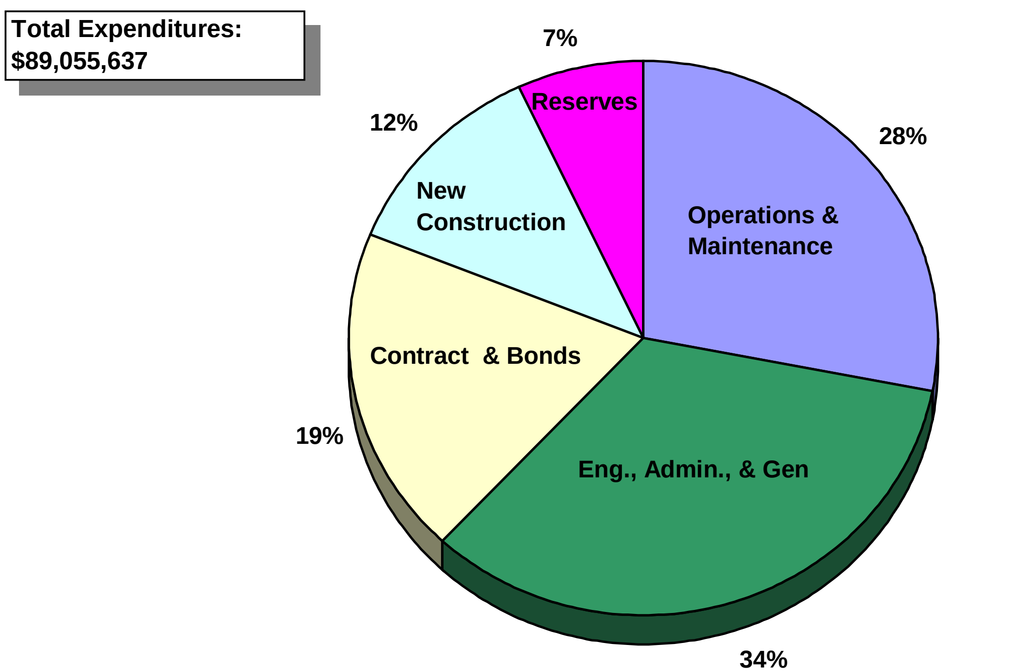
Figure 2-C
Total Expenditures by District Function – Fiscal Year 1998-99



Operational expenditures are presented in terms of (1) District function and (2) expenditure category. Figure 2-C presents District expenditures by function. This chart indicates that 41 percent of annual expenditures are for domestic water service. Sanitation services are the second largest area of expenditure accounting for 23 percent of the total. General expenditures consist of 20 percent of the total and predominantly include the purchase of SWP water for Upper Valley replenishment. Agricultural irrigation and stormwater services each account for 8 percent of total expenditures.

As shown in Figure 2-D, District expenditures by category, operations and maintenance costs and engineering, administrative and general expenses account for about 28 and 34 percent of annual expenditures, respectively. Contract and bond payments including purchase of SWP water also account for about 19 percent of expenditures. New construction accounts for about 12 percent of annual expenditures. In FY 1999, almost 7 percent of the annual expenditures were funded from District reserves, most of which was for the one-time purchase of additional SWP water for storage and future use.

Figure 2-D
Total Expenditures by Category – Fiscal Year 1998-99



ENVIRONMENTAL RESOURCES

The environmental resources of the Coachella Valley, including ecology and wildlife, the Salton Sea, and groundwater resources, are briefly described in this section. A full description of the environmental resources is included in the accompanying PEIR, which addresses the environmental resources of the valley and the impacts of the Plan on those resources.

Coachella Valley Ecology and Wildlife

Biologically, the undeveloped portions of the Coachella Valley are characterized as Colorado desert scrub, sand dune, desert riparian, fan palm oasis, and marsh vegetation communities. Intact natural desert, dune, riparian, and marsh ecosystems may support relatively high wildlife species diversity, including species listed, or proposed for listing, as sensitive. The California Natural Diversity Data Base (NDDB) listings provided 149 site records for 31 sensitive species or habitats in the Coachella Valley. A review of existing literature records, field guides, and other resource agency listings of sensitive species indicates numerous additional species of concern on the Valley floor.

Freshwater-wetland and riparian habitats within the Coachella Valley Stormwater Channel (CVSC) may support sensitive species, many of which are migratory birds. Certain other agricultural drains also support populations of the endangered desert pupfish, a species listed as endangered by California and the federal government. The extensive freshwater marshes at the terminus of the CVSC (the north end of the Salton Sea) have provided important nesting, sheltering, and feeding resources for resident and migratory waterfowl, including federally listed threatened and endangered species. Continually rising Salton Sea levels and salinity concentrations have significantly damaged these marshes. The principal threat to desert-floor biological resources in the valley is continued urban and resort development. In response, three fringe-toed lizard reserves have been established for that endangered species in the Valley, and a Coachella Valley multi-species habitat conservation plan is under way.

Salton Sea

The Salton Sea is a closed basin of saline water that occupies the bottom of the Salton Sink, a topographic low that divides the Coachella Valley from the Imperial Valley. The Sea has existed in various states in the past. The present day Salton Sea was recreated between 1905 and 1907, when uncontrolled flooding caused the Colorado River to leave its channel and drain into the Salton Sink rather than the Gulf of California. After two years, the river was diverted to its former course. Due to evaporation, the Salton Sea has receded substantially since 1905, and its salinity has increased. Other than occasional flash floods, the Sea's principal sources of water since then have been farm drainage and domestic and industrial wastewater from the Imperial, Coachella, and Mexicali Valleys.

The Salton Sea, the largest inland surface water body entirely within the boundaries of the state of California, is about 25 percent saltier than ocean water. Of the many marine fishes stocked in the Salton Sea, three have survived to become popular game fish. Because the Salton Sea has no natural outlet other than evaporation, its salinity has been increasing. There is concern that the Salton Sea will someday be unable to sustain fish life.

The Salton Sea Authority was established in 1993 to assess the conditions in the sea, to develop alternatives for addressing problems, to perform environmental evaluations of alternatives, and to select an approach and develop funding for implementation. The Salton Sea Authority is comprised of representatives of CVWD, Imperial Irrigation District, Riverside County Board of Supervisors, Imperial County Board of Supervisors, and several ex-officio members.

Groundwater Resources

The Coachella Valley's groundwater basin extends from the northwest edge of the Upper Valley near Whitewater to the Salton Sea in the Lower Valley. Basin-wide groundwater quality is difficult to characterize as groundwater quality varies throughout the Valley. Most water pumping for domestic purposes has TDS concentrations of less than 300 mg/L. A general description of the geology and uses associated with each portion of the groundwater basin is provided below.

Upper Valley

Most of the sediments underlying the Upper Valley consist of coarse sand and gravel with minor clay. The coarsest sediments typically occur in the northern part of the Valley near Whitewater and tend to become finer toward the southern part of the Upper Valley near Indio. Because of the large proportion of coarser sediments in the Upper Valley, water applied at the ground surface will percolate directly through the sand into the underlying groundwater aquifer, making groundwater recharge a relatively simple task. Groundwater pumped from this portion of the Coachella Valley groundwater basin is used primarily for domestic purposes and golf course irrigation.

Lower Valley

The groundwater pumped from the Lower Valley is used primarily for agricultural and domestic purposes. Conceptually, the groundwater within the Lower Valley occurs in four main hydrogeologic units: the semi-perched aquifer, the Upper aquifer, the aquitard, and the Lower aquifer. Each of these principal layers is illustrated in Figure 2-E on the following page.

Semi-perched aquifer. The Semi-perched aquifer is areally extensive in the Lower Valley. This unit consists of silts, clays, and fine sands associated with deposition in ancient Lake Cahuilla. The unit thickens to the south, ranging in thickness from a few feet near La Quinta to as much as 100 feet near the Salton Sea. This unit generally retards the deep percolation of surface runoff and applied irrigation water.

Upper aquifer. The permeable portions of the older underlying alluvium form the Upper aquifer, which occurs at depth below the Semi-perched aquifer and is approximately 100 to 300 feet thick. This unit consists of silts and fine sands with some clay. This unit typically contains more clay in the south, near the Salton Sea, and more sand in the north.

Aquitard. The 100 to 200 foot-thick aquitard, located directly above the Lower aquifer, restricts groundwater flow between the Upper and Lower aquifers. This unit typically consists of clay and sandy clay with discontinuous sand lenses.

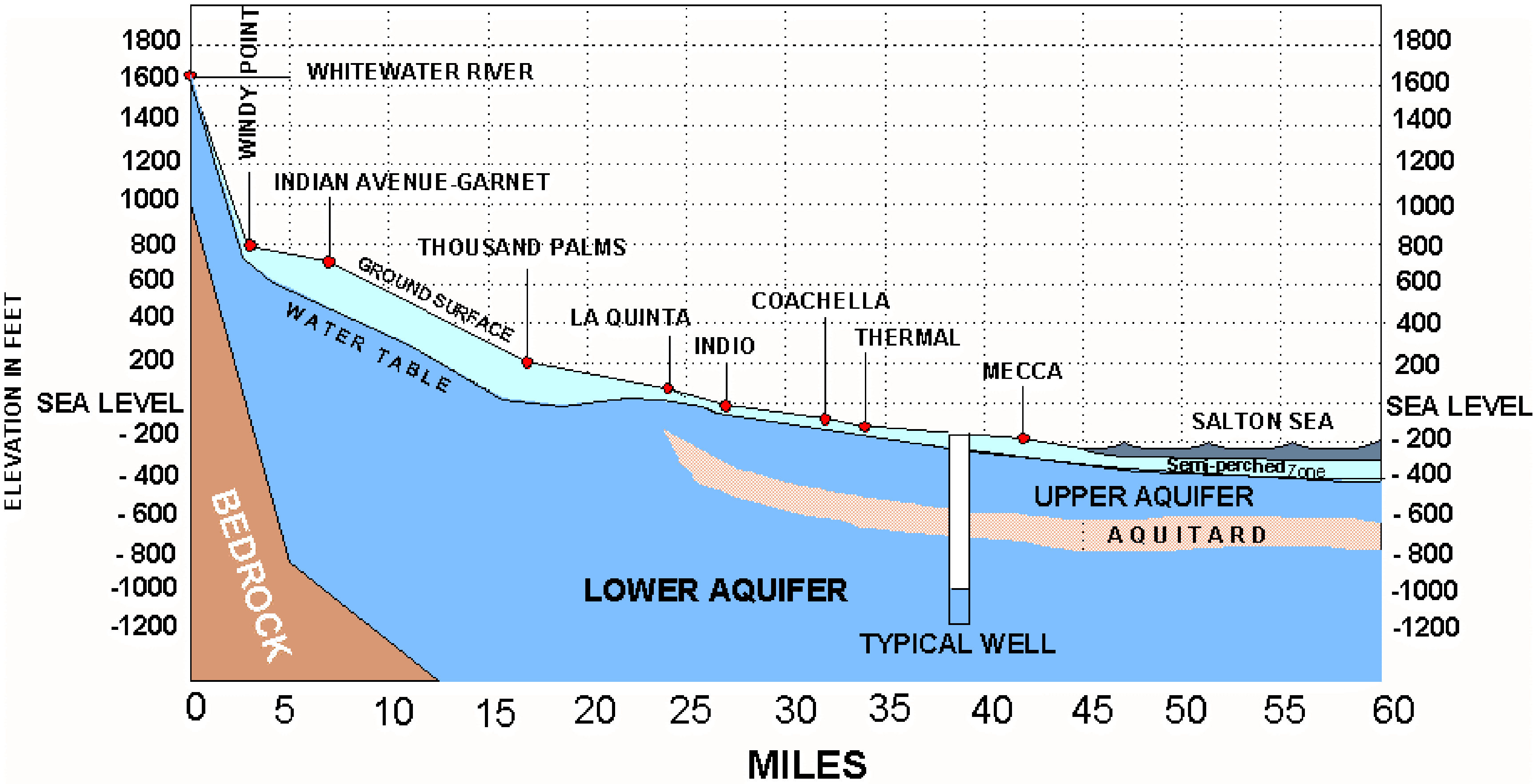


Figure 2-E

Coachella Valley Groundwater Basin Profile

Lower Aquifer. Generally over 1,000 feet in thickness, the Lower aquifer is the principal water-bearing zone and constitutes the single most important groundwater source in the Lower Valley. The Lower aquifer consists of gravel, sand, silt, clay and poorly consolidated sandstones and conglomerates. Recharge to the Lower aquifer is by deep percolation of irrigation return from overlying units, runoff from mountain streams and inflow from the Upper Valley. Water is removed from the Lower aquifer primarily by water supply wells.

CONCLUSIONS

Agricultural development in the Coachella Valley began before the turn of the century. The Lower Valley has developed into one of the most productive agricultural regions in the country. More recently, the Upper Valley has become a nationally recognized resort center. All development in the Valley is directly dependent upon effective and efficient utilization of available water supplies. Continued growth in population, resort and agricultural activities will place additional demands on the the Valley's water supplies.

Early in the century, Valley residents established water and stormwater districts to serve and protect the Valley. Several of these operations were later consolidated into the CVWD. A variety of services, including irrigation and domestic water delivery and conservation, wastewater reclamation and recycling, stormwater protection, agricultural drainage, water education and groundwater recharge are provided by the District. Responsible for maintaining and ensuring the adequacy and safety of water supplies in the Valley, the District also acts to protect its water supplies, including those of the Colorado River, and for securing supplies for the future.

The District's responsibilities led to the development of the Plan. Alternatives for future water supplies and recommendations for meeting future needs are described in subsequent sections of this report.

Section 3
Historical Water Conditions

Historical management actions, growth patterns, water use practices and hydrologic factors all affect the current condition of a groundwater basin. This section presents historical water conditions and evaluates the water supply conditions of the Coachella Valley. Topics include a discussion of historical water management activities, demands and supplies, hydrologic inflows and outflows to the groundwater basin and the cumulative impacts of overdraft. These overdraft impacts include loss of freshwater storage, changes in water levels, water quality degradation, and the potential for land subsidence. The historical time period for this evaluation is 1936 to 1999.

HISTORICAL WATER MANAGEMENT

The water management story in the Coachella Valley began as early as 1915, when the need for a supplemental water source was recognized in order for the Coachella Valley to continue to flourish. As a result, the CVWD was formed in 1918 to protect the Valley's groundwater resources and to provide a supplemental source of water.

One of the first actions of the District's original board of directors was to hire an engineer to study procedures "to protect and conserve the status of the watershed." The engineer was to survey the wells from Point Happy to Palm Springs, laying "stress upon the possibilities of spreading the storm waters over the area of sand dunes and gravel beds above Edom as a means of conserving water at a very small cost." By December 1918, a contract had been awarded for construction of the Whitewater Spreading Facility, built to catch stormwater runoff and to recharge the groundwater basin.

During the next 16 years, District activities focused on obtaining imported Colorado River water. In 1934, negotiations with the federal government were completed, and plans were in place for the construction of the Coachella Branch of the All American Canal. Construction of the Canal began in 1938, was interrupted by World War II, and was finally completed in 1949 when the first deliveries of imported Colorado River water were made to area growers. The impact of imported water on the Coachella Valley was almost immediate. By the early 1960s, water levels in the Lower Valley had returned to their historical highs.

Although groundwater levels in the Lower Valley had recovered, water levels in the Upper Valley were still declining. In 1963, CVWD and DWA entered into contracts with the State of California for entitlements to SWP water. To avoid the estimated $150 million cost of constructing an aqueduct to bring SWP water directly to the Coachella Valley, CVWD and DWA entered into an agreement with Metropolitan to exchange Colorado River Aqueduct water for SWP water.

Metropolitan's Colorado River Aqueduct crosses the northern portion of the Coachella Valley to convey water to serve Metropolitan's member agencies along the Southern California coastal plain. The exchange agreement allows the Coachella Valley to trade its SWP entitlements to

Metropolitan on a "acre-foot for acre-foot" basis for Colorado River water. In 1972, the District began construction of percolation ponds to allow the exchange water as well as natural flows in the Whitewater River to seep into the valley's underground water supply. By 1999, the District and DWA have jointly percolated nearly 1.7 million acre-ft of SWP water including pre-deliveries, which were exchanged with Metropolitan for Colorado River water.

CVWD, DWA, and Metropolitan also signed an advance delivery agreement in 1984 that allows Metropolitan to store additional SWP water in the Upper Valley during wet years via the Whitewater Spreading Facility. At one time, Metropolitan had stored up to 529,000 acre-ft in the groundwater basin. In 1999, Metropolitan had about 290,300 acre-ft of water in storage in the Coachella Valley.

Recycled water has also been a priority water management practice in the Coachella Valley since the early 1960s. The first permit to use recycled water for golf course irrigation in the Coachella Valley was issued by the Regional Water Quality Control Board (Regional Board) to the Palm Desert Country Club in 1965. In 1999, CVWD and DWA provided 8,100 acre-ft of recycled water from four treatment facilities for golf course and greenbelt irrigation purposes.

Water conservation is another key ingredient for managing water demands in the Coachella Valley. The District educates Valley residents in water-efficient landscaping techniques, works with local farmers to ensure reasonable beneficial use of irrigation water, and provides in-school visits to more than 21,000 children each year, educating them about water conservation, water value, and aquatic safety.

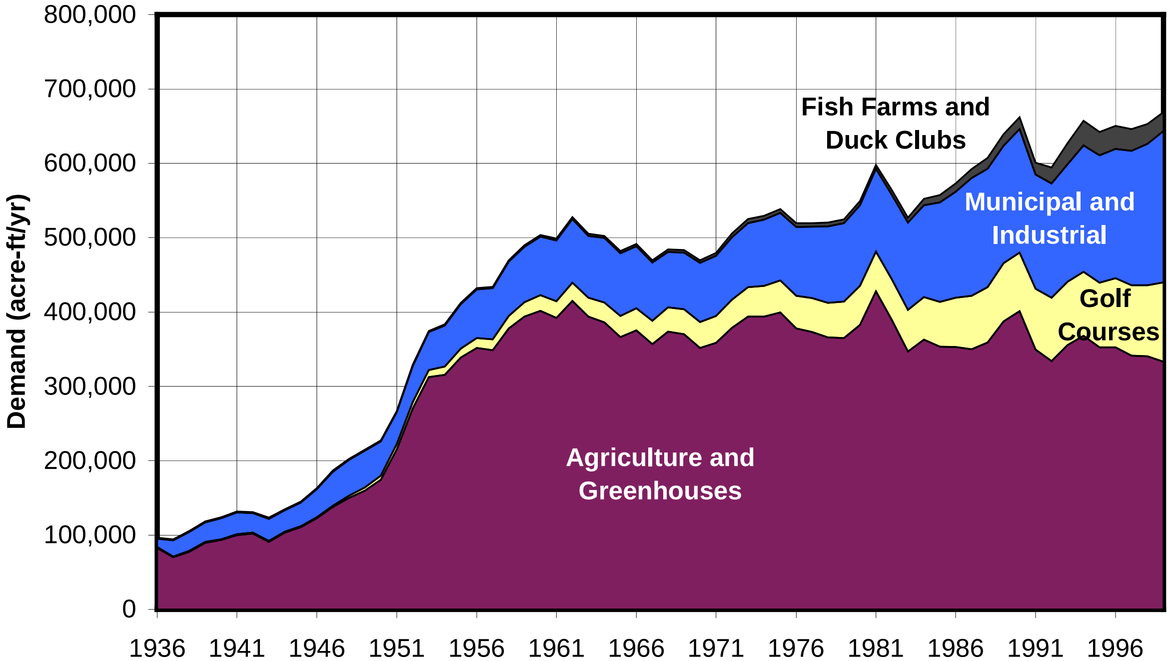
HISTORICAL WATER DEMANDS

Historical demands for water in the Coachella Valley are classified as urban and agricultural uses. Urban uses include domestic, industrial, and golf course uses. Agricultural uses include crop irrigation, fish farming, greenhouses, and duck clubs. A summary of the historical water demands is presented in Table 3-1. In 1936, water demand for the Valley was approximately 96,300 acre-ft/yr. By 1999, Coachella Valley demands were approximately 668,900 acre-ft/yr of which 224,200 acre-ft/yr was in the Upper Valley and 444,700 acre-ft/yr was in the Lower Valley. This represents a nearly seven-fold increase in demand during this 64-year period. The total historical water demands are summarized in Figure 3-A.

Agricultural Water Demands

The agricultural demand in 1936 was located principally in the Lower Valley, with a total demand of approximately 84,100 acre-ft/yr. About 1,500 acres of agriculture (mostly date and citrus orchards) existed in the Upper Valley in 1936 (Pillsbury 1941). Previous studies included this agricultural water use with domestic and golf course use (USGS 1972). Total agricultural demand in 1999 was approximately 358,700 acre-ft/yr, more than a fourfold increase since 1936. Approximately 900 acre-ft of this demand is located in the Upper Valley; the remainder is in the Lower Valley.

Figure 3-A
Historical Demands by Type of Use



In 1936, the agricultural demand constituted more than 87 percent of the total Valley demand and more than 95 percent of the Lower Valley demand. Agricultural demand increased dramatically from 1936 to the early 1960s especially after Canal water became available. Since that time, demand has decreased slightly due to improved irrigation efficiency, with variation due to weather and crop patterns. Currently, agricultural demand is 54 percent of the total Valley demand and 80 percent of the Lower Valley demand.

Crop Irrigation

The Coachella Valley is famous for many crops including citrus, table grapes, dates and a variety of fruits and vegetables. In 1936, more than 98 percent (82,600 acre-ft) of the total agricultural demand was for crop irrigation. The 1999 crop irrigation demand was approximately 332,500 acre-ft or 93 percent of the total agricultural demand as shown in Table 3-1. Nearly all of the current crop irrigation demand occurs in the Lower Valley.

Fish Farms and Duck Clubs

Fish farming is a water-dependent agricultural enterprise that is attracted by the warm groundwater in the Lower Valley. A variety of fish are grown in the Valley for the market, including striped bass, catfish, and tilapia. Fish farm operations range from earthen ponds to highly intensive tank systems using pure oxygen aeration. Approximately 1,000 acres of ponds are located in the Coachella Valley. As presented in Figure 3-A, water demand for fish farms remained relatively small (less than 1,000 acre-ft/yr) from 1936 to 1971, but has increased dramatically since that time. The total water demand by fish farms was approximately 21,100 acre-ft/yr in 1999.

Table 3-1
Summary of Historical Water Demands in 1936 and 1999
(acre-ft/yr)

Component	1936			1999		
	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total
Agricultural						
Crop Irrigation	11,300	71,300	82,600	900	331,600	332,500
Greenhouses	0	0	0	0	800	800
Total Agricultural	**11,300**	**71,300**	**82,600**	**900**	**332,400**	**333,300**
Municipal and Industrial						
Municipal Demand	6,900	4,000	10,900	145,600	57,300	202,900
Industrial Demand	0	0	0	0	1,100	1,100
Total Municipal and Industrial	**6,900**	**4,000**	**10,900**	**145,600**	**58,400**	**204,000**
Fish Farms and Duck Clubs						
Fish Farms	0	200	200	0	21,100	21,100
Duck Clubs	0	1,300	1,300	0	4,300	4,300
Total Fish Farms and Duck Clubs	**0**	**1,500**	**1,500**	**0**	**25,400**	**25,400**
Golf Course						
Golf Course	1,300	0	1,300	77,700	28,500	106,200
Total Golf Course						
TOTAL DEMAND	**19,500**	**76,800**	**96,300**	**224,200**	**444,700**	**668,900**

Duck clubs provide ponded water to attract ducks and other waterfowl during their winter migration. The duck clubs are located north of the Salton Sea. The ponds are typically filled in late summer and water levels are maintained until mid-winter. As presented in Table 3-1, water demand by duck clubs has more than tripled since 1936 (estimated at 1,300 acre-ft). The total 1999 duck club demand was approximately 4,300 acre-ft/yr.

Greenhouses

Greenhouses, located in the Lower Valley near the Salton Sea, grow fresh flowers for the Southern California floral market. 1999 use was approximately 800 acre-ft/yr. Greenhouses use the warm groundwater to provide temperature regulation as well as irrigation. This demand currently comprises less than 1 percent of the total water demand for the basin.

Urban Demands

Historical urban water demands include domestic, golf course, and industrial uses. Each of these components is summarized in Table 3-1. The total urban demand for the basin was approximately 12,200 acre-ft/yr in 1936 and was approximately 310,200 acre-ft/yr in 1999. In 1936, urban demand constituted approximately 13 percent of the total water demands. Currently, the proportion of urban demand has more than tripled to 46 percent of the total demand.

Municipal Water Use

Municipal water use includes residential, commercial, governmental and institutional demands in the Valley. Also included is on-farm domestic use in the Lower Valley. Three major domestic water purveyors, DWA, CVWD, and Mission Springs Water District, serve water in the Upper Valley. Four major domestic water purveyors serve the Lower Coachella Valley: CVWD, the City of Coachella, the City of Indio, and Myoma Dunes Mutual Water Company. Small water users and some households are supplied by individual wells.

Municipal use is currently approximately 65 percent of the total urban water demand. Historical domestic use in the Upper Valley was estimated to be 6,900 acre-ft/yr in 1936. By 1999, domestic use had increased to 145,600 acre-ft/yr. Historical domestic demand for the Lower Valley is presented in Table 3-1. Domestic demand in the Lower Valley increased from approximately 4,000 acre-ft/yr in 1936 to more than 57,300 acre-ft/yr in 1999.

Golf Courses

Golf course irrigation is a significant water use in the Coachella Valley. The first golf course in the Upper Valley was constructed in 1925. As presented in Table 3-1, golf course demand in 1999 was approximately 106,200 acre-ft/yr, of which 77,700 acre-ft/yr is in the Upper Valley and 28,500 acre-ft/yr is in the Lower Valley. Historical golf course demand is presented in Figure 3-A. Golf course demand in the Lower Valley has increased dramatically over the past 40 years, from less than 1,000 acre-ft/yr in 1948 to more than 28,500 acre-ft/yr in 1999.

Industrial

Industrial use is a minor portion (less than 1 percent) of the total water demand in the Coachella Valley. The Colmac Mecca Biomass Cogeneration plant, located near Mecca in the Lower Valley, generates 48 megawatts of power using wood and agricultural waste as fuel. Groundwater is used as the source of boiler feed and cooling water. Current water use is estimated to be approximately 1,100 acre-ft/yr.

HISTORICAL WATER SUPPLIES

Water supplies in the Coachella Valley consist of: groundwater extracted from wells, surface water diverted from local streams, imported water supplied through the Coachella Canal (Canal water), imported water exchanged for SWP water, and recycled water from wastewater treatment plants and fish farms. Precipitation on the Valley floor in this arid region is only 3 to 6 inches/yr (on average) and does not directly provide significant additional water supply because most of the precipitation evaporates or is consumed by the native vegetation. However, the aquifers are recharged by precipitation and runoff from the local mountains.

Groundwater

Groundwater is the principal water supply source in the Coachella Valley. Groundwater is pumped from underground aquifers that are estimated to store about 30 million acre-ft of water (DWR, 1964). Much of this water originates from runoff flowing off the adjacent mountains. A brief description of the groundwater basins was presented in Section 2.

Historical groundwater usage for the Upper and Lower Valleys is presented in Table 3-2 and Figure 3-B. In 1936, groundwater usage was approximately 15,500 acre-ft in the Upper Valley and 76,800 acre-ft in the Lower Valley. By 1999, groundwater usage had increased to 207,800 acre-ft in the Upper Valley and 168,300 acre-ft in the Lower Valley, more than four times the usage in 1936. This rate of increase is smaller than the rate of increase in demand, which has increased more than six-fold, due to the introduction of Canal water in 1949. Groundwater supplied approximately 56 percent of the total 1999 demand (93 percent in the Upper Valley and 38 percent in the Lower Valley). Because additional sources of supply (particularly Canal water) were not available, in 1936, groundwater supplied nearly 96 percent of the total demand. The use of Colorado River water as an additional supply source is discussed further below.

Groundwater is currently used to supply crop irrigation, fish farms and duck clubs, golf courses, greenhouses, industrial use, and municipalities in the Valley. All of the 1999 agricultural demand in the Upper Valley and approximately 19 percent of the agricultural demand in the Lower Valley is supplied by groundwater. In 1999, groundwater supplied approximately 86 percent of the Valley golf course demand (89 percent in the Upper Valley and 79 percent in the Lower Valley).

Surface Water (Local Streams)

Surface water is obtained from several local streams including the Whitewater River, Snow, Falls and Chino Creeks. In 1999, surface water supplied approximately 6,900 acre-ft of water to the Upper Valley (approximately 3 percent of its water supply) to meet municipal demand. Because the surface water supply is directly affected by variations in annual precipitation, the annual supply is highly variable. Since 1936, the estimated historical surface water supply has ranged from approximately 4,000 to 9,000 acre-ft/yr.

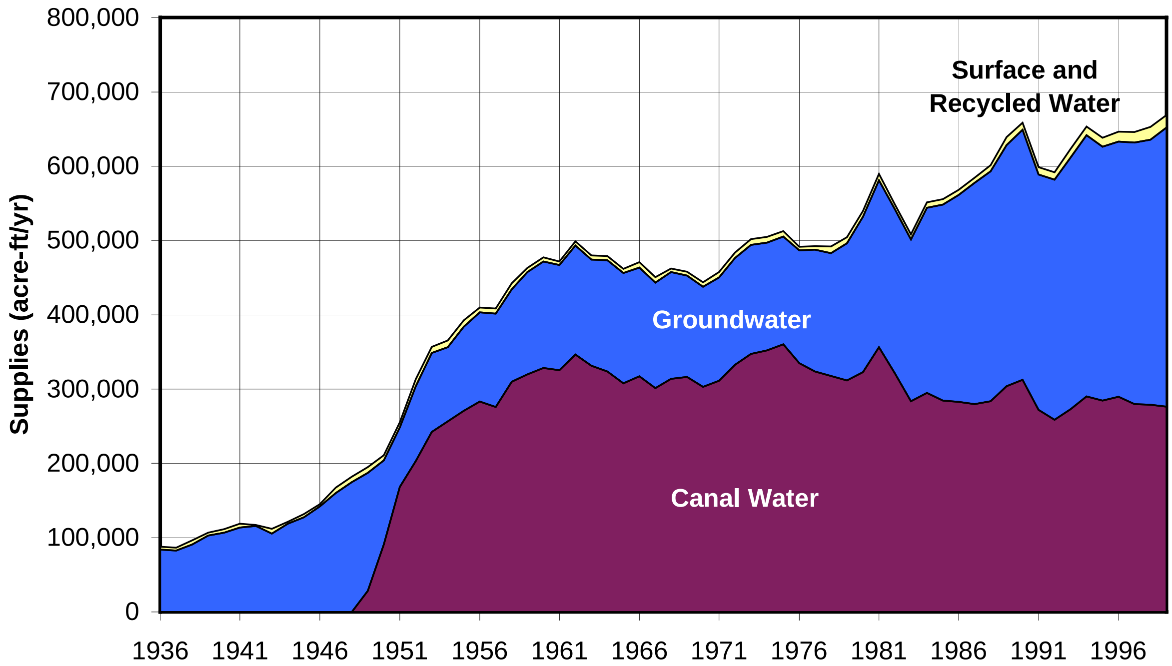
Coachella Canal Water

Water from the Coachella Canal is a significant water supply for the Lower Coachella Valley. The Coachella Canal is a branch of the All American Canal that brings Colorado River water into the Imperial and Coachella Valleys.

Table 3-2
Summary of Historical Water Supplies in 1936 and 1999
(acre-ft/yr)

Water Source	1936			1999		
	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total
Groundwater						
Crop Irrigation	11,300	71,300	82,600	900	63,900	64,800
Duck Clubs	0	200	200	0	3,500	3,500
Fish Farms	0	1,300	1,300	0	19,600	19,600
Golf Courses	1,300	0	1,300	69,100	22,400	91,500
Greenhouses	0	0	0	0	800	800
Industrial	0	0	0	0	1,100	1,100
Domestic	2,900	4,000	6,900	137,800	57,000	194,800
Total Groundwater	**15,500**	**76,800**	**92,300**	**207,800**	**168,300**	**376,100**
Local Streams						
Municipal	**4,000**	**0**	**4,000**	**6,900**	**0**	**6,900**
Recycled Water						
Golf Courses	0	0	0	7,200	0	7,200
Municipal	0	0	0	900	0	900
Total Recycled Water	**0**	**0**	**0**	**8,100**	**0**	**8,100**
Fish Farm Effluent						
Duck Club	0	0	0	0	200	200
Fish Farm	0	0	0	0	0	0
Agriculture	0	0	0	0	1,300	1300
Total Effluent	**0**	**0**	**0**	**0**	**1,500**	**1,500**
Canal Water						
Crop Irrigation	0	0	0	0	266,400	266,400
Duck Clubs	0	0	0	0	600	600
Fish Farms	0	0	0	0	1,600	1,600
Golf Courses	0	0	0	1,400	6,100	7,500
Domestic	0	0	0	0	200	200
Total Canal Water	**0**	**0**	**0**	**1,400**	**274,900**	**276,300**
TOTAL SUPPLY	**19,500**	**76,800**	**96,300**	**224,200**	**444,700**	**668,900**

Figure 3-B
Historical Supply Summary by Type



History

As agriculture in the Imperial and Coachella valleys developed during the early 1900s, alternative sources of water including the Colorado River were considered to meet growing demand. The Imperial Valley began receiving Colorado River water in 1901 via the Imperial Canal that was partially located in Mexico. However, the supply was not reliable because of frequent canal breaks and the lack of control south of the international border. The routine flooding along the Lower Colorado River and the tons of silt carried in the Imperial Canal water were problems that had been ignored. By 1904, the Imperial Canal was blocked with sediment cutting off water supply to the Imperial Valley. To resolve the problem, a temporary diversion was constructed in Mexico. However, flood conditions caused this diversion to fail allowing the entire flow of the River to enter the Salton Sink—thus creating the Salton Sea. In the Coachella Valley, the rapid rate of groundwater extraction led to a substantial decline in groundwater levels, limiting the groundwater supply. Local supplies were, therefore, not adequate to meet future demands. These problems generated interest in construction of a storage reservoir on the Colorado River and a canal that would be located entirely in the United States.

The Upper Basin States (Colorado, Wyoming, Utah and New Mexico) feared that increased use of water in the Lower Basin States (California, Arizona and Nevada) would allow the latter to claim a prior right to the water. Negotiations between the states and the federal government eventually culminated in signing the Colorado River Compact on November 24, 1922. Details of the water allocation are discussed later in this section. After another six years of negotiation and debate in Congress, the Boulder Canyon Project Act was adopted in 1928. This act authorized construction of Boulder (now Hoover) Dam and the All-American Canal. The act also authorized the Secretary of the Interior to negotiate contracts with the ultimate water users in each state and prohibited the use of river water by anyone not having a contract.

Under the *Seven Party Agreement* dated August 18, 1931, executed by the California agencies seeking to use Colorado River water, a system of priorities was established defining the designated amounts and places of use for the water. This division of water is discussed later in this section. Originally, lands in the Coachella Valley shared the same priority for water as lands in the Imperial Valley. In fact, at one point, the CVWD board approved a contract for Colorado River water service to CVWD and IID as one district. However, Coachella Valley farmers opposed having their lands subjected to the huge debt obligation for construction of IID's existing distribution system and they recalled the CVWD Board of Directors. The new board sought a separate contract with the federal government. The Secretary of Interior agreed to a separate contract provided CVWD reached agreement with IID on division of the water allocated to CVWD and IID. Ultimately, IID and CVWD signed the *Compromise Agreement* dated February 14, 1934, in which IID was given a prior right to the third and sixth priority water over Coachella "for irrigation and potable purposes only, and exclusively for use in the Imperial Service Area."

The contract between the United States and CVWD, signed October 15, 1934, designated a portion of the Coachella Valley service area as Improvement District No. 1 (ID-1). The contract restricts the use of Colorado River water delivered by the Coachella Canal to reasonable beneficial use for lands within the ID-1 boundary. This 136,436-acre area includes the majority of the agricultural areas in the Lower Valley and a small portion of the agricultural areas in the Upper Valley. No changes to the ID-1 service area are planned as part of the Plan.

Construction of the All-American Canal was completed before World War II, and the U.S. Bureau of Reclamation started work on the Coachella branch in 1938. The nation's involvement in World War II, along with a lack of materials and funds, halted the Coachella Canal project until 1946. The Canal was finished in 1948, with the first supplies arriving from the Colorado River in 1949.

Water delivered to the Coachella Valley is diverted from the Imperial Dam 18 miles upstream from Yuma, Arizona into the All-American Canal. Coachella's supply is then diverted into the 122-mile-long Coachella branch, which extends from near the Mexican border northwestward to Lake Cahuilla near La Quinta. This lake, which is at the terminus of the Coachella Canal, serves as a storage reservoir to regulate irrigation water demands and provides opportunity for recreation. The capacity of the Coachella Canal is approximately 1,500 cfs.

Allocation

The *Law of the River* controls the allocation of the Colorado River water to the seven Colorado River Basin states. The *Law of the River* refers to the collection of interstate compacts, federal and state legislation, various agreements and contracts, an international treaty, a U.S. Supreme

Court decree, and federal administrative actions that govern the rights to use of Colorado River water. The *Colorado River Compact*, signed in 1922, apportioned the waters of the Colorado River Basin between the Upper Colorado River Basin (Colorado, Wyoming, Utah, and New Mexico) and the Lower Basin (Nevada, Arizona, and California). Annual use of water allocated by the Colorado River Compact is 15 million acre-ft: 7.5 million acre-ft to the Upper Basin and 7.5 million acre-ft to the Lower Basin, plus up to 1 million acre-ft of surplus supplies. The Lower Basin's water was further apportioned among the three Lower Basin states by the *Boulder Canyon Project Act* in 1928 and the 1964 U.S. Supreme Court decree in *Arizona v. California*. Arizona's basic annual apportionment is 2.8 million acre-ft, California's is 4.4 million acre-ft, and Nevada's is 0.3 million acre-ft. California has been actually diverting up to 5.3 million acre-ft in recent years, using the unused portions of the Arizona and Nevada entitlements. Mexico is entitled to 1.5 million acre-ft of the Colorado River under the *1944 United States-Mexico Treaty for Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande*. However, this treaty did not specify a required quality for water entering Mexico. In 1973, the United States and Mexico signed Minute No. 242 of the International Boundary and Water Commission requiring certain water quality standards for water entering Mexico.

California's apportionment of Colorado River water is allocated by the 1931 *Seven Party Agreement* among Palo Verde Irrigation District, Imperial Irrigation District, CVWD, and Metropolitan. The three remaining parties - the City and the County of San Diego and the City of Los Angeles - are now part of Metropolitan. The allocations defined in the *Seven Party Agreement* are shown in Table 3-3. The Supreme Court in *Arizona v. California* also assigned "present perfected rights" to the use of river water to a number of individuals, water districts, towns and Indian tribes along the river. These rights, which total approximately 2,875,000 acre-ft/yr, are charged against California's 4.4 million acre-ft/yr allocation and must be satisfied first in times of shortage. Under the 1970 *Criteria for Coordinated Long-Range Operation of the Colorado River Reservoirs* (Operating Criteria), the Secretary of the Interior determines how much water is to be allocated for use in Arizona, California and Nevada and whether a surplus, normal or shortage condition exists. The Secretary may allocate additional water if surplus conditions exist on the River.

Historically, CVWD has not had a specific allocation to Colorado River water. Instead, CVWD has had an undefined share of the 3.85 million acre-ft/yr allocated to the California agricultural agencies under Priority 3(a). During 1999, the California agencies negotiated the California Water Use Plan. This plan defines how California will reduce its use of Colorado River water to its 4.4 million acre-ft/yr allocation. In October, 1999, CVWD, IID, and Metropolitan reached agreement on the "Key Terms" that will be necessary elements in a formal Quantification Settlement Agreement (QSA) regarding a division and quantification of their respective shares of Colorado River water. The detailed QSA document is being prepared for review and, pending completion of all required environmental reviews, formal approval by the three agencies' Boards. This agreement supplements the 1931 agreement.

Table 3-3
Priorities and Water Delivery Contracts
California Seven-Party Agreement of 1931

Priority	Description	Acre-ft/yr
1	Palo Verde Irrigation District gross area of 104,500 acres of valley lands	3,850,000
2	Yuma Project (Reservation Division) not exceeding a gross area of 25,000 acres within California	
3(a)	Imperial Irrigation District, Coachella Valley Water District, and lands in Imperial and Coachella Valleys to be served by the All American Canal	
3(b)	Palo Verde Irrigation District - 16,000 acres of mesa lands	
4	Metropolitan Water District of Southern California for use on coastal plain	550,000
	Subtotal – California's Basic Apportionment	**4,400,000**
5(a)	Metropolitan Water District of Southern California for use on coastal plain	550,000
5(b)	Metropolitan Water District of Southern California for use on coastal plain	112,000
6(a)	Imperial Irrigation District and lands in the Imperial and Coachella Valleys to be served by the All American Canal	300,000
6(b)	Palo Verde Irrigation District - 16,000 acres of mesa lands	
	Total	**5,362,000**

Historical Supplies

Figure 3-B presents the volume of water delivered to the Coachella Canal between 1949 and 1999. In recent years, Canal water deliveries have decreased in spite of a relatively constant total demand. Since the early 1980s, many farms have converted to drip irrigation, which has improved irrigation efficiency. Since drip irrigation needs a low suspended solids water supply, some farmers switched to groundwater to avoid the cost of filtering Canal water, causing a decline in Canal water deliveries. Canal diversions measured at Imperial Dam have ranged from 275,000 to 370,000 acre-ft/yr during the 1990s. In 1999, Canal deliveries (less conveyance losses) were approximately 276,300 acre-ft (Table 3-2). This water is used for crop irrigation, duck clubs, fish farms, golf course irrigation and municipal irrigation in the Lower Valley and golf course irrigation in the Upper Valley. In 1999, Canal water supplied approximately 41 percent of the total water demand in the basin. Most of this use is for crop irrigation in the Lower Valley, which receives close to 80 percent of its supply from Canal water.

Recycled Water

Recycled municipal wastewater has historically been used for irrigation of golf courses and other municipal greenbelt and landscape areas. Table 3-2 and Figure 3-B present the historical recycled water usage for the Upper Valley. Recycled water was not used prior to 1965 and remained below 500 acre-ft/yr until the late 1980s. Usage in the Upper Valley dramatically increased in the late 1980s, increasing to 8,100 acre-ft in 1999. In addition to municipal wastewater, approximately 1,500 acre-ft/yr of fish farm effluent was recycled in the Lower Valley for agricultural irrigation, duck clubs, and fish farms in 1999.

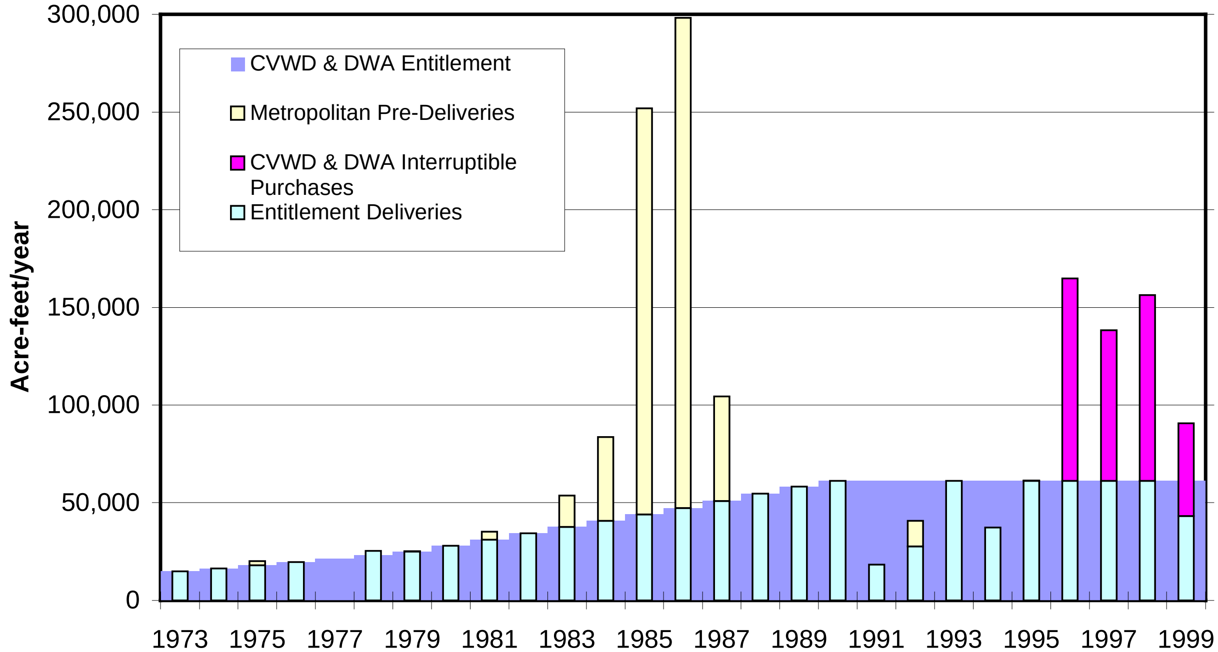
State Water Project Water

To recharge groundwater supplies, CVWD and DWA obtain imported water supplies from the SWP, which is managed by the Department of Water Resources (DWR). CVWD and DWA are two of 29 agencies holding long-term water supply contracts with the State of California for SWP water. CVWD's entitlement to SWP water is 23,100 acre-ft/yr while DWA's is 38,100 acre-ft/yr, for a combined total of 61,200 acre-ft/yr. SWP water originates from rainfall and snowmelt in Northern California. Runoff is stored in Lake Oroville, the project's largest storage facility, and then released down the Feather River to the Sacramento River and the Sacramento-San Joaquin Delta. Water is diverted from the Delta into the Clifton Court Forebay and then pumped into the 444-mile-long California Aqueduct. SWP water is stored in San Luis Reservoir, which is jointly operated by the DWR and the U.S. Bureau of Reclamation. Six pumping stations lift the water more than 3,000 feet and energy is recovered at powerplants along the aqueduct.

CVWD and DWA do not directly receive SWP water. Instead their SWP water is delivered to Metropolitan pursuant to the exchange agreement described above. Metropolitan in turn delivers an equal amount of Colorado River water to CVWD and DWA at the Whitewater River. CVWD is participating in the East Branch Enlargement to provide the capacity to obtain additional water from the SWP when it is available.

Nearly 1.7 million acre-ft of Colorado River water has been delivered through the exchange program since its inception in 1973 (Figure 3-C). In 1984, CVWD and DWA entered into an advance delivery agreement with Metropolitan to percolate additional Colorado River supplies in the Upper Basin during periods of surplus water availability in the Colorado River Basin. These pre-deliveries, which were also released to the Whitewater River and percolated in the Upper Basin, were at times substantial. During the three-year period from 1985 through 1987, more than 650,000 acre-ft of exchange water was released to the Whitewater River. As of 1999, Metropolitan had stored approximately 290,300 acre-ft of Colorado River water in the groundwater basin. Metropolitan will utilize banked supplies during periods of future water shortage in Southern California. When Metropolitan requires the stored water, it takes both the Colorado supplies and CVWD's and DWA's entitlements as long as necessary or until the banked quantity is exhausted. CVWD and DWA, in turn, will pump the previously stored water from the basin and will pay for SWP water delivered to Metropolitan. However, until the banked water is needed, the CVWD and the DWA benefit by higher water levels and lower pumping costs. The recharge program, which has been monitored, modeled, and studied by the U.S. Geological Survey, has helped to balance the inflow and outflow of groundwater from the Upper Coachella Basin.

Figure 3-C
Historic State Water Project Deliveries
(1973-1999)



In 1996, CVWD and DWA recognized the need for additional imported water in order to eliminate groundwater overdraft. Since then, the two districts have purchased additional Pool A, Pool B, and interruptible water from the SWP resulting in average purchases of 142,000 acre-ft/yr. These additional supplies are not expected to be available in the future and cannot be relied upon to provide a reliable long-term source of water to the Coachella Valley. In 1999, SWP exchange water purchases used for recharge in the Upper Valley totaled nearly 108,600 acre-ft/yr, of which about 18,000 acre-ft/yr was delivered from the Metropolitan storage account. The extra recharge was purchased from the SWP Turn-back Pool.

GROUNDWATER OVERDRAFT

As discussed above, the demand for water in the Coachella Valley has increased dramatically since 1936, resulting in overdraft of the limited groundwater supplies.

Definition of Overdraft

DWR Bulletin 160-93 describes *overdraft* as follows:

> "Where the ground water extraction is in excess of inflow to the ground water basin over a period of time, the difference provides an estimate of overdraft. Such a period of time must be long enough to produce a record that, when averaged, approximates the long-term average hydrologic conditions for the basin."

Bulletin 118-80 defines "overdraft as the condition of a ground water basin where the amount of water extracted exceeds the amount of ground water recharging the basin "over a period of time." It also defines "critical condition of overdraft" as water management practices that "would probably result in significant adverse overdraft-related environmental, social, or economic effect." Water quality degradation and land subsidence are given as examples of two such adverse effects.

The definition of *overdraft* should incorporate an evaluation of the consequences of extracting more groundwater from a basin than is recharged. Such consequences may include increased pumping costs, water quality degradation, land subsidence, and saltwater intrusion. The existence of overdraft implies that continuation of current water management practices will result in significant negative impacts on environmental, social or economic conditions (Todd, 1980; ASCE, 1987). The discussion of overdraft in the Coachella Valley focuses on the historical components of the groundwater balance, groundwater levels, water quality, subsidence, and saltwater intrusion.

Water Balance

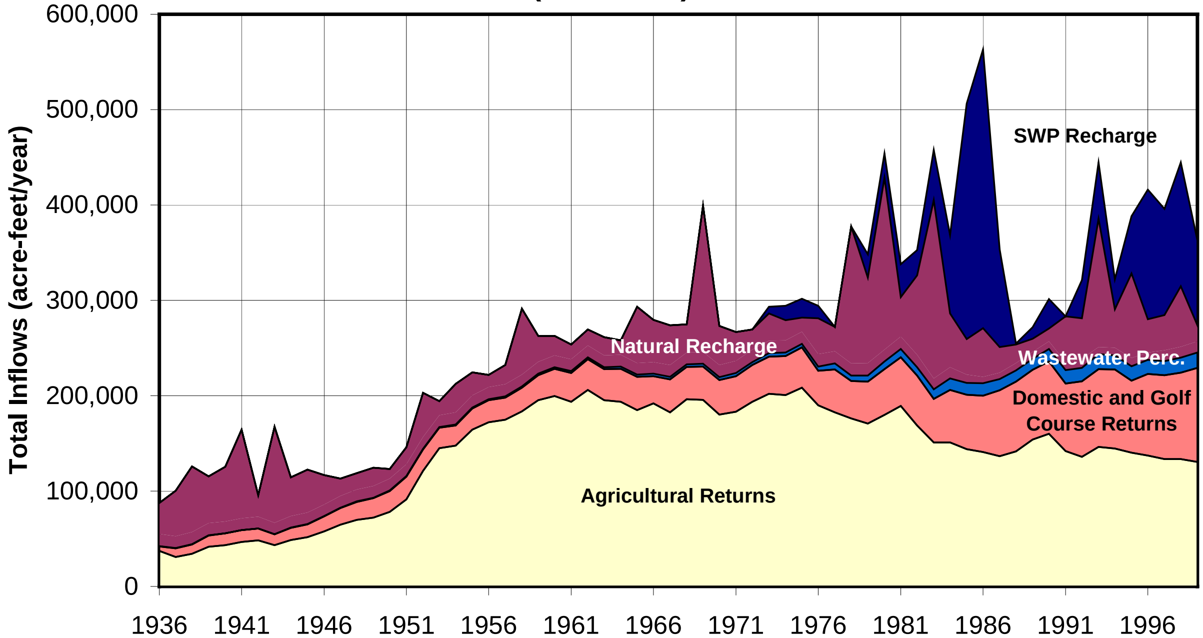
A water balance provides a mechanism for evaluating one component of overdraft within the Coachella Valley, the inflows and outflows to the basin. The difference between annual inflows and outflows is the change in groundwater storage. A complete water balance for the years 1936 and 1999 is presented in Table 3-4.

Inflows

Inflows to the study area include natural recharge (infiltration of stream flow and mountain runoff), artificial recharge, return flows, and inflows from outside the groundwater basin. Table 3-4 summarizes the total inflows for the years 1936 and 1999. A time history of the inflows is also presented in Figure 3-D. Total inflows have increased from 146,800 acre-ft/yr in 1936 to 392,200 acre-ft/yr in 1999, more than a threefold increase. In 1936, approximately 64 percent of the total basin inflows were in the Lower Valley compared to 40 percent in 1999. This change is due in large part to additional recharge and golf course returns in the Upper Valley, both of which are discussed further in the following sections.

Natural Recharge. Precipitation in the San Jacinto and Santa Rosa Mountains produces surface runoff and subsurface inflow that are the significant sources of recharge to the basin. Additional recharge may be derived from precipitation in the Little San Bernardino Mountains in extremely wet years. The volume of natural recharge varies dramatically annually due to wide variations in precipitation. Perennial flow is limited to only a few streams. The average historical natural recharge is approximately 49,000 acre-ft/yr, ranging from 187,000 acre-ft/yr in extremely wet years to 10,000 acre-ft/yr in dry years. As presented in Table 3-4, the natural recharge component for 1999 was approximately 16,800 acre-ft/yr.

Figure 3-D
Summary of Historical Groundwater Inflows by Source
(1936-1999)



Return Flows. Return flows are the amount of water applied for irrigation (either agricultural, golf course, or urban) not utilized by plants to satisfy their evapotranspiration (ET) requirement and water returned to the groundwater basin through domestic usage (domestic irrigation and septic tank flow). Total returns for the Upper and Lower Valleys for 1936 and 1999 are summarized in Table 3-4. In 1936, total return flows were approximately 42,000 acre-ft/yr. Currently, total return flows are approximately 245,700 acre-ft/yr. As shown in Figure 3-D, return flows comprise a significant portion of the total inflows to the groundwater basin. In 1936, returns represented approximately 29 percent of the total inflow budget. Currently, return flows are more than 60 percent of the total inflow budget. As agricultural and urban demand increases, the returns also increase. In particular, domestic and golf course returns have increased more than tenfold from nearly 5,000 acre-ft/yr in 1936 to more than 98,500 acre-ft/yr in 1999.

Agricultural return flows have generally decreased over the past 20 years due to increased irrigation efficiency. For example, the return flow for the period 1972 to 1976 (based upon data from 1975) was nearly 200,000 acre-ft/yr compared to 141,000 acre-ft/yr for the 1992 to 1996 time period.

Agricultural return waters typically have TDS concentrations greater than 2,000 mg/L, unsuitable for beneficial use. Therefore, except for those areas underlain by tile drains, this poor quality water infiltrates deep into the groundwater basin, thereby reducing the available freshwater storage by the amount of returns not intercepted by drains.

Where groundwater or recycled water is used for golf course irrigation, the quality of the return water is still potable and provides beneficial inflow. However, where Canal water is the source of supply, the incremental TDS increase of the return water makes this portion of return flows non-potable.

Artificial Recharge. Artificial recharge includes recharge using SWP exchange water in the Upper Valley. SWP water is discussed in the previous section and presented in Figure 3-C.

Inflows from Outside the Groundwater Basin. Inflows from outside the basin include underflow from the San Gorgonio Pass area and flows across the Banning Fault. Historical data are presented in Figure 3-D. Inflows typically range from 7,000 acre-ft/yr to 13,000 acre-ft/yr. The 1999 estimated inflow was approximately 11,500 acre-ft/yr. This is a relatively small component of the water balance (less than 3 percent) and does not change significantly with time.

Outflows

Outflows from the basin include groundwater pumpage, flow to drains, evapotranspiration, and flow to the Salton Sea, as shown in Table 3-4. For convenience, net flow to the Salton Sea and net flow to the Lower Valley from the Upper Valley are also summarized in Table 3-4. Total outflows from the basin have more than doubled, from approximately 180,500 acre-ft/yr in 1936 to 465,800 acre-ft/yr in 1999. In 1936, approximately 59 percent of the total basin outflows occurred in the Lower Valley compared to 49 percent in 1999. Relative to groundwater pumpage, flow between the Upper and Lower Valleys is minor.

Groundwater Pumpage. Groundwater pumpage refers to the amount of groundwater pumped for agricultural and domestic use. These data are summarized in Figure 3-E and were discussed in the previous section. As presented in Table 3-4, groundwater pumpage increased from approximately 92,400 acre-ft/yr in 1936 to 376,100 acre-ft/yr in 1999. Groundwater pumpage is currently the largest component of outflow from the basin (nearly 88 percent in the Upper Valley and 79 percent in the Lower Valley). In 1936, more than 72 percent of the outflows from the Lower Valley were associated with pumping of groundwater.

