FINAL REPORT

Antelope Valley Water Resource Study

Antelope Valley Water Group

November 1995
K/J 934620.00

Kennedy/Jenks Consultants

Kennedy/Jenks Consultants

Engineers and Scientists
1000 Hill Road, Suite 200
Ventura, California 93003
805-658-0607
FAX 805-650-1522

10 November 1995

Antelope Valley Water Group
c/o City of Palmdale
708 East Palmdale Blvd.
Palmdale, CA 93551

Attention: Mr. Leon Swain

Subject: Antelope Valley Water Resource Study
K/J 934620.00 (6.01)

In accordance with our agreement dated 21 July 1993, Kennedy/Jenks Consultants is pleased to submit forty (40) copies of the final report of Antelope Valley Water Resource Study. The final report incorporates comments from the Antelope Valley Water Group as well as comments received as a result of the four public meetings held to present the results of the study.

The study provides an assessment of the water resources in the valley, develops a water conservation program for the valley, evaluates the feasibility of reclaimed water use, evaluates the feasibility of aquifer storage and recovery, discusses the effects of changes in groundwater levels and provides a water resource protection plan. Recommended actions are also included.

The public should note that the Antelope Valley Water Resource Study is not related to the Antelope Valley Storm Water Conservation and Flood Control District Act (Assembly Bill No. 65). In addition, the Antelope Valley Water Group members concur with Section 4, Part B of the Act which states:

> "Notwithstanding any other provision of law, the district [Flood Control District] may not adopt or implement any groundwater management plan ...unless all of the entities within the boundaries of the district...consent... In preparing, adopting, and implementing any plan, the district shall consult with those entities."

It was a pleasure to work with the members of the Antelope Valley Water Group on this important study. Please contact us if you have any questions or need additional information.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

Lynn M. Takaichi
Vice President

CPH/EMB/emfs:934620\cover.ltr

Enclosures (40)

ANTELOPE VALLEY WATER RESOURCE STUDY
ANTELOPE VALLEY WATER GROUP
K/J 934620.00

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

934620.00

TABLE OF CONTENTS
(Continued)

LIST OF APPENDICES

LIST OF FIGURES

TABLE OF CONTENTS
(Continued)

LIST OF FIGURES (Cont.)

LIST OF FIGURES (Cont.)

TABLE OF CONTENTS
(Continued)

LIST OF FIGURES (Cont.)

LIST OF TABLES

TABLE OF CONTENTS
(Continued)

LIST OF TABLES (Cont.)

TABLE OF CONTENTS
(Continued)

LIST OF PLATES

CHAPTER 1

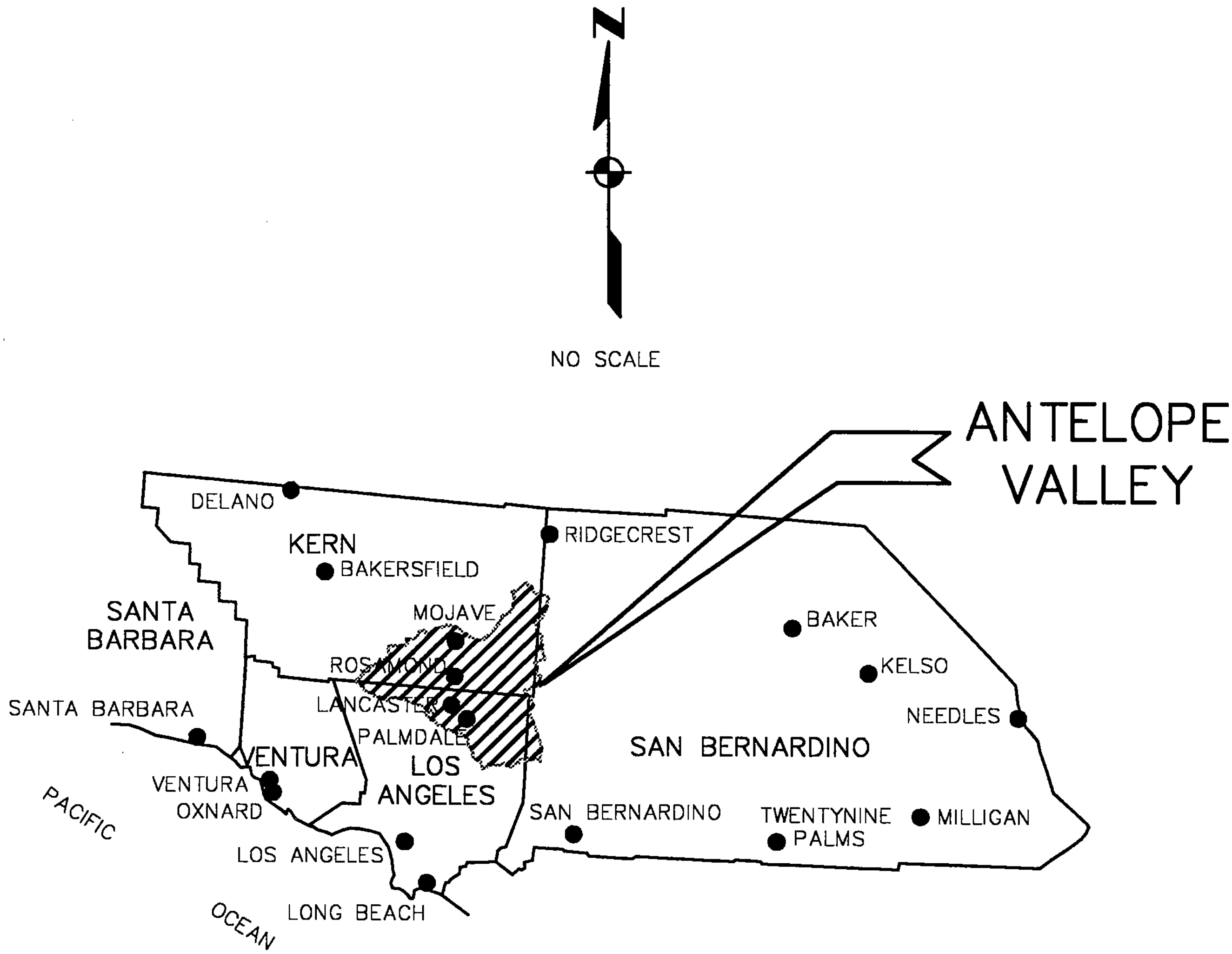
EXECUTIVE SUMMARY

As rapid development has increased the demand for both more water and higher quality water in the Antelope Valley, the competition for available water supplies has increased. Recent water resource studies by individual water purveyors have attempted to provide a technical foundation and/or management strategy for the area's water resources. However, these attempts have generally been met with criticism and mistrust. The Antelope Valley Water Group (AVWG) was formed in 1991 to provide a means of communication for the Valley agencies with an interest in water. Water Group members include the Cities of Palmdale and Lancaster, Edwards Air Force Base (Edwards AFB), Antelope Valley - East Kern Water Agency (AVEK), Antelope Valley United Water Purveyors Association (AVUWPA), Los Angeles County Waterworks Districts, (LACWW), Palmdale Water District (PWD), Rosamond Community Services District (RCSD), and County Sanitation Districts of Los Angeles County (CSDLAC). In an attempt to prepare a water resource study with a regional focus, rather than an individual focus, the AVWG initiated the Antelope Valley Water Resource Study.

STUDY AREA CHARACTERISTICS

The Antelope Valley, as defined for the purposes of this report, encompasses approximately 2,400 square miles in northern Los Angeles County, southern Kern County and western San Bernardino County. (See Figure ES-1.) The Valley is bordered on the southwest by the San Gabriel Mountains, on the northwest by the Tehachapi Mountains, and on the east by a series of hills and buttes that generally follow the San Bernardino County line. Major communities within the Valley include Boron, Edwards AFB, Lancaster, Mojave, Palmdale and Rosamond. Mean daily summer temperatures range from 63° Fahrenheit (F) to 93° F, and mean daily winter temperatures range from 34° F to 57° F. Precipitation ranges from 5 inches per year along the northern boundary of the Valley to 10 inches per year along the southern boundary.

The Antelope Valley is a closed basin. Surface water from the surrounding hills and from the Valley floor flow primarily toward three dry lakes on Edwards AFB: 1) Rosamond Lake, 2) Buckhorn Lake and 3) Rogers Lake. The most hydrologically significant streams include Big Rock Creek, Little Rock Creek, and Amargosa Creek. Except during the biggest rainfall events of a season, surface water flows toward the Valley from the surrounding mountains, quickly percolating into the stream bed and recharging the groundwater basin. Surface water flows that reach the dry lakes are generally lost to evaporation. The Little Rock Creek is the only developed surface water supply in the Valley. The Little Rock Reservoir, jointly owned by PWD and Little Rock Creek Irrigation District (LCID), collects run-off from the San Gabriel Mountains. The dam currently has a useable storage capacity of 600 acre-feet of water; however, PWD and LCID are planning modifications to the dam which will increase the storage capacity to 3,500 acre-feet.



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Antelope Valley Location Map

November 1995
K/J 934620.00

Figure ES-1

The Antelope Valley Groundwater Basin is comprised of two primary aquifers: 1) the principal aquifer and 2) the deep aquifer. The principal aquifer is an unconfined aquifer. Separated from the principal aquifer by clay layers, the deep aquifer is generally considered to be confined. In general, the principal aquifer is thickest in the southern portion of the Valley near the San Gabriel Mountains, while the deep aquifer is thickest in the vicinity of the dry lakes on Edwards AFB. The Antelope Valley Groundwater Basin is divided into twelve subunits. The subunits are Finger Buttes, West Antelope, Neenach, Willow Springs, Gloster, Chaffee, Oak Creek, Pearland, Buttes, Lancaster, North Muroc, and Peerless.

Historically, land uses within the Valley have focused primarily on agriculture; however, the Valley is in transition from predominantly agricultural uses to predominantly residential and industrial uses.

Growth in the Antelope Valley proceeded at a slow pace until 1985. However, between 1985 and 1990, the growth rate increased approximately 1,000 percent from the average growth rate between the years 1956 to 1985. Historical and projected population for the Antelope Valley are shown in Table ES-1 and depicted on Figure ES-2. The medium population curve is selected for use in this report. Projections indicate that approximately 986,000 people will reside in the Valley by the year 2020. This represents an increase of approximately 278 percent from the 1990 population. It is noted that population forecasting is not an exact science due to an element of uncertainty to whether or not the projections will be truly realized. Additionally, the population projections used in the report were obtained from sources that may have been influenced by the rapid growth that occurred in the Valley prior to 1990. Areas of concentrated population within the Valley include Lancaster, Palmdale, Edwards AFB, Rosamond, Mojave, and Boron.

ASSESSMENT OF WATER RESOURCES

Historical water demands were 192,600 acre-feet in 1975, 246,000 acre-feet in 1980, 167,000 acre-feet in 1985 and 144,000 acre-feet in 1989 (USGS, 1994a). Water demands decreased between 1950 to late 1980s due to decreasing irrigated acreage. However, due to the population growth beginning in the mid 1980s, water demands are increasing. Projected water demands for the Antelope Valley are shown on Figure ES-3.

The total available water deliveries for the Antelope Valley were 192,600 acre-feet in 1975, 246,000 acre-feet in 1980, 167,000 acre-feet in 1985 and 144,000 acre-feet in 1989 (USGS, 1994a). Historical water supplies were made up of a combination of local surface water from Little Rock Reservoir, State Water Project (SWP) water, groundwater, and reclaimed water. Table ES-2 shows the potential current and projected water supplies in Antelope Valley. As shown in the table, the potential current water supply ranges between 212,900 and 240,800 acre-feet, and the potential 2020 water supply ranges between 275,700 and 303,600 acre-feet. The water supplies identified in Table ES-2 do not include potential reductions in deliveries due to hydrologic conditions.

TABLE ES-1

ANTELOPE VALLEY
HISTORICAL AND PROJECTED POPULATION

Area	1980	1990	2010	2020 [1]
Lancaster	48,027	97,291	212,138 [2]	269,558
Palmdale	12,277	68,842	245,341 [3]	326,815
Edwards AFB	8,554	7,423	7,671	7,671
Rosamond	2,869	9,969 [4]	39,256 [5]	52,696
Mojave	2,886	3,793[8]	8,737	11,209
Boron	2,815	2,903	3,071	3,155
Other	46,922	70,179 [6]	221,787 [6]	314,896[6]
Total	124,350	260,400	738,000 [7]	986,000[7]

(1) Extrapolated based on 1990 and 2010 populations except for Palmdale, Edwards AFB, Rosamond and Other. Palmdale is extrapolated based on 1993 and 2010 populations. Rosamond is extrapolated based on 2000 and 2010 populations. Edwards AFB 2020 population is maintained at 2010 level and Other is the difference between the total and the areas of concentrated population.

(2) From SCAG 1993 population projections.

(3) Average of City of Palmdale's General Plan projections and SCAG's 1993 projections.

(4) Interpolated based on 1980 and 1993 populations.

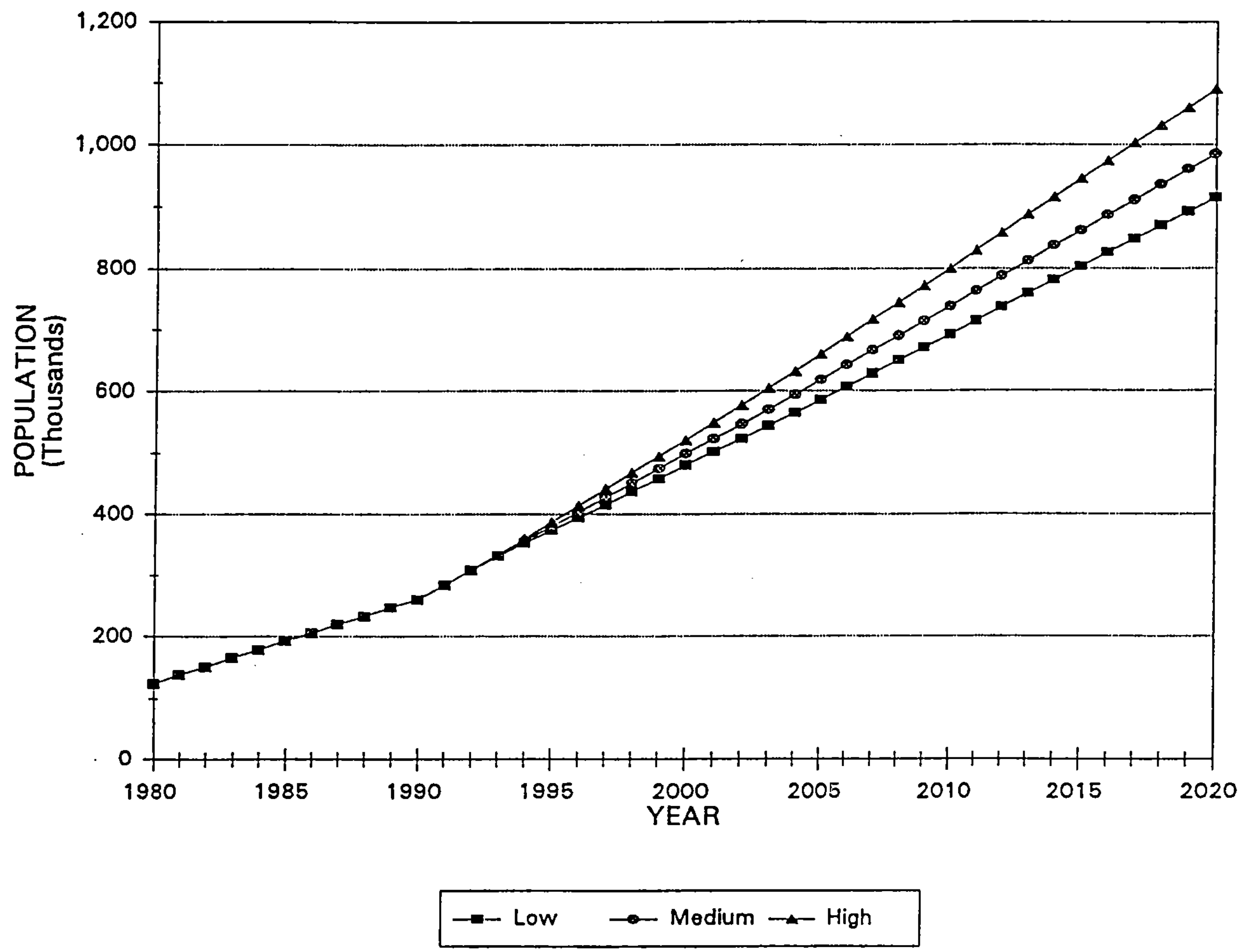
(5) Average of County of Kern's Rosamond Specific Plan projections and projections based on proposed Desert Highlands development.

(6) Difference between total and the areas of concentrated population.

(7) From DWR's November 1993 Draft California Water Plan Update (Bulletin 160).

(8) From Kern Council of Governments.

Groundwater is estimated to have a natural recharge amount of approximately 31,200 to 59,100 acre-feet per year (USGS, 1993). SWP entitlements for the Antelope Valley are currently estimated to be approximately 153,800 acre-feet. Available storage from Little Rock Reservoir was 600 acre-feel; however, modifications to the Little Rock Dam are anticipated to increase the storage capacity to 3,500 acre-feet. According to the PWD, the average annual yield from the new reservoir is estimated to be approximately 7,000 acre-feet. The Palmdale, Lancaster, Rosamond, Edwards AFB, and Mojave Wastewater Reclamation Plants (WRPs) represent the plants with the highest probability of developing a reclaimed water system. The combined 1993 and projected 2020 flow from these five plants represent nearly 98 percent of the total potential reclaimed water supply for the entire Valley and is estimated to be 18.7 million gallons per day (mgd) (20,900 acre-feet per year) and 74.7 mgd (83,700 acre-feet per year) respectively.



It is noted that population forecasting is not an exact science due to an element of uncertainty to whether or not the projections will be truly realized. Additionally, the population projections used in the report were obtained from sources that may have been influenced by the rapid growth that occurred in the Valley prior to 1990.

Kennedy/Jenks Consultants

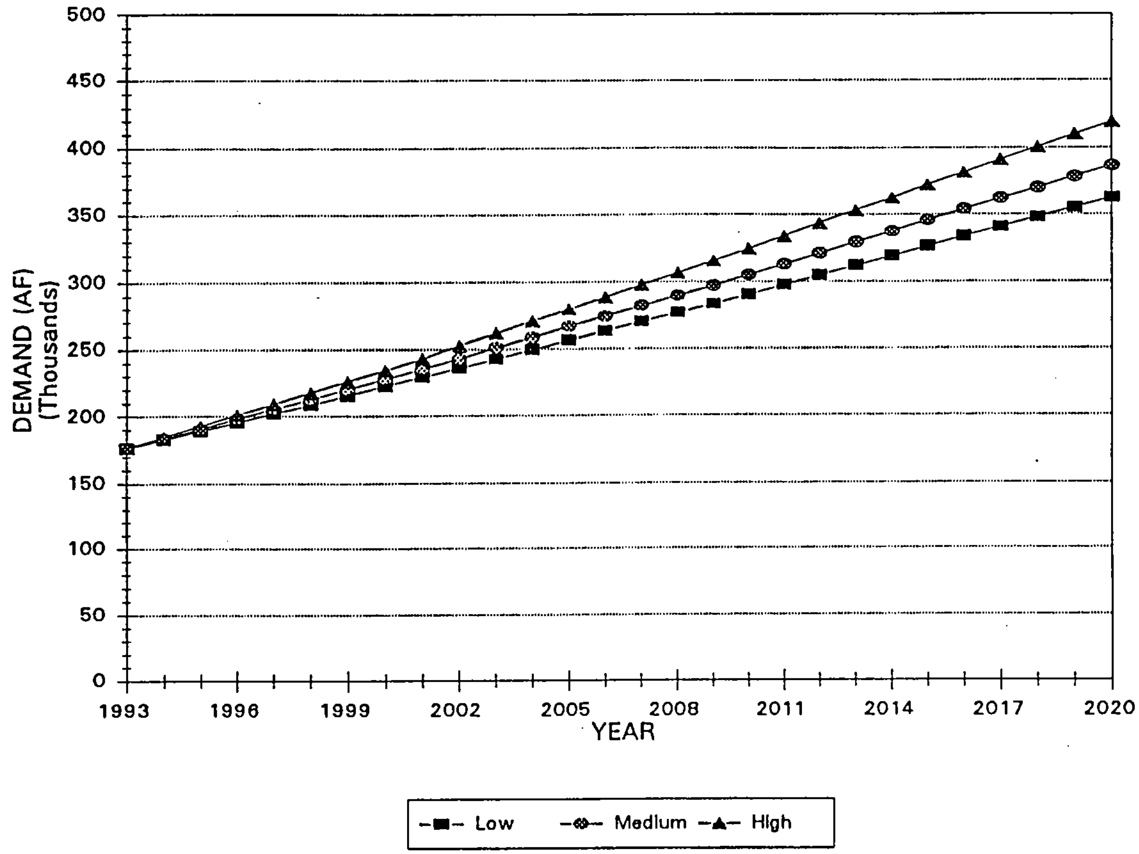
Antelope Valley Water Group
Antelope Valley Water Resources Study

Population Projections–Antelope Valley

November 1995
K/J 934620.00

Figure ES–2

Figure ES–2



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Projections
Antelope Valley

November 1995
K/J 934620.00

Figure ES-3

Figure ES-3

TABLE ES-2

POTENTIAL ANNUAL WATER SUPPLY
FOR THE ANTELOPE VALLEY [1]

Source	*1993 Potential Supply (acre-feet)*	*2020 Potential Supply (acre-feet)*
Groundwater [2]	31,200 to 59,100	31,200 to 59,100
State Project Water		
AVEK [3]	134,200	134,200
LCID	2,300	2,300
PWD	17,300	17,300
Subtotal	153,800	153,800
Little Rock Reservoir [4]	7,000	7,000
Reclaimed Water [5]	20,900	83,700
Total [6]	212,900 to 240,800	275,700 to 303,600

(1) Supplies listed have not been adjusted to account for potential reductions in deliveries due to hydrologic conditions.

(2) Estimates of natural recharge from USGS "Study Plan for the Geohydrologic Evaluation of Antelope Valley, and Development and Implementation of Ground-Water Management Models."

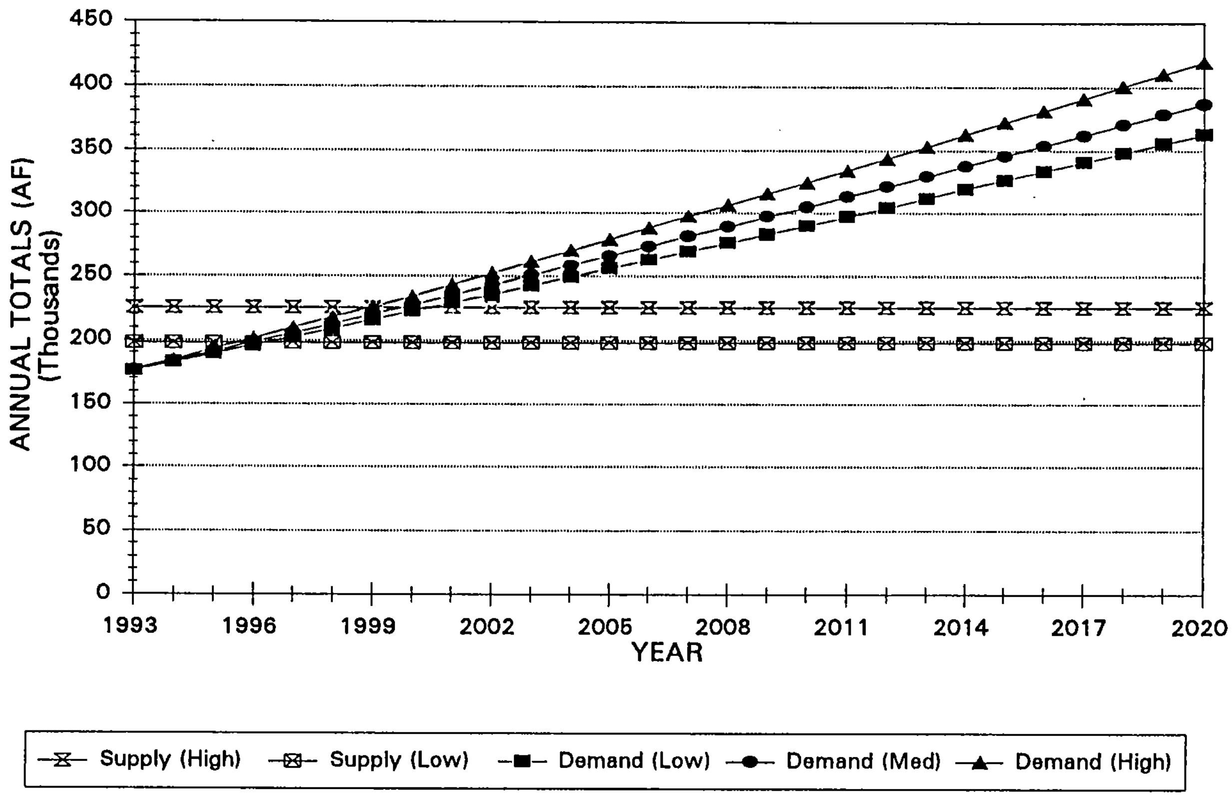
(3) Based on historical deliveries of approximately 3 % to areas outside the Antelope Valley, subtracted from AVEK's total entitlement of 138,400 acre-feet per year.

(4) PWD estimates that average yield from the reservoir following modifications to the dam will be 7,000 acre-feet per year.

(5) The numbers shown are current and projected production for Palmdale, Lancaster, Rosamond, Edwards AFB, and Mojave WRPs.

(6) Potential useable stormwater is not included in the total.

Figure ES-4 depicts the high and low water supply projection along with the low, medium and high water demand projection for the Valley to the year 2020. The high and low water supply projection are based on Table ES-2 with one exception, the potential reclaimed water supply listed in Table ES-2 for 1993 and 2020 are not included. Instead, the reclaimed water supply for both 1993 and 2020 is taken as the current reclaimed water use (approximately 6,500 acre-feet). Therefore, the 1993 and 2020 potential supply ranges between 198,500 and 226,400 acre-feet per year. For purposes of the reliability analysis, the high supply curve and medium demand curve are selected. The supply curve does not take into account the issue of reliability and the effects that reliability will have on the yield of each water supply source.



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Potential Supply and Projected Demand
(Without Delivery Reductions)

November 1995
K/J 934620.00

Figure ES-4

Figure ES-4

Figure ES-5 depicts the effects that reliability will have on the yield of the water supplies. The medium demand and projected supply estimates at the 50, 80 and 90 percent probability levels are shown on Figure ES-5. The most optimistic supply assumption (i.e., delivery of 100 percent of available water supplies) is also shown. As shown on the figure, without exceeding groundwater extractions of 59,100 acre-feet per year, the probability of meeting the estimated 1993 water demand is approximately 73 percent. For comparison, the Metropolitan Water District of Southern California (MWD) has established the following service objectives:

Percentage of Demand	Percentage of the Time
80%	100%
90%	92%
100%	90%

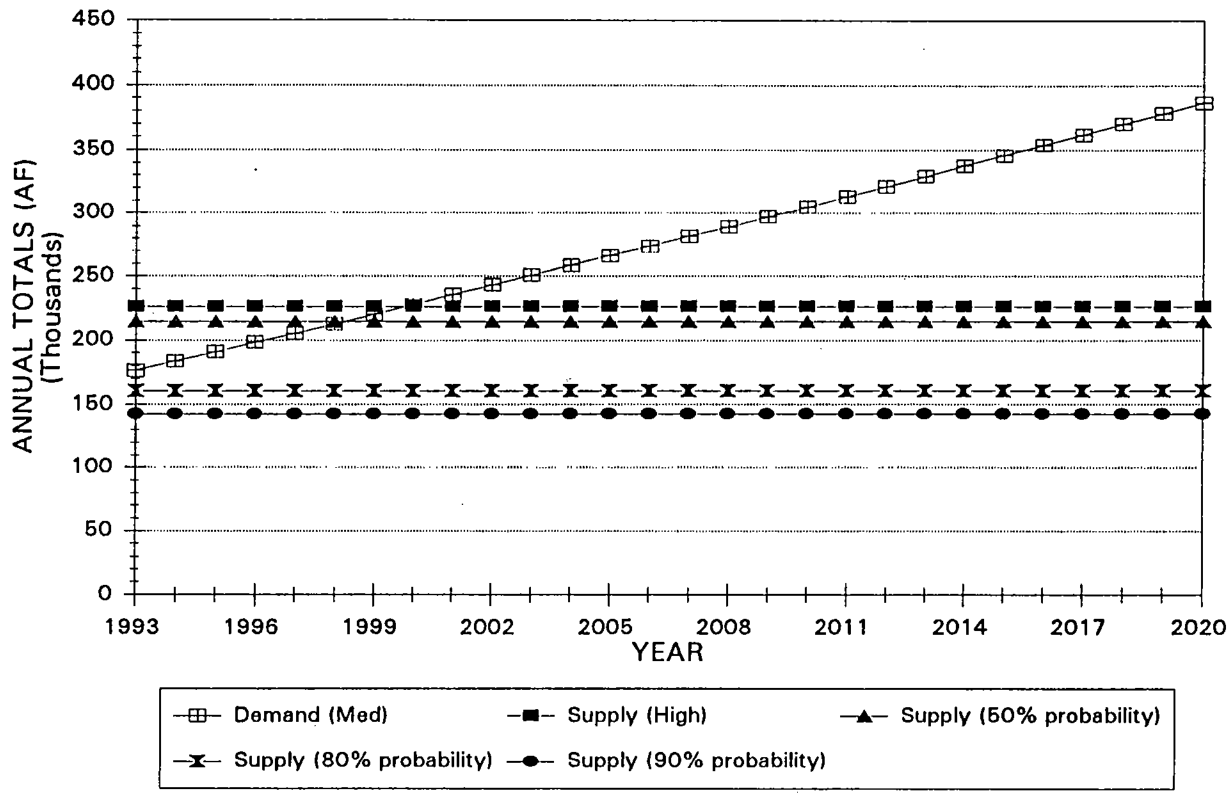
Based on the projections presented on Figure ES-5, the water supply reliability of the Antelope Valley is currently below MWD's objectives. By the year 1998 (projected population of 451,000), 100 percent of the water demand is estimated to be met only 50 percent of the time without overdrafting the groundwater basin. Similarly, by the year 2000 (projected population of 499,000), 100 percent of the potential water supplies would be required to meet the projected water demands without overdrafting the groundwater basin.

To assess the effects of SWP deliveries on groundwater levels, areas that receive SWP deliveries were compared with areas that did not. By comparing the hydrographs from areas that remained in similar land uses, the effect on groundwater levels would be from SWP deliveries and not by other causes (i.e., land use transitions). Hydrographs in areas that do not receive SWP water indicate groundwater levels are generally remaining level, whereas hydrographs in areas that do receive SWP water generally indicate a rising of groundwater levels.

To assess the effects on groundwater levels due to transition from agricultural to urban land uses, hydrographs in areas of agriculture that had transitioned to urban were compared with hydrographs in areas of agriculture that had not transitioned. The rate of decline in water levels prior to 1977-1978 was noticeably more than the rate of decline after 1977-1978 when SWP deliveries started to significantly contribute to the Valley's water supply. Importation of SWP water generally has a beneficial effect on groundwater levels and urbanization generally has an adverse effect on groundwater levels. However, it is likely that the increased use of SWP water could mitigate these adverse effects.

WATER CONSERVATION

Water conservation programs existing in the Antelope Valley are primarily directed at urban areas. These programs are provided through agencies like the City of Lancaster, the LACWW, PWD and RCSD. Urban water conservation programs in the Antelope Valley include ordinances, literature and advertising, and phased water conservation plans. The Agricultural Stabilization and Conservation Service (ASCS)



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Supply and Projected Demand (Includes Delivery Reductions)

November 1995
K/J 934620.00

Figure ES-5

Figure ES-5

office provides agricultural conservation programs for farmers and ranchers. The ASCS provides an Agricultural Conservation Program (ACP) which offers cost sharing to farmers and ranchers to encourage conservation practices on agricultural land that will result in long-term benefits. The Federal Government pays up to 80 percent of the cost of needed conservation practices.

Urban water conservation measures are identified in the September 1991 Memorandum of Understanding Regarding Urban Water Conservation in California and the Urban Water Management Planning Act. The Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California was entered into in 1991 by urban water suppliers, public advocacy organizations and other interested groups who recognized the need for conservation due to increasing water demands for urban, agricultural and environmental uses. Urban water conservation practices or Best Management Practices (BMPs) identified in the MOU are intended to reduce long-term urban water demands. In addition to identifying BMPs, the MOU also included Potential Best Management Practices (PBMPs). The intent of the MOU was to study and then determine whether or not the PBMP's met the criteria designated as BMPs. The Urban Water Management Planning Act requires urban water retailers supplying more than 3,000 acre-feet of water per year or serving more than 3,000 customers to prepare an Urban Water Management Plan (UWMP) to achieve conservation and efficient use of water. The Act requires the UWMP to evaluate specific water management practices.

Agricultural water conservation measures are identified in the Department of Water Resources (DWR) November 1993 draft "California Water Plan Update" (Bulletin 160). Enactment of the Agricultural Water Suppliers Efficient Water Management Act in 1990 requires the DWR to establish an advisory committee to evaluate Efficient Water Management Practices (EWMPs) for agricultural water suppliers. According to Bulletin 160, the advisory committee is working to develop a process for implementation of EWMPs through the agricultural water management plans required under the California Agricultural Water Management Planning Act. A current assessment of the impact of implementation of EWMPs is not available through the DWR.

Although not currently in operation in the Antelope Valley, the Mobile Agricultural Water Conservation Laboratory (Mobile Lab) program can be regarded as a potential conservation program for the Valley. The Mobile Lab operates under the leadership of the local Resource Conservation District, with technical and management assistance from the local Soil Conservation Services (SCS) Field Office. The Mobile Lab provides agricultural growers with individual, site-specific performance evaluations of their irrigation systems by measuring efficiency of the systems. Data are collected for the specific site for calculations on distribution uniformity and application efficiency. Based on an analysis of the results, recommendations or suggestions are made by the Mobile Lab team on management or physical changes to improve water use efficiency of the irrigation system. The program is voluntary and free of charge.

The measures recommended for inclusion in the water conservation plan for the Antelope Valley are listed in Table ES-3. Because agricultural water use is expected to decline significantly during the planning period (1994-2020), the plan consists primarily of urban conservation programs developed for the City of Palmdale, City of Lancaster and Community of Rosamond. Evaluation of urban water conservation measures was performed utilizing the DWR's Water Plan computer software. Benefit to cost (B/C) analyses were performed for each recommended urban water conservation measure to determine cost effectiveness. The overall B/C ratios for the City of Palmdale, City of Lancaster, and Community of Rosamond were calculated to be 4.7, 3.0, and 4.5 respectively.

The Agricultural Water Suppliers Efficient Water Management Practices Act requires the DWR to establish an advisory committee to evaluate EWMPs aimed at agricultural water suppliers concerning conservation of irrigation water. Because the evaluation of the EWWPs will require detailed planning by each water agency and will include analysis of technical feasibility, social and district economic criteria and legal feasibility of each practice, an assessment of the impact of implementation of EWWPs (i.e., costs and water savings) is not currently available through the DWR. Therefore, until DWR's assessment of the EWMPs is complete, analyses of potential agricultural conservation measures for the Valley cannot be provided. However, based on the available case studies, an agricultural water conservation program can be recommended on a preliminary basis. It is recommended that a Mobile Lab program be established to serve agricultural areas in the Antelope Valley.

An implementation schedule as well as the estimated water savings for each conservation measure selected for the Antelope Valley is also shown in Table ES-3. Implementation of the urban conservation measures is assumed to begin in 1994 and continue through the year 2020. (Note that although conservation programs currently exist in the Antelope Valley, for purposes of estimating water savings using DWR's WaterPlan software, the year 1994 was assumed to be the beginning of the planning period.) Estimated water savings from the urban measures range from 0.67 to 87,356 acre-feet for the City of Palmdale, 0.34 to 43,775 acre-feet for the City of Lancaster, and 0.34 to 7,821 acre-feet for the Community of Rosamond. The estimated water savings is shown as the total amount of water saved over the entire implementation period (1994 to 2020). Implementation of the agricultural conservation measure is assumed to begin in 1995 and continue through the year 2020. Estimated water savings for the agricultural measure is 68,800 acre-feet over the entire implementation period (1995 to 2020).