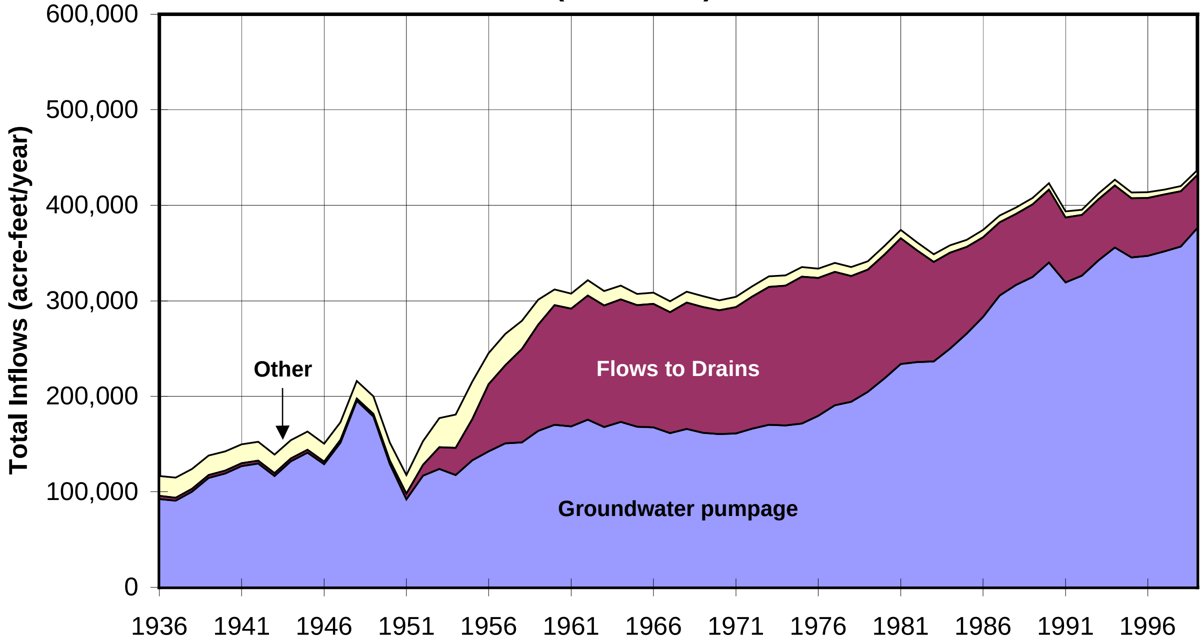
Flow to Drains. Semi-perched groundwater conditions in many parts of the Lower Valley impede the downward migration of applied water at the surface. This condition causes waterlogged soils and the accumulation of salts in the root zone. Surface (open) drains were constructed in the 1930s to alleviate this condition. Subsurface drainage systems were first installed in 1950 to control the high water table conditions and to intercept poor quality return flows. Thus, the drains act as a barrier to the percolation of poor quality return flows into the deeper potable aquifers.

Table 3-4
Historical Water Budget Summary

Water Balance Component	1936 Upper Valley	1936 Lower Valley	1936 Total	1999 Upper Valley	1999 Lower Valley	1999 Total
Inflows						
Natural Recharge	32,000	600	32,600	15,400	1,400	16,800
Agricultural Returns	4,600	32,600	37,200	400	130,300	130,700
Domestic Returns	2,800	1,500	4,300	46,600	12,600	59,200
Golf Course Returns	500	0	500	27,200	12,100	39,300
Wastewater Percolation	200	0	200	15,600	900	16,500
SWP Recharge	0	0	0	88,800	0	88,800
Inflows from outside study area	12,700	200	12,900	11,300	200	11,500
Inflows from Upper Valley	0	59,100	59,100	0	29,400	29,400
Total Inflows	**52,800**	**94,000**	**146,800**	**205,300**	**186,900**	**392,200**
Outflows						
Groundwater pumpage	15,500	76,900	92,400	207,800	168,300	376,100
Flows to Drains	0	3,200	3,200	0	55,800	55,800
Evapotranspiration	0	21,100	21,100	0	4,900	4,900
Net Flow to Salton Sea	0	5,300	5,300	0	-400	-400
Outflows to Lower Valley	59,100	0	59,100	29,400	0	29,400
Total Outflows	**74,600**	**106,500**	**181,100**	**237,200**	**228,600**	**465,800**
Change in Storage						
Annual Change in Storage	-21,800	-12,500	-34,300	-31,900	-41,700	-73,600
Cumulative Change in Storage (since 1936, in acre-ft)	-21,800	-12,500	-34,300	-983,800	-437,600	-1,421,400
Annual Change in Freshwater Storage	-21,800	-20,000	-41,800	-32,400	-104,300	-136,700
Cumulative Change in Freshwater Storage (since 1936, in acre-ft)	-21,800	-20,000	-41,800	-985,600	-3,698,400	-4,684,000

*Units in Acre-ft/yr unless otherwise noted.

Figure 3-E
Summary of Historical Outflows by Source
(1936-1999)



Flow in the drains resulting from agricultural drainage is summarized in Figure 3-E. As presented in this figure, flow in the drains increased steadily as the drains were installed, until the early 1970s. Drain flow remained relatively stable through the 1970s and has steadily declined since 1980. This decline is due in part to a general decline in surface water deliveries, increased groundwater production, and increased irrigation efficiency of agriculture. Flow to the drains in the mid-1970s was approximately 145,000 acre-ft/yr, whereas 1999 agricultural flow to the drains was only 55,800 acre-ft (Table 3-4). Flow in the drains currently comprises approximately 24 percent of the total outflows from the Lower Valley.

Evapotranspiration. Native vegetation on undeveloped lands receives its water supply from precipitation and shallow groundwater. In the area underlain by the Semi-perched aquifer, evapotranspiration (ET) was a significant water loss component in the Lower Valley. As lands were developed for agricultural uses, the amount of ET from native vegetation declined. The installation of drains in the 1950s and 1960s further reduced ET as the water table was lowered. Further ET reductions occurred in the 1980s and 1990s as increased pumping reduced groundwater levels. Historical ET estimates are presented in Table 3-4 and Figure 3-E. The ET component in 1999 was a relatively small outflow (less than 1 percent) of the total outflow balance. This value has generally decreased with time as water levels in the Lower Valley have declined.

Net Outflow to the Salton Sea. Historically, when groundwater levels were relatively high, groundwater naturally flowed toward the Salton Sea. Shallow semi-perched groundwater discharged into the Salton Sea and deeper groundwater left the basin as subsurface outflow. As groundwater levels in the basin declined, the rate of outflow decreased. Modeling studies indicate that some inflow from the Sea may have occurred in recent years.

Historical outflow to the Salton Sea is presented in Table 3-4. The net outflow to the Salton Sea has decreased from more than 5,300 acre-ft/yr in 1936 to an inflow of about 400 acre-ft/yr under 1999 conditions. The accompanying increased inflow from the Salton Sea into the groundwater basin is indicative of potential seawater intrusion into the aquifers.

Water quality degradation is probable in the Lower Valley. When groundwater is in hydraulic continuity with saltwater bodies such as the Salton Sea, conditions may allow for the migration of saltwater into the freshwater aquifers of the basin when the aquifer water levels are not above the level of the Sea. Since groundwater levels adjacent to the Sea are currently below the level of the Sea, a landward hydraulic gradient exists between the Sea and the groundwater basin, which induces the movement of the saline water into the groundwater aquifers.

Movement of this saline water into the groundwater basin has a significant negative effect on groundwater quality. The 1999 inflow of brackish water from the Salton Sea to the groundwater basin is estimated at 400 acre-ft/yr (0.5 percent of the total basin inflow).

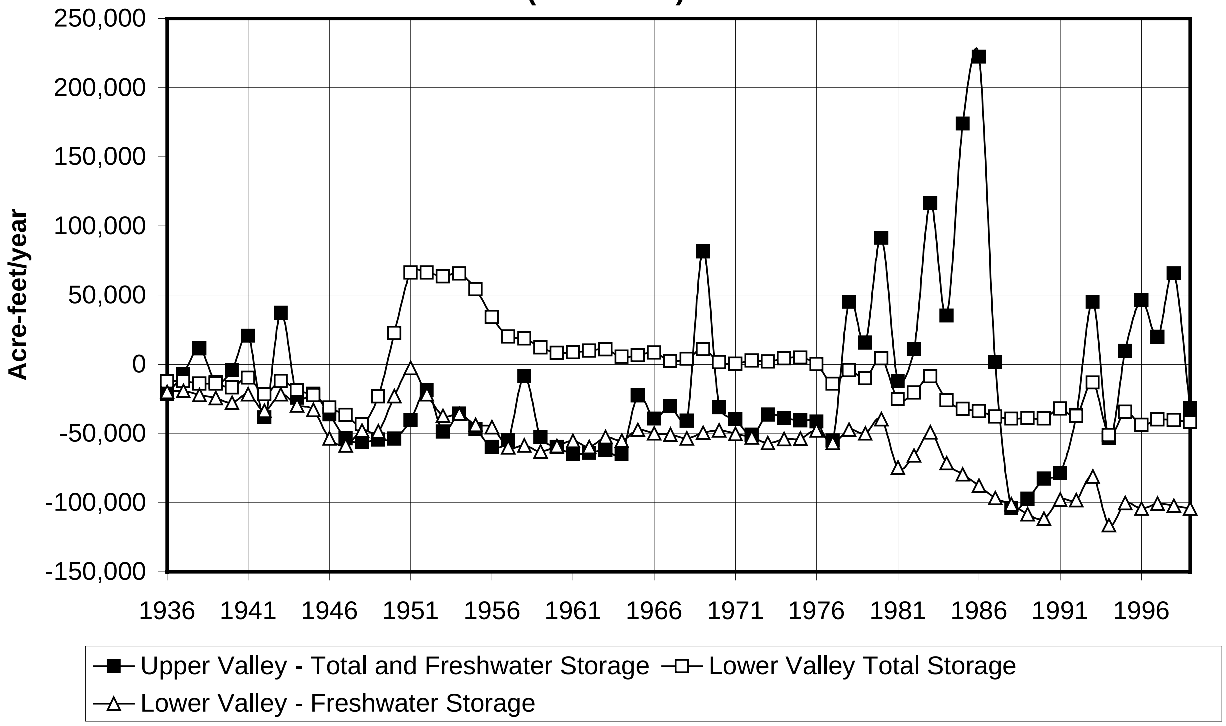
Change in Storage

The change in storage represents the annual difference between inflows and outflows in the groundwater basin. During wet years or periods of high artificial recharge, the change in storage is positive (storage increases). In dry years or periods of high pumping, the change in storage is negative (storage decreases). The historical change in storage for the Upper and Lower Valleys is presented in Figure 3-F.

As presented in Table 3-4, the estimated groundwater storage decreased by approximately 34,300 acre-ft/yr in 1936 (a loss of 12,500 acre-ft/yr in the Lower Valley and a loss of 21,800 acre-ft/yr in the Upper Valley). From 1936 to the late 1940s, groundwater storage generally decreased in both valleys as groundwater pumping increased. After the initiation of Canal water deliveries in 1949, the deficit in the Lower Valley was eliminated, and a surplus of nearly 66,000 acre-ft/yr existed in the early 1950s. As groundwater pumping increased in the 1980s, water levels and groundwater storage in the Lower Valley declined resulting in a deficit of more than 50,000 acre-ft/yr in the 1990s.

In the Upper Valley, storage generally declined until SWP exchange water was delivered in 1973. Since that time, the change in storage has largely been dependent upon SWP deliveries. During the late 1980s and early 1990s, Metropolitan pre-delivered SWP exchange water to the Coachella Valley under their advance delivery agreement, resulting in higher water levels and increased storage. From 1996 to 1999, CVWD and DWA purchased additional SWP exchange water for recharge in the Upper Valley causing a temporary increase in storage. This increased recharge did not affect storage in the Lower Valley. Metropolitan can annually take back up to 61,200 acre-ft of their pre-delivered water stored in the groundwater basin, which is equivalent to CVWD's and DWA's current SWP allocation.

Figure 3-F
Historical Change in Storage
(1936-1999)

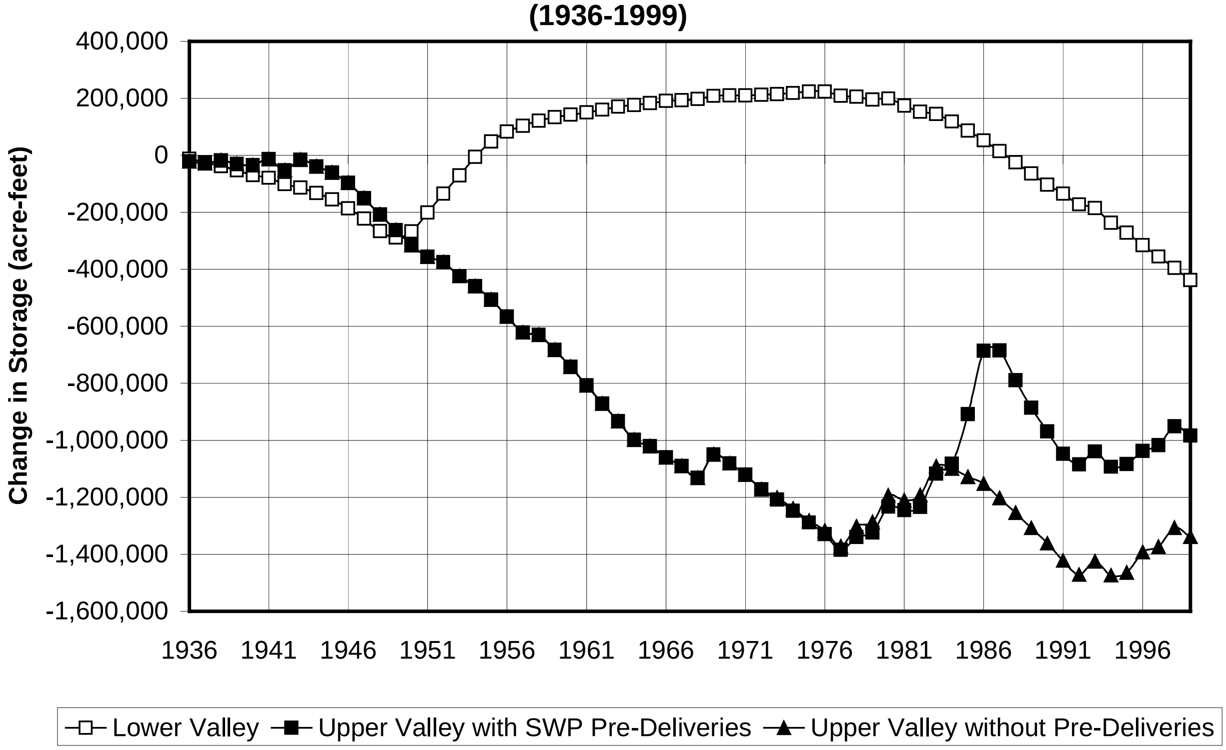


The cumulative change in storage is the sum of the annual changes in storage over a given period of time and it generally mimics water level changes. Figure 3-G presents the cumulative change in storage in the Upper and Lower Valleys since 1936. This figure shows the Upper Valley has lost about one million acre-ft of storage in that period. However, if water in Metropolitan's storage account is excluded from the Upper Valley estimate, the storage loss is 1.4 million acre-ft. In the Lower Valley, nearly 437,600 acre-ft of storage has been lost, about 50 percent more than the cumulative loss of the late 1940s. Excluding pre-delivered water, there is a total cumulative groundwater storage loss of more than 1.7 million acre-ft since 1936 in the Coachella Valley.

Change in Freshwater Storage

Several inflow components of the water balance, although they contribute to total basin storage, are not potable and provide only minimal benefit to the basin. These poor quality waters provide the mechanisms to maintain water elevation while reducing the available storage space for potable water. This issue was recognized by DWR in *Bulletin 108* where return flows from lands overlying the semi-perched aquifer were excluded from the water balance (DWR, 1964). These poor quality waters include: agricultural return flows percolating past the drains, golf course return flows from Canal water use and Salton Sea water intrusion. The change in freshwater storage is summarized in Table 3-4 and Figure 3-F.

Figure 3-G
Cumulative Change in Storage
(1936-1999)

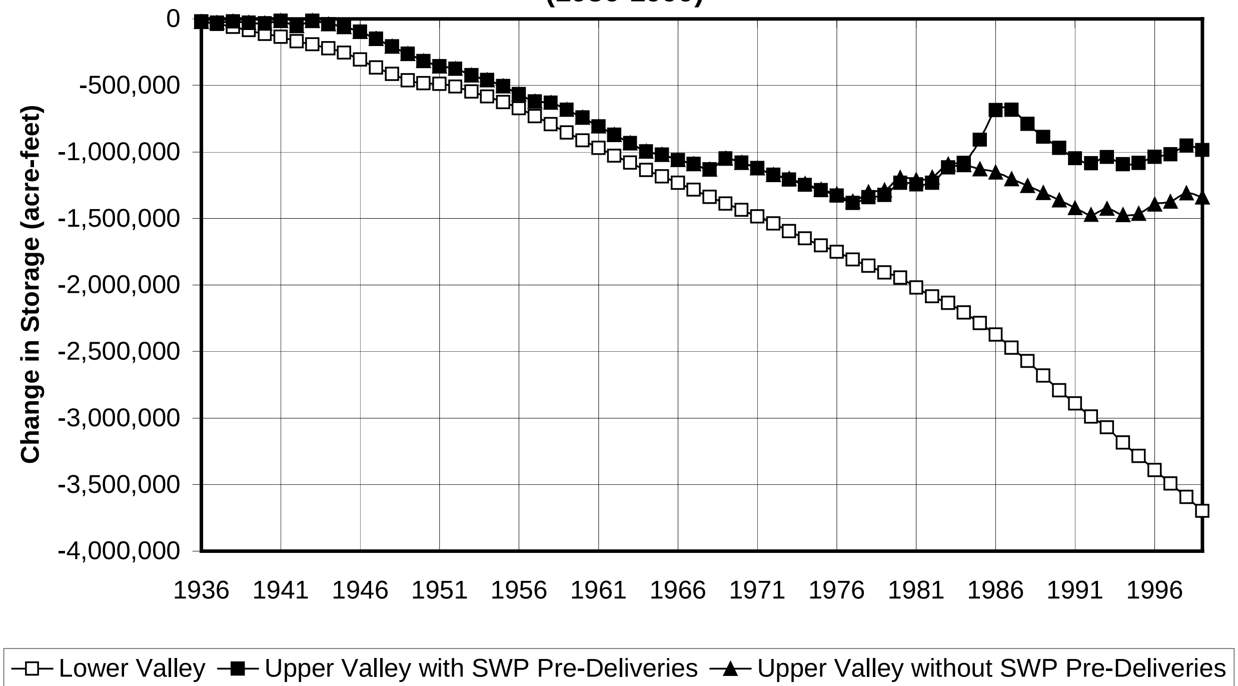


As presented in Table 3-4, approximately 41,800 acre-ft/yr of freshwater storage was lost in 1936. By 1999, approximately 136,700 acre-ft/yr of freshwater storage had been lost, of which approximately 119,000 acre-ft/yr was lost in the Lower Valley, while approximately 32,400 acre-ft/yr of storage was lost in the Upper Valley.

Table 3-4 and Figure 3-H present the cumulative change in freshwater storage in the Upper and Lower Valleys. Between 1936 and 1999, Lower Valley lost nearly 3.7 million acre-ft of freshwater storage. During the same period, the Upper Valley lost nearly 1 million acre-ft of freshwater storage. This results in a Valley-wide freshwater storage loss of nearly 4.7 million acre-ft. Since the 290,300 acre-ft of pre-delivered water is reserved for Metropolitan's use, the net freshwater storage loss is nearly 4.8 million acre-ft.

It is important to note, however, that the net change in storage calculation does not completely address overdraft concerns, including changes in water quality or subsidence. These concerns, as they relate to overdraft, are discussed in the following section.

Figure 3-H
Cumulative Change in Freshwater Storage
(1936-1999)

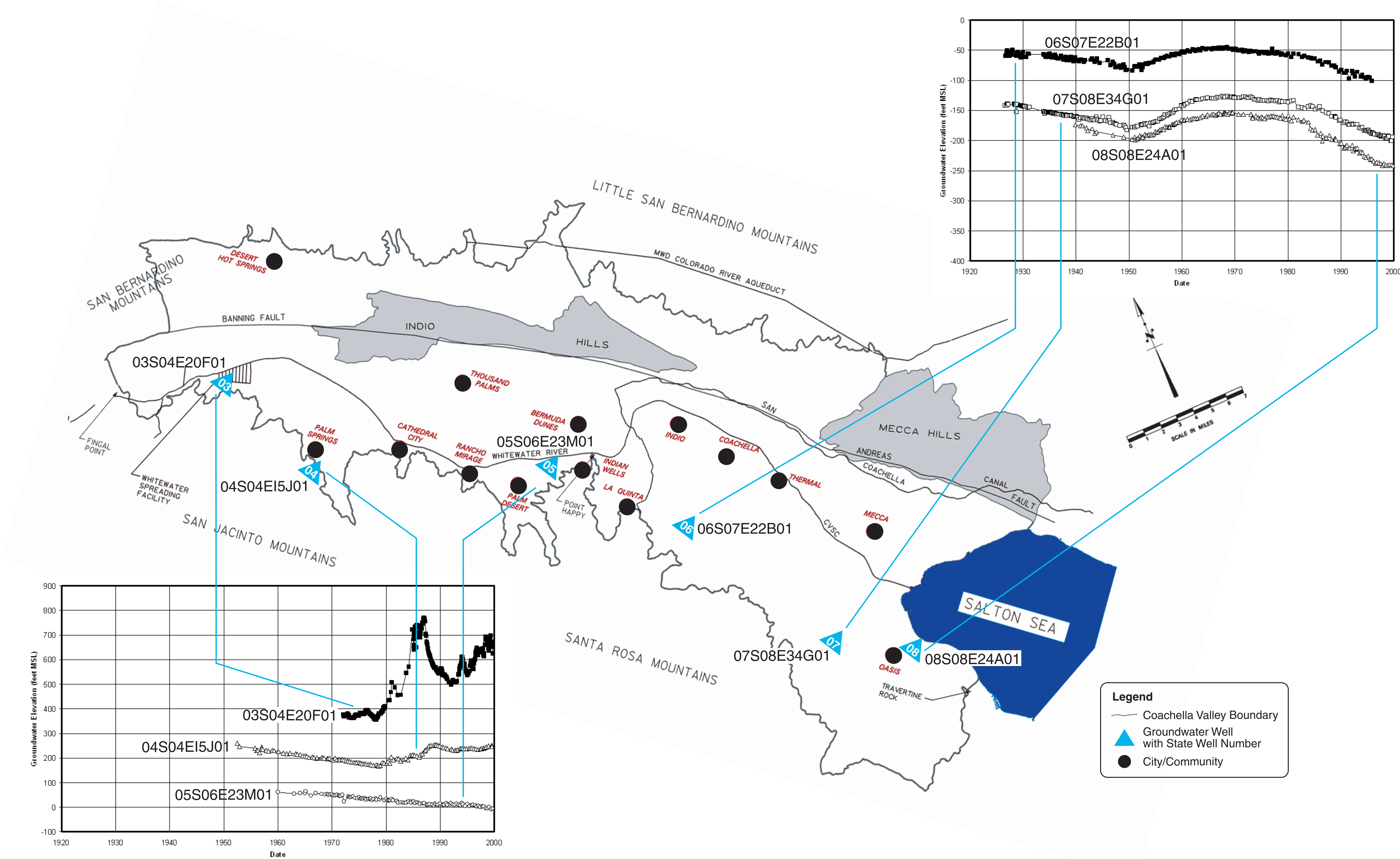


Groundwater Levels

As discussed above, groundwater extraction in the Coachella Valley has exceeded inflows for many years resulting in a decrease of groundwater levels throughout the basin. Representative hydrographs for wells in the Upper and Lower Valleys are presented in Figure 3-I.

Water levels in the Upper Valley typically decreased 50 to 100 feet from the early 1950s to the late 1970s, as shown for Wells 04S04E15J01 (near Palm Springs) and 05S06E23M01 (near Indian Wells). With the introduction of SWP exchange water in 1973, water levels began to recover in wells in the northern portion of the Upper Valley. Water levels in Well 04S04E15J01 increased dramatically in the late 1980s, resulting from pre-delivery of SWP exchange water from 1984 to 1986. Well 03S04E20F01 (located close to the spreading grounds) shows a more dramatic change. Wells that are far from the spreading grounds (such as Well 05S06E23M01) show a slower response to the recharge, as indicated in the early 1990s. Water levels have continued to decline in wells farther from the spreading grounds.

Water levels in the Lower Valley typically decreased on the order of 50 feet from the 1920s to the early 1950s. Following the introduction of Canal water for irrigation in 1949, water levels steadily increased during the 1950s and early 1960s, until leveling off during the late 1960s and early 1970s, and then declined through the early 1980s. Water levels have declined dramatically from the early 1980s to the present, particularly in wells located near the Salton Sea. Water levels in the vicinity of Well 08S08E24A01 (near Oasis) have declined in excess of 80 feet since the mid-1980s. The increased fish farm demand, the increased use of groundwater for drip



MONTGOMERY WATSON

Figure 3-I
Historical Water Levels in the Coachella Valley

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irrigation systems by local farmers, and the increased number of new golf courses have contributed to these significant groundwater level declines through the Lower Valley.

Water Quality

Water quality can be evaluated either in terms of the historical quality of groundwater pumped from wells and the net salt added to the basin. Although the addition of salts to the basin through water use is not likely to impact the quality of groundwater produced from the Lower aquifer immediately, this poor quality water will eventually migrate downward in the absence of management strategies to control this movement. Therefore, the total salt balance is an important long-term water quality indicator, although its effects may not be immediately realized.

Historical Groundwater Quality

Historical water quality data are presented in Table 3-5. Basin-wide groundwater quality is difficult to characterize because groundwater quality varies with such factors as depth (or the screened interval of a water supply well), proximity to faults, presence of surface contaminants, proximity to the recharge basin, and other hydrogeologic or cultural features.

During the 1930s, TDS concentrations throughout the Coachella Valley were typically less than 250 mg/L except in localized areas (DWR, 1979). In the 1970s, the groundwater typically contained 300 mg/L TDS in the Upper aquifer and 150 to 200 mg/L TDS in the Lower aquifer (DWR, 1979). Nitrate concentrations during the 1930s were typically less than 4 mg/L throughout the Valley. In wells adjacent to the Whitewater River, nitrate concentrations had increased to more than 45 mg/L by the late 1970s (DWR 1979). According to DWR (1979), the high nitrates are believed to be derived from fertilizers applied to agricultural lands and golf courses, effluent from septic tanks and wastewater treatment plants, buried vegetation in former swamp lands (mesquite forests) along the Whitewater River, or combinations thereof.

Table 3-5
Summary of Representative Water Quality of Upper and Lower Aquifers

<table>
<tr><th rowspan="3">Aquifer</th><th colspan="6">Total Dissolved Solids – mg/L</th></tr>
<tr><th colspan="2">1938-39</th><th colspan="2">1970-75</th><th colspan="2">Current</th></tr>
<tr><th>Range</th><th>Average</th><th>Range</th><th>Average</th><th>Range</th><th>Average</th></tr>
<tr><td>Semi-Perched</td><td>-</td><td rowspan="3">< 250</td><td>-</td><td></td><td>530 - 8,312</td><td>2,200</td></tr>
<tr><td>Upper aquifer</td><td>-</td><td>-</td><td>300</td><td>152 - 889</td><td>540</td></tr>
<tr><td>Lower aquifer</td><td>-</td><td>-</td><td>150 - 200</td><td>131 - 198</td><td>160</td></tr>
<tr><td>Coachella Canal</td><td>-</td><td>-</td><td>-</td><td>-</td><td>585 - 1,106</td><td>800</td></tr>
<tr><td>SWP Exchange Recharge</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>660</td></tr>
</table>

In the Semi-perched aquifer, TDS concentrations range from 530 to 8,312 mg/L, with an average of about 2,200 mg/L. Few wells are screened exclusively in the Semi-perched aquifer. Therefore, TDS values are based upon the water quality in the Coachella Valley drains.

In the Upper aquifer, TDS concentrations range from 152 to 889 mg/L, with an average of about 540 mg/L. Higher TDS concentrations in the Upper aquifer are typically detected along the Valley margins, particularly in the vicinity of the San Andreas fault system and in an area southeast of Oasis. Groundwater in areas south of Indio and east of Mecca also contain higher TDS concentrations (above 750 mg/L). The water quality of the Upper aquifer has decreased since the 1930s. In particular, the average TDS of the Upper aquifer in the 1970s was approximately 300 mg/L compared to approximately 540 mg/L TDS today.

In the Lower aquifer, representative TDS concentrations range from 131 to 198 mg/L with an average of 160 mg/L. TDS concentrations in some areas of the Lower aquifer may be higher. For example, in areas where the Upper and Lower aquifers are merged (e.g., along the western margin of the Valley), TDS concentrations are typically higher and more representative of Upper aquifer quality. Similarly, in other areas adjacent to major faults, the TDS content of the Lower aquifer is greater than 1,000 mg/L TDS. One of these areas is along the fault zone separating the Thousand Palms and Fargo Canyon Subareas from the Thermal Subarea. Along this northern fringe of the basin, near the San Andreas Fault and the presumed extension of the Garnet Hill Fault, the TDS concentrations exceed 1,000 mg/L. Isolated wells near Indio and Coachella exhibit similar TDS concentrations. In portions of the Oasis Subarea, groundwater also ranges from 500 to 1,000 mg/L TDS. The concentrations of TDS in the Lower aquifer unlike the shallower zones have remained relatively constant since the 1930s.

As discussed previously, groundwater levels are currently declining throughout the Coachella Valley. In the Lower Valley, this decline, due to a combination of reduced Coachella Canal deliveries and increased groundwater pumpage, has reduced groundwater flow into the agricultural drains. This allows high-TDS water to migrate from the Semi-perched zone downward to the Upper aquifer. Additionally, decreasing water levels in the Lower aquifer allows poorer quality Upper aquifer water to migrate downward into the Lower aquifer, particularly along the margins of the basin, where the aquitard separating the two zones is thin or absent. The net result is a decline in the water quality of the Lower aquifer in the Lower Valley.

Salt Inputs

Although it may not be noticeable in the production well data, water use practices typically add salts to the groundwater basin. Salt is added to the groundwater basin through natural recharge, wastewater percolation, application of fertilizers, imported water use (irrigation or recharge), and intrusion from the Salton Sea. Salt is removed from the basin by the agricultural drains, wastewater discharge to the CVSC and subsurface outflow to the Salton Sea. Table 3-6 summarizes the water quality assumptions used to evaluate a simplified salt budget and lists the inputs and outputs to the net salt contribution. It is important to recognize that the simplified salt balance presented herein assumes that the salt contribution factor from each component of the salt balance will remain constant throughout the planning period. In addition, the salt budget is calculated on a basin-wide basis and therefore, does not consider local vertical or horizontal changes in water quality.

Table 3-6
Summary of Salt Budget Assumptions

Component	Total Dissolved Solids (mg/L)	Salt Contribution (tons/acre-ft)
INPUTS		
Direct Groundwater Inputs		
Natural Recharge	210	0.3
SWP Exchange Recharge [1]	530 to 750	0.7 to 1.0
Canal Deliveries [1]	625 to 975	0.9 to 1.3
Inflow from the Upper Valley	240	0.3
Inflow from the Salton Sea	44,000	59.7
Fish Farm and Duck Clubs Reuse	190	0.3
Input through Use		
Domestic Use Increment	250	0.3
Agricultural Fertilizer	--	0.02
Golf Course Fertilizer	--	0.02
OUTPUTS		
Outflow to the Lower Valley	240	0.3
Drain Flows [1]	1,000 to 3,200	1.4 to 3.5
Outflows to the Salton Sea	2,100	2.8
Fish Farm and Duck Clubs Pumping	190	0.3
Municipal Wastewater Discharge	450	0.5

Note: [1] Range in TDS based upon historical and projected variations in water quality

Natural Recharge. Natural recharge includes inflows from the San Gorgonio River, the Whitewater River, San Gorgonio Pass and across the Banning fault. The quality of this input is approximately 210 mg/L (DWR, 1964). This represents a salt contribution of approximately 0.3 tons per acre-ft.

Imported Supplies. Colorado River water from Metropolitan's intake (via the SWP exchange) and from the Coachella Canal add salt to the basin. Historically, the TDS concentrations of the SWP Exchange water have ranged from approximately 530 mg/L to 750 mg/L with an average of approximately 660 mg/L based upon the water quality of Metropolitan's Colorado River Aqueduct since 1973. The SWP exchange water quality was approximately 567 mg/L TDS in 1999. The historical TDS concentrations of Canal water (at Avenue 52) ranged from approximately 625 mg/L to 975 mg/L with an average of approximately 800 mg/L since 1949 (CVWD, unpublished). The quality of Canal water at Avenue 52 in 1999 was approximately 674 mg/L TDS (CVWD, unpublished).

Upper Valley to Lower Valley. The salt contribution from the Upper Valley into the Lower Valley was estimated by evaluating the water quality from production wells located near the boundary between the Upper and Lower Valley. These data represent combined water quality of both the Upper and Lower aquifer as many wells in this area were screened across several water-bearing units. The water quality of these wells was approximately 240 mg/L TDS (CVWD, unpublished).

Subsurface Inflow from Salton Sea. The quality of the subsurface inflow from the Salton Sea has been assumed to be the current quality of the Salton Sea with TDS concentrations of 44,000 mg/L. This represents a salt contribution of approximately 59.7 tons per acre-ft of water.

Municipal Use. Salt contribution from municipal use can be subdivided into indoor usage (septic systems) and outdoor usage (irrigation). Indoor usage introduced via septic systems contributes additional salt to the basin through water use. Outdoor usage does not contribute additional salt to the basin. The remainder of municipal demand is discharged to the sewer system and enters the basin via the wastewater treatment plants. Table 3-7 presents the proportion of municipal use that contributes to the salt load from each source. The TDS concentrations from each source are also presented. The incremental contribution from indoor use was assumed to be approximately 250 mg/L.

Table 3-7
Summary of Municipal Use Assumptions

Source	TDS Increment (mg/L)	Upper Valley	Lower Valley
Indoor Use (Septic)	250	9.4 percent	10.1 percent
Indoor Use (Sewer)	250	16.6 percent	24.1 percent
Outdoor Use (Irrigation)	0	74 percent	65.8 percent

Fertilizers. Salts are also added in the form of fertilizers. The fertilizer application rate largely depends upon the type of crop grown. The amount of additional salt added from fertilizer application is defined as the TDS increment. TDS increment values range from 0.14 tons per acre /yr, for low-fertilizer crops such as citrus and grapes, to 0.3 tons per acre /yr for various grains and truck crops (Water Resources Engineers, 1970). These data were compiled to estimate the total salt input from agricultural fertilizers.

Application of fertilizer to irrigated urban turf also contributes to the basin salt load. The TDS increment value for urban turf is 0.17 tons per acre /yr (Water Resources Engineers, 1970). Assuming a 75 percent irrigation efficiency and an urban irrigation requirement of approximately 7.1 feet of applied water, the fertilizer requirement is approximately 0.02 tons of fertilizer per acre-ft of water used for municipal irrigation.

Salt Outputs

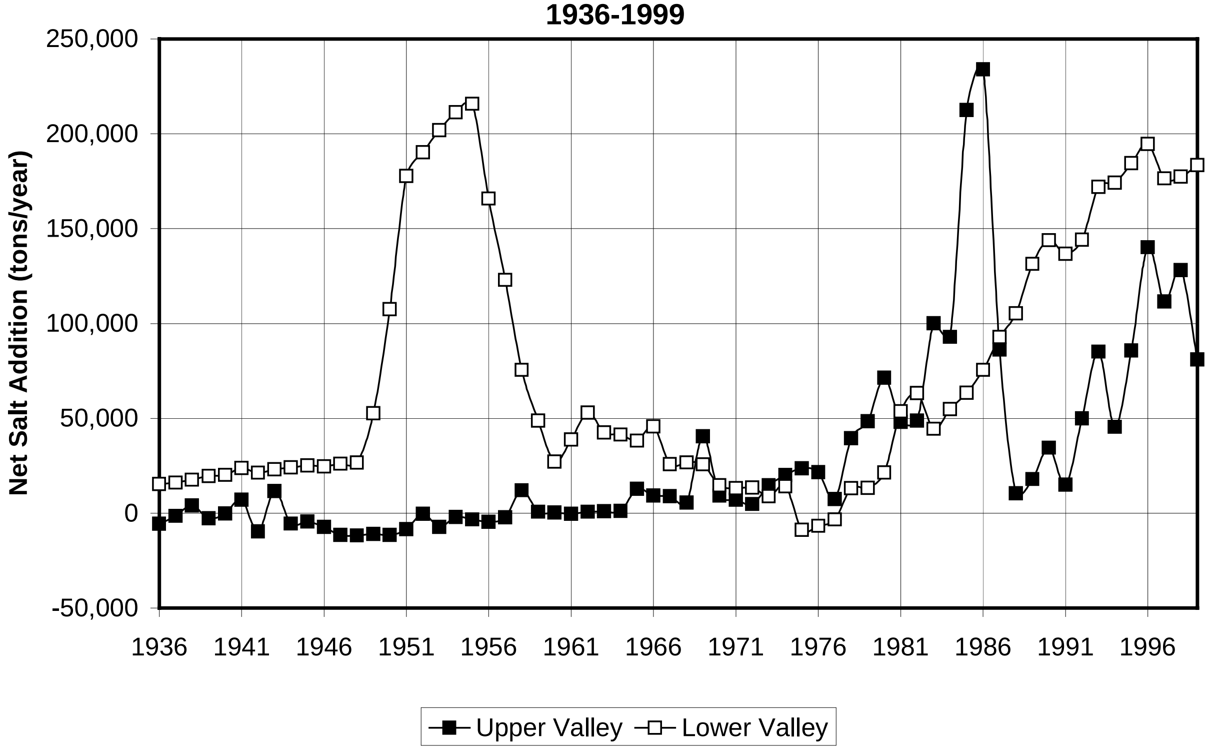
Outputs in the salt budget include outflow to the Lower Valley, drain flows, outflows to the Salton Sea, fish farm and duck club pumping and municipal wastewater discharge. Each of these components is listed in Table 3-6.

Agricultural Drainage. Salts can be removed from the basin via the CVSC and 25 agricultural drains that drain directly into the Salton Sea. The CVSC contains several components including agricultural drainage, regulatory water, fish farm effluent, and wastewater treatment plant effluent. The quality of the agricultural drainage component is dependent upon the quality of the applied water for irrigation and the irrigation efficiency. In general, as the applied water TDS and the irrigation efficiency increaes, the TDS of the agricultural returns also increase. The estimated quality of the agricultural returns has ranged from approximately 1,000 mg/L to 3,200 mg/L with an approximately TDS of 2,200 mg/L in 1999. Drain flows can therefore remove between 1.4 to 3.5 tons of salt per acre-ft.

Municipal Wastewater. Municipal wastewater discharge quality is the average effluent quality from the Lower Valley wastewater treatment plants. This quality is approximately 349 mg/L TDS, which removes approximately 0.5 tons per acre-ft of discharge.

Outflows to the Salton Sea. The average TDS concentration of the 25 agricultural drains that drain directly into the Sea (2,100 mg/L) is used to estimate outflows to the Salton Sea. This component removes approximately 2.8 tons of salt per acre-ft from the basin.

Figure 3-J
Historical Annual Salt Addition to the Groundwater Basin
1936-1999



The historical salt addition for 1936 and 1999 is presented in Table 3-8. The net salt addition was approximately 12,000 tons per year in 1936. The net salt addition to the entire basin in 1999 was approximately 265,000 tons. Approximately 65 percent of the current net salt addition (184,000 tons per year) occurs in the Lower Valley. In 1936, the net salt addition in the Upper Valley was negative because of the net flow from the Upper Valley to the Lower Valley. As presented in Figure 3-J, the salt condition of the basin remained relatively balanced until Canal water began to replace groundwater pumpage in the late 1940s. Canal water has much higher TDS concentrations than typical groundwater. The rate of salt addition decreased after the installation of the drains, which removed much of the salt from agricultural drainage from the basin. After recharge activities began in the Upper Valley, the rate of salt addition began to increase again. In the Lower Valley, declining drain flows have decreased the outflows from the basin. Likewise, declining water levels have provided the opportunity for Salton Sea intrusion, which added about 71,000 tons of salt in 1999.

Table 3-8
Historical Salt Balance (1936-1999)

	1936			1999		
Component	**Upper Valley**	**Lower Valley**	**Total**	**Upper Valley**	**Lower Valley**	**Total**
Salt Addition						
Natural Recharge	13,000	1,000	14,000	8,000	1,000	9,000
SWP Recharge	0	0	0	70,000	0	70,000
Canal Water Use	0	0	0	1,000	251,000	252,000
Salton Sea Intrusion	0	0	0	0	71,000	71,000
Fish Farm/Duck Club Reuse	0	0	0	0	0	0
Input from Upper Valley	0	19,000	19,000	0	10,000	10,000
Domestic Use Increment	1,000	1,000	2,000	8,000	7,000	15,000
Fertilizers	1,000	17,000	18,000	4,000	16,000	20,000
Total Salt Adddition	15,000	38,000	53,000	91,000	356,000	447,000
Salt Removal						
Drain Flows	0	4,000	4,000	0	156,000	156,000
Outputs to Salton Sea	0	16,000	16,000	0	2,000	2,000
Fish Farm/Duck Club Pumping	0	1,000	1,000	0	7,000	7,000
Municipal Wastewater Discharge	0	1,000	1,000	0	7,000	7,000
Output to Lower Valley	19,000	0	19,000	10,000	0	10,000
Total Salt Removed	19,000	22,000	41,000	10,000	172,000	182,000
TOTAL SALT ADDED	-4,000	16,000	12,000	81,000	184,000	265,000

[1] all units are in tons per year.

Based upon these salt estimates, the average TDS has increased approximately 127 mg/L in the Upper Valley since 1936. Similarly, in the Lower Valley, the average TDS of the basin has increased approximately 197 mg/L since 1936. It is important to recognize that this estimate is an average and does not account for vertical or lateral variations in water quality. Note that most of the Valley salt accumulation is in the shallow aquifer where pumping from wells is limited.

Subsidence

An important part of managing a groundwater basin is to prevent or minimize land subsidence. If groundwater levels are lowered too much, the land surface may start to subside or sink. Subsidence occurs when water stored in the clay layers is squeezed out when deep water pressure is lowered. The overlying weight of the sediments then compacts the clays. Land surface subsidence is permanent no matter how much water is recharged into the water bearing aquifers. Because subsidence of this nature is not uniform, damage may occur to the existing infrastructure. Linear man-made structures are particularly susceptible to damage, including canals, sewers, water delivery systems, drainage works, flood control facilities, transportation systems, and well casings. The financial impact of this type of subsidence is nearly impossible to predict.

Long-term declines in water levels of sufficient magnitude to induce land subsidence have occurred in portions of the Coachella Valley. Thus the potential for surface subsidence is substantial.

In addition to vertical compaction, regional and local horizontal movements can occur due to large amounts of localized pumpage or changes in aquifer thickness. Changes in aquifer thickness occur along the basin margins or where there are irregular, shallow subcroppings of bedrock. These horizontal movements can ultimately result in inelastic failures at the ground surface. These failures, which appear as surface fissures, can also damage man-made structures, interrupt irrigation of agriculture, capture runoff, and become direct conduits for poor quality water to enter the aquifer.

Figures 3-K and 3-L show surface fissures that occurred in 1948 near the intersection of Adams Street and Avenue 52 near La Quinta, which may have resulted from land subsidence. Little is known about the origin of these fissures. However, they occurred along the edge of the valley, where the potential for shallow subcropping of bedrock is high, and at the time when water levels were at historical lows.

In 1996, the District entered into a cooperative agreement with the U.S. Geological Survey to establish a precise elevation network to monitor land subsidence in the lower Coachella Valley and to develop baseline measurements for accurate determination of future land subsidence. The study also involved reviewing historical data to determine the location, existence, and magnitude of previous subsidence.

Figure 3-K
Subsidence in the Lower Valley (Surface Fissure)

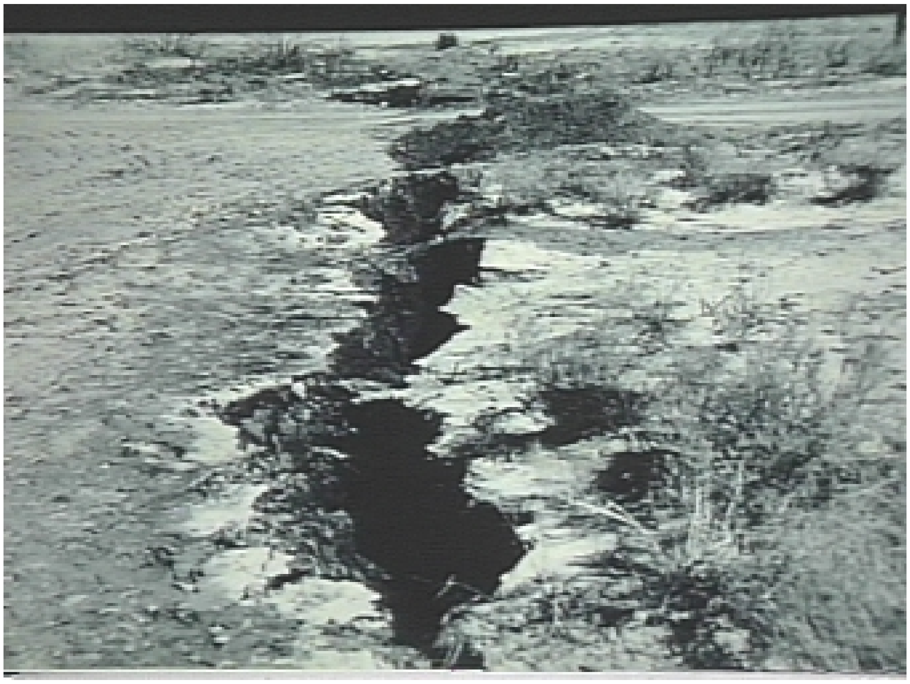


Figure 3-L
Subsidence in the Lower Valley (Aerial View)

Preliminary study results indicate that subsidence at network monument locations has occurred in varying degrees (Ikehara et. al., 1997). Fourteen of the seventeen monument locations indicated cumulative subsidence measurements ranging from 0.2 to 0.5 feet from the 1930s to 1996. Where data were available, historical subsidence was plotted with time and compared to water level changes in nearby wells. In general, subsidence occurred during periods of water level decline, and rebound occurred during intervening periods of water level recovery. Since the magnitude of these subsidence determinations is near or within the range of uncertainty (+/-0.2 feet) for measurements made under these conditions, these measurements do not unequivocally indicate that subsidence has occurred. However, since the timing of the subsidence measurements corresponded with water level declines, land subsidence is probably occurring, and a significant part of the measured subsidence likely has occurred since 1991, about the time when water levels began declining below their previously recorded low levels. Recent studies have indicated that as much as 7 cm of subsidence had occurred in the Palm Desert area between 1996 and 1998.

Estimated Overdraft

As discussed above, the effects of overdraft are manifested in terms of lost storage, water level declines, water quality degradation, and subsidence. Since these effects vary with location, it is desirable to develop a single estimate of the groundwater overdraft. Clearly, change in storage estimates may account for water level changes but do not adequately consider water quality or subsidence impacts. Considering all of these factors, the change in freshwater storage is used in this plan to estimate the groundwater overdraft. This measure reflects water level declines, the loss of storage space to poor quality water, and seawater intrusion. Although it does not directly reflect subsidence impacts, the corresponding water level increases necessary to exclude poor quality inflows should more than eliminate any potential subsidence.

Based on the foregoing discussion, the overdraft for the Coachella Valley is estimated to be 136,700 acre-ft/yr for the year 1999. The Upper Valley overdraft is estimated to be 32,400 acre-ft/yr while the Lower Valley overdraft is estimated to be 104,300 acre-ft/yr. Note that the District purchased nearly 50,000 acre-ft of additional SWP Exchange entitlement from other SWP contractors during 1999. If this water had not been purchased, the overdraft would be higher. This approach for estimating overdraft will be applied in the following chapter to estimate future overdraft in the absence of a water management plan.

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Section 4
Baseline Conditions:
The No Project Alternative

The review of historical water conditions in Section 3 indicates that water supply problems exist today. However, to determine whether these problems will continue, a reasonable estimate of future water conditions is necessary. These conditions include future water demands and the supplies required to meet those demands. They also provide a baseline for developing and comparing the effectiveness of the alternative management plans that are developed in Section 5. This section presents a discussion of future supplies and demands anticipated for the Valley, the projected water balance and the expected impacts of overdraft as if no management plan is implemented. This baseline is referred to as the No Project Alternative. The section concludes with a discussion of the need for a management plan.

FUTURE DEMANDS AND SUPPLIES

The following discussion of future supplies and demands sets the framework for the basic planning assumptions for the No Project as well as the Plan. Specific details of the Plan are discussed in Section 5.

Planning Assumptions

Projections of future conditions are by their nature approximations and as such are frequently based on historical trends or on estimates made by others. In the development of future water demands and supplies, a number of assumptions have been made, as described below. The planning period for the Plan has been established as 2000 to 2035.

Water Conservation

No Project incorporates existing water conservation programs throughout the Valley. State law mandates several water conservation techniques, which have been already implemented in the Valley. For example, State plumbing codes have required the installation of ultra-low-flush toilets (1.6 gallons/flush) and low-flow showerheads (2.5 gpm maximum) on all new construction since 1992. In addition, State law required each City to adopt a water-efficient landscape ordinance or enforce the Department of Water Resources' model ordinance by January 1, 1993. To provide conservative estimates of future water demand, no additional urban water conservation is assumed. Similarly, no additional agricultural water conservation is assumed in the No Project Alternative.

Municipal Growth Assumptions

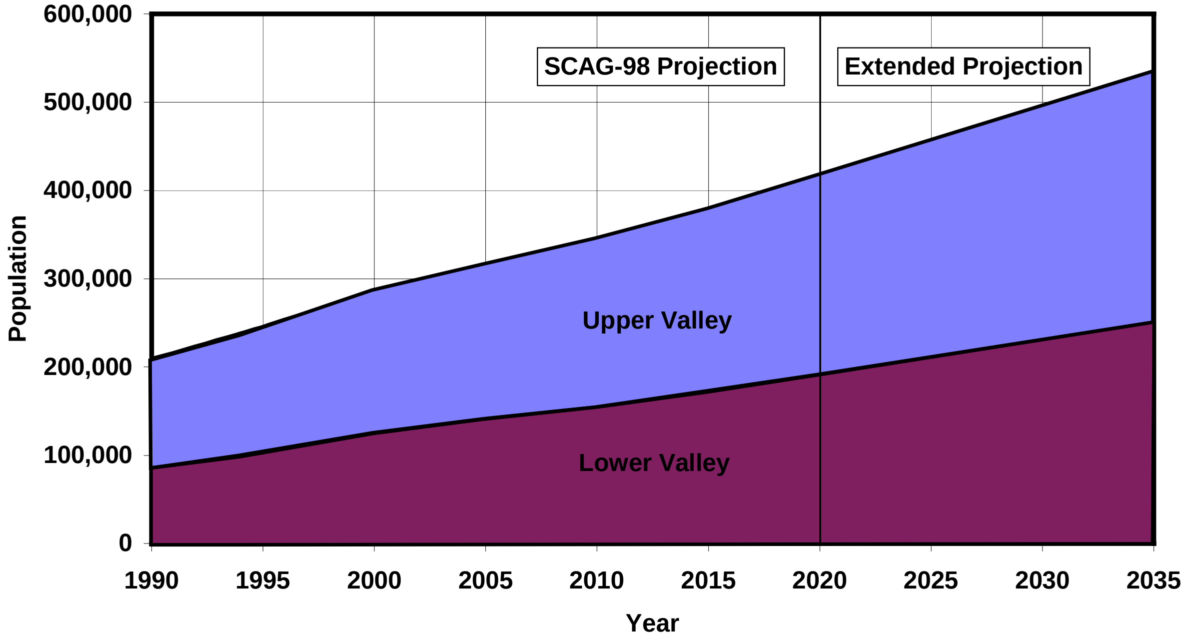
The Southern California Association of Governments (SCAG) and the Coachella Valley Association of Governments (CVAG) have projected population growth in the Coachella Valley. The most recent population, housing, and employment projections available are the SCAG/CVAG 1998 forecasts. Population projections are presented in Table 4-1 and Figure 4-A.

Table 4-1
Population Projections for the Coachella Valley

City	SCAG/CVAG Projections [1]						Extended Projection [2]		
	1994	2000	2005	2010	2015	2020	2025	2030	2035
Lower Valley									
Coachella	19,969	20,763	21,252	21,725	22,280	22,918	23,556	24,194	24,832
Indio	42,090	47,624	51,022	54,335	58,183	62,620	67,057	71,494	75,931
La Quinta	16,634	20,379	22,680	24,922	27,526	30,530	33,534	36,538	39,542
Unincorporated	23,350	37,411	46,040	54,459	64,234	75,507	86,780	98,053	109,326
Subtotal	102,043	126,177	140,994	155,441	172,223	191,575	210,927	230,279	249,631
Upper Valley									
Cathedral City	34,943	38,678	41,206	43,527	46,224	49,335	52,446	55,557	58,668
Indian Wells	3,096	3,480	3,715	3,947	4,214	4,522	4,830	5,138	5,446
Palm Desert	27,273	29,930	31,949	33,684	35,698	38,021	40,344	42,667	44,990
Palm Springs	42,411	47,240	50,214	53,106	56,469	60,343	64,217	68,091	71,965
Rancho Mirage	10,699	12,076	12,918	13,743	14,698	15,800	16,902	18,004	19,106
Unincorporated	16,986	27,115	33,336	39,403	46,454	54,586	62,718	70,850	78,982
Subtotal	135,408	158,519	173,338	187,410	203,757	222,607	241,457	260,307	279,157
Total	237,451	284,696	314,332	342,851	375,980	414,182	452,384	490,586	528,788

Notes: [1] SCAG, 1998.
[2] Estimated based upon trend from 2015 to 2020.

Figure 4-A
Projected Population for the Coachella Valley Study Area



The population in the Valley is projected to increase from 227,451 in 1994 to 375,980 in 2015, a growth of 65 percent. Growth will be more rapid in the Lower Valley, where population is projected to increase by 69 percent by 2015. Population growth in the Upper Valley is expected to be about 50 percent. Unincorporated areas are expected to experience the most rapid growth, which nearly triple by 2015.

Because SCAG and CVAG only projected population to 2020, projections from 2020 to 2035 were estimated by extending the trend from 2015 to 2020 into the future. From 1994 to 2035, total population is projected to more than double to 528,788. A large proportion of this growth is projected to occur in currently unincorporated areas of the Valley.

Population is frequently used to estimate water demands using the per capita method. Under this method, municipal water demands are projected to increase in proportion to population growth. For this plan, water demand increases are assumed to vary according to the growth rates of the individual cities and unincorporated areas within the Valley. For example, water demands in the City of La Quinta are projected to increase 69 percent by 2015, and demands in Cathedral City are projected to increase 30 percent by 2015, in proportion to the increase in population projected for these areas. These increased demands are assumed to be supplied by existing production wells nearest to each city. Certain municipal demands such as homeowner's associations and private homes, which are served by private wells, are assumed to remain constant. On-farm domestic water use is assumed to remain constant at 3,000 acre-ft/yr (two homes per 40 acres at 1 acre-foot per year).

Agricultural Growth Assumptions

Future agricultural demands are based on an analysis of 1996 crop surveys (Lord, 1996). The District conducts semiannual crop surveys. Crop evapotranspiration and the leaching requirement (applied water required to maintain salt tolerance of crops) were estimated and applied to crop acreage in each section. Water demand was computed assuming a District-wide irrigation efficiency of 70 percent. Subsequent on-farm investigations have confirmed this estimate of efficiency. For future conditions, it is assumed that these cropping patterns will generally continue.