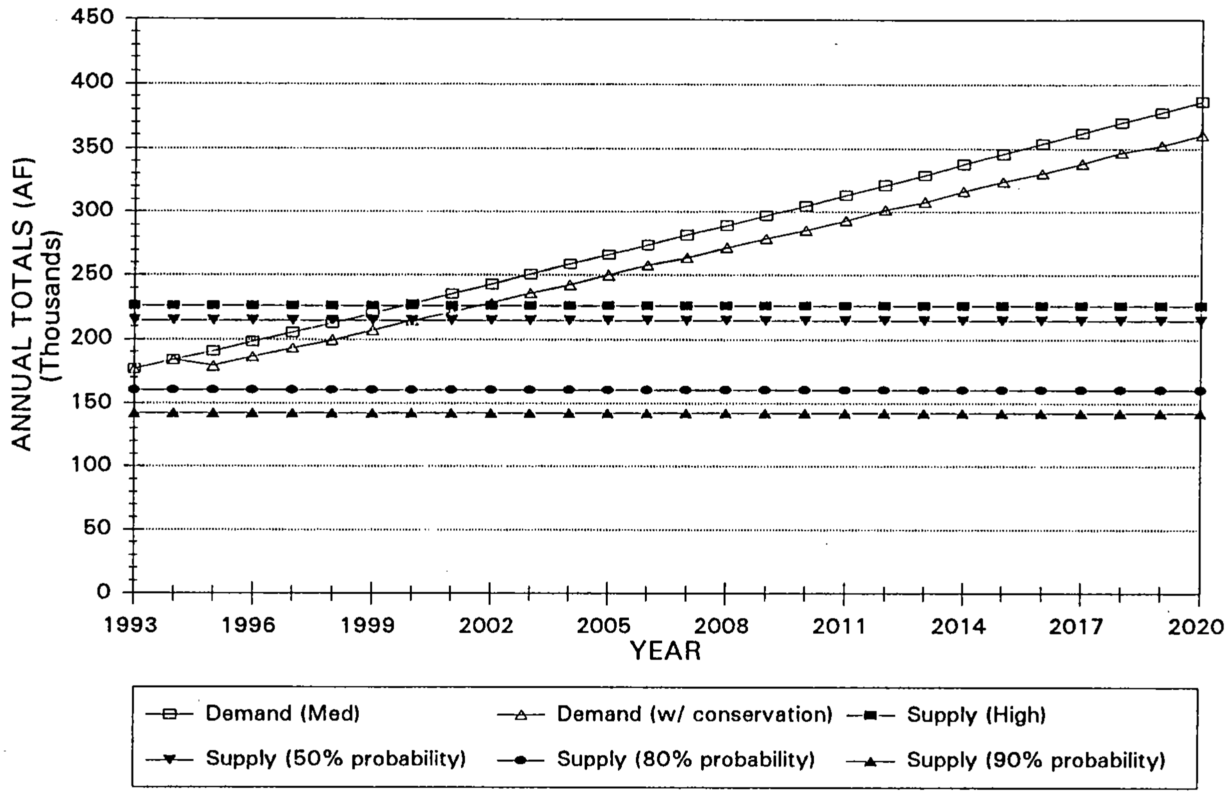
Figure ES-6 depicts the medium water demand with and without implementation of conservation measures and projected supply estimates at the 50, 80, and 90 percent probability levels. The most optimistic supply assumption (i.e., delivery of 100 percent of available water supplies) is also shown. Figure ES-6 is identical to Figure ES-5 with one exception, a second demand curve is provided to show the affect on the projected water demands from implementation of the conservation program discussed above. As shown on Figure ES-6, without exceeding

TABLE ES-3

IMPLEMENTATION SCHEDULE
AND ESTIMATED WATER SAVINGS

Conservation Measure	Implementation Years	Estimated Water Savings (acre-feet)
City of Palmdale		
• Ultra Low-Flush Toilet Ordinance, New Residential (1)	1994-2020	0.67
• Standards for New Large Landscapes (1)	1994-2020	40
• Retrofit Kit Program	1994-2020	7,357
• Information and Education, Residential	1994-2020	78,642
• Seasonal Rates, Residential	1994-2020	52,415
• Uniform or Increasing Block Rates, Residential	1994-2020	87,356
Total		225,811
City of Lancaster		
• Ultra Low-Flush Toilet Ordinance, New Residential (1)	1994-2020	0.34
• Standards for New Large Landscapes (1)	1994-2020	80
• Information and Education, Residential	1994-2020	25,233
• Residential Water Audit and Retrofit Kit	1994-2020	1,245
• Seasonal Rates, Residential	1994-2020	43,775
• Seasonal Rates, Commercial	1994-2020	6,575
• Seasonal Rates, Industrial	1994-2020	10,927
• Uniform or Increasing Block Rates, Residential	1994-2020	43,775
• Uniform or Increasing Block Rates, Commercial	1994-2020	10,961
• Uniform or Increasing Block Rates, Industrial	1994-2020	18,210
• Large Turf Irrigation Audits	1994-2020	9,325
Total		170,106
Community of Rosamond		
• Ultra Low-Flush Toilet Ordinance, New Residential (1)	1994-2020	0.34
• Standards for New Large Landscapes (1)	1994-2020	40
• Seasonal Rates, Residential	1994-2020	5,694
• Uniform or Increasing Block Rates, Residential	1994-2020	5,694
• System Water Audit, Leak Detection, and Repair	1994-2020	7,821
• Residential Retrofit Kit	1994-2020	2,496
Total		21,745
Agricultural		
• Mobile Lab Program	1995-2020	68,800

(1) Existing regulations



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Supply and Projected Demand (Includes Conservation)

November 1995
K/J 934620.00

Figure ES-6

Figure ES-6

groundwater extractions of 59,100 acre-feet per year, the probability of meeting the estimated 1993 water demand is approximately 73 percent. Without a conservation program, by the year 1998 (projected population of 451,000), 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2000 (projected population of 499,000), 100 percent of the potential water supplies would be required to meet the water demand. With a conservation program, by the year 2000, 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2002 (projected population of 547,000), 100 percent of the potential water supplies would be required to meet the water demand.

USE OF RECLAIMED WATER

The Palmdale WRP, Lancaster WRP, Rosamond WRP, and Edwards AFB WRP have the greatest potential for expansion, as well as the highest projected flows in the year 2020. Therefore, discussion of reclaimed water use focusses on these four plants. Edwards AFB WRP is discussed to a lesser extent than the other three plants, because design of water reclamation facilities are already underway.

The Palmdale WRP is an undisinfected secondary treatment facility with a capacity of 8.0 mgd. The Lancaster WRP is currently the only facility in Antelope Valley supplying tertiary treated water (0.6 mgd design capacity). A majority of the plant's flow is treated to a secondary treatment level. Total capacity of the plant is 10.0 mgd. The Rosamond WRP is a 2.0 mgd primary treatment facility. RCSD is planning to convert the existing system to a 2.0 mgd tertiary treatment facility in 1996. The Edwards AFB WRP is a 1.5 mgd primary treatment facility. Edwards AFB is designing a 2.5 mgd tertiary treatment facility scheduled to be constructed in 1995.

The average daily wastewater flow in the year 2020 is estimated to be 37.2 mgd for the Palmdale WRP and 29.8 mgd for the Lancaster WRP. The average daily wastewater flow in the year 2020 for the Rosamond WRP and the Edwards AFB WRP is estimated to be 3.0 and 2.5 mgd respectively.

Table ES-4 presents a list of high potential reclaimed water users identified in the report. The estimated annual, peak month, peak day and peak hour demands for the high potential reclaimed water users are also shown. The total annual reclaimed water demand is approximately 35,600 acre-feet per year. Total peak month demand is estimated to be approximately 6,300 acre-feet, and total peak day demand is estimated to be 74 million gallons or 216 acre-feet.

The recommended conceptual plan is divided into 4 main reclaimed water systems:

- Palmdale and Lancaster Tertiary System (Tertiary System)
- Palmdale and Lancaster Secondary System (Secondary System)
- Rosamond System
- Edwards AFB System

TABLE ES-4

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
	Palmdale/Lancaster Tertiary System										
	2840 ZONE										
101	Palmdale High School	Existing	Tertiary	138	25.3	0.82	265.9	7	12 am - 6 am	6	739
102	Desert Aire Golf Course	Existing	Secondary-D	120	22.0	0.71	231.2	7	10 pm - 8 am	10	385
104	McAdam Park	Existing	Tertiary	72	13.2	0.43	138.7	7	10 pm - 8 am	10	231
105	Courson Park	Existing	Tertiary	23	4.1	0.13	43.4	7	10 pm - 8 am	10	72
118	Desert Rose Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
120	Tumbleweed Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
122	Cactus K-8 School	Existing	Tertiary	36	6.7	0.22	70.1	7	12 am - 6 am	6	195
124	Mesa Intermediate School	Existing	Tertiary	52	9.5	0.31	100.2	7	12 am - 6 am	6	278
	2840 ZONE TOTAL			493	90.4	2.92	949.7				2,179
	2920 ZONE										
65A	Palmdale Business Park	Future	Tertiary	118	16.6	0.54	174.6	7	12 am - 6 am	6	485
65B	Palmdale Business Park Golf Course	Future	Secondary-D	453	50.9	1.64	535.3	7	12 am - 6 am	6	1,487
100	Antelope Valley Country Club	Existing	Secondary-D	375	68.8	2.22	722.5	7	10 pm - 6 am	8	1,505
107	Desert Sands Park	Existing	Tertiary	68	12.5	0.40	131.0	7	10 pm - 8 am	10	218
121	Yucca Elementary School	Existing	Tertiary	23	4.3	0.14	45.1	7	12 am - 6 am	6	125
128	Highlands High School	Existing	Tertiary	100	18.3	0.59	192.7	7	12 am - 6 am	6	535
134	Summerwind Elementary School	Future	Tertiary	42	7.6	0.25	80.2	7	12 am - 6 am	6	223
	2920 ZONE TOTAL			1,179	179.0	5.77	1,881.4				4,579
	2620 ZONE										
52	Lancaster Business Park	Existing	Tertiary	55	10.0	0.32	105.6	7	12 am - 6 am	6	293
53A	Serrano Ranch	Future	Tertiary	329	60.3	1.95	633.9	7	12 am - 6 am	6	1,761
53B	Serrano Ranch Golf Course	Future	Secondary-D	633	116.1	3.74	1,219.7	7	12 am - 6 am	6	3,388
54	K&B Development (Tract 49864)	Future	Tertiary	47	8.6	0.28	90.2	7	12 am - 6 am	6	250
64	Fox Airfield Commercial Development	Future	Tertiary	1,920	352.0	11.35	3,699.5	7	12 am - 6 am	6	10,276
152A	Lancaster City Park	Existing	Tertiary	150	23.5	0.91	295.0	6	10 pm - 6 am	8	615

TABLE ES-4

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand (af/dy)	Peak Day Demand (1000 gpd)	Operating Conditions During Peak Day: Days/week	Operating Conditions During Peak Day: From - To	Operating Conditions During Peak Day: Total Hours	Peak Hour Demand (gpm)
152B	Lancaster City Park	Future	Tertiary	32	5.9	0.23	73.5	6	10 pm - 6 am	8	153
153	Jane Reynolds Park	Existing	Tertiary	30	5.2	0.20	64.6	6	10 pm - 6 am	8	135
154	Mariposa Park	Existing	Tertiary	28	6.2	0.24	78.3	6	10 pm - 6 am	8	163
155	Eastside Park	Existing	Tertiary	71	10.3	0.40	129.5	6	10 pm - 6 am	8	270
156	El Dorado Park	Existing	Tertiary	40	6.5	0.25	81.0	6	10 pm - 6 am	8	169
158	Skytower Park	Existing	Tertiary	48	8.8	0.34	110.3	6	10 pm - 6 am	8	230
159	Apollo Lakes County Park *	Existing	Tertiary	129	30.4	1.44	470.0	7	12 am - 6 am	6	1,306
160	Antelope Valley High School	Existing	Tertiary	130	23.8	0.77	250.5	7	12 am - 6 am	6	696
161	Desert Winds High School	Existing	Tertiary	8	1.4	0.05	14.8	7	12 am - 6 am	6	41
163	Parkview Intermediate High School	Existing	Tertiary	65	11.9	0.38	124.9	7	12 am - 6 am	6	347
169	Mariposa Elementary School	Existing	Tertiary	38	7.0	0.22	73.1	7	12 am - 6 am	6	203
170	Joshua Elementary School	Existing	Tertiary	56	10.3	0.33	108.7	7	12 am - 6 am	6	302
171	El Dorado Elementary School	Existing	Tertiary	25	4.6	0.15	48.6	7	12 am - 6 am	6	135
172	Linda Verde Elementary School	Existing	Tertiary	28	5.1	0.16	53.6	7	12 am - 6 am	6	149
175A	Joshua Memorial Park	Existing	Secondary-D	90	16.5	0.53	173.4	7	12 am - 6 am	6	482
175B	Joshua Memorial Park	Future	Secondary-D	21	3.9	0.12	40.5	7	12 am - 6 am	6	112
186	New Vista Elementary School	Future	Tertiary	43	7.9	0.26	83.2	7	12 am - 6 am	6	231
	2620 ZONE TOTAL			4,016	736	25	8,022				21,706
	Tertiary System Total			5,688	1,006	33	10,853				28,463
	Palmdale/Lancaster Secondary System										
2	Alfalfa Farm	Existing	Secondary-U	1,151	214.6	7.40	2,627.4	7	12 am - 12 am	24	1,825
2A	Alfalfa Farm	Existing	Secondary-U	1,306	243.6	8.40	2,982.4	7	12 am - 12 am	24	2,071
4	Grain & Alfalfa Farm	Existing	Secondary-U	2,895	540.6	18.90	6,553.8	7	12 am - 12 am	24	4,551
5	Alfalfa Farm	Existing	Secondary-U	2,706	504.6	17.40	6,177.9	7	12 am - 12 am	24	4,290
6A	Alfalfa Farm	Existing	Secondary-U	1,866	348.0	12.00	4,260.6	7	12 am - 12 am	24	2,959
6B	Alfalfa Farm	Existing	Secondary-U	1,120	208.8	7.20	2,556.4	7	12 am - 12 am	24	1,775
8	Nebeker Ranch *	Existing	Secondary-U	4,229	788.8	27.20	9,657.3	7	12 am - 12 am	24	6,706
9	Alfalfa Farm	Existing	Secondary-U	1,617	301.6	10.40	3,692.5	7	12 am - 12 am	24	2,564
9A	Alfalfa Farm	Existing	Secondary-U	746	139.2	4.80	1,704.2	7	12 am - 12 am	24	1,184
11	Alfalfa Farm	Existing	Secondary-U	1,244	232.0	8.00	2,840.4	7	12 am - 12 am	24	1,973
12A	Christmas Tree & Landscape Farm *	Existing	Secondary-U	81	18.8	0.80	233.9	7	12 am - 12 am	24	162

TABLE ES-4

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
13	Alfalfa Farm	Existing	Secondary-U	995	185.6	6.40	2,272.3	7	12 am - 12 am	24	1,578
13A	Alfalfa Farm	Existing	Secondary-U	622	116.0	4.00	1,420.2	7	12 am - 12 am	24	986
13B	Alfalfa Farm	Existing	Secondary-U	995	185.6	6.40	2,272.3	7	12 am - 12 am	24	1,578
13C	Alfalfa Farm	Existing	Secondary-U	373	69.6	2.40	852.1	7	12 am - 12 am	24	592
15A	DOA Test Farm	Existing	Secondary-U	32	7.5	0.32	93.6	7	12 am - 12 am	24	65
15B	DOA Pistachio Farm *	Existing	Secondary-U	112	29.4	0.90	338.3	7	12 am - 12 am	24	235
15C	DOA Chestnut Farm *	Existing	Secondary-U	149	39.2	1.20	451.1	7	12 am - 12 am	24	313
15D	DOA Barley Farm *	Existing	Secondary-U	304	57.2	2.20	643.3	7	12 am - 12 am	24	447
18A	Sod Farm	Existing	Secondary-D	684	126.1	5.20	1,683.4	7	12 am - 12 am	24	1,169
173	Paiute Ponds *	Existing	Secondary-D	1,456	228.4	7.37	2,400.0	7	12 am - 12 am	24	1,667
174A	Wagas Land Duck Ponds	Existing	Secondary-D	1,558	186.0	6.00	1,954.8	7	12 am - 12 am	24	1,358
176	Young Ranch	Existing	Secondary-D	253	43.1	1.39	453.0	7	12 am - 12 am	24	315
	Secondary System Total			26,493	4,814	166	58,121				40,362
	Rosamond System										
200	Rosamond Elementary School	Existing	Tertiary	17	3.1	0.10	32.6	7	10 pm - 8 am	10	54
201	Hamilton Elementary School	Existing	Tertiary	65	11.9	0.38	125.2	7	10 pm - 8 am	10	209
202	Rosamond High School	Existing	Tertiary	66	12.1	0.39	127.2	7	10 pm - 8 am	10	212
203	Tropico Middle School	Existing	Tertiary	26	4.8	0.15	50.1	7	10 pm - 8 am	10	83
204	Rare Earth Continuation School	Existing	Tertiary	17	3.1	0.10	32.6	7	10 pm - 8 am	10	54
205	Rosamond Park	Existing	Tertiary	30	5.5	0.18	57.8	7	12 am - 6 am	6	161
206	West Park	Existing	Tertiary	15	2.8	0.09	28.9	7	12 am - 6 am	6	80
207	Desert Highlands Development	Future	Tertiary	209	29.8	1.15	373.3	6	12 am - 6 am	6	1,037
208	Desert Highlands Golf Course	Future	Secondary-D	90	16.5	0.63	206.8	6	12 am - 6 am	6	574
209	Tract 5052	Future	Tertiary	15	2.8	0.09	29.4	7	12 am - 6 am	6	82
210	Tract 5172	Future	Tertiary	58	10.7	0.35	112.6	7	12 am - 6 am	6	313
211	Tract 5188	Future	Tertiary	12	2.2	0.07	23.1	7	12 am - 6 am	6	64
212	Tract 5195	Future	Tertiary	20	3.6	0.12	38.2	7	12 am - 6 am	6	106
213	Tract 5196	Future	Tertiary	19	3.5	0.11	37.0	7	12 am - 6 am	6	103
214	Tract 5198	Future	Tertiary	19	3.5	0.11	37.0	7	12 am - 6 am	6	103
215	Tract 5204	Future	Tertiary	19	3.6	0.11	37.5	7	12 am - 6 am	6	104
216	Tract 5313	Future	Tertiary	4	0.7	0.02	7.8	7	12 am - 6 am	6	22

TABLE ES-4

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
217	Tract 5394	Future	Tertiary	6	1.0	0.03	10.8	7	12 am - 6 am	6	30
218	Tract 5400	Future	Tertiary	38	7.0	0.23	74.0	7	12 am - 6 am	6	206
220	Tract 4558	Future	Tertiary	12	2.2	0.07	23.4	7	12 am - 6 am	6	65
	Rosamond System Total			758	130.5	4.50	1,465.0				3,661
	Edwards AFB System										
1	Wing Headquarters	Existing	Tertiary	11	1.8	0.06	19.1	7	10 pm - 8 am	10	32
16	Muroc Manner	Existing	Tertiary	19	2.8	0.09	29.7	7	10 pm - 8 am	10	50
1020	IFAST	Existing	Tertiary	19	1.9	0.06	20.3	7	10 pm - 8 am	10	34
1200	Base Operations	Existing	Tertiary	6	1.0	0.03	10.1	7	10 pm - 8 am	10	17
1220	Test Pilot School	Existing	Tertiary	5	0.7	0.02	7.8	7	10 pm - 8 am	10	13
1250	Offices	Existing	Tertiary	0	0.0	0.00	0.2	7	10 pm - 8 am	10	0
1260	Offices	Existing	Tertiary	5	0.8	0.03	8.2	7	10 pm - 8 am	10	14
1400	Engineering	Existing	Tertiary	9	1.3	0.04	13.7	7	10 pm - 8 am	10	23
1440	Ridley Mission Control Center	Existing	Tertiary	25	2.8	0.09	29.5	7	10 pm - 8 am	10	49
1600	T-38	Existing	Tertiary	13	1.1	0.03	11.1	7	10 pm - 8 am	10	19
1609	C-17	Existing	Tertiary	0	0.0	0.00	0.2	7	10 pm - 8 am	10	0
1610	Colonial Inn	Existing	Tertiary	4	0.5	0.02	5.6	7	10 pm - 8 am	10	9
1633	Offices	Existing	Tertiary	3	0.5	0.02	5.1	7	10 pm - 8 am	10	9
1830A	Enviornmental	Existing	Tertiary	5	0.7	0.02	7.1	7	10 pm - 8 am	10	12
2201	Softball Field	Existing	Tertiary	10	1.6	0.05	16.4	7	10 pm - 8 am	10	27
2419	Grass Island	Existing	Tertiary	3	0.4	0.01	4.5	7	10 pm - 8 am	10	8
2421	Civilian Personnel	Existing	Tertiary	3	0.5	0.02	4.9	7	10 pm - 8 am	10	8
2430	OSI	Existing	Tertiary	8	1.2	0.04	12.3	7	10 pm - 8 am	10	20
2453	Education Center	Existing	Tertiary	3	0.4	0.01	4.6	7	10 pm - 8 am	10	8
2500	Oasis Club	Existing	Tertiary	15	2.2	0.07	23.1	7	10 pm - 8 am	10	39
2600	Comm. Building	Existing	Tertiary	7	1.0	0.03	10.3	7	10 pm - 8 am	10	17
2650A	CSC	Existing	Tertiary	13	1.9	0.06	20.3	7	10 pm - 8 am	10	34
2656	Library Park	Existing	Tertiary	16	2.3	0.07	24.4	7	10 pm - 8 am	10	41
2665	Library	Existing	Tertiary	16	2.4	0.08	25.0	7	10 pm - 8 am	10	42
2670	Post Office	Existing	Tertiary	6	0.9	0.03	9.8	7	10 pm - 8 am	10	16
2700	Chapel	Existing	Tertiary	21	3.1	0.10	32.9	7	10 pm - 8 am	10	55

TABLE ES-4

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand (af/dy)	Peak Day Demand (1000 gpd)	Operating Conditions During Peak Day: Days/week	Operating Conditions During Peak Day: From - To	Operating Conditions During Peak Day: Total Hours	Peak Hour Demand (gpm)
2750	FTEMF	Existing	Tertiary	54	7.9	0.26	83.2	7	10 pm - 8 am	10	139
2800	Procurement	Existing	Tertiary	17	2.6	0.08	27.1	7	10 pm - 8 am	10	45
2858	Comm. Bulding	Existing	Tertiary	3	0.4	0.01	4.4	7	10 pm - 8 am	10	7
2860	Security Police	Existing	Tertiary	10	1.5	0.05	15.9	7	10 pm - 8 am	10	26
3497	Self Help	Existing	Tertiary	2	0.3	0.01	3.0	7	10 pm - 8 am	10	5
3500	Civil Engineering	Existing	Tertiary	2	0.2	0.01	2.4	7	10 pm - 8 am	10	4
3507	Dog Pound	Existing	Tertiary	6	0.8	0.03	8.7	7	10 pm - 8 am	10	15
3510	Vehicle Maintenance Shop	Existing	Tertiary	1	0.0	0.00	0.4	7	10 pm - 8 am	10	1
3535	Headquarters	Existing	Tertiary	15	2.3	0.07	23.9	7	10 pm - 8 am	10	40
3535	Off-Site (Rosamond Blvd).	Existing	Tertiary	19	2.9	0.09	30.6	7	10 pm - 8 am	10	51
3804	Jet Test Cell	Existing	Tertiary	4	0.4	0.01	3.7	7	10 pm - 8 am	10	6
3810	Jet Maintenance Facility	Existing	Tertiary	31	4.5	0.15	47.4	7	10 pm - 8 am	10	79
3920	Altitude Chamber	Existing	Tertiary	4	0.6	0.02	6.5	7	10 pm - 8 am	10	11
3940	Programs	Existing	Tertiary	3	0.4	0.01	4.5	7	10 pm - 8 am	10	8
3950	Office	Existing	Tertiary	3	0.5	0.02	4.9	7	10 pm - 8 am	10	8
3950A	Offices	Existing	Tertiary	8	1.2	0.04	12.4	7	10 pm - 8 am	10	21
Q	Dorms	Existing	Tertiary	207	30.8	0.99	323.2	7	10 pm - 8 am	10	539
R	Rosamond Blvd, So. Muroc Dr.	Existing	Tertiary	13	1.9	0.06	20.3	7	10 pm - 8 am	10	34
5201	Softball Field	Existing	Tertiary	12	1.9	0.06	19.5	7	10 pm - 8 am	10	33
5208	Wings Field	Existing	Tertiary	29	4.3	0.14	45.4	7	10 pm - 8 am	10	76
5210	Youth Center	Existing	Tertiary	15	2.3	0.07	23.9	7	10 pm - 8 am	10	40
5211	Hap Arnold Park	Existing	Tertiary	10	1.4	0.05	14.9	7	10 pm - 8 am	10	25
5213	Robers Field	Existing	Tertiary	22	3.3	0.11	34.4	7	10 pm - 8 am	10	57
5214	Bowling	Existing	Tertiary	2	0.3	0.01	3.4	7	10 pm - 8 am	10	6
5215	Little League Field	Existing	Tertiary	7	1.0	0.03	10.6	7	10 pm - 8 am	10	18
5216	Softball Field	Existing	Tertiary	12	1.8	0.06	18.8	7	10 pm - 8 am	10	31
5220	Soccar Field	Existing	Tertiary	10	1.5	0.05	16.0	7	10 pm - 8 am	10	27
5221	Little League Field	Existing	Tertiary	13	2.0	0.06	20.6	7	10 pm - 8 am	10	34
5500	Hospital	Existing	Tertiary	23	2.6	0.08	27.5	7	10 pm - 8 am	10	46
5510	Hospital Barracks	Existing	Tertiary	5	0.8	0.02	7.9	7	10 pm - 8 am	10	13
5513	Dental Clinic	Existing	Tertiary	24	3.6	0.12	37.5	7	10 pm - 8 am	10	63
5550	Veterinary Clinic	Existing	Tertiary	3	0.4	0.01	4.0	7	10 pm - 8 am	10	7
5560	Fire Station	Existing	Tertiary	7	1.1	0.04	11.6	7	10 pm - 8 am	10	19
5600	Officer's Club	Existing	Tertiary	30	4.4	0.14	46.6	7	10 pm - 8 am	10	78
5601	VIP Billeting	Existing	Tertiary	11	1.7	0.05	17.3	7	10 pm - 8 am	10	29

TABLE ES-4

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand (af/dy)	Peak Day Demand (1000 gpd)	Operating Conditions During Peak Day: Days/ week	Operating Conditions During Peak Day: From - To	Operating Conditions During Peak Day: Total Hours	Peak Hour Demand (gpm)
5602	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
5603	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
5604	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
5606	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
6000	Commissary	Existing	Tertiary	12	1.8	0.06	18.5	7	10 pm - 8 am	10	31
6002	Branch Bank	Existing	Tertiary	6	0.8	0.03	8.8	7	10 pm - 8 am	10	15
6005	Baskin Robbins	Existing	Tertiary	6	0.9	0.03	9.4	7	10 pm - 8 am	10	16
6006	Burger King	Existing	Tertiary	10	1.5	0.05	15.6	7	10 pm - 8 am	10	26
6441	Preschool	Existing	Tertiary	2	0.3	0.01	3.4	7	10 pm - 8 am	10	6
6445	Social Actions	Existing	Tertiary	1	0.1	0.00	1.2	7	10 pm - 8 am	10	2
6447	Housing Chapel	Existing	Tertiary	15	2.3	0.07	23.9	7	10 pm - 8 am	10	40
6459	Child Care Center	Existing	Tertiary	4	0.7	0.02	6.8	7	10 pm - 8 am	10	11
7020	Old Youth Center	Existing	Tertiary	26	3.8	0.12	40.4	7	10 pm - 8 am	10	67
B	Park	Existing	Tertiary	25	3.7	0.12	39.3	7	10 pm - 8 am	10	66
C	Park	Existing	Tertiary	23	3.4	0.11	35.4	7	10 pm - 8 am	10	59
F	Park	Existing	Tertiary	62	9.2	0.30	96.9	7	10 pm - 8 am	10	162
G	Park	Existing	Tertiary	4	0.6	0.02	5.8	7	10 pm - 8 am	10	10
H	Park	Existing	Tertiary	12	1.8	0.06	18.4	7	10 pm - 8 am	10	31
I	MH Park Playground	Existing	Tertiary	5	0.8	0.03	8.2	7	10 pm - 8 am	10	14
J	Famcamp	Existing	Tertiary	33	4.9	0.16	51.1	7	10 pm - 8 am	10	85
K	Schools	Existing	Tertiary	156	23.2	0.75	243.7	7	10 pm - 8 am	10	406
L	Golf Course	Existing	Tertiary	934	139.6	4.50	1,467.0	7	10 pm - 8 am	10	2,445
M	Love Avenue	Existing	Tertiary	14	2.2	0.07	22.9	7	10 pm - 8 am	10	38
N	Miscellaneous Use	Existing	Tertiary	82	3.0	0.10	31.9	7	10 pm - 8 am	10	53
O	Industrial Use	Future	Tertiary	28	3.9	0.13	41.0	7	10 pm - 8 am	10	68
P	Irrigation Use	Future	Tertiary	307	43.2	1.39	454.0	7	10 pm - 8 am	10	757
	Edwards AFB System Total			2,685	384.7	12.41	4,043.2				6,739
	GRAND TOTAL			35,624	6,335	216	74,483				79,225

* Current user of reclaimed water
Secondary-D: Disinfected Secondary
Secondary-U: Undisinfected Secondary

The tertiary system would serve tertiary treated reclaimed water to approximately 34 users in three service zones. Service zone maximum water surface elevations are 2,620, 2,840 and 2,920 feet above sea level. The secondary system would serve secondary treated reclaimed water to approximately 23 users in one service zone (maximum water surface elevation of 2,680 feet). The Rosamond system would serve tertiary treated water to approximately 20 users in one service zone (maximum water surface elevation of 2,620 feet).

Main pump stations would be located at the reclaimed water supply. Each of the service zones would contain storage reservoirs, distribution system piping, and booster pump stations.

The estimated construction cost of the reclaimed water system is shown in Table ES-5. As shown in the table, the treatment facilities for the tertiary and the Rosamond systems are $24,417,000 and $7,731,000 respectively. The distribution facilities for the tertiary, secondary, and Rosamond systems are $36,456,000, $67,486,000, and $8,296,000 respectively. The total cost for construction of the entire regional system is approximately $144,386,000 (1994 dollars). Construction costs include 15 percent for contractor overhead and profit, 20 percent for engineering/administration and 25 percent for contingencies.

Edwards AFB is currently designing a 2.5-mgd tertiary wastewater treatment plant. The following is a list of facilities for the planned reclaimed water distribution system:

- A 3,125 gallon per minute (gpm) main pump station at the wastewater treatment plant.
- A 3,125 gpm booster pump station.
- A 2.2 mg storage reservoir.
- Approximately 31,740 feet of polyvinyl chloride (PVC) pipe ranging from 4 to 18 inches in diameter.

The estimated capital cost of the planned distribution facilities is $6,300,000. Operation and Maintenance (O&M) costs were estimated to be $140,000 per year.

Table ES-6 shows the unit cost of the reclaimed water distribution facilities and the unit cost of the treatment facilities for each system. As shown in the table, the unit costs for the distribution facilities for the tertiary, secondary and Rosamond systems are $858, $359 and $1,218 per acre-foot respectively (includes annualized capital). The unit costs for the treatment facilities for the tertiary and Rosamond systems are $999 and $1,649 per acre-foot respectively (includes annualized capital). Total unit costs (distribution and treatment) for the tertiary, secondary and Rosamond systems are $1,857, $359 and $2,867 per acre-foot, respectively. These costs assume construction of the project is financed at market rates instead of low interest loans. The unit costs would be reduced if low interest loans were utilized for construction financing.

TABLE ES-5

PRELIMINARY COST ESTIMATE

COMPONENT	ESTIMATED COST (1994 Dollars)
I. Treatment Facilities	
A. Tertiary System	
Palmdale - 3.0 mgd	$ 6,200,000
Lancaster - 8.0 mgd	9,061,000
SUBTOTAL	$ 15,261,000
Contractor's OH & Profit (15%)	2,289,000
Engineering/Admin (20%)	3,052,000
Contingency (25%)	3,815,000
TOTAL (Tertiary System)	$ 24,417,000
B. Rosamond System	
Rosamond - 2.0 mgd	$ 4,832,000
SUBTOTAL	4,832,000
Contractor's OH & Profit (15%)	725,000
Engineering/Admin (20%)	966,000
Contingency (25%)	1,028,000
TOTAL (Rosamond System)	$ 7,731,000
TOTAL (Treatment Facilities)	$ 32,148,000
II. Distribution Facilities	
A. Tertiary System	
1. Main Pump Stations	
Palmdale - 2,000 gpm	
Lancaster - 5,600 gpm	$ 518,000
	1,004,000
2. Booster Pump Stations	
No. 1 - 1,320 gpm	
No. 2 - 1,520 gpm	$ 249,000
No. 3 - 5,660 gpm	275,000
No. 4 - 8,935 gpm	648,000
No, 5 - 5,600 gpm	875,000
	648,000
3. Reservoirs	
No. 1. - 1.0 mg	
No. 2. - 2.0 mg	$ 500,000
No. 3. - 1.0 mg	1,000,000
No, 4. - 2.4 mg	500,000
No. 5. - 4.6 mg	1,200,000
	2,300,000
4. Distribution Pipelines	
30-inch D.I. (100 LF)	
24-inch PVC (1,600 LF)	$ 15,000
18-inch PVC (93,800 LF)	154,000
16-inch PVC (9,500 LF)	6,754,000
14-inch PVC (43,700 LF)	608,000
12-inch PVC (27,600 LF)	2,447,000
10-inch PVC (7,500 LF)	1,325,000
8-inch PVC (24,900 LF)	996,000
6-inch PVC (12,800 LF)	240,000
	307,000
5. System Flushing and Testing	
	$ 222,000
SUBTOTAL	
Contractor's OH & Profit (15%)	$ 22,785,000
Engineering/Admin (20%)	3,418,000
Contingency (25%)	4,557,000
TOTAL	5,696,000
	$36,456,000

CONTINUED ON RIGHT

COMPONENT	ESTIMATED COST (1994 Dollars)
B. Rosamond System	
1. Main Pump Station	
Rosamond - 1,050 gpm	$ 324,000
2. Booster Pump Stations	
No. 7 - 1,611 gpm	$ 288,000
3. Reservoirs	
No. 9 - 1.5 mg	$ 750,000
4. Distribution Pipelines	
16-inch PVC (2,200 LF)	$ 128,000
12-inch PVC (39,200 LF)	1,882,000
10-inch PVC (19,400 LF)	776,000
8-inch PVC (21,800 LF)	698,000
6-inch PVC (8,600 LF)	206,000
5. System Flushing and Testing	$ 91,000
SUBTOTAL	$ 5,143,000
Contractor's OH & Profit (15%)	771,000
Engineering/Admin (20%)	1,029,000
Contingency (25%)	1,353,000
TOTAL (Rosamond System)	$ 8,296,000
C. Secondary System	
1. Main Pump Stations	
Palmdale - 25,800 gpm	$ 2,591,000
Lancaster - 15,700 gpm	1,846,000
2. Booster Pump Stations	
No. 6 - 3,000 gpm	$ 421,000
3. Open Reservoir	
No. 6 - 400 AF	$ 9,123,000
No. 7 - 565 AF	3,682,000
4. Distribution Pipelines	
42-inch D.I. (43,100 LF)	$9,051,000
36-inch D.I. (48,800 LF)	8,784,000
24-inch D.I. (15,840 LF)	1,901,000
20-inch D.I. (14,700 LF)	1,470,000
16-inch D.I. (5,400 LF)	432,000
14-inch D.I. (18,700 LF)	1,309,000
12-inch D.I. (5,500 LF)	330,000
10-inch D.I. (20,500 LF)	1,025,000
6-inch D.I. (1,300 LF)	39,000
5. System Flushing and Testing	$ 174,000
SUBTOTAL	$ 42,178,000
Contractor's OH & Profit (15%)	6,327,000
Engineering/Admin (20%)	8,436,000
Contingency (25%)	10,545,000
TOTAL (Secondary System)	$ 67,486,000
TOTAL (Distribution Facilities)	$112,238,000
GRAND TOTAL	**$ 144,386,000**

934620.00

TABLE ES-6

ECONOMIC ANALYSIS OF THE RECLAIMED WATER SYSTEMS
(1994 DOLLARS)

Distribution Facilities	*Reclaimed Water Demand (AF/YR)*	*Annualized Capital Cost (1)*	*Annual Water Purchase Cost (2)*	*ANNUAL O&M COST*				*Includes Annual Capital Cost*		*Excludes Annual Capital Cost*	
				Pumping Cost (3)	*Parts Cost (4)*	*Labor Cost (5)*	*Total O&M Cost*	*Total Annual Cost*	*Cost per AF*	*Total Annual Cost*	*Cost per AF*
Tertiary System	5,688	$3,714,866	$341,280	$709,145	$84,725	$28,800	$822,670	$4,878,816	$858	$1,163,950	$205
Secondary System	26,493	$6,876,823	$1,589,580	$899,800	$120,024	$14,400	$1,034,224	$9,500,627	$359	$2,623,804	$99
Rosamond System	758	$845,363	$0	$55,200	$14,786	$7,200	$77,186	$922,549	$1,218	$77,186	$102
TOTAL	32,939	$11,437,052	$1,930,860	$1,664,145	$219,535	$50,400	$1,934,080	$15,301,992	$465	$3,864,940	$117

Treatment Facilities	*Reclaimed Water Demand (AF/YR)*	*Annualized Capital Cost (1)*	*Annual O&M Cost(6)*	*Includes Annual Capital Cost*		*Excludes Annual Capital Cost*	
				Total Annual Cost	*Cost per AF*	*Total Annual Cost*	*Cost per AF*
Tertiary System	5,688	$2,488,092	$2,195,370	$5,683,462	$999	$2,195,370	$386
Rosamond System	758	$787,789	$462,000	$1,249,789	$1,649	$462,000	$609
TOTAL	6,446	$3,275,881	$57,370	$6,933,251	$1,076	$2,657,370	$412

(1) Assumes 20 year period at 8% interest rate.
(2) For tertiary and secondary systems, cost to purchase reclaimed water from County Sanitation Districts of Los Angeles County. Current cost estimated to be $60/acre-feet. For Rosamond system; assumed RCSD operates WRP and purveys water.
(3) Assumes 80% pump efficiency, 90% motor efficiency, and electricity cost of $0.10 per Kwhr. Includes operation costs of booster and reuse pumps.
(4) Assumes annual parts cost to be 1% of construction costs of pumping stations, plus 0.1% of construction costs of storage reservoirs and pipelines.
(5) Assumes $25 per hour.
(6) From Dave Richard's "A Summary of Wastewater Reclamation Costs in California".