Several existing sections of agricultural land, particularly in the northern portion of the Lower Valley are projected to convert to urban use by 2035. Because it is currently unknown exactly when this conversion will take place, the agricultural demand in this portion of the Valley was gradually reduced each year until 2035. In addition, some vacant land within ID-1 in the central portion of the Lower Valley currently zoned for agriculture will be farmed by 2035. Most of these. Therefore, expansion of the existing distribution system will be required. The result of these conversions is a net increase in the agricultural demand of about 13,500 acre-ft/yr by 2035. Increased demand located within ID-1 is assumed to be supplied with Canal water while land outside ID-1 will be supplied with groundwater. No Canal water conversion is assumed to take place in the Oasis area. Upper Valley agricultural demands are assumed to remain constant at current levels.

Golf Course Growth Assumptions

Golf courses represent a significant demand sector in the Coachella Valley that is expected to continue growing. Current plans indicate that 40 additional courses could be constructed by 2015 (Desert Sun, 1996). It was assumed that the probability of a course actually being constructed is about 75 percent. In addition, it is expected that improved irrigation efficiency will reduce the water demand of these new courses. Therefore, accounting for the improved irrigation efficiency and the probability of occurrence, projected demands for each new 18-hole course are estimated to be about 900 acre-ft/yr.

The water supply for golf courses depends on their location and current supply. Most existing Upper Valley golf courses are supplied with groundwater unless served with recycled water. Recycled water is currently delivered to golf courses from WRP-7, WRP-9, WRP-10 and Palm Springs/DWA Water Reclamation Plant. Existing courses in the vicinity of WRP-10 will need to use more recycled water in the future because future wastewater flows at WRP-10 are projected to exceed the current percolation capacity at WRP-10. Therefore, several existing courses closest to WRP-10 that currently use only groundwater are projected to use recycled water in the future. Recycled water users are assumed to meet only 70 to 90 percent of their demand with recycled water because groundwater must be pumped in summer months to meet demand when recycled water availability decreases.

Some Golf courses in the Lower Valley currently receive Canal water to meet a portion of their demand. All new Lower Valley golf courses in ID-1 will receive Canal water. All existing

Lower Valley courses that currently receive Canal water will continue to be supplied at the current rates.

Fish Farm and Duck Club Assumptions

Fish farm demands are based on surveys conducted by the District in 1994. Nearly all fish farms currently pump groundwater, except for a few that use Canal water to meet a portion of their demand. Canal water use for existing fish farms will remain at current levels. Water demands for new fish farms are assumed to increase 5,000 acre-ft/yr by 2005.

Fish farm pumping is projected to decrease due to on-going water conservation and recycling efforts. Reuse of fish farm effluent will increase from 1,500 acre-ft/yr in 1999 to 5,000 acre-ft/yr in the future. This effluent is assumed to be used by agricultural irrigators, duck clubs and fish farms. Therefore, discharge of fish farm effluent to the CVSC and other drains will decrease from 13,000 acre-ft/yr in 1999 to 7,700 acre-ft/yr in the future.

Duck club water demands will increase from 4,300 acre-ft/yr to 4,600 acre-ft/yr as several inactive duck clubs become operational by 2001. Most of the duck clubs currently pump groundwater, except for three clubs that use Canal water to meet a portion of their demand (about 500 acre-ft/yr). This use will continue. In addition, reuse of fish farm effluent is assumed to meet about 600 acre-ft/yr of this demand.

State Water Project Supplies

The SWP exchange with Metropolitan will continue in the future. DWR has performed hydrologic and operational analyses of the SWP as part of the joint California-Federal Bay-Delta studies (CALFED). SWP exchange water deliveries are expected to average 83 percent of entitlement or 50,000 acre-ft/yr based on baseline studies for the CALFED Program (2020D09C-CALFED-786). This annual amount of SWP delivery is equivalent to the historical average amount of SWP exchange water recharged at the Whitewater Spreading Facility. Water recharged at the Whitewater Spreading Facility is subject to evaporation losses of 2 percent based on historical evaporation data and wetted pond acreage.

Whitewater River

The Whitewater River flows from the San Bernardino Mountains southerly through the Coachella Valley. In its upper reaches, it conveys natural runoff along with SWP Exchange water to the Whitewater Spreading Facility for groundwater recharge. Below the spreading grounds, the river predominantly conveys stormwater to the Salton Sea. Below Point Happy, the river channel has been designated the Coachella Valley Stormwater Channel (CVSC). In 1997, the District filed an application with the State Water Resources Control Board to appropriate all waters in the CVSC (up to a maximum of 150 cfs) draining from lands irrigated in ID-1. The application was submitted with the intent to retain local control of local water resources. This project was not included in No Project.

Projected Demands

Demands for water in the Coachella Valley are divided between urban uses (municipal and domestic, industrial, and golf courses) and agricultural uses (crop irrigation, fish farming, greenhouses, and duck clubs).

Figure 4-B
Alternative 1 - No Project
Water Demand Projections

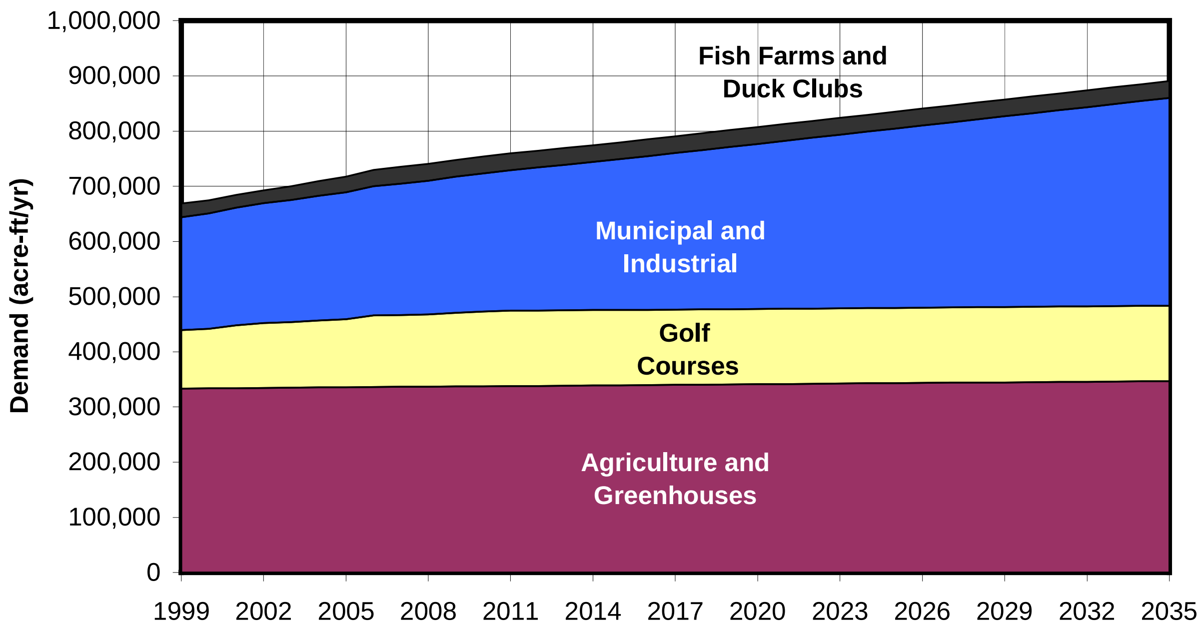


Figure 4-B and Table 4-2 present the current water demand in the study area and projects water demand through the year 2035. Municipal and domestic demands are exceeded by agricultural demands but are expected to increase at a faster rate than agricultural demands. The total demand for 1999 is estimated to be approximately 668,900 acre-ft/yr. The year 2035 demand is anticipated to be approximately 890,600 acre-ft/yr (an increase of 33 percent). In 1999, urban demand comprised 46 percent of the total demand while agricultural water use was 54 percent. By the year 2035, it is estimated that urban water use will comprise 58 percent of the total demand and agricultural use 42 percent, due to the growth of urban demand and the relative stability of agricultural demand.

The total demand for the Lower Valley is projected to increase from 444,700 acre-ft/yr in 1999 to 538,400 acre-ft/yr in 2035, an increase of 21 percent. Of this amount, about 95 percent of the Lower Valley demand is located within the ID-1 boundary. Water demand outside ID-1 is projected to increase slightly, from 21,200 acre-ft/yr in 1999 to 28,100 acre-ft/yr in 2035.

Table 4-2
Summary of Projected Demands (1999-2035)
Alternative 1 - No Project

Component	1999			2015			2035		
	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total
Agricultural									
Crop Irrigation	900	331,600	332,500	900	337,600	338,500	900	345,100	346,000
Greenhouses	0	800	800	0	800	800	0	800	800
Total Agricultural	**900**	**332,400**	**333,300**	**900**	**338,400**	**339,300**	**900**	**345,900**	**346,800**
Municipal and Industrial									
Municipal and Industrial	145,600	57,300	202,900	190,200	80,800	271,000	259,300	115,300	374,600
Industrial	0	1,100	1,100	0	2,300	2,300	0	2,300	2,300
Total Municipal and Industrial	**145,600**	**58,400**	**204,000**	**190,200**	**83,100**	**273,300**	**259,300**	**117,600**	**376,900**
Fish Farms and Duck Clubs									
Fish Farms	0	21,100	21,100	0	25,800	25,800	0	25,800	25,800
Duck Clubs	0	4,300	4,300	0	4,600	4,600	0	4,600	4,600
Total Fish Farms - Duck Clubs	**0**	**25,400**	**25,400**	**0**	**30,400**	**30,400**	**0**	**30,400**	**30,400**
Golf Courses									
Golf Course Demand	77,700	28,500	106,200	92,100	44,400	136,500	92,100	44,400	136,500
Total Golf Courses	**77,700**	**28,500**	**106,200**	**92,100**	**44,400**	**136,500**	**92,100**	**44,400**	**136,500**
TOTAL DEMAND	**224,200**	**444,700**	**668,900**	**283,200**	**496,300**	**779,500**	**352,300**	**538,300**	**890,600**

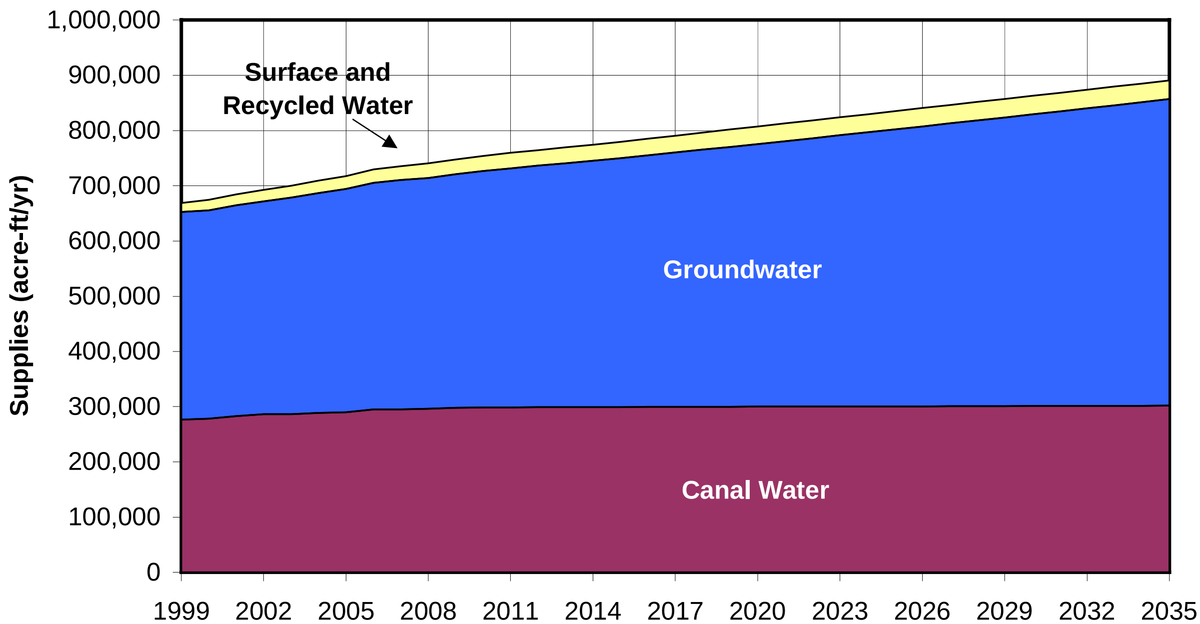
Note: Values are rounded to the nearest 100 acre-ft

The total demand in the Upper Valley is projected to increase from 224,200 acre-ft/yr in 1999 to 352,300 acre-ft/yr in 2035, an increase of 57 percent. Of this amount, demand within ID-1 is expected to triple from 8,700 to 27,400 acre-ft/yr by 2035. Water demands in the DWA service area are expected to increase from 53,900 to 78,900 acre-ft/yr in the same period.

Projected Supplies

Water supplies consist of groundwater extracted from wells, surface water from diversions of local streams, imported water supplied through the Coachella Canal (Canal water), and recycled water from water treatment plants and fish farms. Precipitation in this arid region does not directly provide additional water supply, although the recharge of groundwater aquifers and bodies of surface water by precipitation has been included in the models that support the analysis of water supply. Figures 4-C and 4-D present the projected direct water supplies to meet demand and the projected imported water supplies, respectively.

Figure 4-C
Alternative 1 - No Project
Direct Water Supply Summary

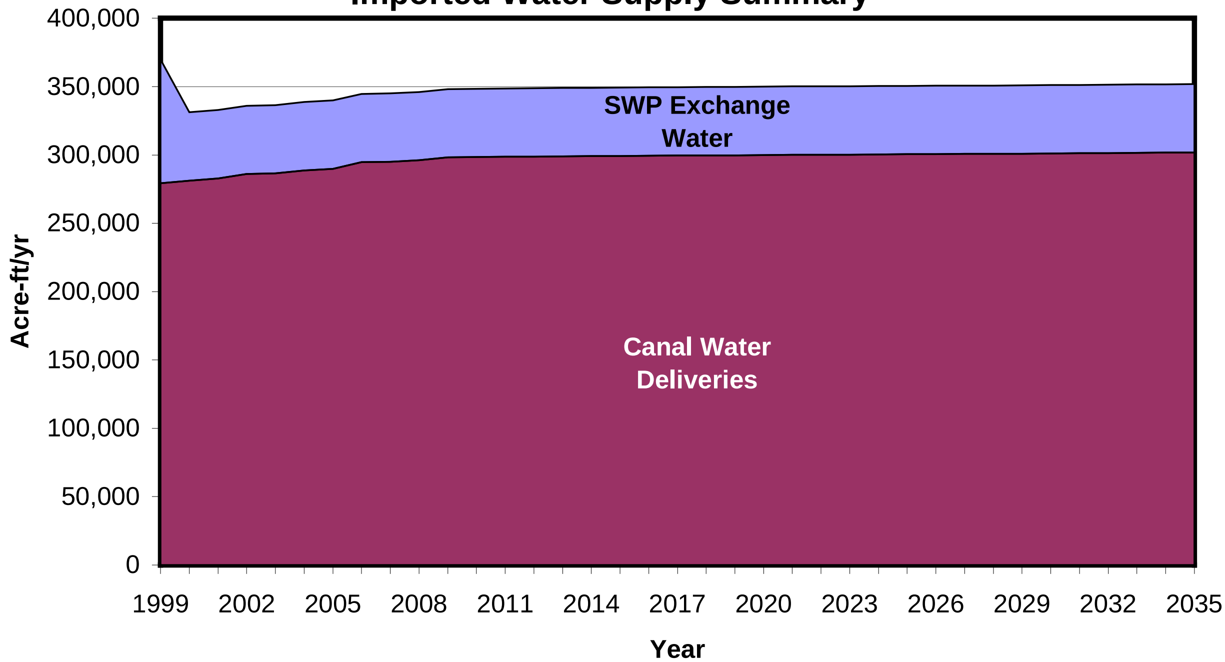


Supplies to Meet Demand

Figure 4-C presents the current water supply to the study area and estimates the water supply through the year 2035. These data are also summarized in Table 4-4 for the Upper and Lower Valleys groundwater (which includes recharged SWP Exchange water) meets approximately 56 percent of the total demand for 1999, approximately 376,100 acre-ft/yr. Most of the remaining demand is met with Canal water (41 percent; 276,300 acre-ft/yr), with 1 percent (8,100 acre-ft/yr)

of demand met by recycled water (which was originally groundwater), 1 percent by fish farm effluent (1,500 acre-ft/yr) and 1 percent by surface water (6,900 acre-ft/yr). These percentages will not change significantly by the year 2035. In that year, 62 percent (555,100 acre-ft/yr) of the demand will be supplied with groundwater, 34 percent (301,900 acre-ft/yr) with Canal water, 2.5 percent (22,000 acre-ft/yr) recycled water, 0.5 percent (5,100 acre-ft/yr) fish farm effluent and 1 percent (6,500 acre-ft/yr) surface water.

Figure 4-D
Alternative 1 - No Project
Imported Water Supply Summary



Groundwater provides most of the water required by golf courses, both in the Upper and the Lower Valleys. In the Lower Valley, approximately 79 percent of the 1999 golf course demand is met with groundwater, and 21 percent is met with Canal water. Future water supply for Lower Valley golf courses (year 2035) will consist of approximately 50 percent groundwater and 50 percent Canal water. In the Upper Valley, where Canal water is generally unavailable, approximately 89 percent of golf course demand is met with groundwater, 9 percent with recycled water, and 2 percent with Canal water. By 2035, the percentage of groundwater is 77 percent of demand, whereas recycled water use increases to about 23 percent and Canal water use decreases to less than 1 percent of demand.

With current water supplies, 80 percent of the 1999 irrigation demand (approximately 266,400 acre-ft/yr) is provided by Canal water, 19 percent (64,800 acre-ft/yr) by groundwater (Table 4-4) and less than 1 percent with fish farm effluent. The irrigation demand in 2035 is expected to be met by 80 percent Canal water (277,500 acre-ft/yr), 19 percent groundwater (66,600 acre-ft/yr), and less than 1 percent fish farm effluent (1,900 acre-ft/yr) (Table 4-4).

Table 4-3
Summary of Projected Supplies (1999-2035)
Alternative 1 - No Project

Supply	1999			2015			2035		
	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total
Groundwater									
Crop Irrigation	900	63,900	64,800	900	61,900	62,800	900	65,700	66,600
Duck Clubs	0	3,500	3,500	0	3,500	3,500	0	3,500	3,500
Fish Farms	0	19,600	19,600	0	21,600	21,600	0	21,600	21,600
Golf Courses	69,100	22,400	91,500	73,900	22,400	96,300	71,000	22,400	93,400
Greenhouses	0	800	800	0	800	800	0	800	800
Industrial	0	1,100	1,100	0	2,300	2,300	0	2,200	2,200
Municipal	137,800	57,000	194,800	182,800	80,600	263,400	251,900	115,100	367,000
Total Groundwater	**207,800**	**168,300**	**376,100**	**257,600**	**193,100**	**450,700**	**323,800**	**231,300**	**555,100**
Local Streams									
Municipal	6,900	0	6,900	6,500	0	6,500	6,500	0	6,500
Recycled Water									
Golf Courses	7,200	0	7,200	17,200	0	17,200	21,100	0	21,100
Municipal	900	0	900	900	0	900	900	0	900
Total Recycled Water	**8,100**	**0**	**8,100**	**18,100**	**0**	**18,100**	**22,000**	**0**	**22,000**

Table 4-3 (continued)
Summary of Projected Supplies (1999-2035)
Alternative 1 - No Project

	1999			2015			2035		
	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total
Fish Farm Effluent									
Crop Irrigation	0	1,300	1,300	0	1,800	1,800	0	1,900	1,900
Duck Clubs	0	200	200	0	500	500	0	500	500
Fish Farms	0	0	0	0	2,700	2,700	0	2,700	2,700
Total Fish Farm Effluent	**0**	**1,500**	**1,500**	**0**	**5,000**	**5,000**	**0**	**5,100**	**5,100**
Canal Water									
Crop Irrigation	0	266,400	266,400	0	273,900	273,900	0	277,500	277,500
Duck Clubs	0	600	600	0	600	600	0	600	600
Fish Farms	0	1,600	1,600	0	1,500	1,500	0	1,600	1,600
Golf Courses	1,400	6,100	7,500	1,000	22,000	23,000	0	22,000	22,000
Municipal	0	200	200	0	200	200	0	200	200
Total Canal Water	**1,400**	**274,900**	**276,300**	**1,000**	**298,200**	**299,200**	**0**	**301,900**	**301,900**
Total Supplies	**224,200**	**444,700**	**668,900**	**283,200**	**496,300**	**779,500**	**352,300**	**538,300**	**890,600**

Note: All values are rounded to the nearest 100 acre-ft

About 81 percent of the water supply for duck clubs currently is provided by groundwater, 5 percent by fish farm effluent and 14 percent by Canal water (Table 4-4). The projections assume that groundwater, Canal water, and fish farm effluent use will remain the same. Water supply for greenhouse use is provided by geothermally heated groundwater. This source of supply is not expected to change during the period of study.

SWP Exchange Water

Although it is not a direct source of supply to meet demand, SWP exchange water is accounted for in the water supply as groundwater and is an important supply source for the groundwater basin. Total SWP exchange water supplies are summarized in Table 4-5 and Figure 4-D. For the future projections, this supply is projected to be the long-term average SWP supply allocated to the DWA and the District. Although this supply will vary with hydrologic conditions in Northern California, long-term averages represent a reasonable estimate of this supply. Recharge of SWP water is expected to average 50,000 acre-ft/yr based on projected average SWP supply availability.

Table 4-4
Total Imported Water Deliveries
Alternative 1 - No-Project

Source	Deliveries[1] acre-ft/yr		
	1999	**2015**	**2035**
SWP Exchange	90,600[2]	50,000	50,000
Canal Water	279,300	299,300	301,800
Total	**369,900**	**349,300**	**351,800**

1 – Deliveries exclude conveyance losses
2 – Amount includes additional SWP exchange water purchased from Pool B. Therefore amount for 1999 is higher than projected amounts

FUTURE OVERDRAFT

As discussed above, the total demand for water in the Coachella Valley is projected to increase. This increased demand for limited water supplies directly affects the status of basin overdraft. The following section discusses the projected overdraft of the basin as it relates to groundwater balance, change in storage, water quality, subsidence, and Salton Sea intrusion.

Hydrologic (Groundwater) Balance

The following section presents the projected groundwater balance (1999 to 2035) for the Coachella Valley under the No Project Alternative. The groundwater balance consists of an accounting of the basin inflows and basin outflows and also estimates the annual change in storage.

Basin Inflows

Total basin inflows are summarized in Figure 4-E and Table 4-6. Natural recharge is based on the long-term average hydrology for the Coachella Valley during the period 1936-1996. In 1999, basin inflows were approximately 186,900 acre-ft/yr in the Lower Valley. Inflows to the Lower Valley are projected to increase to 195,100 acre-ft/yr in the year 2015 and 191,700 in 2035. This increase is largely a function of increased return flows in the Lower Valley resulting from increased municipal and agricultural demand. In 1999, basin inflows to the Upper Valley were approximately 205,300 acre-ft/yr. Inflows to the Upper Valley are projected to increase to 240,500 acre-ft/yr by the year 2035. This increase is primarily a result of the increased returns from municipal and golf course use in the Upper Valley.

In 1999, basin inflows to the Upper and Lower Valleys totaled approximately 409,800acre-ft/yr. Total inflows are projected to increase to 432,200 acre-ft/yr in 2035. As discussed above, this increase is primarily due to increased return flows from municipal and golf course uses. As discussed in Section 3, portions of the return flows are not suitable for beneficial use and actually decrease the freshwater storage in the basin. The change in freshwater storage is discussed later in this section.

Basin Outflows

Total basin outflows from 1999 to 2035 are summarized in Figure 4-F and Table 4-6. In 1999, outflows from the Lower Valley were approximately 228,600 acre-ft/yr. Outflows from the Lower Valley are projected to increase to 268,000 acre-ft/yr by the year 2035. This change in outflow is due to increased pumping and decreased drain flows and subsurface flow to the Salton Sea. Drain flows are projected to decrease from 55,800 acre-ft/yr in 1999 to 34,200 acre-ft/yr by 2035 as groundwater levels decline, reducing the export of salt from the Lower Valley.

Current outflows from the Upper Valley are approximately 237,200 acre-ft/yr. Outflows from the Upper Valley are projected to increase to 330,900 acre-ft/yr by the year 2035. Each of these increases results from a projected increase in the groundwater demand in both the Upper and Lower Valleys.

In 1999, basin outflows from the Upper and Lower Valleys totaled approximately 465,800 acre-ft/yr. Despite a projected decrease in drain flows, total outflows are projected to increase to 598,900 acre-ft/yr by the year 2035. This change is primarily the result of increased groundwater pumpage from 376,100 acre-ft/yr in 1999 to 555,100 acre-ft/yr in 2035.

Change in Storage

As discussed in Section 3, change is storage is the difference between inflows and outflows. In the Lower Valley, the 1999 annual water balance indicates a storage loss of approximately 41,700 acre-ft. Projected change in storage is presented in Figure 4-G. The annual storage loss

Figure 4-E
Summary of Projected Inflows by Source (1999-2035)
Alternative 1 - No Project

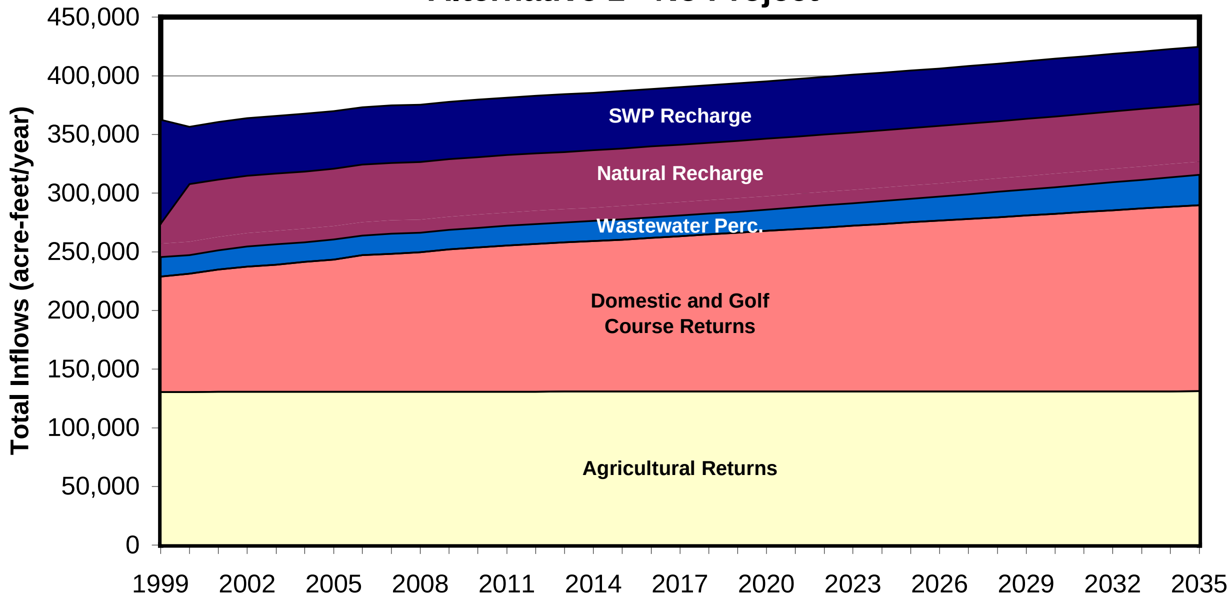
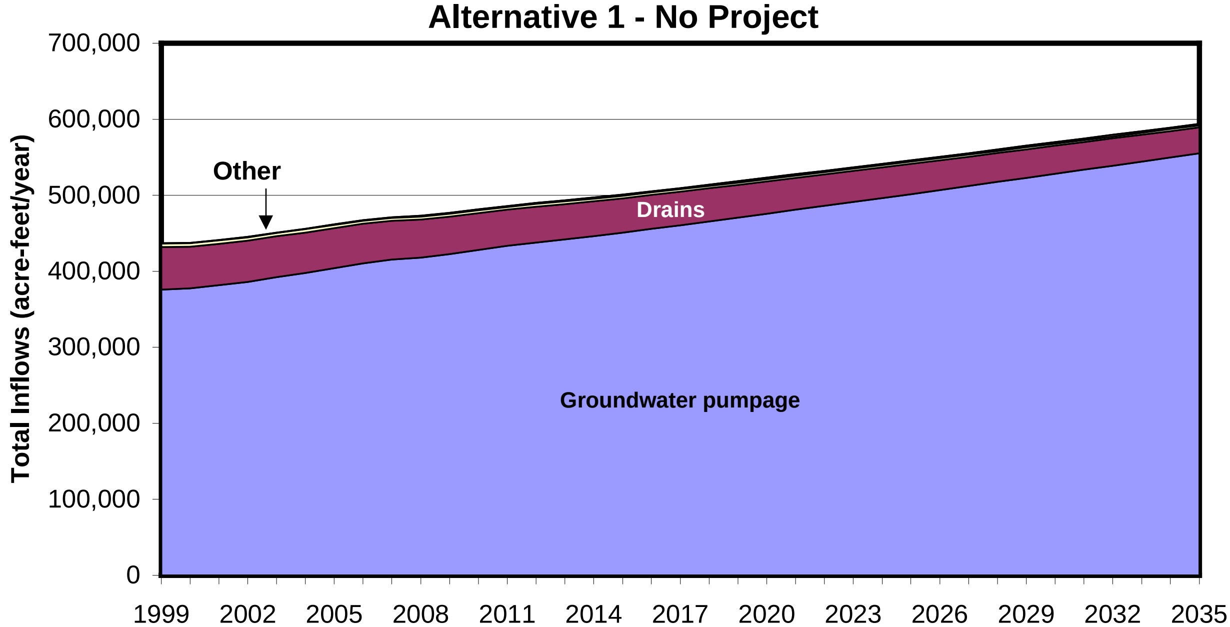
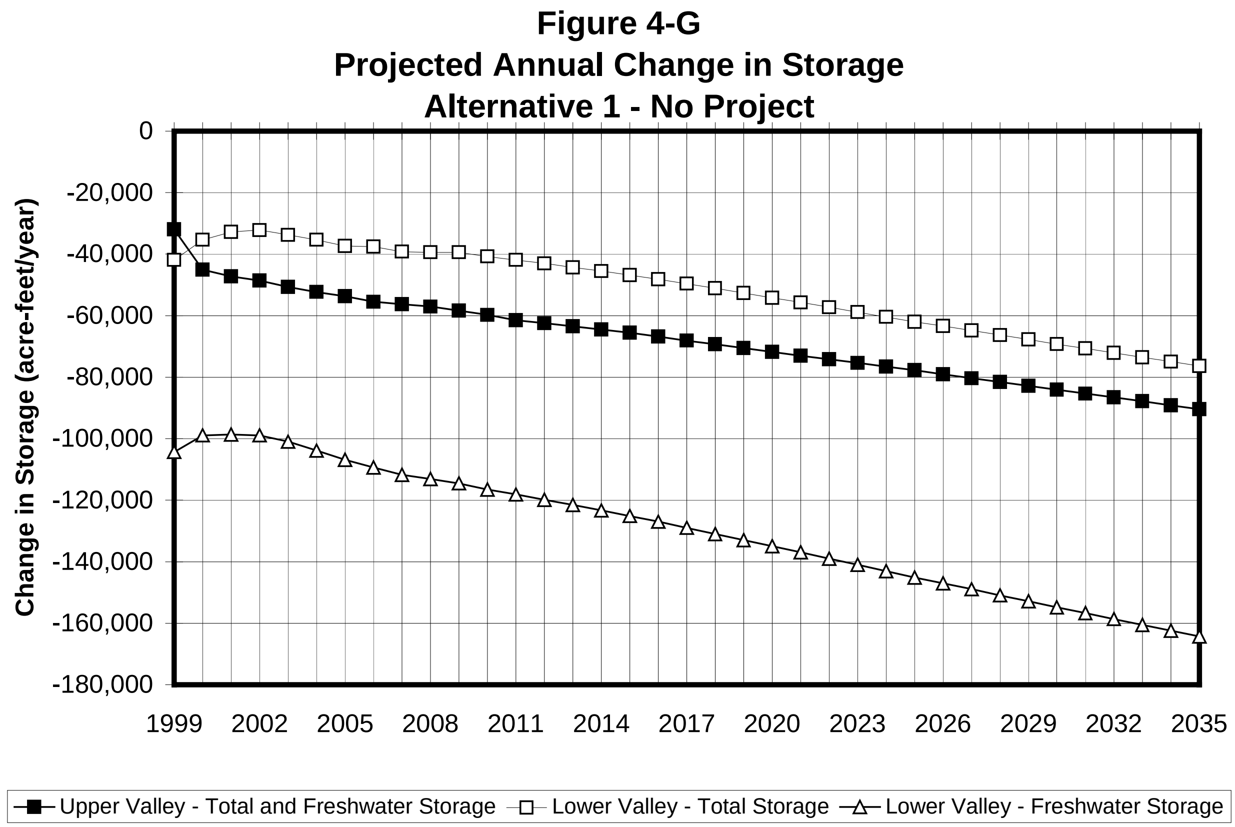


Figure 4-F
Summary of Projected Outflows by Source (1999-2035)
Alternative 1 - No Project



in the Lower Valley is expected to be about 76,300 acre-ft by 2035. In the Upper Valley, there is currently a 21,900 acre-ft/yr storage loss. Storage loss is expected to be 90,400 acre-ft/yr by 2035 (Figure 4-H and Table 4-6). This storage loss is due in a large part to inadequate recharge to meet projected increasing demand. Valleywide, there was a 73,600 acre-foot per year groundwater storage loss for 1999. The annual change in storage by the year 2035 is projected to be a loss of approximately 166,700 acre-ft/yr.



Because the groundwater imbalance has been present for many years, the cumulative change in storage is significant. In 1999, the Lower Valley groundwater basin had lost 437,600 acre-ft of storage since 1936 while the Upper Valley had lost 983,800 acre-ft of storage, for a basinwide loss of approximately 1.4 million acre-ft. However, as presented in Figure 4-H, if pre-deliveries of SWP water are excluded from the storage calculation, the current Upper Valley storage loss increases to nearly 1.7 million acre-ft. By the year 2035, the deficit for the Lower Valley is projected to be 2.3 million acre-ft. Similarly, the storage loss in the Upper Valley is projected to be approximately 3.4 million acre-ft. By 2035, if the SWP pre-deliveries are excluded, the Upper Valley storage loss becomes approximately 3.7 million acre-ft. The total cumulative deficit since 1936 for the entire valley in 2035 is nearly 5.8 million acre-ft (or 6.1 million acre-ft, if pre-deliveries are excluded).

Table 4-5
Projected Water Budget
Alternative 1 - No Project

	1999			2015			2035		
	Upper Valley	**Lower Valley**	**Total**	**Upper Valley**	**Lower Valley**	**Total**	**Upper Valley**	**Lower Valley**	**Total**
INFLOWS									
Natural Recharge	15,400	1,400	16,800	43,700	5,200	48,900	43,700	5,200	48,900
Agricultural Returns	400	130,300	130,700	400	130,500	130,900	400	130,900	131,300
Domestic Returns	46,600	12,600	59,200	60,900	17,300	78,200	83,000	24,200	107,200
Golf Course Returns	27,200	12,100	39,300	32,400	19,000	51,400	32,400	19,000	51,400
Wastewater Percolation	15,600	900	16,500	16,000	1,300	17,300	20,800	5,000	25,800
SWP Recharge	88,800	0	88,800	49,000	0	49,000	49,000	0	49,000
Inflows from outside study area	11,300	200	11,500	11,200	200	11,400	11,200	200	11,400
Inflows from Upper Valley	0	29,400	29,400	0	21,600	21,600	0	7,200	7,200
Total Inflows	**205,300**	**186,900**	**392,200**	**213,600**	**195,100**	**408,700**	**240,500**	**191,700**	**432,200**
OUTFLOWS									
Groundwater pumpage	207,800	168,300	376,100	257,500	193,000	450,500	323,700	231,400	555,100
Flows to Drains	0	55,800	55,800	0	45,300	45,300	0	34,200	34,200
Evapotranspiration	0	4,900	4,900	0	4,800	4,800	0	4,600	4,600
Net Flow to Salton Sea	0	-400	-400	0	-1,300	-1,300	0	-2,200	-2,200
Outflows to Lower Valley	29,400	0	29,400	21,600	0	21,600	7,200	0	7,200
Total Outflows	**237,200**	**228,600**	**465,800**	**279,100**	**241,800**	**520,900**	**330,900**	**268,000**	**598,900**
Change in Storage	-31,900	-41,700	-73,600	-65,500	-46,700	-112,200	-90,400	-76,300	-166,700
Cumulative Change in Storage [1]	-983,800	-437,600	-1,421,400	-1,885,900	-1,062,300	-2,948,200	-3,456,800	-2,311,700	-5,768,500
Change in Freshwater Storage	-32,400	-104,300	-136,700	-65,900	-125,100	-191,000	-90,400	-164,300	-254,700
Cumulative Change in Freshwater Storage [1]	-985,600	-3,698,400	-4,684,000	-1,896,400	-5,479,800	-7,376,200	-3,469,500	-8,397,000	-11,866,500

[1] — Cumulative change in storage since 1936

Change in Freshwater Storage

As discussed in Section 3 of this report, the water balance does not provide a complete evaluation of the overdraft situation in the basin (particularly water quality). Several components of the water balance (agricultural return flows not intercepted by drains, golf course returns and Salton Sea intrusion) decrease the potable storage within the groundwater basin. The following section evaluates the change in freshwater storage under No Project.

Table 4-5 and Figure 4-H present the change in freshwater storage in the Upper and Lower Valleys. Currently, there is a freshwater storage deficit of approximately 136,700 acre-ft/yr, 104,300 acre-ft/yr in the Lower Valley and 32,400 acre-ft/yr in the Upper Valley. This annual freshwater storage deficit is projected to increase to 254,700 acre-ft/yr by 2035, 164,300 acre-ft/yr in the Lower Valley and 90,400 acre-ft/yr in the Upper Valley. This change is due primarily to the decreased flow from the Upper Valley to the Lower Valley, decreased drain flows and increased groundwater pumping.

Figure 4-H
Projected Cumulative Change in Storage
Alternative 1 - No Project

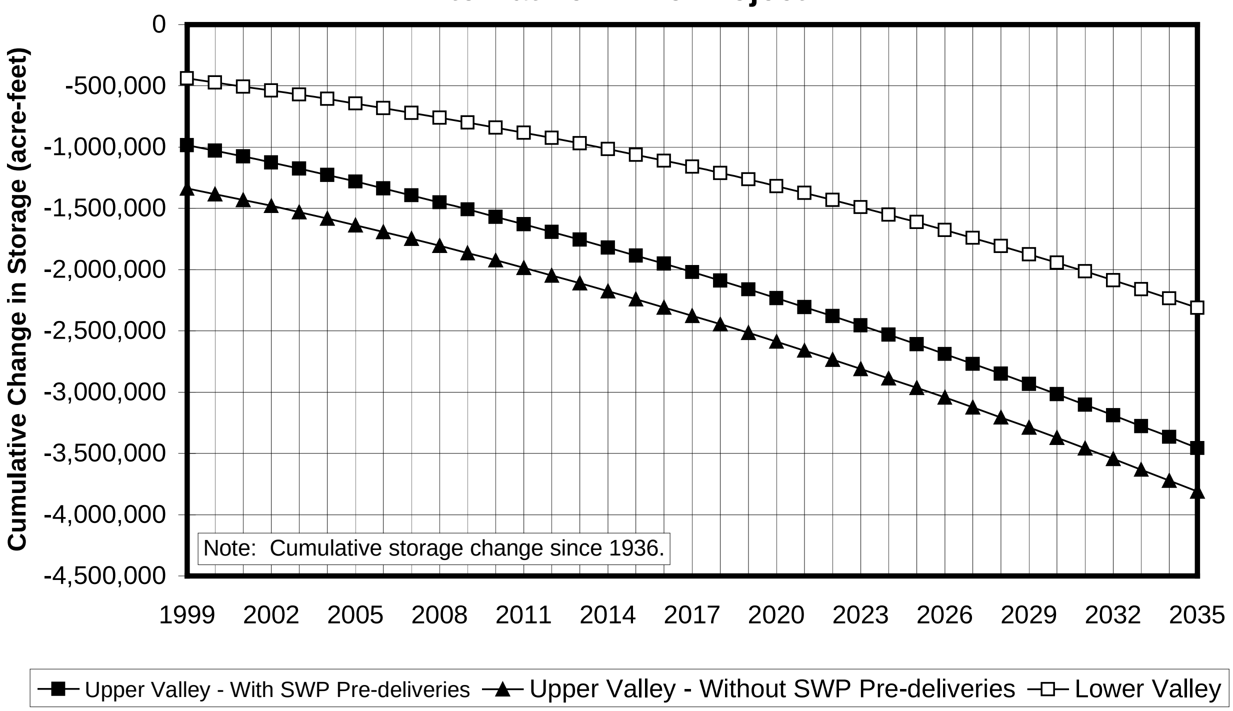
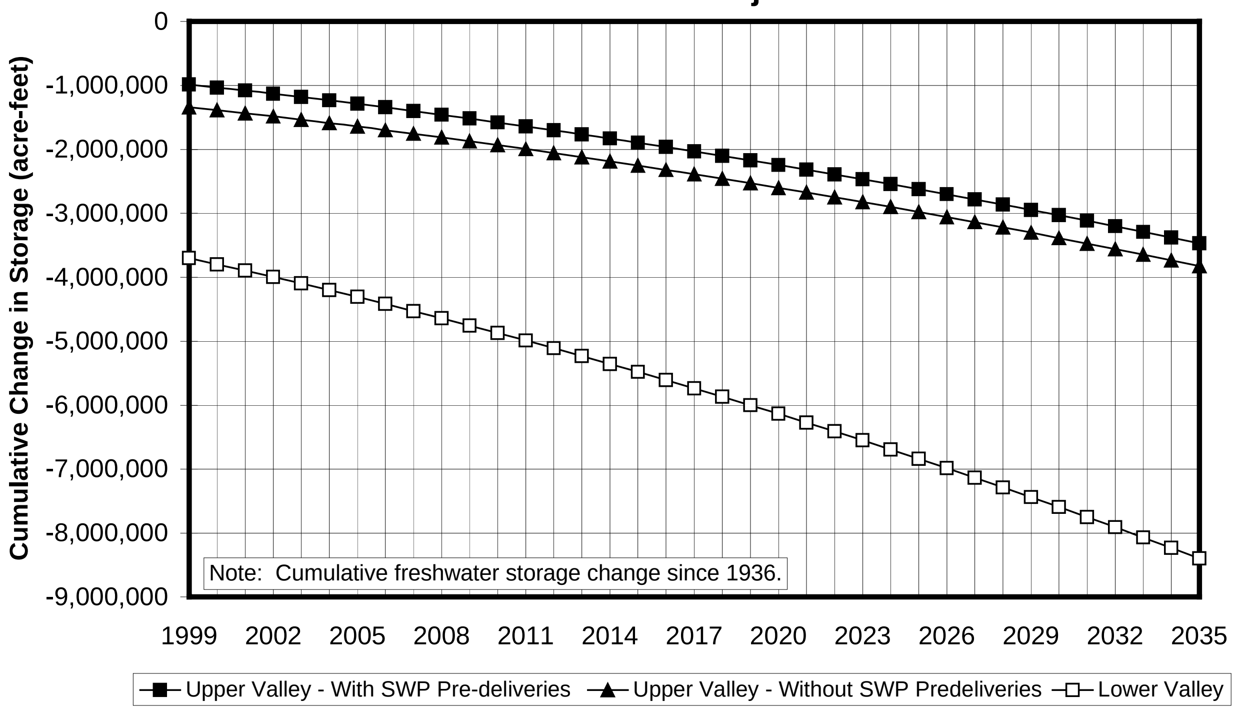


Figure 4-I presents the cumulative change in freshwater storage under No Project from 1999 to 2035. The current cumulative deficit in freshwater storage since 1936 for 1999 was nearly 4.7 million acre-ft (3.7 million in the Lower Valley, 1 million acre-ft in the Upper Valley). This deficit is projected to increase to 11.9 million acre-ft by 2035. The Lower Valley deficit is projected to increase to 8.4 million and the Upper Valley deficit is projected to increase to nearly

3.5 million acre-ft by 2035. The Lower Valley exhibits a steady decline in storage that is mimicked by water level declines.

Figure 4-I
Projected Cumulative Change in Freshwater Storage
Alternative 1 - No Project



Overdraft Impacts

The groundwater imbalance discussed above creates an overdraft condition, which can result in additional detrimental effects to the groundwater basin. These include: a decline in water levels, subsidence, water quality degradation including Salton Sea water intrusion.

Water Levels

As shown in Figure 4-J, water levels in the Lower Valley are projected to decline an additional 80 to 120 feet in from 1999 to 2035 under current conditions. Water levels in the Upper Valley are projected to decline as much as 300 feet.

Subsidence

To evaluate the potential for groundwater subsidence, the 1999 and projected groundwater levels were compared to historical low groundwater levels. As presented in Section 3, in the Lower Valley the historical low groundwater levels occurred in 1949, prior to the delivery of Canal water. If groundwater levels fall below 1949 levels, the potential for land subsidence is high.

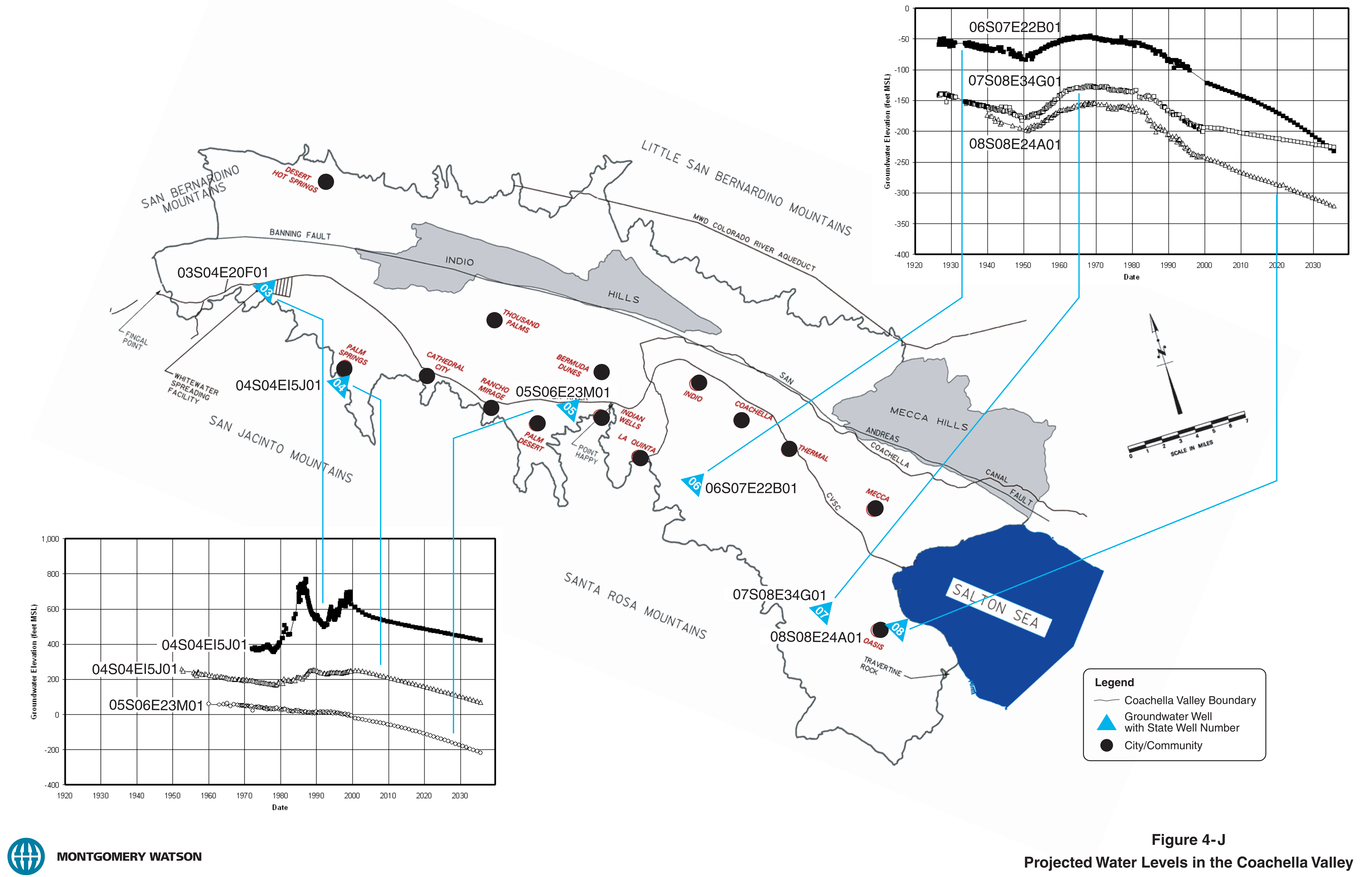


Figure 4-J
Projected Water Levels in the Coachella Valley

Conversely, if the groundwater levels are above 1949 levels, the potential for land subsidence is minimized.

Table 4-6 presents the difference between projected water levels and 1949 groundwater levels throughout the Valley. In 1999, the risk for subsidence was highest in the Palm Desert area, where land subsidence has already occurred. In the future, in each area of the Valley, water levels are projected to be even further below 1949 levels, ranging from 85 feet below 1949 levels in the Thermal area to more than 305 feet below 1949 levels in the Palm Desert area. The greatest risk for land subsidence occurs in areas such as the Lower Valley and the southern portion of the Upper Valley, where significant clay layers separate water-producing zones. Because the aquitard separating the Upper and Lower Aquifers is thin or absent in much of the Upper Valley (such as Palm Springs and North Palm Springs), the relative risk of land subsidence is lower in these areas.

As presented above, water levels are projected to continue to decline in the Lower Valley to levels below those of the late 1940s. In addition, water levels are projected to decline more than 200 feet in the Palm Desert area, an area where land subsidence has already been documented. As described in Section 3, this situation could lead to detrimental subsidence effects. The exact amount of subsidence at any given location is impossible to predict; however, as water levels continue to decline, the rate of subsidence is likely to increase.

Water Quality Degradation (Salt Balance)

Water quality degradation is a serious effect of overdraft. In particular, declining water levels and decreased drain flows allow the migration of poor-quality water into the underlying aquifer units of the basin and prevents the removal of applied salts from leaving the basin through the drains.

A summary of the projected salt balance for No Project alternative to the basin is presented in Table 4-7. These data are also presented in Figure 4-K. In the Lower Valley, the annual addition of salt to the basin for 1999 was approximately 184,000 tons per year. This equates to an annual increase in TDS of approximately 7.7 mg/L per year. The annual addition of salt in the Lower Valley is projected to be approximately 418,000 tons per year in the year 2035 (TDS increase of approximately 19.6 mg/L per year). In the Upper Valley, the rate of salt addition is approximately 81,000 tons per year (5.4 mg/L per year). By the year 2035, the rate is expected to be approximately 84,000 tons per year (7.3 mg/L per year). Despite a relatively constant amount of salt added to the basin, the average TDS addition rate will still increase because the volume of the basin is projected to decrease as storage is lost. The total Valley salt addition rate is expected to increase from approximately 265,000 tons per year in 1999 to 504,000 tons per year in 2035. This represents a total increase in TDS of approximately 580 mg/L in the Lower Valley and 270 mg/L in the Upper Valley from 1999 to 2035. This increase represents a theoretical basin average assuming the No Project Alternative and complete mixing. In reality, the salt increase will tend to be higher in the

Table 4-6
Summary of Projected Subsidence Risk

Location	1999		2015		2035	
	Water Level Change from 1949	**Subsidence Risk**	**Water Level Change from 1949 No Project**	**Subsidence Risk No Project**	**Water Level Change from 1949 No Project**	**Subsidence Risk No Project**
Upper Valley						
N. Palm Springs	-35	Low	-60	Low	-150	Moderate
Palm Springs	-50	Low	-115	Low	-230	Moderate
Thousand Palms	-95	High	-155	Very High	-275	Very High
Palm Desert	-105	Very High	-175	Very High	-305	Very High
UV/LV Boundary	-80	High	-145	Very High	-280	Very High
Lower Valley						
Indio	-15	Moderate	-70	High	-165	Very High
Coachella	5	Low	-35	Moderate	-110	Very High
Thermal	0	Low	-25	Moderate	-85	High
Mecca	-25	Moderate	-45	Moderate	-90	High
Oasis	-35	Moderate	-70	High	-115	Very High
Near Salton Sea	-30	Moderate	-60	High	-105	Very High

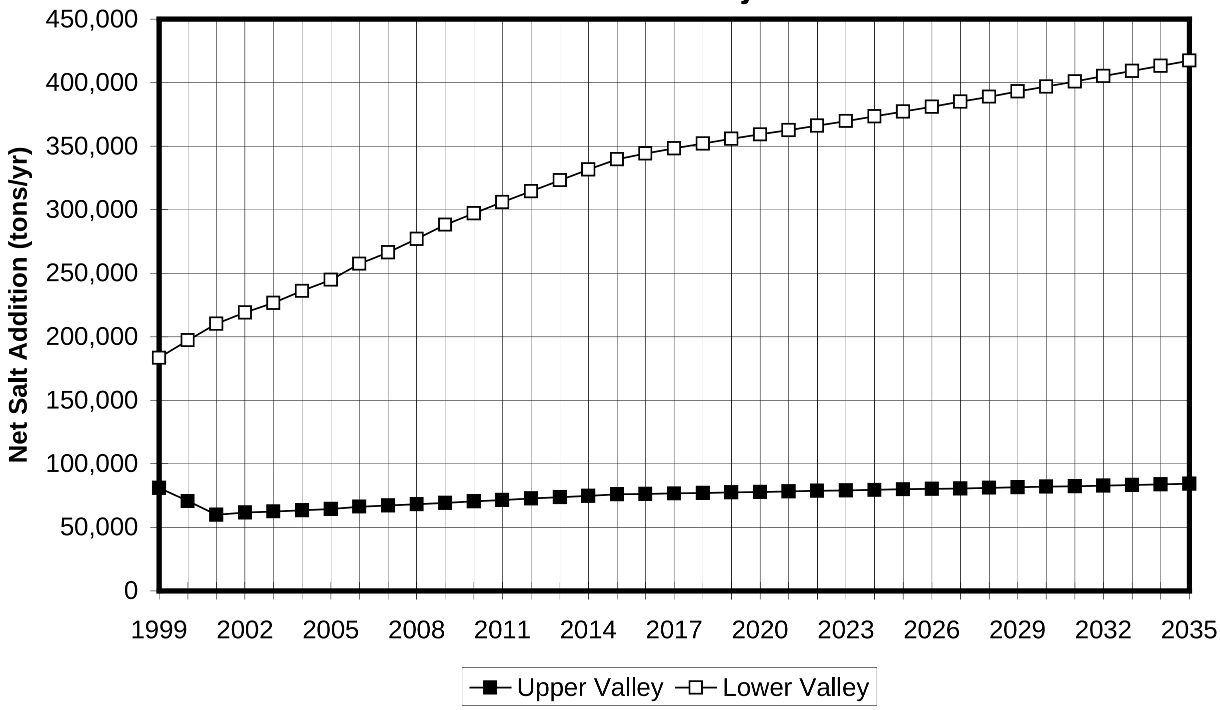
Low Risk = above 1949 levels and in portions of Valley where clay is essentially absent
Moderate Risk = less than 50 feet below 1949 levels or more than 150 feet below 1949 levels in portions of Valley where clay is essentially absent
High Risk = more than 50 feet but less than 100 feet below 1949 levels or more than 250 feet below 1949 levels in portions of Valley where clay is essentially absent
Very High Risk = more than 100 feet below 1949 levels or more than 300 feet below 1949 levels in portions of Valley where clay is essentially absent

Table 4-7
Summary of Projected Salt Addition
Alternative 1- No-Project

Component	1999			2015			2035		
	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total	Upper Valley	Lower Valley	Total
Salt Addition									
Natural Recharge	8,000	1,000	9,000	16,000	2,000	18,000	16,000	2,000	18,000
SWP Recharge	70,000	0	70,000	51,000	0	51,000	51,000	0	51,000
Canal Water Use	1,000	251,000	252,000	1,000	356,000	357,000	0	360,000	360,000
Salton Sea Intrusion	0	71,000	71,000	0	123,000	123,000	0	164,000	164,000
Fish Farm/Duck Club Reuse	0	0	0	0	1,000	1,000	0	1,000	1,000
Input from Upper Valley	0	10,000	10,000	0	7,000	7,000	0	2,000	2,000
Domestic Use Increment	8,000	7,000	15,000	10,000	9,000	19,000	14,000	13,000	27,000
Fertilizers	4,000	16,000	20,000	5,000	17,000	22,000	7,000	18,000	25,000
Total Salt Adddition	**91,000**	**356,000**	**447,000**	**83,000**	**515,000**	**598,000**	**88,000**	**560,000**	**648,000**
Salt Removal									
Drain Flows	0	156,000	156,000	0	154,000	154,000	0	118,000	118,000
Outputs to Salton Sea	0	2,000	2,000	0	2,000	2,000	0	1,000	1,000
Fish Farm/Duck Club Pumping	0	7,000	7,000	0	8,000	8,000	0	8,000	8,000
Municipal Wastewater Discharge	0	7,000	7,000	0	10,000	10,000	0	15,000	15,000
Output to Lower Valley	10,000	0	10,000	7,000	0	7,000	2,000	0	2,000
Total Salt Removed	**10,000**	**172,000**	**182,000**	**7,000**	**174,000**	**181,000**	**2,000**	**142,000**	**144,000**
TOTAL SALT ADDED	**81,000**	**184,000**	**265,000**	**76,000**	**341,000**	**417,000**	**86,000**	**418,000**	**504,000**

shallow aquifers and lower in the deeper aquifers due to the presence of silt and clay layers that impede vertical flow.