Figure ES-7 depicts the medium demand with and without implementation of conservation measures and projected supply estimated at the 50, 80, and 90 percent probability levels. The most optimistic supply assumption (i.e., delivery of 100 percent of available water supplies) is also shown. Figure ES-7 is based on Figures ES-5 and ES-6 with one exception, the reclaimed water supply for the year 2020 is taken as the supply that will meet the demand for the high potential reclaimed water users identified in Table ES-4 (approximately 35,600 acre-feet). As shown on Figure ES-7, without exceeding groundwater extractions of 59,100 acre-feet per year, the probability of meeting the estimated 1993 water demand is approximately 73 percent. Without a conservation program and including the reclaimed water system identified in this report, by the year 1999 (projected population of 475,000), 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2001 (projected population of 523,000), 100 percent of the potential water supplies would be required to meet the water demand. With a conservation program and including the reclaimed water system, by the year 2002 (projected population of 547,000), 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2004 (projected population of 595,000), 100 percent of the potential water supplies would be required to meet the water demand.

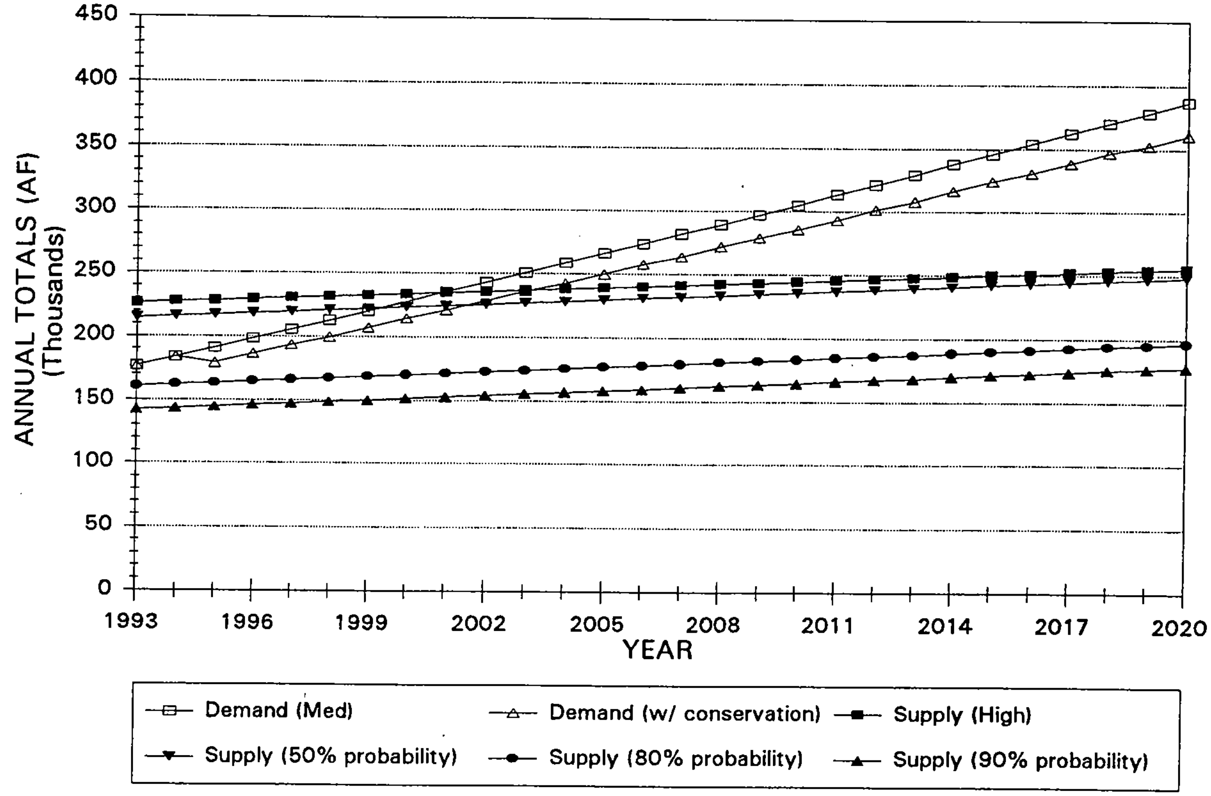
AQUIFER STORAGE AND RECOVERY

Aquifer Storage and Recovery (ASR) include the following methods of storing and recovering water from the groundwater basin:

- Spreading/Infiltration - use of surface spreading basins to allow infiltration of water into the aquifer.
- Injection - use of new or existing wells for direct injection of water into the aquifer.
- In-lieu Use - use of an alternative source of water, other than groundwater, when available, and use of groundwater when the alternative source is unavailable.

The entire groundwater basin of the Antelope Valley is estimated to have 68 million acre-feet of storage of which 13 million acre-feet is currently available (DWR, 1980). Approximately 55 million acre-feet of groundwater was estimated to remain in storage as of 1975. This stored water, however, may not be entirely accessible due to 1) uneconomical pumping depths, 2) distance between the groundwater basin and current users, and 3) the potential for causing land subsidence.

At present, the principal source of recharge of the groundwater in the Antelope Valley is runoff, principally recharged in the foothills of the mountains. Numerous studies have been conducted to estimate natural recharge since 1924, some based on little data. The most recent studies estimate natural recharge at 31,200 to 59,100 acre-feet per year (USGS, 1993).



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Supply and Projected Demand
(Includes Reclaimed Water Use)

November 1995
K/J 934620.00

Figure ES–7

Figure ES–7

There are a variety of source waters that could be available for recharge into the groundwater of the Antelope Valley. They include:

- SWP
  - Treated potable water
  - Untreated water directly from the California Aqueduct

- Reclaimed Water (for spreading only)
  - Secondary treatment
  - Tertiary treatment

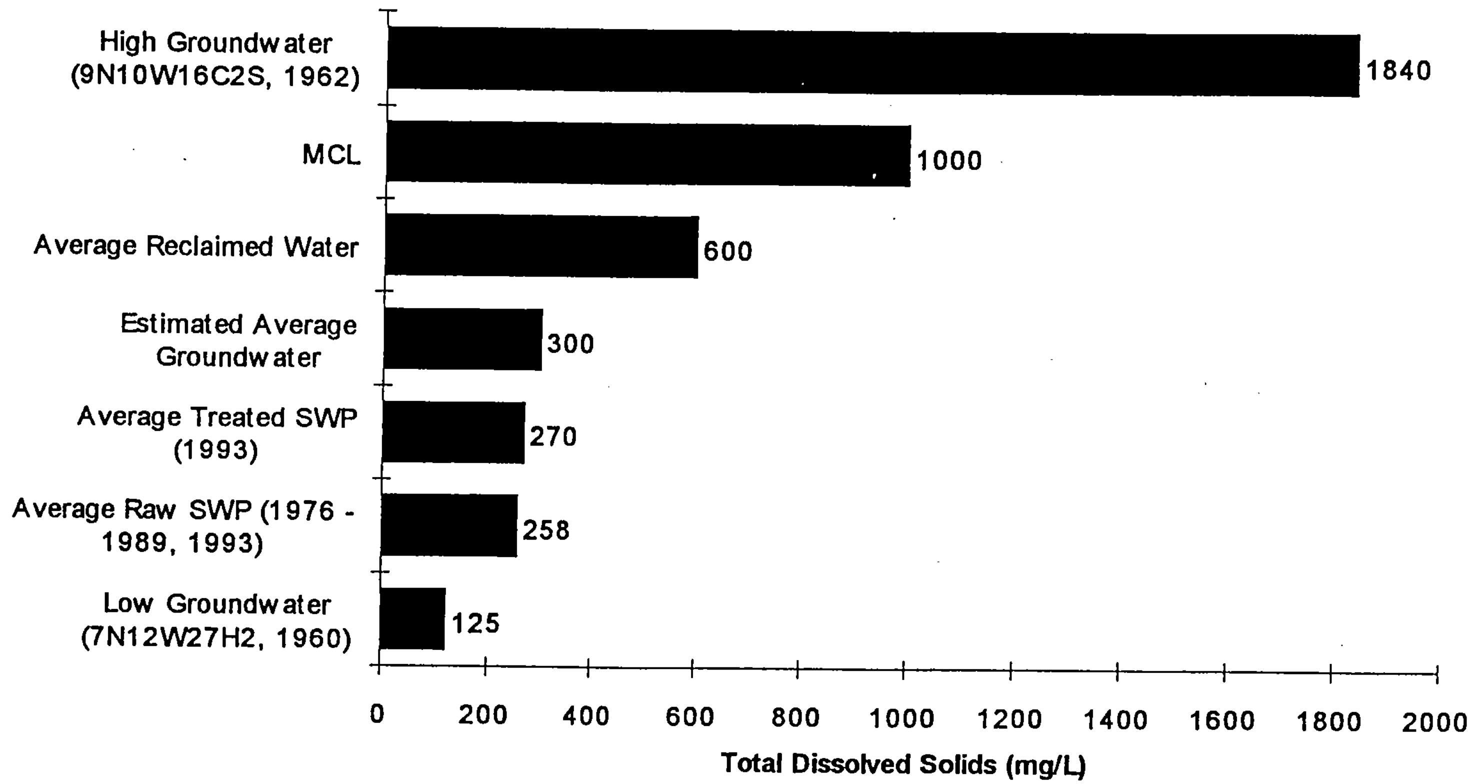
- Surface Water
  - Little Rock Creek and Little Rock Reservoir
  - Big Rock Creek
  - Amargosa Creek

The range in total dissolved solids (TDS) values of the potential sources of groundwater in the Antelope Valley is shown on Figure ES-8. The average raw SWP TDS value is an average of the annual average from 1976 to 1989 and 1993 (1993 TDS average is obtained from the average of January through June of 1993). The highest groundwater TDS level within the wells for which data were evaluated was 1840 milligrams per liter (mg/L) in a well located on Edwards AFB where perched water tables and the accompanying high salts occur. The low groundwater TDS of 125 mg/L occurred in a well in the LACWW wellfield near Lancaster. The average TDS value was estimated at about 300 mg/L based on the wells for which water quality was evaluated.

Certain characteristics affect economic viability and technical feasibility and are a key to a successful ASR program. If the aquifer is unsuitable for groundwater extraction, it is likely to be unsuitable for groundwater infiltration or injection. The following characteristics are desirable for both infiltration and injection programs:

- Suitable surface and sub-surface hydrogeologic conditions
- Adequate storage capacity
- Proximity to potential recharge water sources
- Proximity to existing groundwater production sites
- Impermeable faults to impound groundwater
- Compatible water quality

Both infiltration and injection require aquifer materials that have a high ability to accept and transmit water. These materials include sands and gravels at the surface for rapid infiltration and in the subsurface for rapid acceptance of injected water. As previously mentioned, there is an estimated available storage of 13 million acre-feet in the Antelope Valley aquifers. In order to have a cost-effective recharge program, the potential recharge sites should be located within a reasonable distance and hydraulic gradient of the potential source waters. Potential infiltration and injection sites should be assessed relative to the location of the existing facilities in order to minimize capital costs. In certain instances where



Note: Groundwater samples collected between 1960 - 1992 at wells in Antelope Valley

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Comparison in Antelope Valley

November 1995
K/J 934620.00

Figure ES-8

it is necessary to control the ultimate storage location of the infiltrated or injected groundwaters, fault and bedrock control of the groundwater impound may be a necessary characteristic that will need to be investigated further. In addition, it is important that the potential recharge site has good quality groundwater that will not compromise the quality of the water to be infiltrated or injected.

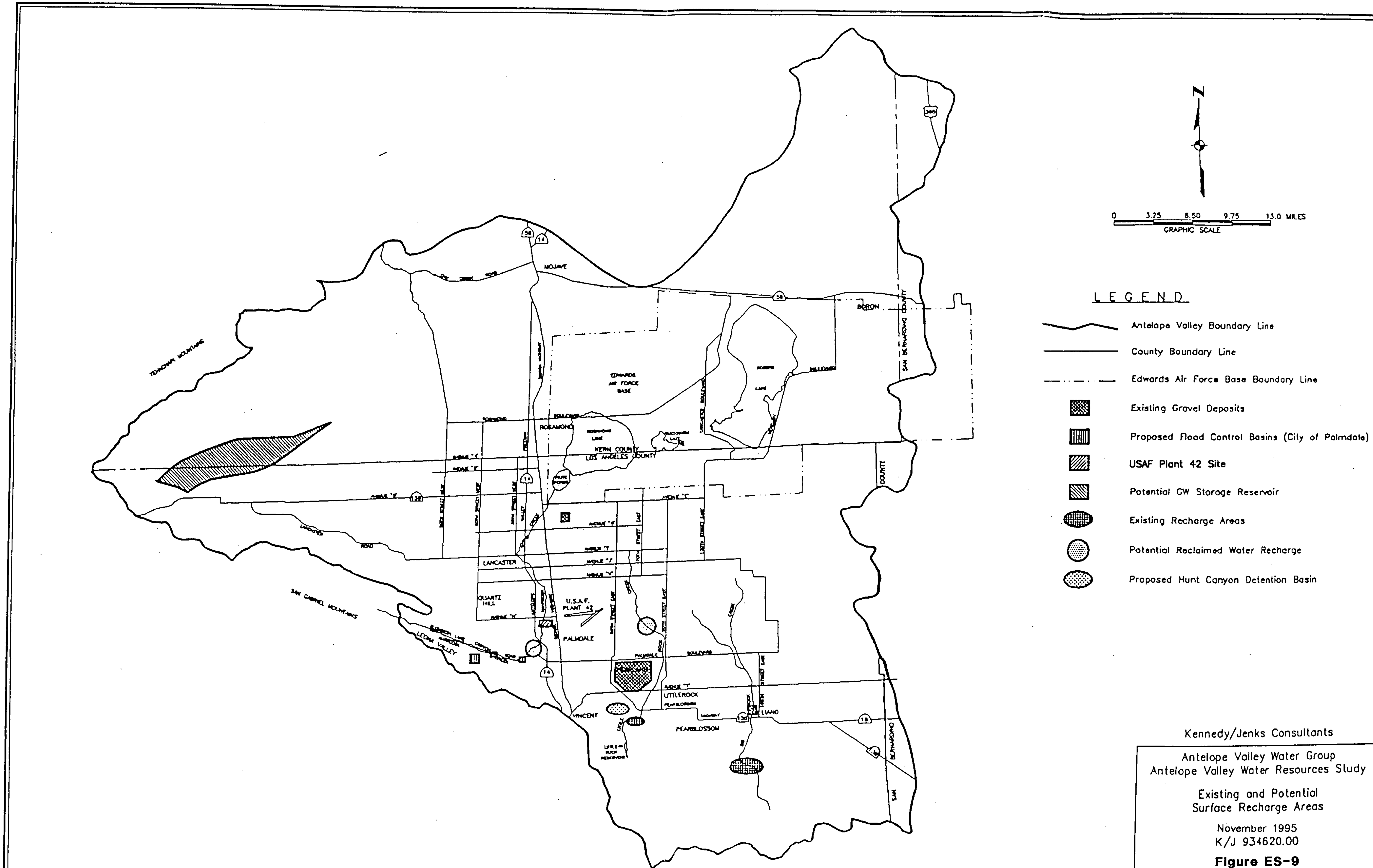
Based on the characteristics favorable to a good surface infiltration site and previous work that has been conducted in assessing infiltration sites, the following areas have been focussed on for more detailed analysis:

- Little Rock Creek
- Big Rock Creek
- Amargosa Creek
- West Antelope Subunit
- Groundwater recharge zones described in the Los Angeles County Department of Public Works (LACDPW) "Final Report on the Antelope Valley Comprehensive Plan of Flood Control and Water Conservation," dated June 1987.

The general location of existing and potential surface recharge sites can be found on Figure ES-9. Infiltration as a mechanism to recharge groundwater appears to be technically feasible. The sites with the highest potential for recharge by spreading appear to be:

- Amargosa Creek south of Avenue "N" between 10th Street West and Division Street (LACDPW Site).
- Little Rock Creek near Avenue "N" between 60th Street and 70th Street East, Department of Airport (DOA) Property.
- Amargosa Creek near Elizabeth Lake Road and 25th Street West.

There are several potential recharge sources including SWP water, reclaimed water, and natural recharge waters which should be generally acceptable for infiltration from a water quality perspective. More detailed water quality analyses should be conducted at the potential recharge sites to gather current information on the condition of the aquifer in these specific locations. Until those data are available, comparisons of water quality with the potential recharge sources cannot be reliably made. If specific areas for recharge are selected that have water quality that is worse than the potential source waters, the recharge program may benefit the aquifer.



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Existing and Potential
Surface Recharge Areas

November 1995
K/J 934620.00

Figure ES-9

In addition, the potential formation of wetlands at the LACDPW site and the DOA site could result in increased wildfowl activity that could interfere with airfield operations. Depending on the timing of the operation of spreading ponds at the sites, this concern could be mitigated or reduced by developing an operation plan that accounts for migration patterns of the wildfowl.

Overall, further investigation will be required at each of the specific sites and should include, at a minimum, the following:

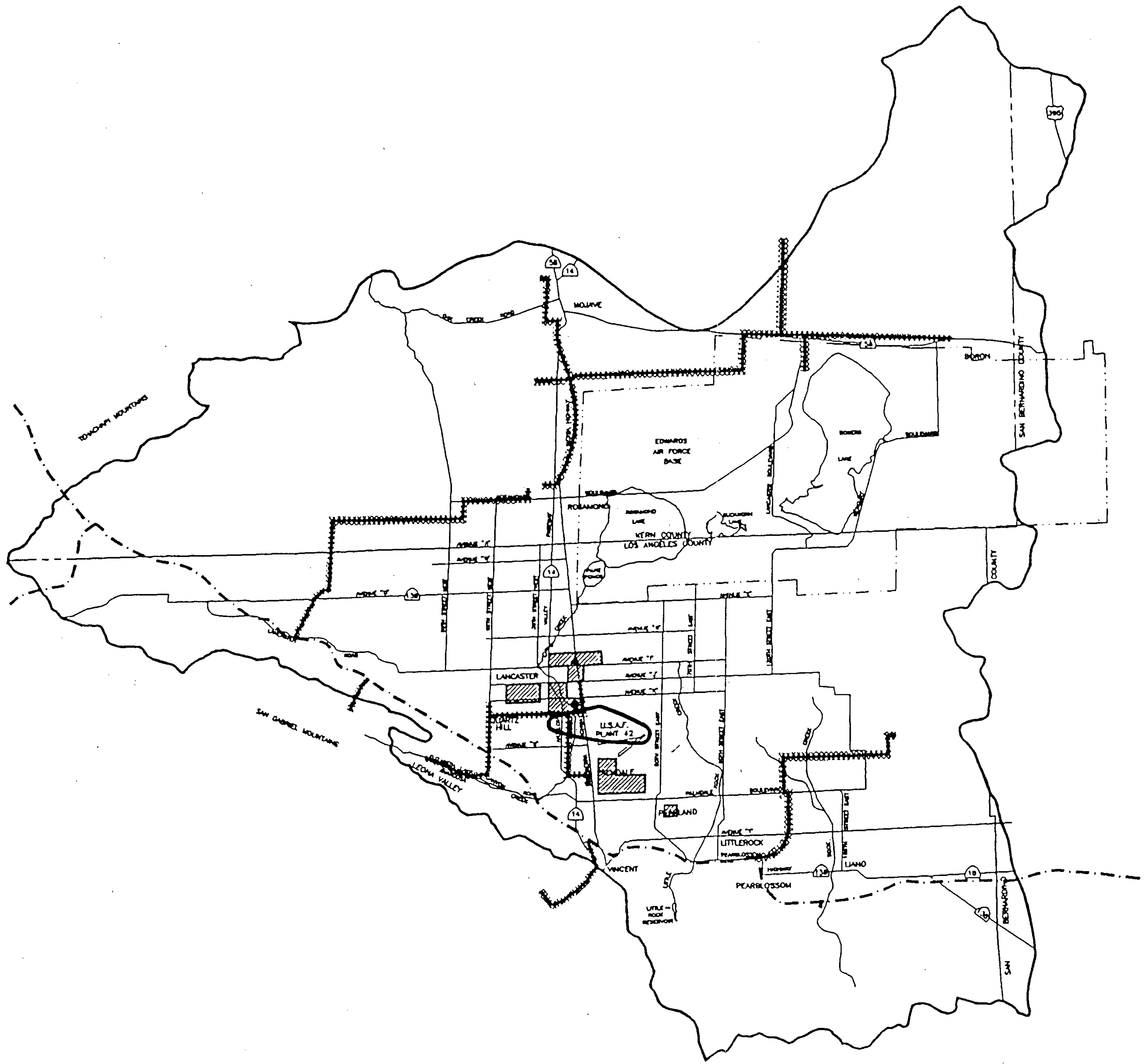
- Water quality of source waters and groundwater.
- Quantity and timing of availability of source waters.
- Hydrogeologic characteristics including travel times through unsaturated zones and percolation rates.
- Concerns of wildfowl interference at airfield operations.
- Location of extraction sites and travel times to those sites.

Potential injection areas include the municipal wellfields within the existing LACWW and PWD municipal wellfields (See Figure ES-10). Specific areas within the wellfields that have been assessed include:

- Potential LACDPW wells at Avenue K-8 and Division Street.
- Wells in USGS/LACWW/AVEK Injection Study.

Injection has not been extensively studied in the Valley, however, groundwater recharge by injection appears to be technically feasible. The existing wellfields could provide both the injection and extraction facilities necessary to conduct such a program. The specific areas that should be explored further because of their proximity to the distribution system and potential treated SWP water are:

- LACWW wells located:
    - South of Avenue "K" between 10th Street West and Division Street (where USGS is conducting its injection study).
    - South of Avenue "L" between 10th Street West and Division Street (adjacent to the area above).
- PWD wells south of Avenue "P" between 20th Street East and 40th Street East.



0 3.25 6.50 9.75 13.0 MILES
GRAPHIC SCALE

N

LEGEND

- Antelope Valley Boundary Line
- County Boundary Line
- Edwards Air Force Base Boundary Line
- California Aqueduct
- AVEK Distribution
- Existing Municipal Wellfields
- USGS Injection Study (1994)
- Proposed LACDPW Injection (1992)
- Groundwater Depression

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Antelope Valley
Potential Injection Areas

November 1995
K/J 934620.00

Figure ES-10

It appears that treated SWP water should be generally acceptable for injection from a water quality perspective. The presence of trihalomethanes (THMs) in the treated SWP water may require treatment and/or alternative disinfection methods. Although higher concentrations of THM in the injected water than in the groundwater could be considered a violation of the Regional Water Quality Control Board's non-degradation policy for water quality, injection of treated State water has been allowed in other groundwater basins. However, more detailed water quality analyses will have to be conducted at the potential injection sites to gather current information on the condition of the aquifer water quality in these specific locations. Until those data are available, comparisons of water quality with the potential recharge source cannot be reliably made. If specific areas for recharge are selected that have water quality that is worse than the potential source waters (i.e., higher nitrates), the recharge program may benefit the aquifer.

Depending on the results of the USGS's injection study, significant additional work will be required and should include, at a minimum, the following:

- Estimation of the actual volumes that could be injected at each site.
- Evaluation of aquifer behavior during injection and extraction and a determination of aquifer characteristics at specific sites.
- Evaluation of potential ground surface effects during injection and extraction.
- Determination of upgrades that may be required at each well and pump station.
- Evaluation of the operation of the injection/extraction system based on the availability of treated SWP water.
- Evaluation of the potential changes to water treatment plant operations that may be required to continue injection and extraction over the long-term.

EFFECTS OF CHANGES IN GROUNDWATER LEVELS

According to the USGS, groundwater levels in the Lancaster area have declined by as much as 200 feet from 1915 to 1988 (USGS, 1994). Conversely, well hydrographs maintained by AVEK and in cooperation with the USGS, indicate groundwater levels in portions of the Valley have risen in recent years. Declining groundwater levels over a long period of time generally indicate over-extraction from a groundwater basin; conversely, increasing groundwater levels over a long period of time may indicate under-extraction from a basin (or recovery from over-extraction). In addition to these obvious indications, changes in groundwater levels are of concern, because a variety of damages can result.

Potential damages attributable to changes in groundwater levels include land subsidence, increased pumping costs, waterlogging, and water quality degradation.

Damages can range from minor structural damage to major physical damage to the ground surface rendering land virtually useless. Table ES-7 lists potential damages attributable to changes in groundwater levels. As indicated in Table ES-7, declining groundwater levels potentially result in two primary damages: 1) land subsidence and 2) increased pumping costs. Land subsidence is defined by USGS as the vertical lowering of the land surface over an area of many square miles (USGS, 1991) and may be the result of a variety of causes. Regardless of the cause of land subsidence, the resulting damages are similar. In general, damages will be most pronounced when subsidence gradients (change in subsidence levels over a given distance) are high. Increased pumping costs result directly from declining groundwater levels. As the pumping lift increases, so does the power cost to lift the water. As groundwater declines, additional pump bowls and larger motors may be necessary.

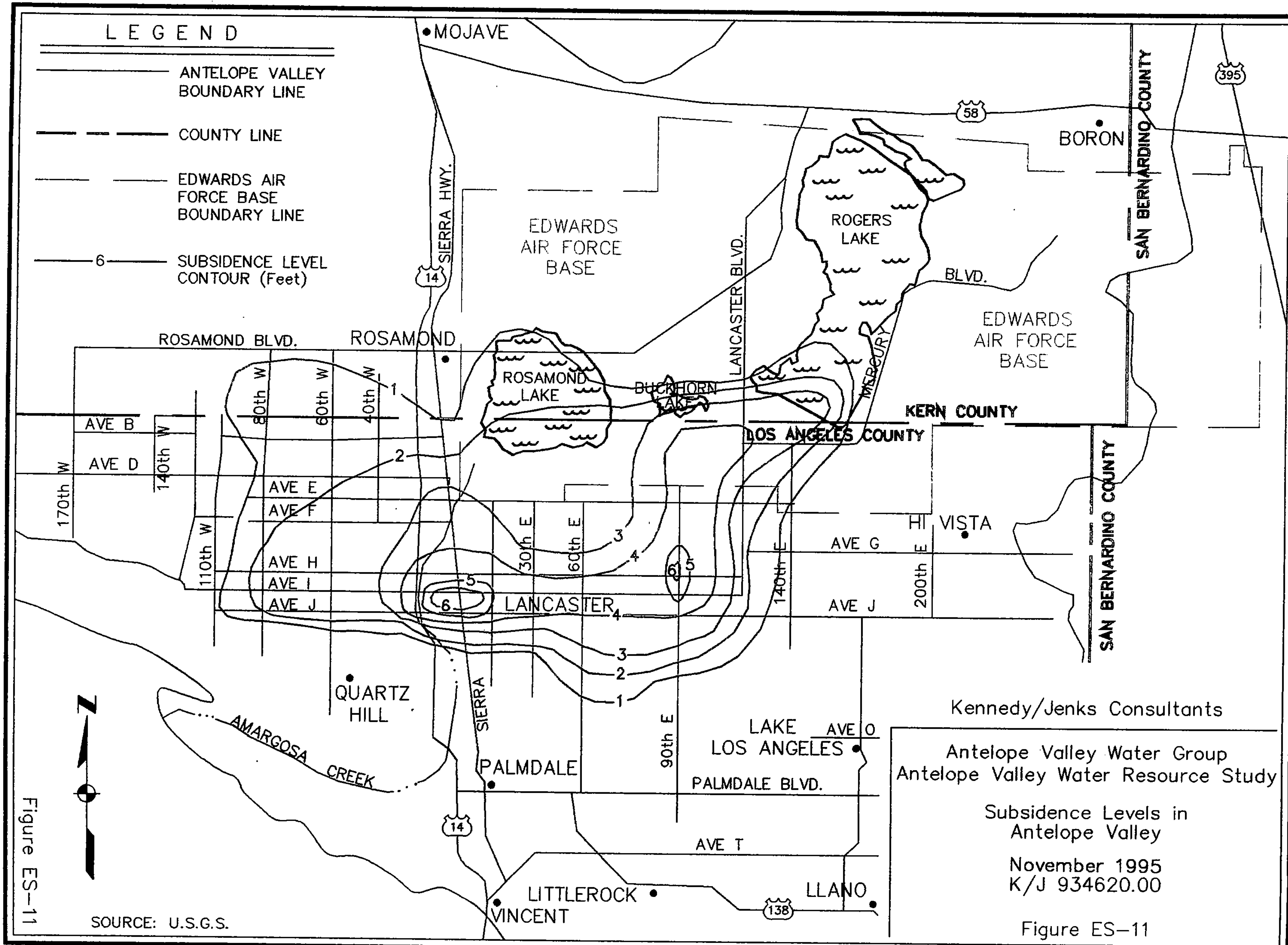
Potential damages attributable to increasing groundwater levels include waterlogging and water quality degradation. Waterlogging is defined as saturation of soil with water. The effects of waterlogging are dependent not only upon the elevation of the groundwater table but also on the soil type. Generally, the effects of waterlogging will be most noticeable in granular soils. Water quality degradation can result from nitrates being drawn down into the aquifers by rising groundwater levels and then being spread by depressions caused from overpumping. Nitrates are the end product of aerobic stabilization of organic nitrogen and, as such, occur in polluted waters that have undergone self-purification. Nitrate in groundwater can come from fertilizer, poultry manure, or domestic wastewater. Nitrates can cause blue baby syndrome which can be fatal for infants.

Subsidence levels of up to 7 feet have occurred in some areas of Antelope Valley. (See Figure ES-11.) Conversations held with various agencies and companies indicate that within the Antelope Valley, the Lancaster and Edwards AFB areas are currently experiencing problems or damages that appear to be related to land subsidence. USGS (1992) reported that as much as 2 feet of land subsidence had affected Antelope Valley by 1967 and was causing surface deformations at Edwards AFB. Fissures, cracks and depressions on Rogers Lakebed were affecting the use of the lakebed as a runway for airplanes and space shuttles. A paper by Thomas L. Holzer and Malcolm Clark titled "Earth Fissure in T7N, R11W, Section 3 near Lancaster, California" in January 1981, identified a fissure measuring approximately 0.35 miles long, up to 7.5 feet deep and 3 feet wide located between Avenues G and H and between 50th and 60th Streets East. A study done by Geolabs - Westlake Village (1991) studied a 10 square mile area in Lancaster identified to have fissures and sinklike depressions. The report identified fissures ranging in width from one inch to slightly over one foot. The lengths of the fissures ranged mainly between 50-200 feet, with the longest continuous fissures in the 600-700 foot range. Sinkholes ranged mainly between one to five feet deep and less than four feet in diameter. One sinkhole measured 20 feet long and 15 feet wide. Other potentially significant damages identified and may or may not be attributable to land subsidence include structural damage to the wastewater treatment plant building on Edwards AFB, cracked sidewalks and pavement.

TABLE ES-7

POTENTIAL DAMAGES ATTRIBUTABLE TO CHANGES IN GROUNDWATER LEVELS

Declining Groundwater Levels	*Increasing Groundwater Levels*
Land subsidence resulting in the following: • Development of cracks, fissures, sinklike depressions and softspots. • Change in natural drainage patterns often resulting in increased areas of flooding or increased erosion. • Degradation of groundwater quality. • Permanent reduction in groundwater storage capacity. • Change in gradient in gravity pipelines (sanitary and storm sewers) or canals often resulting in lost capacity. • Damage to well casings, pipelines, buildings, roads, railroads, bridges, levees, etc. • Costs associated with repairs and rebuilding. • Costs associated with construction of new facilities such as pumping stations for gradient changes. • Reduction in land value. • Lawsuits. Increased pumping costs.	Waterlogging resulting in the following: • Increased liquefaction potential. • Structural damage. • Rendering septic systems useless. • Costs associated with repairs and rebuilding. • Reduction in land value. Water quality degradation.



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Subsidence Levels in Antelope Valley

November 1995
K/J 934620.00

Figure ES-11

Figure ES-11

Increasing groundwater levels have occurred in portions of the Valley. For most of these areas, no damage related to these increases has been identified, due to the fact the groundwater level is still significantly below the ground surface. However, for the Leona Valley area in the southern portion of the Valley, damages potentially attributable to increasing groundwater levels were identified in April 1993. The apparent damages appear to be typical and include waterlogging and water quality degradation.

WATER RESOURCE PROTECTION PLAN

The basic water resource protection strategy focuses on minimizing demand growth, protecting and optimizing the use of existing water resources, and developing additional water resources to meet projected future demands. Specific elements of the recommended strategy are presented below:

- Improve Utilization of Available Water Supplies
- Manage the Groundwater Basin
- Protect Groundwater Quality
- Reduce Long Term Water Demands
- Improve State Water Project Reliability
- Obtain Additional Imported Water Supplies

To implement the basic strategy identified above, the water purveyors in the Antelope Valley must initiate several institutional, engineering, financial, and public education activities. The recommended actions that appear to be the most important are:

- Create institutional framework to manage the development and use of water supplies including groundwater basin. Two approaches are:
  - Coordinated Agreement by the Water Purveyors
  - Special Act Legislation

- Determine the safe yield of the Antelope Valley groundwater basin.
  - Review alternative approaches to developing safe yield estimates, determine the most appropriate approach, and perform the necessary studies.

- Continue the current groundwater monitoring program and publish an annual report on basin conditions.
  - Make the best use of available wells and existing monitoring efforts and install new monitoring wells in key areas to improve groundwater level and quality network.
  - Protect existing benchmarks.
  - Expand existing land subsidence monitoring network to include tighter control in subsidence-prone areas.
  - Conduct Global Positioning System surveys on a more frequent basis to provide more adequate monitoring of land subsidence.

- Install additional continuous monitoring gages for streamflow.
- Collect and compile groundwater extraction data.
- Publish an annual report of Basin conditions and groundwater management activities.

- Develop a program to optimize the use of available water supplies.
  - Implement or facilitate the implementation by others of the water conservation, reclaimed water, stormwater management and aquifer storage and recovery programs.
  - Consider the application of groundwater replenishment assessments to fund a portion of the program cost.
  - Consider the application of basin equity assessments.

- Develop the recommended water conservation, reclaimed water, stormwater management and aquifer storage and recovery programs.
  - Conduct detailed program-specific planning studies.
  - Evaluate cost allocation between the water management elements of the programs and other institutional beneficiaries.

- Actively encourage the DWR to complete the State water project and/or improve reliability.
  - Continue to monitor the development of Federal-State Bay Delta protection plans.
  - Encourage the development of consistent operating procedures for Delta water exports.
  - Actively participate in discussion with DWR over water and cost allocation issues.

- Obtain additional imported water supplies.
  - Implement a phased water acquisition program.

- Develop a revenue plan to implement the recommended programs. Potential revenue sources include:
  - Replenishment Assessments
  - Basin Equity Assessments
  - Production Assessments
  - Facility Capacity Fees
  - Standby Charges

- Initiate public education program.
  - Provide information regarding integrated water management, the framework of the recommended programs, and the financial resources required.
  - Provide information regarding implementation issues of the individual programs.
  - Publish an annual report of basin conditions and groundwater management activities.

CHAPTER 2

INTRODUCTION

This chapter presents a brief background of the Antelope Valley Water Group and the need for a water resource study. The objectives, scope of services and conduct of the study are summarized.

BACKGROUND AND AUTHORIZATION

The Antelope Valley encompasses approximately 2,400 square miles in northern Los Angeles County, southern Kern County, and western San Bernardino County. The water demands within the Antelope Valley are serviced by a variety of water purveyors, including large wholesale agencies, irrigation districts, special districts providing primarily municipal and industrial water, investor-owned water companies, mutual water companies, and private well-owners.