Figure 4-K
Projected Net Annual Salt Addition to Groundwater Basin
Alternative 1 - No Project



Another element of water quality degradation is the potential for seawater intrusion from the Salton Sea. As basin water levels continue to decline, the potential for seawater intrusion increases. Modeling studies indicate that inflows from the Sea will occur with reduced water levels. These potential inflows of brackish water displace freshwater in the basin and are currently migrating toward production wells.

Projections for the future indicate the potential for intrusion will increase from about 400 acre-ft/yr in 1999 to about 2,200 acre-ft/yr in 2035 with lowered water levels (Table 4-6).

Estimate of Overdraft

As discussed in Section 3, the estimated overdraft is a function of several factors. The change in freshwater storage gives a reasonable estimate of overdraft considering all of the potential adverse impacts of overdraft. Projections of future groundwater conditions are based on long-term estimates of natural and artificial recharge in the basin. Using these data, the overdraft in the Lower Valley was estimated to be 104,300 acre-ft/yr in 1999 and will increase to 164,300 acre-ft/yr by 2035. In the Upper Valley, the estimated overdraft is 32,400 acre-ft/yr in 1999 increasing to 90,400 acre-ft/yr by 2035. Total groundwater overdraft is estimated to be 136,700 acre-ft/yr in 1999 increasing to 254,700 acre-ft/yr by 2035. During the period 1999 to 2035, nearly 4.4 million acre-ft of groundwater will be removed from storage or lost to contamination as a result of overdraft in the absence of a water management plan. This represents a loss of about 15 percent of total basin storage in this 35-year period.

NEED FOR MANAGEMENT PLAN

Current conditions in the Coachella Valley indicate that the groundwater basin is overdrafted. This section projects that a continuation of current conditions will result in increased overdraft with its related adverse impacts of declining water levels, water quality degradation and the risk of land subsidence. As a result, it is imperative that the District develop a water management plan for the Coachella Valley that will resolve the overdraft problem and protect the groundwater supply for use by future generations.

Section 5
Water Management Plan Alternatives

This section describes alternative water management strategies developed to meet the objectives of the Water Management Plan. The alternatives look at water management from different conceptual viewpoints, each with the intent of achieving the goals of the Plan in a timely, cost-effective, and environmentally responsible manner.

Three alternative management plans are identified to meet the current and future demands of the Coachella Valley. Due to the programmatic nature of the Plan, the alternatives and their associated facilities and programs are conceptual and, other than those programs identified as ongoing projects, may differ in their ultimate configuration.

PROPOSED ALTERNATIVES

District staff and consultants conducted several brainstorming sessions to identify potential management elements for inclusion in the Plan. Potential elements were considered without regard for cost, environmental impact, technical feasibility, or other considerations. Additional input was obtained through public meetings with local Indian tribes, state and federal agencies, regional and local governments, other interested and affected parties and the public at large resulting in additional potential management elements for consideration. A detailed description of the element screening and alternative formulation process is contained in Appendix B.

Potential management elements were subsequently organized into six categories: pumping restrictions, demand reduction, local water sources, imported water sources, water management actions, and water quality approaches. Each of the potential management elements was rated based on the element's ability to reduce overdraft, technical feasibility, potential environmental impacts, costs, legal and regulatory factors and regional economic impacts. Based on these ratings, numerous potential elements were eliminated from further consideration.

The remaining "short-listed" elements were organized into the following conceptual management alternatives:

- No Project,
- Pumping Restrictions,
- Demand Management,
- Groundwater Recharge,
- Source Substitution, and
- Combinations.

With the exception of the No Project alternative, which is required under the California Environmental Quality Act (CEQA), a preliminary evaluation of each conceptual alternative was performed to determine whether the alternative could reasonably be expected to meet the Plan objectives. The evaluation process involved technical analyses coupled with professional judgement and experience. The three water management alternatives in addition to the No

Project Alternative selected for evaluation within the Plan are summarized below. Table 5-1 represents the management elements ultimately included in the alternative management plans.

Table 5-1
Potential Management Elements Contained in Alternative Management Plans

Water Management Elements	Alternative 1 No Project	Alternative 2 Pumping Restrictions	Alternative 3 Demand Management	Alternative 4 Combination
Pumping Restrictions		●		
General water rights adjudication				
Demand Reduction (Conservation)				
Adoption of agricultural best management practices (BMPs)		●	●	●
Mandate or encourage efficient irrigation methods	○	○	●	●
Use moisture sensors or other plant stress indicators			●	●
Prohibitions on wasteful use	○	○	●	●
No net demand increase			●	●
Plan check new irrigation systems	○	○	●	●
Public education	○	○	●	●
Tiered or seasonal water pricing			●	●
Replenishment assessments	○	○	●	●
Domestic water user audits			●	●
Water-efficient plumbing and irrigation systems			●	●
Restriction turf on golf courses and common areas			●	●
Adoption of urban BMPs			●	●
Drought-tolerant landscaping and turf	●	●	●	●
Measure amount of annual pumping by each groundwater user	○	●	●	●
Evapotranspiration-based water rates			●	●
Hire a water conservation coordinator			●	●
Require plumbing retrofit on sale			●	●
Develop and enforce water efficient landscape ordinances			●	●
Local Water Sources				●
Agricultural drainage water (including CVSC water)				
Reuse fish farm effluent	○	○	○	○
Construct on-site stormwater retention	○	○	○	○
Municipal wastewater effluent – Upper Valley	○	○	○	●
Municipal wastewater effluent – Lower Valley				●
Imported Water Sources				●
Obtain additional SWP water entitlement				
Obtain SWP turn-back pool water				●
Obtain additional Colorado River water				●

Table 5-1
Potential Management Elements Contained in Alternative Management Plans (Continued)

Water Management Elements	Alternative 1 No Project	Alternative 2 Pumping Restrictions	Alternative 3 Demand Management	Alternative 4 Combination
Water Management Actions	○	○	○	●
Groundwater Recharge by spreading				
Provide in-lieu water to agricultural groundwater users within ID-1	○	○	○	●
Provide in-lieu water to fish farms				●
Provide in-lieu water to golf courses	○	○	○	●
Provide in-lieu water to potable domestic users				●
Provide in-lieu water to non-potable domestic users				●
Provide in-lieu water to duck ponds				●
Provide in-lieu water for industrial and power plant cooling use				●
Use Coachella Canal to convey non-federal water to users outside ID-1				●
Fish farm internal reuse	○	○	○	○
Cap flowing artesian wells			●	●
Water Quality Approaches	○	○	○	○
Canal water treatment provided by individual users				
Provide tertiary treatment for wastewater	○	○	○	●
Provide potable water treatment for surface supplies				●

○ Existing level of implementation
● Increased level of implementation

Alternative 2 - Pumping Restriction by Adjudication

Alternative 2, pumping restriction by adjudication, is based upon court-ordered restrictions imposed through a process in which the water rights of the basin are allotted to individual groundwater pumpers. Overdraft is reduced by reducing groundwater pumping throughout the Coachella Valley to the perennial yield of the basin. This yield is the amount of groundwater that can be pumped each year without adversely depleting the basin, lowering long-term groundwater levels, or negatively affecting the quality of the groundwater in the basin. The exact limit of individual well pumpage is determined in the adjudication process. No additional Canal, recycled, or SWP water supplies are included in this alternative. Table 5-3 compares the basic elements of supply and demand of the No-Project Alternative and Alternative 3 for the years 2015 and 2035.

Adjudication can take many forms, ranging from a stipulated decree to a court-defined judgment. Adjudication can also include a management approach, frequently referred to as a physical solution. A physical solution recognizes the substantial investment in groundwater production facilities and defines a management approach that allows continued use of the groundwater basin.

Table 5-2
Coachella Valley Water Supply and Demand
Alternative 2 - Pumping Restriction by Adjudication
(acre-ft)

	1999	2015			2035		
	No Project Alternative	No Project Alternative	Alternative 2	1999-2015 Differences	No Project Alternative	Alternative 2	1999-2035 Differences
Supply							
Canal Water							
Crop Irrigation	266,400	273,900	273,900	7,500	277,500	277,500	11,100
Golf Courses	7,500	23,000	23,000	15,500	22,000	22,000	14,500
Duck Clubs	600	600	600	0	600	600	0
Fish Farms	1,600	1,600	1,600	0	1,600	1,600	0
Recharge	3,000	0	0	-3,000	0	0	-3,000
Domestic	200	200	200	0	200	200	0
Groundwater[1]	282,500	400,600	177,900	-102,600	505,200	183,700	-96,800
Surface Water	6,900	6,500	6,500	-400	6,500	6,500	-400
SWP							
Recharge	90,600	50,000	50,000	-40,600	50,000	50,000	-40,600
Irrigation	0	0	0	0	0	0	0
Recycled Water							
Municipal	8,100	18,100	18,100	10,000	22,000	22,000	13,900
Fish Farm	1,500	5,000	5,000	3,500	5,000	5,000	3,500
Ag. Drainage	0	0	0	0	0	0	0
Total Supply	**668,900**	**779,500**	**556,800**	**-112,100**	**890,600**	**569,100**	**-99,800**
Demand							
Agriculture[2]	333,300	339,300	295,100	-38,200	346,800	294,900	-38,400
Municipal & Ind.	204,000	273,300	153,100	-51,000	376,900	175,300	-28,700
Golf Courses	106,200	136,500	95,700	-10,500	136,500	88,000	-18,200
Fish Farms & Duck Clubs	25,400	30,400	12,900	-12,500	30,400	10,900	-14,500
Total Demand	**668,900**	**779,500**	**556,800**	**-112,100**	**890,600**	**569,100**	**-99,800**

1 Groundwater supply is total groundwater pumpage less artificial recharge.
2 Includes crop irrigation and green houses 1999.

The details of pumping reductions defined in adjudication can also take several forms. Under a form known as mutual prescription, each pumper is assigned a prescriptive right equal to the average pumping in a five-year period. Each pumper's annual pumping allocation is proportional to the total prescriptive rights and the perennial yield. Recent court decisions have made mutual prescriptions more difficult to establish because all producers must agree to this form of adjudication.

If mutual prescription is not acceptable water rights can be divided between overlying users, e.g., agricultural users and appropriators such as cities and water districts. Under State law, overlying property owners have an equal right to a reasonable amount of groundwater for use on their overlying lands. Use of groundwater for municipal water supply is considered an appropriation and has a lower priority than overlying users. However, under State law, a public agency cannot lose its water rights due to prescription by others, and court rulings state that return flows from imported water can be claimed by the importing agency.

Because of the complexities of the adjudication process and the many forms that the final adjudication can take, several basic assumptions are made regarding this alternative. One important assumption is that any adjudication, whether a stipulated decree or a court-defined judgment, will take many years to implement. In this alternative, the analysis assumes that at least eleven years will be required to determine the form and to implement pumping restrictions within adjudication. The first eleven years of this alternative are thus identical to the No Project Alternative. An eleven-year time frame for implementing adjudication may be overly optimistic. The Mojave adjudication took 30 years to implement and is still not completed.

Since an overdraft exists in both the Upper and Lower Valleys, any adjudication will necessarily apply to both areas. The overdrafts in the Upper and Lower Valleys are different; thus the pumping reductions associated with the adjudication could be computed separately for each portion of the valley. Alternative 2 assumes that Upper Valley pumping would be reduced by approximately 35 percent while Lower Valley pumping would be reduced by approximately 70 percent. The majority of the reductions would likely be ramped in, perhaps over a five-year period, resulting in attainment of most pumping restrictions by the year 2015.

Alternative 3 - Management of Demand and Maximization of Local Resources

Alternative 3 focuses on maximizing the use of available local water resources and managing water demand while maintaining imported water usage at approximate current levels. Demand would be managed, to the extent practical, by maximizing water conservation for both urban and agricultural uses. Local resources would be maximized by the increased use of recycled water. The following major components and assumptions are included:

- Implementation of extensive water conservation measures for urban water use,
- Reduction of non-agricultural irrigation demand through mandatory xeriscaping for new residential, commercial, and golf course properties,
- Increased conservation by agricultural water users through the use of more efficient irrigation technology and application methods,
- Increased recycled water use by Upper and Lower Valley golf courses, homeowner associations and agricultural users, and
- Fixed imported water supplies at current levels.

Table 5-3 compares the basic elements of supply and demand of the No-Project Alternative and Alternative 3 for the years 2015 and 2035.

Water Conservation

Implementation of extensive water conservation measures for municipal and domestic water use is assumed to reduce existing demands and future indoor use by 10 percent and future outdoor use by 50 percent. Future domestic demand reductions would be achieved through <u>mandatory</u>

implementation of xeriscaping throughout the Valley. Xeriscaping can achieve up to a 50 percent reduction in outdoor demands, provided that desert plant species are used instead of current non- native landscaping species. Future golf courses would be required to achieve about a 20 percent reduction in demand through mandatory restrictions, allowing only the tees, greens, and small portions of the fairways to be turf, with the remainder of the course landscaped with desert species.

Table 5-3
Coachella Valley Water Supply and Demand
Alternative 3 - Management of Demand and Maximization of Local Resources
(acre-ft)

	1999	2015			2035		
	No Project Alternative	**No Project Alternative**	**Alternative 3**	**1999-2015 Differences**	**No Project Alternative**	**Alternative 3**	**1999-2035 Differences**
Supply							
Canal Water							
Crop Irrigation	266,400	273,900	269,400	3,000	277,500	279,900	6,500
Golf Courses	7,500	23,000	27,500	20,000	22,000	26,600	19,100
Duck Clubs	600	600	600	0	600	600	0
Fish Farms	1,600	1,600	1,600	0	1,600	1,600	0
Recharge	3,000	0	0	-3,000	0	0	-3,000
Domestic	200	200	200	0	200	200	0
Groundwater1	282,500	400,600	285,000	2,500	505,200	341,500	59,000
Surface Water	6,900	6,500	5,600	-1,300	6,500	5,300	-1,600
SWP							
Recharge	90,600	50,000	50,000	-40,600	50,000	50,000	-40,600
Irrigation	0	0	0	0	0	0	0
Recycled Water							
Municipal	8,100	18,100	36,500	28,400	22,000	46,500	38,400
Fish Farm	1,500	5,000	4,800	3,300	5,000	4,900	3,400
Ag. Drainage	0	0	0	0	0	0	0
Total Supply	**668,900**	**779,500**	**681,200**	**12,300**	**890,600**	**750,100**	**81,200**
Demand							
Agriculture2	333,300	339,300	305,500	-27,800	346,800	312,200	-21,100
Municipal & Ind.	204,000	273,300	225,800	21,800	376,900	288,000	84,000
Golf Courses	106,200	136,500	119,500	13,300	136,500	119,500	13,300
Fish Farms & Duck Clubs	25,400	30,400	30,400	5,000	30,400	30,400	5,000
Total Demand	**668,900**	**779,500**	**681,200**	**12,300**	**890,600**	**750,100**	**81,200**

1 Groundwater supply is total groundwater pumpage less artificial recharge.
2 Includes crop irrigation and green houses 1999.

Aggressive water conservation by agricultural users is assumed to reduce agricultural water demands by 10 percent due to improvements in irrigation technology and application methods. This level of conservation would result in an increase in irrigation efficiency from 70 percent to 77 percent. Groundwater return flows resulting from agricultural use of Canal water for irrigation would be reduced by the amount of conservation, thus potentially increasing the overdraft. Additional agricultural conservation could be achieved only through land fallowing or crop restrictions, neither of which is considered a viable option.

Recycled Water Use

Alternative 3 includes additional use of recycled water from the Upper Valley water reclamation plants for golf course irrigation. Based upon the demand and availability of recycled water from the Upper Valley plants, it is assumed that up to 75 percent of the golf course demand could be served with recycled water. Recycled water use is limited due to the seasonal availability of recycled water.

Alternative 3 includes additional use of recycled water from the Lower Valley water reclamation plants for agricultural irrigation in the Lower Valley. The recycled water would likely be delivered into the District's existing Canal water distribution system. Wheeling water in this manner may require the approval of Reclamation. Preliminary discussions with Reclamation indicate that this method of providing recycled water to the Canal would likely be approved since it represents sound water management principles. The Oasis slopes are one area where recycled water use in the Lower Valley may be practical. Grape vineyards on the Oasis slopes produce high-quality, early-season grapes that bring top dollars to growers. Groundwater levels under the slopes are dropping much faster than those under the Valley floor. As water levels continue to decline and pumping costs increase, the cost of recycled water may become competitive with groundwater in areas such as this.

In addition to recycling wastewater flows, fish farms in the Lower Valley are potential sources of high-quality effluent that could be recycled with little or no treatment for irrigation purposes or for seasonal use at local duck clubs. As described in the No Project Alternative, the District is currently working with the largest of the existing fish farms on an effluent reuse program. This program has been incorporated into the No Project Alternative. Because the remaining fish farms are generally small and are dispersed throughout the area, they offer limited potential for recycled use. For these reasons, no additional recycling of fish farm effluent is included in Alternative 3.

Although not included in this alternative, recycled water from agricultural drain flows could be used for agricultural irrigation. Although flow in the Whitewater River was fully apportioned in 1928, the District filed an application with the State Water Resources Control Board in 1997 to appropriate all waters in the CVSC (up to a maximum of 150 cfs) draining from lands irrigated in ID-1. The application was submitted with the intent to retain local control of local water resources. Under Alternative 3, agricultural drainage decreases from its current levels. Recycling of municipal waste additionally decreases flows in the CVSC. Major reductions in flows to the CVSC could have substantial environmental effects in the watercourse. For this reason, recycling of CVSC drain flows is not included in this alternative.

Imported Water Supplies

Imported water supplies will be held at approximate historic levels in this alternative. Recharge of the Upper Valley using SWP exchange water is assumed to continue at the long-term average of 50,000 acre-ft/yr. Colorado River water use within ID-1 is targeted at 300,000 acre-ft/yr. As agricultural water conservation is implemented, Canal water usage will decline. The water made available by conservation will in turn be supplied to Lower Valley golf courses and other groundwater pumpers.

Alternative 4 - Combination Alternative

Alternative 4 includes three basic water management elements: conservation, source substitution and groundwater recharge. The most feasible and cost-effective measures identified in Table 5-1 are combined to form an alternative that incorporates the following elements within each of the three basic water management categories:

Conservation
- Urban water conservation measures, and
- Agricultural water conservation measures.

Source Substitution
- Canal water to agricultural groundwater pumpers within ID-1,
- Canal water for golf course irrigation within ID-1,
- Additional recycled water to golf courses in the Upper Valley,
- Desalted agricultural drain water for agricultural irrigation outside ID-1,
- Recycled water for agricultural irrigation in Lower Valley
- Treated Canal water for urban uses within ID-1, and
- SWP exchange water for irrigation of golf courses in the Upper Valley.

Groundwater Recharge
- Direct recharge of Upper Valley groundwater basins with imported Colorado River water exchanged for SWP water, and
- Lower Valley groundwater recharge with Coachella Canal water.

Conservation

Water conservation can and should be treated like any other water supply option. Conservation includes long-term programs to permanently reduce water demands through programs such as water-efficient plumbing fixtures and landscaping, improved irrigation technology (both urban and agricultural), and ongoing public information and education programs. The goal of water conservation programs is to provide long-term water savings without producing dramatic lifestyle changes on the part of those conserving.

Urban conservation in the Valley will focus on water-efficient plumbing and landscaping, irrigation technology, and public information and education programs. In many areas, urban conservation centers on installation of ultra-low-flush (ULF) toilet and low-flow showerhead replacement. Indoor water use in the Coachella Valley is less than 30 percent of municipal and domestic use. About half of the housing units in the Valley are less than 20 years old and already comply with building code provisions requiring low-flush or ULF toilets and low-flow showerheads. Indoor conservation activities should target the older dwelling units. Since landscape irrigation constitutes a major portion of most residential units' water use, it offers a greater potential for conservation. Public information and education programs will continue to play a major role in emphasizing the importance of water conservation efforts and in keeping the issue in the general public's mind.

The Water Conservation in Landscaping Act (1992) requires each city and county to adopt a water efficiency ordinance for landscaping. The District has employed a water management specialist to work closely with large landscapers such as country clubs, developers, and government agencies to ensure wise water management. This vigorous program is intended to maintain water-efficient landscaping and irrigation systems, optimize existing systems, and improve the overall efficiency of local water use. Alternative 4 will continue these efforts, with added emphasis on the use of water-efficient plantings in existing landscaping.

Agricultural conservation will consist of working with valley growers to ensure that the most up-to-date agricultural practices are used. Individual growers water use practices will be reviewed on a field-by-field basis, evaluating the unique characteristics of each field and crop type. Confidential reports indicating the general efficiency of each field and containing recommendations for improved efficiency will be made to each grower. Potential improvements may include conversion from furrow and sprinkler irrigation to drip irrigation and also the refinement of existing systems to improve distribution uniformity.

Implementation of the extensive water conservation measures included in Alternative 3 could have substantial impacts on the quality of life in the Coachella Valley. Water conservation measures included in Alternative 4 are not as extensive as those included in Alternative 3. Total urban water demand would decrease a minimum of 10 percent due to conservation. Golf course demand will also be reduced by approximately 5 percent through improved irrigation management.

Water conservation by agricultural users is assumed to reduce agricultural water demands by a minimum of 7 percent due to improvements in irrigation technology and application methods. This level of conservation would result in an increase in irrigation efficiency from 70 percent to approximately 75 percent. Water conservation measures include implementation of best management practices (BMPs) for urban water conservation, an increase in golf course irrigation efficiencies, and continued agricultural conservation. Water savings would increase in the future as demands increase.

Source Substitution

Source substitution, as used in the Plan, refers to the delivery of an alternate source of supply in place of groundwater use. This technique is sometimes referred to as *in-lieu* recharge, as groundwater is allowed to accumulate in the basin rather than be pumped. For the Coachella Valley, available alternate supplies consist of Canal water, recycled water and SWP exchange water.

Canal Water. Water from the Coachella Canal is a significant water supply for the Lower Coachella Valley. The Coachella Canal brings Colorado River water into the Coachella Valley for use within ID-1. In recent years, Canal water deliveries have decreased in spite of a relatively constant total demand. Increased use of Canal water in lieu of groundwater could have a substantial effect on overdraft.

Agricultural Conversion from Groundwater to Canal Water. Agriculture accounted for approximately 357,800 acre-ft (80 percent) of the water use in the Lower Valley in 1999. Of the total agricultural use, more than 87,000 acre-ft was groundwater. Most agricultural groundwater users are within ID-1 and are eligible to receive water from the Coachella Canal.

There are several reasons why growers use groundwater rather than Canal water. In some parts of the Valley the distribution system was never completed and not all growers have access to Canal water. The Oasis area, which annually accounts for approximately 27,000 acre-ft of demand, with 21,000 acre-ft within ID-1, is the largest area within ID-1 without a distribution system.

Another primary reason for the use of groundwater over Canal water is the advent of drip irrigation. Many growers utilizing drip irrigation have switched from Canal water to groundwater because it contains far less sediment than Canal water and does not require the expensive filtration systems needed to use Canal water with drip systems. In addition, growers are also able to apply groundwater at their convenience, thereby avoiding the construction and maintenance of reservoirs and the scheduling of irrigation water deliveries through the District.

Conversion of agricultural groundwater use to Canal water use would take two forms:

1. Expansion of the distribution system to areas within ID-1 not served by the current distribution system, and
2. Conversion of groundwater users who have Canal water available for use but choose to irrigate with groundwater.

This alternative assumes that through distribution system expansion, extensive outreach programs, and other incentives, as much as 25,700 acre-ft/yr of agricultural groundwater use could be converted to Canal water use by 2035.

Golf Course Use of Canal Water. With approximately 100 golf courses in the Coachella Valley, the golf industry is one of the Valley's largest employers. Initially located mostly in the Upper Valley, golf courses are now also a major part of the Lower Valley's economy and are major water users. The District has for many years advocated the use of Canal water for golf course irrigation purposes for courses located within ID-1.

Today, many of the golf courses within ID-1 use Canal water for all or part of their irrigation needs. All new golf courses within ID-1 will be required to use Canal water as their primary water supply. As many of the existing courses as possible will be converted from groundwater to Canal water and courses currently using both groundwater and Canal water will be encouraged to maximize Canal water use.

Recycled Water. Recycled water is a significant potential local resource that could be used to help reduce overdraft. Recycled water currently plays a limited role in the Valley's water supply.

Of the 668,900 acre-ft of water used in 1999, recycled water, including fish farm effluent used for irrigation purposes, accounted for only 9,600 acre-ft, or 1.5 percent.

Upper Valley. In the Upper Valley, municipal wastewater is the only source of recycled water. Currently, all wastewater produced in the Upper Valley is reused through direct application for irrigation or percolated into the groundwater basin. This trend is expected to continue.

From a groundwater balance approach, there are only minor differences between replacing groundwater with recycled wastewater for direct irrigation purposes and percolating it back into the basin. Treated sewage effluent not recycled for irrigation purposes in the Upper Valley is percolated back into the groundwater basin. Therefore, recycling water for irrigation purposes has little net impact on the total amount of water available for use in the Upper Valley although there are water quality benefits.

Because recycled water has high nutrient (nitrate) concentrations, long-term percolation could eventually lead to degradation of the groundwater supply. The Regional Water Quality Control Board (RWQCB) has also voiced concerns that use of recycled water on golf courses is a source of nitrate pollution in the Upper Valley. The RWQCB is concerned that golf courses using recycled water are over watering. Experience does not bear this out. Since recycled water rates are comparable to the costs of pumping groundwater, there is no economic incentive to overwater. In addition, studies at the University of California at Riverside have indicated that little nitrate moves past the root zone in well-managed courses (University of California at Riverside, 1998). Use of nitrate-rich recycled water for irrigation reduces the amount of artificial fertilizer needed on golf courses and other turf areas, thus lowering the nitrate loading on the entire basin. Therefore, recycling water for irrigation purposes has substantial water quality benefits over percolation.

One difficulty in recycling wastewater effluent for irrigation involves supply and demand. Flows to Valley treatment plants are greatest in the high-tourism winter months, when irrigation demands are lowest. Flows are conversely lowest in summer, when irrigation demand is highest. This imbalance results in the need to pump groundwater during the summer months.

Upper Valley recycled water use would increase in the areas near water reclamation plants under Alternative 4. Both the District and DWA would continue to encourage recycled water use to the maximum extent practical. Municipal recycled water use in the Upper Valley is projected to increase from 8,000 acre-ft in 1999 to 26,000 acre-ft in 2015 and to 30,000 acre-ft by 2035.

Lower Valley. There are three sources of recycled water available for potential use in the Lower Valley.

- Fish farm effluent,
- Agricultural return flows from the CVSC and District drains, and
- Municipal recycled water.

Effluent from fish farms is a high quality water currently reused for irrigation of crops in areas adjacent to larger fish farms. The reuse potential of this water is limited because most fish farms are relatively small and do not produce sufficient effluent to make recycling effective. Today 1,500 acre-ft per year of fish farm effluent is recycled. Alternative 4 assumes that this number will increase to approximately 4,900 acre-ft per year.

The Whitewater River flows from the San Bernardino Mountains southerly through the Coachella Valley. In its upper reaches, it conveys natural runoff along with SWP Exchange water to the Whitewater Spreading Facility for groundwater recharge. Below the spreading grounds, the river predominantly conveys stormwater to the Salton Sea. In its natural state, the Whitewater River terminated in an alluvial fan midway down the valley near Point Happy. Below Point Happy, the river channel is a manmade extension of the Whitewater River and has been designated the Coachella Valley Stormwater Channel.

Although flow in the Whitewater River was fully apportioned in 1928, the District filed an application with the State Water Resources Control Board in 1997 to appropriate all waters in the CVSC (up to a maximum of 150 cfs) draining from lands irrigated in ID-1. The application was submitted with the intent to retain local control of local water resources. Under the application, initial diversions must take place by 2013, building up to full diversion by 2063.

Alternative 4 assumes that up to 11,000 acre-ft/yr of agricultural drain water will be desalted to a quality equivalent to Canal water and delivered for irrigation use. Approximately 13.6 mgd of drain water would be diverted and filtered prior to desalination. The desalination facility would have a 10-mgd capacity that will produce about 7.5-mgd of product water. Approximately 3.5 mgd of the flow would be bypassed and blended with the product water to produce the desired quality. Delivery of this water would begin at a rate of about 4,000 acre-ft/yr and reaches 11,000 acre-ft/yr in approximately fifteen years. The alternative does not identify specific users for this water, but rather the product water will be delivered to the District's Canal water distribution system. An equal amount of Canal water can be delivered for irrigation purposes to users outside ID-1.

Municipal recycled water use must be viewed differently in the Lower Valley than in the Upper Valley. Flows from the Lower Valley's three major treatment facilities cannot be percolated into the groundwater basin as are flows from Upper Valley treatment facilities. Underground clay layers formed by ancient Lake Cahuilla make percolation of treated wastewater flows in the Lower Valley impossible without extensive and expensive pumping. Currently, effluent from the Lower Valley's three major treatment facilities flow directly into the Salton Sea via the CVSC without any direct or indirect reuse.

In 1999, approximately 11,000 acre-ft of wastewater was treated and discharged into the CVSC. By the year 2015, flows to Lower Valley treatment plants are estimated to increase to approximately 17,000 acre-ft/yr and to approximately 25,000 acre-ft/yr by 2035. Approximately 8,000 acre-ft/yr of the effluent from the Lower Valley treatment plants is projected to offset groundwater extraction by golf courses or agricultural users in the Lower Valley.

SWP Exchange Water. Since the golf industry is one of the Valley's largest water users. There are a number of golf courses in the Rancho Mirage-Palm Desert-Indian Wells area that use groundwater as their primary source of supply. Although the recharge program at the Whitewater Spreading Facility has positively affected groundwater levels in this area, groundwater levels have continued to experience a steady decline.

Providing an alternative source of supply for golf courses in this area would have a major impact on groundwater levels. SWP water could be delivered to golf courses in this part of the Valley by diverting SWP exchange water currently being recharged at the Whitewater Spreading Facility. Instead of being delivered through the Colorado River Aqueduct, exchange water would be delivered using the Coachella Canal. A pump station would be constructed along the Canal in the Bermuda Dunes area and a distribution system from there would deliver SWP exchange water to area golf courses. The distribution system would be constructed in phases over a 5 to 10 year period. Approximately 40,000 acre-ft per year would be delivered at project build out.

Canal Water for Domestic Use. Alternative 4 also includes a long-term plan to use treated Canal water to meet municipal demand within ID-1. This conversion would include the construction of one or more conventional water filtration plants and would include pipelines to convey water from the Canal to the filtration plants and pipelines, pumping stations and reservoirs to deliver water from the filtration plants to the existing water distribution systems. Approximately 30,000 acre-ft per year would ultimately be delivered for municipal use at project build out.

Groundwater Recharge

Groundwater recharge has been an important water management tool for many years in the Coachella Valley. Construction of the original Whitewater Spreading Facility began in 1918 to capture stormwater runoff and recharge the groundwater basin. CVWD and DWA began recharging the Upper Valley with SWP exchange water in 1973. In the Coachella Valley, groundwater recharge offers many advantages over other management options.

Because the Coachella Valley has been historically dependent on groundwater, its water supply infrastructure requires little or no modification as long as water levels remain constant. The existing infrastructure also allows for maximizing the flexibility of the groundwater basin through conjunctive use of surface and groundwater supplies during times of shortages and abundance.

Upper Valley. The Upper Valley and the Lower Valley are different hydrogeologically. The Upper Valley can be described as a giant tilted bathtub full of sand, with the high end at the northwest edge of the Valley near Whitewater and the low end near Indio. Water placed on the ground surface in this part of the Valley will percolate through the sand directly into the groundwater aquifer, making recharge a relatively simple task.

The Whitewater Spreading Facility is located within the city limits of Palm Springs. Operating at full capacity, the recharge facility can percolate in excess of 300,000 acre-ft/yr into the groundwater basin. CVWD and DWA exchange their current SWP entitlement of 61,200 acre-ft/yr with Metropolitan for Colorado River water. This amount of recharge is far below the current capacity of the recharge facility. In fact, in 1985 and 1986, the facility received its full SWP entitlement and also received advance deliveries from Metropolitan totaling 251,994 acre-ft and 298,201 acre-ft, respectively. No capital improvements would be required to substantially increase the amount of water recharged annually in the Upper Valley.

Water quality is of concern when recharging relatively high-quality groundwater (240± mg/L Total Dissolved Solids or TDS) with Colorado River water (660± mg/L TDS). At the present time, Colorado River water is the only available source of imported water for the Coachella Valley. Water quality effects from current recharge programs have been minimal. The District is currently exploring options for obtaining additional long-term entitlements of imported SWP exchange water for the Upper Valley.

Alternative 4 assumes that ultimately annual SWP water entitlements would be increased to approximately 175,000 acre-ft by acquiring additional long-term entitlements, by purchasing surplus SWP water on the spot market, or through a combination thereof. A total annual entitlement of 175,000 acre-ft is expected to result in an actual annual deliveries of approximately 140,000 acre-ft of which approximately 100,000 acre-ft/yr would be recharged and the remainder would be delivered to Upper Valley golf courses via the Coachella Canal. All SWP water would be exchanged with Metropolitan for Colorado River water under the existing exchange agreement. The additional recharge would be accomplished using the existing Whitewater Spreading Facility.

Lower Valley. Recharge in the Lower Valley groundwater basin is substantially more difficult than in the Upper Valley. The Lower Valley can also be described as a tilted bathtub full of sand but with layers of nearly impervious clay between the ground surface and the groundwater. Sediments from the bed of ancient Lake Cahuilla, which at different times throughout history inundated the area, formed these clay layers, or aquitards. Water applied to the surface percolates only to the depth of the aquitard, where it becomes semi-perched and does not easily reach the usable groundwater aquifer. There are areas near the edges of the Valley where the aquitard disappears and recharge is possible.

Water quality concerns in the Lower Valley are similar to those in the Upper Valley relative to recharging the basin with imported Colorado River water. However, the effects of overdraft on water quality are much more severe in the Lower Valley. Declining water levels allow increased infiltration of poor-quality waters from the semi-perched aquifer. In addition, water levels near the Salton Sea are below the level of the sea, making salt water intrusion a concern. Coachella Canal water is of a much higher quality (800 mg/L TDS) than either Salton Sea water (44,000 mg/L TDS) or water in the semi-perched aquifer (2,000 mg/L TDS). Increasing water levels reduces the threat of salt-water intrusion from the Salton Sea and also reduces the amount of infiltration from the semi-perched aquifer into the Lower Aquifer.

The District currently operates the Dike No. 4 pilot recharge facility, which has successfully demonstrated that recharge is possible in the Lower Valley. In 1998, the facility was expanded in order to determine the ultimate recharge capacity of a facility at this location. It may be possible to recharge as much as 30,000 to 60,000 acre-ft/yr at this location.

Table 5-4
Coachella Valley Water Supply and Demands
Alternative 4 - Combination Alternative
(acre-ft)

	1999	2015			2035		
	No Project Alternative	No Project Alternative	Alternative 4	1999-2015 Differences	No Project Alternative	Alternative 4	1999-2035 Differences
Supplies							
Canal Water[1]							
Crop Irrigation	266,400	273,900	268,900	2,500	277,500	292,100	25,700
Golf Courses	7,500	23,000	34,000	26,500	22,000	35,300	27,800
Duck Clubs	600	600	600	0	600	600	0
Fish Farms	1,600	1,600	1,500	-100	1,600	1,500	-100
Recharge	3,000	0	45,800	42,800	0	80,000	77,000
Domestic	200	200	200	0	200	31,500	31,300
Groundwater[2]	282,500	400,600	201,400	-81,100	505,200	183,200	-99,300
Surface Water	6,900	6,500	5,900	-1,000	6,500	5,900	-1,000
SWP							
Recharge	90,600	50,000	81,300	-9,300	50,000	103,000	12,400
Irrigation	0	0	39,700	39,700	0	37,000	37,000
Recycled Water							
Municipal	8,100	18,100	31,600	23,500	22,000	38,100	30,000
Fish Farm	1,500	5,000	4,900	3,400	5,000	4,900	3,400
Ag. Drainage	0	0	8,000	8,000	0	11,000	11,000
Total Supply	668,900	779,500	723,800	54,900	890,600	824,100	155,200
Demands							
Agriculture[3]	333,300	339,300	315,700	-17,600	346,800	322,700	-10,600
Municipal & Ind.	204,000	273,300	246,200	42,200	376,900	339,500	135,500
Golf Courses	106,200	136,500	131,500	25,300	136,500	131,500	25,300
Fish Farms & Duck Clubs	25,400	30,400	30,400	5,000	30,400	30,400	5,000
Total Demand	668,900	779,500	723,800	54,900	890,600	824,100	155,200

1 Includes 35,000 acre-ft/yr of SWP entitlement water delivered through the Coachella Canal in accordance with the Quanitification Settlement Agreement.
2 Groundwater supply is total groundwater pumpage less artificial recharge.
3 Includes crop irrigation and green houses.

Alternative 4 assumes a total of 80,000 acre-ft/yr of recharge divided among two Lower Valley locations. A permanent facility near the Dike No. 4 pilot recharge facility is assumed to have a capacity of 40,000 acre-ft/yr as are facilities near the west end of Avenue 70 (Martinez Canyon). Recharge water would be Colorado River water delivered through the Coachella Canal.

Local geologic conditions, including the presence of subsurface clay layers and faults, affect the feasibility of individual sites. The maximum amount of potential recharge in the Lower Valley is not known at this time. If recharge at the desired volumes is not technically feasible, then the District may need to consider other source substitution options for use and delivery of Canal water to other potential users.

Table 5-4 compares the basic elements of the supply and demand of the No Project Alternative and Alternative 4 for the years 2015 and 2035.

CONCLUSIONS

The alternative water management strategies described in this section are not intended to be exact blueprints for future water management activities but alternative road maps identifying different routes for managing the water resources of the Coachella Valley. The alternatives attempt to solve the long-term water needs of the Valley in a timely, cost-effective and environmentally responsible manner, by building alternatives that approach water management from different conceptual viewpoints.

Section 6 identifies the criteria used to judge the alternatives and to select the alternative that best meets the long-term needs of the Coachella Valley.

Section 6
Evaluation of Alternatives

The selection of a preferred alternative involves evaluating each proposed alternative against a set of specific criteria that, if met, will achieve the desired objectives of the Plan. The alternative which best meets these evaluation criteria is selected as the preferred alternative. This section describes (1) the evaluation process, (2) the evaluation criteria, (3) the evaluation results, and (4) the selection of the preferred alternative based on the evaluation results.

EVALUATION PROCESS

The process of evaluating the effectiveness of each alternative in meeting the Plan's goals and objectives involves technical analyses coupled with professional judgment and experience. To assist in the evaluation process, the District developed a three-dimensional groundwater model (model) for the Coachella Valley. The model provides a scientific basis for understanding the impacts of the management alternatives on changes in basin storage, sustainability of groundwater levels, land subsidence, and intrusion of lower-quality water from the semi-perched zone and the Salton Sea. Covering the entire Coachella Valley, the model built upon previous modeling investigations by the USGS (Tyley, 1974; Swain, 1978; and Reichard and Meadows, 1992). A description of the model is provided in Appendix C.

Upon completion, three pre-eminent scientists and engineers in the field of groundwater hydrology subjected the model to a peer-review. The review panel consisted of Steve Larson, S. S. Papadopulos & Associates, Inc.; Jim Mercer, HSI GeoTrans, Inc.; and Irwin Remson, Stanford University (Professor Emeritus). The panel concluded, "One of the strengths of the groundwater model is the nature of the team that put it together. The team included expertise in modeling as well as geology, hydrology, and water management." The panel also concluded, "The peer-review panel believes that the model is suitable to aid in making management decisions concerning water development in the Coachella Valley" (Larson et al., 1998).

Another important technical tool is an economic evaluation (BBC Research and Consulting, 2000). The purpose of this evaluation was to provide a comparative economic and financial evaluation among the four alternatives within the Coachella Valley as a whole. Consistent with other elements of the Plan, the economic and financial evaluation primarily focused on the planning period. Potential longer-term economic and financial effects were discussed, but not quantified. The evaluation provided a reconnaissance level, order of magnitude comparison of the economic and financial effects of each alternative.

EVALUATION CRITERIA AND RESULTS

Each water management alternative is evaluated using the following set of criteria. These criteria are derived from the Plan objectives presented in Section 1.

1. The ability to eliminate overdraft and its associated adverse impacts, including:
    a. Decreasing groundwater basin storage,
    b. Declining groundwater levels,

   c. Land subsidence, and
   d. Water quality degradation,
2. The ability to maximize conjunctive use opportunities,
3. The ability to minimize adverse economic impacts to Coachella Valley water users, and
4. The ability to minimize environmental impacts.

Criterion 1: Eliminate Overdraft and Associated Adverse Impacts

The elimination of the groundwater basin overdraft is a primary goal of the Plan. The definition of overdraft provided in Section 3 includes two components: (1) the condition of a groundwater basin at which the groundwater outflows exceed inflows (reduction in groundwater storage) and (2) the adverse impacts associated with overdraft, such as declining groundwater levels, land subsidence, and water quality degradation. An increase in groundwater storage must occur in order to eliminate the overdraft and associated adverse impacts. This condition will occur either by increasing groundwater inflows to exceed groundwater outflows or by reducing outflows to be less than inflows. Groundwater levels must be stabilized at levels that will prevent adverse impacts, including land subsidence and water quality degradation. As groundwater levels increase over time, water quality degradation in the Lower Valley associated with additional return flows to the Upper Aquifer and salt water intrusion from the Salton Sea are substantially reduced. Similarly, higher groundwater levels reduce pumping costs for groundwater users.

Criterion 1a: Changes in Groundwater Basin Storage

The groundwater inflows and outflows for both the Upper and Lower Valley are estimated using the model. The change in groundwater storage is determined by comparing these estimates. Change in groundwater storage is evaluated in terms of the change in total storage and the change in freshwater storage.

The change in freshwater storage is a critical concern. Water applied in reasonably efficient agricultural or landscaping operations results in return flows with elevated salinity. The addition of poor-quality return flows to the basin has the effect of occupying available storage to the exclusion of higher-quality natural inflows or artificial recharge. As a result, the net amount of freshwater storage in the groundwater basin decreases.

Freshwater storage in the Coachella Valley is not a new issue. The approach adopted in 1964 by the California Department of Water Resources (DWR) in Bulletin 108 was to subtract out agricultural drainage in the semi-perched area from calculations of basin overdraft (p. 140, Bulletin 108). Bulletin 108 (p. 141) succinctly identified the problem as:

> *'Determination of the usable water supply within the Coachella Valley groundwater basin includes a consideration of the quality of the waters. On this basis, the semi-perched groundwater is not a source of supply. Although the gross amount of groundwater in storage is increasing within the Coachella Valley groundwater basin, the amount of usable supply in storage is decreasing.'*

Because the Upper Valley has no significant confining layers, the only management techniques available are to minimize the drainage by maximizing the efficiency of applied water and to recharge additional freshwater supplies. The presence of the semi-perched zone in the Lower Valley, which acts as a natural barrier to deep percolation, requires different management techniques. Historically, downward percolation of agricultural drainage from the semi-perched layer into the Upper and Lower Aquifers was inhibited by the relatively greater pressure head in these underlying aquifers. Thus, the agricultural return was discharged by the subsurface drainage system to the CVSC and ultimately the Salton Sea. Even with an upward pressure differential, some drainage flows into the Upper Aquifer, particularly on the margins around the periphery of the Lower Valley where no drains are present.

Total Change in Storage. The total change in storage incorporates the following groundwater inflows and outflows:

Inflows	Outflows
Natural recharge	Groundwater pumping
Domestic return flows	Flows to drains
Agricultural return flows	Evapotranspiration
Golf course return flows	Subsurface flow to the Salton Sea
Wastewater percolation	
Subsurface flow from the Salton Sea	
SWP exchange recharge	
Canal recharge	

The total change in storage is determined by comparing the inflows and outflows. If inflows exceed outflows (a positive change in storage), the total groundwater storage is increasing. Conversely, if outflows exceed inflows (a negative change in storage), the total groundwater storage is decreasing. As shown in Table 6-1, Alternatives 2 and 4 would result in positive changes in 2035 total groundwater storage. However, Alternative 4 is the only alternative that would result in a cumulative increase in total storage over the planning period (1999 to 2035).

Changes in Freshwater Storage. The change in freshwater storage is used to estimate the groundwater overdraft under each alternative. Change in freshwater storage is the difference between the inflows and outflows of the basin, excluding the following inflow components:

1. *Agricultural return flows* not intercepted by agricultural drains,
2. *Golf course return flows* supplied by Canal and recycled water, and
3. *Subsurface inflow from the Salton Sea* (i.e., saltwater intrusion).

By excluding these inflows, a more accurate approximation of actual annual overdraft is possible.

Table 6-1
Comparison of Changes in Total Storage

Alternative	Annual Change in Storage 2035			Cumulative Change in Storage 1999-2035		
	Upper Valley (acre-ft/yr)	**Lower Valley** (acre-ft/yr)	**Total** (acre-ft/yr)	**Upper Valley** (acre-ft)	**Lower Valley** (acre-ft)	**Total** (acre-ft)
1	-90,400	-76,000	-166,800	-2,473,000	-1,874,100	-4,347,100
2	2,300	2,100	4,400	-1,628,200	-378,900	-2,007,100
3	-48,800	-36,100	-84,900	-1,539,100	-752,200	-2,291,300
4	6,900	-4,600	2,300	276,500	114,900	391,400

The overdraft in 1999 of 136,700 acre-ft/yr is estimated to increase to 254,700 acre-ft/yr under Alternative 1. As shown in Table 6-2, only Alternative 4 will completely eliminate the overdraft throughout the Valley. However, additional groundwater pumping restrictions in the Lower Valley under Alternative 2 would, by definition of adjudication, be implemented to limit the annual change in freshwater storage and eliminate overdraft. Table 6-2 also shows the cumulative change in freshwater storage for the period 1999 through 2035.

Table 6-2
Comparison of Changes in Freshwater Storage

Alternative	Annual Change in Storage 2035			Cumulative Change in Storage 1999-2035		
	Upper Valley (acre-ft/yr)	**Lower Valley** (acre-ft/yr)	**Total** (acre-ft/yr)	**Upper Valley** (acre-ft)	**Lower Valley** (acre-ft)	**Total** (acre-ft)
1	-90,400	-164,300	-254,700	-2,483,900	-4,698,600	-7,182,500
2	1,900	-31,000	-29,100	-1,710,900	-5,790,500	-7,501,400
3	-48,800	-61,000	-109,800	-1,524,200	-1,887,700	-3,411,900
4	6,500	300	6,800	253,100	-1,436,100	-1,183,000

Criterion 1b: Groundwater Levels

Groundwater levels in the Coachella Valley have been declining for many years and will continue to decline, as indicated by the discussion in Section 4 - No Project Alternative, unless corrective actions are taken. As groundwater levels decline due to reductions in groundwater storage, the potential for associated adverse impacts such as land subsidence and water quality degradation increases significantly. The change in groundwater levels from 1999 to 2035 serves as the basis for comparing the impacts of each alternative. Localized areas may have different water level changes than those indicated in the tables.

Upper Valley. As shown in Table 6-3, changes in groundwater levels for Alternative 4 range from no change at Palm Springs to a 30-foot decrease at N. Palm Springs. Although Upper Valley groundwater levels are declining under Alternative 4, the magnitude of the declines are significantly less than under Alternatives 1 or 3, which range from –85 feet to –200 feet.

Table 6-3
Upper Valley Groundwater Level Changes: 1999 to 2035

Location	Alternative 1	Alternative 2	Alternative 3	Alternative 4
N. Palm Springs	-115	-65	-85	-30
Palm Springs	-180	-60	-120	0
Thousand Palms	-180	-50	-110	-20
Palm Desert	-200	-40	-120	-25
UV-LV Boundary	-200	-25	-110	-25

Values are rounded to the nearest 5 feet

Lower Valley. Table 6-4 illustrates the impacts on groundwater levels at six Lower Valley locations. Alternatives 1 and 3 generally show declines throughout the Lower Valley from 1999 to 2035. Alternatives 2 and 4 would result in higher Lower Valley groundwater levels at all six locations. Alternative 4 shows an increase of nearly 75 feet near Oasis, the largest increase of any alternative. The Salton Sea values are representative of the northwestern shore of the Salton Sea, north and slightly west of Oasis.

Table 6-4
Lower Valley Groundwater Level Changes: 1999 to 2035

Location	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Indio	-150	+5	-70	+10
Coachella	-110	+20	-35	+30
Thermal	-90	+35	-15	+45
Mecca	-65	+65	+5	+55
Oasis	-80	+65	+10	+75
Salton Sea	-70	+70	+5	+65

Values are rounded to the nearest 5 feet

Criterion 1c: Land Subsidence

A recent USGS study of land subsidence in the Lower Valley indicated that land subsidence resulting from groundwater withdrawal is possibly occurring. A significant part of the potential land subsidence may have occurred since the early 1990s, when groundwater levels began declining below previously recorded lows (Ikehara et al., 1997). The previously recorded lows in groundwater levels occurred around 1949.

To evaluate the potential for land subsidence, the 2035 groundwater levels under each alternative are compared to the 1949 groundwater levels. If the 2035 groundwater levels are below the 1949 levels, the potential for land subsidence is likely to increase. Conversely, if the groundwater levels in 2035 are above the 1949 levels, the potential for land subsidence is reduced.

Upper Valley. Subsidence normally occurs in aquifers with thick clay layers that can compress when dewatered. The Upper Valley consists predominantly of sandy soils with relatively thin clay layers and is less likely to experience land subsidence. Recent studies have indicated that as much as 7 cm of subsidence had occurred in the Palm Desert area between 1996 and 1998.

Although the 2035 groundwater levels are below the 1949 levels under each of the Alternatives as shown in Table 6-5, there appears to be minimal increased potential for land subsidence in the Upper Valley because the aquitard separating the Upper and Lower Aquifers is thin or absent in much of the Upper Valley (such as Palm Springs and North Palm Springs).

Table 6-5
Comparison of Groundwater Levels: 2035 vs. 1949[1]
(feet)

Location	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Upper Valley				
N. Palm Springs	-150	-100	-120	-65
Palm Springs	-230	-115	-170	-50
Thousand Palms	-275	-145	-205	-115
Palm Desert	-305	-145	-225	-130
Upper-Lower Valley Boundary	-280	-105	-190	-105
Lower Valley				
Indio	-165	-15	-85	-10
Coachella	-110	+20	-35	+30
Thermal	-85	+35	-10	+50
Mecca	-90	+40	-15	+35
Oasis	-115	+30	-25	+40
Salton Sea	-105	+40	-25	+35

[1] Positive (+) values indicate 2035 water levels above 1949 levels;
Negative (-) values indicate 2035 water levels below 1949 levels.
Values are rounded to the nearest 5 feet.

Lower Valley. In contrast, the Lower Valley has numerous clay layers that could compress when dewatered causing land subsidence. As shown in Table 6-5, declining water levels indicate the potential for land subsidence throughout the entire Lower Valley under Alternatives 1 and 3. Under Alternatives 2 and 4, the potential for land subsidence would be minimized throughout the Lower Valley, except near Indio where the 2035 groundwater level will be slightly lower than the 1949 level.

Criterion 1d: Water Quality Degradation

Water quality degradation is a serious adverse impact of overdraft. In particular, declining water levels and decreased drain flows within the Lower Valley allow the migration of poor-quality water into the underlying aquifer units of the basin and prevent the removal of applied salts from leaving the basin through the drains.

To evaluate the potential for water quality degradation, the projected salt balance for each alternative is compared as shown in Table 6-6. The components of salt addition and salt removal used to determine the salt balance include:

Salt Addition	**Salt Removal**
Natural recharge	Drain flows
SWP recharge	Outputs to Salton Sea
Canal water use	Fish farm/duck club pumping
Salton Sea intrusion	Municipal wastewater discharge
Input from Upper Valley	Output to Lower Valley
Domestic use increment	
Fertilizers	

Table 6-6
Comparison of Salt Balance Estimates

Component	1999	2035			
		No Project	Alternative 2	Alternative 3	Alternative 4
Upper Valley - Annual Salt Increase (tons/yr)	81,000	86,000	76,000	81,000	177,000
Lower Valley - Annual Salt Increase (tons/yr)	184,000	418,000	-8,000	248,000	-22,000
Total Valley – Annual Salt Increase (tons/yr)	265,000	504,000	68,000	329,000	155,000

The current net salt addition in the Coachella Valley is 265,000 tons per year. By 2035, Alternative 2 would result in the lowest rate of salt addition to the Coachella Valley of 68,000 tons per year-a dramatic decrease compared to 1999 conditions. Under Alternative 4, the net salt rate would decrease to 155,000 tons per year by 2035, lower than 1999. The net salt addition rate would increase under Alternatives 1 and 3 relative to 1999.

Criterion 2: Maximize Conjunctive Use Opportunities

The reliability of the Coachella Valley's water supplies can be improved through conjunctive use of both surface and groundwater supplies. Conjunctive use of surface and groundwater may be defined as an integrated plan that capitalizes on the combination of available surface and groundwater resources in order to achieve a reliable long-term water supply. When surface water is available, surface water is utilized to the maximum extent possible. Surface water not used directly is also recharged to augment groundwater storage. Conversely, when surface supplies are limited, surface water resources may be supplemented by pumping additional groundwater.

Conjunctive use opportunities can also be improved by increasing the diversity of available surface supply sources. The availability and use of alternate surface supply sources, i.e. SWP exchange water, Canal water, or recycled water in lieu of groundwater expands conjunctive use opportunities.

Each alternative is evaluated based on the alternative's ability to maximize conjunctive use opportunities. The conjunctive use potential is evaluated based on the ability to:

1) Store available surface water supplies
2) Extract stored water
3) Utilize alternate supply sources

Ability to Store Available Surface Water

Water can be stored through direct or in-lieu groundwater recharge. Direct recharge involves surface spreading as done at the Whitewater Spreading Facility. In-lieu recharge occurs when groundwater is left in the ground and an alternate source of supply is used, such as recycled or imported water. Surface water includes all potential sources including Colorado River water and SWP exchange water.

Upper Valley. The Whitewater Spreading Facility in the Upper Valley has considerable excess recharge capacity above the average recharge amount (approximately 50,000 acre-ft/yr). Under Alternatives 1, 2, and 3, no additional Upper Valley recharge would take place. Under Alternative 4, Upper Valley annual recharge would increase to approximately 100,000 acre-ft by 2035. The additional recharge would only slightly reduce the excess capacity of the Whitewater Spreading Facility that can be used to store water in the groundwater basin. Therefore, Alternative 4 receives a ranking of "excellent" regarding the ability to store additional water in the Upper Valley.

Lower Valley. Alternatives 1, 2, and 3 are ranked "poor" regarding the ability to store water in the Lower Valley due to the exclusion of groundwater recharge under these alternatives. Alternative 4 receives a ranking of "good" regarding the ability to store water since approximately 80,000 acre-ft/yr would be stored by direct recharge in addition to in-lieu recharge associated with source substitution management elements.

Potential to Extract Stored Water

For conjunctive use to be efficient, surface water stored in the groundwater basin would need to be extracted for use during periods of limited surface water availability.

Upper Valley. The current SWP groundwater banking agreement with Metropolitan requires the District to forego the delivery of SWP Exchange water when SWP supplies are limited. In these periods, little or no imported water would be recharged in the basin. Water previously stored in the Upper Valley portion of the groundwater basin by Metropolitan is transferred to CVWD and DWA and is extracted by groundwater producers. Alternatives 1 through 4 each receive rankings of “excellent” regarding the potential to extract stored water and because of the current groundwater banking agreement with Metropolitan.

Lower Valley. Alternatives 1, 2, and 3 receive rankings of “poor” regarding the potential to extract stored water since no water is stored in the Lower Valley under these alternatives. Alternative 4 receives a ranking of “good” because the ability to store water would exist via groundwater recharge facilities, and pumping capacity would be maintained under this alternative.

Ability to Utilize Alternate Supply Sources

In order to expand conjunctive use opportunities, alternate sources of water supply must be available for use in-lieu of groundwater pumping or for direct recharge.

In-Lieu Use

Three primary alternate sources of supply for in-lieu use are recycled water, Canal water, and SWP exchange water.

Recycled Water. Under Alternatives 1 and 2, recycled water would continue to be the only alternate source of supply for irrigation of golf courses and green belts in the Upper Valley. In the Lower Valley, fish farm effluent is the only alternate source of supply under Alternatives 1 and 2. As a result, Alternatives 1 and 2 receive rankings of “fair” regarding the use of recycled water as an alternate source of supply. Alternative 3 would greatly increase the delivery of recycled water for irrigation of golf courses and green belts in the Upper Valley while continuing the delivery of fish farm effluent for agricultural irrigation in the Lower Valley. Alternative 3 receives an “good” ranking. Under Alternative 4, the use of recycled water in the Upper Valley would be greater than under Alternatives 1 and 2. However, in the Lower Valley, desalted agricultural drain water will serve as an alternate source of supply for agricultural irrigation outside of ID-1. Due to the presence of three alternate sources of recycled water supply under Alternative 4 (municipal, fish farm, and agricultural drain flows), Alternative 4 receives an “excellent” ranking.

Canal Water. In-lieu use of Canal water is primarily for agricultural and golf course irrigation within the Lower Valley. Due to minimal conversion activities under Alternatives 1, 2, and 3, small amounts of Canal water would be substituted both for agricultural and golf course uses. Canal water would be used as an alternate source of supply for golf course irrigation purposes under Alternative 3. Under Alternative 4, Canal water would be used for agricultural and golf course irrigation as well as for domestic use. Based on the projected amounts of Canal water use in 2035, Alternatives 1 through 4 receive rankings of “fair”, “fair”, “good”, and “excellent”, respectively.

SWP Exchange Water. Under Alternative 4, Canal water obtained through SWP exchange will be delivered to Upper Valley golf courses in lieu of groundwater. Furthermore, Canal water obtained through SWP exchange under the Quantification Settlement will be delivered for agricultural irrigation in the Lower Valley. Since this is the only alternative that includes SWP exchange water as an alternate source of supply, Alternative 4 receives an “excellent” ranking while the other alternatives receive “poor” rankings.

Direct Recharge Use

Three potential sources of water for direct recharge purposes are SWP water exchanged for Colorado River water, Canal water and/or surplus Colorado River water.

SWP Exchange Water. Although sufficient capacity exists at the Whitewater Spreading Area to recharge additional water, Alternatives 1, 2, and 3 receive rankings of “fair” since decreased SWP water supplies for recharge purposes are included in these alternatives. Alternative 4 receives an “excellent” ranking since an increase in SWP exchange water use for recharge purposes is held approximately at current levels.

Canal Water. Use of Canal water for recharge purposes is limited to areas benefiting ID-1, which is predominantly in the Lower Valley. The Coachella Canal has sufficient capacity to deliver additional water to the Lower Valley. However, Alternatives 1, 2, and 3 receive rankings of “poor” since no increased Canal water for recharge purposes is included in these alternatives. Alternative 4 receives an “excellent” ranking since it includes increased Canal water supplies, which could be utilized for direct recharge purposes.

Surplus Colorado River Water. Surplus Colorado River water could theoretically be utilized for recharge purposes in both the Upper and Lower Coachella Valley. However, there are several restraints, which, for practical purposes, limit the use of surplus Colorado River water to the Lower Valley. As previously stated, the Coachella Canal has sufficient capacity to deliver additional water to the Lower Valley. Capacity to deliver surplus water to the Upper Valley is currently limited by the capacity of Metropolitan’s aqueduct. It is anticipated that at times when surplus flows are available, Metropolitan will be using the aqueduct’s full capabilities for its own purposes. The high cost of constructing additional facilities to deliver surplus water to the Upper Valley minimizes the Upper Valley potential. Although the Coachella Canal has sufficient capacity to deliver additional water to the Lower Valley for the purpose of recharging surplus Colorado River water, recharge is only included in Alternative 4 and, therefore, receives an “excellent” ranking. The other alternatives receive “poor” rankings due to the lack of groundwater recharge in the Lower Valley.

Summary

The ratings assigned within each reliability consideration and the overall supply reliability ranking of each alternative are summarized in Table 6-7.

Table 6-7
Evaluation of Conjunctive Use Opportunities

Component	Alternative 1: No Project	Alternative 2: Pumping Restrictions by Adjudication	Alternative 3: Managing Demand & Maximizing Local Resources	Alternative 4: Combination Alternative
Conjunctive Use				
Ability to store water Upper Valley: Lower Valley:	Excellent Poor	Excellent Poor	Excellent Poor	Excellent Good
Ability to extract stored water Upper Valley: Lower Valley:	Excellent Poor	Excellent Poor	Excellent Poor	Excellent Good
Supply Sources				
Ability to use alternate supplies in lieu of groundwater: Recycled Water Canal Water SWP Exchange Water	Fair Fair Poor	Fair Fair Poor	Good Good Poor	Excellent Excellent Excellent
Ability to use alternate supplies for recharge purposes: SWP Exchange Water Canal Water Surplus Colorado River Water	Fair Poor Poor	Fair Poor Poor	Fair Poor Poor	Excellent Excellent Excellent
OVERALL RANKING	**Fair**	**Fair**	**Fair to Good**	**Good to Excellent**

Criterion 3: Minimize Economic Impact to Coachella Valley Water Users

This criterion provides a comparative evaluation of the economic and financial impacts associated with the Plan alternatives. The evaluation is based on a reconnaissance-level economic and financial analysis (BBC Research and Consulting, 2000). The economic impact analysis has been made relative to six economic factors:

- Economic sustainability,
- Economic development,
- Regional economic activity measures,
- Economic and financial risks,
- Direct costs, and

- Indirect costs or savings.

Economic sustainability, economic development, and regional economic impact assessments are based upon comparison of the projected economic conditions in the Coachella Valley, according to the Coachella Valley Association of Governments and conditions that could occur under each Plan alternative. In general, the evaluation of economic and financial effects focused on year 2015, to provide an assessment of near-term implications, and 2035, to allow assessment of longer-term impacts. None of the Plan alternatives promotes additional economic or demographic growth beyond CVAG's projections.

The results of the economic and financial assessment are summarized below.

Economic Sustainability

From an economic viewpoint, sustainability is the ability of the alternatives to support existing Coachella Valley economic activities and meet the needs of projected growth to 2035. Alternative 1 - No Project relies upon increased pumping and allows for continued groundwater overdraft. Although available data suggest that Alternative 1 could continue to meet Coachella Valley water requirements through 2035, this alternative will not be sustainable indefinitely. Continued reliance on groundwater will eventually lead to water quality degradation, rising pumping costs, well replacement costs, subsidence risk, and water scarcity which will diminish the economic viability of the Coachella Valley in the absence of additional water management measures. In essence, Alternative 1 borrows from the future of the Coachella Valley to meet current demands.

Alternative 3 also allows for continued overdraft and is therefore unsustainable over a long time period, although the time frame is extended as compared with Alternative 1. Alternative 2 would reduce groundwater pumping to sustainable levels hydrologically, but would likely force a future of minimal, if any, economic growth in the Coachella Valley. Given its severe effects, Alternative 2 would not be economically sustainable at current levels of employment and income in the Coachella Valley. Alternative 4 offers both economic and hydrologic sustainability due to the increased use of imported water supplies in both the Upper and Lower Valleys.

Economic Development

The availability and quality of water supplies at affordable prices are generally prerequisites for many types of economic development. Under Alternative 1, water would continue to be available to meet growth projections as well as existing needs. Over time, this water would be more expensive and reduced in quality, resulting in unknown effects upon economic development. Under Alternative 2, it is very likely that the reality of a water shortage due to adjudication and groundwater pumping restrictions would constrain economic development and growth in the Valley relative to baseline conditions under Alternative 1. Even the perception of shortage, or potential shortage, could be an economic development issue.

Alternative 3 and, to some extent, Alternative 2 focus on aggressive conservation measures, including outdoor landscaping restrictions which might impact the attractiveness of the area.

The retention and attraction of both businesses and residents might be more difficult under such circumstances. For example, if one prospective future household in ten and one prospective future visitor in ten does not come to Coachella Valley because of these myriad water concerns, the area would experience substantial economic losses, as compared with what would have occurred under Alternative 1. More than 400 homes would not be built each year, visitor spending would decrease by approximately $130 million per year, and employment would decrease by about 2,800 jobs, as compared to baseline economic and demographic conditions.

Alternative 4 would sustain currently projected economic development in the Coachella Valley.

Regional Economy

During the planning period, Alternative 2 is likely to cause the largest adverse impacts on Coachella Valley employment, income, and other broad economic measures. Based upon current water use levels for Coachella Valley economic activities, it is estimated that impacts due to reductions in groundwater supplies available for crop production and golf courses alone could diminish crop revenues and visitor spending in the Coachella Valley by more than $200 million per year compared to 2000 conditions, by more than $500 million per year compared to 2015 demand projections and by more than $700 million compared to 2035 demand projections. About 3,000 jobs linked to agriculture and tourism would be lost compared to 2000, more than 6,600 would be lost compared to 2015, and more than 8,200 jobs could be lost compared to 2035 projections.

The most dramatic impact of Alternative 2, however, would be the projected reduction in supplies available for municipal and domestic use. Under current water use patterns, Alternative 2 water supplies would support 89,000 fewer permanent residents than lived in the Valley in 2000 and 32,000 fewer seasonal residents than live in the Valley today. This shortage becomes even more severe when compared to projected demands in 2015 and 2035

Of course, it is very unlikely that large numbers of existing residents would be forced to leave the Valley under Alternative 2. Based on the experience of other regions, responses to the diminished water supply could include conservation efforts and large-scale transfers of water rights from agriculture to municipal and domestic use. Given agriculture's strong economic position in the Coachella Valley, water transfers are less likely. However, assuming for purposes of this evaluation that sufficient water supplies were transferred from agriculture to municipal and domestic use, nearly 120,000 acre-ft/yr would need to be transferred from agriculture to maintain existing households and seasonal residences and to provide for anticipated population growth in the Valley by 2015. By 2035, about 200,000 acre-feet/yr would have to transfer from agriculture, potentially fallowing 2/3 of the irrigated lands in the Coachella Valley.

Although transfers could theoretically provide supplies to meet the needs of existing residents and visitors and perhaps permit slow growth in the Valley, the impacts on the agricultural economy would be severe. Lost agricultural production could reach about $280 million by 2015 and $430 million by 2035. Although farm owners would presumably be compensated for selling their water supplies, such a scenario would involve abandonment of a substantial portion of the extraordinarily productive lands, irrigation-related capital improvements, and agricultural infrastructure in the area. Alternative 2 could lead to considerable change in the culture as well as the economy of the Coachella Valley. Adjudication in other areas suggests that the social impacts of this approach are also profound, often pitting neighbor against neighbor in disputes over water rights.

Water quality degradation is likely to be most pronounced under Alternatives 1 and 3. Higher plumbing and equipment replacement costs, lower crop yields, and the expense of various treatment or filtering devices would be incurred due to degradation of water quality. An increase in TDS of 200 mg/L, for example, would mean additional costs for residents, businesses, and farmers, ranging from \$10 million to \$60 million or more per year, according to studies in Tucson and southern California. Over time, Alternatives 1 and 3 are likely to lead to substantial impacts on the regional economy because of diminishing water quality.

Economic and Financial Risks

The shortcomings of Alternatives 1, 2, and 3 described above and earlier in this section might produce an aura of uncertainty about the Coachella Valley. The cumulative effect of questions about sufficient supplies, pumping and well costs, water quality, subsidence, and constrained water use patterns might extend to less obvious aspects of the local economy. Future investment in the region and current asset values could generate less interest, borrowing costs could rise, and financing availability could be threatened over time. Given the high value of water in this area for both agricultural and domestic purposes, such risks are probably unacceptable.

Direct Costs

Direct costs represent the costs that would be incurred in order to implement the management options included in each alternative. The direct costs are described below and are shown in Table 6-8. All costs are reported in constant (uninflated) 2000 dollars.

Alternative 1 - No Project. The direct costs under Alternative 1 represent the baseline costs for the continuation of current water management activities by the District. These costs are projected to continue at an average of about \$12 million per year, for a cumulative cost through 2015 of approximately \$189 million and through 2035 of approximately \$377 million. The annual and cumulative costs are considered the baseline in this evaluation, since they would be incurred regardless of which alternative is selected as the preferred alternative. Because the No Project Alternative is defined as the future without proactive management measures beyond current practices, there are no new direct project costs from the standpoint of economic comparison. Present value costs from 2000 through 2015 would be about \$138 million, using a 4 percent real discount rate based on the approximate difference between CVWD borrowing costs and current inflation levels. Present value costs over the entire planning period, through 2035, would be approximately \$208 million.

Table 6-8
Projected Direct Costs of Water Management Plan Alternatives in 2015, and Over 2000 through 2035 Planning Period (Reported in Constant 2000 Dollars)

	Alternative			
	1	2	3	4
Total Annual Cost	$11,000,000	$12,000,000	$15,000,000	$29,000,000
Projected Demand (annual acre-feet)*	780,000	557,000	681,000	724,000
Cost per Acre-ft	$14	$21	$24	$40
Cumulative Cost Through 1999-2035 ($ Millions)	$377	$452	$616	$1,217
Present Value Cost Through 2035 ($ Millions)**	$208	$253	$339	$607

* Baseline demand projection counting conservation as a source of supply
** Present value using a 4 percent real discount rate on uninflated cost estimates

Alternative 2 - Pumping Restrictions by Adjudication. Direct costs under Alternative 2 are highly uncertain, but legal and administrative fees associated with perfecting and restricting groundwater pumping rights could be substantial. For the purposes of this analysis, direct transaction costs associated with adjudicating groundwater rights, establishing reduction rules, and monitoring enforcement have been estimated at $10 million per year over the initial five years of adjudication implementation based upon the current experience of a similar adjudication process in South Texas. Continuing costs for governance, monitoring, and enforcement could be more than $1 million per year. If a physical solution were imposed as part of an adjudication, those costs would be on top of the direct costs of adjudication.

Alternative 3 - Management of Demand and Maximization of Local Resources. Direct costs associated with Alternative 3 include continuation of costs for existing management measures and additional costs associated with more stringent conservation and source substitution management elements. Including the baseline costs of about $189 million to continue current water management efforts, cumulative direct costs for Alternative 3 between 2000 and 2015 would total approximately $310 million. Cumulative costs through 2035 would be approximately $616 million. Present value cost would be about 227 million through 2015 and $339 million through 2035. The projected annual costs under Alternative 3 decline from a peak of about $30 million per year in 2005 to $15 million by 2035.

Alternative 4 - Combination Alternative. Including the baseline costs under Alternative 1 of about $189 million, cumulative direct costs for Alternative 4 between 2000 and 2015 would total approximately $493 million. Cumulative direct costs by 2035 would total about $1.2 billion. Applying a 4-percent real discount rate to the projected cost results in cumulative present value cost estimate of $347 million through 2015 and $607 million through 2035. These present value costs include about $138 million in baseline costs through 2015, and $208 million in baseline costs through 2035 to continue the current management practices included in Alternative 1. Because stabilization of groundwater levels and other benefits of implementing these alternatives would accrue to all Coachella Valley water users, the costs of each alternative may be considered in terms of the costs per acre-foot of total Valley-wide water demand. These unit costs are shown in Table 6-8. Actual cost impacts on Valley water users will likely depend upon the District's approach to raising required revenues.

Indirect Costs or Savings

There are a number of ways of identifying the indirect economic effects of the four alternatives. For example, one approach would be to estimate the value of the groundwater lost from storage due to overdraft under Alternatives 1, 2, and 3. Cumulative freshwater storage losses through 2035 for Alternatives 1, 2, and 3 range from 3.4 million acre-ft to approximately 7.1 million acre-ft. The value of this lost resource could be estimated based on an avoided cost approach, examining the next best alternative for attaining a comparable quantity of water. For example, the cost of importing and treating a similar volume from an alternative water supply, such as SWP, could be calculated.

In a certain sense, replacement alternatives are encompassed by Alternative 4. Consequently, the selected approach to estimating indirect economic impacts in this evaluation was to focus on impacts and costs to the end-user. This approach allows for comparison both between the No Project Alternative and among Alternatives 2 through 4.

Alternative 1 - No Project. Under Alternative 1, groundwater levels are expected to decline in both the Upper Valley and the Lower Valley. These declines in groundwater levels are expected to have at least two types of impacts on groundwater users in the Coachella Valley. Costs associated with pumping groundwater, including energy costs and, in some cases, costs for rehabilitating or replacing wells, pumps, and other equipment, would increase with lower water levels. In addition, continued declines are projected to have an increasing impact on Coachella Valley groundwater quality due to return flows into the Upper Aquifer and intrusion of Salton Sea waters in the Lower Valley. With groundwater levels projected to decline well below 1949 levels in parts of the Lower Valley by the end of the planning period, land subsidence and property damage are additional unpredictable risks associated with Alternative 1. Alternative 1 effects are the baseline against which potential indirect impacts of the three other alternatives are measured. Hence, each of the other three alternatives offers specific avoided costs associated with Alternative 1.

Alternative 2 - Pumping Restrictions by Adjudication. By design, Alternative 2 would ultimately reduce groundwater pumping, stabilize groundwater levels, and minimize the potential for water quality degradation. However, the legal and administrative processes required under this alternative would take time. For purposes of the Plan, it is assumed that restrictions would not be in place until after year 2010. Beginning in year 2011, groundwater pumping would be reduced by more than 220,000 acre-ft over a five-year transition period. In total, annual pumping costs in 2015 are projected at about $8.2 million under Alternative 2, compared with about $15.5 million under the No Project Alternative, due to restrictions placed on the amount of water which can be pumped. By 2035, annual groundwater pumping cost savings under Alternative 2 would be about $16 million, compared with Alternative 1.

An analysis by Olson Engineering Systems in 1996 determined that electricity costs represent approximately 60 percent of the total costs of groundwater pumping for Coachella Valley agricultural users, with the remaining 40 percent of costs being comprised of repair, maintenance and capital replacements for Valley wells. Given the likelihood that increased depths to groundwater under the No Project Alternative will require redrilling and recasing of many wells, particularly in the later years of the study period, it is likely that these non-electricity costs will increase at least as rapidly as the costs for pumping electricity. Factoring in these additional costs, the avoided cost groundwater pumping cost savings under Alternative 2 could reach $12 million by 2015 and more than $26 million by 2035.

Alternative 3 – Management of Demand and Maximization of Local Resources. Under Alternative 3, there are also indirect costs and benefits relative to Alternative 1. Groundwater overdraft would be reduced but not fully eliminated under this alternative. Annual pumping cost savings under Alternative 3, compared to the No Project Alternative, would be $2.2 million in 2005, $4.3 million in 2015, $6.5 million in 2025 and $9.3 million in 2035.

Including avoided cost savings for capital replacements, repair and maintenance on Valley groundwater wells; indirect cost savings under Alternative 3 could reach $7 million per year by 2015 and more than $15 million per year by 2035.

Alternative 4 – Combination Alternative. Under Alternative 4, there are also indirect benefits relative to the No Project Alternative. Groundwater levels would generally be increased under this alternative, resulting in energy savings for each acre-foot of groundwater pumped. Further, less total groundwater would be pumped than under the No Project Alternative, producing additional savings relative to the No Project Alternative. Annual pumping cost savings under Alternative 4 is expected to increase from $5.9 million in 2015 to $13 million in 2035.

Including avoided cost savings for capital replacements, repair and maintenance on Valley groundwater wells; indirect cost savings under Alternative 4 could reach nearly $10 million per year by 2015 and more than $21 million per year by 2035.

Table 6-9 shows projected groundwater pumping and electricity costs per acre-foot pumped in 2015 and 2035. Costs for capital equipment, replacement and maintenance of Valley wells are not reflected in Table 6-9. Valley-wide averages may be misleading because the average pumping cost depends both on the amount of decline in groundwater levels and on the mix of wells that are in production.

Summary of Economic Evaluation

An overall comparison of the economic evaluation results for each alternative is presented in Table 6-10.

Table 6-9
Projected Groundwater Pumping Costs under Management Plan Alternatives

	2015	2035
Alternative 1 – No Project		
Annual Pumping Volume	450,000	554,000
Cost per Acre-foot	$54.70	$70.30
Total Cost	$24,618,000	$38,955,000
Alternative 2 – Pumping Restrictions		
Annual Pumping Volume	228,000	233,000
Cost per Acre-foot	$57.40	$57.90
Total Cost	$13,088,000	$13,502,000
Alternative 2 Savings/(Cost) vs. No Project	$11,530,000	$25,453,000
Alternative 3 – Manage Demand		
Annual Pumping Volume	335,000	391,000
Cost per Acre-foot	$53.00	$62.00
Total Cost	$17,749,000	$24,231,000
Alternative 3 Savings/(Cost) vs. No Project	$6,869,000	$14,724,000
Alternative 4 – Combination		
Annual Pumping Volume	328,000	366,000
Cost per Acre-foot	$46.70	$49.90
Total Cost	$15,310,000	$18,253,000
Alternative 4 Savings/(Cost) vs. No Project	$9,308,000	$20,702,000

Source: Simulations with groundwater model by Montgomery Watson, 2000.

Criterion 4: Minimize Environmental Impacts

As discussed in Section 1, the District has prepared a Program Environmental Impact Report (PEIR) to fully assess the potential environmental impacts of the Plan and to develop feasible mitigation measures to minimize those effects (Montgomery Watson, 2000). The PEIR will also serve as the foundation for future second-tier or site-specific CEQA documents to be prepared for individual elements of the preferred alternative. The PEIR summarizes the results of technical and environmental analyses and stakeholder coordination regarding the Plan and its alternatives.

Analysis of Environmental Impacts

Several critical environmental impact-related issues, including changes in groundwater storage, groundwater levels, land subsidence, and water quality, have been evaluated previously as part of Criterion 1. The discussion of environmental effects under Criterion 4 therefore focuses on other critical potential environmental effects, including surface water, human, cultural and biological resources.

Coachella Canal. Under Alternatives 1, 2, and 3, Canal water usage is projected to increase 8 percent by 2035 from 279,200 acre-ft/yr to 301,800 acre-ft/yr. Under Alternative 4, Canal

Table 6-10
Summary of Reconnaissance-Level Economic and Financial Impact Evaluation of Alternatives through 2015

Evaluation Criteria	Alternative 1 No Project	Alternative 2 Adjudication	Alternative 3 Demand Management	Alternative 4 Combination
Economic Sustainability	Unsustainable past study time horizon; loss of groundwater storage	Sustainable from water but not economic standpoint	Unsustainable in long term; loss of groundwater storage	Sustainable
Economic Development	Greater uncertainty from perception of diminishing supplies and quality	Little or no growth in valley, $70 -$250 million loss in business, up to 4,400 jobs lost	Diminished appeal with xeriscaped lawns and golf courses, potential of 400 fewer new homes, $100 million less in visitor spending	Does not constrain development
Economic and Financial Risks	Diverse, considerable risks beyond study time horizon	Considerable uncertainty	Uncertainty about conservation success and groundwater reliance	No increased risk
Regional Economy	Rise in cost of living and doing business, $10-$60 million cost of water quality degradation, substantial long-term impacts.	Severe widespread impacts	Potential impacts due to economic development concerns. $10-$60 million cost of water quality degradation.	Minimally positive investment effects; water quality degradation less than other alternatives
Direct Annual Costs in 2015/2035	$11/9 Million	$12/10 Million	$16/15 Million	$29/37 Million
Indirect Annual Costs in 2015/2035	$10-$60 Million	$200-$600 Million	$100-$200 Million	$0
Annual Savings in 2015/2035 **	$0	$19/44 Million	$11/25 Million	$16/34 Million
Net Costs or Impacts ***	$19-$71 Million	$166-$593 Million	$90-$205 Million	$3-13 Million

* Indirect impacts are expressed as a range of potential economic impacts, such as losses in revenue, based upon past experience in other areas.

** Indirect savings of pro-active alternatives do not include unquantified benefits relative to the No Project Alternative from avoiding subsidence, Salton Sea intrusion and loss of agricultural land. All indirect savings are likely to increase rapidly in the years following 2015.

*** Net costs or impacts are the combined direct, alternative specific, costs with the indirect economic impacts on the Coachella Valley, less indirect savings, e.g. reduced pumping.

deliveries for direct use plus groundwater recharge will increase to 441,000 acre-ft/yr by 2035 and will account for approximately 93 percent of the total flows in the Canal. The remaining 79 percent (37,000 acre-ft/yr) of the total Canal flows under Alternative 4 will be from agricultural drain water desalinated for irrigation use and SWP exchange water for Upper Valley golf courses. Overall, total flow in the Canal will increase from 279,200 acre-ft/yr to approximately 478,000 acre-ft/yr by 2035 or 71 percent. The peak monthly flows are not projected to exceed the capacity of the Canal (1,300 cfs) under any of the alternatives. Therefore no significant adverse impacts to existing infrastructure or operational practices are projected. In addition, no significant water quality or biological impacts to the Canal are projected under any alternative.

Colorado River Aqueduct. Under Alternatives 1, 2, and 3, SWP exchange water deliveries to the Whitewater Spreading Facility will decrease to the long-term average delivery of approximately 50,000 acre-ft/yr. Because the facilities currently have sufficient capacity to deliver current volumes and will not change water quality of the Colorado River Aqueduct, there will be no significant adverse impacts of these alternatives. Under Alternative 4, the total volume of SWP exchange water delivered to the Valley will remain at the average for the past five years of about 140,000 acre-ft/yr by 2035, with about 103,000 acre-ft/yr delivered to the Whitewater Spreading Facility. Use of this water will not require the construction of additional facilities nor result in any substantial changes in water quality of the Colorado River Aqueduct. Peak releases to the Whitewater River will be no higher than historical levels; however, the number of days of flow may change. Deliveries depend on the operational needs of Metropolitan. Therefore, Alternative 4 will have no significant adverse impacts on the Colorado River Aqueduct. Based upon this analysis, none of the alternatives will have any adverse environmental impacts to the Colorado River Aqueduct.

Coachella Valley Stormwater Channel. Flows in the CVSC and agricultural drains have decreased significantly over the last 20 years, and are projected to continue to decrease by approximately 13 percent from 1999 levels under Alternative 1, and by 8 percent in Alternative 3 by 2035. These flows would increase under Alternatives 2 and 4 as groundwater levels in the basin recover and upward gradients are re-established. In terms of the salt balance, an increase in drain flows is generally considered beneficial. By 2035, the flows would increase by approximately 50 percent under Alternative 2 and nearly double under Alternative 4. The increases in flows will affect biological resources, as discussed below, but will not adversely impact any other beneficial uses of the drains.

The quality of the flows in the CVSC and agricultural drains are also projected to change. Under Alternative 1, TDS concentrations in the CVSC would decrease from about 1,400 mg/L in 1999 to about 1,200 mg/L by 2035 because of higher projected municipal wastewater flows and reduced high TDS agricultural drainage into the CVSC. This is considered a beneficial impact. Under Alternatives 2, 3 and 4, average CVSC TDS would increase to about 1,900 mg/L, 2,100 mg/L and 2,600 mg/L, respectively. The average drain quality of the 25 drains that drain directly into the Salton Sea (excluding the CVSC) is projected to decrease from approximately 2,000 mg/L TDS in 1999 to about 1,900 mg/L by 2035 under Alternative 1 and remain approximately the same under Alternative 3. The TDS of these drains are projected to increase to approximately 2,400 mg/L under Alternative 2 and 2,900 mg/L under Alternative 4. However, individual drains may have higher or lower TDS concentrations as they do today. The water quality objective for the Coachella Valley drains is 2,000 mg/L TDS from non-agricultural sources. In 1999, about 60 percent of the CVSC flow and more than 90 percent of the drain flow came from agricultural sources. Agricultural sources will continue to be the primary source of flow in both the CVSC and the drains in future. Therefore, the average quality under each alternative would continue to meet the existing water quality objective for TDS of 2,000 mg/L from non-agricultural sources. Therefore, the projected increases in TDS in the drains and CVSC under Alternatives 2, 3 and 4 would not be a significant impact.

Salton Sea. Each of the alternatives will have significant impacts on the Salton Sea. Under No Project, the water levels are projected to increase as much as 2.6 feet to a level of –224.4 feet MSL by 2035. Water levels are projected to also increase under Alternatives 2 and 3 (4.3 feet and 2.7 feet, respectively). Since the methods of conservation have not been finalized, CVWD has evaluated two inflow scenarios that bracket the probable range in reduced inflows from the 100,000 acre-ft/yr IID transfer to assess the potential effects of Alternative 4 on the Salton Sea. One scenario assumes that all conservation would occur through tailwater recycling or other similar methods that would directly reduce the inflows to the Sea from IID by 100,000 acre-ft/yr. With this first scenario, total Salton Sea inflows would decrease by 24,000 acre-ft/yr and water levels would increase by approximately 0.7 feet by 2035. The other scenario assumes all conservation would result from land fallowing or other similar methods that reduce the importation and consumptive use of water. By comparing the inflows to the Sea attributable to IID with IID's Colorado River diversions, 32 percent of the imported water flows to the Sea. Applying this percentage to the proposed transfer implies a reduction in inflows of 32,000 acre-ft/yr. With this second scenario, total Salton Sea inflows would increase by 44,000 acre-ft/yr and water levels would increase by approximately 3.9 feet by 2035. The increases in water level projected under each alternative would be significant. However, the cumulative impact with other related projects to restore the Sea will reduce the level of the Sea and are projected to minimize the adverse impacts.

The salinity of the Sea is also projected to increase under each alternative. Under No Project, the salinity of the Sea is projected to increase approximately 12,000 mg/l to 56,000 mg/l by 2035. Similarly, under Alternatives 2 and 3, salinity is projected to be approximately 53,000 mg/l and 56,000 mg/l by 2035. Under the first scenario for Alternative 4 (with 100,000 acre-ft/yr reduction), the salinity of the Sea is projected to be approximately 60,000 mg/l compared to 54,000 mg/l under the second scenario for Alternative 4 (with 32,000 acre-ft/yr reduction). Each of these has significant environmental impacts compared to existing conditions.

Under each of the alternatives, the level of the Salton Sea is projected to increase, thereby inundating land surrounding the Salton Sea. Under No Project, the area of the Sea is projected to increase by approximately 6,000 acres by 2035. Similarly, the area of the Sea is projected to increase 10,000 acres under Alternative 2 and 6,000 acres under Alternative 3. The area under Alternative 4 is projected to range from 1,500 acres to 9,000 acres, with IID's reduction of 100,000 acre-ft/yr and 32,000 acre-ft/yr, respectively. These could result in significant land use impacts as discussed below.

Energy. Under Alternatives 1 and 3, energy required for pumping groundwater (kilowatt-hours per year) would increase by 21 percent and 38 percent, respectively, as groundwater levels continue to fall. Under Alternative 4, groundwater levels would begin to recover, and by 2035 pumping energy would be only 4 percent above present levels. Under Alternative 2, there would be a 23 percent decrease in all energy uses due to substantial increases in groundwater levels resulting from mandatory pumping restrictions. Therefore, Alternatives 1 and 3 result in the most severe adverse impacts in terms of energy costs. Alternatives 2 and 4 are generally beneficial due to increased groundwater levels and subsequent lower pumping costs.

Land Use. The severe restriction of water supply in Alternative 2 may cause the loss of some agriculture in the Lower Valley and curtail the planned development of urban and golf courses in the Upper Valley. The increase in the level of the Salton Sea would have significant land use impacts adjacent to the Sea. These would include loss of agricultural land due to rising water levels. This effect is significant compared to current conditions for all alternatives, including No Project.

Cultural Resources. The Coachella Valley is rich in cultural resources from long Indian occupation and subsequent European settlement, particularly along the Valley boundaries that were the banks of ancient Lake Cahuilla. There would be no Valley-wide impacts on any historic or archaeological resources under any alternative beyond those projected under Alternative 1.

Site specific effects associated with construction would be evaluated in the future CEQA documents for individual project facilities proposed under each alternative. The potential for impacts is proportional to the amount of construction. Alternative 1 and 2 would have no impacts. Alternative 4 would have higher potential for impacts if recharge basins, desalination and water treatment facilities were constructed in undisturbed areas. Alternative 3 would have a lower potential for effects, as pumping stations would likely be located in agricultural areas and pipelines in existing roadways.

Recreation. Existing land-based recreational resources would be significantly affected by any of the alternatives. Alternative 2 would have significant adverse effects on irrigated parks and golf courses because of severe water cutbacks. The increasing salinity of the Salton Sea is threatening the recreational fishery. In addition, rising Sea levels would effect shoreline recreational resources under all alternatives. As discussed above, continued increases in TDS are predicted for the Salton Sea under all alternatives (in the absence of other restoration efforts). Of the four alternatives, the lowest TDS increase by 2035 is predicted under Alternative 4.

Endangered Species – Aquatic/Riparian. Increases in drain and CVSC flows under Alternatives 2 and 4 could benefit the endangered desert pupfish that lives in the drains by creating additional aquatic habitat. Flow and depth in the drains measured by CVWD indicated that many drains have no more than 1 or 2 inches of water. Both drain flows and pupfish populations have been declining in recent years. Alternatives 1 and 3 would further decrease drain flow, resulting in a negative effect. All other alternatives would increase drain flows and increase habitat for pupfish. However, increased flows could also create additional habitat for larger predatory fishes, a potential negative effect that would require monitoring.

The additional drain flow could widen and expand the riparian and wetland habitat at the mouth of the CVSC at the north end of the Salton Sea. This additional habitat could be beneficial for the listed clapper rail and black rail. Other wetland and riparian habitat would be unchanged because of on-going routine channel maintenance for flood control.

Endangered Species – Terrestrial. There would be no Valley-wide impacts on any terrestrial species under any alternative. Site-specific effects of construction and operation will be evaluated in future CEQA documents for individual facilities. The potential for impacts is proportional to the amount of construction. Alternatives 1 and 2 would have no adverse impacts, but Alternative 2 could result in potential increases in desert habitat due to agricultural land being left fallow. Alternative 4 would have higher potential for impacts if recharge basins, desalination and water treatment facilities were constructed in areas of undisturbed native vegetation. Alternative 3 would have slightly lower potential for effects, as facilities for delivery of recycled water would likely be located in agricultural areas and in existing roadways.

Summary of Environmental Impacts

Based upon a comparison of Plan alternatives with respect to the factors above, Alternative 4 would have the greatest beneficial effect on Coachella Valley water supplies and is the overall environmentally superior alternative. Alternative 4 best meets project objectives by combining environmental benefits and minimizing impacts. Alternative 4 decreases overdraft, creating stable water levels in the Upper Valley and increasing water levels in the Lower Valley. Subsidence potential halts and energy use for groundwater pumping is also minimized. In addition, Alternative 4 also provides the least adverse impacts to surface water, groundwater, biological and human resources.

SELECTION OF PREFERRED ALTERNATIVE

The preferred alternative selected from the four alternatives will best meet the objectives of the evaluation criteria. Table 6-11 provides a summary comparison of the evaluation of each alternative. A discussion of the evaluation results is provided below.

Summary of Evaluation

As indicated by the economic analysis, Alternatives 1, 2, and 3 would result in significant adverse economic impacts to the Coachella Valley, in the long term. These alternatives would not sustain long-term economic viability, they would add considerable financial risk, they would curtail economic development, and they would not sustain the economy of the Coachella Valley. When the economic costs of these impacts are considered, the net costs of Alternatives 1, 2, and 3 would be extremely high. The social, economic, and environmental impacts of these alternatives would also make them undesirable.

Alternative 2 shows positive impacts in terms of change in groundwater storage, increased groundwater levels, and decreased potential for land subsidence and Salton Sea intrusion. However, the near-term economic consequences of Alternative 2 would be severe. The benefits of Alternative 2 would be equally achievable under Alternative 4 without the severe adverse economic impacts to the Valley.

Table 6-11
Summary of Evaluation Results

EVALUATION CRITERIA	Alternative 1 No Project	Alternative 2 Adjudication	Alternative 3 Demand Management	Alternative 4 Groundwater Recharge
1. Eliminate Overdraft				
1a. Changes in groundwater storage				
Changes in total storage	Decrease of 166,800 Acre-ft/yr in 2035 Cumulative decrease of 4,347,100 AF	Increase of 4,400 Acre-ft/yr in 2035 Cumulative decrease of 2,007,100 AF	Decrease of 84,900 Acre-ft/yr in 2035 Cumulative decrease of 2,291,300 AF	Increase of 2,300 Acre-ft/yr in 2035 Cumulative increase of 391,400 AF
Changes in freshwater storage	Decrease of 254,700 Acre-ft/yr in 2035 Cumulative decrease of 7,182,500 AF	Decrease of 29,100 Acre-ft/yr in 2035 Cumulative decrease of 7,501,400 AF	Decrease of 109,800 Acre-ft/yr in 2035 Cumulative decrease of 3,411,900 AF	Increase of 6,800 Acre-ft/yr in 2035 Cumulative decrease of 1,183,000 AF
1b. Declining groundwater levels	UV: -115 to -200 ft LV: -65 to -150 ft	UV: -25 to - 65 ft LV: +5 to +70 ft	UV: -85 to -120 ft LV: +5 to -70 ft	UV: 0 to -30 ft LV: +10 to +75 ft
1c. Land Subsidence	High potential throughout Lower Valley	Minimal Potential	High potential throughout Lower Valley	Minimal Potential
1d. Water quality degradation	Net salt addition of 489,000 Tons/yr in 2035	Net salt addition of 147,000 Tons/yr in 2035	Net salt addition of 324,000 Tons/yr in 2035	Net salt addition of 243,000 Tons/yr in 2035
2. Maximize Conjunctive Use Opportunities	Fair	Fair	Fair to Good	Good to Excellent
3. Minimize Economic Impacts	$21-$71 Million	$193-$593 Million	$105-$205 Million	$13 Million
4. Minimize Environmental Impacts	Poor*	Fair*	Poor*	Good*

*Additional information provided in PEIR (Montgomery Watson, 2000)

From among Alternatives 1, 2, 3, and 4, the alternative(s) that best meets each evaluation criterion are summarized in Table 6-12.

Preferred Alternative

The evaluation results indicate that Alternative 4 would best:

- maximize the increase in total storage,
- eliminate groundwater overdraft throughout the Valley,
- minimize the decline of groundwater levels in the Upper Valley while increasing groundwater levels throughout the Lower Valley,
- minimize the potential for land subsidence,
- maximize conjunctive use opportunities,
- minimize the economic impacts to Valley water users, and
- minimize the environmental impacts.

Table 6-12
Summary of Evaluation Results - Alternatives 1, 2, 3, and 4

Evaluation Criteria	Alternative			
	1	2	3	4
1.0 Eliminate overdraft				♦
1.a Change in groundwater storage				
Total change in storage				♦
Change in freshwater storage				♦
1.b Declining groundwater levels		♦		♦
1.c Land subsidence		♦		♦
1.d. Water quality degradation		♦		
2.0 Maximize Conjunctive Use Opportunities				♦
3.0 Minimize Economic Impacts				
Economic sustainability, economic development, economic and financial risk, and regional economy				♦
Net cost				♦
4.0 Minimize Environmental Impacts				♦

"♦" denotes a relatively superior alternative - multiple dots denote equally superior alternatives

Based on these results, Alternative 4 would best meet the goals and objectives of the Plan and is therefore selected as the preferred alternative.

Section 7 describes the strategy for implementation of the preferred alternative.

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Section 7
Implementation of Preferred Alternative

INTRODUCTION

Implementation of the preferred alternative will require numerous decisions regarding the priorities for implementation, the financing mechanisms for various elements of the plan, potential cooperative agreements with other agencies, and balancing needs with available resources. A significant activity in decision-making and implementation is coordination and consultation with other governing agencies and tribal interests. The District cannot, nor should it, attempt to unilaterally implement water management activities that are within the purview of local or other governments. This coordinating effort will be a major focus of implementation. Detailed implementation plans will be developed by the District for each water management category following completion of the Water Management Plan.

MANAGEMENT ELEMENTS AND IMPLEMENTATION STRATEGIES

The preferred alternative includes water conservation, increased water supplies to the Valley and a combination of source substitution and groundwater recharge. Each of these categories is discussed below. A map depicting the location of the principal program elements included in the preferred alternative is presented in Figure 7-A.

Water Conservation

The judicious use of water is the focus of significant attention from utilities, regulatory agencies and the public throughout the nation. Population growth, environmental concerns, periodic droughts and the economics of new water supply development demonstrate the need to make efficient use of the available water supplies. Water conservation is described as any beneficial reduction in water use or in water losses. Conservation measures can be applied to all water uses; however, in the Coachella Valley, the primary focus of water conservation is on municipal, agricultural irrigation, golf course irrigation, and fish farm uses. As shown in Table 7-1 water conservation measures are expected to decrease total water demand by approximately seven percent by 2015. This level of reduction will be maintained through the remainder of the planning period. By 2035, water conservation is expected to further reduce demands.

Municipal Conservation

The *Memorandum of Understanding Regarding Urban Water Conservation* (MOU), dated September 1991 (as amended April 8, 1998 - CUWCC, 1998), asks that water agencies commit to make a “good faith effort” to: (1) develop comprehensive conservation Best Management Practices (BMPs) programs using sound economic criteria and (2) consider water conservation on an equal basis with other water management options.

Table 7-1
Minimum Water Conservation Assumptions for the Preferred Alternative

Water Use Category	Minimum Conservation Goal (Reduction from No Project Demand)
Municipal	10 percent by 2010
Golf Courses	
Existing in 1999	5 percent by 2010
Built after 1999 [1]	Case-by-Case
Industrial	Case-by-Case
Crop Irrigation	7 percent by 2015
Fish Farms	Case-by-Case
Duck Clubs	Case-by-Case
Greenhouses	Case-by-Case
Total Demand	7 percent

[1] Future golf courses are assumed to implement water conservation measures under No Project

The MOU has identified a list of BMPs for urban water conservation that are generally recognized as producing more efficient water usage and are considered technically and economically feasible. The list of BMPs was updated in September 1997 to include the following:

1. Water Survey Programs for Single-Family Residential and Multi-Family Residential Customers
2. Residential Plumbing Retrofit
3. System Water Audits, Leak Detection and Repair
4. Metering with Commodity Rates for all New Connections and Retrofit of Existing Connections
5. Large Landscape Conservation Programs and Incentives
6. High-Efficiency Washing Machine Rebate Programs (new)
7. Public Information Programs
8. School Education Programs
9. Conservation Programs for Commercial, Industrial, and Institutional Accounts
10. Wholesale Agency Assistance Programs (new)
11. Conservation Pricing
12. Conservation Coordinator
13. Water Waste Prohibition
14. Residential Ultra Low Flush Toilet (ULFT) Replacement Programs

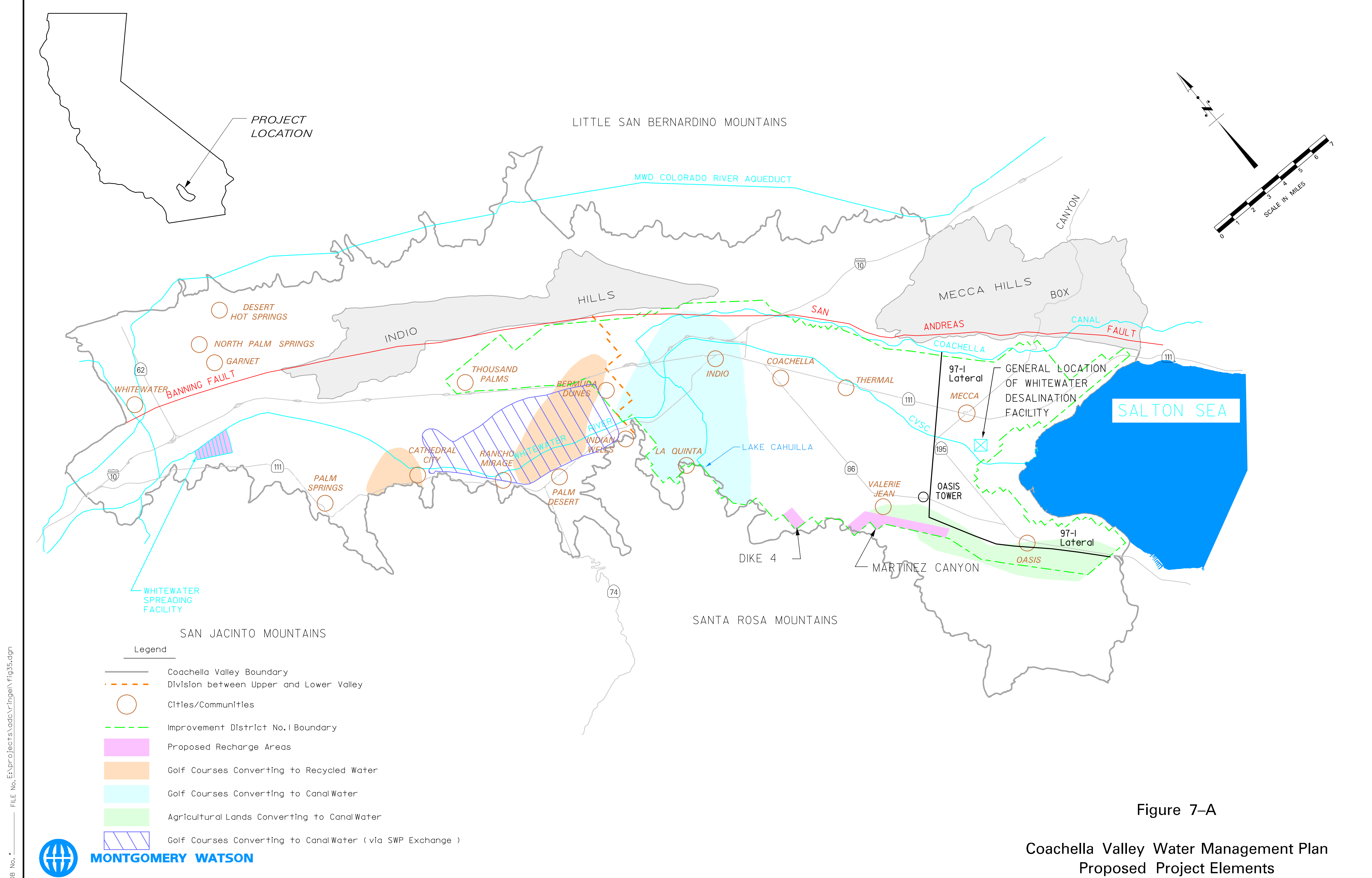


Figure 7–A

Coachella Valley Water Management Plan
Proposed Project Elements

The MOU also references eleven potential BMPs that are subject to on-going study to determine whether the practices meet the criteria for inclusion in the list of BMPs. The District is not currently a signatory to the MOU; however, DWA is a signatory. Under the Plan, the District will consider signing the MOU.

The District will revise and update the urban water management plan submitted to the California Department of Water Resources (DWR). The goal of the plan will be to further reduce urban water demand by a minimum of 10 percent by 2010 and maintain this level of reduction throughout the planning period without producing dramatic lifestyle changes on the part of those conserving. In the future, as total demand increases, the volume of water conserved will increase.

During revision of the urban water management plan, various existing and new water conservation measures will be evaluated including:

- <u>Water Efficient Landscaping</u>-maintaining water-efficient urban and residential landscaping and irrigation systems, optimizing existing systems, improving the overall efficiency of local water use, turf restrictions, xeriscaping, developing and enforcing water efficient landscape ordinances.
- <u>Water Efficient Plumbing</u>-retrofitting indoor plumbing with ultra-low flush toilets and low-flow showerheads, encouraging development of local ordinances requiring retrofitting as a condition of sale of a property, installing water efficient plumbing in all new buildings.
- <u>Tiered or Seasonal Water Pricing</u>-revising the District's water pricing structure to a tiered or increased block-rate structure that will encourage water conservation by increasing the price of water either year-around or seasonally as usage increases.
- <u>Alternate Water Supplies-</u>requiring the use of alternate water supplies (such as recycled or Canal water) for urban irrigation purposes where available.
- <u>Public Information and Education Programs</u>-promoting the importance of water conservation efforts within the schools and to the general public.
- <u>Municipal Development</u> Policies-working with municipalities, counties, and other agencies to incorporate specific policies regarding water conservation measures into future general plan updates and development policies.
- <u>Conservation Coordinator</u>-designating a full-time position and support staff as required to coordinate and develop water conservation plans.
- <u>Maximum Allowable Water</u> Allowance-establish new and enforce existing annual Maximum Applied Water Allowances for parks, playgrounds, sports fields, school yards, and other recreational areas.

Agricultural Conservation

The *Agricultural Efficient Water Management Act of 1990* (California Water Code Section 10900-10904) required DWR to evaluate water management practices to improve the efficiency of agricultural water use. DWR's effort culminated in the development of the *Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California* (Ag MOU). The Ag MOU identified three categories of efficient water management practices, which are presented in Table 7-2.

Table 7-2
Agricultural Efficient Water Management Practices

List A – Generally Applicable Efficient Water Management Practices	List B – Conditionally Applicable Efficient Water Management Practices	List C – Other Efficient Water Management Practices
(Required by All Signatory Water Supplies)	(Practices Subject to Net Benefit Analysis)	(Practices Subject to Detailed Net Benefit Analysis)
1. Prepare and adopt a Water Management Plan. 2. Designate a Water Conservation Coordinator. 3. Support the availability of water management services to water users. 4. Improve communication and cooperation among water suppliers, water users and other agencies. 5. Evaluate the need, if any, for changes in policies of the institutions to which the water supplier is subject. 6. Evaluate and improve efficiencies of water suppliers' pumps.	1. Facilitate Alternative Land Use. 2. Facilitate use of available recycled water that otherwise would not be used beneficially, meets all health and safety criteria and does not cause harm to crops or soils. 3. Facilitate the financing of capital improvements for on-farm irrigation systems. 4. Facilitate voluntary water transfers that do not unreasonably affect the water user, the water supplier, the environment or third parties. 5. Line or pipe ditches and canals. 6. Increase flexibility in water ordering by, and delivery to, the water users within operational limits. 7. Construct and operate water supplier spill and tailwater recovery systems. 8. Optimize conjunctive use of surface and groundwater. 9. Automate canal structures.	1. Water Measurement and Water Use Report 2. Pricing and Incentives

However, the Ag MOU does not specifically address on-farm practices. The District is not a signatory to the Ag MOU because of a provision that would prevent the District from enforcing its legal rights. Many of the measures listed in Table 7-2, however, have been implemented by CVWD.

As presented in Table 7-1, the preferred alternative strives to reduce agricultural demand for crop irrigation by a minimum of 7 percent by 2015. This corresponds to an increase in irrigation efficiency from 70 to 75 percent. This level of conservation is believed to be achievable based on recent farm water use evaluations performed for CVWD by J.M. Lord. Conservation would be maintained at this level for the remainder of the planning period. The District will prepare an agricultural water conservation plan to develop and evaluate specific existing and new agricultural conservation measures including:

- Efficient Irrigation Practices-working with Valley growers to ensure that the most up-to-date irrigation practices are being employed, converting from furrow irrigation to drip irrigation, refining existing drip irrigation management and design to improve distribution uniformity such as buried drip systems, installation of pressure compensating emitters, and including more emitters per line.
- On-farm Water Audits-reviewing individual grower's water use practices on a field-by-field basis and evaluating the unique characteristics of each field and crop type. Confidential reports will be made to each grower indicating the general efficiency of each field and containing recommendations for improved efficiency.

Golf Course Conservation

Golf course conservation is expected to reduce the water demand of existing golf courses by at least 5 percent by 2010 and maintain that level throughout the planning period. New golf courses are assumed to implement existing water conservation measures. The District will prepare a golf course water conservation plan to develop and evaluate specific existing and new golf course conservation measures including:

- Efficient Irrigation Practices-promoting the use of more efficient irrigation techniques, such as improved sprinkler layouts, computer-based irrigation systems and ET-based irrigation scheduling.
- Golf Course Turf Restrictions-establishing criteria in a local ordinance to specify the maximum allowable irrigated area for golf courses. Such an ordinance would restrict the placement of turf grass on the tees, greens, and small portions of the fairways.
- Maximum Allowable Water Allowance-enforce existing annual Maximum Applied Water Allowances for newly installed and rehabilitated landscapes. Establish annual Maximum Applied Water Allowances for golf courses.

District Operating Policies

In addition to municipal, agricultural, and golf course conservation measures, the District is in the process of reviewing its operating policies. The purpose of this review is to identify CVWD operating policies that (1) result in additional water savings or (2) make the use of Canal water more attractive to groundwater users.

Evaluation of Water Conservation Programs

The District's water conservation programs will be evaluated to determine the effectiveness of voluntary programs with recommendations for improvement in specific areas, such as public education, ordinances, etc. Based on the evaluation results, additional conservation measures will be considered.

Additional Water Supplies

In addition to water conservation, the District and DWA will need to obtain additional water supplies to eliminate current and future overdraft. Evaluation of many potential alternative supplies has identified four sources that will be augmented as part of the preferred alternative. These sources are the Colorado River, State Water Project, Whitewater River and recycled water. The steps to be taken to augment these supplies are discussed below.

Colorado River Water

CVWD has used Colorado River water diverted through the All-American and Coachella Canals since 1949. However, under the *Law of the River*, CVWD has an undefined Priority 3 allocation to Colorado River water. (See Section 3 for more details).

In October 1999, CVWD, IID and Metropolitan entered into a landmark agreement to reach a settlement on the division of water rights to Colorado River water. The intent of this agreement is to quantify the rights of each agency and allow the transfer of water between willing buyers and sellers. The Quantification Settlement Agreement includes:

- Capping IID and CVWD Priority 3 water,
- Modification to the 1988 IID/Metropolitan Water Conservation Agreement,
- Amendment to the 1989 Metropolitan/IID/CVWD/PVID Approval Agreement and transferring 20,000 acre-ft/yr to CVWD,
- Conservation and transfer of 200,000 acre-ft/yr from IID to SDCWA,
- Exchange Agreement between SDCWA and Metropolitan,
- Conservation and transfer of 100,000 acre-ft/yr from IID to CVWD,
- Lining the All-American Canal and the Coachella Canal and transfer of conserved water to Metropolitan less 16,000 acre-ft/yr for the San Luis Rey Indian Water Rights Settlement,
- Sharing obligations to provide 14,500 acre-ft/yr from IID and CVWD for miscellaneous present perfected rights (PPRs),
- Transferring of 35,000 acre-ft/yr of SWP water from Metropolitan to CVWD,
- Quantification of surplus water available under Priority 6 and 7,
- Various conditions precedents for approval of the final agreement,

Under the Quantification Settlement Agreement, CVWD's entitlement under its share of the Priority 3 allotment is capped at 330,000 acre-ft/yr at Imperial Dam less 26,000 acre-ft/yr of conserved water made available by lining the Coachella Canal. Metropolitan will provide 20,000 acre-ft/yr to CVWD at Imperial Dam under the 1989 Approval Agreement for the 1988 Metropolitan/IID Water Conservation Agreement. CVWD has the option to purchase water from IID in two phases of 50,000 acre-ft/yr each. This water would be made available by the implementation of water conservation measures by IID which are financed by the payments for water by CVWD. The first phase would be available beginning in 2007 and the second phase would be available beginning in 2017. Under the terms of the quantification settlement agreement, CVWD may acquire the water in increments of 5,000 acre-ft/yr, reaching full entitlement by 2033. CVWD may acquire the water at rates of 3,000 acre-ft/yr and 4,000 acre-ft/yr given one year's notice to IID. Metropolitan will transfer 35,000 acre-ft/yr of its SWP entitlement to CVWD on a permanent basis. This water is assumed to be used in increments of 5,000 acre-ft/yr. CVWD, IID and Metropolitan have agreed to provide 16,000 acre-ft/yr of water from the lining of the All-American and Coachella Canals as part of the San Luis Rey settlement. During wet years, CVWD will also have access to 119,000 acre-ft/yr of Priority 6 water after Metropolitan and IID have received 38,000 acre-ft/yr and 63,000 acre-ft/yr, respectively. When all water transfers have been completed, CVWD will have a total entitlement of 456,000 acre-ft/yr at Imperial Dam as shown in Table 7-3. After completion of the Canal lining projects, CVWD expects its conveyance losses to drop from a current average of 46,000 acre-ft/yr to 15,000 acre-ft/yr. Figure 7-B presents the build-up curve for Colorado River water to CVWD under the Quantification Settlement Agreement. This build-up curve will impact the timing of the various projects to be implemented under the Water Management Plan. The term of the Quantification Settlement Agreement is 75 years.