Water supply for the Valley comes from three primary sources: the State Water Project (SWP), the Little Rock Dam, and the Antelope Valley Groundwater Basin. The Valley's SWP entitlements total 153,800 acre-feet per year. With proper treatment, SWP water is a high quality water well-suited for municipal and industrial (M&I) uses; however, in light of the recent drought, the reliability of the SWP water supply is being questioned. The Littlerock Dam is currently undergoing modifications that will increase storage capacity to 3,500 acre-feet. Water stored at the Littlerock Dam is used directly for agricultural uses and is used for M&I uses following treatment. The Antelope Valley Groundwater Basin is a large basin comprised of a principal aquifer, which is utilized the most, and deep aquifers. Groundwater levels appear to be dropping in portions of the basin and rising in other portions. Water quality is generally good (i.e., Total Dissolved Solids is less than 1,000 parts per million) Valley-wide except for the northeast portion of the Valley, the borders of the Lancaster Subunit, and some shallow wells in North Edwards and Boron. Some high concentrations of boron associated with naturally-occurring boron deposits, and high nitrates associated with fertilizer use and poultry farming near the towns of Littlerock and Quartz Hill are some areas of exception. The groundwater in the basin is used for both agricultural and M&I uses.

Reclaimed water and stormwater are secondary sources of water supply. A portion of the effluent from the Valley's two large wastewater treatment plants, County Sanitation Districts of Los Angeles County (CSDLAC) plants in Palmdale and Lancaster, is used for maintenance of wetlands, agricultural irrigation, landscape irrigation, and a park impoundment. The unused effluent is spread and percolates into the ground or evaporates. Stormwater from the mountains and hills surrounding the Valley and from the Valley itself is either collected in basins or drains naturally towards the low center of the Valley. Virtually none of this surface flow exits the Valley. Previous efforts at stormwater recharge by surface spreading appear to have been marginally successful. The United States Geological Survey

(USGS) estimates that approximately 1.4 million acre-feet of average annual precipitation is lost to evaporation each year.

Historically, land uses within the Antelope Valley have been focused on agriculture; however, the valley is in transition from predominately agricultural uses to predominately residential and industrial uses. An estimated 332,000 people currently reside within the Valley. It is projected that the population of the Valley will reach nearly 1,000,000 in the year 2020. This represents an increase of 201 percent from the current population.

As rapid development has increased the demand for both more water and higher quality water and the prolonged drought has caused curtailments of SWP deliveries, the competition for available water supplies has increased. Recent water resource studies by individual water purveyors have attempted to provide a technical foundation and/or management strategy for the area's water resources. However, these attempts have generally been met with criticism and mistrust.

The Antelope Valley Water Group (AVWG) was formed in 1991 to provide a means of communication for the Valley agencies with an interest in water. Water Group members include the Cities of Palmdale and Lancaster, Edwards Air Force Base (Edwards AFB), Antelope Valley - East Kern Water Agency (AVEK), Antelope Valley United Water Purveyors Association (AVUWPA), Los Angeles County Waterworks Districts, (LACWW), Palmdale Water District (PWD), Rosamond Community Services District (RCSD), and CSDLAC. In an attempt to prepare a water resource study with a regional focus, rather than an individual focus, the AVWG initiated the Antelope Valley Water Resource Study. The agencies that contributed funds for the water resource study (AVWG Technical Advisory Committee members) include the cities of Palmdale and Lancaster, AVEK, LACWW, USGS, AVUWPA, PWD, RCSD, and CSDLAC.

The AVWG divided the study into two elements. The first element is being performed by USGS and focuses on 1) evaluation of the past and present water use and source of supply, 2) projection of water demands into the future, 3) development of a detailed study plan for the basic hydrogeology, 4) development of a detailed study plan for a groundwater management model, and 5) assessment of land subsidence. The draft report was completed in October 1993, and the final report is scheduled for completion in late 1994.

On 21 July 1993, AVWG, with the City of Palmdale as the contracting agency, authorized Kennedy/Jenks Consultants to proceed with the second element of the water resource study. The second element focuses on 1) assessment of water resources in light of the demands projected by USGS, 2) evaluation of the feasibility of aquifer storage and recovery, 3) development of a regional water conservation plan, 4) assessment of effects of changes in groundwater levels, 5) development of alternative plans for water resource protection, and 6) preparation of a report compiling USGS and consultant data and results.

OBJECTIVES

The primary objective of AVWG's water resource study is to develop consensus on a water resource management plan that addresses the need of the M&I purveyors to reliably provide the quantity and quality of water necessary to serve the growth projected by the planning agencies while concurrently addressing the need of agricultural users to have adequate supplies of reasonable cost irrigation water.

In order to achieve this objective, the following specific goals were developed:

- To provide the technical foundation for the consensus plan.
- To develop an innovative water resource development plan that optimizes existing resources.
- To achieve an acceptable compromise between urban and agricultural objectives.
- To develop a water resource management strategy to implement the consensus plan.

SCOPE OF SERVICES

To accomplish the objectives, the following scope of services was developed:

<u>Task 1 - Project Management</u>

1.1 Attend a kick-off meeting to discuss the scope of work and applicable procedures for the project and to collect available background data from the meeting participants.

1.2 Prepare a monthly technical memorandum discussing project status, preliminary findings, and project direction to be distributed to the Technical Advisory Committee members and USGS for review.

1.3 Prepare an agenda and organize and chair meetings of the Technical Advisory Committee and USGS to discuss the technical memorandum and other issues.

1.4 Conduct public meetings on status and results of the study.

<u>Task 2 - Collect and Review Available Studies</u>

2.1 Collect and review available studies.

2.2 Interview each of the participating agencies for information on their concerns, ideas, and planned projects.

Task 3 - Assess Water Resources

3.1 Collect and review USGS data on past, present, and future water demands (USGS Elements I and II); past and present sources of supply; and future availability of local groundwater supplies.

3.2 Identify the available sources of reclaimed water, the quantity of reclaimed water available projected to the year 2020, and the current uses of reclaimed water.

3.3 Using probability analysis, assess the reliability of surface water provided by the Littlerock Dam and reclaimed water.

3.4 Collect the reliability analyses from the State Department of Water Resources (DWR) and the Metropolitan Water District of Southern California and use these evaluations to assess the reliability of SWP water, based on both current SWP facilities and projects proposed to enhance the SWP yield.

3.5 Perform a risk analysis of the ability of local and imported water supplies, including reclaimed water and proposed SWP enhancement projects, to meet water demands to the year 2020.

3.6 Based on data gathered in subtask 3.1, assess the effects of variations in SWP water supply on groundwater levels by comparing historical groundwater levels to historical SWP water supplies.

3.7 Based on data gathered in subtask 3.1, assess the effects on groundwater levels of a transition from a predominantly agricultural demand (highly dependent upon groundwater) to a M&I demand.

Task 4 - Evaluate Feasibility of Implementing Aquifer Storage and Recovery Methods

4.1 Collect and review information from USGS (USGS Element III and IV) and existing studies on the hydrogeologic characteristics of the basin.

4.2 From data gathered from USGS and supplemental information gathered from Los Angeles County and DWR, inventory wells within the basin.

4.3 Based on data collected in subtask 4.1, identify areas suitable for groundwater recharge by surface infiltration or subsurface injection.

4.4 Review the basin plan prepared by the Regional Water Quality Control Board.

4.5 Based on information collected in subtask 4.1 and 4.4, assess the effect on groundwater quality of recharge of treated and untreated potable water.

4.6 Based on information collected in subtask 4.1 and 4.4, assess the effect on groundwater quality of recharge of reclaimed water.

<u>Task 5 - Evaluate the Feasibility of Use of Reclaimed Water</u>

5.1 Identify potential users of reclaimed water and their corresponding water demands.

5.2 Evaluate the cost and feasibility of converting the existing wastewater treatment plants to tertiary treatment.

5.3 Evaluate the cost and feasibility of constructing a backbone reclaimed water system.

5.4 Based on subtasks 4.6 and 5.1 through 5.3, develop a conceptual plan for use of reclaimed water.

<u>Task 6 - Develop and Evaluate Water Conservation Alternatives</u>

6.1 Collect and review information on conservation programs existing in the Valley.

6.2 Review state mandated water conservation measures (best management practices) for applicability to the Antelope Valley.

6.3 Based on other water conservation programs throughout the State and information from the DWR including Water Plan program, assess the effectiveness of existing and applicable state mandated water conservation measures in terms of cost versus water savings.

9.5 Address public comments in report.

9.6 Prepare a final report and submit one hundred (100) copies to AVWG.

CONDUCT OF THE STUDY

The information developed in this second element of AVWG's water resource study is a result of review of existing studies; contact with the AVWG members, other water purveyors and cities within the Antelope Valley, USGS, Edwards AFB personnel, and residents of the Valley; contact with a number of local, state, and federal agencies; field work; office analysis; and computer modeling. The initial phase of the project was concerned with the collection and evaluation of existing data and reports. Discussions with the planning, operations, and engineering staffs of the water purveyors, wastewater treatment plant owners, cities, and Edwards AFB were conducted to assess current and future operations relating to water and reclaimed water. Data gathered and analyses generated by USGS during the first element of the water resource study were collected and reviewed during the first phase of the study.

Subsequent phases were concerned with evaluation of the data collected in light of Tasks 3 through 7 described previously in "Scope of Services" and development of a plan which increases the reliability of the available water supplies. Technical issues addressed include the following:

- The use of reclaimed water without adverse crop effects or groundwater degradation.
- The use of stormwater without adversely affecting flood control operations.
- Maximum groundwater use prior to water quality degradation.
- Beneficial use of state water when full entitlements are available.
- Basic management options to maximize conjunctive use opportunities, maintain water quality and avoid adverse impacts due to fluctuating ground water levels.
- Implementation of water conservation opportunities without coercive measures.

Through analysis of data and development of water supply enhancement opportunities, a plan for optimizing existing water resources was developed. Capital costs were estimated and issues associated with implementation of these opportunities were discussed.

Throughout the study, regular meetings with the AVWG Technical Advisory Committee were held and progress reports were presented. Interim work products were submitted to the Committee for review and comments were received.

CHAPTER 3

STUDY AREA CHARACTERISTICS

This chapter describes the general environmental setting of the Antelope Valley in terms of location, climate and hydrologic features. Brief descriptions of land use and population trends are also included. The United States Geological Survey (USGS) 1994 draft report titled "Land Use and Water Use in the Antelope Valley, California" and the USGS 1987 report titled "Geohydrology of the Antelope Valley Area California and Design for a Groundwater-Quality Monitoring Network" were the primary sources of information presented in this chapter.

LOCATION

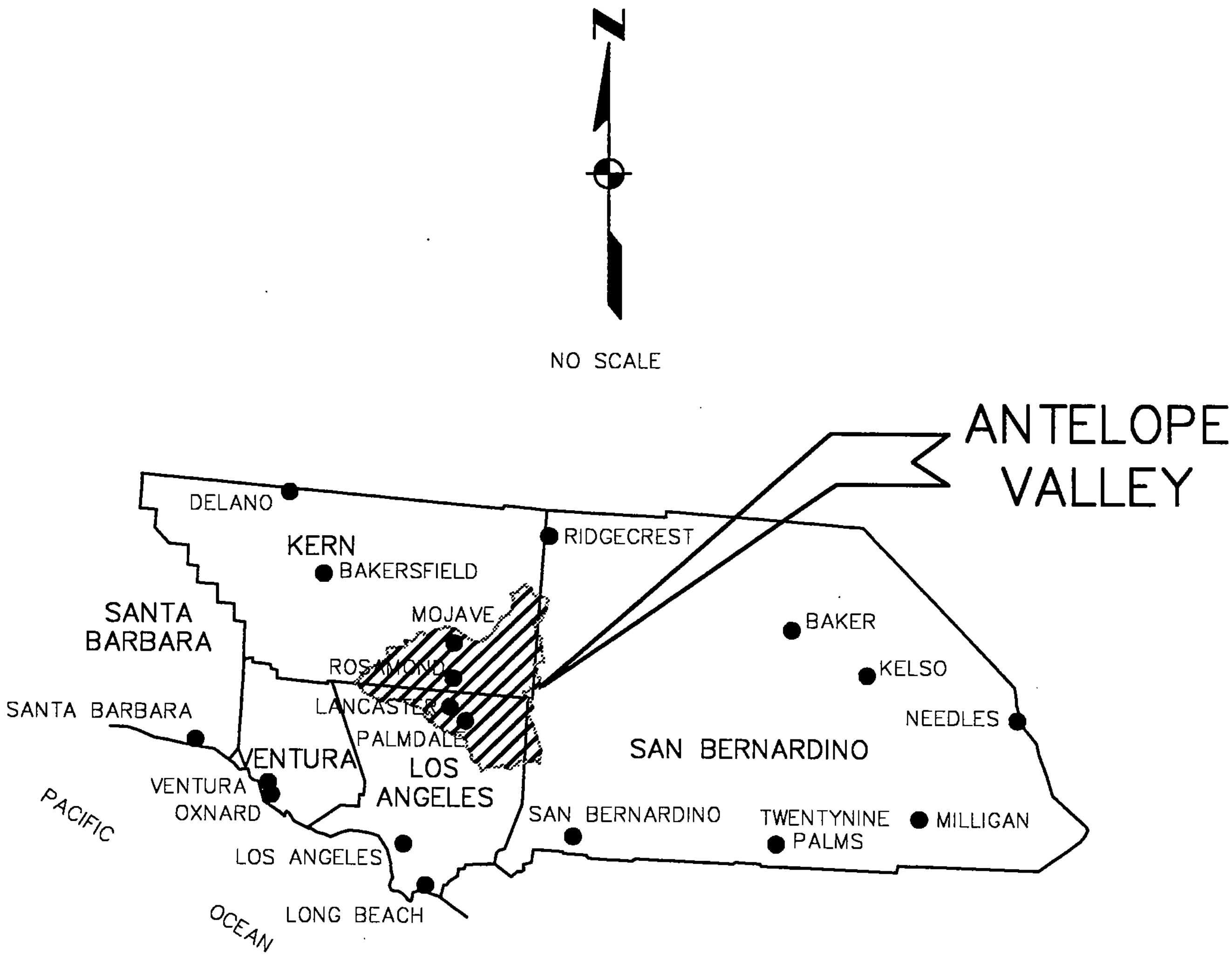
The Antelope Valley, as defined for the purposes of this report, encompasses approximately 2,400 square miles in northern Los Angeles County, southern Kern County and western San Bernardino County. (See Figure 3-1.) The Valley is bordered on the southwest by the San Gabriel Mountains, on the northwest by the Tehachapi Mountains, and on the east by a series of hills and buttes that generally follow the San Bernardino County line. (See Plate 1.)

As shown on Plate 1, major communities within the Valley include Boron, Edwards Air Force Base (AFB), Lancaster, Mojave, Palmdale and Rosamond. Smaller communities include Little Rock, Quartz Hill, Leona Valley, Pearblossom, Llano and Pearland. The communities are concentrated in the eastern portion of the Valley.

Four major roadways traverse the Valley. The Antelope Valley Freeway (I-14) and the Sierra Highway both bisect the Valley from north to south. The Pearblossom Highway (Highway 138) traverses the southeastern and central-western portions of the Valley in an east-west direction. Highway 58 traverses the northern portion of the Valley in an east-west direction.

CLIMATE

Comprising the southwestern portion of the Mojave Desert, the Valley ranges in elevation from approximately 2,300 feet to 3,500 feet above sea level. Vegetation native to the Valley are typical of high desert and include Joshua trees, saltbush, mesquite, sagebrush, and creosote bush. The Valley climate is characterized by hot summer days, cool summer nights, cool winter days and cool winter nights. Typical of a semiarid region, mean daily summer temperatures range from 63° Fahrenheit (F) to 93° F, and mean daily winter temperatures range from 34° F to 57° F. The growing season is primarily from April through October. Precipitation ranges from 5 inches per year along the northern boundary of the Valley to 10 inches per year along the southern boundary. Historical precipitation for the Lancaster area is shown on Figure 3-2.



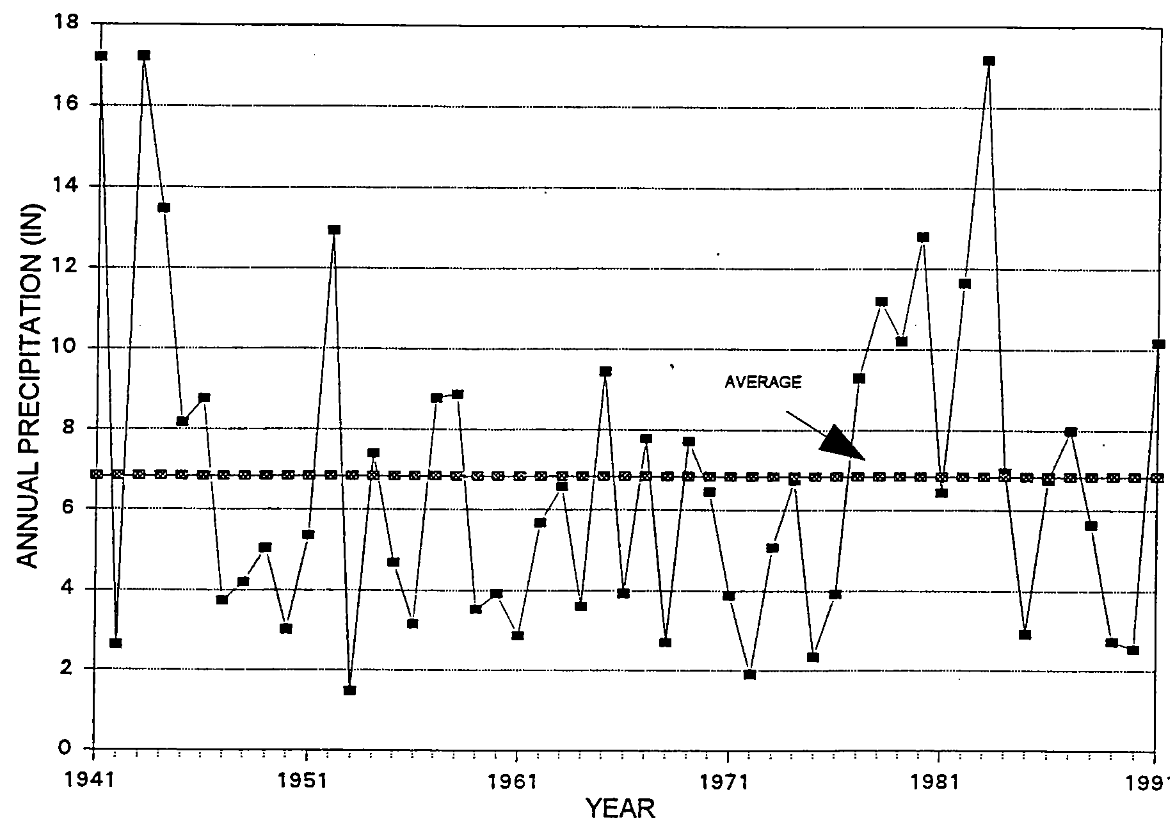
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Antelope Valley Location Map

November 1995
K/J 934620.00

Figure 3-1



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Historical Precipitation for Lancaster

November 1995
K/J 934620.00

Figure 3–2

Figure 3–2

HYDROLOGIC FEATURES

Surface water and groundwater features of the Antelope Valley are discussed below.

Surface Water

The Antelope Valley is a closed basin. Surface water from the surrounding hills and from the Valley floor flow primarily toward three dry lakes on Edwards AFB: 1) Rosamond Lake, 2) Buckhorn Lake and 3) Rogers Lake.

Surface water flows are carried by ephemeral streams. The most hydrologically significant streams begin in the San Gabriel Mountains in the southwestern edge of the Valley and include, from east to west, Big Rock Creek, Little Rock Creek, and Amargosa Creek. (See Plate 1.) Except during the biggest rainfall events of a season, surface water flows toward the Valley from the surrounding mountains, quickly percolating into the stream bed and recharging the groundwater basin. Surface water flows that reach the dry lakes are generally lost to evaporation. It appears that little percolation occurs in the Valley other than near the base of the surrounding mountains due to impermeable layers of clay overlying the groundwater basin. USGS estimates that nearly 1.4 million acre-feet of surface water in the Valley is lost to evapotranspiration each year (USGS, 1987).

The Little Rock Creek is the only developed surface water supply in the Valley. The Little Rock Reservoir, jointly owned by Palmdale Water District (PWD) and Little Rock Creek Irrigation District (LCID), collects run-off from the San Gabriel Mountains. (See Plate 1.) The Dam currently has a useable storage capacity of 600 acre-feet of water; however, PWD and LCID are planning modifications to the dam which will increase the storage capacity to 3,500 acre-feet. These modifications are scheduled for completion in 1994. Historically, water stored at the Little Rock Dam has been used directly for agricultural uses within LCID's service area and for municipal and industrial (M&I) uses within PWD's service area following treatment at PWD's water purification plant.

Groundwater

The Antelope Valley Groundwater Basin is comprised of two primary aquifers: 1) the principal aquifer and 2) the deep aquifer. The principal aquifer, an unconfined aquifer, actually provided artesian flows in 1909. Separated from the principal aquifer by clay layers, the deep aquifer is generally considered to be confined. In general, the principal aquifer is thickest in the southern portion of the Valley near the San Gabriel Mountains, while the deep aquifer is thickest in the vicinity of the dry lakes on Edwards AFB.

The Antelope Valley Groundwater Basin is divided into twelve subunits as shown on Plate 1. The subunits are Finger Buttes, West Antelope, Neenach, Willow Springs, Gloster, Chaffee, Oak Creek, Pearland, Buttes, Lancaster, North Muroc, and Peerless. Studies performed by the USGS and the State Department of Water Resources (DWR) indicate that groundwater levels appear to be generally dropping in the eastern areas of the basin and rising in the western areas. Groundwater quality is excellent within the principal aquifer but degrades toward the northern portion of the dry lake areas. Considered to be generally suitable for domestic, agricultural, and industrial uses, the water in the principal aquifer has a total dissolved solids (TDS) concentration ranging from 200 to 800 milligrams per liter (mg/L). The deeper aquifers typically have higher TDS levels. Hardness ranges from 50 to 200 mg/L and high fluoride, boron, and nitrates are a problem in some areas of the basin. The groundwater in the basin is used for both agricultural and M&I uses.

LAND USE

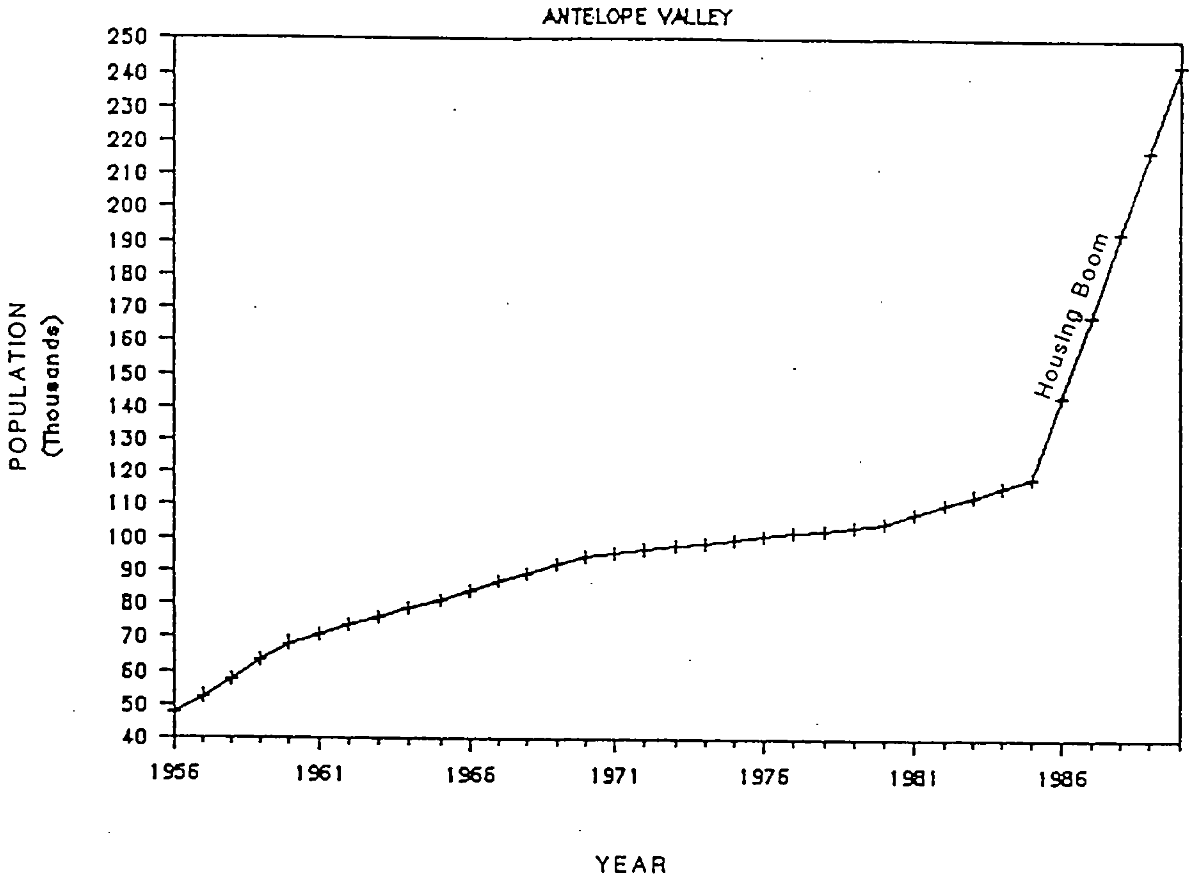
Historically, land uses within the Valley have focused primarily on agriculture; however, the Valley is in transition from predominantly agricultural uses to predominantly residential and industrial uses. USGS's 1994 draft report indicates that agricultural land use has decreased from 73,000 acres in the early 1950s to 12,854 acres in 1993. The USGS (1994a) cites the DWR prediction that agricultural land use will decrease to approximately 900 acres in 2020. Historically, crops grown in the Valley have included alfalfa, wheat, barley and other livestock feed crops. In recent years, onions, turf and orchards have become more prominent. Broken down by the various types of crops, acreages in 1993 were 6,124 acres for alfalfa, 955 acres for pasture and turf, 835 acres for grain, 32 acres for field crops, 2,645 acres for truck crops and 2,263 acres for deciduous trees.

The increase in residential land use is evident from the population growth in the Valley which is discussed in the next section. With significantly lower prices than in Southern Los Angeles County, the Valley housing market has seen an increase in commuters to the Los Angeles area.

Industrial land use in the Valley consists primarily of manufacturing for the aerospace industry and mining. Edwards AFB, and the U.S. Air Force Flight Production Center (Plant 42) provide a strong aviation and military presence. Reductions or realignments in the defense industry could adversely affect this presence. Mining of Borate in the northern areas of the Valley and salt extract, rock, gravel and sand in the southern areas of the Valley contribute to the Valley's industrial land uses.

POPULATION

Historically, growth in the Antelope Valley proceeded at a slow pace until 1985. However, between 1985 and 1990, the growth rate increased approximately 1,000 percent from the average growth rate between the years 1956 to 1985. (See Figure 3-3.)



Source: Law Environmental November 25, 1991 "Water Supply Evaluation, Antelope Valley, California"

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Historical Population – Antelope Valley

November 1995
K/J 934620.00

Figure 3-3

Historical and projected population for the Antelope Valley are shown in Table 3-1 and depicted on Figure 3-4. Population data and projections were based primarily on information presented in the USGS 1994 draft report. USGS 2010 and 2020 projections for the Antelope Valley were provided by the DWR in a preliminary draft of Bulletin 160. However, in the Bulletin 160 draft dated November 1993, DWR revised the projections. Table 3-1 reflects these revisions. Projections indicate that approximately 986,000 people will reside in the Valley by the year 2020. This represents an increase of approximately 278 percent from the 1990 population. Areas of concentrated population within the Valley include Lancaster, Palmdale, Edwards AFB, Rosamond, Mojave, and Boron.

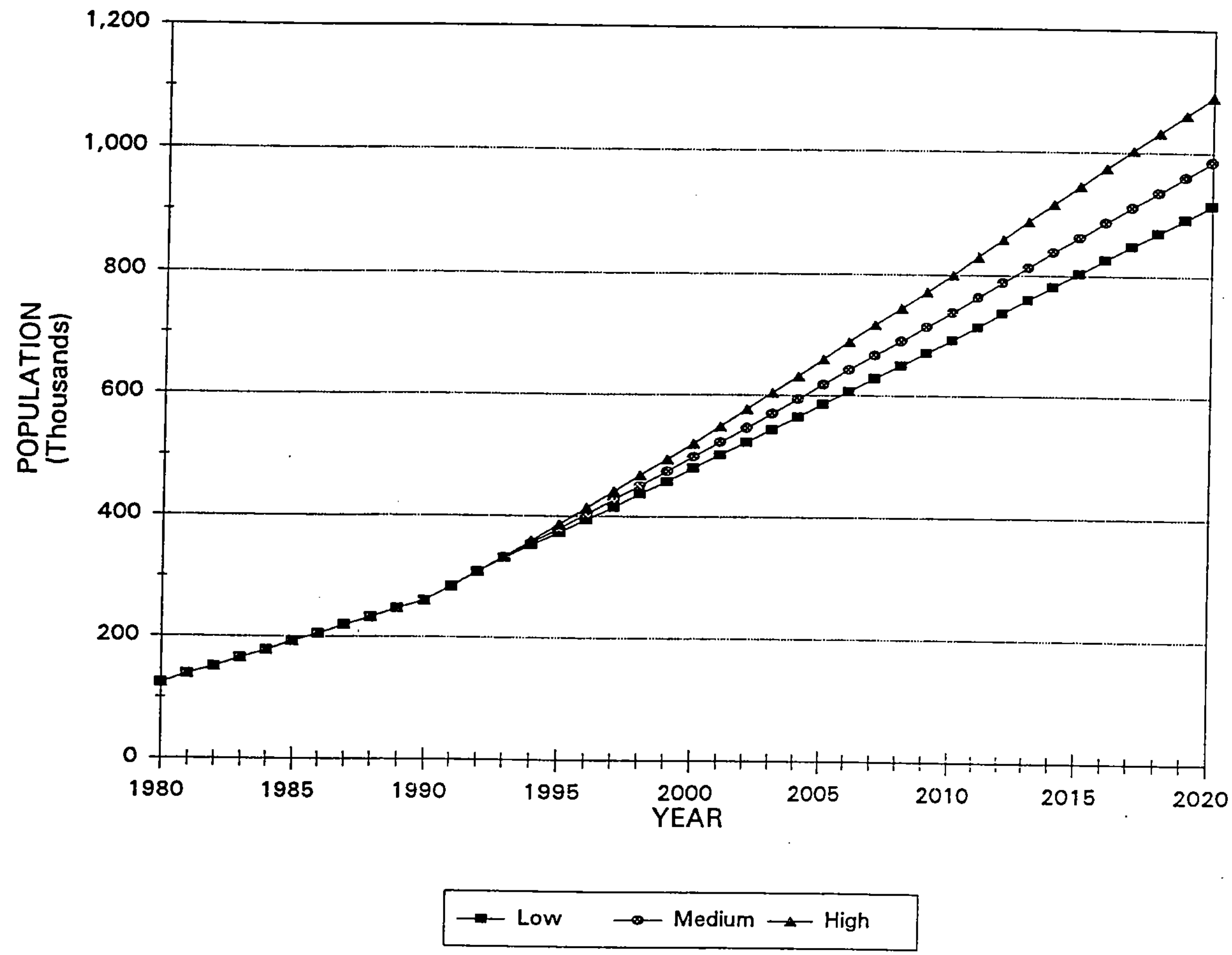
It is noted that population forecasting is not an exact science due to an element of uncertainty to whether or not the projections will be truly realized. Additionally, the population projections used in this report were obtained from sources that may have been influenced by the rapid growth that occurred in the Valley just prior to 1990. (See Figure 3-3.)

TABLE 3-1

ANTELOPE VALLEY
HISTORICAL AND PROJECTED POPULATION

Area	*1980*	*1990*	*2010*	*2020* (1)
Lancaster	48,027	97,291	212,138 (2)	269,558
Palmdale	12,277	68,842	245,341 (3)	326,815
Edwards AFB	8,554	7,423	7,671	7,671
Rosamond	2,869	9,969 (4)	39,256 (5)	52,696
Mojave	2,886	3,793 (8)	8,737	11,209
Boron	2,815	2,903	3,071	3,155
Other	46,922	70,179 (6)	221,787 (6)	314,896 (6)
Total	124,350	260,400	738,000 (7)	986,000 (7)

(1) Extrapolated based on 1990 and 2010 populations except for Palmdale, Edwards AFB, Rosamond and Other. Palmdale is extrapolated based on 1993 and 2010 populations. Rosamond is extrapolated based on 2000 and 2010 populations. Edwards AFB 2020 population is maintained at 2010 level and Other is the difference between the total and the areas of concentrated population.
(2) From SCAG 1993 population projections.
(3) Average of City of Palmdale's General Plan projections and SCAG's 1993 projections.
(4) Interpolated based on 1980 and 1993 populations.
(5) Average of County of Kern's Rosamond Specific Plan projections and projections based on proposed Desert Highlands development.
(6) Difference between total and the areas of concentrated population.
(7) From DWR's November 1993 Draft California Water Plan Update (Bulletin 160).
(8) From Kern Council of Governments.



It is noted that population forecasting is not an exact science due to an element of uncertainty to whether or not the projections will be truly realized. Additionally, the population projections used in the report were obtained from sources that may have been influenced by the rapid growth that occurred in the Valley prior to 1990.

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Population Projections—Antelope Valley

November 1995
K/J 934620.00

Figure 3–4

Figure 3–4

Projections to 2010 for Edwards AFB, Mojave, and Boron presented in the USGS report were utilized in Table 3-1, and revisions are described in the following sections. Population for Edwards AFB in the year 2020 was assumed to remain at the projected 2010 population. Projections to 2020 for Mojave and Boron were extrapolated from the actual 1990 and projected 2010 populations. USGS projections for Palmdale, Lancaster, and Rosamond were revised and are described in Table 3-1.

Descriptions of the method, assumptions and sources used to estimate the projections are discussed below.

Palmdale

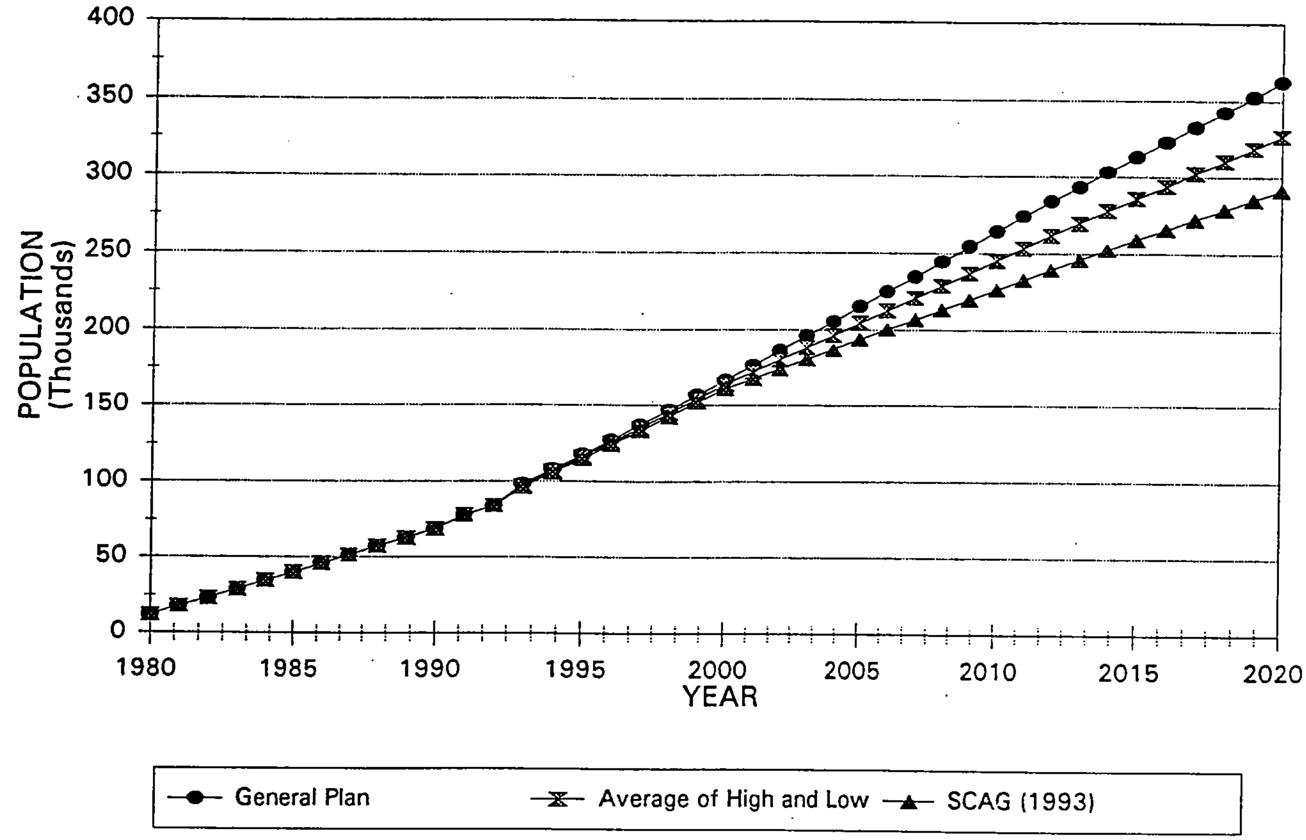
Three population projections were done for the City of Palmdale. (See Figure 3-5.) The high curve was based on the City of Palmdale, January 25, 1993."General Plan." The City projected a population of 264,215 people by the year 2010. Based on this projection and the estimated 1992 population of 84,238, population for 2020 was extrapolated. The low curve was based on the Southern California Association of Government (SCAG) 1993 estimates of 161,203 person in 2000 and 226,465 persons in 2010, extrapolated to 2020. An average of the high and low curve provided a medium curve. The medium curve was selected for use in this report.