Table 7-3
CVWD Colorado River Deliveries Under Quantification Settlement

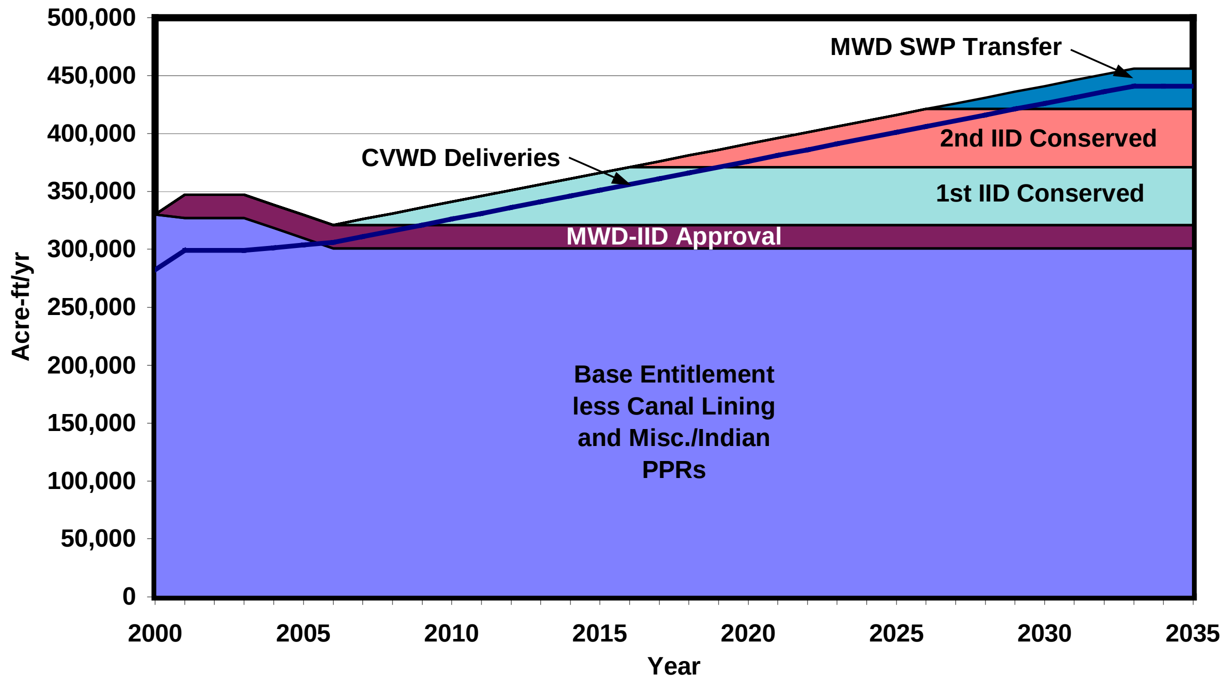
Component	Amount – acre-ft/yr
Base Allotment	330,000
1988 MWD/IID Approval Agreement	20,000
Coachella Canal Lining (to Metropolitan)	-26,000
To Miscellaneous/Indian PPRs	-3,000
IID/CVWD First Transfer	50,000
IID/CVWD Second Transfer	50,000
Metropolitan SWP Transfer	35,000
Total Diversion at Imperial Dam	456,000
Less Conveyance Losses[1]	-15,000
Total Deliveries to CVWD	441,000

1 Assumed losses after completion of canal lining projects.

The preferred alternative includes delivery of 441,000 acre-ft/yr of Canal water by 2033 and remaining at that level until 2035. Approximately 361,000 acre-ft/yr of this amount will be supplied directly to existing and future users in the Valley. Of this amount, about 83,000 acre-ft/yr will replace groundwater pumping (source substitution). The remaining 80,000 acre-ft/yr will be used for groundwater recharge. The Quantification Settlement Agreement provides the mechanism for obtaining the additional Colorado River supply needed to implement the Water Management Plan. The projects required to use Canal water are discussed later in this section.

Although the Water Management Plan has been designed to coincide with the terms of the Quantification Settlement Agreement, CVWD intends to proceed with the Plan regardless of the outcome of quantification. If the Quantification Settlement Agreement is not executed, CVWD would seek other sources of water to eliminate overdraft. Since the District would be constrained by the existing Colorado River allocations, its use of Colorado River water would be within the 3.85 million acre-ft/yr allocation to the first three priorities. The District would attempt to obtain some or all of the water required through transfer of conserved water from IID.

Figure 7-B
Build-up for CVWD Colorado River Water



SWP Exchange Water

CVWD and DWA currently have contracts with the State of California for a combined entitlement of 61,200 acre-ft/yr of SWP water. Reliability studies performed by DWR indicate this SWP entitlement can provide an average supply of about 50,000 acre-ft/yr. In 1996, CVWD and DWA recognized the need for additional imported water in order to eliminate groundwater overdraft. Since then, the two districts have purchased additional Pool A, Pool B, and interruptible water from the SWP resulting in average purchases of 142,000 acre-ft/yr. These additional supplies are not expected to be available in the future and cannot be relied upon to provide a reliable long-term source of water to the Coachella Valley.

The preferred alternative identifies the need for average deliveries of 140,000 acre-ft/yr of SWP exchange water; 103,000 acre-ft/yr for recharge at the Whitewater Spreading facility and 37,000 acre-ft/yr for direct use on mid-Valley golf courses. Assuming average deliveries of 80 percent of entitlement, CVWD and DWA need to obtain firm combined SWP entitlements of approximately 175,000 acre-ft/yr. To the extent possible, additional long-term entitlements would be obtained from other SWP contractors. If adequate long-term entitlements cannot be obtained, surplus SWP water will continue to be purchased on a year-to-year basis as needed and as available.

SWP exchange water obtained from Metropolitan under the Quantification Settlement Agreement will be delivered via the Coachella Canal for agricultural irrigation purposes in the Lower Valley.

Recycled Water

Treated Municipal Effluent. There are seven municipal wastewater treatment plants located in the Coachella Valley. The cities of Coachella and Palm Springs and the Valley Sanitary District (VSD) operate one water reclamation plant (WRP) each. CVWD operated four water reclamation plants designated WRP-4, WRP-7, WRP-9 and WRP-10. Water is recycled from each plant except for the Coachella, VSD and WRP-4 facilities, which discharge treated effluent to the CVSC. The other facilities discharge to percolation ponds when the demand for recycled water is low. Use of recycled water is assumed to increase by about 14,000 acre-ft/yr in the absence of the Water Management Plan as growth occurs in the Valley.

The use of municipal recycled water will increase an additional 16,000 acre-ft/yr compared to No Project conditions. The proposed uses for municipal recycled water are discussed in the following section.

Desalinated Agricultural Drain Water. Up to 11,000 acre-ft/yr of agricultural drain flows will be desalted to a quality equivalent to Canal water and delivered to local farmers for agricultural irrigation. Approximately 13.6 mgd of drain water would be diverted and filtered prior to desalination. The desalination facility would have a 10-mgd capacity that will produce about 7.5-mgd of product water. Approximately 3.5 mgd of the flow would be bypassed and blended with the product water to produce the desired quality. Delivery of this water would begin at a rate of about 4,000 acre-ft/yr and reaches 11,000 acre-ft/yr in approximately fifteen years. The preferred alternative does not identify specific users for this water since the product water would be delivered to the District’s Canal water distribution system at the 97.1 Lateral, where the downstream demand is for agricultural irrigation. Since this water is non-federal, it is not subject to the contractual restrictions regarding use of Canal water within the ID-1 service area. The District anticipates that an equal amount of Canal water can be delivered to golf courses or the portion of the Oasis system outside ID-1. Preliminary discussion with USBR officials indicated that such an exchange of water might be feasible. No specific location for the plant has been identified.

The treatment process would produce about 2.6 mgd of filter backwash and brine waste. Preliminary studies have considered both on-site and off-site evaporation ponds for brine disposal. On-site evaporation ponds would require about 530 acres of surface area due to the relatively low TDS of the brine. Alternatively, the brine could be conveyed to the Salton Sea either in the CVSC or a parallel brine outfall. Evaporation ponds located near the sea could remove an equivalent amount of salt by evaporating Salton Sea water. Approximately 110 acres of ponds would be required in this case. Decisions on the method of brine disposal will be addressed as project implementation proceeds.

Source Substitution

Source substitution is the delivery of an alternate source of water to users currently pumping groundwater. This approach is frequently referred to as *in-lieu* delivery where other water sources are delivered in place (or *in-lieu*) of groundwater use. The substitution of an alternate water source reduces groundwater extraction and allows the groundwater to remain in storage, thus reducing overdraft. Alternative sources of water include: municipal recycled water from WRP-7, WRP-9, WRP-4 or the City of Palm Springs Wastewater Treatment Plant; Canal water, desalinated agricultural drain water, or SWP Exchange water delivered through the Coachella Canal.

Source substitution projects under the preferred alternative includes the following:

- Conversion of existing and future golf courses in the Lower Valley from groundwater to Canal water,
- Conversion of existing and future golf courses in the Upper Valley from groundwater to recycled water,
- Conversion of existing and future golf courses in the Upper Valley from groundwater to Canal via SWP Exchange water,
- Conversion of agricultural irrigation from groundwater to Canal water, primarily in the Oasis area, and
- Conversion of municipal use from groundwater to treated Canal water in ID-1.

Specific details on each of these projects are presented below. Because the timing for the various projects is dependent on the available water supplies and the economics of the various projects, the implementation schedules presented are generalized.

Conversion of Lower Valley Golf Courses

Canal water use will be expanded to serve additional golf courses within ID-1. Existing golf courses within ID-1 that use groundwater will be supplied with Canal water. The District will develop a program to convert existing courses from groundwater to Canal water. Many of the existing golf courses within ID-1 have Canal water connections but are not making full use of the water. The District will also work with the courses currently using both groundwater and Canal water to maximize their Canal water use. Because of the availability of desalinated agricultural drainage water, the preferred alternative may also include conversion of Lower Valley golf courses that are located outside ID-1.

The facilities required to serve golf courses located inside ID-1 are generally expected to be minimal as the Canal water distribution system is currently in place. Some new pipelines and pumping facilities may be required to convey desalinated agricultural drainage water that is exchanged for Canal water to courses located outside ID-1. Conversion of golf courses is expected to reduce groundwater pumping by about 14,000 acre-ft/yr by 2035.

Upper Valley Golf Course Conversion to Recycled Water

Water from wastewater treatment plants in the Upper Valley is currently either recycled for golf courses or municipal irrigation or disposed by percolation/evaporation ponds located at each facility. Use of nitrogen-rich recycled water for irrigation lowers the amount of inorganic fertilizers needed on golf courses and other landscaped areas, thus reducing the nitrogen loading on the entire basin. One difficulty in recycling sewage effluent for irrigation purposes involves fluctuations in supply and demand. Flows to Valley treatment plants are generally higher in the winter months when irrigation demands are at their lowest, and flows are conversely lower when demand is highest.

In the Upper Valley, recycled water use for golf course and park irrigation will be expanded in areas adjacent to treatment plants where it is most cost-effective. The preferred alternative anticipates about 8,000 acre-ft/yr more recycled water use than the No Project conditions. The facilities required to expand the recycled water systems are expected to include pipelines and pump stations.

Conversion of Upper Valley Golf Courses to SWP Exchange Water

There are a number of golf courses in the Rancho Mirage-Palm Desert-Indian Wells area that pump groundwater for irrigation. This area has experienced a steady decline in groundwater levels over the past 50 years or more. Recent information indicates that there is an increased risk of land subsidence if water levels continue to decline. Therefore, conversion of the golf courses in this area to imported or recycled water is a high priority for the District.

Since this area is outside the ID-1 service area, it is not eligible for Canal water delivery. However, the District could redirect a portion of its SWP entitlement to this area. Conveyance options include the construction of over 20 miles of pipelines from the Whitewater turnouts, over 12 miles of pipelines from the Metropolitan aqueduct at Fan Canyon (east of Dillon Road) or by taking delivery through the Coachella Canal. The latter option would be similar to the proposed conveyance of desalinated Whitewater River water in the Canal delivery system. The Coachella Canal conveyance option was chosen as it involves the least amount of conveyance facilities to bring imported water to the Rancho Mirage-Palm Desert-Indian Wells area.

This project will require construction of over 30 miles of pipelines, two major pumping stations and delivery connections to each course. The project to convert the Upper Valley golf courses is expected to be implemented in phases beginning in the late 2000s and finishing in the mid 2010s. A total of 37,000 acre-ft/yr of groundwater pumping would be eliminated by this project.

Conversion of Existing Lower Valley Agriculture

Agricultural users of groundwater within the ID-1 service area will also be converted to Canal water. The Plan anticipates converting most of the groundwater pumping within the currently served portion of ID-1 to Canal water by the mid-2010s. Because most of these users have connections to the District's Canal water distribution system, these conversions will require minimal infrastructure modifications.

Agricultural users located in the unserved area of ID-1 other than the Oasis area are also proposed to convert from groundwater to Canal water in the late-2020s. Since these users do not currently have connections to the distribution system, some new conveyance facilities will be required. The extent of these new facilities will be determined prior to any project-specific environmental documentation. Delivery of Canal water to agricultural users within ID-1 is expected to decrease future (2035) groundwater pumping by 30,000 acre-ft/yr.

Oasis Area Agricultural Conversion

The Oasis area is located near the northwest shore of the Salton Sea extending westerly up the alluvial fans. The westerly portions of the Oasis area are eligible to receive Canal water but lack a distribution system to convey water to the area farms. Other portions of the Oasis area are outside the ID-1 boundary and are ineligible for Canal water service. The Oasis area annually accounts for approximately 27,000 acre-ft/yr of demand, of which about 21,000 acre-ft/yr of groundwater is used within ID-1 (Summers Engineering, 1996). The Plan proposes the extension of the Canal water distribution system to serve all acreage in the Oasis area. Studies conducted for CVWD indicate this project could supply Canal water to about 6,700 acres of land located within ID-1 and about 2,200 acres outside ID-1 (Summers Engineering, 1996). The Oasis Conversion Project involves construction of over 20 miles of pipelines, two pumping stations, two small regulating reservoirs and miscellaneous facilities to convey Canal water to this area from the vicinity of the 97.1 Lateral.

Since portions of the Oasis area are outside ID-1, only non-federal water could be served to these users. CVWD proposes to develop agricultural drainage water for this use. The District would track the amount of desalinated agricultural drainage water conveyed in the system and serve a like amount to users outside ID-1. Facilities to serve water to this portion of the Oasis area are expected to include two pumping stations, about six miles of pipeline and other appurtenant facilities.

The ID-1 portion of the Oasis area is expected to convert to Canal water by the mid-2020s. The portion of the Oasis area outside ID-1 will be completed in the late-2020s. Because detailed engineering studies have not been conducted, separate environmental documents will be prepared for this project prior to its implementation.

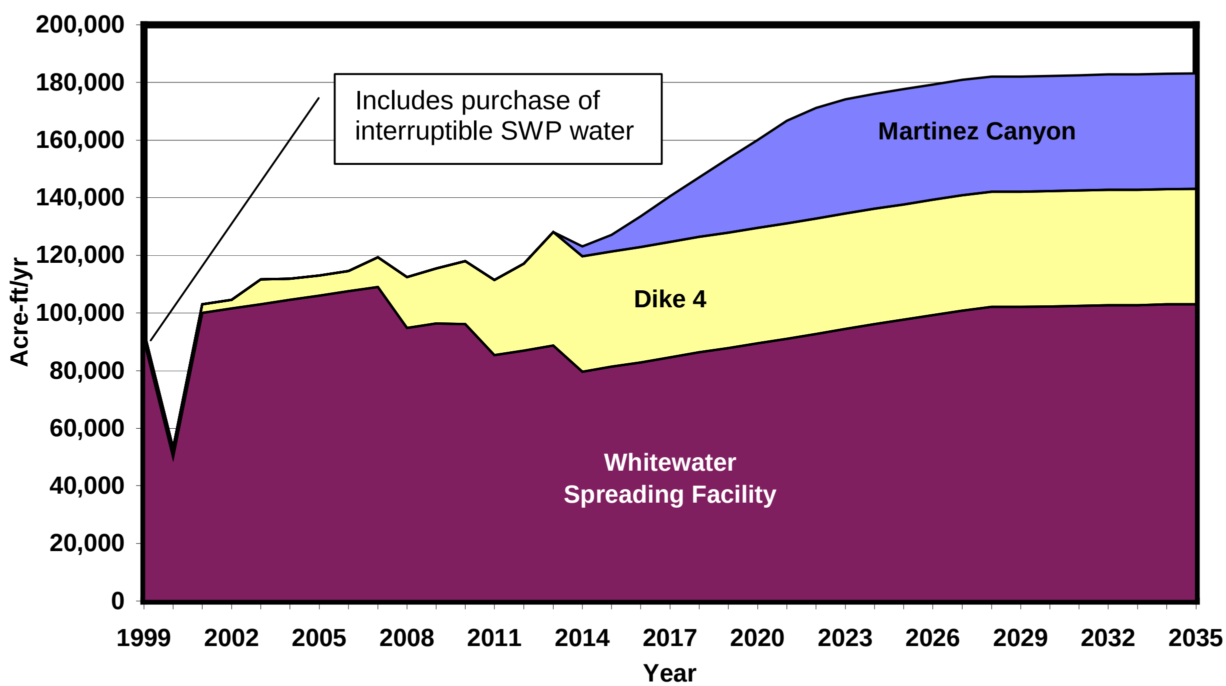
Conversion of Municipal Use to Canal Water

Approximately 30 percent of the municipal demand in the Lower Valley would receive Canal water. The facilities required for this conversion would include the construction of one or more potable water treatment plants having a total capacity of at least 30 mgd. Other facilities would include pipelines to convey water from the Canal to the filtration plants, pipelines, pumping stations and reservoirs to deliver water from the filtration plants to the existing municipal water systems. Total municipal usage of treated Canal water is estimated to be about 32,000 acre-ft/yr. These facilities are projected to be phased in during the late 2020s and early 2030s.

Groundwater Recharge

Groundwater recharge is a critical tool for modern water management. Groundwater recharge involves the infiltration of local or imported water into the groundwater aquifer through recharge basins. CVWD and DWA have been recharging the Upper Valley aquifers using SWP Exchange water at the Whitewater River Spreading Facility since 1973. Imported water will continue to be spread at the Whitewater facility using the existing recharge basins. In addition, new recharge facilities will be constructed in the Lower Valley. Figure 7-C presents the projected amount of water used for groundwater recharge through 2035. It should be noted that recharge for the year 2000 assumes delivery of SWP exchange water equal to the long-term average of 50,000 acre-ft/yr. Overall, groundwater recharge will increase by approximately 90,000 acre-ft/yr above 1999 levels.

Figure 7-C
Groundwater Recharge Flows under Preferred Alternative



Whitewater Spreading Facility

CVWD and DWA would recharge an average of 103,000 acre-ft/yr of SWP water at the Whitewater Spreading Facility. As with the current operation, the SWP water would be exchanged for Colorado River water with Metropolitan. No capital improvements would be required at the Whitewater facility.

Dike No. 4 Recharge

Although it may be possible to recharge in the range of 30,000 to 60,000 acre-ft/yr of Canal water at the Dike No. 4 recharge location, the Plan assumes an average recharge rate of approximately 40,000 acre-ft/yr. The Dike No. 4 recharge facility would be constructed within three to four years. The facility would include approximately 240 acres of recharge ponds along with a pumping station and over two miles of pipeline to convey water from Lake Cahuilla to the site. This recharge project will be subjected to separate environmental review when the project is more thoroughly defined.

Martinez Canyon Recharge

CVWD has evaluated other potential recharge sites in the Lower Valley including the Martinez Canyon area along the western margin the Valley. The Martinez Canyon recharge facility is expected to be operational by the mid-2010s and would be at full capacity by the mid-2020s. The basins could be constructed in phases to match the availability of Canal water. An average recharge rate of approximately 40,000 acre-ft/yr is assumed. The facility is expected to include approximately 240 acres of recharge basins, a pumping station and about three miles of pipeline to convey water from the Oasis Tower to the site. This recharge project will be subjected to separate environmental review when the project is more thoroughly defined. The District plans to conduct a demonstration recharge study to determine the feasibility of a large-scale facility.

Groundwater Monitoring Program

As the Plan is implemented, the District's ongoing groundwater monitoring program will play an integral roll in the District's understanding of the basin's response to different plan elements. The effectiveness of the Plan will be measured against its impacts on groundwater levels, water quality and subsidence potential. Data collected through the monitoring program will enable future updates to the plan to accurately assess individual plan elements and their effectiveness in meeting the goals of the Plan.

The monitoring program will include:

- monitoring of groundwater levels and water quality in the Valley,
- monitoring of potential saltwater intrusion from the Salton Sea including construction of additional multi-level piezometer wells,
- the CVWD/USGS land subsidence monitoring program in the Valley, and

- review of the monitoring data and incorporation of new information into the groundwater model to enhance the usefulness of the model in predicting trends and impacts of management actions.

A thorough monitoring program is essential to the success of the Water Management Plan.

COOPERATIVE AGREEMENTS WITH OTHER AGENCIES

The District, DWA, and Metropolitan have historically worked together on programs which are mutually beneficial to all three agencies. The exchange program at the Whitewater Spreading Facility and the advance delivery program are two such examples. Several other programs, which would provide benefits to both the Coachella Valley and to Metropolitan, are currently being studied. These programs are designed to provide the Coachella Valley with a firm long-term water supply and to provide Metropolitan with the dry-year supplies needed to serve its member agencies.

CVWD and DWA are currently negotiating the transfer of 100,000 acre-ft/yr of SWP entitlement from Metropolitan. As proposed, Metropolitan would permanently transfer 100,000 acre-ft/yr of its SWP entitlements to DWA and the District. In years when SWP supplies are less than full entitlements or Colorado River supplies are reduced, Metropolitan will have the ability to buy back some or all of the transferred water in any given year. It is envisioned that within any given period, CVWD and DWA would take the water roughly half the time resulting in a long-term average of an additional 50,000 acre-ft/yr for the Valley. If this entitlement transfer is completed, CVWD would need to obtain additional entitlements of about 50,000 acre-ft/yr to meet remaining needs. The water obtained from these proposed transfers would be exchanged with Metropolitan for Colorado River water delivered either to the Whitewater River turnouts or to the All-American Canal at Imperial Dam.

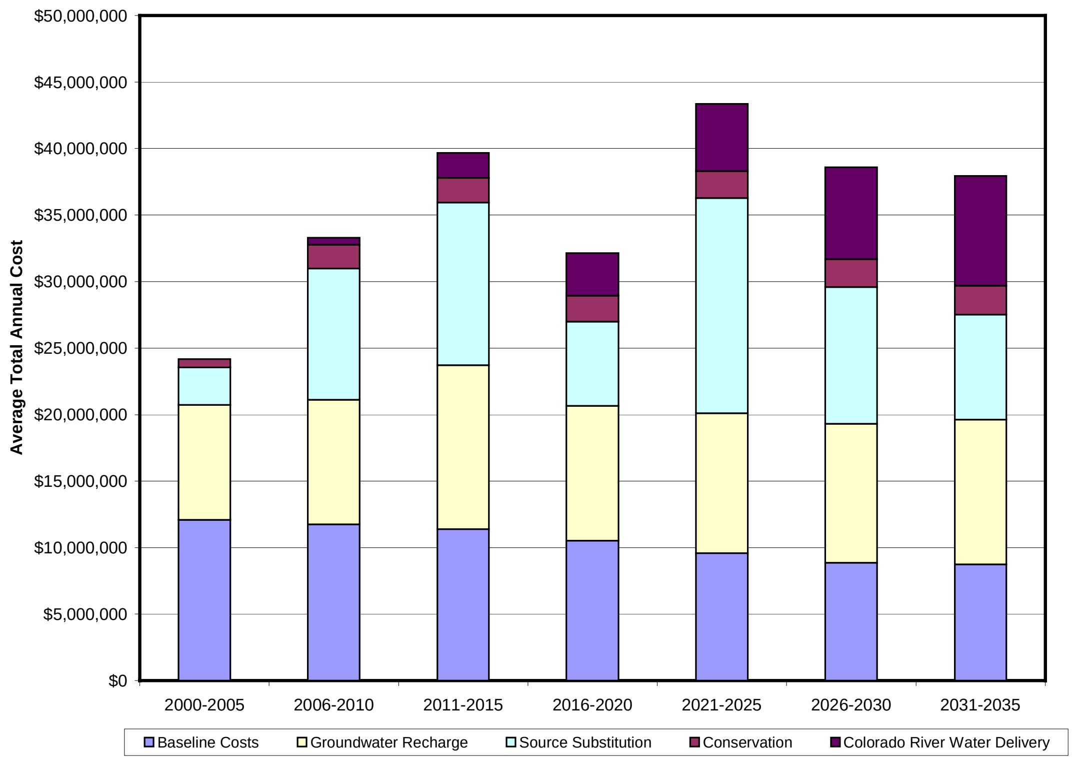
The District and Metropolitan are also studying the potential of implementing a conjunctive use program in the Coachella Valley. Metropolitan currently has water available for storage and the Coachella Valley has a groundwater basin capable of storing surplus water. A successful conjunctive use program must be able to store water when available, either through direct recharge or in-lieu use, and to recover the stored water effectively during drought periods. Metropolitan would benefit from the program by increasing its dry-year water supply and the Coachella Valley would benefit from Metropolitan financed facilities, higher water levels, and from portions of the stored water being transferred into CVWD ownership.

IMPLEMENTATION COSTS

Each management category-conservation, groundwater recharge, and source substitution—will have specific implementation costs in addition to the baseline costs associated with the No Project alternative. The baseline costs include existing water conservation activities, existing delivery of recycled water to Upper Valley golf courses, and the continued purchase of existing SWP entitlements for Upper Valley groundwater recharge. In order to spread these implementation costs over the entire planning period, assumptions were made regarding the initiation of certain management elements within each category. Conservation activities primarily involve costs associated with additional manpower, which are included as an operation and maintenance (O&M) cost. The costs associated with groundwater recharge and source substitution activities include both capital and O&M costs.

The average annual implementation costs for the preferred alternative throughout the planning period are illustrated in Figure 7-D. The total capital cost associated with groundwater recharge and source substitution elements in the preferred alternative is estimated at $180 million. The average annual costs for each category include capital costs, depreciation of the capital investment over time, and O&M costs (fixed and variable).

Figure 7-D
Estimated Total Annual Implementation Cost for Preferred Alternative



FINANCING MECHANISMS

Several financing mechanisms are available to provide funding for the Plan including:

- Water rates,
- Replenishment assessments,
- Assessment districts,
- General property taxes,
- Financing by agencies outside the District,
- Grants, and

- Developer fees.

Each of these funding mechanisms is discussed below.

Water Rates

Both municipal and agricultural customers are charged for the use of water based on the District's rate structure. Municipal customers of the District pay $0.61 to $1.10 per 100 cubic feet of water used to cover the O&M costs of the water system. Municipalities providing domestic water in the Coachella Valley charge similar fees for urban use. Normally, capital costs (construction cost for wells, pipelines, treatment plants, distribution systems, pumping plants, etc.) associated with growth are paid for through developer's fees, water rate revenues, etc. Agricultural users of Canal water are charged $15 to $20 per acre-foot of water used to cover the O&M costs associated with the distribution of irrigation water.

Replenishment Assessments

DWA and CVWD currently charge a replenishment assessment to groundwater pumpers in the Upper Valley. The replenishment assessment, which is charged on an per-acre-foot pumped basis, pays for a portion of the cost of SWP water that is exchanged for delivery of Colorado River water with Metropolitan. Both DWA and CVWD pay major portions of their respective replenishment assessments. DWA currently pays for approximately $1.3 million of its $1.5 million assessment program while CVWD pays for approximately $3.6 million of its $6.5 million program.

A replenishment assessment may be levied only on pumpers in an area benefiting from the replenishment activities. In the future, as the existing exchange continues and additional SWP entitlements are exchanged with Metropolitan and delivered to the Upper Valley, it is likely that the existing replenishment assessment will continue to be an important financial mechanism in ensuring adequate supplies of water for the Upper Valley.

In order to establish a replenishment assessment in the Lower Valley, benefits of replenishment activities, such as groundwater recharge at Dike No. 4 or other facilities, would have to be demonstrated. Other activities included in the preferred alternative that benefit groundwater pumpers could also be financed through a replenishment assessment, including the cost of treatment and distribution of reclaimed water for recharge or direct use in-lieu of groundwater and the cost of programs providing incentives to use reclaimed water or Colorado River water in-lieu of groundwater. Following preparation of a report that defines the area of benefit and the assessment amount, a replenishment assessment could be established.

Assessment Districts

Local assessment districts could be established to pay for capital costs associated with specific projects. An example would be construction of the Oasis area distribution system. In the Oasis area, construction costs would be incurred to extend the existing Canal water system to irrigators. This could include pipelines, pumping stations, reservoirs, etc. All or part of the construction costs could be amortized over some period of time and bonded. The Oasis area is a potential candidate because there is an identified project that benefits a specific area. Other projects that may be identified in the future, that also benefit specific areas, may also be financed through the use of assessment districts.

General Property Taxes

The District receives an increment of the county's general property tax revenues which are used for any number of District related activities. The District levies an additional property tax increment to cover bonded indebtedness, which pays for portions of the District's SWP obligation. Additional general property taxes for purposes other than the District's SWP obligation cannot be authorized.

Funding by Agencies Outside the District

With its large groundwater basin, the Coachella Valley is in a position to store surface water for later use. This "conjunctive use" of groundwater and available surface supplies provides an opportunity for the Coachella Valley to participate with other major water users in southern California in joint activities that may be mutually beneficial. The District staff is currently exploring several types of mutually beneficial joint funding options. Currently none have reached fruition, but they will be explored as a means of providing funding for various elements of the Plan.

Grants

Within the last four years, California voters have approved historic levels of general obligation bond financing for water-related programs for improving California water supply reliability and water quality and for restoring watershed ecosystems. This support extends to implementation of measures contained in the Coachella Valley Water Management Plan.

In 1996, voters approved the $995 million Proposition 204 -- the Safe, Clean, Reliable Water Supply Act. In 2000, the voters approved Propositions 12 and 13 – the $2.1 billion Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Act and the $1.97 billion Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act.

Proposition 204 funds actions such as ecosystem restoration, clean water and water recycling programs, drainage water management programs, and water conservation and groundwater recharge programs. In particular, it includes:

- a $60 million low-interest loan program for local agency water recycling projects,
- a $27.5 million low-interest loan program for local agency construction of agricultural drainage water management units (drainage management units at the Salton Sea are specially identified as eligible projects),
- a $25 million low-interest loan program for local agency water conservation and groundwater recharge programs, and

- a $25 million loan and grant program for feasibility studies and implementation of projects that develop new water supplies, such as conveyance, groundwater extraction, or diversion facilities.

Proposition 12 funds watershed and riparian corridor improvements, wetlands habitat development, land acquisition for restoration and habitat, and agricultural land stewardship programs. An $82.5 million program was explicitly authorized to provide a state match for projects developed pursuant to the federal Salton Sea Reclamation Act of 1998. In addition, $5 million was specified for environmental restoration projects approved pursuant to the Salton Sea Reclamation Act and the final EIS for the Salton Sea restoration project.

With respect to wildlife habitat programs, Proposition 12 provides $5 million for acquisition/development of wetlands outside of the San Joaquin Valley, $10 million for acquisition of riparian habitat and watershed conservation, $40 million for acquisition/restoration of habitat supporting threatened/endangered species, and $100 million for acquisition of lands covered by Natural Community Conservation Plans (subject to legislative approval). These habitat acquisition programs could contribute to the Lower Colorado River Multi-Species Conservation Program.

Proposition 13 funds a variety of loan and grant programs and other activities. This includes:

- a $35 million low-interest loan (construction) and grant (feasibility studies) agricultural water conservation program for local agencies,
- a $30 million low-interest loan (implementation) and grant (feasibility studies) urban water conservation program for local agencies,
- a $30 million low-interest loan and grant groundwater recharge facilities program for local agencies,
- a $200 million grant program for feasibility studies and design and construction for local agency conjunctive use programs,
- a $180 million loan and grant program for interim water supply/water quality infrastructure projects located in the Delta export service area that could be completed by March 2009 (eligible project types include groundwater storage, water transfers, agricultural water conservation and drainage management- projects must be approved by the Governor),
- a $40 million loan and grant program for local agency water recycling projects with 60 percent of the funding reserved for specified southern California counties (half of the funding is reserved for grants for construction of projects meeting specified conditions including reducing Colorado River water demands), and
- a $235 million grant program for specified project types in the Santa Ana River watershed (eligible projects include groundwater banking, water conservation, and treatment of brackish or contaminated groundwater).

Developer Fees

New development, within areas served by the District, pays a development fee called the Water System Backup Facilities Charge (WSBFC). The WSBFC, assessed on all new development and redevelopment, was originally established in 1978 to provide a funding mechanism to cover the incremental costs for construction of backup facilities (pipelines, wells, booster stations, reservoirs, treatment facilities, etc,) associated with a particular development. In 1991, the charge was revised to include a component to cover the purchase of imported water to ensure an adequate long-term supply of water is available for each development.

As programs are developed and costs are established, Water Management Plan costs associated with providing water to and acquiring imported water for new development will likely be passed on, through the WSBFC, to new development.

Financing of the Preferred Alternative

It is not possible to predict the specific financing mechanisms that will be applied to each of the elements of the preferred alternative. Funding will likely be through a combination of mechanisms that best meet the needs of the Valley water users. Public input regarding financing options will be sought as specific items are proposed or constructed.

Effects on Water User Groups

Until such time as specific financing mechanisms are determined, it is not possible to determine the exact economic impact on different types of user groups. Table 7-4 shows the possible economic effects on several different types of user groups within the Coachella Valley.

Table 7-4
Potential Economic Effects on Water User Groups

Water User Group	Range of Effects
Domestic Water Users(District Wide)	$0.05 to $0.20 per hundred cubic feet
Canal Water Users(Lower Valley only)	$0 to $5 per acre foot
Lower Valley Groundwater Users	$10 to $40 per acre foot
Upper Valley Groundwater Users	$0 to $25 per acre foot
Property Owners	$0 to $0.02 per $100 taxable value
Developer Fees	$0 to $2,000 per unit

CONCLUSIONS

The Coachella Valley Water Management Plan’s goal is to assure adequate quantities of safe, high-quality water at the lowest cost to District water users. If the Plan is to succeed, it must be a living document that is flexible and can be adapted to meet the changing needs of the Coachella Valley. As management elements are set in place, and results of implementation strategies are quantified, the Plan will be periodically evaluated to determine how well it is meeting the needs of the Valley, to consider new information and opportunities, and if needed to make appropriate adjustments. Along with the Plan, a Programmatic Environmental Impact Report has been prepared that fully discusses the social, economic, and environmental impacts of the preferred alternative.

The next step is a public review of the Plan. Public forums and workshops will invite input from the general public, taxpayers, water users, local governments, tribal interests, federal and state agencies, and other Colorado River water users. Public review may result in modifications to the proposed preferred alternative. It is anticipated that the Plan will be recommended to the District Board of Directors for adoption near the end of 2000.

Actions needed to ensure that the preferred alternative meets the objectives of the Plan require commitment, consensus, and cooperation from all water users in the Valley. The success of past water management efforts, coupled with implementation of the recommendations in the Coachella Valley Water Management Plan, will allow the Coachella Valley to sustain its vibrant economy and move into the new century with a reliable, affordable, and stable water supply.

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Appendix A
References

ASCE, 1987. *Groundwater Management*. 3rd Edition. ASCE Manuals and Reports on Engineering Practice Number 40. 263 pp.

BBC, 2000. Preliminary Economic and Financial Evaluation of Water Management Plan Alternatives BBC Research and Consulting. Denver, Colorado. 29 pp.

Colorado River Board of California, 2000. California's Colorado River Water Use Plan – Draft, June 2, 2000. 156 pp.

CUWCC, 1998. Memorandum of Understanding Regarding Urban Water Conservation California Urban Water Conservation Council.

CVWD, 1999. Annual Review 1999. Coachella Valley Water District. 25 pp.

CVWD, 1997. Coachella Valley Water District Engineers Report on Water Supply and Replenishment Assessment, 1997-1998. 56 pp.

Department of Water Resources, 1964. Coachella Valley Investigation, Bulletin No. 108. California Department of Water Resources. 145 pp.

Department of Water Resources, 1993. Bulletin 160-93. California Department of Water Resources.

Department of Water Resources, 1979. Coachella Valley Area Well Standards Investigation California Department of Water Resources. 40 pp.

Desert Sun, 1996. "Greens get green light in golf course boom" by Steve DiMeglio. *The Desert Sun* , January 21, 1996.

Ikehara, M. E., S. K. Predmore, and D. J. Swope, 1997. Geodetic Network to Evaluate Historical Elevation Changes and to Monitor Land Subsidence in Lower Coachella Valley, California. U.S. Geological Survey Water Resources Investigations Report 97-4237. Map.

Lord, J. M., 1996. Unpublished data.

Larson, S., J. Mercer, and I. Remson, Coachella Valley Groundwater Model Peer Review Report. Prepared for Redwine and Sherrill. Riverside, California. September 18, 1998. 19 pp.

Montgomery Watson, 2000. Draft Program Environmental Impact Report. Prepared for the Coachella Valley Water District.

Pillsbury, A. F., 1941. Observations on Use of Irrigation Water in Coachella Valley, California. Bulletin 649. University of California Berkeley.

Reichard, E. G. and J. K. Meadows, 1992. Evaluation of a groundwater flow and transport model of the Upper Coachella Valley, California. U.S. Geological Survey Water Resources Investigations Report 91-4142. 101 pp.

SCAG/CVAG, 1998. Coachella Valley Population, Household, and Employment Projections by Census Tract. Coachella Valley Association of Governments.

Swain, L. A., 1978. Predicted water level and water quality effects of artificial recharge in the Upper Coachella Valley, California, using a finite-element digital model. U.S. Geological Survey Water Resources Investigations Report 77-29. 54 pp.

Todd, D. K., 1980. Groundwater Hydrology. 2nd Edition. John Wiley and Sons. New York, New York.

Tyley, S. J., 1974. Analog model study of the groundwater basin of the Upper Coachella Valley, California. U.S. Geological Survey Water Supply Paper 2027. 77 pp.

University of California at Riverside, 1998. Movement of Nitrogen Fertilizer in a Turfgrass System. California Turfgrass Culture. Volume 48, Nos. 1 & 2. Cooperative Extension, University of California at Riverside. 4 pp.

Appendix B
Formulation of Alternatives

The purpose of Appendix B is to document the process used to develop the alternatives for the Water Management Plan. The appendix describes the approach followed in the alternatives development process, the management elements considered for inclusion in potential alternatives, the screening of the elements, formulation of conceptual alternatives from combinations of elements, and the evaluation of the conceptual alternatives with the goal of selecting a final list of alternatives for detailed evaluation. The final alternative plans are presented in Section 5 and evaluated in Section 6 of this Water Management Plan.

APPROACH TO ALTERNATIVES DEVELOPMENT

The process of developing and evaluating alternatives involves six steps, which are presented graphically in **Figure B-1**. These six steps were used to gradually condense the many potential management elements into alternatives and to narrow the range of potential alternatives that will be considered in the Water Management Plan. The remainder of the discussion in this document describes each step and the outcome of the evaluations involved in each step.

Step 1 – Define Management Objectives

A water management plan must be designed to meet a specific set of objectives. These objectives are discussed in more detail in the Water Management Plan text. The following management objectives were used in developing the water management plan for the Coachella Valley:

1. Eliminate Overdraft and Associated Adverse Impacts

2. Maximize Future Conjunctive Use Opportunities

3. Minimize Economic Impact to Coachella Valley Water Users

4. Minimize Environmental Impacts

Step 2 – Define Management Elements

CVWD staff and its consultants conducted several brainstorming sessions to identify possible groundwater management elements. These management elements were generally organized according to the following categories:

- Elements that change the water use pattern of individual water user groups

- Elements that increase the overall water supply

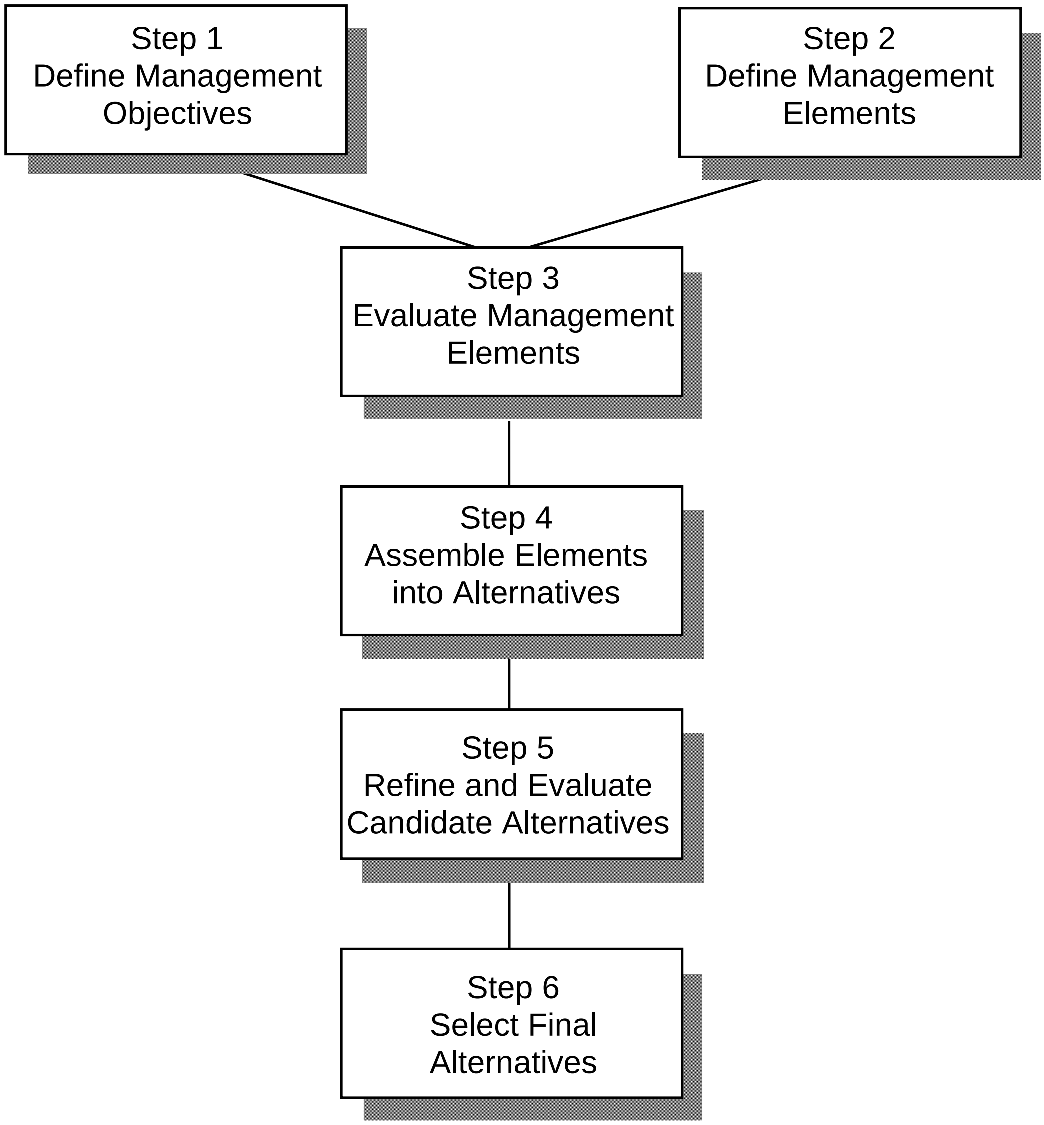


Figure B-1
Alternatives Development Process

Elements that change the water use patterns of individual water user groups can include many possible activities including demand management and adjudication. Demand management activities result in lower demands for water and include such elements as changes in irrigation methods, penalties for excessive water use, crop land fallowing, public education, and landscaping restrictions. Adjudication involves the adoption of legal restrictions on the amount of groundwater that can be pumped.

Elements that increase the overall water supply include source substitution and groundwater recharge projects. Source substitution activities involve changing the current source of water for a particular use to another more abundant source. Source substitution may include supplying municipal wastewater, Coachella Canal water, SWP water, drain water or other local water sources to users instead of their current groundwater supply. Groundwater recharge projects could use SWP water, additional Colorado river water from the Coachella Canal, desalted water from the Salton Sea or the Gulf of California, recovery of additional runoff, and/or use of municipal wastewater. Other potential elements may include water transfers and exchanges.

It is likely that no single element is capable of eliminating the overdraft. Consequently, a combination of elements may be needed. The challenge is to identify the more viable elements that could be combined into alternatives.

Step 3 – Evaluate Management Elements

In Step 2, a wide range of potential elements is produced for implementing groundwater management in the Coachella Valley. Step 3 involved screening the elements based on the following criteria:

- Does the option address one or more of the management objectives?
- Is the option technically supportable?
- Does the option have any significant unavoidable adverse environmental impacts?
- Will the option help reduce the overdraft at a reasonable cost?
- Is the option consistent with existing laws and regulations and does it have reasonable permitting requirements?
- Is the option distinct from the other elements being considered?

This evaluation ranked the elements according to their relative preference using the same criteria identified above. A numerical ranking for each criterion was used with "1" being the least preferable and "5" being the most preferable.

Step 4 – Assemble Elements into Conceptual Alternatives

There are many potential ways to combine elements into alternatives. The primary rationale used in this step is to combine elements that have similar purposes into alternatives. The general basis for these alternatives is the following categories:

- Demand Management
- Pumping Restrictions
- Source Substitution
- Groundwater Recharge
- Combinations

Alternatives in the demand management category would emphasize measures to reduce water demands by users. Similarly, alternatives that emphasize source substitution would primarily include elements that replace groundwater production with other sources.

Combination alternatives include elements from more than one category. Based on the four main categories listed above, there are six potential combinations of any two categories. For example, adjudication could be combined with source substitution or groundwater recharge to meet the management objectives. There are four unique combinations of three or more categories that could become alternatives. Such an alternative could emphasize source substitution while including demand reduction and source augmentation to lesser degrees.

Step 5 –Evaluate Conceptual Alternatives

In Step 5, the alternatives generated in Step 4 are evaluated to identify those alternatives that best meet the management objectives. The evaluation of candidate alternatives will be performed by comparing each alternative against the management plan objectives and determining whether the alternative could reasonably by expected to meet the objectives.

Screening of alternatives was performed in this step to verify ability to meet the objectives. Only those alternatives that can meet the management objectives were considered in subsequent steps.

Step 6 – Select Final Set of Alternatives

The selection of a final set of alternatives was based on the outcome of Step 5. The final set of alternatives should have no fatal flaws and should meet most of the management objectives. These alternatives plus a no action (no project) alternative were evaluated in the Water Management Plan and the PEIR.

WATER MANAGEMENT ELEMENTS

The following is a description of the elements identified along with a brief assessment of each option. Elements are categorized as follows:

A. Pumping Restrictions

B. Demand Management

C. Local Water Sources

D. Imported Water Sources

E. Water Management Actions

F. Water Quality Approaches

The first two categories are management elements that change water use patterns while the next three include elements that increase overall supply as discussed previously in Step 2. The final category includes water quality approaches that may be needed in conjunction with other elements.

A. Pumping Restrictions

Pumping restrictions consist of legal or administrative limitations on the amount of groundwater that can be pumped from a basin. Pumping restrictions are typically implemented when no other action will control overdraft. Pumping restrictions may also be implemented to ensure an equitable distribution of production between users. Three methods for implementing pumping restrictions are described below.

Element A-1 General Adjudication

Adjudication is a water rights judgment where the court determines the water rights and the terms of adjudication. A general adjudication requires disputing parties to present evidence supporting their claims of rights as well as the physical characteristics of the basin. A physical solution may be included where existing pumpers are permitted to continue extraction subject to specified terms including payment for replenishment, reimbursement of named parties and management costs.

Element A-2 Stipulated Decree

A stipulated decree is a water rights judgment that is negotiated between all parties who agree to the terms of adjudication. The stipulated agreement becomes a judgment when ratified by the court. Like a general adjudication, a stipulated decree may include a physical solution where existing pumpers may continue to use their facilities subject to specified terms including payment for replenishment and other management costs

Element A-3 Legislative Approaches

A water management agency can be designated to manage a groundwater basin. The powers of the management agency are normally defined by law. Examples of groundwater management agencies include Orange County Water District, Water Replenishment District of Southern California in Los Angeles County and Fox Canyon Groundwater Management Agency in Ventura County. In addition to special district legislation, many other water agencies have water management powers defined in their enabling legislation. CVWD and DWA currently have such powers.

B. Demand Management

Demand management involves the reduction in water demands for urban and agricultural uses. The typical methods for demand management include various water conservation measures to reduce demands. However, more strict demand management measures could include changes in land use planning and allowable development, fallowing of agricultural land and development restrictions.

Element B-1 Adopt Agricultural BMPs

In 1996, the California Department of Water Resources, in conjunctive with representatives of the agricultural and environmental communities; local State and federal agencies; academia and research institutions; the private sector and other inserted parties developed the *Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California* (CUWCC, 1998). Signatories to this MOU commit to develop a water management plan that evaluates Efficient Water Management Practices (EWMPs) and to make a "good faith effort" to implement its water management plan. The EWMPs currently include many measures that are already implemented by CVWD.

Element B-2 Crop Allocations and Restrictions

Acreage allocations could be established for specific crops based on water use, economics and other conditions to reduce water consumption. Growing certain high water use crops such as alfalfa or dates could also be restricted.

Element B-3 Land Fallowing

Water demand could be reduced by paying farmers not to grow certain high water-demanding crops. The reduction in demand could increase water supply availability. Generally, the amount of water saved would equal the crop evapotranspiration, which averages about 3.7 acre-ft/yr/acre. For every 1,000 acres of crop land fallowed, about 3,700 acre-ft/yr of water would be saved. Such a program has been implemented by the Metropolitan Water District of Southern California with the Palo Verde Irrigation District to fallow land during dry years. This program makes additional Colorado River water available to Metropolitan during periods of low supply.

Element B-4 Mandate or Encourage Efficient Irrigation Methods

An ordinance could be adopted restricting the use of flood irrigation and mandating use of other more efficient irrigation methods including drip or sprinkler methods. About 50 percent of farm acreage currently use drip irrigation. CVWD currently provides low-interest financing to homeowners associations for installing efficient irrigation systems. Low-interest financing could also be provided to farmers. CVWD experience indicates drip irrigation reduces effective irrigated acreage by about 15 percent.

Element B-5 Mandate Automated Flood Irrigation Methods

An ordinance could be adopted requiring the use of more efficient automated flood irrigation methods to manage the quantity of water applied.

Element B-6 Modify Leaching Practices and Timing

Leaching accounts for 10-20 percent of agricultural water demands depending on the water source and the crop. Soil salt balance investigations indicate the current leaching practices may not be adequate to maintain a beneficial salt balance in the Valley. CVWD could investigate and encourage implementation of alternative methods to improve salt leaching efficiency to reduce water use. This option could include optimizing the timing of leaching to minimize water demands.

Element B-7 Price Differential for Flood Irrigation

CVWD could establish a higher water rate for farmers using flood irrigation or other inefficient irrigation methods. The rate differential could be based on the average difference in overall applied water between low- and high-efficiency irrigation methods.

Element B-8 Use Moisture Sensors or Other Plant Stress Indicators

Moisture sensors (also known as tensiometers) are used to measure the water content in the root zone and can determine the optimal timing for irrigation. CVWD could require farmers to install moisture sensors or other plant stress indicators to enhance irrigation efficiency.

Element B-9 Prohibitions on Wasteful Use

CVWD could work with local city and county agencies to enact and enforce ordinances prohibiting wasteful use of water. Prohibited uses could include washing sidewalks, driveways, etc., allowing gutter flooding, landscape irrigation between 10:00 AM and 6:00 PM, use of single pass cooling systems in new connections, non-recirculating systems in all new conveyer car wash systems, and non-recycling decorative water fountains. Additional prohibitions could apply during water supply emergencies. The local cities and the county may need to adopt ordinances to enforce the prohibitions. CVWD adopted an ordinance (no. 860) in 1952 that prohibits the wasteful application of water by agricultural users. This ordinance effectively prohibits agricultural runoff from fields.

Element B-10 No Net Demand Increase

Projected growth in the Coachella Valley is expected to result in increased water demands. CVWD could impose a ban on new connections unless new demand is offset by a corresponding reduction in demand elsewhere in the Valley. A demand offset program could be implemented for developers wanting approval for new construction or farmers desiring to expand irrigated acreage. They must demonstrate that at least as much water will be conserved as their new project will use, or contribute a specified amount of money into a fund that finances a comparable amount of water conservation improvements.

Element B-11 Plan Check New Irrigation Systems

A plan check procedure could be established before completion of the permit process for all of the new irrigation systems to ensure more efficient and water saving design is incorporated. CVWD has already implemented a plan check procedure for landscape plans in conjunction with Coachella Valley cities.

Element B-12 Public Education

Public information and school education programs are important parts of any water conservation program. CVWD could increase its current public information and school education programs to promote water conservation benefits and measures that can be taken by all end users.

Element B-13 Tiered or Seasonal Water Pricing

The purpose of tiered pricing schedules is to provide an economic incentive for reducing water use. Current water rates utilize a “single block” where all water use is charged the same unit rate. Alternative pricing structures could include excess use charges (or inclining block rate structure), penalty charges, and seasonal rates. Excess use charge applies a higher unit price to the volume consumed above a set limit or allocation. Penalty charges are similar to excess use charges except that the same unit price is charged for the entire volume consumed and a flat fee is assessed if total usage exceeds a set ceiling. Seasonal rates impose a higher unit price during peak usage months.

Element B-14 Replenishment Assessments

Groundwater pumpers in the Upper Valley pay a replenishment assessment that covers a portion of the costs to import SWP water for groundwater replenishment. The District’s enabling legislation allows it to include the costs of SWP water, other imported water sources or reclaimed water for direct or in-lieu recharge. A replenishment assessment could be established to recover portions of the costs to implement groundwater management programs in the Lower Valley. Each pumper would be responsible for paying their fair share of the costs for new reclamation, groundwater recharge and source substitution needed to eliminate overdraft. Pumpers that use small volumes of water (less than 25 acre-ft/yr) are currently exempted from the pump tax.

Element B-15 Domestic Water User Audits

Periodic water audits provide domestic water users with specific information on their current water use and methods for reducing consumption. To maximize the benefits of the program, the initial focus should be on the largest users who would be contacted and offered water audits. Ultimately, all water users would be offered audits. The audits would include checking for leaks, measuring the flow rates of toilets, showerheads and faucets, recommending replacement of inefficient fixtures, checking irrigation systems and timers, developing customer irrigation schedules, and providing a report summarizing the potential for water savings. CVWD currently conducts water audits for golf courses and homeowners associations.

Element B-16 Water Efficient Plumbing and Irrigation Systems

The District could work with local building departments to ensure that ultra-low flush (ULF) toilets and other water efficient plumbing fixtures are installed in all renovated construction. CVWD could provide information to building inspectors to ensure that these measures are implemented. The cities may need to develop related ordinances for implementation.

Element B-17 Water Waste Patrols

A demand reduction program (or water conservation ordinance) could be enforced using water waste patrols, frequently referred to as “water cops.” Warnings could be issued for the first one or two violations. Subsequent violations are subject to fines and, if still uncorrected, installation of water flow restrictors on the service to the user.

Element B-18 Alternative Methods for PM10 (Dust) Control

Fine dust (designated PM10 or particulate matter smaller than 10 micron) generated by farming and construction practices is a significant air quality problem in the Valley. Water is frequently used to reduce dust emissions. Alternative methods for dust control could be identified and adopted to eliminate the traditional use of large quantities of water. The current PM10 plan calls for improved urban and agricultural practices to control dust. However, the methods are not completely defined.