Lancaster

Three population projections were done for the City of Lancaster. (See Figure 3-6). The method used for estimating projections was obtained primarily from the City of Lancaster 1992 "State of the City Report" (SOC Report). The SOC Report provided a low, medium and high curve based on the average growth rate experienced by the City between 1980 and 1990 (low curve), the average growth experienced by the City between 1985 and 1990 (medium curve), and SCAG 1989 estimates (high curve). The average growth for the three curves were 4,071, 6,407, and 7,274 persons per year respectively.

The City's average growth rates for the three curves in the SOC Report have been revised for the purposes of this report for the following reasons: 1) the SOC Report used an estimate of 88,732 for the 1990 population but the U. S. Census Bureau reports a 1990 population of 97,291 (Department of Community Development, 1993), and 2) in 1993 SCAG decreased its population estimates for Lancaster.

Using the most recent data available, the low curve was revised and is based on an average growth of 4,941 persons per year between 1980 and 1990. The medium curve is based on SCAG 2000 and 2010 estimates of 152,280 and 212,138, respectively, and extrapolated to 2020 based on an average growth rate of 5,742 people per year (average growth rate between 1990 actual and 2010 projected population).



Kennedy/Jenks Consultants

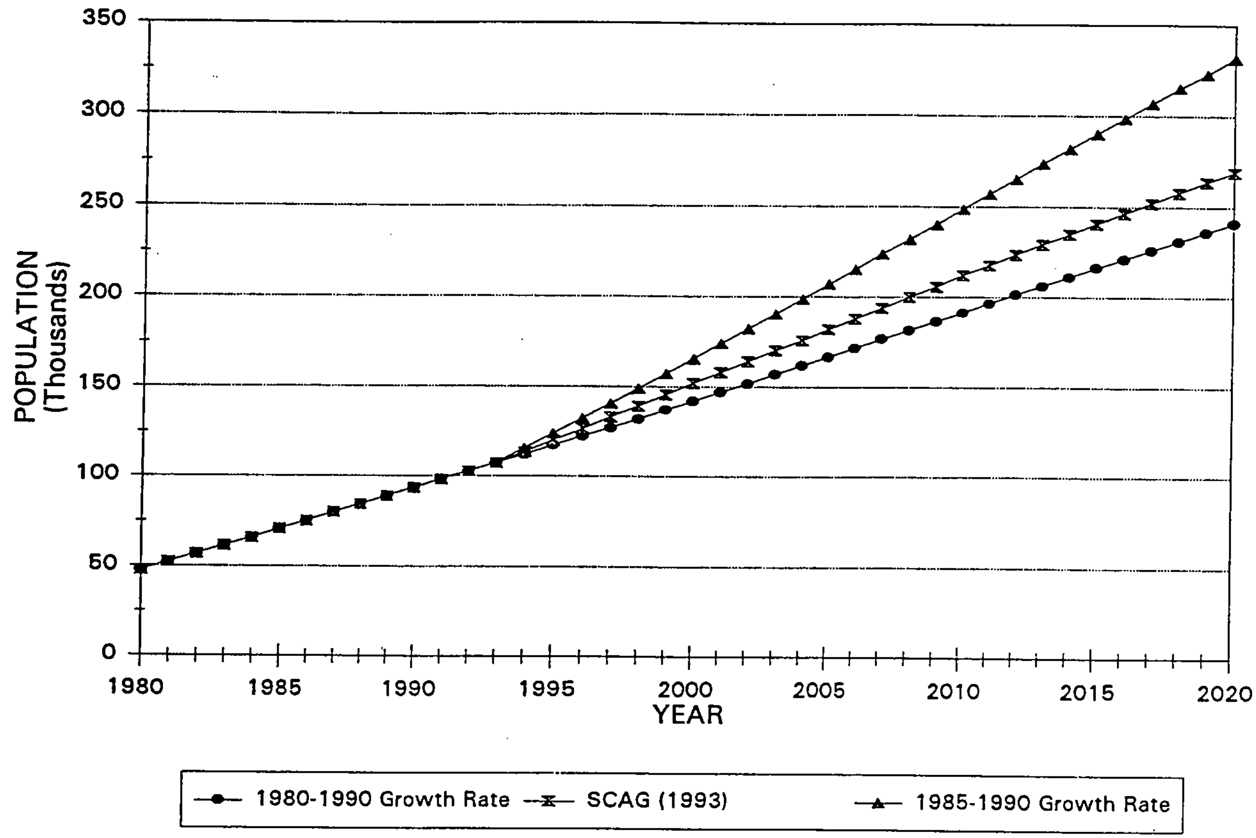
Antelope Valley Water Group
Antelope Valley Water Resources Study

Population Projections—City of Palmdale

November 1995
K/J 934620.00

Figure 3–5

Figure 3–5



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Population Projections—City of Lancaster

November 1995
K/J 934620.00

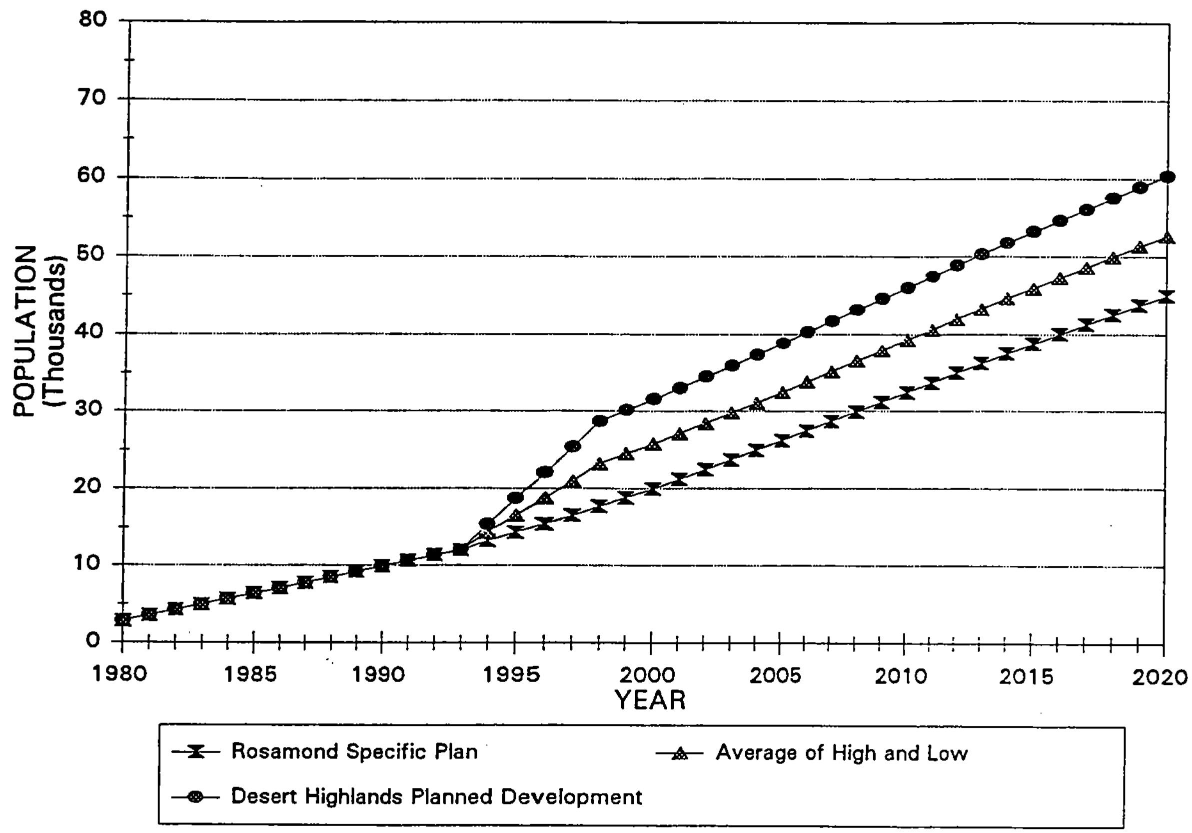
Figure 3–6

Figure 3–6

The high curve is based on the City's average growth of 8,307 people per year between 1985 and 1990. The medium curve was selected for use in this report.

Rosamond

Three population projections were done for the area of Rosamond. (See Figure 3-7.) The low curve was based on the 1993 population of 12,095 provided by Rosamond Community Services District (RCSD), and 2000 and 2010 population estimates of 20,000 and 32,500, respectively, provided in the County of Kern 1992 "Rosamond Specific Plan." Population for 2020 was extrapolated based on 2000 and 2010 population estimates. The high curve was based on an assumption that approximately 7,000 homes from the proposed Desert Highlands development will be inhabited by the year 1998. This translates to approximately 28,800 people residing in Rosamond in 1998. Population to 2020 was extrapolated based on the 1980 and projected 1998 population. An average of the low and high curves provided a medium curve. The medium curve was selected for use in this report.



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Population Projections –
Community of Rosamond

November 1995
K/J 934620.00

Figure 3–7

Figure 3–7

CHAPTER 4

ASSESSMENT OF WATER RESOURCES

This chapter assesses the ability of available water resources within the Antelope Valley to meet the water demands of the Valley through the year 2020. Elements of the chapter include a description of water demands and supplies, an evaluation of the reliability of water supplies, an assessment of the effects of State Water Project deliveries on groundwater levels, and an assessment of the effects on groundwater levels due to transition from a predominantly agricultural area to a predominantly urban area.

WATER DEMANDS

The following section discusses historical, current and projected water demands for the Antelope Valley. The United States Geological Survey (USGS) draft "Land Use and Water Use in the Antelope Valley, California" dated March 14, 1994 (1994 Draft Report) is the primary source of information for the Water Demands and Water Supplies sections.

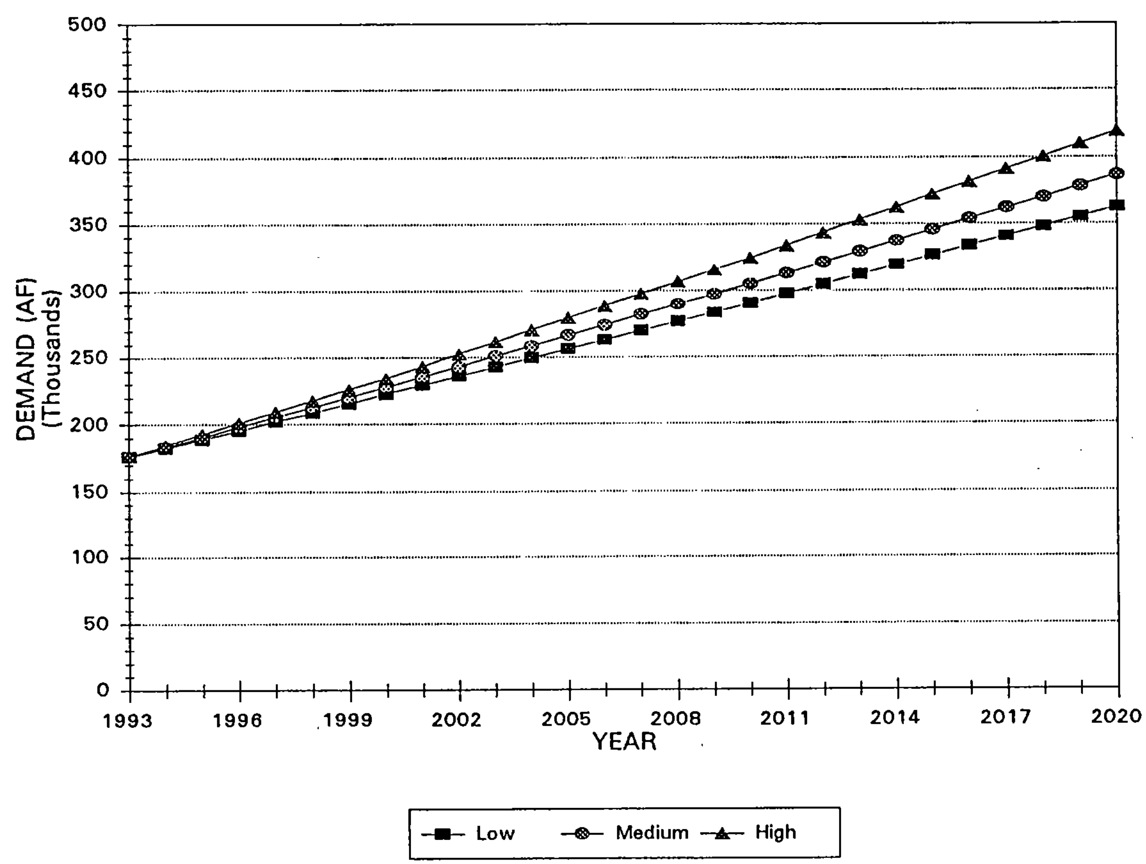
Historical Demands

Historical water demands were 192,600 acre-feet in 1975, 246,000 acre-feet in 1980, 167,000 acre-feet in 1985 and 144,000 acre-feet in 1989 (USGS, 1994a). Water demands decreased between 1950 to late 1980s due to decreasing irrigated acreage. However, due to the population growth beginning in the mid 1980s, water demands are increasing. Approximately 63 percent of total recorded water demands in 1990 were met by public water suppliers (USGS, 1994a).

Current and Projected Demands

Projected water demands for the Antelope Valley are shown on Figure 4-1. Projections were based on the summation of the individual water demand projections for the City of Palmdale, City of Lancaster, Rosamond Community Services District (RCSD), Other and Agricultural. These individual water demand projections are presented on Figures 4-2 to 4-6. Water demand projections to the year 2020 for the various cities\communities\categories are described below. Low, medium and high water demand projections are based on low, medium and high population projections presented in Chapter 3.

<u>City of Palmdale</u>. Water demand projections for the City of Palmdale are based on a per capita demand of 0.32 acre-feet per person per year derived from 1993 population and water use data from Palmdale Water District (PWD) and applied to the low, medium, and high population projections.



Kennedy/Jenks Consultants

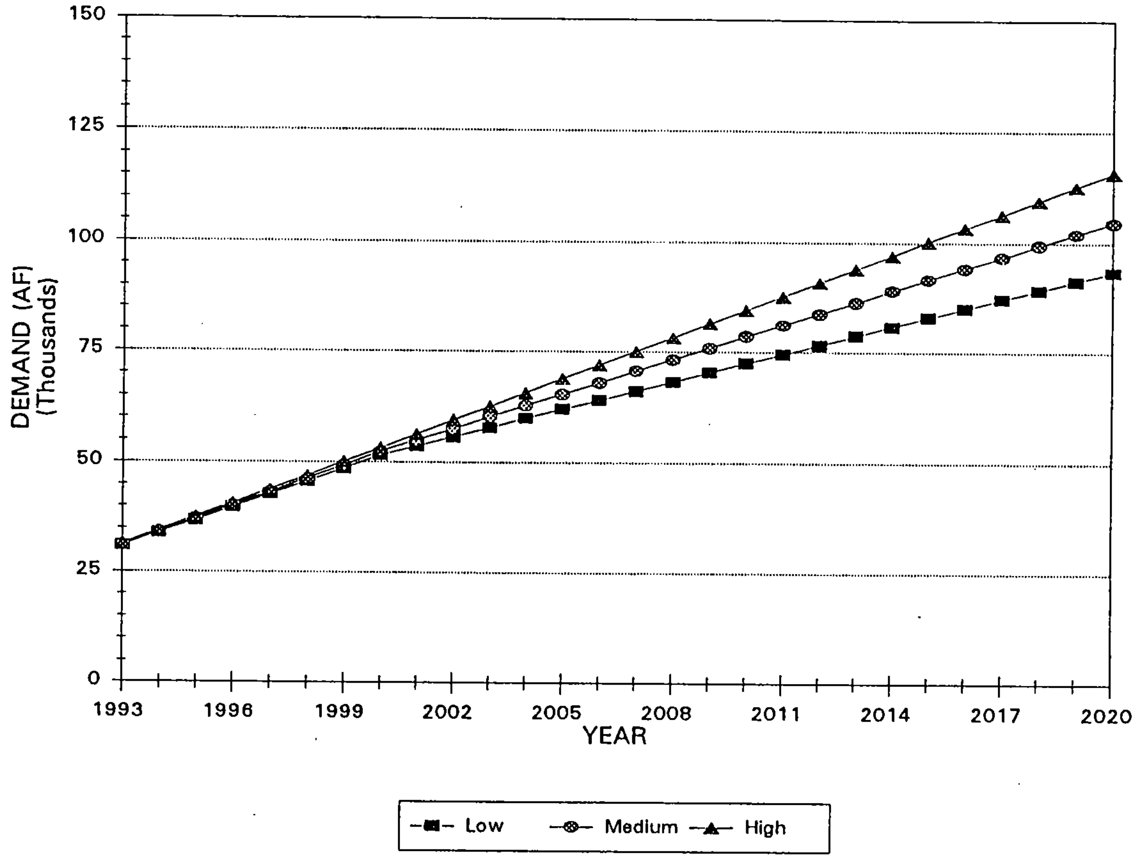
Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Projections
Antelope Valley

November 1995
K/J 934620.00

Figure 4–1

Figure 4–1



Kennedy/Jenks Consultants

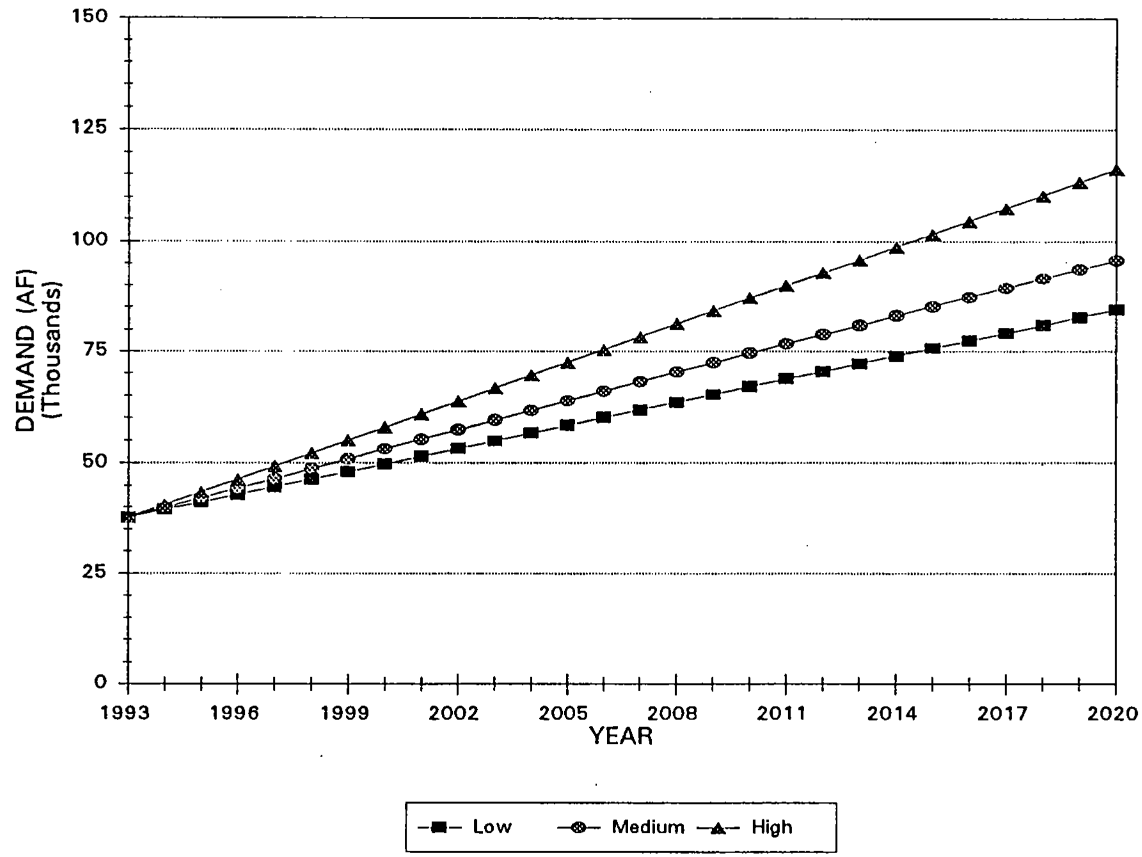
Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Projections
Palmdale

November 1995
K/J 934620.00

Figure 4–2

Figure 4–2



Kennedy/Jenks Consultants

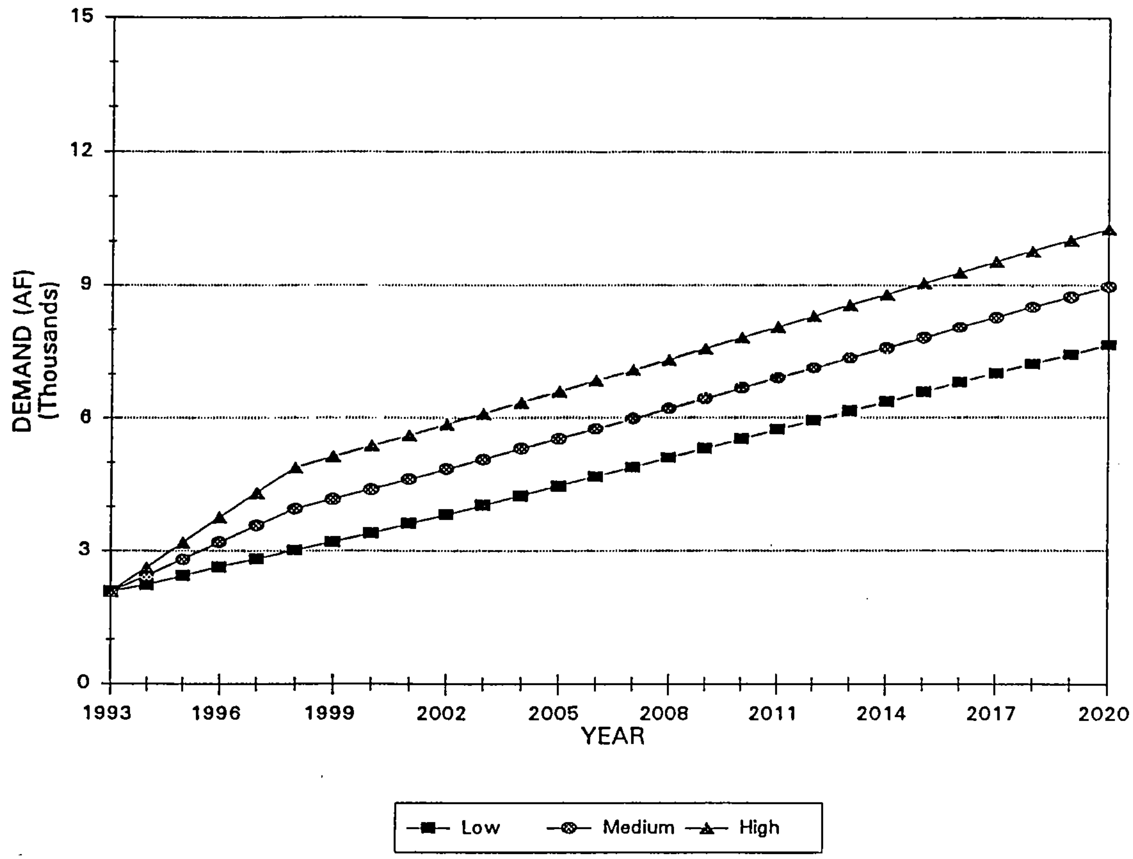
Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Projections
Lancaster

November 1995
K/J 934620.00

Figure 4–3

Figure 4–3



Kennedy/Jenks Consultants

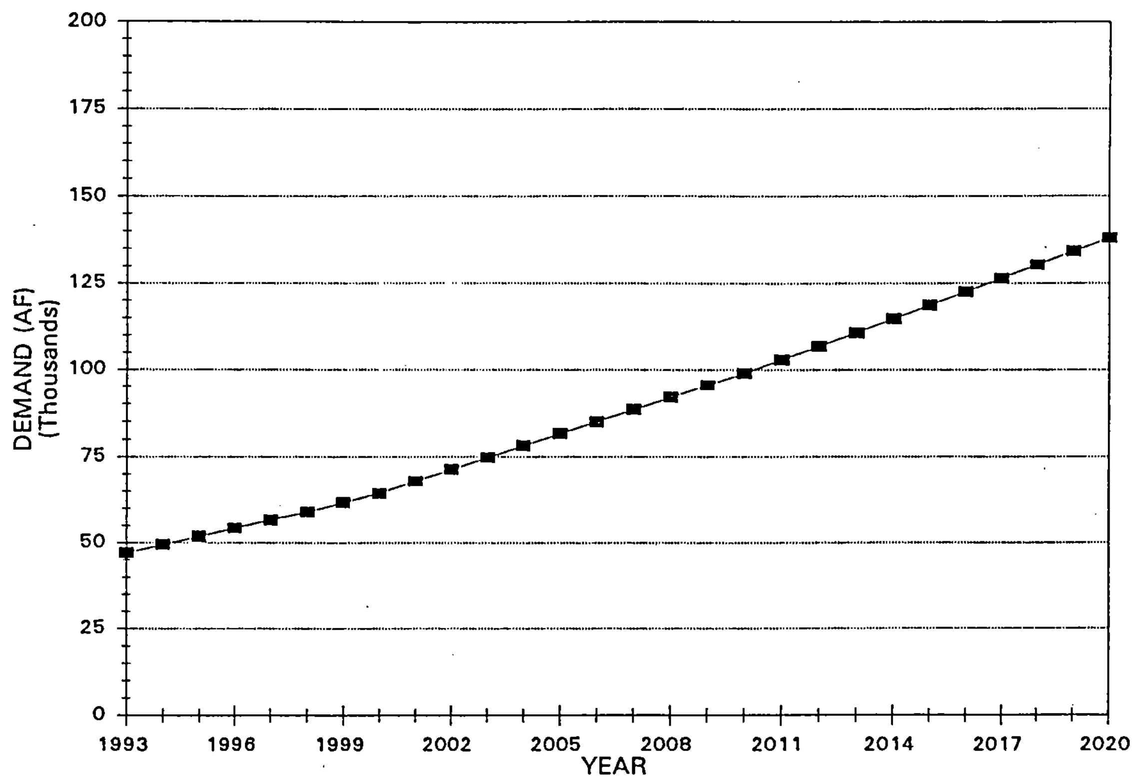
Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Projections
Rosamond

November 1995
K/J 934620.00

Figure 4–4

Figure 4–4



Kennedy/Jenks Consultants

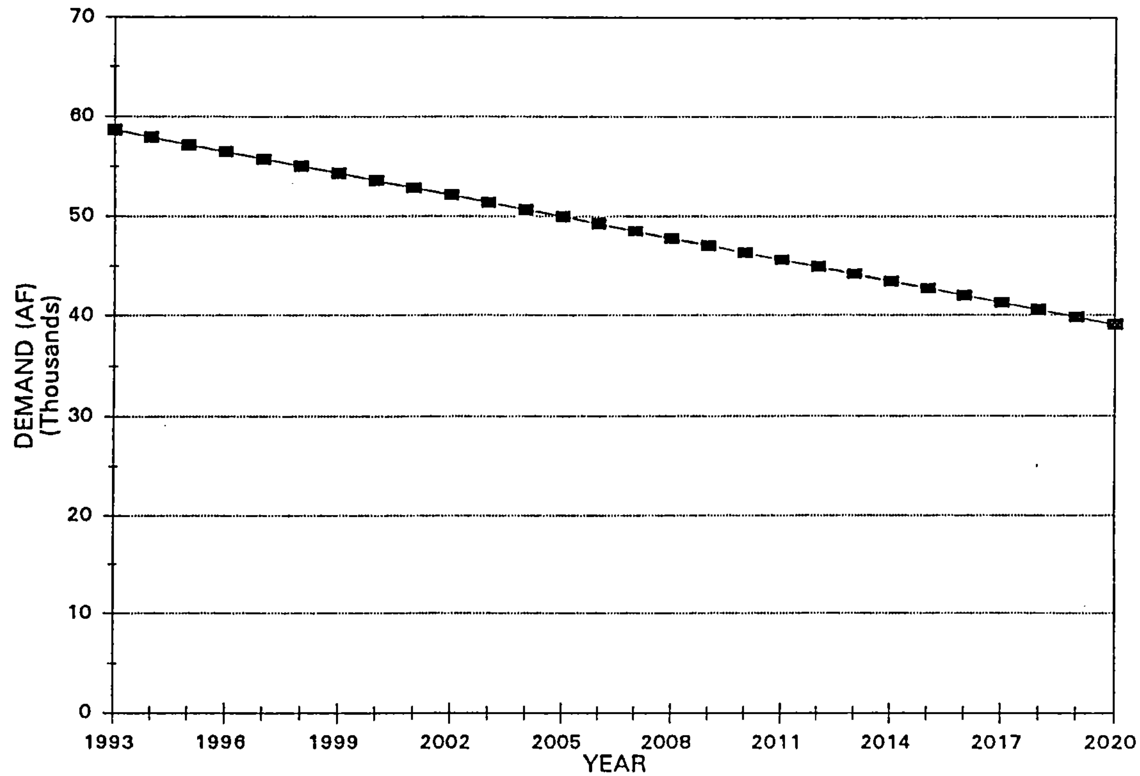
Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Projections
Other

November 1995
K/J 934620.00

Figure 4–5

Figure 4–5



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Projections
Agricultural

November 1995
K/J 934620.00

Figure 4–6

Figure 4–6

City of Lancaster. Water demand projections for the City of Lancaster are based on a per capita demand of 0.35 acre-feet per person per year derived from information provided in the City of Lancaster 1992 State of the City (SOC) report and applied to the low, medium, and high population projections. (The City of Lancaster water demand is consistent with the Los Angeles County Waterworks water demand of 0.32 to 0.34 acre-feet per person per year.)

RCSD. Water demand projections for the RCSD are based on a per capita demand of 0.17 acre-feet per person per year derived from 1993 population and water use data from RCSD and applied to the low, medium, and high populations.

Other. Water demand projections for the Other category are based on a per capita demand of 0.41 acre-feet per person per year derived from 1990 population and water use data provided by the Antelope Valley United Water Purveyors Association and applied to the population projection presented in Chapter 3. The Other category includes Edwards Air Force Base (AFB), Mojave, Boron and Other from Table 3-1.

Agricultural. As shown in Table 4-1, current and projected 2020 agricultural water uses in the Antelope Valley are approximately 59,000 acre-feet and 39,100 acre-feet respectively. Current agricultural acreage were obtained from the USGS's 1994 Draft Report. Estimates of agricultural acreage for the year 2020 are based on the acreage that would be necessary for reclaimed water use (i.e., identified as high potential reclaimed water users in Chapter 6 plus half of the existing agricultural acreage (not including the high potential reclaimed water users). Water demands are based on typical water use data obtained from the Soil Conservation Service.

AVAILABLE WATER SUPPLIES

Available water resources in the Antelope Valley consists of local groundwater, surface water from Little Rock Reservoir, imported water from the State Water Project (SWP), and reclaimed water. Stormwater runoff, although not presently managed well or used, is a resource that has potential for greater use in the Antelope Valley (USGS, 1994a). This chapter focuses on water supplies from groundwater, Little Rock Reservoir, SWP and reclaimed water. A brief description of historical, current and projected water supplies for the Valley is presented below.

Historical Supplies

The total available water deliveries for the Antelope Valley were 192,600 acre-feet in 1975, 246,000 acre-feet in 1980, 167,000 acre-feet in 1985 and 144,000 acre-feet in 1989 (USGS, 1994a). Historical water supplies were made of a combination of local surface water from Little Rock Reservoir, SWP water, groundwater, and reclaimed water. Groundwater has supplied between 50 to 90 percent of the total annual water supply in the Antelope Valley in recent years. This may be due in part to the recent drought condition which affected deliveries from the SWP and

TABLE 4-1

CURRENT AND PROJECTED AGRICULTURAL LAND AND WATER USE IN THE ANTELOPE VALLEY

Crop	Acres (1)	Net Annual Water Use (2) (inches)	Gross Annual Water Use (3) (acre-feet/acre)	Annual Water Demand (4) (acre-feet)
1993 Irrigated Crops				
Alfalfa	6,124	48.55	6.2	37,969
Pasture/Turf	955	41.18 (5)	5.3	5,062
Grain	835	10.73	1.4	1,169
Field Crops	32	10.73	1.4	45
Truck Crops	2,645	17.02	2.2	5,819
Deciduous Trees/Vines	2,263	29.67 (6)	3.8	8,599
Total	12,854			58,663
2020 Irrigated Crops				
Alfalfa	4,639 (7)	48.55	6.2	28,762
Pasture/Turf	595 (7)	41.18 (5)	5.3	3,154
Grain	613 (7)	10.73	1.4	858
Field Crops	16 (7)	10.73	1.4	22
Truck Crops	1,323 (7)	17.02	2.2	2,911
Deciduous Trees/Vines	900 (8)	29.67 (6)	3.8	3,420
Total	8,086			39,127

(1) From USGS 1994 draft report "Land Use and Water Use in the Antelope Valley, California", Table 1.
(2) From USDA Soil Conservation Service (SCS). Rainfall occuring during the growing season is assumed to be insignificant.
(3) Net annual water use divided by an irrigation efficiency factor of 0.65 and converted to acre-feet /acre.
(4) Acreage multiplied by the gross annual water use.
(5) Average of pasture and turf net annual water use as provided by SCS.
(6) Average of almonds, orchards, pecans, pistachios, and walnuts net annual water use as provided by SCS.
(7) Assumed to be the sum of the estimated acres to be served reclaimed water, and half of the 1993 crop acreages (excludes estimated acreage to be served reclaimed water).
(8) From USGS 1994 draft report, Table 1. Estimate provided to USGS by DWR.

diversions from the Little Rock Reservoir. The following sections describes historical water supplies for the Valley.

Groundwater. Historically, groundwater has been the primary water supply source for the Antelope Valley. Groundwater pumpage for the Los Angeles County portion of the Antelope Valley peaked in 1956 with 268,000 acre-feet, followed by a decline to 45,000 acre-feet in 1983 (USGS, 1994a). Since 1983, groundwater use increased to a high of 91,000 acre-feet in 1991. However, estimates of total pumpage may be low due to incomplete data obtained from the California State Water Resources Control Board. Apparently, all registered well owners in the Los Angeles County portion of the Antelope Valley have not consistently reported annual pumpage. In addition, pumpage data for much of the Kern County portion of the Valley were not available.

State Water Project. SWP deliveries to the Valley began in 1972. The Antelope Valley - East Kern Water Agency (AVEK), PWD, and Little Rock Creek Irrigation District (LCID) provide SWP water to the Antelope Valley. As shown in Table 4-2, deliveries peaked in 1981 with approximately 80,000 acre-feet. Since 1981 however, deliveries have ranged between 14,000 and 58,000 acre-feet per year. SWP entitlements are also shown in Table 4-2. Between 1976 and 1982, total deliveries ranged between 19 and 92 percent of the total entitlements. Between 1983 and 1992, total deliveries ranged between 9 and 69 percent of the total entitlements.

Little Rock Reservoir. Historically, the available storage from Little Rock Reservoir was 600 acre-feet. As shown in Table 4-3, diversions from the reservoir ranged from 310 to nearly 7,700 acre-feet from 1956 to 1990. Current modifications to the dam are anticipated to increase the storage capacity to 3,500 acre-feet.

Reclaimed Water. Wastewater influent reached nearly 21,000 acre-feet in 1990 (USGS, 1994a). The combined wastewater flows from Edwards AFB, the City of Palmdale and the City of Lancaster contributed to approximately 92 percent of the 21,000 acre-feet. According to the USGS, approximately 6,000 acre-feet was reused for irrigation and wetlands in 1990, and nearly 5,500 acre-feet was used for land disposal. Historical average daily flows from the Palmdale, Lancaster, Rosamond, and Edwards AFB Water Reclamation Plants (WRPs) are shown in Table 6-2.

Current and Projected Supplies

Table 4-4 shows the potential current and projected water supplies in Antelope Valley. As shown in the table, the potential current water supply ranges between 212,900 and 240,800 acre-feet, and the potential 2020 water supply ranges between 275,700 and 303,600 acre-feet. The only difference between the current and 2020 potential supply is the reclaimed water supply, which is expected to increase as the population in the Valley increases. The water supplies identified in Table 4-4 do not include potential reductions in deliveries due to hydrologic conditions. A brief description of each supply source is presented below.

TABLE 4-2

HISTORICAL DELIVERIES AND ENTITLEMENTS
(AVEK, PWD AND LCID)

Year	*AVEK Deliveries (acre-feet)*	*AVEK Entitlements (acre-feet)*	*PWD Deliveries (acre-feet)*	*PWD Entitlements (acre-feet)*	*LCID Deliveries (acre-feet)*	*LCID Entitlements (acre-feet)*
1972	53	20,000	0	1,620	338	170
1973	20	25,000	0	2,940	290	290
1974	1,259	30,000	0	4,260	400	400
1975	8,068	35,000	0	5,580	520	520
1976	27,782	44,000	0	6,900	589	640
1977	11,202	50,000	0	8,220	111	730
1978	44,137	57,000	0	9,340	208	920
1979	60,493	63,000	0	10,260	133	1,040
1980	72,407	69,200	0	11,180	191	1,150
1981	79,375	75,000	0	11,700	1,270	1,270
1982	50,291	81,300	0	12,320	0	1,380
1983	32,961	87,700	0	12,940	38	1,500
1984	32,662	35,000	0	13,560	1	1,610
1985	37,064	40,000	1,558	14,180	0	1,730
1986	32,449	42,000	3,096	14,800	163	1,840
1987	34,094	44,000	5,379	15,420	1,080	1,960
1988	34,079	46,000	1,770	16,040	419	2,070
1989	45,280	125,700	9,009	16,660	971	2,190
1990	47,206	132,100	8,608	17,300	1,747	2,300
1991	9,568	138,400	3,914	17,300	522	2,300
1992	37,490	138,400	6,600	17,300	1,143	2,300

Source: Department of Water Resources "Management of the California State Water Project", Bulletin 132-92, December 1992.

Groundwater. Groundwater is estimated to have a natural recharge amount of approximately 31,200 to 59,100 acre-feet per year (USGS, 1993). Average natural recharge estimates from previous investigations were obtained by the USGS and adjusted according to factors such as diversion, evapotranspiration, and similar drainage area (natural recharge estimates from various investigations were calculated based on different interpretations of surface water drainage areas).

State Water Project. SWP entitlements for the Antelope Valley are currently estimated to be approximately 153,800 acre-feet. The entitlements of AVEK, PWD and LCID are 138,400, 17,300, and 2,300 acre-feet per year respectively. A small

TABLE 4-3

HISTORICAL DIVERSIONS FROM LITTLE ROCK RESERVOIR

Year	*PWD Diversions (acre-feet)*	*LCID Diversions (acre-feet)*	*Total Diversions (acre-feet)*
1956	2,422	1,869	4,291
1957	1,752	117	1,869
1958	2,434	2,436	4,870
1959	1,311	2,041	3,352
1960	385	609	994
1961	0	386	386
1962	5,534	2,142	7,676
1963	136	979	1,115
1964	262	1,842	2,104
1965	1,318	1,739	3,057
1966	0	1,922	1,922
1967	0	2,534	2,534
1968	3,150	1,741	4,891
1969	2,105	2,261	4,366
1970	1,396	1,849	3,245
1971	1,389	1,663	3,052
1972	1,360	1,587	2,947
1973	1,523	1,672	3,195
1974	938	1,651	2,589
1975	1,586	1,513	3,099
1976	1,151	NA	1,151
1977	468	NA	468
1978	2,024	1,688	3,712
1979	913	1,950	2,863
1980	913	1,950	2,863
1981	1,638	1,040	2,678
1982	1,680	1,604	3,284
1983	714	1,199	1,913
1984	927	1,464	2,391
1985	1,460	1,375	2,835
1986	332	1,250	1,582
1987	0	1,000	1,000
1988	1,330	1,000	2,330
1989	1,400	700	2,100
1990	110	200	310

Source: Law Environmental "Water Supply Evaluation, Antelope Valley, California", for Palmdale Water District, November 25, 1991.

portion of AVEK entitlements have historically been delivered to areas outside the Antelope Valley borders. Based on information provided by AVEK, it is estimated that approximately 3 percent of historical deliveries made to AVEK did not serve the Antelope Valley. For this report, it is assumed that 3 percent of future deliveries made to AVEK will continue to serve areas outside the Valley borders.

TABLE 4-4

POTENTIAL ANNUAL WATER SUPPLY
FOR THE ANTELOPE VALLEY (1)

Source	*1993 Potential Supply (acre-feet)*	*2020 Potential Supply (acre-feet)*
Groundwater (2)	31,200 to 59,100	31,200 to 59,100
State Project Water		
AVEK (3)	134,200	134,200
LCID	2,300	2,300
PWD	17,300	17,300
Subtotal	153,800	153,800
Little Rock Reservoir (4)	7,000	7,000
Reclaimed Water (5)	20,900	83,700
Total (6)	212,900 to 240,800	275,700 to 303,600

(1) Supplies listed have not been adjusted to account for potential reductions in deliveries due to hydrologic conditions.
(2) Estimates of natural recharge from USGS "Study Plan for the Geohydrologic Evaluation of Antelope Valley, and Development and Implementation of Ground-Water Management Models."
(3) Based on historical deliveries of approximately 3 % to areas outside the Antelope Valley, subtracted from AVEK's total entitlement of 138,400 acre-feet per year.
(4) PWD estimates that average yield from the reservoir following modifications to the dam will be 7,000 acre-feet per year.
(5) The numbers shown are current and projected production for Palmdale, Lancaster, Rosamond, Edwards AFB, and Mojave WRPs.
(6) Potential useable stormwater is not included in the total.

Little Rock Reservoir. Available storage from Little Rock Reservoir was 600 acre-feet. Modifications to the Little Rock Dam are anticipated to increase the storage capacity to 3,500 acre-feet. According to the PWD, the average annual yield from the new reservoir is estimated to be approximately 7,000 acre-feet.

Reclaimed Water. Table 4-5 lists the wastewater treatment facilities in the Antelope Valley with the 1993 and projected 2020 reclaimed water flow. Current

TABLE 4-5

RECLAIMED WATER SOURCES

Facility Name	*1993 Flow (mgd)*	*Projected 2020 Flow (mgd)*	*Current Users of Reclaimed Water*
Palmdale WRP	7.4	37.2	Los Angeles City Department of Airports Pistachio Farm Chestnut Farm Christmas Tree Farm Landscape Plant Farm Barley Farm
Lancaster WRP	8.4	29.8	Apollo Lakes County Park - Aquatic Park Piute Ponds - Wetlands Nebeker Ranch - Alfalfa Farm
Rosamond WRP	0.8	3.0	None
Edwards AFB WRP	1.7	2.5	None
Mojave WRP (1)	0.4	2.2	None
Plant 42 WRP (2)	0.25	0.25	None
Desert Lake WRP (3)	0.08	0.4	None
Boron WRP (1)	0.12	0.6	None
Edwards AFB Missile Test Site WRP (2)	0.05	0.05	None
Edwards AFB N. Base WRP (2)	0.075	0.075	None
Boron Federal Prison WRP (2)	0.01	0.01	None
Total	***19.29***	***76.09***	***N/A***

(1) Projected reclaimed water supply is based on Mojave WRP's 1990 flow per capita (180 gallons/capita/day) applied to 2020 projected population.

(2) Projected reclaimed water supply is assumed to remain the same as existing supply.

(3) Projected reclaimed water supply is based on Mojave WRP's historical growth rate of 0.0124 million gallons per day per year (1980-1993).

N/A Not Applicable.

users, if any, are also listed. As shown in the table, 1993 and projected 2020 reclaimed water flows are estimated to be approximately 19.29 (21,600 acre-feet per year) and 76.09 million gallons per day (mgd) (85,200 acre-feet per year) respectively. Reclaimed water from the Palmdale WRP is currently used on the Department of Airport (DOA) property. A portion of the flow is used at various farms on the property. The remaining flow is currently spread over the 2600 acres of DOA land. Reclaimed water from the Lancaster WRP is used at Nebeker Ranch to irrigate alfalfa crops. A small portion is used at the Apollo Lake County Park, and the remaining flow is currently diverted to Piute Ponds.

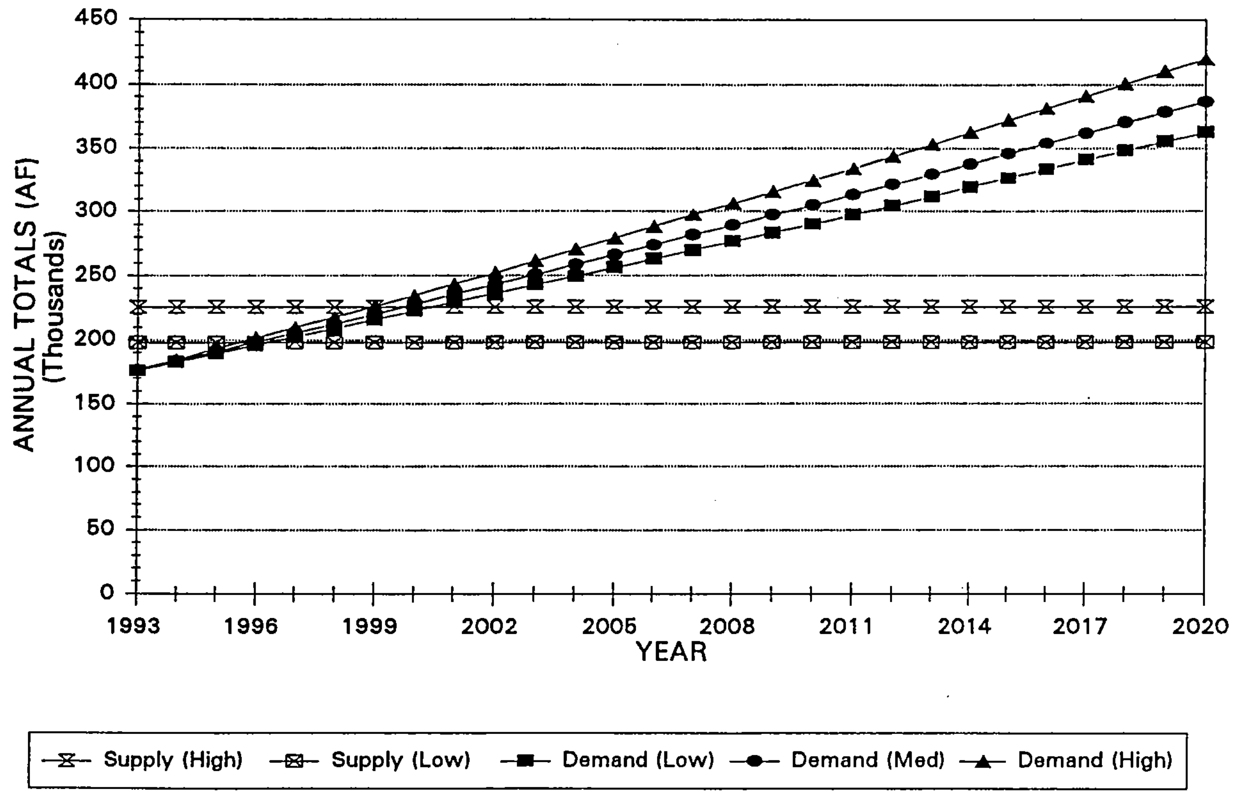
The Palmdale, Lancaster, Rosamond, Edwards AFB, and Mojave WRPs represent the plants with the highest probability of developing a reclaimed water system. The combined 1993 and projected 2020 flow from these five plants represent nearly 98 percent of the total potential reclaimed water supply for the entire Valley and is estimated to be 18.7 mgd (20,900 acre-feet per year) and 74.7 mgd (83,700 acre-feet per year) respectively.

RELIABILITY OF WATER SUPPLIES

Figure 4-7 depicts the high and low water supply projection along with the low, medium and high water demand projection for the Valley to the year 2020. The high and low water supply projection are based on Table 4-4 with one exception; the potential reclaimed water supply listed in Table 4-4 for 1993 and 2020 is not included. Instead, the reclaimed water supply for both 1993 and 2020 is taken as the current reclaimed water use (approximately 6,500 acre-feet). Therefore, the 1993 and 2020 potential supply ranges between 198,500 and 226,400 acre-feet per year. For purposes of the reliability analysis, the high supply curve and medium demand curve are selected. (See Figure 4-8.) The supply curve does not take into account the issue of reliability and the effects that reliability will have on the yield of each water supply source. The following section assesses the reliability of SWP water, Little Rock Reservoir water and reclaimed water. Groundwater is considered 100 percent reliable when the amount considered available for withdrawal is less or equal to the estimated natural recharge amount.

Reliability of SWP Supply

The Department of Water Resources (DWR) utilizes a computer model called DWRSIM to simulate operation of the SWP. The model operates the SWP on a monthly basis, using the actual hydrology from 1922 through 1992. The output of the model provides an estimate of annual quantities of water that could be available to meet SWP entitlement requests. The model takes into account many variables and assumptions such as minimum Delta outflow requirements, facility improvements, and pumping operation at the Delta export pumps. The most significant factors that affect the SWP supply estimates are the future demand, Delta environmental requirements and future SWP facilities. Total entitlement of all SWP contractors is 4.2 million acre-feet per year.



Kennedy/Jenks Consultants

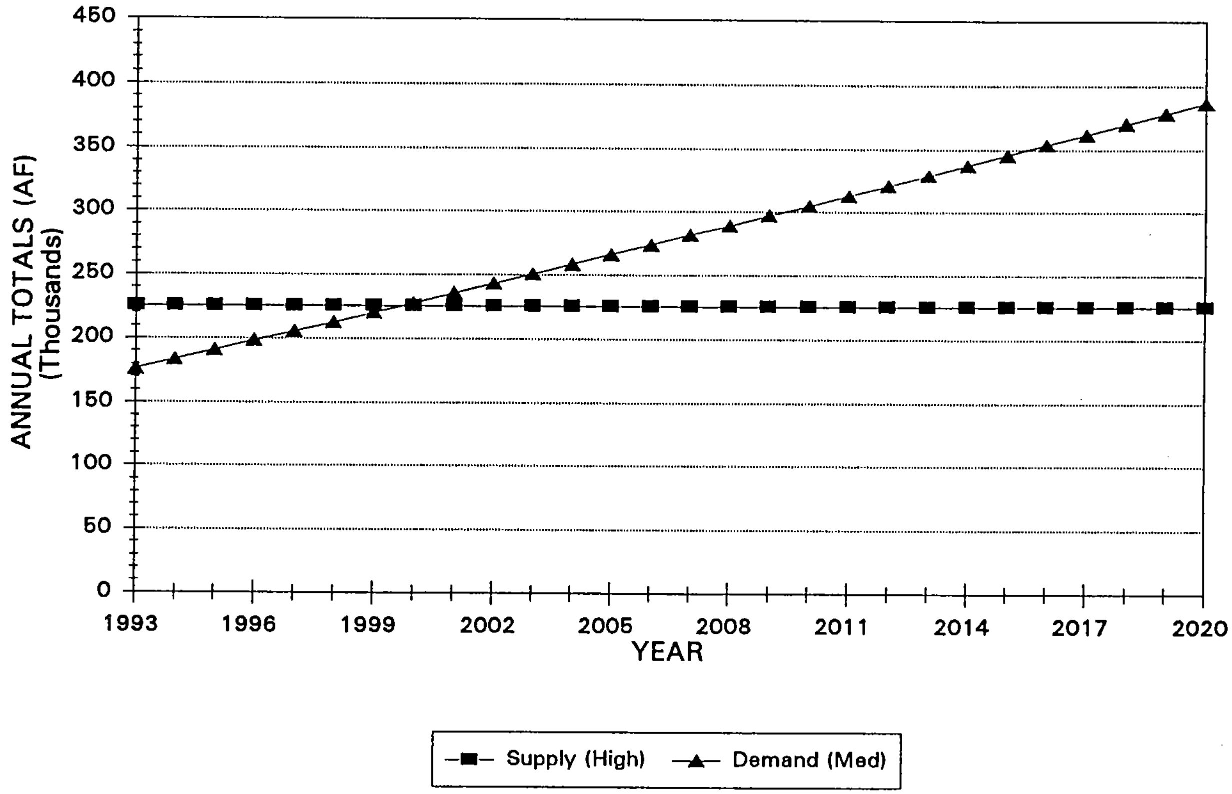
Antelope Valley Water Group
Antelope Valley Water Resources Study

Potential Supply and Projected Demand
(Without Delivery Reductions)

November 1995
K/J 934620.00

Figure 4–7

Figure 4–7



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Potential Supply and Projected Demand (Without Delivery Reductions)

November 1995
K/J 934620.00

Figure 4–8

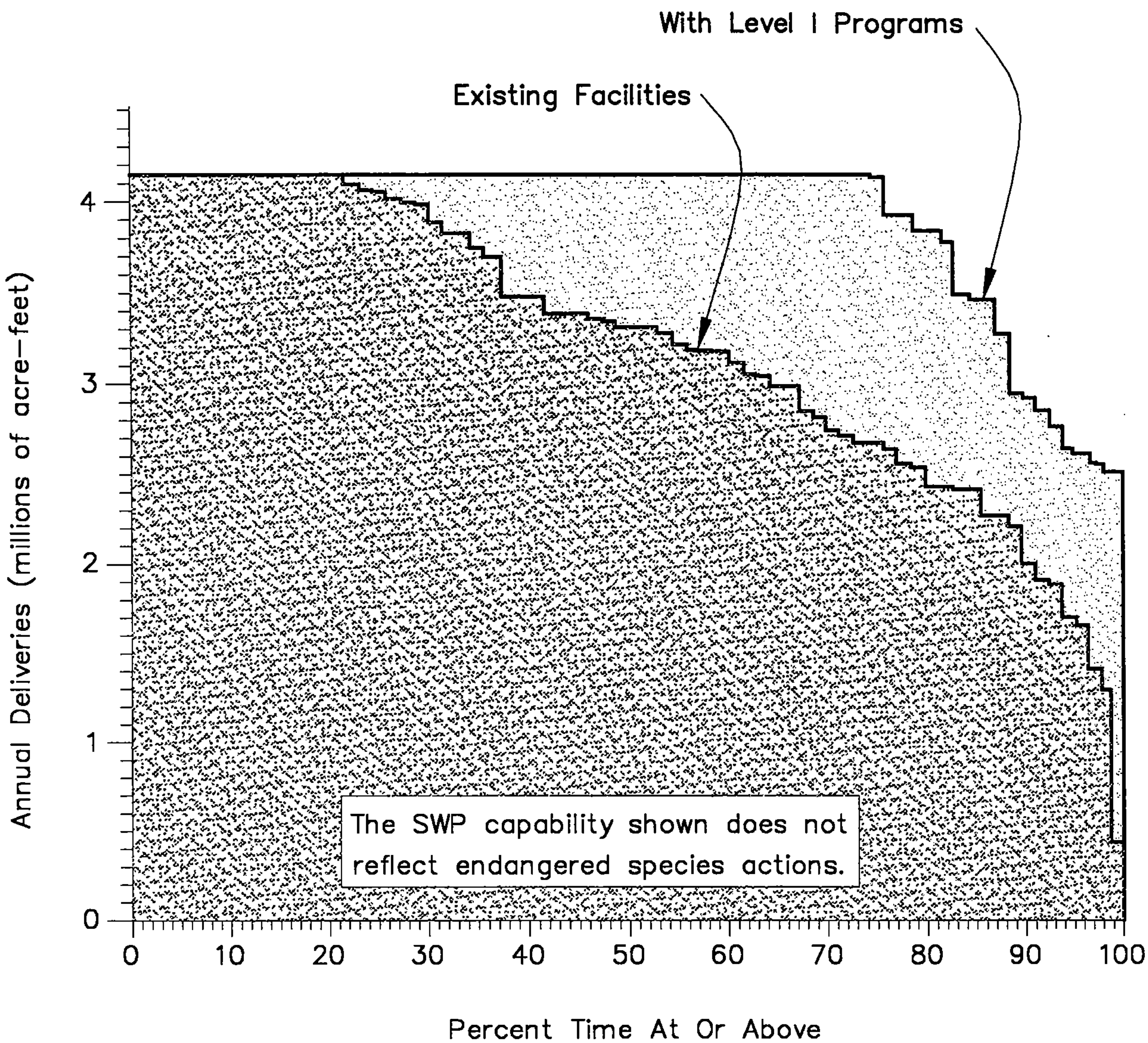
Figure 4–8

The reliability of SWP water is currently undergoing significant changes. Pending actions from federal requirements are currently being discussed that will significantly impact future SWP water supply. Biological opinions have been issued under the Endangered Species Act which will affect operation of the Delta. In February 1993, the National Marine Fisheries Service (NMFS) issued a biological opinion concerning the operation of the Central Valley Project (CVP) and SWP for winter-run chinook salmon. In February 1994, the United States Fish and Wildlife Services (FWS) issued their biological opinion concerning operation of the CVP and SWP for the Delta smelt. Both species have been listed under the State and Federal Endangered Species Acts. These opinions are intended to restrict pumping at the SWP and CVP export pumps in the Delta. In addition to the Delta pumping restrictions, the Environmental Protection Agency (EPA) issued a draft proposal for additional flow requirements in December 1993 under the Clean Water Act. The EPA is considering establishing stricter Bay/Delta water quality standards.

Figure 4-9 shows the SWP delivery capability for year 2020 with existing and Level 1 water supply management programs. Level 1 Water Management Programs include the South Delta Water Management Program (interim), Kern Water Bank (underground storage), Los Banos Grandes Facilities (open storage south of the Delta) and Long Term Delta program. The curves do not include pending federal requirements discussed above. As shown on Figure 4-9, with existing facilities, the SWP will be able to meet its requirements of 4.2 million acre-feet about 20 percent of the time. Level 1 Water Management Programs will enable the SWP to meet its requirements about 75 percent of the time.

Figure 4-10 shows the SWP delivery capability for year 2000 with existing facilities and Federal requirements. With these requirements, it is anticipated that the SWP will not be capable of ever delivering the full entitlement of all of the contractors. Based on Figure 4-10, the percentage of time that SWP delivery request anticipated to be met is summarized in Table 4-6. The DWR notes that "due to significant uncertainties regarding how Delta impacts will be allocated among all water users," several key factors related to implementation of the Federal Delta standards have not been considered in Figure 4-10. Not all of the criteria required by the NMFS and FWS in their biological opinions are included in Figure 4-10. The most significant criterion not modeled is the "take" limit at the SWP and CVP export pumps in the Delta. "Take" is defined as the maximum number of fish that can be killed by Delta pumping during certain periods. If "take" limits are exceeded for winter-run chinook salmon and Delta smelt, pumping can be restricted. The DWRSIM model does not account for pumping restrictions that might occur if "take" limits are exceeded.

Additionally, the Coordinated Operation Agreement (COA) between the CVP and the SWP is also not accounted for on Figure 4-10. The COA is an agreement between the United States Bureau of Reclamation and the DWR that establishes the basis for how the CVP and the SWP will be operated. The COA ensures that each project receives an equitable share or negotiated amounts of water supplies from the Central Valley's supply. If Federal requirements are enacted, the sharing



Based on D 1485 and 4.2 Million Acre Feet Maximum Delivery

SWP Level I Water Management Programs
- South Delta Water Management Program
- Kern Water Bank – First Stage
- Kern Water Bank – Second Stage
- Kern Water Bank – Local Elements
- Los Banos Grandes Facilities
- Long Term Delta Program

Source: Department of Water Resources, Draft, November 1993, "California Water Plan Update"

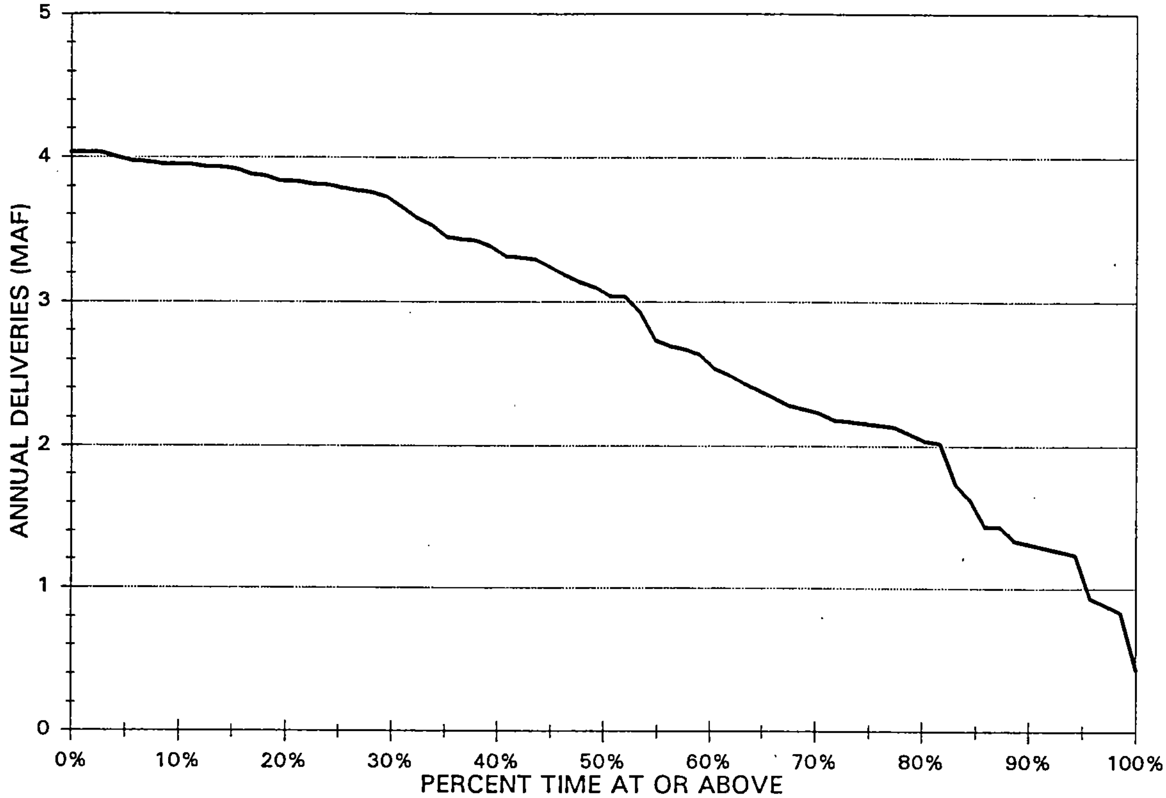
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Delivery Capability of SWP (w/o Federal Requirements)

November 1995
K/J 934620.00

Figure 4–9



Assumptions:

- D 1485
- 4.1 MAF Maximum Delivery
- Existing Facilities
- Federal Requirements for Salmon, Smelt and Delta Water Quality

Source: Department of Water Resources

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Delivery Capability of SWP (with Federal Requirements)

November 1995
K/J 934620.00

Figure 4–10

responsibility assumptions used in the program will change due to changes in the operating criteria of the system. As the new regulations are developed, the DWR will attempt to analyze the potential impacts in its model. It is anticipated that new Delta environmental requirements will decrease the estimated SWP supply from that shown in Figure 4-10.

Figure 4-10 assumes existing SWP facilities. According to the DWR, additional future SWP facilities are anticipated to increase the estimated SWP supply, however, until the various Delta issues are resolved, the feasibility of constructing additional SWP facilities and accurately estimating the increased water supply from such facilities is difficult to determine. It is anticipated that new facilities will increase the reliability and delivery capability of the SWP supply.

TABLE 4-6

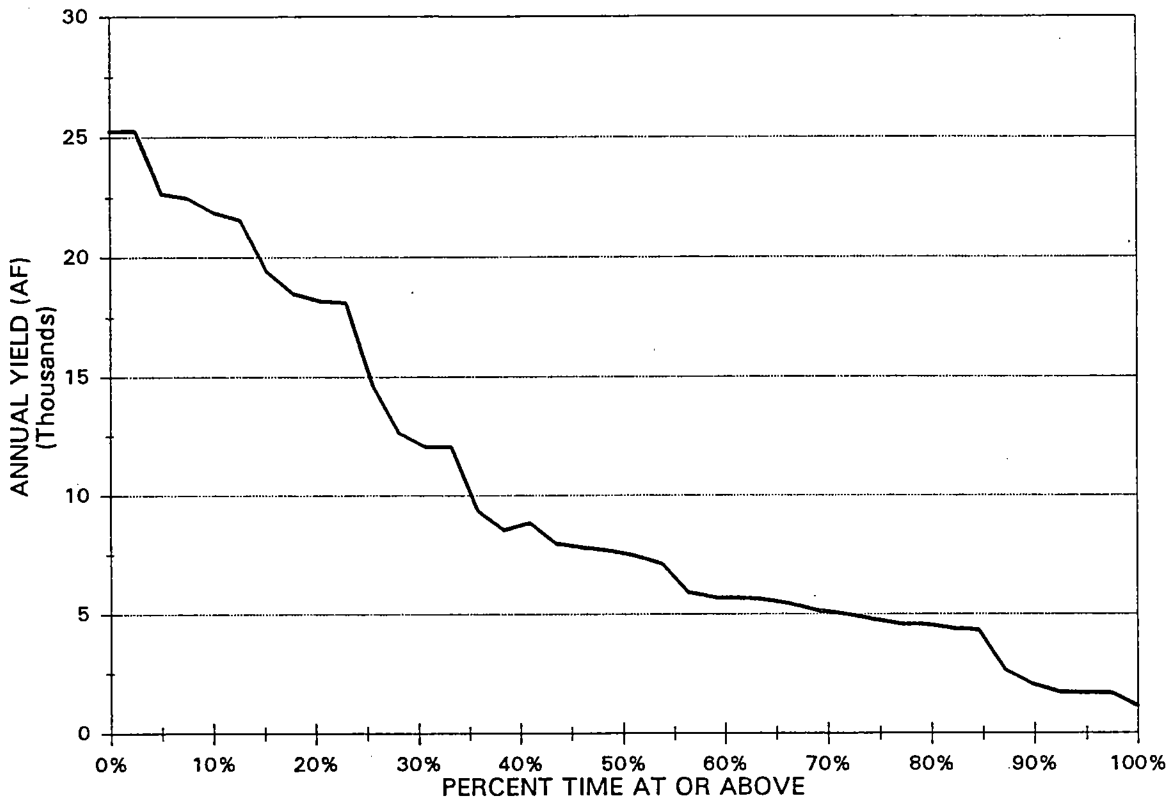
PROBABILITY OF WATER SUPPLIES

Probability	*Current Estimated Supply (acre-feet)*	*2020 Estimated Supply (acre-feet)*
Groundwater		
100% probability of getting 100% of potential supply	59,100	59,100
State Water Project		
50% probability of getting at least 76% of potential supply	116,800	116,800
80% probability of getting at least 50% of potential supply	77,000	77,000
90% probability of getting at least 36% of potential supply	46,200	46,200
Little Rock Reservoir		
50% probability of getting at least 100% of potential supply	7,000	7,000
80% probability of getting at least 64% of potential supply	4,500	4,500
90% probability of getting at least 30% of potential supply	2,100	2,100
Reclaimed Water		
100% probability of getting 100% of potential supply (current)	6,500	6,500

Reliability of Little Rock Reservoir Supply

Figure 4-11 shows the yield capability of Little Rock Reservoir. The reliability analysis for the Little Rock Reservoir water supply was based on the maximum yield from the reservoir using actual hydrology from 1954 to 1993. To obtain the annual yield from the Reservoir, estimates for beginning storage, inflows, evaporation, diversions, overflows and ending storage volume were calculated on a monthly basis. The total annual diversions were the sum of the monthly diversions.

PWD provided information on operational constraints for the model. One constraint is a limitation on diversions to the maximum channel capacity between Little Rock



Assumptions:

- Minimum 500 AF Recreational Storage from January through Labor Day.
- Maximum Diversions Limited by Maximum Channel Capacity to Lake Palmdale.
- Inflows from 1954 to 1993 will repeat.

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Yield Capability of Littlerock Dam

November 1995
K/J 934620.00

Figure 4–11

Reservoir and Lake Palmdale. The second constraint is a minimum pool of 500 acre-feet of storage for recreational purposes from January through Labor Day. Starting with the beginning storage volume, inflow from Little Rock Creek and Santiago Creek was added. Streamgage data from Little Rock Creek (No. L1-R) and Santiago Creek (No. F125-R) was obtained from the Los Angeles County Department of Public Works. Evaporation was deducted using DWR's evapotranspiration curves and PWD's data for storage volume and surface area. If the amount left in the reservoir was greater than the overflow volume of the Reservoir, the difference was assumed to overflow. The amount left in storage (minus the minimum 500 acre-feet recreational storage) was assumed to be diverted.

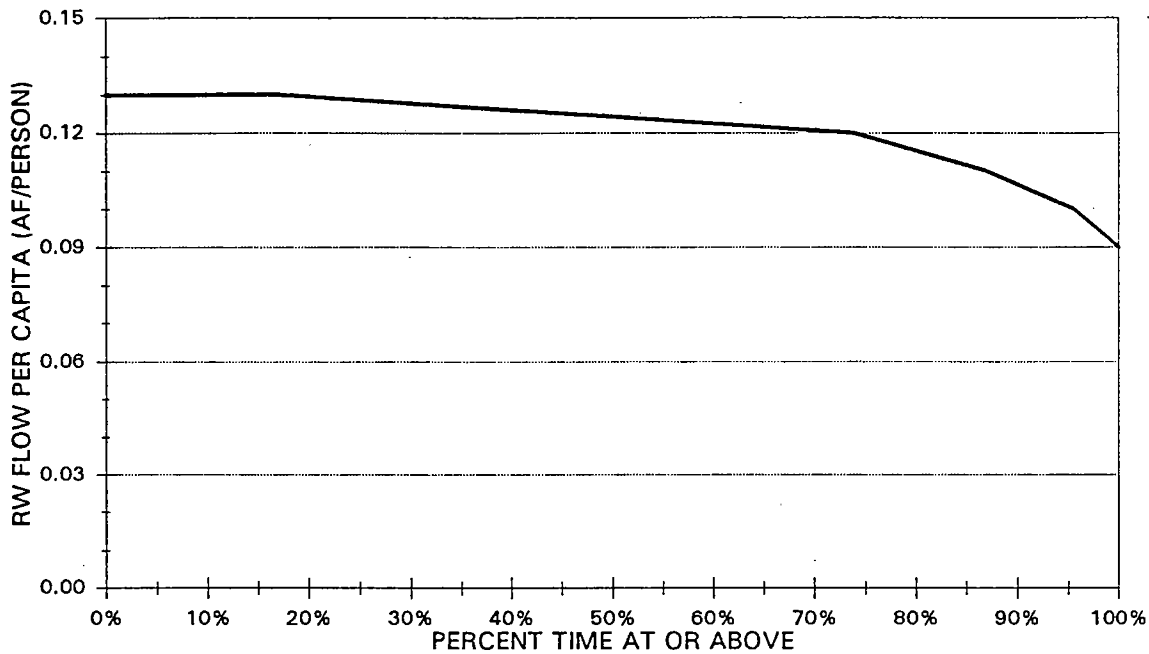
Assuming 1954 to 1993 hydrology, the analysis projects annual diversions ranging between 1,170 to 25,300 acre-feet per year. PWD estimates an annual average yield of 7,000 acre-feet from the Reservoir. Therefore, although the analysis indicated potential diversions greater than 7,000 acre-feet, this report assumes 7,000 acre-feet as the maximum annual yield. The result of the analyses is shown on Figure 4-11 and summarized in Table 4-6. Based on the analysis, Little Rock Reservoir can yield 7000 acre-feet or 100 percent of the supply at least 50 percent of the time.

Reliability of Reclaimed Water Supply

The reliability analysis for reclaimed water is based on wastewater influent from 1970 to 1992. Historical wastewater production from the Palmdale and Lancaster WRPs divided by historical population for the two cities provided wastewater production per capita. This unit production of wastewater from 1970 to 1992 ranged from 0.09 to 0.13 acre-feet per person per year. Figure 4-12 represents the frequency that the unit production of reclaimed water exceeded a given value. Figures 4-13 and 4-14 are based on Figure 4-12 and the 1993 and 2020 population estimates for the Valley. Based on this analysis, the wastewater treatment plants in the Valley could reliably produce 20,900 acre-feet per year in 1993 and 60,000 acre-feet per year in the year 2020. However, because the potential reclaimed water supply for both 1993 and 2020 is taken as the current reclaimed water use (approximately 6,500 acre-feet), the reclaimed water supply is considered 100 percent reliable. This is summarized in Table 4-6.

Reliability of Available Water Supplies

Figure 4-15 depicts the yield capabilities of the combined water supplies for the Antelope Valley. The graphs are based on the combined probability of available water supplies. However, because groundwater and reclaimed water have a 100 percent reliability, weighted averages were used to compute the reliability of the aggregate water supply. As mentioned previously, the potential water supply is 225,900 acre-feet per year (assuming a high estimate for the groundwater supply). From Figure 4-15, the probability of receiving 100 percent of the supply is approximately 29 percent. As the probability increases, the yield capability



Assumptions:

- Reclaimed Water Flow based on combined flow from Palmdale and Lancaster WRP's (1970 to 1992).
- Population based on combined City of Palmdale and City of Lancaster populations from 1970 to 1992.