Element B-19 Restrict Turf on Golf Courses and Common Areas

Turf irrigation for golf courses and landscaping is a significant water use in the Valley. To reduce the irrigation demand, criteria could be established in an ordinance to specify the maximum allowable irrigated area for golf courses and residential developments. Alternatively, an allowable evapotranspiration (ET) budget could be provided to a developer specifying the maximum amount of water that can be applied to landscaped areas. Limiting water use to some fraction, say 50 percent of potential ET, would limit the installation of high ET landscaping such as turf. Such a program may require a water rate incentive to discourage overwatering.

Element B-20 Evaporation Retardants

Evaporation from water bodies is approximately 6 ft/yr in the Valley. Evaporation retardants could be applied at lakes and other large water bodies to minimize evapotranspiration. Similarly, covers for swimming pools could reduce evaporation losses.

Element B-21 Adopt Urban BMPs

CVWD could adopt the *Memorandum of Understanding Regarding Urban Water Conservation in California* prepared by the California Urban Water Conservation Council to support and implement reliable water conservation practices. Signing this MOU would require CVWD to make a good faith effort to implement the Urban Best Management Practices (BMPs) as outlined therein. The District would also be required to submit progress reports to the council every other year.

Element B-22 Drought Tolerant/Avoidant Landscaping and Turf

The District could promote the use of various drought tolerant/avoidant landscaping and turf to replace other high water demand landscaping through the public information program and local nurseries. This option emphasizes the use of native plants in landscaping.

Element B-23 Outlaw Water Misters

CVWD could impose restrictions or prohibitions on the use of water misters to cool exterior spaces by evaporation. This measure may not be a significant water use in the study area.

Element B-24 Restrict Landscape Impoundments

Restrictions could be established on the construction of ponds and lakes that use additional water. As an alternative, CVWD could require that ponds and lakes are approved only if recycled or Canal water is used and the pond or lake is an integral part of the irrigation system.

Element B-25 Zoning Restrictions

Water demand is a function of the types of land use and associated developed. Developments having water features or golf courses typically consume more water than developments that do not include such features. CVWD could work with local cities and Riverside County to develop zoning restrictions that could reduce water usage.

Element B-26 Issue Drainage Permits and Metering

Farmers use subsurface tile drainage systems to prevent waterlogging of the root zone. On-farm drain systems are connected to the District’s drainage system that flows to the CVSC and the Salton Sea. To reduce the loss of water from drains, CVWD could issue permits and require metering of all drainage water and charge for excessive drainage.

Element B-27 Higher Power Costs for Groundwater Production

The current energy cost in the Lower Valley is relatively low, making groundwater pumping an economical approach for farmers. CVWD could work with IID and SCE to implement a higher power rate for groundwater service. The power rate would need to be high enough to make the use of alternative water sources more economical to the farmer.

Element B-28 Measure Amount of Annual Pumping by Each Groundwater User

State law currently states that use of water without a method of measurement is a waste and unreasonable use of water (Water Code §520, et seq.) State law also requires annual filing with the SWRCB of “Notice of Extraction and Diversion of Water” by all users in excess of 25 acre-ft/yr in Riverside, San Bernardino, Los Angeles, and Ventura counties (Water Code §4999, et seq.) CVWD could adopt an ordinance requiring metering of all wells and reporting of all production. Measuring of groundwater production could be done directly through meters or indirectly through power consumption provided annual pump tests are conducted.

Element B-29 More Efficient Well Drilling and Development Techniques

Water is used in the drilling and development of water wells. CVWD could investigate and require implementation of more efficient well drilling techniques. The purpose would be to reduce potential waste of water during construction and to minimize regional impacts of pumping.

Element B-30 Evapotranspiration-based water rates

Water rate schedules could be developed that charge higher rates for water use in excess of typical monthly potential evapotranspiration (ET_o) rates. Alternatively, water rates could be based on some fraction of ET_o rates. This measure is a variation of Element B-13.

Element B-31 Hire a Water Conservation Coordinator

CVWD could designate a full-time position and support staff as required to act as water conservation coordinator. The coordinator would be responsible for: 1) coordination and oversight of conservation programs and BMP implementation, 2) preparation and submittal of periodic reports on the status of water conservation programs, and 3) communication and promotion of water conservation issues to agency senior management; coordination of agency conservation programs with operations and planning staff; preparation of annual conservation budget; and preparation of the conservation elements of the agency's Urban Water Management Plan.

Element B-32 Require Plumbing Retrofit on Sale

The Urban BMPs include retrofitting of older high flow toilets with ultra low flush toilets (ULFTs). The MOU for Urban Conservation indicates that a retrofit program should be at least as effective as would occur if retrofitting were required upon resale of homes. CVWD could work with the local cities and the county to develop ordinances requiring the installation of ULFTs and low-flow plumbing fixtures at the time of resale for all homes and businesses built prior to 1992.

Element B-33 Develop and Enforce Water Efficient Landscape Ordinances

Cities and counties were required to adopt a water efficient landscape ordinance by January 1, 1993 or the model ordinance developed by DWR would take effect. However, the cities in the Coachella Valley adopted ordinances that frequently did not include an enforcement mechanism. CVWD would work with the local cities and counties to revise the existing water efficient landscaping ordinances to better define the landscaping requirements including enforcement mechanisms. The ordinances would be designed to minimize the amounts of turf and other high water using landscaping materials in new developments. Enforcement could be linked to provision of water service (non-compliance could result in termination of water service).

C. Local Water Sources

Local water sources could be used to meet current and projected groundwater overdraft. Local sources are defined as currently undeveloped or under-developed water supplies that exist within the Coachella Valley. In some cases, treatment of the local sources is required to meet the intended use of the water. Treatment issues are discussed under Item F – Water Quality Approaches.

Element C-1 Reuse Agricultural Drainage Water (Including CVSC water)

Currently, about 56,000 acre-ft/yr of agricultural drainage flows into the CVSC or directly to the Salton Sea. CVWD could construct facilities to capture and desalt agricultural drainage and use the product water for direct use or for groundwater replenishment. Potential supply is at least 50,000 acre-ft/yr and could increase if drain flows increase in the future. Membrane processes may be required to remove TDS from water to a suitable level for agriculture. Conveyance facilities are required to convey treated water to the distribution system for use. Due to water quality concerns, brine would need to be disposed either in on-site lined evaporation ponds or in off-site ponds near the Salton Sea. Off-site disposal would require a brine pipeline to the Salton Sea. Sea water would then be pumped to evaporation ponds to remove an equal amount of salt.

Element C-2 Reuse Fish Farm Effluent

Most fish farms and duck clubs discharge any excess water either into the drain system or into the CVSC. However, good estimates of the amount of discharge exist for only a few fish farms. Facilities could be constructed to collect, treat and convey fish farm effluent for use. Potential supply is in the range of 1-5,000 acre-ft/yr. Additional treatment/filtration may be needed to meet water quality requirements for use; unknown treatment needed for nutrient removal.

Element C-3 Reuse Greenhouse Effluent

Greenhouses pump geothermally heated groundwater to maintain a constant warm temperature during the winter months. After use, the water is discharged to the drains. Facilities could be constructed to collect, treat and convey greenhouse effluent for use. Potential supply is in the range of 5-800 acre-ft/yr. Supply may not be cost effective due to limited effluent availability.

Element C-4 Pump Semi-perched Groundwater

In many parts of the Lower Valley, the depth to groundwater is quite shallow. Shallow wells could be constructed to extract shallow perched groundwater as an additional water supply. The quality of Semi-perched groundwater is too poor for direct use without treatment. Extraction may increase basin overdraft.

Element C-5 Pump Groundwater under Salton Sea

Untapped groundwater resources may exist under the Salton Sea. The District could construct wells to extract groundwater from under Salton Sea and convey the water to upstream users via the Coachella Canal or new facilities. Due to uncertain quality, treatment may be necessary to meet end user requirements. Pumping may increase the groundwater overdraft problem and could induce vertical migration of Salton Sea water into the underlying aquifer causing permanent degradation.

Element C-6 Pump Upper Basin Groundwater to Lower Basin

Currently, the District uses imported water to recharge the Upper Valley because the facilities to convey imported water to users is very costly. CVWD could construct facilities to extract Upper

Basin groundwater and convey it to Lower Basin users. Major pumping and conveyance facilities would be required. Overdraft problems in the Upper Basin may be increased.

Element C-7 Capture Stormwater Runoff

Local stormwater runoff could be captured to supplement the local groundwater supplies. Water could be conveyed to recharge basins or to the Canal for distribution. This option could involve the construction of in- or off-channel recharge facilities along the Whitewater River or its tributaries. This option is similar to the activities performed by the Orange County Water District in the Santa Ana River. Potential yield is uncertain (minimum additional yield); most water is already being captured in the Whitewater River upstream from Indio.

Element C-8 Construct On-site Stormwater Retention

Facilities could be constructed to retain local runoff generated by developments on-site. The captured water could then be used for groundwater recharge via spreading. Significant changes may be required in existing and future developments. Most, if not all, new development is currently required to retain the 100-year storm on-site. The amount of yield is uncertain.

Element C-9 Reuse Municipal Wastewater Effluent – Upper Valley

The reuse of treated municipal wastewater is an important resource in the Coachella Valley. The District could construct facilities to increase the reuse of municipal wastewater effluent. Potential uses include non-potable supply (golf courses, parks, schools, cemeteries, agriculture) or groundwater recharge. Tertiary filtration is required for most uses. Effluent availability for reuse should increase with growth as percolation capacity is limited. Wastewater has a relatively low TDS (450 mg/L).

Element C-10 Reuse Municipal Wastewater Effluent – Lower Valley

This element is essentially the same as Element C-9. However, in the Lower Valley, municipal effluent is discharged into the CVSC where if flows into the Salton Sea. Reuse of effluent from Lower Valley plants would result in recovery of a lost resource and would produce an overdraft reduction if it were used to offset groundwater extraction.

Element C-11 Water Rights Purchases

CVWD could obtain additional water supply by purchasing water rights from suitable sources. The supply availability is uncertain since most local sources are fully utilized. It may be difficult to identify suitable water sources for acquisition.

Element C-12 Desalt Salton Sea Water

There is more than 7 million acre-ft of water in the Salton Sea. Annual inflow to the sea exceeds 1.3 million acre-ft/yr making it a significant source of local water. However, its salinity is 25 percent greater than ocean water. The District could construct facilities to desalt Salton Sea water for direct beneficial use. The product water could be conveyed to the Coachella Canal for use. The level of treatment depends upon end use requirements. Brine disposal is likely to be a significant problem to avoid increasing the salt concentration in the Salton Sea. Regulatory and environmental requirements are unknown. Such a project would be extremely expensive.

Element C-13 Greywater Reuse

The reuse of household wastewater for irrigation, or other types of reuse offers another potential water source. The so-called greywater must not contain toilet waste, soiled diapers, or other sewage. Proper alteration of wastewater drainage connections and other features (to avoid cross-connection or interfere with water pressure) must be approved by local building or plumbing authority. The types of reuse and application methods are restricted, depending on the water quality. Potential water savings are not currently quantified.

D. Imported Water Sources

The Coachella Valley is heavily dependent on imported water sources to meet current demands. Additional imported water could be obtained through purchase or other methods of acquisition.

Element D-1 Obtain Additional SWP Water Entitlement

The District and DWA currently have entitlements to 62,100 acre-ft/yr of State Water Project water. CVWD and DWA could obtain additional SWP entitlements from other SWP contractors for use in the Valley. Current estimates indicate an average supply of at least 100,000 acre-ft/yr of additional SWP water may be required. Since there are no facilities to convey SWP water to the Valley, any additional SWP water must be exchanged with MWD. The quality of the recharged water is the same as MWD's Colorado River Aqueduct water. Additional water conveyance and treatment facilities will be required if the water is supplied for direct potable use. The existing Whitewater River Spreading Facilities have sufficient percolation capacity if the water is used for groundwater recharge.

Element D-2 Purchase SWP Turn-back Pool Water

In 1994, the SWP contractors and DWR developed the Monterey Agreement, which settled a number of issues involving the availability of SWP water. The agreement allows water contractors that do not use their entire water entitlement to "turn-back" their used water to DWR for purchase by other SWP contractors. The District and DWA have been purchasing additional SWP water from the turn-back pool on an "as-available" basis since 1996. The agencies could continue to purchase turn-back pool water when it is available. The amount of water that can be purchased varies from year to year but is expected to be available primarily in wetter than normal years. No reliable estimate can be made of this source since its availability varies.

Element D-3 Purchase Central Valley Project Transfers

Water from the Central Valley Project is occasionally available during years of surplus supplies. The Central Valley Project Improvement Act (CVPIA) authorized the transfer of surplus water to non-CVP contractors. CVWD could negotiate the purchase of surplus or unused Central Valley Project water when it is available. Water would probably be conveyed through the State Water

Project and exchanged with MWD for Colorado River water. Multi-agency agreements would be required. CVWD would compete with other agencies attempting to contract for water transfers.

Element D-4 Obtain Additional Colorado River Water

Under the California Seven Party Agreement of 1931, the District has an unspecified allotment of Colorado River water under Priority 3. The total allotment of water to California agricultural agencies is 3.85 million acre-ft/yr. Through negotiation or litigation, the District could obtain a fixed allotment of sufficient volume to meet its current and future needs within the ID-1 service area. This additional water may come from water transfers from other California agencies. The Quantification Settlement establishes a fixed allocation of Colorado River water for the Coachella Valley.

Element D-5 Recover Coachella Canal Seepage (first 84 miles)

A significant amount of Colorado River water (up to 132,000 acre-ft/yr) seeped into the ground in Imperial County before the first portion of the Coachella Canal was lined in 1981. This "lost" water could be pumped from the East Mesa area and conveyed to CVWD through the Coachella Canal. Detailed studies are required to determine the disposition of the water. The water is believed to be of poor quality. MWD and IID are currently investigating this project.

Element D-6 Lower Colorado River Water Supply

The Lower Colorado Water Supply Project is to provide a 10,000 acre-ft/yr water supply for BLM lands and cities and individuals along the Colorado River in California that do not have Colorado River water rights or that have inadequate rights to meet their existing and future needs. This supply is limited to BLM recreational lands and existing and potential domestic, municipal, and recreational users along the Colorado River in California.

The project is being developed in two stages with two wells, with the first stage of the Project already completed. The Project will eventually be expanded to five wells that would provide up to 10,000 acre-ft/yr. The total capacity of the 5,000 acre-ft/yr first stage has been contracted to the City of Needles and BLM. The City of Needles will subcontract with eligible users in San Bernardino, Riverside, and Imperial Counties.

Those domestic, municipal, and recreational users along the River in California found to be using mainstream Colorado River water by the Bureau of Reclamation through direct diversions or by wells which have no or inadequate Colorado River water rights, and are determined to be eligible, can contract for a supply from the Lower Colorado Water Supply Project. This source would not likely provide any water for CVWD.

Element D-7 Line Middle Reach of Coachella Canal

The U.S. Bureau of Reclamation is proposing to line 33.4 miles of the Coachella Canal, which loses an average of 32,350 acre-ft/yr through seepage. This reach of the Canal is located between Siphon 7 near Niland and Siphon 32 near North Shore. The project was authorized by

Congress under P.L. 100-675, which provides for non-Federal funding. Water conserved by the project would be available for use in California. Users of the conserved water would be required to pay the project costs in proportion to the amount used. Water recovered from the canal lining could supplement existing Canal diversions for agricultural uses or groundwater recharge. The estimated yield of this project (net of leakage allowance and water releases for environmental mitigation) is about 26,000 acre-ft/yr. Lining of this portion of the Canal is an important component of the Quantification Settlement Agreement. The Draft EIS/EIR for the project was originally released in December 1993. The project has been reactivated and the EIS/EIR is expected to be finalized in late 2000. The project has been funded by State of California.

Element D-8 Colorado River Transfers

CVWD may be able to negotiate the purchase of additional water supplies from the upper Colorado River basin states. Amount of water available for transfer and the cost is unknown. Given the increasing use by Upper Basin states, it is unlikely that much water would be available. USBR would need to promulgate regulations covering the Colorado River transfers and water banking. Existing contracts would have to be renegotiated or amended. Significant legal and institutional barriers are expected from upper basin states assigning additional water to lower basin states. Environmental impacts are uncertain. An EIS would be required.

Element D-9 Obtain Water from USBR Yuma Desalter

The Bureau of Reclamation constructed and operates the 72-mgd Yuma Desalter to help the United States meet salinity requirements for Colorado River water that is delivered to Mexico. CVWD could negotiate a contract with the Bureau of Reclamation to purchase water from the Yuma Desalter. The water would be conveyed to CVWD through the Coachella Canal for delivery to agricultural and urban water users. Alternatively, desalter water could be exchanged with Mexico with a like amount of Colorado River water conveyed through the Coachella Canal. The cost of water may be relatively expensive compared to other elements ($300-$400/acre-ft at Yuma). The quality of delivered water would be essentially the same as Canal water.

Element D-10 Desalt Gulf of California Water

CVWD could construct facilities to desalt Gulf of California water and convey the product water to CVWD for beneficial reuse. Major treatment and conveyance facilities would be required. Brine disposal could be a significant issue. There is potential for significant environmental impacts. Such an option would be very expensive and would require international treaties or agreements with the Mexican government.

Element D-11 Purchase Water from Non-Adjacent Basins

Additional water supplies could be purchased from non-adjacent basins. The availability of water is currently unknown. One example might involve acquiring water rights in another desert groundwater basin. It may be difficult to identify suitable water sources for acquisition. Implementation cost is unknown. There is potential for significant environmental impacts.

Element D-12 Water Tankering

Fresh water from Canada or the Pacific Northwest could be transported to the area augmenting the water supply. Oil tankers would be converted to fresh water use. Water would be delivered to the MWD system at the coast and conveyed to CVWD through an exchange agreement similar to the existing SWP exchange agreement. The availability of such water must be considered; Canada is currently opposing similar projects. Long term contracts with marine transportation firms are required. Offshore terminal and transmission facilities along with on-shore transmission and storage facilities are required to unload a tanker within about 48 hours. Since the water would be exchanged for Colorado River water, there would be no water quality benefit to the Coachella Valley. .

Element D-13 Obtain Imported Water Through Indian Tribes

Coachella Valley Indian tribes have indicated potential access to additional water supplies that could be imported into the Valley. However, the source of this water has not been identified. The water supply benefits would be limited if the water were obtained from any current CVWD sources (i.e., SWP or Colorado River) due to conflicting uses and availability.

E. Water Management Actions

Potential water management actions include methods of using additional supplies obtained from local or imported water sources. Actions include groundwater recharge, which augments the current groundwater supplies, in-lieu uses, which substitute other local or imported supplies to groundwater users. Other management actions could include modification of the Canal water service area, internal recycling of fish farm effluent and capping any flowing wells.

Element E-1 Groundwater Recharge by Spreading

Groundwater recharge by spreading involves the ponding of water in shallow basins were it can seep into the groundwater basin. Potential spreading sites must be relatively free of underlying clay layers (aquitards) that would impede the vertical movement of the percolating water. In the Coachella Valley, potential recharge sites are limited to the Upper Valley and near the westerly edge of the Lower Valley where significant clay layers are generally absent. The District and DWA operate the Whitewater River Spreading Facility in the Upper Valley, which has the capacity to recharge at least 300,000 acre-ft/yr.

The District has identified several potential recharge sites in the Lower Valley. One site is located near Dike 4, a flood control dike located south of Lake Cahuilla. The District has operated a pilot recharge facility at this location since 1997. Another potential recharge area is the large alluvial fan emanating from Martinez Canyon. The District operated a small pilot recharge facility in this area in 1998 and plans to construct a larger-scale demonstration project. The potential recharge capacity in the Lower Valley has not been quantified.

Element E-2 Groundwater Recharge by Injection

In those areas where there are substantial underlying clay layers, the use of injection wells has been a successful recharge mechanism. The design of an injection well is similar to that of a water supply well. The injected water recharges an aquifer from the surface bypassing the unsaturated zone and any intervening low permeability layers. The injected water can be delivered at essentially zero pressure minimizing energy costs. Alternatively, the injected water can be pressurized to increase the injection rate. This method minimizes evaporation losses and avoids many site hydrogeological constraints that lead to poor infiltration, especially the clay layers in the Lower Valley. However, to avoid pre-mature clogging of the wells, the injected water must be filtered before injection. CVWD would need to construct treatment, conveyance and injection facilities to recharge the groundwater aquifer with Coachella Canal water via injection. This method could also utilize existing wells to inject water during off-peak (winter) periods for summer extraction provided the wells are properly designed.

Element E-3 Groundwater Recharge by Sub-surface Drip Irrigation

An alternative to spreading, subsurface drip irrigation may be a mechanism for groundwater recharge in areas where the underlying geology is suitable for recharge but land use does not allow the construction of percolation ponds. This mechanism would involve the installation of buried perforated pipelines that can both irrigate overlying vegetation and allow additional deep percolation to recharge the groundwater basin. This approach has not been tried on a large scale and therefore its feasibility has not been demonstrated.

Element E-4 Groundwater Recharge by Collector Wells

Similar to injection wells, collector wells also avoid many hydrogeological constraints by recharging the aquifer directly. A collector well is a well that penetrates the aquifer to be recharged with an injection pressure limited to that at which the head from the column of water can deliver based on gravitational forces alone. Collector wells are relatively large diameter wells (42 inches to 48 inches in diameter) with depths up to 200 feet. Many collector wells would be required to achieve the desired recharge rates due to the lack of pressurization and slower rate of recharge.

Element E-5 Provide In-lieu Water to Agricultural Groundwater Users Inside ID No. 1 Boundaries

CVWD could provide water to those agricultural users within ID No. 1 boundaries that currently use groundwater for irrigation. CVWD could also provide some financial incentives to encourage groundwater pumpers to convert to canal water. CVWD has prepared a manual for farmers on the use canal water for irrigation. Some water supplies may require treatment to remove turbidity for agricultural users if drip irrigation is to be employed. The Bureau of Reclamation may need to reclassify certain unclassified or Class 6 lands to Class 1S prior to delivery of water.

Element E-6 Expand the ID No. 1 Boundaries

CVWD could work with the Bureau of Reclamation to expand the ID-1 boundary to allow more agricultural users to obtain Canal water. Such a modification would primarily affect the Oasis area where about 2,200 acres of land lie outside the ID-1 area. Since the ID-1 boundary is defined in the contract between the District and the Bureau of Reclamation for the Coachella Canal, a contract amendment would be required. Opposition from other Colorado River water users would be expected.

Element E-7 Provide In-Lieu Water to Fish Farms

Currently, only a few fish farms use Canal water as a supplemental water source. CVWD could provide in-lieu water for fish farms use. To do this, construction of distribution facilities would be required to convey water form the Canal system to the fish farms. Since most fish farms use warm groundwater for its heat content, a separate heat source may be required to maximize fish growth. Treatment may also be required to meet water quality requirements.

Element E-8 Provide In-Lieu Water to Golf Courses

Several courses have been converted to use Canal water; others have connections but use small amounts of water. CVWD could provide in-lieu water for golf course irrigation. In the Lower Valley, many existing and planned courses are near the existing Canal water system. Therefore, little additional conveyance facilities would be required. In the Upper Valley, substantial distribution facilities would be required to convey water from imported water sources to the golf courses. It may be possible to integrate the existing recycled water system with a future imported water delivery system. CVWD has prepared a manual on the use of canal water for golf course irrigation. Colorado River water quality may not be suitable for some types of grasses.

Element E-9 Provide In-Lieu Water to Greenhouses

CVWD could provide in-lieu water for greenhouse use. Since the greenhouses use warm groundwater for its heat content, a separate heat source may be required for plant growth. Additional treatment may needed to meet water quality requirements.

Element E-10 Provide In-Lieu Water to Potable Domestic Uses

CVWD could deliver in-lieu water for potable use. Coachella Canal or SWP Exchange water could be used, since other sources may contain municipal wastewater. Treatment is needed to meet State and federal surface water treatment requirements. Therefore, this element must be implemented in conjunction with Element F-3. TDS level (650–800 mg/L) may be a concern. New water conveyance facilities are needed to potable water systems.

Element E-11 Provide In-Lieu Water to Non-Potable Uses

In-lieu water could be supplied and delivered for non-potable use. Potential uses include residential and commercial irrigation, fire fighting and toilet flushing. A dual distribution system would be required. Coachella Canal water and recycled municipal wastewater are the most logical sources. Such an approach would reserve groundwater pumping for potable uses.

Element E-12 Provide In-Lieu Water to Duck Ponds

Duck clubs currently pump groundwater to fill ponds because most are located outside the ID-1 service area. CVWD could deliver in-lieu water to duck ponds for wetlands enhancement. A distribution system would be required to convey water from the source to point of use. Little water quality issues are expected.

Element E-13 Provide In-Lieu Water for Industrial and Power Plant Cooling Use

CVWD could deliver in-lieu water for appropriate industrial reuse. Conveyance and treatment facilities may be needed to meet industrial water quality requirements. The future usage is estimated to be less than 2,500 acre-ft/yr.

Element E-14 Use the Coachella Canal to Convey Non-Federal Water to Users Outside ID-1 Boundaries

Agricultural and other users outside the ID-1 boundary currently use approximately 185,000 acre-ft/yr of groundwater. The Warren Act (43 USC §523) allows the conveyance of non-federal water in federal facilities if excess capacity is available. Under this element, the District would place non-federal water (such as recycled or SWP water) into the Canal water distribution system for delivery to agricultural and golf course irrigators. CVWD could also redistribute groundwater pumping patterns to best manage water demands and water quality needs at various locations. Federal approval may be required. Expanded conveyance facilities would be required to deliver water to users located outside ID-1.

Element E-15 Irrigation Pump Back Systems

CVWD could develop a system to reuse effluent from irrigation practices. Current irrigation practices produce little to no direct tailwater or runoff. Therefore, the potential use of pumpback systems is limited. However, recycling of drain water is considered in Element C-1.

Element E-16 Fish Farm Internal Reuse

Several fish farms have implemented partial reuse of their effluent. CVWD encourages additional fish farms to internally reuse water. Treatment needs for internal reuse at the fish farms are unknown but may include wetland treatment or conventional wastewater treatment processes. The potential exists for disease transmission. Fish farms may need to provide an external heat source.

Element E-17 Cap Flowing Artesian Wells

CVWD could construct facilities to stop the loss of water from any existing flowing artesian wells into the Salton Sea. The existence of flowing wells in the Salton Sea area and the amount of water that could be saved are uncertain.

F. Water Quality Approaches

Although water quality improvement is not a specific objective of the Water Management Plan, certain water quality management approaches are considered in developing the Plan.

Element F-1 Canal water treatment provided by individual users

Currently, Coachella Canal water is served to various users without additional treatment. Treatment is the responsibility of individual users as required for their specific needs. An example would be farmers using Canal water for drip irrigation providing filtration. Under this element, the current practice would continue.

Element F-2 Provide Tertiary Treatment for Wastewater

Most recycled water uses require tertiary treatment (chemical coagulation, filtration and disinfection) of wastewater to comply with State DHS regulations. The District currently provides tertiary treatment for most effluent used for irrigation. Tertiary treatment would be provided to meet any new recycled water uses requiring that level of treatment.

Element F-3 Provide Potable Water Treatment for Surface Supplies

The federal and State surface water treatment rules require treatment of all surface waters and all groundwaters under the direct influence of surface water. The District does not currently deliver surface water for potable use. However, if Canal water is delivered for municipal use, the District would need to provide conventional water treatment for that water. Facilities required could include pipelines, pumping stations, storage reservoirs and treatment plants.

Element F-4 Desalt Canal Water Before Use

Colorado River water has a higher salinity than local groundwater. To reduce potential impacts of Colorado River water use on groundwater supplies, the Colorado River supplies could be desalted to a comparable quality as groundwater. Treatment facilities would likely include the use of reverse osmosis (RO) or electrodialysis reversal (EDR) for salt removal. The cost of large-scale desalination is currently quite high ($400–$600/acre-ft). Desalination processes require a substantial amount of energy for the treatment process. The process produces brine that must be disposed in an environmentally acceptable manner. Discharge of brine to the Salton Sea would adversely impact the quality of the sea. Alternatively, large areas of evaporation ponds would be needed. For example, a desalination plant, capable of producing about 100,000 acre-ft/yr, produces about 12,000 acre-ft/yr of brine and requires about 2,400 acres (almost 4 sections) of land for evaporation ponds. The District currently delivers in excess of 270,000 acre-ft/yr of Canal water and expects to use about 440,000 acre-ft/yr by 2035.

Element F-5 Desalt SWP Exchange Water Before Use

SWP Exchange water has a higher salinity than local groundwater. To reduce potential adverse water quality impacts of recharging with SWP Exchange water on groundwater supplies, the SWP Exchange supplies could be desalted to a comparable quality as groundwater or current

SWP supplies (300 mg/l). Treatment facilities would likely include the use of reverse osmosis (RO) or electrodialysis reversal (EDR) for salt removal. The cost of large-scale desalination is currently quite high ($400–$600/acre-ft). Desalination processes required a substantial amount of energy for the treatment process. The process produces brine that must be disposed. Discharge of brine to surface waters is not environmentally acceptable since the brine could percolate into the groundwater basin. The only viable disposable method would be evaporation; large areas of evaporation ponds would be needed. For example, a desalination plant, capable of producing about 50,000 acre-ft/yr, produces 5,500 acre-ft/yr of brine and requires about 1,100 acres (1.7 sections) of land for evaporation ponds. The District and DWA currently use about 140,000 acre-ft/yr and expect to use about 175,000 acre-ft/yr of SWP Exchange water by 2035.

Element F-6 Extend SWP to the Coachella Valley

In the 1970s, DWR evaluated alternative configurations for conveying SWP water to the Mojave Water Agency, San Gorgonio Pass Water Agency (SGPWA), DWA and CVWD. The high cost to construct a facility to the Coachella Valley lead to the development of an exchange agreement with Metropolitan. DWR is currently constructing the East Branch Extension that will bring SWP water to the SGPWA. However, this facility does not include capacity to convey DWA's and CVWD's SWP entitlement. An extension of the SWP to the Valley would likely cost in excess of $250 million. The benefit of such an extension is improved water quality (TDS <300 mg/l) for recharge in the Upper Valley.

PRELIMINARY SCREENING OF ELEMENTS

Screening Criteria

The 85 management elements are screened using the following set of evaluation criteria:

- Ability to reduce overdraft
- Technically supportable
- Potential environmental impacts
- Expected costs
- Legal and regulatory implementation

Elements are rated on a scale of 1 to 5 with 5 being excellent and 1 being very poor. Options having the highest rankings are "short-listed" for further evaluation and formulation into Water Management Plan alternatives. **Table B-1** presents the basis for the numerical rating used in this screening process. **Table B-2** beginning on the following page presents the results of the screening. The "ranking" shown in **Table B-2** is based on the total points scored for each option. Options with the highest point score are ranked "1" decreasing in order from that point.

Table B-1
Element Rating Factors

Rating		Ability to Reduce Overdraft	Technically Supportable	Environmental Impacts	Expected Costs	Legal & Regulatory Implementation
5	Excellent	>10,000 AF/yr	Proven, reliable technology with many installations	No negative impact; beneficial environmental impact.	Less than $50	None
4	Good	5-10,000 AF/YR	Demonstrated technology at some locations.	Minimal negative impact; some beneficial environmental impact.	$50 to $100	Minimal
3	Fair	1-5,000 AF/YR	May be technically feasible for some applications	Some negative environmental impact, but can be satisfactorily mitigated.	$100 to $500	Moderate
2	Poor	0-1,000 AF/YR	Technical feasibility unproven based on currently available information.	Negative environmental impact that can only be partially mitigated.	$500 to $1,000	Significant
1	Very Poor	None or Unknown	Not technically feasible based on currently available information.	Significant negative environmental impact and controversy.	More than $1,000	Very Significant

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
		A-1	General water rights adjudication	5	5	1	3	1	15	**8**	• Very lengthy and expensive process • Uncertain outcome, depends on testimony and judge's decision • Does not usually regulate water quality • Is not binding on non-parties or non-using overlying owners • Parties must seek court action to settle subsequent disputes • Groundwater management may be defined by the judgment • Does not develop additional supplies • May create local economic hardships if a physical solution is not included • Requires appointment of a watermaster to oversee the judgment
	✓	A-2	Stipulated water rights decree	5	4	2	4	2	17	**6**	• Similar to general adjudication but avoids some of the costs • Outcome more uncertain than general adjudication • Requires all parties to agree • One party could hold the others "hostage" • May be less time consuming if no one protests
		A-3	Legislative approaches to groundwater management	1	4	3	3	3	14	**9**	• Establishes local control over water resources • May create an additional layer of government • Avoids expense of adjudication • Legislation is developed through negotiation • Considers both public interest and private rights • Requires special legislation • Pumping restrictions may be enforced by ordinance

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
✸	✓	B-1	Adopt Agricultural Best Management Practices	1	4	5	4	4	18	**5**	• Demonstrates willingness to commit to additional water saving measures • May duplicate existing conservation activities • Certain BMPs have been implemented in CVWD service area • Other BMPs may not be applicable to CVWD service area • Level of demand reduction is uncertain without other demand management actions
		B-2	Crop allocations and restrictions	5	4	1	3	1	14	**9**	• Affects freedom of farmer to meet market demands • Level of water savings is a function of the specific allocations or restrictions • May adversely affect local economy • May require additional government authority to implement • Uncertain savings compared to overall evapotranspiration
		B-3	Land fallowing	5	4	3	2	1	15	**8**	• Cost depends on the agricultural market. Based on average crop value of $7,832/acre (CVWD, 2000) • Needs to pay a price sufficient to compensate growers for not growing a crop (or reducing acreage) • Affects the region's economic viability by reducing crop production and income • May require additional legal authority to implement • Results in in-lieu replenishment if groundwater pumping is reduced

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
✓	✓	B-4	Mandate or encourage efficient irrigation methods	4	4	4	3	3	18	**5**	• District provides low interest loans to homeowners associations • Drip irrigation reduces effective irrigated acreage by about 15 percent based on CVWD experience • May improve crop yield • May reduce deep percolation and drain flows to Salton Sea, but reduction may offset overdraft reduction • May require periodic flooding to leach salts from the root zone • May require better quality of water for other irrigation methods • Suitability may be crop and soil dependent • Presumes that flood irrigation is inherently inefficient which may not be a valid conclusion
		B-5	Mandate automated flood irrigation methods	3	3	3	4	2	15	**8**	• Reduces net irrigation demand • No need to reduce the amount of existing agriculture or change the existing crop • Requires periodic leaching to flush salts out of the root zone • Cost of implementation is uncertain
		B-6	Modify leaching practices and timing	3	2	3	4	3	15	**8**	• Level of potential savings is not likely to be more than 5-10 percent of total leaching water requirement, or about 2,000 to 5,000 acre-ft/yr. • May require growth of salt-tolerant or salt-consuming crops to reduce soil salt build-up • Level of savings is a function of the current salt balance. If an adverse salt balance (salt build up) exists, then no savings would occur. • Inadequate salt leaching could limit agricultural viability in the Valley.

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
		B-7	Price differential for flood irrigation	1	2	4	5	2	14	**9**	• May require patrols to monitor the practice • May adversely affect production of certain crops • Needs to be linked to other measures for controlling irrigation methods • Amount of savings depends on the assumed irrigation efficiency of flood irrigation compared to other methods and the price differential
	✓	B-8	Use moisture sensors or other plant stress indicators	1	4	5	4	5	19	**4**	• Reduces irrigation demand by improving irrigation efficiency • Reasonable cost measure for water conservation • Uncertain level of water savings • Could be linked to other irrigation management methods
✓	✓	B-9	Prohibitions on wasteful use	1	5	5	2	4	17	**6**	• CVWD has already implemented wasteful use prohibition in agriculture • Amount of water savings is not likely to be significant • Sets the tone for the importance of other water management practices
	✓	B-10	No net demand increase	2	4	5	3	3	17	**6**	• May adversely affect local economy • Depends on community development • May require additional governmental authority to implement • Offset program may result in reduced water demand in the future
✓	✓	B-11	Plan check new irrigation systems	1	5	5	4	5	20	**3**	• Requires inter-agency cooperation • May require cities to develop related ordinances for implementation

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
✓	✓	B-12	Public education	1	5	5	4	5	20	**3**	• CVWD has an active public education program • Success is not guaranteed since it requires a voluntary alteration of water use habits • Can be implemented quickly at no direct cost to the customer • Helps the public to appreciate the severity of current and future water shortages • Level of demand reduction depends on time, money and effort spent • Amount of savings cannot be directly quantified • Must be implemented in conjunction with other demand management measures
	✓	B-13	Tiered or Seasonal Water Pricing	1	4	5	5	5	20	**3**	• Magnitude of demand reduction is uncertain • May require individual metering groundwater producers. Domestic and irrigation customers are currently metered. • Needs a realistic assessment of time/effort to change the pricing structure and retrofit any existing unmetered connections
✓	✓	B-14	Replenishment assessments	1	4	5	5	5	20	**3**	• Magnitude of demand reduction is uncertain • May require individual metering groundwater producers. Upper Valley pumpers are currently metered. • Needs a realistic assessment of time/effort to change the pricing structure and retrofit any existing unmetered connections.

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
	✓	B-15	Domestic water user audits	3	5	5	4	5	22	**1**	• Minimizes unaccounted-for water usage and reduces water demands • Complements the public education programs • May require additional government authority to implement • Level of demand reduction could be 5-10% of demand for larger users • Requires follow up audits at least once every five years • May require multi-lingual training and information necessary for implementation • CVWD currently conducts water audits for golf courses and homeowners associations
	✓	B-16	Water efficient plumbing and irrigation systems	2	5	5	3	5	20	**3**	• Requires inter-agency cooperation • May require cities to develop related ordinances for implementation • Minimal additional savings on new construction
		B-17	Water waste patrols	1	2	5	2	2	12	**11**	• Proven effective for previous experiences by other agencies, a visible reminder to the community • Amount of water savings not quantifiable • Additional duties for the CVWD staff • Enforcement powers needed must be clearly specified in ordinances • Needs support from the public
		B-18	Alternative methods for PM10 (dust) control	1	2	4	3	3	13	**10**	• May require improved tillage practices • Amount of water savings is uncertain since alternative methods are not defined • Additional study needed to quantify benefits and costs

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
	✓	B-19	Restrict Turf on Golf Courses and Common Areas	4	4	5	4	2	19	**4**	• May affect the aesthetics of golf course and developments • Reduces irrigation demand • May require additional legal authority or close coordination with cities and county
		B-20	Evaporation retardants	1	2	3	3	4	13	**10**	• Requires cost effective measure/material • May adversely affect the aesthetics of lakes • May adversely affect irrigation water quality • Water savings are likely to be less than 1,000 acre-ft/yr since few open bodies of water exist.
✸	✓	B-21	Adopt Urban Best Management Practices	4	5	5	3	5	22	**1**	• Some BMPs have been implemented by CVWD • Demonstrates willingness to commit to additional water saving measures • Certain BMPs may not be applicable to CVWD service area • Level of demand reduction is uncertain for some measures • Use of water efficient plumbing and other BMPs are included in other options
✓	✓	B-22	Drought tolerant/avoidant landscaping and turf	3	5	5	4	5	22	**1**	• On-going CVWD program • Limits choices of landscaping varieties • Requires support from the public information program • Cost to implement can be relatively high unless landscaped with initial construction • May overlap with existing programs

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
		B-23	Outlaw water misters	1	4	2	5	2	14	**9**	• May not be a significant water use in the study area • Level of current water use and potential demand reduction is unknown • May require an energy efficient replacement • Use of misters may be considered a visible sign of water waste
		B-24	Restrict landscape impoundments	1	3	2	4	2	12	**11**	• May limit ideas or options for landscaping • Requires less maintenance • Water savings is uncertain
		B-25	Zoning restrictions	1	3	3	3	1	11	**12**	• Requires significant inter-governmental cooperation • May not be within CVWD's current legal authority • Potential adverse impacts on local economy • Restricts landowner's development potential and may violate property rights • Amount of water savings is uncertain
		B-26	Issue drainage permits and metering	1	3	4	3	3	14	**9**	• Existing drainage system precludes excessive drainage • No method to identify source of normal drainage • Adequate drainage is needed to maintain soil salt balance
		B-27	Higher power costs for groundwater production	1	2	5	5	2	15	**8**	• Increases cost of groundwater production • May reduce pumping if alternative source is available, but not quantifiable • May affect economic viability of certain farms • May not be viable for those areas that do not have access to canal water

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
✓	✓	B-28	Measure the amount of annual pumping by each groundwater user	1	5	5	5	4	20	**3**	• Existing program in Upper Valley • Does not directly reduce groundwater use • Increases cost to farmers for installation and maintenance •
		B-29	More efficient well drilling and development techniques	1	1	5	2	4	13	**10**	• Concept is not well defined • Amount of water savings is minimal at best
	✓	B-30	Evapotranspiration-based water rates	1	5	4	5	3	18	**5**	• Amount of water savings is not quantified • Could reduce summer demands by encouraging use of low water-using plants
	✓	B-31	Hire a water conservation coordinator	1	5	5	4	5	20	**3**	• Important element of any water conservation program
	✓	B-32	Require plumbing retrofit on sale	2	5	5	5	3	20	**3**	• Has been implemented in many other areas • Requires adoption of ordinances by cities • Savings based on number of dwelling units sold each year
	✓	B-33	Develop and enforce water efficient landscape ordinances	4	5	4	3	3	19	**4**	• Cities have adopted ordinances but level of compliance is uncertain • Requires close coordination with cities
	✓	C-1	Reuse agricultural drainage water (including CVSC water)	5	4	2	2	3	16	**7**	• May require membrane processes to remove TDS from water • Cost effectiveness depends on the salinity, but likely to be at least $400/acre-ft • Requires conveyance facilities to recharge sites • Brine disposal problems • Potential impacts on CVSC and Salton Sea • CVWD has filed to appropriate this water for use by 2013

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
✓	✓	C-2	Reuse fish farm effluent	4	4	4	4	2	18	**5**	• May be cost effective for agricultural use • Estimated unit cost <$100 per acre-ft • Existing program for some fish farms
		C-3	Reuse greenhouse effluent	2	2	3	2	2	11	**12**	• May not be cost effective • Availability of effluent is minimal
		C-4	Pump semi-perched groundwater	1	4	3	2	3	13	**10**	• May increase potential overdraft • Requires pumping and conveyance facilities • May need to deal with water rights and other regulatory issues • May require treatment; level of treatment depends upon source water quality • Could require brine disposal • Possible environmental impact
		C-5	Pump groundwater under Salton Sea	1	2	2	3	3	11	**12**	• Requires major pumping and conveyance facilities • Some treatment may be required, depending on water quality and end user requirements • Potential significant environmental impacts • May increase the overdraft problem • Could induce vertical migration of Salton Sea water into the underlying aquifer causing permanent degradation
		C-6	Pump Upper Basin groundwater to Lower Basin	1	4	1	3	4	13	**10**	• Requires costly pumping and conveyance facilities • Must consider the availability and quality of such water • Unknown treatment may be required, depending on water quality and end user requirements • Possible environmental impact • May cause increased overdraft problems in the Upper Basin

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
✓		C-7	Capture stormwater runoff	1	4	3	3	3	14	**9**	• Potential yield is uncertain; some water is already being captured in the channel • May need some treatment before percolating into the ground • Requires storage facilities capable of handling large volumes of water over a short duration • May need to comply with storm water discharge rules; potential water quality problems with runoff • Possible environmental impact
✓	✓	C-8	Construct on-site stormwater retention	1	5	3	3	5	17	**6**	• Recharge suitability depends on local hydrogeology • Requires additional facilities to collect runoff • May require significant changes in existing developments • Not effective for groundwater recharge in Lower Valley • Amount of yield is uncertain
✓	✓	C-9	Reuse municipal wastewater effluent – Upper Valley	1	5	4	3	4	17	**6**	• Tertiary treatment required for most uses • 450 mg/L TDS • May have additional regulatory requirements • Requires conveyance facilities • Possible environmental impact depending on use • Reuse in Upper Valley produces no additional recoverable water
	✓	C-10	Reuse municipal wastewater effluent – Lower Valley	5	5	4	3	4	21	**3**	• Tertiary treatment required for most uses • 450 mg/L TDS • May have extensive additional regulatory requirements • Requires conveyance facilities • Possible environmental impact depending on use • Reuse produces recoverable water

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
		C-11	Purchases water rights	1	4	2	3	2	12	**11**	• Requires specific institutional arrangements to implement • May be a lengthy process • May be difficult to identify suitable water sources for acquisition • Possible environmental impact • Uncertain supply availability • Requires significant investigation
		C-12	Desalt Salton Sea water	5	4	2	1	2	14	**9**	• Requires major treatment and conveyance facilities • Requires designated site for treatment • Requires brine disposal • Possible environmental impact • Very expensive • Regulatory requirements are unknown; may be difficult to convince DHS
		C-13	Reuse greywater	1	3	4	3	2	13	**10**	• Requires proper alteration of wastewater drainage connections and other features (to avoid cross-connection or interfere with water pressure) approved by local building or plumbing authority • Restricted type of reuse and application methods, depending on the water quality • On-site facilities required • Potential water savings may not be significant

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
	✓	D-1	Obtain additional SWP water entitlement	5	5	3	3	4	20	**3**	• CVWD has identified several potential sellers of SWP entitlements • Requires exchange with MWD to convey water to Upper Basin • Water quality is same as MWD's Colorado River Aqueduct due to exchange • Possible environmental impact in area of origin • May require water conveyance and recharge facilities • Could use existing recharge sites near Windy Point
✓	✓	D-2	Obtain SWP Turn-back Pool water	5	5	4	3	4	21	**2**	• CVWD is currently purchasing Turn-back Pool water • Requires exchange with MWD to convey water to Upper Basin • Water quality is same as MWD's Colorado River Aqueduct due to exchange • May require water conveyance and recharge facilities • Could use existing recharge sites near Windy Point • Water purchased only when not needed by others
		D-3	Purchase Central Valley Project transfers	1	5	3	3	3	15	**8**	• Amount of water available is uncertain • Requires agreements with several agencies • Requires exchange with MWD but provides little benefit to MWD • CVWD would compete with other agencies attempting to contract for water transfers • Transfer water could cost $200-$600/acre-ft plus conveyance
	✓	D-4	Obtain additional Colorado River water	5	5	3	4	3	20	**3**	• Includes current Quantification Settlement Agreement • Water supply would be produced through water transfers from other agencies • May reduce inflows to Salton Sea

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
		D-5	Recover Coachella Canal seepage (first 84 miles)	1	4	2	3	3	13	**10**	• Detailed studies are required to determine the disposition of the water • Poor water quality • Volume of recoverable water is uncertain • May be legal/institutional problems • Environmental impacts are uncertain • MWD and IID are currently investigating this project
		D-6	Lower Colorado River water supply	1	4	3	3	1	12	**11**	• Water is reserved for use by other users along the river • International Boundary & Water Commission involvement in expanded well field • Institutional problems allocating this water to agriculture • Amount of additional supply available to CVWD and associated benefits is uncertain
		D-7	Line Middle Reach of Coachella Canal	1	5	3	3	2	14	**9**	• Saved water will go to MWDSC under Quantification Settlement Agreement. Not available to CVWD • Project funded by State of California • Projected cost of water is about $250/acre-ft
		D-8	Colorado River transfers	1	4	3	3	1	12	**11**	• Amount of water available is uncertain • Would require USBR promulgation of regulations covering the Colorado River and water banking • Existing contracts may have to be renegotiated or amended • Significant institutional barriers in upper basin states assigning additional water to lower basin states • Environmental impacts are uncertain. Would require an EIS.

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
	✓	D-9	Obtain Water from USBR Yuma Desalter	5	4	3	3	2	17	**6**	• Cost of water may be relatively expensive compared to other options ($300-$400/acre-ft at Yuma) • Quality would be same as existing Canal water • Level of environmental compliance is uncertain • May require International Boundary & Water Commission approval
		D-10	Desalt Gulf of California water	5	1	1	1	1	9	**14**	• Requires major treatment and conveyance facilities • Requires designated site for treatment • Level of treatment depends upon end use requirements • Requires brine disposal • Possible significant environmental impacts • Very expensive • May require international treaties or agreements with Mexican government
		D-11	Purchase water from non-adjacent basins	1	3	1	3	2	10	**13**	• Must consider the availability of water • Few known outside sources of water • Requires additional institutional arrangements to implement • May require additional treatment depending upon water quality and end user requirements • Unknown cost • Possible significant environmental impacts

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
		D-12	Water tankering	3	2	2	1	1	9	**14**	• Must consider the availability of such water. Canada is currently opposing similar projects • Requires long term contracts with marine transportation firms • Air quality and visual impacts during tanker off-loading • Complex operations - requires an exchange with a coastal water purveyor • Never tried in California • Good quality water • Cost is comparable with seawater desalination based on bids received by Santa Barbara
		D-13	Obtain imported water through Indian tribes	1	3	3	3	2	12	**11**	• Concept has not been explored • Could compete with current CVWD supplies • Water quality would be same as existing imported supplies
✓	✓	E-1	Groundwater recharge by spreading	5	5	2	4	4	20	**3**	• Existing program in Upper Valley • Recharge sites must be located in areas without underlying clay layers to achieve recharge; requires detailed hydrogeologic investigation • Allows higher TDS water to directly enter aquifers • Relatively inexpensive compared to other recharge methods; estimated cost is about $50-100 per acre-ft • May require construction of facilities outside ID-1 boundary to obtain suitable geology • Use of Bureau of Reclamation or other Federal lands may require Federal approval and could trigger NEPA compliance

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
	✓	E-2	Groundwater recharge by injection	5	5	2	3	3	18	**5**	• Needs additional treatment/filtration to meet water quality requirements for injection • Minimal land constraints • May have additional regulatory requirements • Allows higher TDS water to directly enter aquifers • Relatively expensive compared to other recharge methods • Estimated unit cost $200-300 per acre-ft • Allows water to be recharged where needed
		E-3	Groundwater recharge by sub-surface drip irrigation	1	2	2	3	3	11	**12**	• Unproven technology • Yield uncertain • Would require extensive pilot testing • Adverse impacts on existing golf courses and agricultural lands
		E-4	Groundwater recharge by collector wells	1	3	2	4	3	13	**10**	• Has been applied in some locations • Would require extensive pilot testing • Amount of yield likely to be small
	✓	E-5	Provide in-lieu water to agricultural groundwater users within ID-1 boundaries	5	5	4	4	4	22	**1**	• Water may need to be filtered to remove turbidity for agricultural users if drip irrigation is to be employed • Requires additional institutional arrangement and regulatory negotiation to implement • Additional cost for on-farm treatment may be needed • Must consider the suitability of Canal water quality for crops grown within the boundaries • May require Bureau to reclassify certain unclassified or Class 6 lands to Class 1S to deliver water.

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
		E-6	Expand ID-1 boundary	4	3	3	4	1	15	**8**	• May be a lengthy process to finalize the expanded boundaries • Requires negotiation with Bureau of Reclamation approval to amend existing supply contracts • May require approval of other Colorado River users including IID.
	✓	E-7	Provide in-lieu water to fish farms	5	3	4	4	4	20	**3**	• May require heat source to maximize fish growth • May require treatment to meet water quality requirements • TDS level may be a concern • Unknown regulatory requirements • Possible environmental impact • Needs water conveyance facilities • Must consider the availability of canal water • Must be used within the ID-1 boundaries
✓	✓	E-8	Provide in-lieu water to golf courses	5	5	4	4	4	22	**1**	• May require additional treatment to meet water quality requirements • TDS level (800 mg/L) may be a concern • Canal water must be used within the ID-1 boundaries • Needs water conveyance facilities • Must consider the availability of Canal water • Several courses have been converted to use Canal water

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
		E-9	Provide in-lieu water to greenhouses	2	2	3	3	4	14	**9**	• May require heat source for plant growth • May require additional treatment to meet water quality requirements • TDS level (800 mg/L) may be a concern • Needs water conveyance facilities • Must be used within the 1D-1 boundaries • Must consider the availability of canal water • Potential savings in groundwater production may be limited
	✓	E-10	Provide in-lieu water to potable domestic users	5	5	4	3	3	20	**3**	• Needs new water conveyance facilities to potable water systems • Requires treatment to meet surface water treatment requirements • TDS level (800 mg/L) may be a concern • Must consider the availability of Canal water • Must be used within the ID-1 boundaries
	✓	E-11	Provide in-lieu water to non-potable domestic users	4	5	4	3	4	20	**3**	• TDS level may be a concern • Needs new water conveyance facilities to non-potable water systems • Canal water must be used within the ID-1 boundaries
	✓	E-12	Provide in-lieu water to duck ponds	3	5	4	4	4	20	**3**	• Needs water conveyance facilities • Must consider the water supply availability • Must be used within the ID-1 boundaries • Environmental enhancement • May not be an efficient use of canal water

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
	✓	E-13	Provide in-lieu water for industrial and power plant cooling use	3	5	4	4	4	20	**3**	• TDS is a significant concern • Type of industrial reuse is highly dependent upon water quality • Possible environmental impact • Must meet the minimum water quality requirements for cooling water • Only one power plant identified to date
	✓	E-14	Use Coachella Canal to convey non-federal water to users outside ID-1 boundaries	5	5	4	4	4	22	**1**	• Requires Bureau of Reclamation approval • Estimated unit cost $200-$500 per acre-ft • Needs source of non-federal water such as CVSC or municipal wastewater
		E-15	Irrigation pump back systems	1	3	3	4	3	14	**9**	• Little water available for pump-back • Must consider the residual quantity of water available to pump back • TDS and other water quality constituents may be a concern (accumulation of salts) • Additional power consumption • Possible environmental impact • Current irrigation practices produce little to no direct runoff
✓	✓	E-16	Fish farm internal reuse	3	4	4	4	4	19	**4**	• Unknown treatment need for internal reuse at the fish farm • Potential disease transmission • May require heat source • Needs internal plumbing retrofit • Several fish farms have implemented partial reuse

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
✓	✓	E-17	Cap flowing artesian wells	1	5	5	4	3	18	**5**	• Existence of flowing wells in the Salton Sea area is uncertain • Possible adverse environmental impact on Salton Sea due to reduced freshwater flow • Magnitude of lost groundwater is unknown • Costs and facility requirements are uncertain • Additional study is required
✓	✓	F-1	Canal water treatment provided by individual users	1	5	2	5	4	17	**6**	• Same as current supply system • Increased Colorado River use may cause higher groundwater TDS
✓	✓	F-2	Provide tertiary treatment for wastewater	1	5	4	4	4	18	**5**	• Required for most recycled water uses • CVWD & DWA currently operate tertiary facilities
	✓	F-3	Provide potable water treatment for surface supplies	1	5	3	3	5	17	**6**	• Required to meet surface water treatment rule • Mitigable environmental impacts from construction
		F-4	Desalting Canal water before use	1	5	1	2	2	11	**12**	• High cost of desalination • Requires large scale desalination facilities • Brine disposal is a major problem • Water quality improvement relative to current supply and groundwater impacts
		F-5	Desalting SWP Exchange water before use	1	5	1	2	2	11	**12**	• High cost of desalination • Requires large scale desalination facilities • Brine disposal is a major problem • Water quality improvement relative to current supply and groundwater impacts

Table B-2
Screening of Potential Water Management Elements

Existing Program	Shortlisted	Element No.	Element Name	Ability to Reduce Overdraft	Technically Supportable	Potential Environ-mental Impacts	Expected Costs	Legal & Regulatory Impacts	TOTAL POINTS	RANKING	Assessment Information
		F-6	Extend SWP to the Coachella Valley	1	5	1	2	2	11	**12**	• High cost of new conveyance facilities • Other SWP contractors are currently building East Branch extension • Minimal opportunities for joint facilities • Water quality improvement relative to current supply and groundwater impacts

✸ Although not a formally adopted program, CVWD has implemented some of the measures included in the BMPs.

Evaluation

Following tabulation of the scores, the elements were ranked from highest scoring to lowest. Those measures having a score of 15 or less (ranking of 8 or lower) were screened out. Based on this screening, 41 options were eliminated from further consideration due to economic and social impacts, environmental impacts, institutional/governmental feasibility, cost, and/or lack of ability to meet Plan goals and objectives. The remaining 44 short listed options indicated in **Table B-3** warranted further consideration. These elements were then considered for inclusion in a variety of alternative management plans. Any element that does not logically fit into any of the alternatives is eliminated from further consideration.

FORMULATION OF ALTERNATIVES

The goal of alternatives formulation is to identify potential alternative management plan configurations that take into account the District's water management goals and objectives as well as incorporating the viable management elements identified in the previous section of this appendix. The basis for all alternatives is CVAG/SCAG-98 growth projections and assumed changes in agricultural land use consistent with existing city and county general plans. These assumptions are presented in the Section 4 of the Water Management Plan.

CONCEPTUAL ALTERNATIVES

Potential management planning alternatives include:

- No Project
- Pumping Restrictions
- Demand Management
- Groundwater Recharge
- Source Substitution
- Combinations of the Above

The "No Project" alternative represents a baseline condition that involves a continuation of the current trend toward increasing urban and agricultural water demands and increasing groundwater production. The No Project alternative will be used to evaluate the effectiveness of other proposed management alternatives.

Pumping restrictions consist of legal or administrative limitations on the amount of groundwater that can be pumped from a basin. Pumping restrictions are typically implemented when no other action will control overdraft. Pumping restrictions may also be implemented to ensure an equitable distribution of production between users.

Table B-3
Short-listed Water Management Elements

Element No.	Element Description
A	**Pumping Restrictions**
A-2	Stipulated water rights decree
B	**Demand Management**
B-1	Adopt Agricultural Best Management Practices
B-4	Mandate or encourage efficient irrigation methods
B-8	Use moisture sensors or other plant stress indicators
B-9	Prohibitions on wasteful use
B-10	No net demand increase
B-11	Plan check new irrigation systems
B-12	Public education
B-13	Tiered or Seasonal Water Pricing
B-14	Replenishment assessments
B-15	Domestic water user audits
B-16	Water efficient plumbing and irrigation systems
B-19	Restrict Turf on Golf Courses and Common Areas
B-21	Adopt Urban Best Management Practices
B-22	Drought tolerant/avoidant landscaping and turf
B-28	Measure the amount of annual pumping by each groundwater user
B-30	Evapotranspiration-based water rates
B-31	Hire a water conservation coordinator
B-32	Require plumbing retrofit on sale
B-33	Develop and enforce water efficient landscape ordinances
C	**Local Water Supplies**
C-1	Agricultural drainage water (including CVSC water)
C-2	Reuse fish farm effluent
C-8	Construct on-site stormwater retention
C-9	Municipal wastewater effluent - Upper Valley
C-10	Municipal wastewater effluent - Lower Valley
D	**Imported Water Supplies**
D-1	Purchase additional SWP water entitlement
D-2	Purchase SWP Turn-back Pool water
D-4	Obtain additional Colorado River water
D-9	Obtain Water from USBR Yuma Desalter
E	**Water Use Actions**
E-1	Groundwater recharge by spreading
E-2	Groundwater recharge by injection
E-5	Provide in-lieu water to agricultural groundwater users within ID-1 boundaries
E-7	Provide in-lieu water to fish farms
E-8	Provide in-lieu water to golf courses
E-10	Provide in-lieu water to potable domestic users
E-11	Provide in-lieu water to non-potable domestic users
E-12	Provide in-lieu water to duck ponds
E-13	Provide in-lieu water for industrial and power plant cooling use
E-14	Use Coachella Canal to convey non-federal water to users outside ID-1 boundaries
E-16	Fish farm internal reuse
E-17	Cap flowing artesian wells
F	**Water Quality Actions**
F-1	Canal water treatment provided by individual users
F-2	Provide tertiary treatment for wastewater
F-3	Provide potable water treatment for surface supplies

Demand management involves the reduction in water demands for urban and agricultural uses. The typical methods for demand management include various water conservation measures to reduce demands. However, more strict demand management measures could include changes in land use planning and allowable development, fallowing of agricultural land and development restrictions. The viable candidate water conservation measures that could be implemented were considered in formulating the alternatives. The level of implementation of specific water conservation measures would be determined in more detail in a separate water conservation plan during the implementation of the eventual preferred alternative.

Groundwater recharge concepts involve providing new sources of water supply to directly increase the available supply of groundwater. An example of source augmentation is the importation of additional water supplies from the Colorado River or the State Water Project for groundwater recharge.

Source substitution involves changing users from their existing groundwater sources to another source that may be more readily available. These elements result in indirect or in-lieu groundwater recharge as groundwater is left in the ground to accumulate in storage. In most cases, water supplies that are not currently fully utilized could replace current groundwater usage. Examples of source substitution include supplying Coachella Canal water for fish farms or agricultural irrigation and supplying reclaimed municipal wastewater for golf course irrigation.

Combination alternatives include various combinations of the four major groups of management elements. For example, demand management elements could be combined with source substitution or source augmentation elements to achieve greater success in reducing overdraft.

Conceptual Alternative 1 - No Project

As the name suggests, the approach of the No Project Alternative is to maintain the current water management activities. In other words, the No Project Alternative would not involve any additional management actions beyond the on-going activities, which include:

- Continued groundwater recharge in the Upper Valley at historical average levels
- Providing Canal water and recycled wastewater effluent to golf courses and agriculture at existing levels
- Domestic, golf course, and agricultural water conservation practices
- Continued per user water use based on current levels

The water management options included in Conceptual Alternative 1 - No Project are assumed to be included under each of the other Plan alternatives. A “No Project” alternative is required under CEQA regulations for evaluation in the PEIR.

Conceptual Alternative 2 – Pumping Restrictions

The approach under Conceptual Alternative 2 is to meet the goals and objectives of the Plan using court-ordered adjudication as the primary management option. Adjudication is the process in which the water rights of the basin are allotted by the court to individual groundwater pumpers. Adjudication would force groundwater pumping to be reduced throughout the Coachella Valley to the point where basin inflows and outflows balance. This balance point, also known as perennial yield, is the amount of groundwater that can be pumped each year without adversely depleting the basin, lowering long-term groundwater levels, or degrading water quality. The exact limit of individual well pumpage would be determined in the adjudication process. To eliminate the current and projected overdraft, pumping would need to be reduced to about 40 percent of the No Project production to balance the basin. The pumping reduction would be substantially higher in the Lower Valley since the yield of that portion of the Valley is very low.

Conceptual Alternative 3 – Demand Management

Under Conceptual Alternative 3, the approach is to manage water demand by maximizing water conservation for urban, golf course, and agricultural uses. The primary features of Conceptual Alternative 3 would include:

- Extensive water conservation measures for urban water use
- Reduction of non-agricultural irrigation demand through mandatory xeriscaping for new residential, commercial, and golf course properties
- Extensive conservation by agricultural water users through the use of more efficient irrigation technology and application methods

To eliminate current and future overdraft, water conservation would need to reduce demands to approximately 40 percent of No Project levels.

Conceptual Alternative 4 – Groundwater Recharge

The approach under Conceptual Alternative 4 is to use groundwater recharge as the sole method of meeting the Plan's goals and objectives. The primary features of Conceptual Alternative 4 include increasing groundwater recharge within the Upper and Lower Valleys as necessary to eliminate the overdraft. Three potential sites in the Upper Valley were considered for recharge: the existing Whitewater River Spreading Facility, a new site near the District's WRP-7 wastewater plant and a new site in the Palm Desert-Indian Wells area. Potential sites considered in the Lower Valley were Dike 4 located south of CVWD's Lake Cahuilla and two sites on the Martinez Canyon alluvial fan. To eliminate overdraft, groundwater recharge would need to be on the order of 250,000 to 300,000 acre-ft/yr higher than No Project levels.

Conceptual Alternative 5 – Source Substitution

The approach of Conceptual Alternative 5 is to maximize the use of alternate water supply sources in lieu of groundwater as a means of reducing overdraft. This would be accomplished by maximizing the use of Coachella Canal water, recycled wastewater and recovery of water from the CVSC. The primary features of Conceptual Alternative 5 would include supplying:

- In-lieu water to agricultural groundwater pumpers,
- In-lieu water for golf course irrigation, and
- Treated water to domestic water users within ID-1

The primary alternate sources of water supply include Canal water, SWP Exchange water, recycled wastewater effluent from the wastewater reclamation plants within the Valley and desalted agricultural drainage. Source substitution would need to reduce groundwater pumping by about 250,000 acre-ft/yr above No Project levels to eliminate overdraft.

Conceptual Alternative 6 – Combination Alternative

Conceptual Alternative 6 utilizes an approach where demand management, pumping restrictions, groundwater recharge, and source substitution options are combined to formulate distinct combination alternatives. The potential combinations of these approaches are shown in **Table** B-4.

Table B-4
Potential Combination Alternatives

Combination Alternative	Demand Management	Pumping Restrictions	Groundwater Recharge	Source Substitution
6A	●	●		
6B	●		●	
6C	●			●
6D		●	●	
6E		●		●
6F			●	●
6G	●	●	●	
6H	●		●	●
6I	●	●		●
6J		●	●	●
6K	●			●

Of these ten potential combinations, those involving pumping restrictions (adjudication) were eliminated because adjudication could be overlaid on any of the combination alternatives. This leaves Combinations "6B", "6C", "6F" and "6H" as unique alternatives. Since some level of demand reduction is an essential part of wise water management, Combination "6F" is eliminated from further consideration. One additional alternative, designated "6K" has been added that evaluates the ability to rely solely on local resources to eliminate overdraft. Each of these remaining four combination alternatives (6B, 6C, 6H and 6K) is described below.

Conceptual Alternative 6B – Demand Management and Groundwater Recharge

Groundwater recharge within both the Upper and Lower Valleys would be emphasized in conjunction with additional demand management. The primary elements of this combination alternative would include:

- Additional urban, golf course, and agricultural water conservation measures
- Direct recharge of Upper Valley groundwater basin with additional imported Colorado River water exchanged for SWP water
- Lower Valley groundwater recharge with Coachella Canal water

Conceptual Alternative 6C – Demand Management and Source Substitution

Conceptual Alternative 6C emphasizes the demand management options included in Conceptual Alternative 3 in conjunction with the increased use of recycled water by Upper and Lower Valley golf courses, urban, and agricultural users. The primary elements of this combination alternative would include:

- Implementation of extensive water conservation measures for urban water use
- Reduction of non agricultural irrigation demand through mandatory xeriscaping for new residential, commercial, and golf course properties
- Increased conservation by agricultural water users through the use of more efficient irrigation technology and application methods
- Increased recycled water use by Upper and Lower Valley golf courses, homeowner associations, and agricultural users
- Increased use of Canal water for golf courses, agriculture and potable use. Filtration is required for potable use

Conceptual Alternative 6H – Demand Management, Groundwater Recharge and Source Substitution

Conceptual Alternative 6H would emphasize source substitution management options along with additional demand management and source augmentation efforts. This combination alternative would include:

- Additional urban, golf course, and agricultural water conservation measures

- Supplying agricultural groundwater users within ID-1 with Canal water
- Delivering Canal water for golf course irrigation
- Supplying domestic water users within ID-1 with treated Canal water
- Encouraging the use of additional recycled water by golf courses
- Maintaining Upper Valley groundwater recharge at current levels
- Groundwater recharge in the Lower Valley

Conceptual Alternative 6K – Demand Management with Local Resources Only

Conceptual Alternative 6K would emphasize the demand management options included in Conceptual Alternative 3 in conjunction with maximizing the recovery of local water by Upper and Lower Valley golf courses, urban, and agricultural users. No additional Canal water or SWP Exchange water would be used. The primary elements of this alternative include:

- Implementation of extensive water conservation measures for urban water use
- Reduction of non-agricultural irrigation demand through mandatory xeriscaping for new residential, commercial, and golf course properties
- Increased conservation by agricultural water users through the use of more efficient irrigation technology and application methods
- Increased recycled water use by Upper and Lower Valley golf courses, homeowner associations, and agricultural users
- Desalination and reuse of agricultural drainage from the CVSC

Table B-5 provides a summary of the selected water management elements included with each potential Plan alternative. The options included in Conceptual Alternative 1 – No Project represent baseline conditions and are included in each of the other alternatives.

Table B-5
Formulation of Potential Water Management Plan Alternatives

	Element	Alt 1 No Project	Alt 2 Pumping Restrictions	Alt 3 Demand Management	Alt 4 Groundwater Recharge	Alt 5 Source Substitution	Alt 6B Demand Mgmt and Source Substitution	Alt 6C Demand Mgmt and Groundwater Recharge	Alt 6H Demand Mgmt, Groundwater Recharge and Source Substitution	Alt 6K Demand Mgmt with Local Resources Only
A-2	Stipulated water rights decree		●							
B-1	Adopt Agricultural Best Management Practices			●			●	●	●	●
B-4	Mandate or encourage efficient irrigation methods	○	○	●	○	○	●	●	●	●
B-8	Use moisture sensors or other plant stress indicators			●			●	●	●	●
B-9	Prohibitions on wasteful use	○	○	●	○	○	●	●	●	●
B-10	No net demand increase			●						
B-11	Plan check new irrigation systems	○	○	●	○	○	●	●	●	●
B-12	Public education	○	○	●	○	○	●	●	●	●
B-13	Tiered or Seasonal Water Pricing			●			●	●	●	●
B-14	Replenishment assessments	○	○	●	●	●	●	●	●	●
B-15	Domestic water user audits			●			●	●	●	●
B-16	Water efficient plumbing and irrigation systems			●			●	●	●	●
B-19	Restrict Turf on Golf Courses and Common Areas			●			●	●	●	●
B-21	Adopt Urban Best Management Practices			●			●	●	●	●
B-22	Drought tolerant/avoidant landscaping and turf	○	○	●	○	○	●	●	●	●
B-28	Measure the amount of annual pumping by each groundwater user	○	●	●	○	○	●	●	●	●
B-30	Evapotranspiration-based water rates			●			●	●	●	●
B-31	Hire a water conservation coordinator			●			●	●	●	●
B-32	Require plumbing retrofit on sale			●			●	●	●	●
B-33	Develop and enforce water efficient landscape ordinances			●			●	●	●	●
C-1	Agricultural drainage water (including CVSC water)					●	●	●	●	
C-2	Reuse fish farm effluent	○	○	○	●	●	○	○	○	●

○ Existing level of implementation ● Increased level of implementation

Table B-5
Formulation of Potential Water Management Plan Alternatives

Element		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6B	Alt 6C	Alt 6H	Alt 6K
		No Project	Pumping Restrictions	Demand Management	Groundwater Recharge	Source Substitution	Demand Mgmt and Source Substitution	Demand Mgmt and Groundwater Recharge	Demand Mgmt, Groundwater Recharge and Source Substitution	Demand Mgmt with Local Resources Only
C-8	Construct on-site stormwater retention	○	○	○	○	○	○	○	○	○
C-9	Municipal wastewater effluent - Upper Valley	○	○	○	○	●	●	○	●	●
C-10	Municipal wastewater effluent - Lower Valley					●	●		●	●
D-1	Obtain additional SWP water entitlement				●	●	●	●	●	
D-2	Obtain SWP Turn-back Pool water	○	○	○	●	●	○	●	●	○
D-4	Obtain additional Colorado River water				●	●	●	●	●	
D-9	Obtain Water from USBR Yuma Desalter									
E-1	Groundwater recharge by spreading	○	○	○	●	○	○	●	●	○
E-2	Groundwater recharge by injection				●			●		
E-5	Provide in-lieu water to agricultural groundwater users within ID-1 boundaries	○	○	○	○	●	●	○	●	●
E-7	Provide in-lieu water to fish farms					●	●		●	
E-8	Provide in-lieu water to golf courses	○	○	○	○	●	●	○	●	●
E-10	Provide in-lieu water to potable domestic users					●	●		●	
E-11	Provide in-lieu water to non-potable domestic users					●	●		●	
E-12	Provide in-lieu water to duck ponds					●	●		●	
E-13	Provide in-lieu water for industrial and power plant cooling use					●	●		●	
E-14	Use Coachella Canal to convey non-federal water to users outside ID-1 boundaries					●	●		●	●
E-16	Fish farm internal reuse	○	○	○	○	●	●	○	○	●
E-17	Cap flowing artesian wells			●	●	●	●	●	●	●
F-1	Canal water treatment provided by individual users	○	○	○	○	○	○	○	○	○
F-2	Provide tertiary treatment for wastewater	○	○	○	○	●	●	○	●	●
F-3	Provide potable water treatment for surface supplies					●	●		●	

○ Existing level of implementation ● Increased level of implementation

EVALUATION OF CONCEPTUAL ALTERNATIVES

Evaluation Criteria

With the exception of Conceptual Alternative 1 – No Project, a preliminary evaluation of each alternative was performed to determine which alternatives should be formally considered and evaluated in the Water Management Plan. A "No Project" alternative must be included in the PEIR in accordance with CEQA regulations.

At a minimum, a potential alternative must be capable of eliminating the overdraft within the Upper and Lower Valley in order to be formally evaluated in the Water Management Plan. Other factors such as conjunctive use opportunities and potential economic impacts were considered during the preliminary evaluation.

The evaluation process involved technical analyses coupled with professional judgment and experience. The technical analyses relied on preliminary results from the Coachella Valley groundwater model (model), described in detail within Appendix C, for the period 2000 through 2015. In addition, economic impact analyses performed by BBC Research and Consulting (BBC, 2000) were used in the evaluation

Evaluation Results

Conceptual Alternative 2 – Pumping Restrictions

The overdraft throughout the Coachella Valley could be eliminated through aggressive adjudication of groundwater pumping. These severe reductions in groundwater pumping would likely result in a future of minimal or negative economic growth. The potential environmental impacts of this option would be relatively low: however, increased groundwater levels would lead to higher flows to the Salton Sea. This alternative provides no opportunities for conjunctive use of imported and local water supplies beyond the amounts provided by the existing recharge program in the Upper Valley. This alternative may not meet District objectives of minimizing adverse economic impacts if severe reductions in groundwater pumping without alternate supplies require dramatic changes in the current and future levels of development to meet the necessary pumping reductions. This alternative will be included as a Plan alternative to provide a contrast with other alternatives and to determine whether the environmental impacts might be reduced with this approach.

Conceptual Alternative 3 – Demand Management

While extensive urban, golf course, and agricultural conservation measures included in Conceptual Alternative 3 would greatly reduce the groundwater pumping, these measures alone would not be capable of eliminating the existing overdraft. The maximum possible reduction in demands has been estimated to be about 235,000 acre-ft/yr. While this amount may be close to the required overdraft reduction, it does not consider the interaction between basin yield and return flows. Modeling studies performed for the Plan indicate that return flows are about 33 percent of demand. If conservation reduces applied water (demands) by 235,000 acre-ft/yr, then return flows would decrease by about 76,000 acre-ft/yr, resulting in a net decrease in overdraft of

159,000 acre-ft/yr. Thus, conservation alone does not eliminate sufficient overdraft to meet the District's objectives. This alternative provides no opportunities for conjunctive use of imported and local water supplies beyond the amounts provided by the existing recharge program in the Upper Valley.

As demands increase, the overdraft condition would continue and result in adverse impacts such as reduced groundwater levels, land subsidence, salt water intrusion from the Salton Sea, and other water quality impacts. Further reductions in groundwater levels would increase pumping costs throughout the Valley. In addition, mandatory conservation practices such as xeriscaping and turf restrictions could adversely impact future economic development. Based on this evaluation, this alternative will not be included as a Plan alternative.

Conceptual Alternative 4 – Groundwater Recharge

The Upper Valley contains relatively permeable soil layers, making artificial groundwater recharge highly effective. The groundwater recharge capacity within the Upper Valley at the existing Whitewater Recharge Facility is approximately 300,000 acre-ft/yr. This is sufficient to eliminate the entire future overdraft. Since only about 90,000 acre-ft/yr of future overdraft occurs in the Upper Valley, it is reasonable to attempt to meet this portion of the overdraft from the Whitewater Facility. However, the distance between the recharge basins in the north and the centers of production in the middle of the basin is more than 15 miles. The transmissivity of the basin is not high enough to move sufficient water over this distance without continued groundwater level declines. Therefore, groundwater gradients would steepen and levels in the Palm Desert area would continue to decline. A review of alternative recharge sites in the Upper Valley indicated one site that could potentially work, but it is slated for a major development. The other site located near the District's WRP-7 has hydrogeologic constraints that may limit large-scale recharge at that location.

Within the Lower Valley, a 100 to 200 foot-thick aquitard, located directly above the Lower Aquifer, restricts groundwater flow between the Upper and Lower Aquifers. This geologic layer typically consists of clay and sandy clay with discontinuous sand lenses. Although the aquitard restricts the majority of groundwater flow, it is not a complete barrier. Small quantities of water pass between the Lower Aquifer and the Upper Aquifer.

Due to the aquitard, groundwater recharge in the Lower Valley can only be performed near the margins of the Lower Valley, where aquitard is absent. Preliminary investigations estimate the groundwater recharge capacity within the Lower Valley at between 60,000 acre-ft/yr and 100,000 acre-ft/yr. To eliminate future overdraft solely with groundwater recharge, recharge in excess of 160,000 acre-ft/yr would be required. This level of recharge is much greater than is believed possible in the Lower Valley.

This alternative could provide opportunities for conjunctive use of imported and local water supplies beyond the amounts provided by the existing recharge program in the Upper Valley. However, the physical limitations on recharge may limit the ability to recharge larger quantities of water in wet periods. Given the physical limitations associated with groundwater recharge within both the Upper and Lower Valley and the inability to eliminate future overdraft, Conceptual Alternative 4 will not be included as a Plan alternative.

Conceptual Alternative 5 – Source Substitution

Theoretically, there is sufficient potential for source substitution to eliminate the entire overdraft. Future groundwater pumping is projected to be 555,000 acre-ft/yr under No Project conditions. Switching about half of this production to alternate sources may be able to eliminate the overdraft. However, this approach would require the construction of extensive facilities to treat and distribute water to the identified uses. These facilities would be costly to construct and have significant adverse impacts on the environment. This alternative provides limited opportunities for conjunctive use of imported and local water supplies. Water users would have access to both supplies; however, available supplies in excess of demand cannot be stored limiting conjunctive use potential. Based on the extent of facilities required, this conceptual alternative is eliminated.

Conceptual Alternative 6B – Demand Management and Groundwater Recharge

This alternative would eliminate the overdraft by demand reduction and groundwater recharge. After deducting for demand management, at least 75,000 acre-ft/yr of additional groundwater recharge would be required in the Upper Valley. To maintain outflow to the Lower Valley, this recharge amount should be higher. This would result in total recharge in the Upper Valley averaging at least 125,000 acre-ft/yr, which is well within the capacity of the Whitewater Spreading facility. The long distance between the recharge basins and the pumping areas north of Point Happy would steepen the groundwater gradient causing groundwater levels to decline further. This may exacerbate the potential for subsidence in the area north of Point Happy.

In the Lower Valley, at least 150,000 acre-ft/yr of recharge would be needed to eliminate overdraft. Achieving this level of recharge in the Lower Valley may be difficult given the hydrogeologic constraints caused by the extensive clay layers. Initial estimates indicate the groundwater recharge potential in the Lower Valley is on the order of 60,000 – 100,000 acre-ft/yr. The estimated level of recharge in the Lower Valley does not appear to be adequate to eliminate the overdraft. This alternative provides opportunities for conjunctive use of imported and local water supplies in the Upper Valley but may have less potential in the Lower Valley due to limited recharge capability. Although this alternative may be less disruptive on the regional economy and the environment, it does not appear to be capable of meeting the overdraft reduction goal by itself. Therefore, this option is eliminated from further consideration.

Conceptual Alternative 6C – Demand Management and Source Substitution

This alternative could be configured to eliminate basin overdraft. Assuming a moderate amount of conservation (65,000 – 70,000 acre-ft/yr), approximately 200,000 acre-ft/yr of source substitution would be required. If the District obtains 50,000 – 100,000 acre-ft/yr of additional SWP entitlement water, the remaining 100,000 – 150,000 acre-ft/yr would need to come from the Colorado River or from recycled municipal wastewater or agricultural drainage. This level of supply appears to be obtainable.

The source substitution portion of this alternative may be more problematic. Although there is adequate groundwater demand (over 500,000 acre-ft/yr after conservation), not all of this groundwater can be economically converted to other sources. Most agricultural groundwater use inside ID-1 could be converted to Canal water provided distribution facilities are constructed to supply the portion of the Oasis area that is not currently served with Canal water. Conversion of most municipal use in the Lower Valley could be accomplished by constructing water treatment plants and transmission pipelines to convey Canal water. However, the only source of imported water for the Upper Valley is SWP Exchange water, which is delivered to the northwest end of the Valley. Major pipeline and treatment facilities would need to be constructed to convey SWP Exchange water from Whitewater southeasterly to serve treated water to most of the Upper Valley area. Such a pipeline would be very costly and could cause extensive environmental disruption. Alternatively, the Coachella Canal could be used to convey SWP Exchange water to uses in the middle portion of the Valley. New transmission and distribution facilities would still be required.

Preliminary groundwater modeling results indicate that source substitution could eliminate the overdraft and the water level response would be comparable to other combination alternatives. Therefore, from a groundwater response perspective, this alternative is satisfactory. It also offers the option for conjunctive use by providing an imported water source while maintaining the ability to use groundwater during droughts. However, opportunities to use supplies in excess of demands (such as surplus water years) limit the ability of the basin to store water for drought periods. Surplus water is normally available in large quantities over relatively short periods. The ability of source substitution facilities to take water are limited by water demands. Groundwater recharge provides the extra capacity to store extra water when it is available.

This alternative may provide the opportunity to reduce potential adverse water quality effects in those portions of the Lower Valley underlain by agricultural drains. Applied Canal water would return to the drain system and flow to the Salton Sea, avoiding direct returns of salt to the groundwater basin. However, over 90 percent of the agricultural demand in the area served by drains currently uses Canal water. In those areas of the Valley where most of the new imported water might be substituted for groundwater (municipal and golf course uses in the Upper and Lower Valley and agricultural use in the Oasis area), returns from use flow directly to the groundwater basin carrying salts to the deep aquifers. Use of Canal water in these areas would increase the TDS of the return flows from the current 1,100 mg/l for groundwater use to about 2,400 mg/l.

In light of the need for extensive distribution systems and the minimal potential for minimizing water quality impacts, this option is eliminated from further consideration.

Conceptual Alternative 6H – Demand Management, Groundwater Recharge and Source Substitution

This alternative involves achieving a balance between demand management, groundwater recharge and source substitution. Recharge potential in the Upper Valley is similar to that anticipated in Conceptual Alternative 6C. As discussed above, the long distance between the Whitewater Spreading facility and the major pumping areas north of Point Happy may result in continued groundwater declines in spite of increased recharge. Therefore, it may be useful to provide recharge at an alternate location closer to the Palm Desert area or to provide source substitution. As discussed in Alternative 4, alternative sites in the lower portions of the Upper Valley do not appear viable. Consequently, source substitution must be considered in this area. Since the area west of Washington Street and south of Interstate 10 is not eligible to receive

Canal water, SWP Exchange water would need to be delivered to this area. This could entail either the construction of a long pipeline from the Whitewater turnout or an exchange for Canal water.

Potential limitations on the amount of water that can be recharged in the Lower Valley lead to the need for a combination of recharge and source substitution. With an overdraft target of about 150,000 acre-ft/yr (after deducting for conservation), a balanced approach for eliminating this overdraft might include roughly equal amounts of recharge and source substitution. This would reduce the amount of land disturbed for pipeline construction and provide sufficient flexibility to meet demands in both wet and dry years by providing conjunctive use opportunities.

This balanced approach for reducing overdraft is evaluated further in the Water Management Plan and PEIR.

Conceptual Alternative 6K – Demand Management with Local Resources Only

This alternative potentially offers the opportunity of eliminating the overdraft without the use of additional imported water. This could be an advantage if sources of imported water cannot be obtained. An inventory of local resources indicates that about 70,000 acre-ft/yr of unused local water is available under No Project conditions. This assumes that all drain flow from the Coachella Valley is recovered, an assumption that is unrealistic given the distribution of drain flow and the need for freshwater flows into the Salton Sea. If all of this available water were recovered, approximately 180,000 acre-ft/yr of net conservation would be required to eliminate overdraft. To achieve this level of net conservation, over 260,000 acre-ft/yr of conservation would be required, which is greater than is believed possible for the Valley. This alternative provides no opportunities for conjunctive use of imported and local water supplies beyond the amounts provided by the existing recharge program in the Upper Valley.

Although this conceptual alternative does not meet the objective of eliminating overdraft, it is evaluated further because it is the only option relying totally on local resources. This provides a basis for comparing the environmental impacts of an alternative that uses no additional imported water.

SUMMARY OF EVALUATION RESULTS

Based on the evaluation presented above the following alternatives are carried forward for more detailed evaluation in the Water Management Plan:

- Conceptual Alternative 1 – No Project
- Conceptual Alternative 2 – Pumping Restrictions
- Conceptual Alternative 6H –Demand Management, Groundwater Recharge and Source Substitution
- Conceptual Alternative 6K – Demand Management with Local Resources Only

Conceptual Alternative 6K has been redesignated Alternative 3 while Conceptual Alternative 6H has been redesignated Alternative 4 in the Water Management Plan and PEIR. The detailed contents of these four alternatives are discussed in Section 5 of the Water Management Plan.

Appendix C
Coachella Valley Groundwater Model

INTRODUCTION

Purpose and Scope

The purpose of the model is to evaluate present and future management options in the Coachella Valley. The model is designed to simulate groundwater flow from San Gorgonio Pass to the Salton Sea. The three-dimensionality of the model allows for good representation of the complex aquifer system in the Lower Valley, improved estimates of pumpage and recharge, representation of the massive drainage network underlying agricultural lands, as well as interaction between the groundwater basin and the Salton Sea.

Previous Investigations

Previous hydrologic studies conducted in Coachella Valley include Mendenhall (1909), Kocher and Harper (1927), Pillsbury (1941), Huberty et al. (1948), and substantial work by the California Department of Water Resources (DWR) (1964; 1979). Detailed descriptions of the geology and hydrogeology of the Coachella Valley groundwater basin are provided in DWR report "Coachella Valley Investigation" (1964). USGS studies in the Upper Valley, including the development of groundwater flow and transport models, include those of Tyley (1974), Swain (1978), and Reichard and Meadows (1992). These studies were motivated chiefly by the need to better understand and forecast effects of artificial recharge at the Whitewater Spreading Facility, including water quality impacts of the recharge. However, no previous hydrologic modeling analysis had included the Lower Valley, and very few estimates of pumpage or returns from irrigated agriculture had previously been determined. Consequently, a major element of this model study was to develop a model that included both the Upper and Lower Valleys, and to develop historical estimates of agricultural groundwater pumpage in the Lower Valley.

MODEL CONSTRUCTION

The model is implemented with the computer code MODFLOW (McDonald and Harbaugh 1988) because it is well suited for simulating groundwater flow in the Coachella Valley, and because of its widespread acceptance in both scientific and legal arenas. MODFLOW simulates groundwater flow in three dimensions using a block-centered, finite-difference approach with a node spacing of 1,000 feet in the x-y plane, and variable vertical node spacing representing variable thickness of the corresponding aquifer or aquitard intervals. The area covered by the groundwater model is shown in **Figure 1**. **Figure 2** shows the groundwater basin boundary and generalized geology of the Coachella Valley.

Boundary Conditions

Boundary conditions are used anywhere in the model domain to account for water entering or leaving that domain. Boundary conditions are used to model sources of water such as recharge ponds, subsurface inflow from adjacent basins, and wells and drains. Model input data describing each set of boundary conditions were developed for the period 1936 to 1996.

The active area of the model is bounded by the San Gorgonio Pass up slope (northwest) and the Salton Sea down slope (southeast), the San Jacinto and Santa Rosa Mountains and associated canyons along the Southwest margin, and the Banning and San Andreas faults along the northeast margin. The base of the model represents the depth to which freshwater actively circulates. In the Upper Valley, the thickness of the active flow system is approximately 1,000 ft (Reichard and Meadows 1992). In the Lower Valley, the thickness of the active flow system ranges from 1,000 ft to over 1,600 ft based on well logs and geologic characterizations from DWR (1964). The upper boundary of the flow system is the water table; processes affecting this boundary include recharge, drains, and evapotranspiration from natural vegetation.

Figure 1
Base Map Showing Model Area and Location of Selected Wells

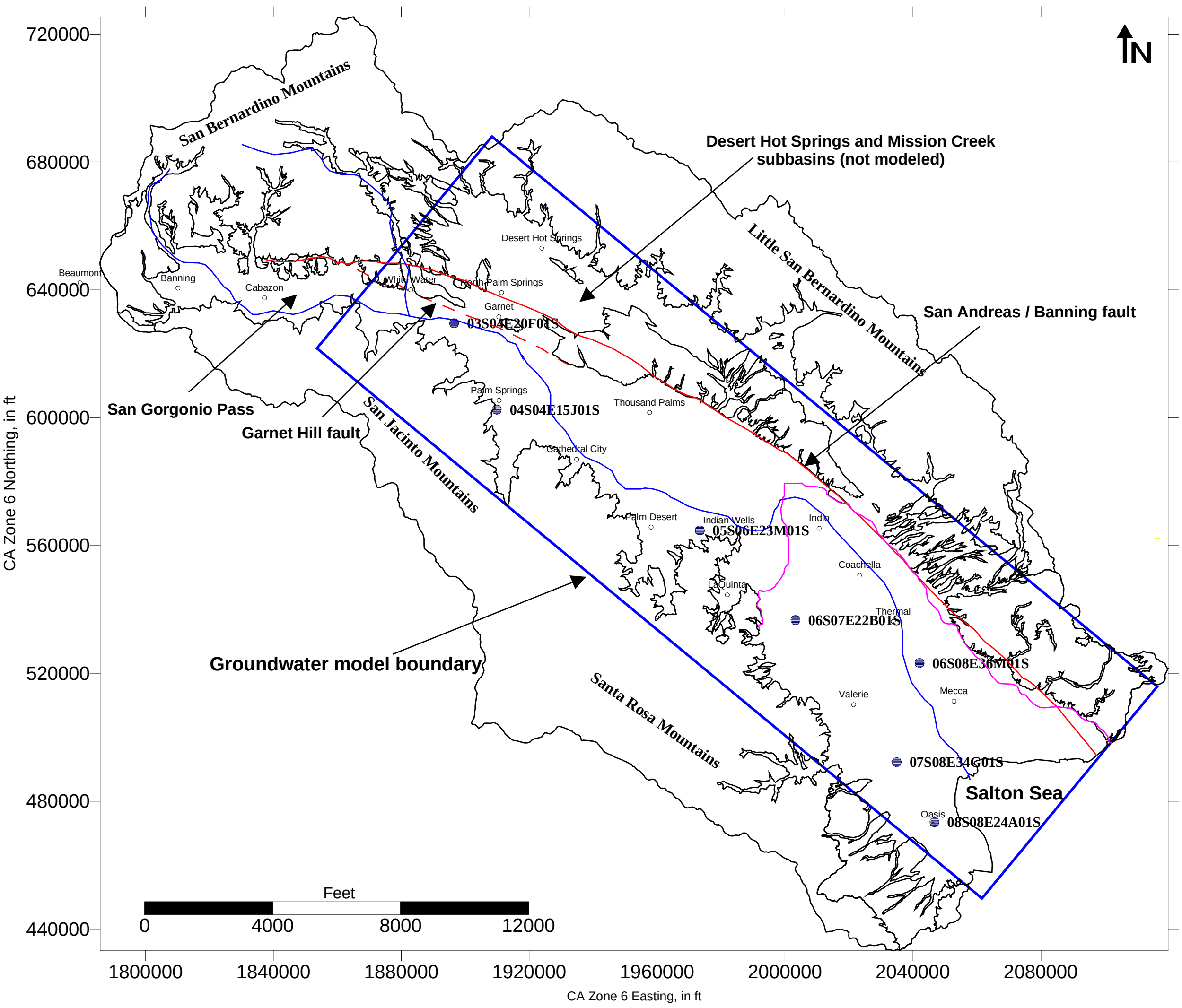
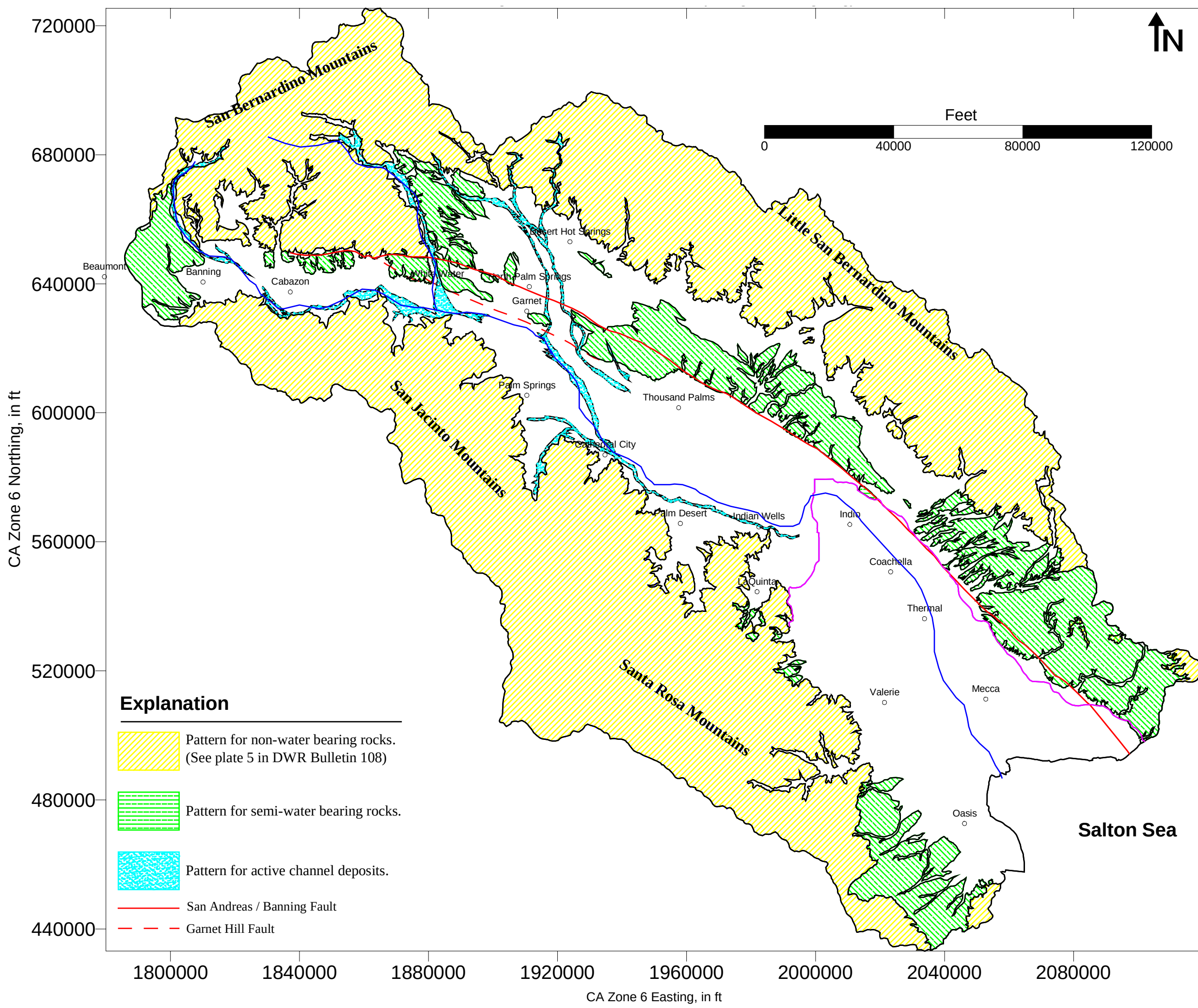


Figure 2
Groundwater Basin Boundary and Generalized Geology



The specific boundary conditions defined for this model are discussed briefly below.

- Natural Recharge: Defines the recharge to the groundwater system from natural sources including precipitation on the Valley floor, infiltration of runoff from precipitation in the mountains, and inflows from adjacent groundwater basins.

- Artificial Recharge: Since 1973, CVWD and DWA have received State Water Project (SWP) water through an exchange agreement with MWD. Water released from MWD's California Aqueduct flows down the Whitewater River channel to the recharge ponds near Windy Point. A portion of the water infiltrates along the channel, and some evaporates from the ponds before percolating to the water table. Estimates of the amount lost to infiltration in the channel and that to evaporation from the ponds were made for the model. Note that in the three years 1985 - 1987, over 650,000 acre-ft of water was released to the Whitewater

River. From 1980 - 1987, groundwater levels in the artificial recharge area increased over 350 ft.

- Pumpage: Pumpage by wells is by far the largest component of discharge from the groundwater system. Other components of discharge include native vegetation evapotranspiration, flow to drains, and subsurface outflow to the Salton Sea. Historical pumping in the Upper Valley was obtained primarily from previous USGS modeling efforts up to 1967, and from CVWD well discharge meter data from 1984 - 1996. Historical pumpage in the Lower Valley is comprised mostly of unmetered agricultural pumpage, and, increasingly, fish farm pumpage. Estimates of golf course demand and some metered municipal, fish farm, and duck club pumpage data were also factored into the Lower Valley pumpage database.

- Return Flows: Return flows are that part of the unused water that percolates back into the groundwater system. Some types of return flows, such as irrigation return and golf course return, have more than one source of water. For example, Colorado River water from the Coachella Canal is used along with groundwater pumped from wells to supply the needs of agriculture. Thus, agricultural return flows are computed from the total applied water less the water consumed by crop evapotranspiration. Golf course return flows are estimated in a similar manner.

- Evapotranspiration: The evapotranspiration package of MODFLOW simulates losses due to groundwater evapotranspiration (ET). The key assumption is that groundwater ET rate varies linearly with hydraulic head between an assigned maximum rate and a rate of zero. The maximum rate is used when the water table is near land surface elevation. A rate of zero is used when the hydraulic head is equal to or less than the elevation corresponding to the extinction depth. ET rate and extinction depth generally vary with space and time and must be assigned to every cell of the model at the beginning of each period.

- Drain Flows: Agricultural drain conditions in the Lower Valley were simulated as a function of space and time by constructing a database of drain locations, depths, and dates of construction from CVWD records. The model calculates drain flows, and measured drain flows serve as an important tool for evaluating the accuracy of the model simulations.

- Salton Sea: The Salton Sea forms the southeastern boundary of the groundwater basin and the model. Transient head boundaries were assigned to model layer 1 cells within the Sea. This type of boundary condition allows recharge from, and discharge to, the Sea. Heads on the Salton Sea boundary are specified as equivalent freshwater heads at the seabed. The southeast edge of the model extends more than 5 miles into the Sea and is a no-flow boundary. This configuration allows groundwater to flow underneath the Sea and discharge upward. Furthermore, this allows the model to simulate groundwater flow from beneath the Sea into the fresh groundwater basin.

Initial Conditions

Simulation of groundwater flow in the Coachella Valley begins in 1936 when sufficient water level data and data needed to estimate pumpage throughout the Valley were available. The year 1936 was also the starting time for the USGS model simulations in the Upper Valley (Tyley 1971).

A groundwater elevation contour map of the entire Valley was created for 1936 and heads from this map were input as initial conditions to the model. These heads are based on water level measurements in wells tapping the unconfined and lower aquifers, and were assigned to model layers 2, 3, and 4, as well as the unconfined areas of layer 1. In the areas containing multiple aquifers, layer 4 represents the lower aquifer, layer 3 represents an aquitard zone, layer 2 represents an upper aquifer, and layer 1 represents the so-called "semi-perched zone" in the Lower Valley. All the pumpage in the model comes from layers 4 and 2. Initial heads in layer 1 were adjusted so that they were not above land surface.

Parameters

Aquifer parameters include thickness, hydraulic conductivity, and storage coefficient. These parameters affect the rate of groundwater movement and the volume of water taken into and released from storage.

- Aquifer Thickness: Elevations of the tops and bottoms of model layers are referenced to land surface elevations, and hence the topography, obtained primarily from USGS digital elevation models (DEM) and topographic maps of the Coachella Valley area. The top of layer 1 elevation chiefly draws from the DEM, but was corrected near the Salton Sea due to errors in the DEM in this area. Total aquifer and hydrostratigraphic unit thickness then follows from elevations assigned to the grid layers.

- Hydraulic Conductivity: Initial estimates of aquifer transmissivity (T) were obtained in part from previously calibrated values used in Reichard and Meadows (1992) for the Upper Valley, some pumping test results for the Lower Valley, and fairly abundant specific capacity data for the entire Valley. Hydraulic conductivity (K) of the confining bed in multiple aquifer zones was estimated based on the sediment texture and heterogeneity and was treated as a calibration parameter. Similarly, vertical K of the aquifer zones was estimated based on the degree of fine-grained bedding present in electric and drillers' logs as well as past experience with three-dimensional heterogeneity in sedimentary basins. Vertical K was also adjusted in calibration.

- Specific Yield and Specific Storage: Distribution of specific yield (S_y) from Reichard and Meadows (1992) was initially used in the Upper Valley for model layer 1; these values were subsequently slightly modified in calibration. Similar specific yield values were initially estimated for the unconfined and semiperched zones of the Lower Valley and modified in calibration. Values for specific storage for confined conditions were developed from field tests.

  Specific storage (S_s) values were estimates for each of the model layers 2, 3, and 4, and were multiplied by layer thickness to obtain storage coefficient (S) for each model layer. The appropriate S_s for confined versus unconfined conditions was selected by MODFLOW as necessary during simulations.

Garnet Hill Fault

The Garnet Hill Fault is located about 1.5 miles south of, and is oriented generally parallel to the Banning Fault. DWR (1964) suggested that the fault has not displaced recent alluvium, but is effective as a barrier to groundwater flow below depths of 100 ft, based on water-level measurements at the fault. The area between the Garnet Hill Fault and the Banning Fault is named the Garnet Hill Subarea (DWR 1964). The few wells present in the Garnet Hill Subarea indicated that water levels are higher in the subarea than in the adjacent Palm Springs Subarea opposite the Garnet Hill Fault.

The Garnet Hill Fault is simulated using the MODFLOW Horizontal Flow Barrier Package (Hsiegh and Freckleton 1993). The barrier is assumed to have no storage capacity. The sole purpose of the barrier is to lower the horizontal conductance between the model cells it separates. The hydraulic characteristic assigned to the barrier in the model is the barrier hydraulic conductivity divided by the width of the barrier. Model-calibrated transmissivities along the Garnet Hill Fault from Swain (1978) were used to compute initial estimates of hydraulic conductivity of the fault barrier. These estimates ranged from 0.02 to 2 ft/day, the lower values generally occur along the northwestern extent, and the higher values occur along the southeastern end of the fault. Estimated initial values were modified during calibration.

Land Subsidence

Capability for modeling of subsidence exists in the present model via implementation of the MODFLOW Interbed Storage Package (Leake and Prudic 1991). Because current evidence of land subsidence in the Valley is minimal, the parameters in the Interbed Storage Package have been set so that simulated subsidence remains below detection (less than approximately 1 ft). It is suspected that substantial drawdown northwest of Point Happy, near the transition between the Upper and Lower Valleys, induced some subsidence that was not detected. Continuing overdraft in this area raises the probability of future subsidence problems.

CALIBRATION AND HISTORICAL SIMULATION RESULTS

Model calibration is the process of refining the model representation of the hydrogeologic framework, estimates of boundary condition heads and fluxes, and aquifer parameters to improve correspondence between measured data and simulated results. Adequate calibration demonstrates the ability of a model to simulate historical water levels and fluxes throughout the basin.

The model was calibrated, using standard methods (ASTM D5490, D5981), to measured water levels and drain flows in the period 1936-96. Measured data on groundwater levels, artificial recharge amounts, drain flows, and elevation of the Salton Sea were available in this historical period. The data show significant changes in groundwater levels, both up and down, owing to major historical shifts in both pumpage and recharge. Thus, a major goal has been to simulate these important historical changes, thereby providing a rigorous test of the ability of the model to adequately simulate effects of future fluctuations in pumpage and recharge. The results are generally excellent, despite the complexities inherent to the Coachella Valley groundwater system.

The modeling effort has been devoted more to estimating historical pumpage and recharge, and to hydrologic data analysis, than to fine-tuning of model parameters during calibration. The following paragraphs briefly discuss the main boundary conditions and parameters adjusted during calibration:

- Although some metered pumpage data and previous estimates of pumpage were available for some time periods, historical pumpage and return flows used in the model were largely estimated in this study. In each case, an improvement in the model databases on historical pumpage and return flows produced substantial improvements in the agreement between measured and historical water levels and drain flows.
- Ephemeral streamflow recharge was at first simulated as constant in time, but test runs of the model showed that some of the major trends in water levels could not be reproduced without varying the recharge in accordance with infrequent but significant flood events. The data for time-varying ephemeral streamflow recharge was based on a hydrologic analysis of precipitation and runoff in watersheds sourced in the San Jacinto and Santa Rosa Mountains as well as the Whitewater River watershed.
- The main parameters adjusted in the calibration were K, S_s, S_y, and vertical hydraulic conductivity (K_v). Magnitudes of all such adjustments were small to moderate and were consistent with available data and conceptual models.
- Measured semi-perched zone water levels and CVWD monitored drain flows were important calibration targets for the boundary condition representing evapotranspiration from native vegetation.

In summary, progressive improvements in the model by inclusion of increasing amounts of data and a refined conceptual model, produced excellent agreement between measured and simulated groundwater levels and drain flows for the period 1936 to 1996. These results indicate the model is valid for simulating the kinds of fluctuations and trends experienced by the system in the past.

PEER REVIEW OF MODEL

Three internationally respected experts in groundwater hydrology and modeling subjected the model to a peer-review. The review committee consisted of Mr. Steve Larson, Dr. James Mercer, and Dr. Irwin Remson. Given the purpose of the model to aid the District in managing groundwater resources in Coachella Valley, the following goals were established for the peer review process:

1. Given the conceptual model, numerical model construction and performance in historical simulation, comment on model reliability.

2. Evaluate suitability of model to simulate prevention of intrusion of groundwater from the Salton Sea and stabilization of groundwater levels in response to management options of artificial recharge.

3. Recommended changes, if needed, to achieve the above.

The peer review process consisted of a review of background materials, site reconnaissance, and participation in a series of meetings with the groundwater modeling team. Three meetings took place over the course of seven months, and consisted of presentations by the modeling team on conceptual and technical aspects of the model. The peer review panel recommended some modifications to the model at the first meeting that were completed and reviewed at the second; additional calibration was recommended at the second meeting that was completed and reviewed at the third. In this way, comments by the panel were considered and the modeling approach was modified as appropriate.

The peer review committee's report was presented to Redwine and Sherrill, counsel for CVWD, in August 1998 (Larson, et. al. 1998). The committee concluded that the model calibration is excellent given the calibration results, the nature of the hydrogeologic system, and the fact that the model is calibrated over two extensive databases: historical and spatial. The committee concluded that "the overall model is valid" and further that "continued study should be restricted to specific local problems." The committee noted that any changes in local areas would not affect the overall model, and that the model may be used in conjunction with the evaluation and comparison of management scenarios.

RESULTS OF PREDICTIVE SIMULATIONS

The model was used to simulate four different water management plan alternatives by estimating water use for each alternative from 1999 to 2035 and, developing model boundary conditions for this period. The four alternatives included:

Alternative 1 - No Project
Alternative 2 - Pumping Restriction by Adjudication
Alternative 3 - Management of Demand and Maximization of Local Resources
Alternative 4 - Combination Alternative

In developing the model boundary conditions for the alternatives, some assumptions were made that are common to each alternative:

- Average recharge rates from infiltration of streamflow and mountain runoff over the 61-year historical data period from 1936 to 96 are applicable to the simulation period 1999 to 2035.

- Salton Sea elevation was held constant at 1999 levels for the period 2000 to 2035.

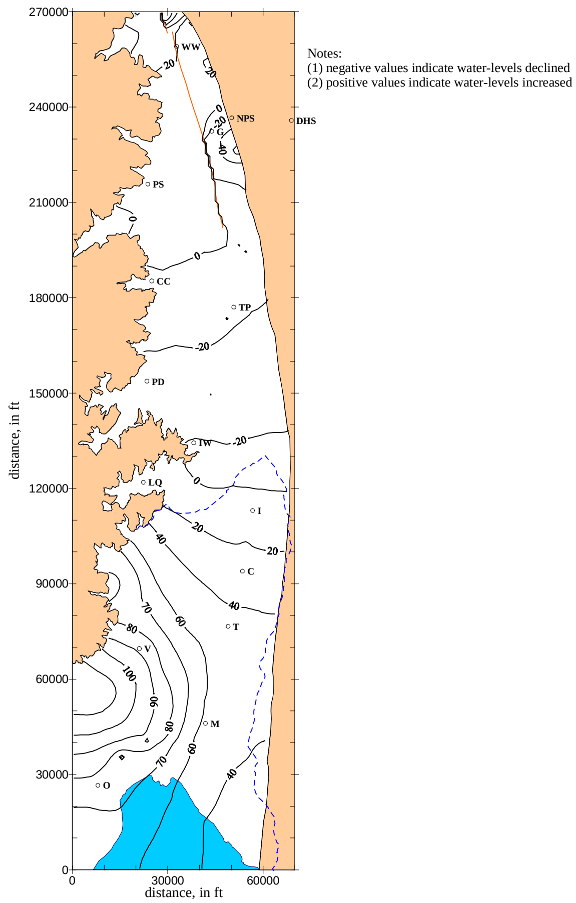
- Minimum SWP inflows were assumed to be 50,000 acre-ft/yr.

- No additional drains were installed after 1996.

Pumpage and recharge estimates were made separately for each alternative as discussed in the Water Management Plan. Results of the predictive simulations were analyzed in terms of (1) sustainability of groundwater levels and (2) maintenance of net groundwater discharge to the

Salton Sea. For each alternative, contour plots of simulated heads (in the main aquifer system) for the year 2035 were made and compared to simulated heads at the end of 1999 (see example in **Figure 3** for Alternative 4).

Figure 3
Alternative 4 – Difference between Layer 4 Heads in 2035 and 1999



CONCLUSIONS

The excellent agreement, both Valley-wide and through the 61-year historical data period, between measured and model simulated water levels and drain flows, demonstrates the adequacy of calibration of the groundwater model of the Coachella Valley.

The model developers conclude that the model is valid for analysis of management options provided the imposed stresses on the system are within the range of those during the calibration period. The peer review team supports this conclusion. Also, infiltration rates for artificial recharge projects should be verified by pilot test, and review of local hydrogeologic conditions should accompany any proposed plans.

REFERENCES

ASTM D5490, 1999, Standard guide for comparing ground-water flow model simulations to site specific information, American Society for Testing and Materials.

ASTM D5981-96el, 1999, Standard guide for calibrating a ground-water flow model application, American Society for Testing and Materials.

California Department of Water Resources, 1964, Coachella Valley Investigation: Bulletin 108.

Hsiegh, P. A., and J. R. Freckleton, 1993, Documentation of a computer program to simulate horizontal flow barriers using USGS MODFLOW. U.S. Geological Survey Open-File Report 92-477.

Huberty, M. R., Pillsbury, A. F., and Sokoloff, V. P., 1948, Hydrologic studies in Coachella Valley, California, University of California Agricultural Experiment Station, Berkeley, California.

Kocher, A. E. and Harper, W. G., 1927, Soil survey of the Coachella Valley area, California, U.S. Department of Agriculture, Field Operations of the Bureau of Soils, Number 16, Series 1923.

Larson, S. P., Mercer, J. W., and L. Remson, 1998, Coachella Valley groundwater model, peer review report.

Leake, S. A., and D. E. Prudic, 1991, Documentation of a computer program to simulate aquifer system compaction using the USGS MODFLOW. Techniques of Water Resources Investigations of U.S. Geological Survey, Book 6, Chapter A2.

McDonald, M. G., and A. W. Harbaugh, 1988, A modular three-dimensional finite-difference ground-water flow model, U.S. Geological Survey Water-Resources Investigations, Book 6, Chapter AI.

Mendenhall, W. C., 1909, Ground waters of the Indio region, California, U.S. Geological Survey Water Supply Paper 225.

Pillsbury, A. F., 1941, Observations on use of irrigation water in Coachella Valley, California. University of California, College of Agriculture, Agricultural Experiment Station, Berkeley, California. Bulletin 649.

Reichard, E. G. and J. K. Meadows, 1992, Evaluation of a ground-water flow and transport model of the upper Coachella Valley, California: U.S. Geological Survey Water-Resources Investigations Report 91-4142, 101 p.

Swain, L. A., 1978, Predicted water-level and water-quality effects of artificial recharge in the upper Coachella Valley, California, using a finite-element digital model: U.S. Geological Survey Water-Resources Investigations Report 77-29, 54 p.

Tyley, S.J., 1971, Analog model study of the ground-water basin of the upper Coachella Valley California. U. S. Geological Survey Open-File Report, January 28, 197 1.

----- 1974, Analog model study of the ground-water basin of the upper Coachella Valley, California: U. S. Geological Survey Water-Supply Paper 2027.

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