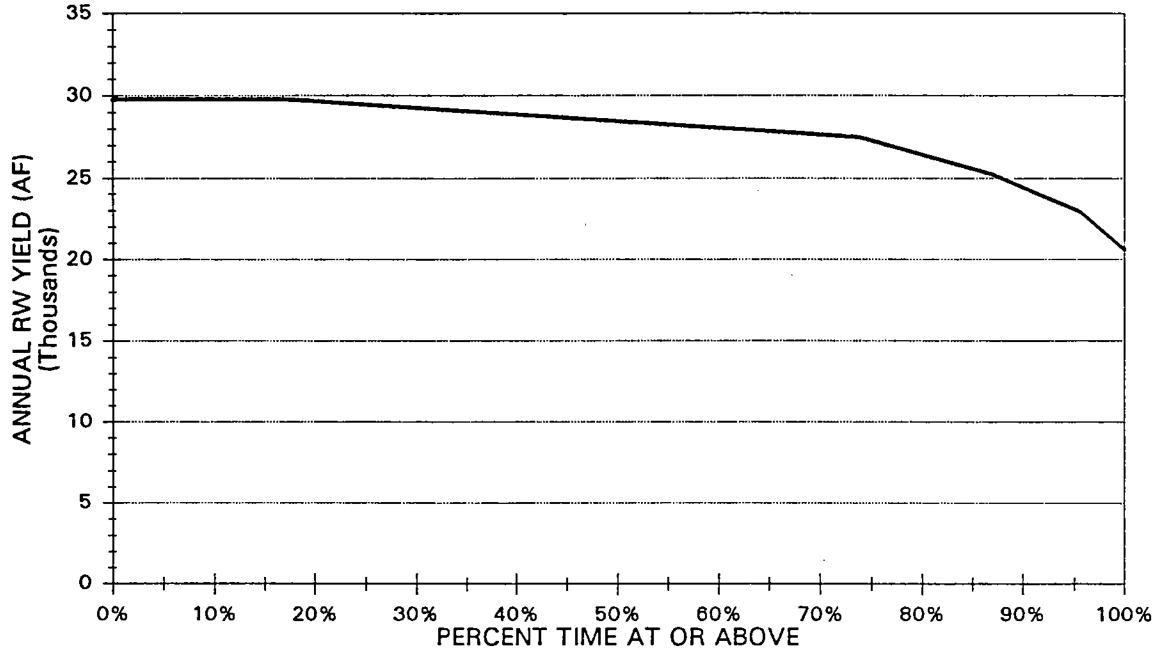
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Unit Production of Reclaimed Water

November 1995
K/J 934620.00

Figure 4–12



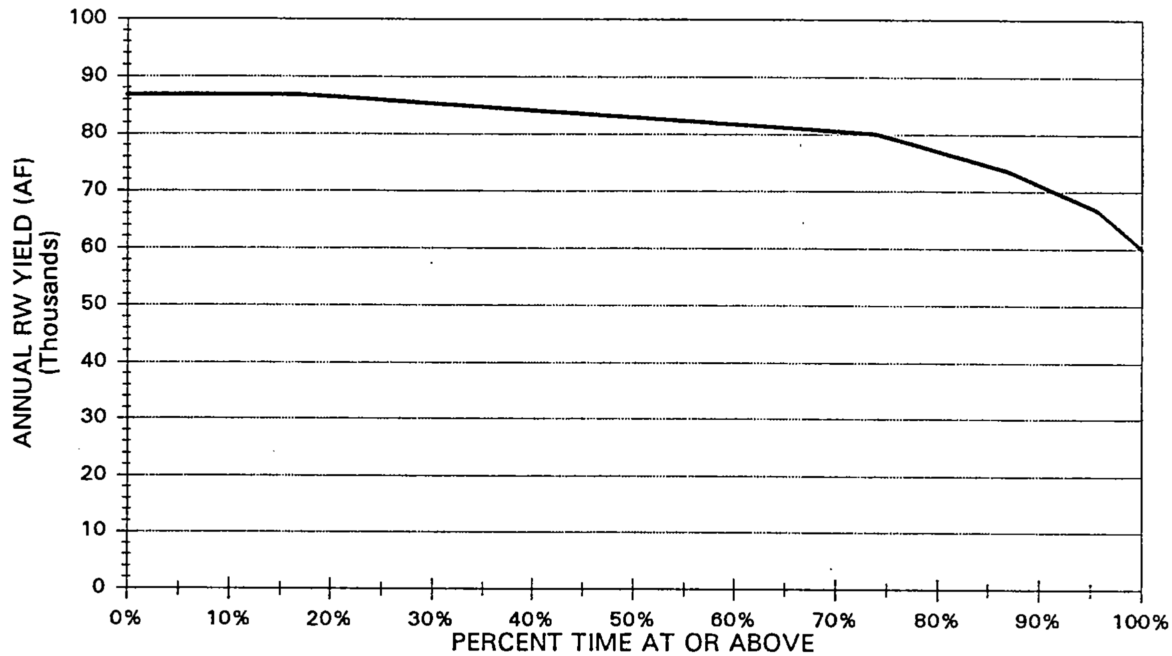
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

1993 Production Capability of Reclaimed Water

November 1995
K/J 934620.00

Figure 4–13



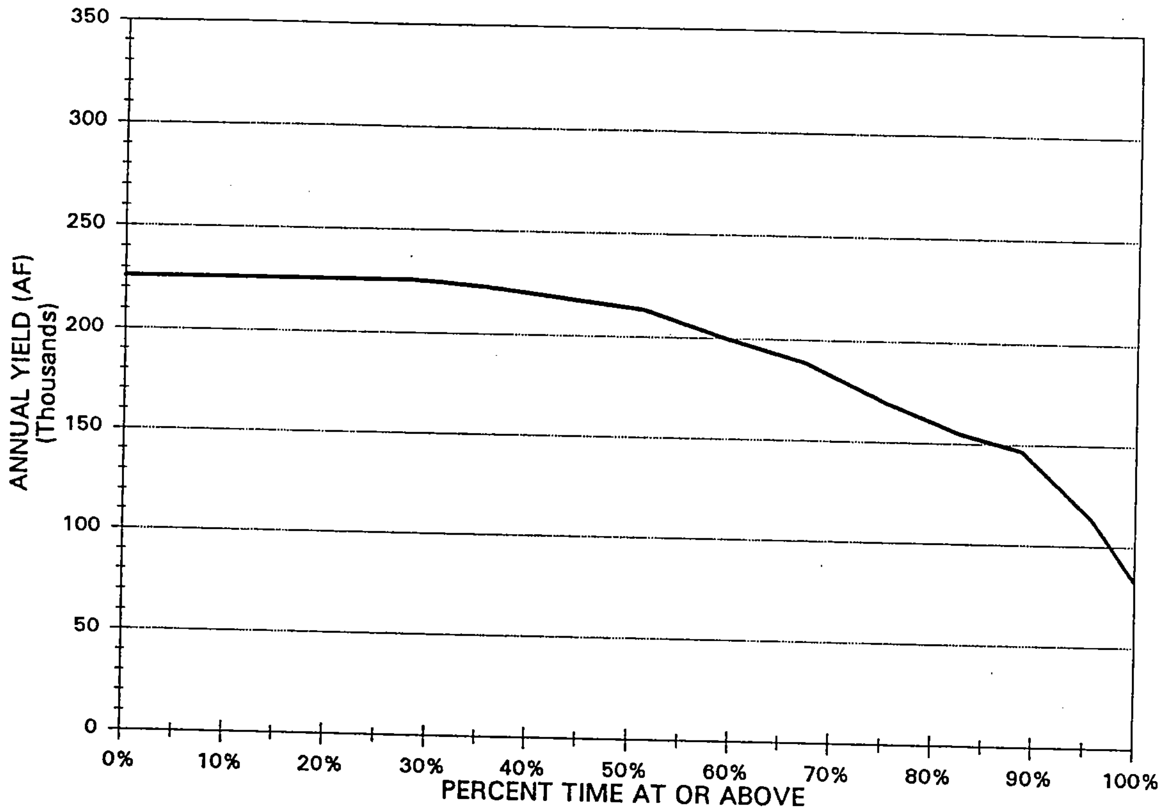
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

2020 Production Capability of Reclaimed Water

November 1995
K/J 934620.00

Figure 4–14



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Yield Capability of Available Water Supplies

November 1995
K/J 934620.00

Figure 4–15

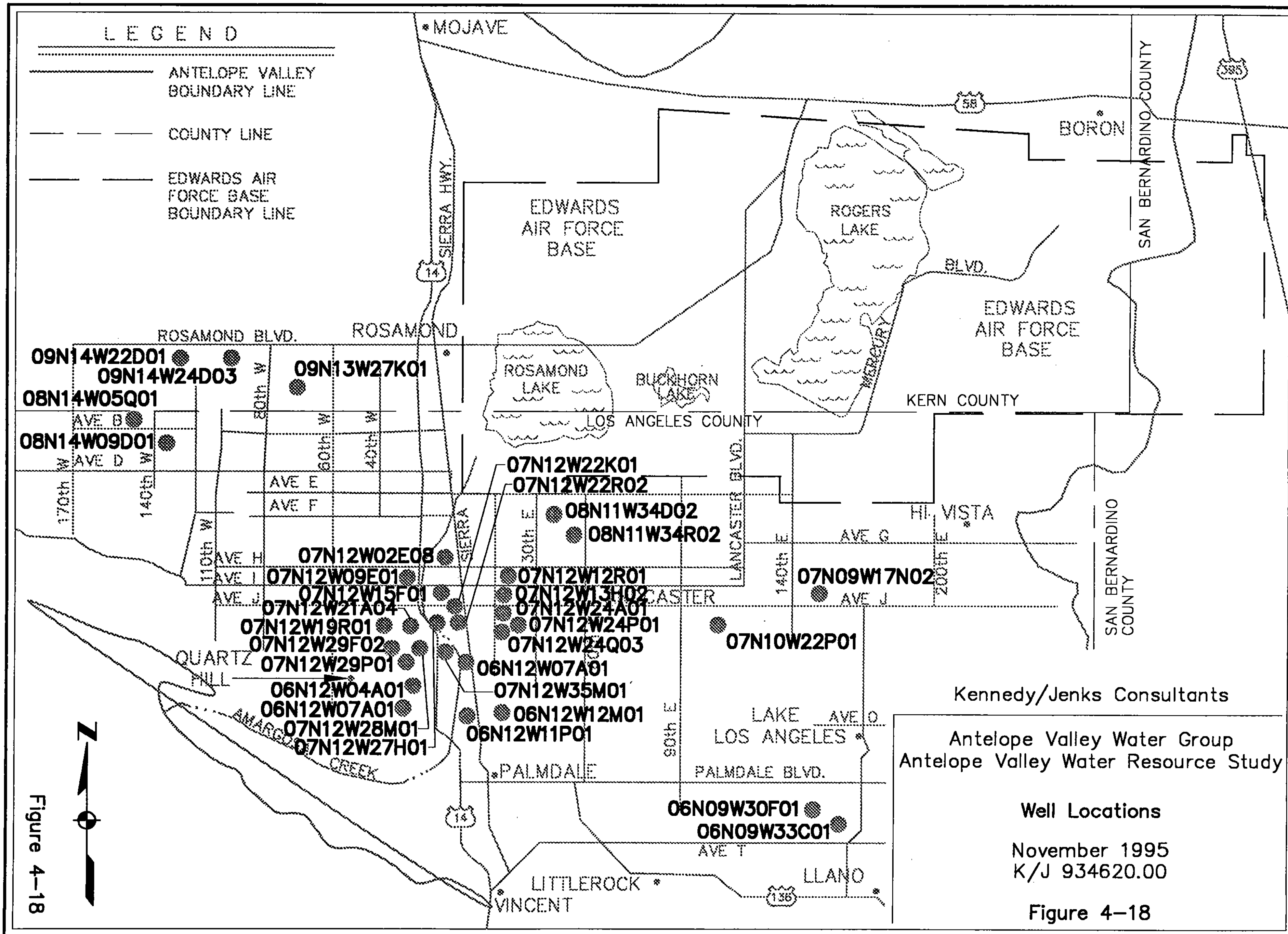
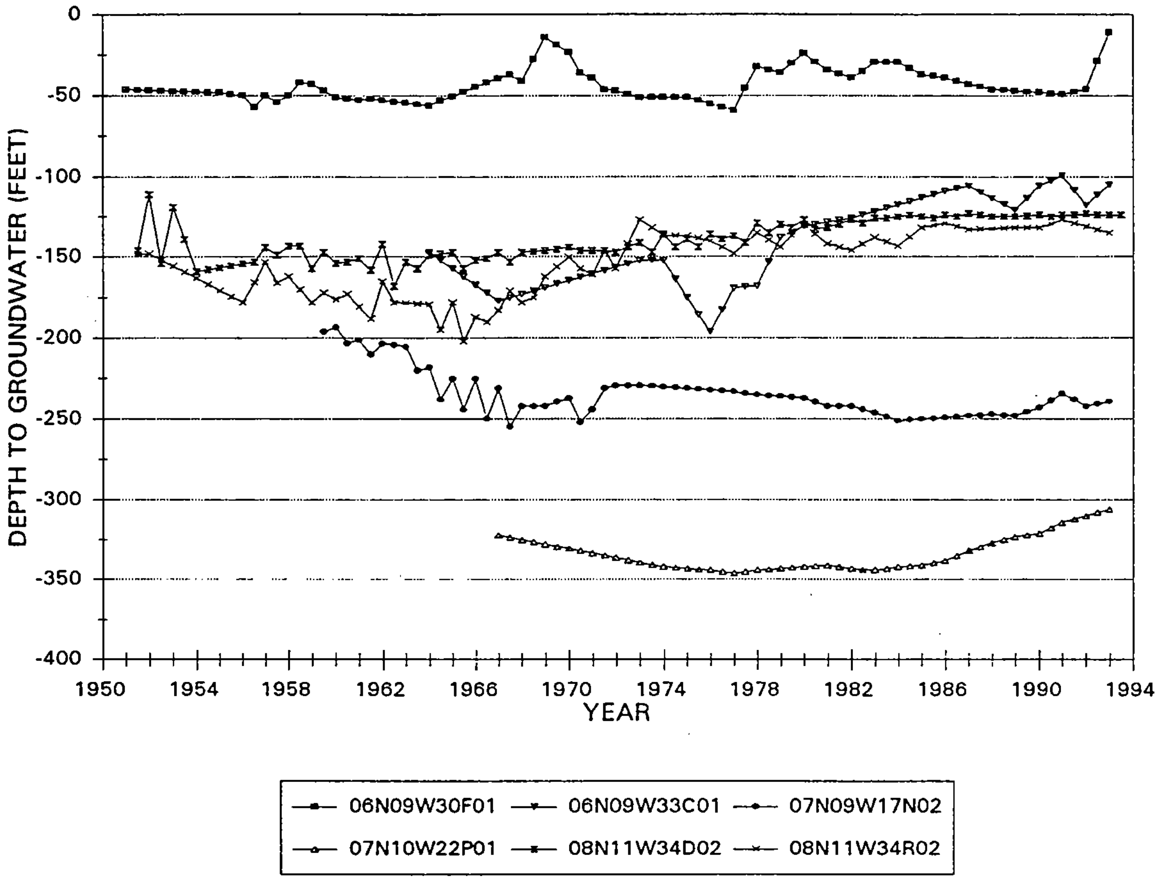

LEGEND
ANTELOPE VALLEY BOUNDARY LINE
COUNTY LINE
EDWARDS AIR FORCE BASE BOUNDARY LINE
MOJAVE
BORON
SAN BERNARDINO COUNTY
EDWARDS AIR FORCE BASE
ROGERS LAKE
ROSAMOND LAKE
BUCKHORN LAKE
KERN COUNTY
LOS ANGELES COUNTY
ROSAMOND
ROSAMOND BLVD.
SIERRA HWY.
MERCURY BLVD.
LANCASTER BLVD.
HI VISTA
LAKE LOS ANGELES
PALMDALE
PALMDALE BLVD.
LITTLEROCK
VINCENT
LLANO
QUARTZ HILL
AMARGOSA CREEK
AVE B
AVE D
AVE E
AVE F
AVE G
AVE H
AVE I
AVE J
AVE O
AVE T
170th W
140th W
110th W
80th W
60th W
40th W
30th E
90th E
140th E
200th E
09N14W22D01
09N14W24D03
08N14W05Q01
08N14W09D01
09N13W27K01
07N12W22K01
07N12W22R02
08N11W34D02
08N11W34R02
07N12W02E08
07N12W09E01
07N12W15F01
07N12W21A04
07N12W19R01
07N12W29F02
07N12W29P01
06N12W04A01
06N12W07A01
07N12W28M01
07N12W27H01
07N12W12R01
07N12W13H02
07N12W24A01
07N12W24P01
07N12W24Q03
06N12W07A01
07N12W35M01
06N12W12M01
06N12W11P01
07N09W17N02
07N10W22P01
06N09W30F01
06N09W33C01
Kennedy/Jenks Consultants
Antelope Valley Water Group
Antelope Valley Water Resource Study
Well Locations
November 1995
K/J 934620.00
Figure 4-18
N

Figure 4–18



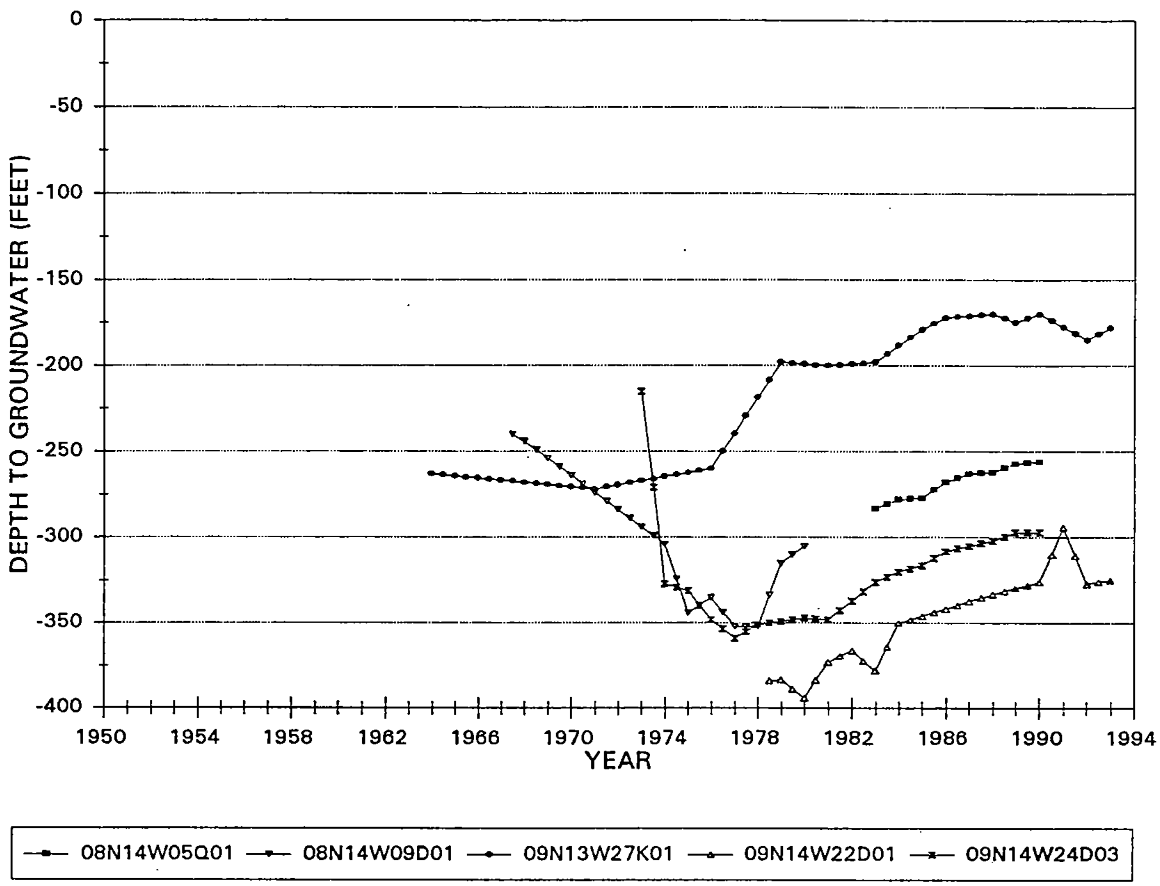
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Hydrographs in Agricultural Areas Without SWP Water

November 1995
K/J 934620.00

Figure 4–19



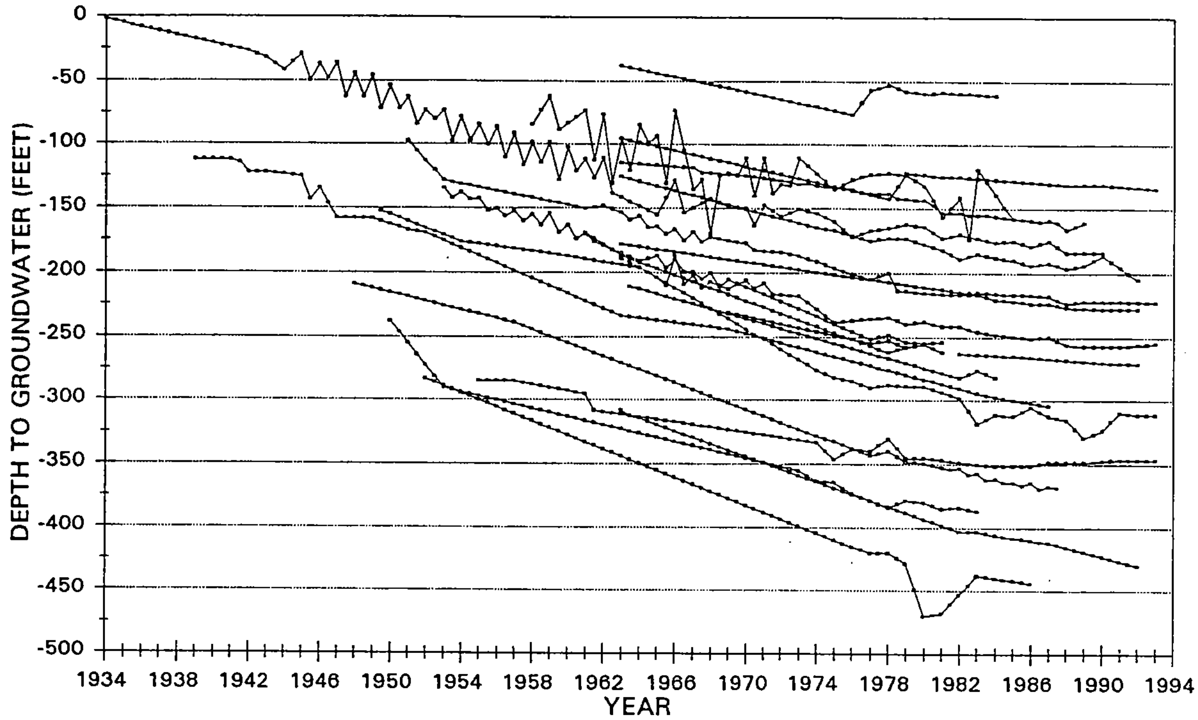
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Hydrographs in Agricultural Areas With SWP Water

November 1995
K/J 934620.00

Figure 4–20



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Hydrographs in Areas that have Transitioned from Agricultural to Urban

November 1995
K/J 934620.00

Figure 4–21

CHAPTER 5

WATER CONSERVATION

Although not truly a water resource, water conservation can stretch available resources by decreasing demands. The importance of long-term conservation has been emphasized by the recent prolonged drought and the fact that water demands are projected to exceed available supplies in the near future. This chapter develops and evaluates water conservation alternatives for the Antelope Valley. Elements of the chapter include a description of the service area, discussion of current water conservation regulations, summary of existing water conservation programs in the Valley, description of existing and projected water demands, and discussion on available water conservation measures as well as case studies on the effectiveness of the most viable measures. Finally, a water conservation program for the Antelope Valley is presented, followed by a discussion of the effects that conservation may have on the reliability of water supplies.

SERVICE AREA

As previously described in Chapter 2 and Chapter 3, the Antelope Valley encompasses approximately 2,400 square miles in northern Los Angeles County, southern Kern County and western San Bernardino County. The water demands within the Antelope Valley are serviced by a variety of water purveyors, including large wholesale agencies, irrigation districts, special districts providing primarily municipal and industrial water, investor-owned water companies, mutual water companies, and private well-owners. Land uses within the Valley have primarily focused on agriculture; however, the Valley is in transition from predominantly agricultural uses to predominantly residential and industrial uses. An estimated 332,000 people currently reside within the Valley. As shown in Table 3-1, it is projected that the population will reach nearly 1,000,000 people by the year 2020. Mean daily summer temperatures range from 63° Fahrenheit (F) to 93° F, and mean daily winter temperatures range from 34° F to 57° F. Major communities within the Valley include Boron, Edwards Air Force Base, Lancaster, Mojave, Palmdale and Rosamond.

As shown in Table 3-1, it is anticipated that the City of Palmdale (Palmdale), the City of Lancaster (Lancaster) and the Community of Rosamond (Rosamond) will have the largest number of people in the Antelope Valley. By the year 2020, the populations are estimated to be 326,815, 269,558 and 52,696, respectively. Therefore, this chapter focuses primarily on these three urban areas as well as agricultural water uses.

WATER CONSERVATION REGULATIONS

A number of federal and state regulations currently encourage water conservation. The regulations include plumbing efficiency standards, urban water management, agricultural water management, and other issues such as graywater and landscape irrigation. A brief description of these regulations is presented below.

Plumbing Efficiency Standards

The Energy and Policy Act of 1992 establishes efficiency standards for toilets, urinals, faucets, and showerheads manufactured in the United States after January 1994. The Act provides some exceptions for facilities such as prisons and commercial buildings.

The Health and Safety Code (Section 17921.3) establishes efficiency standards for toilets sold or installed in California after January 1994. Section 17921.3 establishes a 1.6 gallon per flush requirement for all toilets, urinals and associated flushometer valves sold or installed in California.

Urban Water Management Plans

The Urban Water Management Planning Act requires that urban water retailers supplying more than 3,000 acre-feet of water per year or serving more than 3,000 customers prepare an Urban Water Management Plan (UWMP) by the end of 1985. In 1991, the Act was amended to require that 1) the plans be updated at least every five years, 2) the plans include additional elements, and 3) urban water suppliers, whether serving customers directly or indirectly, prepare a plan. In addition, the Act requires that UWMPs 1) describe and evaluate water reclamation activities, 2) provide estimates of projected reclaimed water use, and 3) describe findings, actions and planning relating to the use of internal and external water audits, and incentive programs. In 1993, the Act was amended to require that the UWMP include a Water Shortage Contingency Plan.

The Public Utilities Commission (PUC) in Decision 90-08-055 issued on 8 August 1990, ordered all Class A water utilities to develop and file Water Management Programs addressing long-term strategies for managing water resources. On 16 September 1992 in Decision 92-09-084, the PUC ordered that effective 1 January 1994, each Class A water utility shall as part of its next general rate case, (1) file an updated water management program, and (2) evaluate the performance of its water management programs.

Agricultural Water Management

The California Agricultural Water Management Planning Act requires all water suppliers providing more than 50,000 acre-feet per year to agricultural growers in California to prepare and submit informational reports identifying potential agricultural water conservation programs. In addition, if water conservation programs identified are applicable, the Act requires the suppliers to prepare and submit a water management plan. In 1991, the Act was amended to require a description of water recycling activities to be included in the informational reports and water management plans.

The Agricultural Water Suppliers Efficient Water Management Practices Act requires the California Department of Water Resources (DWR) to establish an advisory committee to evaluate efficient water management practices for agricultural water suppliers. The Act establishes the mechanism for implementation of the practices. The implementation of the practices is on a cooperative basis similar to that of the urban best management practices.

The Agricultural Water Management regulation authorizes an agricultural water supplier to institute a water conservation or efficient water management program. The program may include making improvements to the supplier's facilities and providing assistance or consultation to its customers on conservation methods.

Other Regulations

Section 14875 of the Water Code legalizes installation and retrofitting of graywater systems in single family residences. Section 14875 authorizes cities and counties to adopt state standards for installation of graywater systems in residential buildings and allows the cities and counties to adopt more stringent standards for graywater systems, or prohibit graywater systems within their jurisdiction.

The Water Conservation in Landscaping Act establishes provisions of a model conservation landscaping ordinance for adoption on the local level. The Act requires cities and counties to adopt the state's DWR model ordinance for the development of water efficient landscapes if the cities and counties have not adopted their own ordinances.

EXISTING CONSERVATION PROGRAMS IN THE ANTELOPE VALLEY

Water conservation programs existing in the Antelope Valley are primarily directed at urban areas. These programs are provided through agencies like the City of Lancaster, the Los Angeles County Waterworks Districts (LACWW), Palmdale Water District (PWD) and Rosamond Community Services District (RCSD). The Agricultural Stabilization and Conservation Service (ASCS) office provides agricultural conservation programs for farmers and ranchers. The following section describes both urban and agricultural conservation programs existing in the Antelope Valley.

Urban Conservation Programs

Urban water conservation programs in the Antelope Valley include ordinances, literature and advertising, and phased water conservation plans as described below.

Conservation Ordinances. The City of Lancaster adopted Ordinance No. 629 in December 1992. This ordinance details landscape development specifications to minimize use of water. The ordinance specifies acceptable water saving irrigation systems and low water-use plant materials. The specifications apply to all new and rehabilitating (including developer installed) landscape development projects, both public and private. Cemeteries, registered historical sites, and projects with a landscaped area of less than 1,000 square feet are exempt from the ordinance. The owner or consultant for any project requiring landscape development as part of the project development is required to submit a Landscape Documentation Package to the City for review. The Landscape Documentation Package will typically include landscape and irrigation drawings, maximum water allowance calculations, irrigation schedules, maintenance schedules, soils analysis report, an approved or tentative grading plan, and a copy of the approved tract or parcel map.

In addition to the ordinance for landscape development specifications, the City of Lancaster also has provisions for graywater use in its municipal plumbing code, Ordinance No. 604. The provisions apply to the construction, alteration and repair of existing graywater systems and to the installation of new systems (allowed in residential occupancies only). The graywater systems supply underground irrigation to trees and other deep-rooted plants using household water which has not come into contact with toilet waste or wastewater from kitchen sinks, dishwaters, or laundry tubs. Permits must first be obtained in order to construct a new graywater system.

Similarly with the City of Lancaster, the County of Los Angeles (LA County) also adopted landscaping and graywater ordinances. On 17 December 1992, LA County adopted Ordinance No. 92-0135 in compliance with the Water Conservation in Landscaping Act. The ordinance establishes a procedure for designing, installing, and maintaining water efficient landscapes in new and rehabilitated projects. Effective 26 September 1991, LA County's ordinance for Graywater Systems for Residential Occupancies provides for construction, alteration and repair of graywater systems for on-site underground irrigation of trees and other deep-rooted plants. Both ordinances apply to the unincorporated areas of the county.

On 21 March 1991, LA County adopted a water wasting ordinance that applied to only unincorporated areas of the county. The ordinance placed limitations on water usage (i.e., washing down paved surfaces, excessive landscape watering, etc.). Water purveyors serving the unincorporated area of the county and all LACWW customers were notified of the ordinance and the $500 fine for noncompliance. This ordinance was terminated on 1 January 1993.

As of February 1991, the PWD adopted water conservation regulations prohibiting the use of water for hose washing of sidewalks, walkways, buildings, and driveways. The regulations also establishes limits on a variety of water uses such as washing motor vehicles, filling decorative fountains, serving drinking water at restaurants, and watering landscaped areas. The prompt repair of leaks from indoor and outdoor plumbing fixtures by all residents is also required under these regulations. In addition, the owner and manager of every short-term commercial lodging facility must post a notice of a water shortage and associated compliance measures.

Conservation Literature and Advertising. Produced by LACWW for the Antelope Valley is a booklet titled "Antelope Valley Colorful Landscapes for Water Conservation." The booklet describes how residents can develop beautiful, water conserving landscapes through low water-use plants, efficient irrigation systems and improved watering techniques.

LA County has been involved in various activities to raise public awareness on the subject of water conservation. A number of public meetings were held by LA County in conjunction with the ordinances regarding the need to conserve water. Water conservation literature and water conservation kits were distributed at the meetings. In addition, arrangements were made with the Lancaster Unified School District to promote water awareness month by providing them with conservation kits, book covers, brochures, posters, and other materials. The County also participated in and helped sponsor the Landscaping for Water Conservation Conference put on by the Antelope Valley College.

RCSD sends informational brochures to its customers during periods of drought requesting its users to practice water conservation.

Phased Water Conservation Plan. LACWW has developed a set of rules intended "to minimize the effect of a shortage of water supplies on the customers of any or all of the Districts during a water shortage emergency." The Phased Water Conservation Plan characterizes the percentage of water supply shortages based on nine phases and involves the issuance of conservation surcharges to users for quantities of water used above the set target water use for a given phase once the supply shortage percentage has been determined. For example, if the LACWW determines that a 20% water shortage will be suffered for a given year, then users will be charged normal rates for up to 80% use and will be surcharged for any use above 80%. Calculation of the surcharges is based upon whether the user's meter size is less than or greater than a specified size. In addition to conservation surcharges, water users are also required to comply with additional water conserving measures related to landscape watering as the percentage of supply shortage increases.

Agricultural Conservation Programs

The Agricultural Conservation Program provided through the ASCS is currently the only available conservation program for agricultural areas in the Antelope Valley. A description of the program as well as a summary of current practices by the Soil Conservation Service is provided below.

Agricultural Conservation Program. The ASCS of the U.S. Department of Agriculture (USDA) provides an Agricultural Conservation Program (ACP) which offers cost sharing to farmers and ranchers to encourage conservation practices on agricultural land that will result in long-term benefits. The ACP is intended to 1) help prevent soil erosion and water pollution, 2) protect and improve productive farm and ranch land, 3) conserve water used for agriculture, 4) preserve and develop wildlife habitat and 5) encourage energy conservation measures. Water conservation programs eligible for cost-sharing are listed as follows:

- Permanently installed systems
- Lining irrigation ditches
- Land leveling
- Tailwater recovery systems or other installations where the installation is an integral part of the irrigation system being reorganized for the conservation of soil or water.

The Federal Government pays up to 80 percent of the cost of needed conservation practices.

Soil Conservation Service. The Soil Conservation Service (SCS) in Lancaster indicates that although a formal conservation program is not currently in place in the Antelope Valley, farmers are practicing conservation through use of efficient irrigation systems. For example, SCS reports that orchard farms are primarily using drip irrigation, and alfalfa farms are primarily using wheel sprinkler irrigation. These two irrigation systems are considered very efficient compared to other forms of irrigation, such as flood irrigation (SCS noted that although the Department of Airports (DOA) practices flood irrigation, the water supply is from the Palmdale Water Reclamation Plant (WRP), and it is the intent of the DOA to consume as much water as possible to assist the WRP in discharge of the reclaimed water).

EXISTING AND PROJECTED WATER DEMANDS

As discussed in Chapter 4 and depicted on Figure 4-7, estimated water demands are expected to exceed available water supplies in the near future (assuming overdrafting of the groundwater basin will not continue). Water conservation can play a key role in the Valley's water management strategy.

The following section summarizes existing and projected water demands presented in Chapter 4 for Palmdale, Lancaster and Rosamond. Existing and projected agricultural water usage is also presented. Low, medium and high water demand projections based on low, medium and high population projections for the three urban areas are presented in Chapter 4. The medium water demand projection curves are utilized in this chapter.

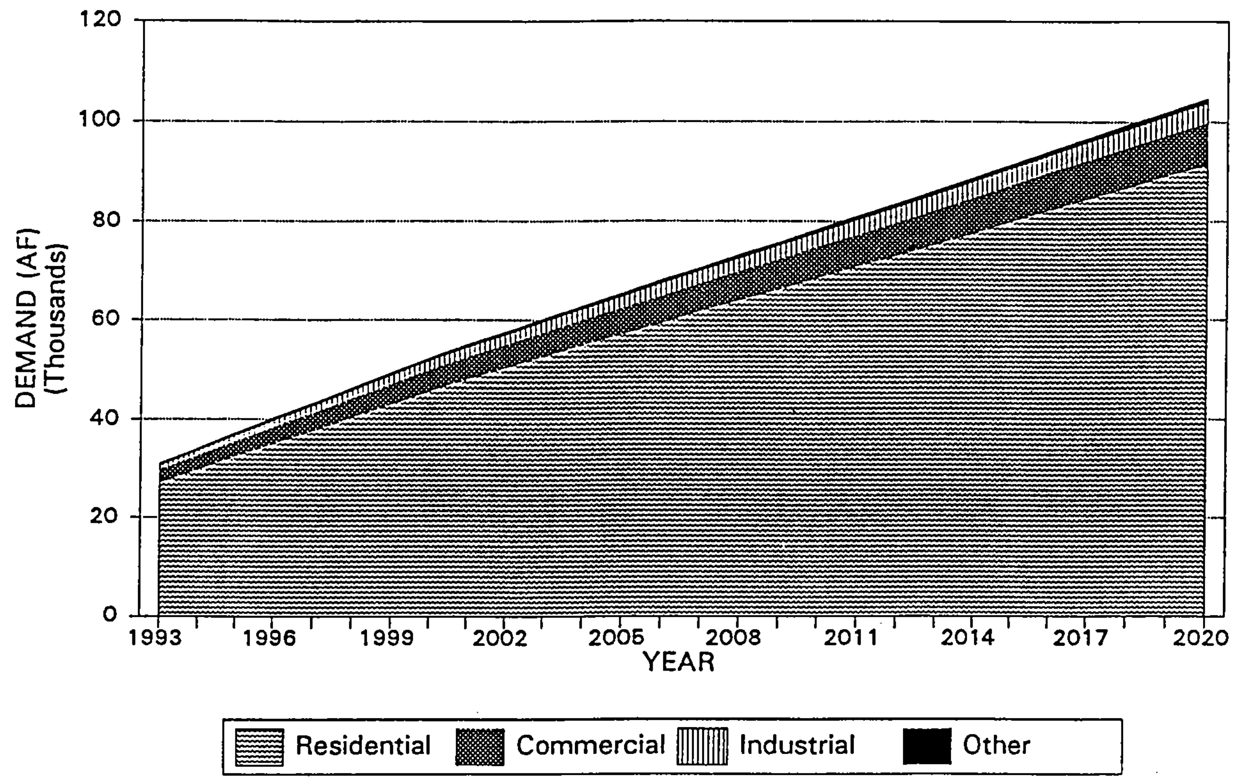
Urban Water Demands

Urban water use in Palmdale, Lancaster and Rosamond is comprised of residential, commercial, industrial, and other uses. Residential use ranges from 50 to 88 percent of the total water demands for these three areas and includes both interior and exterior water use for homes and apartments. Per capita water use in residential areas can vary greatly depending upon climate, landscaping, and density. Most of this variation is related to exterior landscape irrigation. Commercial water use ranges from 7 to 13 percent of the total and can include restaurants, laundries, office buildings, retail stores, golf courses, and other businesses. Industrial water use ranges from 0.02 to 33 percent of the total and is used for cooling, processing, manufacturing, and sanitation. Other water uses range from 1 to 15 percent of the total and can include schools, prisons, hospitals, parks, and fire departments. Figures 5-1 through 5-3 show projected water demands for Palmdale, Lancaster and Rosamond respectively, broken down into residential, commercial, industrial and other categories. Figures 5-4 through 5-6 show the approximate breakdown by percentages for each category for each area. Descriptions of water demand projections for Palmdale, Lancaster and Rosamond are provided below.

City of Palmdale. Water demand projections for Palmdale are based on a per capita demand of 0.32 acre-feet/person/year derived from 1993 population and water use data from PWD and applied to the medium population projection presented in Chapter 3. The breakdown of water use for each user class (residential, commercial, industrial and other) by percentage of the total water use was obtained from information supplied by LACWW and PWD. It is estimated that of the total water used in Palmdale, approximately 87 percent is used by the residential class, 8 percent is used by the commercial class, 4 percent is used by the industrial class, and 1 percent is used by the others. The percentages of water use for each user class are assumed to remain the same over the evaluation period (1994 to 2020).

City of Lancaster. Water demand projections for Lancaster are based on a per capita demand of 0.35 acre-feet/person/year derived from information provided in the City of Lancaster 1992 State of the City (SOC) report and applied to the medium population projection presented in Chapter 3. The SOC report provides estimates of current (1991) and projected water use for each user class. It is estimated that of the total water used in Lancaster in 1991, approximately 51 percent was used by the residential class, 14 percent was used by the commercial class, 19 percent was used by the industrial class and 16 percent was used by the others. The SOC report projects proportionally higher growth in the industrial class, thereby decreasing the proportion of water use for the residential, commercial and other classes. It is estimated that total water use in the year 2020 will comprise of approximately 50 percent residential, 8 percent commercial, 33 percent industrial and 9 percent other uses.

Community of Rosamond. Water demand projections for Rosamond are based on a per capita demand of 0.17 acre-feet/person/year derived from 1993 population and water use data from RCSD and applied to the medium population projection presented in Chapter 3. It is estimated that of the total water used in Rosamond in 1993, approximately 86 percent was used by the residential class, 7 percent was used by the commercial class, 0.02 percent was used by the industrial class and 7 percent was used by the others. (Note that the industrial water demand is not shown on Figures 5-3 or 5-6 due to the small percentage of total water use.) The percentages of water use for each user class is assumed to remain the same over the evaluation period (1994 to 2020).



Kennedy/Jenks Consultants

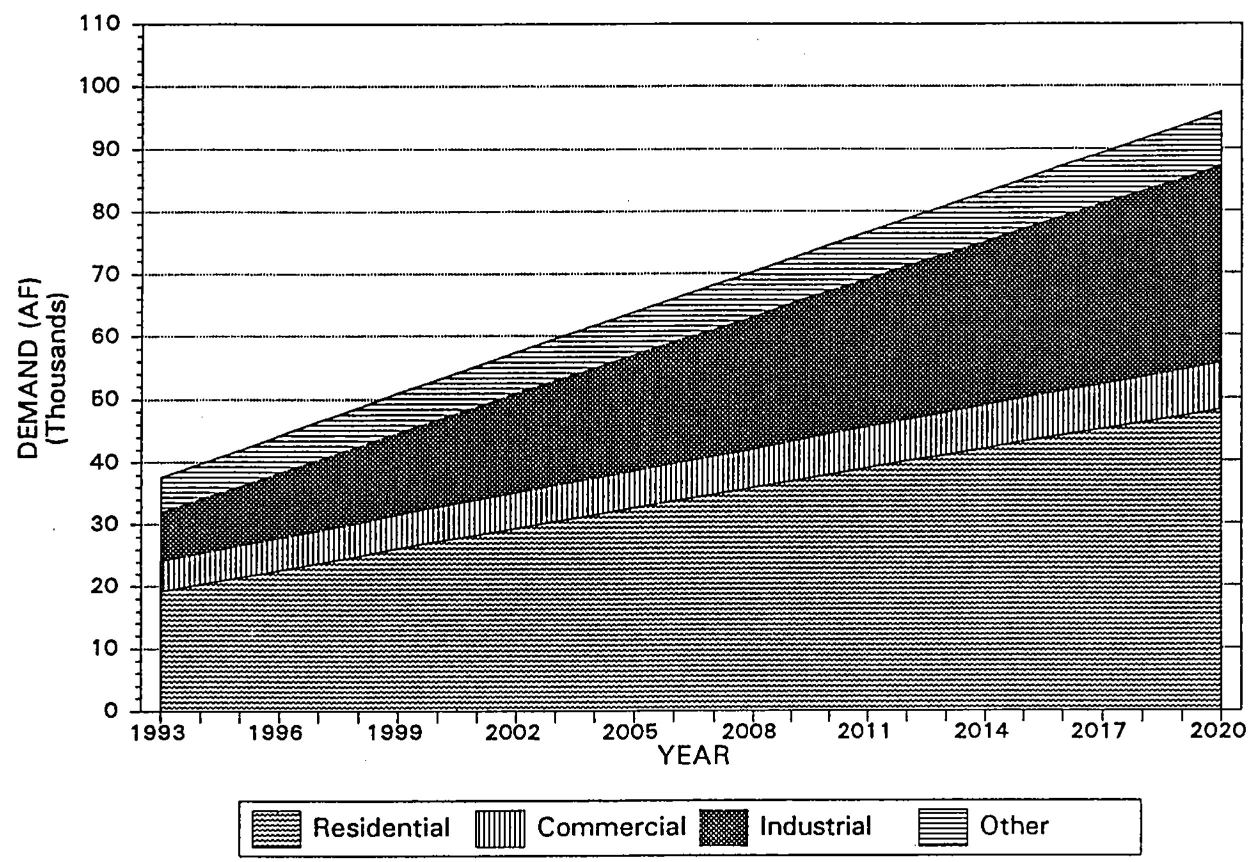
Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected Water Demand by User Class – Palmdale

November 1995
K/J 934620.00

Figure 5–1

Figure 5–1



Kennedy/Jenks Consultants

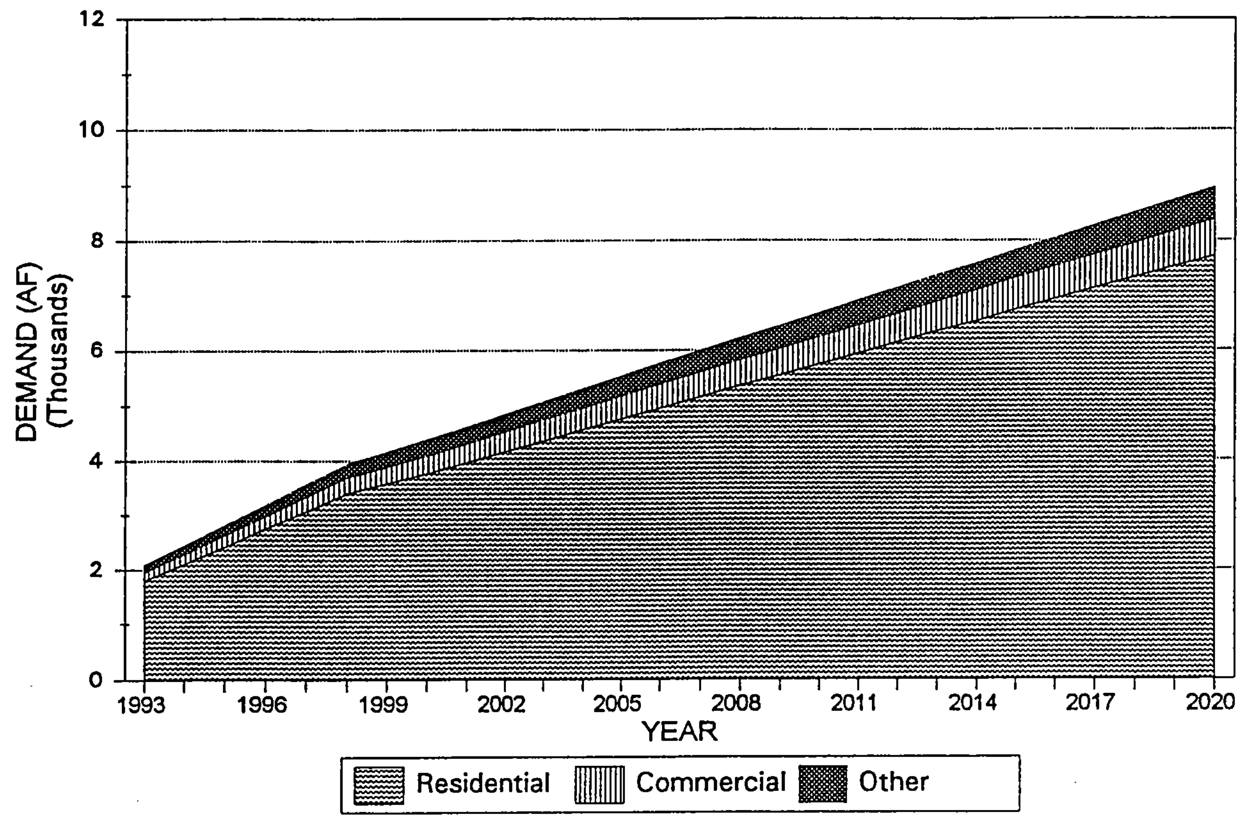
Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected Water Demand
by User Class – Lancaster

November 1995
K/J 934620.00

Figure 5–2

Figure 5–2



Kennedy/Jenks Consultants

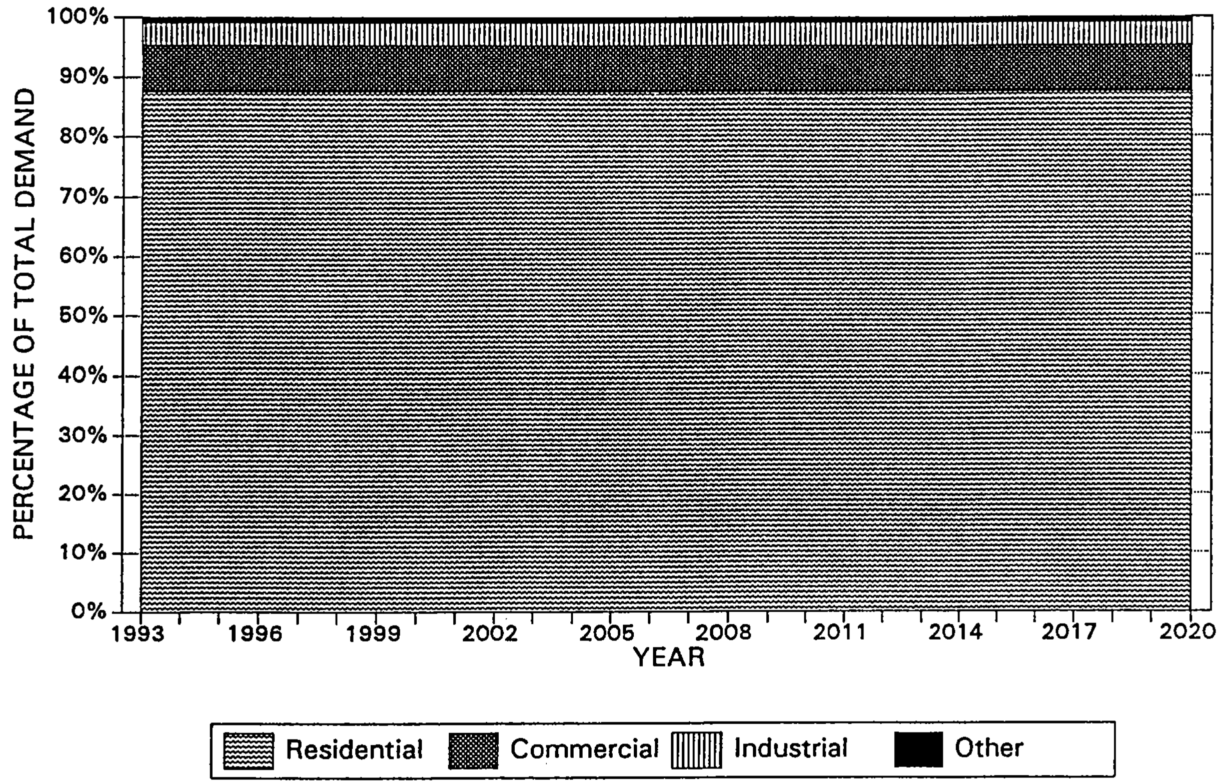
Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected Water Demand by User Class – Rosamond

November 1995
K/J 934620.00

Figure 5–3

Figure 5–3



Kennedy/Jenks Consultants

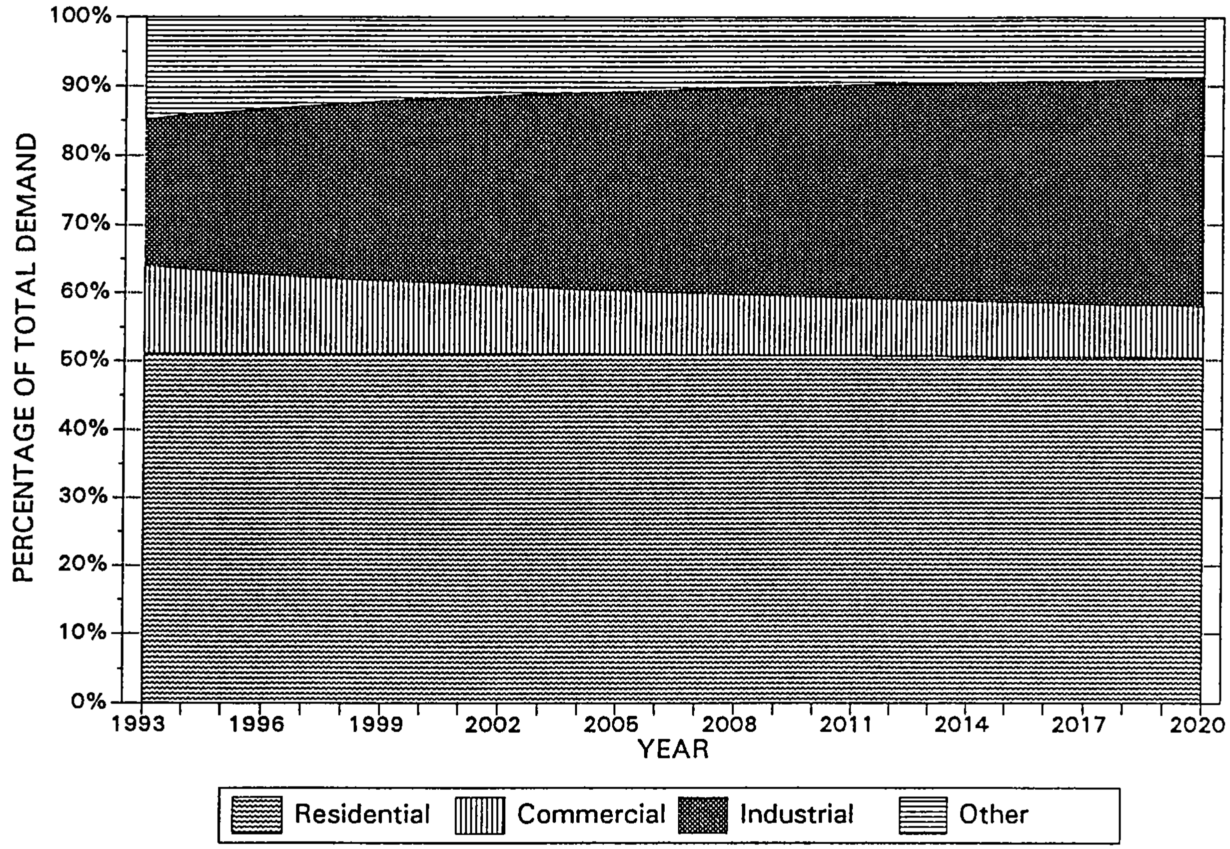
Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Breakdown by User Class – Palmdale

November 1995
K/J 934620.00

Figure 5–4

Figure 5–4



Kennedy/Jenks Consultants

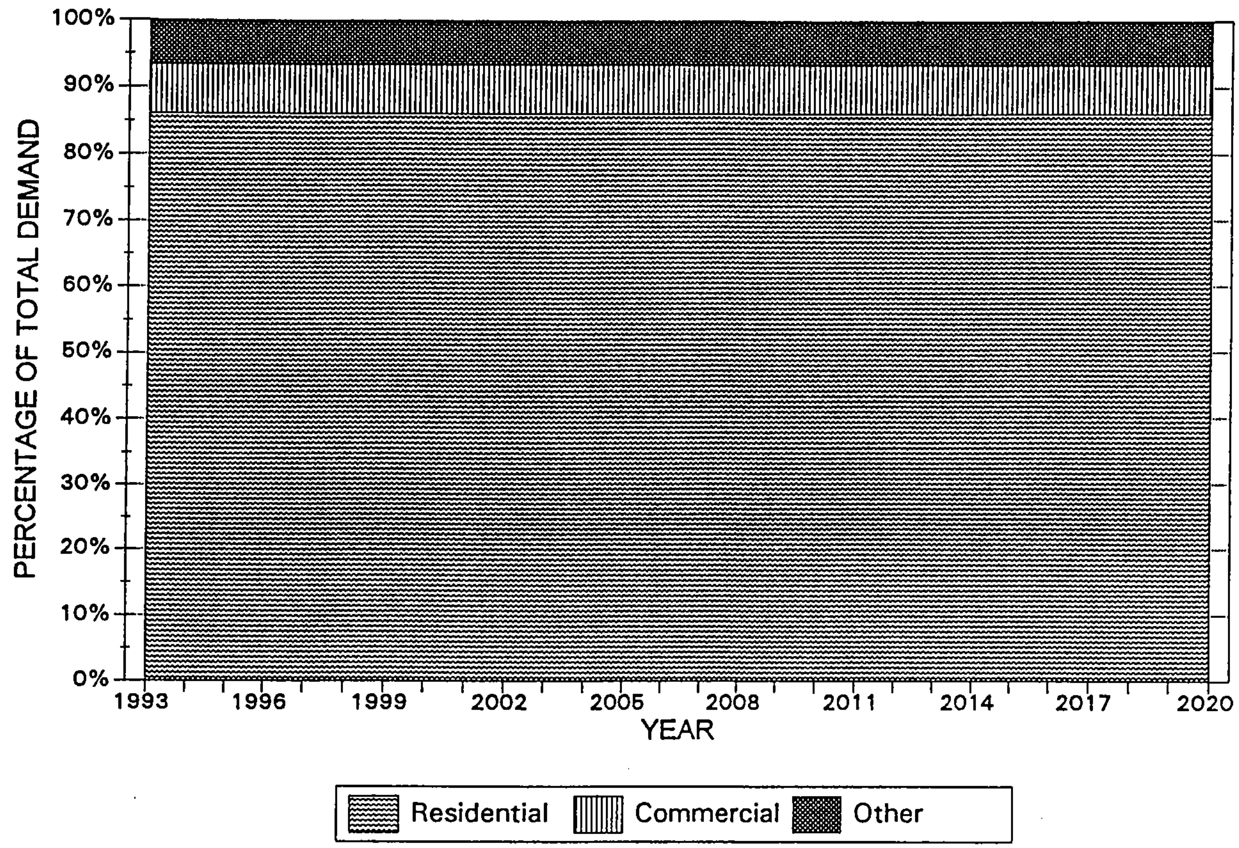
Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Breakdown by User Class – Lancaster

November 1995
K/J 934620.00

Figure 5–5

Figure 5–5



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Water Demand Breakdown by User Class – Rosamond

November 1995
K/J 934620.00

Figure 5–6

Figure 5–6

Agricultural Water Demands

As shown in Table 4-1, current and projected 2020 agricultural water uses in the Antelope Valley are approximately 58,700 acre-feet and 39,100 acre-feet, respectively. These water demands include agricultural farmlands identified as high potential reclaimed water users in Chapter 6. Because the reclaimed water supply is projected to significantly exceed the reclaimed water demands, and the disposal of treated wastewater (i.e. reclaimed water) is highly dependent on maintaining agricultural farmlands, water conservation opportunities do not include the farmlands that have been identified as high potential reclaimed water users. Therefore, current and projected agricultural water demands shown in Table 5-1 and on Figure 5-7 do not include farmlands identified as high potential users of reclaimed water.

WATER CONSERVATION MEASURES

The role of water conservation in water resources management has steadily increased in recent years. According to DWR, many water purveyors began incorporating water conservation into their planning in the early 1970s by distributing water-saving devices to their customers, providing public information and education programs, and implementing leak detection and repair programs. During the 1976-77 drought, more severe water conservation measures such as rationing and revised rate structures became commonplace. Because of its practical and economic values, many California water purveyors now regard water conservation as an integral part of their water supply planning. In addition to increased practice by water purveyors, a considerable amount of literature on water conservation has been published. Due to this increased attention, there is now a wide variety of effective water conservation measures available.

Urban Water Conservation Measures

Urban water conservation measures are identified in the September 1991 Memorandum of Understanding Regarding Urban Water Conservation in California and the Urban Water Management Planning Act.

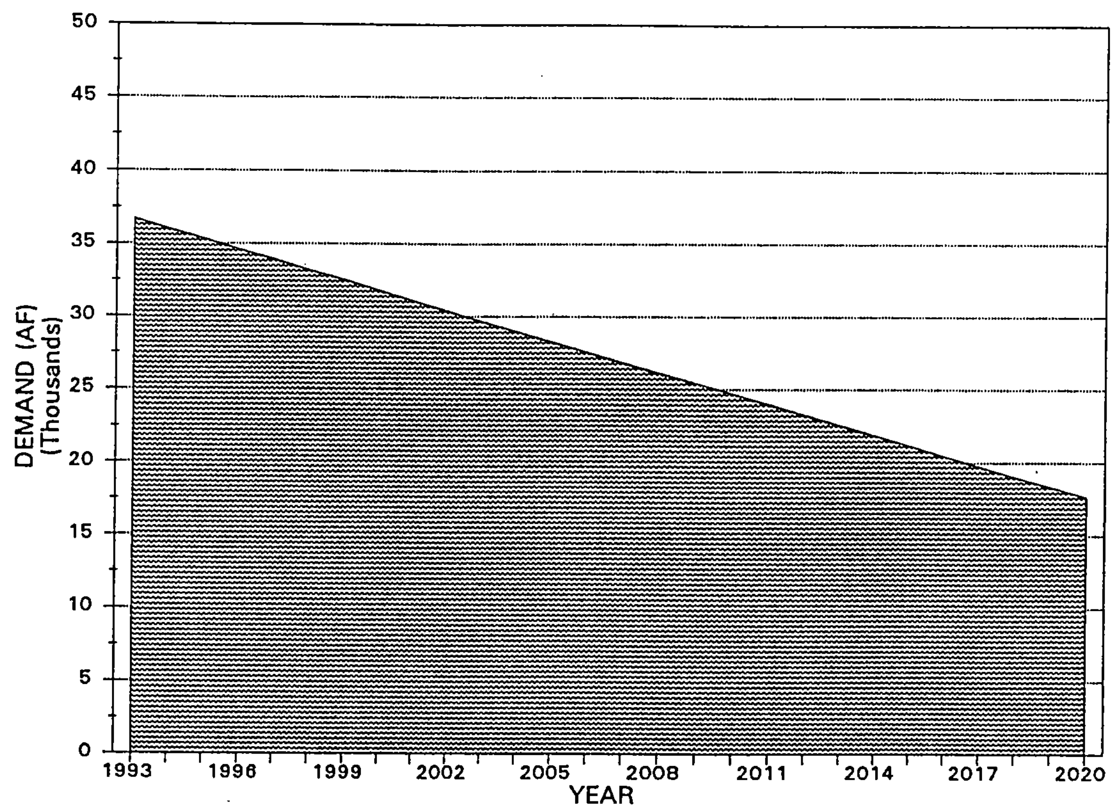
<u>Memorandum of Understanding</u>. The Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California was entered into in 1991 by urban water suppliers, public advocacy organizations and other interested groups who recognized the need for conservation due to increasing water demands for urban, agricultural and environmental uses. (Currently, none of the members of the Antelope Valley Water Group are signatories to the MOU.) Urban water conservation practices or Best Management Practices (BMPs) identified in the MOU are intended to reduce long-term urban water demands and are defined as a policy, program, practice, rule, regulation or ordinance or the use of devices, equipment or facilities which meets either of the following criteria:

TABLE 5-1

CURRENT AND PROJECTED AGRICULTURAL LAND AND WATER USE TO UNDERGO CONSERVATION PROGRAM

Crop	Acreage (1)	Net Annual Water Use (2) (inches)	Gross Annual Water Use (3) (acre-feet/acre)	Annual Water Demand (4) (acre-feet)
1993 Irrigated Crops				
Alfalfa	2,970	48.55	6.2	18,414
Pasture/Turf	720	41.18 (5)	5.3	3,816
Grain	260	10.73	1.4	364
Field Crops	32	10.73	1.4	45
Truck Crops	2,645	17.02	2.2	5,819
Deciduous Trees/Vines	2,165	29.67 (6)	3.8	8,227
Total	8,792			36,685
2020 Irrigated Crops				
Alfalfa	1,485 (7)	48.55	6.2	9,207
Pasture/Turf	360 (7)	41.18 (5)	5.3	1,908
Grain	130 (7)	10.73	1.4	182
Field Crops	16 (7)	10.73	1.4	22
Truck Crops	1,323 (7)	17.02	2.2	2,911
Deciduous Trees/Vines	900 (8)	29.67 (6)	3.8	3,420
Total	4,214			17,650

(1) From USGS 1994 draft report "Land Use and Water Use in the Antelope Valley, California", Table 1 without the estimated acreage identified as high potential reclaimed water users.
(2) From USDA Soil Conservation Service (SCS). Rainfall occuring during the growing season is assumed to be insignificant.
(3) Net annual water use divided by an irrigation efficiency factor of 0.65 and converted to acre-feet/acre.
(4) Acreage multiplied by the gross annual water use.
(5) Average of pasture and turf net annual water use as provided by SCS.
(6) Average of almonds, orchards, pecans, pistachios, and walnuts net annual water use as provided by SCS.
(7) Assumed to be half of the 1993 acreage.
(8) From USGS 1994 draft report, Table 1. Estimate provided to USGS by DWR.



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected Agricultural Water Demand

November 1995
K/J 934620.00

Figure 5–7

Figure 5–7

- An established and generally accepted practice among water suppliers that results in more efficient use or conservation of water.

- A practice for which sufficient data are available from existing water conservation projects to indicate that significant conservation or conservation related benefits can be achieved; that the practice is technically and economically reasonable and not environmentally or socially unacceptable; and that the practice is not otherwise unreasonable for most water suppliers to carry out.

The following is a list of the BMPs identified in the MOU. A description of each BMP is included in Appendix A.

- Interior and exterior water audits and incentive programs for single family residential, multi-family residential, and governmental/institutional customers.

- Plumbing, new and retrofit.

- Distribution system water audits, leak detection and repair.

- Metering with commodity rates for all new connections and retrofit of existing connections.

- Large landscape water audits and incentives.

- Landscape water conservation requirements for new and existing commercial, industrial, institutional, governmental, and multi-family developments.

- Public information.

- School education.

- Commercial and industrial water conservation.

- New commercial and industrial water use review.

- Conservation pricing.

- Landscape water conservation for new and existing single family homes.

- Water waste prohibition.

- Water conservation coordinator.

- Financial incentives.

- Ultra low flush toilet replacement.

In addition to identifying BMPs, the MOU also included Potential Best Management Practices (PBMPs). The intent of the MOU was to study and then determine whether or not the PBMP's met the criteria designated as BMPs. The following is a list of the PBMPs under study identified in the MOU:

- Rate structures and other economic incentives and disincentives to encourage water conservation.
- Efficiency standards for water using appliances and irrigation devices.
- Replacement of existing water using appliances (except toilets and showerheads whose replacements are incorporated as BMPs) and irrigation devices.
- Retrofit of existing car washes.
- Graywater use.
- Distribution system pressure regulation.
- Water supplier billing records broken down by customer class (e.g., residential, commercial, industrial).
- Swimming pool and spa conservation including covers to reduce evaporation.
- Restrictions or prohibitions on devices that use evaporation to cool exterior spaces.
- Point-of-Use water heaters, recirculating hot water systems and hot water pipe insulation.
- Efficiency standards for new industrial and commercial processes.

Urban Water Management Planning Act. As previously discussed, the Urban Water Management Planning Act requires urban water retailers supplying more than 3,000 acre-feet of water per year or serving more than 3,000 customers to prepare an UWMP to achieve conservation and efficient use of water. The Act requires the UWMP to evaluate water management practices identified below:

- Consumer education.
- Metering.
- Water saving fixtures and appliances.
- Pool covers.

- Lawn and garden irrigation techniques.
- Low water use landscaping.
- Internal and external water audits for single-family residential, multi-family residential, institutional, commercial, industrial, and governmental customers.
- Incentive programs to encourage customer audits and program participation.
- Distribution system water audits.
- Leak detection and repair.
- Large landscape water audits and incentives for conversion to water reuse.
- Financial incentives to encourage use of reclaimed water.
- Incentive programs to facilitate development of dual water systems for use of reclaimed water in new construction, for flushing toilets and urinals, landscaping, golf courses, cemeteries, irrigation, and other appropriate purposes.
- Plans to eliminate use of once-through cooling systems, non-recirculating water systems, and non-recycling decorative water fountains and to encourage recirculation of water if proper public health and safety standards are maintained.
- Wastewater reclamation.
- Exchanges or transfer of water on a short-term or long-term basis.
- Management of water system pressure and peak demands.
- Issues relevant to meter retrofitting for all uses
- Incentives to alter water use practices, including fixture and appliance retrofit programs.
- Changes in pricing, rate structure, and regulations.

A copy of the Urban Water Management Planning Act and subsequent amendments is included in Appendix B.

Agricultural Water Conservation Measures

Agricultural water conservation measures are identified in the DWR November 1993 draft "California Water Plan Update" (Bulletin 160) and are described below. A description of the Mobile Agricultural Water Conservation Laboratory program is also presented.

Bulletin 160. Bulletin 160 reports that programs offered through the University of California, California State Universities, local Resource Conservation Districts and the USDA have resulted in constant improvement in use of resources for agricultural productions in California. Through the collective efforts of these groups, DWR reports that irrigation efficiencies have increased and water requirements have decreased. As discussed previously, enactment of the Agricultural Water Suppliers Efficient Water Management Act in 1990 requires the DWR to establish an advisory committee to evaluate Efficient Water Management Practices (EWMPs) for agricultural water suppliers.

The following is a list of identified EWMPs:

- Improve water measurement and accounting.
- Conduct irrigation efficiency studies.
- Provide farmers with "normal-year" and "real time" irrigation, scheduling and crop evapotranspiration (ET) information.
- Monitor surface water qualities and quantities.
- Monitor soil moisture.
- Provide on-farm irrigation system evaluations.
- Monitor quantity and quality of drainage waters.
- Evaluate and improve water user pump efficiencies.
- Designate a water conservation coordinator.
- Improve the condition and type of flow measuring devices.
- Automate canal structures.
- Line or pipe ditches and canals.
- Modify distribution facilities to increase the flexibility of water deliveries.
- Construct or line regulatory reservoirs.

Riverside-Corona Resources Conservation District

The Riverside-Corona Resource Conservation District's (RCRCD) "Irrigation Water Management on Agricultural Lands" dated March 1993 reported that data gathered from field tests show that agricultural irrigators can save 20 to 50 percent in water costs if recommendations and adjustments provided by the Mobile Lab program are implemented. The report estimated that 600 to 1,200 acre-feet of water has been saved each year over the past 5 years, resulting in $210,000 to $420,000 savings each year by local irrigators in western Riverside County. More than 200 farmers and ranchers have used the Mobile Lab to troubleshoot system problems and make scheduling recommendations, and over 400 evaluations on 10,000 acres have been completed by the RCRDC Mobile Lab. Over 2,300 evaluations have been completed by Mobile Labs throughout California.

Pond-Shafter-Wasco Resource Conservation District

Estimates provided by the Pond-Shafter-Wasco Resource Conservation District indicate that approximately 1,500 acre-feet of water could be saved on 6,642 acres of farmland if the irrigation systems were operating more efficiently. The water savings is based on averages over a six year period and is regarded as potential savings from implementation of the recommendations and adjustments provided by the Mobile Lab Program.

A.A. Naumann, Inc

The Regional Water Quality Control Board, Resource Conservation District, United Water Conservation District, Pleasant Valley County Water District, City of Oxnard, Casitas Municipal Water District and the Association of Water Agencies of Ventura County are participating agencies in a pilot project involving testing of underground reusable drip irrigation tape for row crops on the A.A. Naumann Ranch in Ventura County. Most row crops grown in Ventura County are furrow or furrow/sprinkler irrigated, which is reported to be less efficient than buried drip irrigation for the application of water, fertilizers and pesticides. The drip irrigation resulted in a 66 percent savings in water per acre compared to furrow irrigation (2.3 acre-feet versus 7 acre-feet), while product yield increased by almost 10 percent. Pesticide use declined by 33 percent. Savings through reduction of fertilizer, pesticide and water use, accompanied by increases in production yield resulted in a good initial return on the investment of the underground drip irrigation system.

RECOMMENDED WATER CONSERVATION PROGRAMS

This section briefly describes the measures recommended for inclusion in the water conservation plan for the Antelope Valley. Because agricultural water use is expected to decline significantly during the planning period (1994-2020), the plan consists primarily of urban conservation programs developed for the City of Palmdale, City of Lancaster and Community of Rosamond. A brief discussion on the agricultural water conservation program is included in the overall plan for the Antelope Valley. Evaluation of urban water conservation measures was performed utilizing the DWR's Water Plan computer software. Benefit to cost (B/C) analyses were performed for each recommended urban water conservation measure to determine cost effectiveness. A discussion on the B/C analyses as well as an implementation plan for each water conservation measure is also included.

City of Palmdale

Table 5-2 identifies the conservation measures recommended for the City of Palmdale. The water conservation program for Palmdale consists of 6 measures: 2 existing and 4 potential. The two existing measures, Ultra Low-Flush Toilet Ordinance for New Residential and Standards for New Large Landscapes, are measures established in regulations previously described. The 4 potential conservation measures recommended for consideration by the City of Palmdale are described below.

<u>Retrofit Kit Program</u>. This program involves the provision of fixture retrofit kits to 5,900 housing units built prior to 1980. The measure is intended to reduce residential water consumption by eliminating some of the high water using fixtures typically found in older housing units (pre-1980). The kits include the following:

- Two toilet tank displacement dams to reduce the volume of water used by non-conserving toilets.
- Two leak detection tablet packets to identify equipment-related leakage in residential toilets.
- One ultra-low flow showerhead to achieve water savings through replacement of one non-conserving showerhead.

<u>Information and Education, Residential</u>. This program is designed to increase customer "water" awareness and promote understanding of local community water conservation projects. The program may involve in-school education by providing educators with a water conservation curriculum, a teacher training workshop and/or through water conservation assemblies. Information may be disseminated to the public through bill stuffers, brochures, print media, television, etc. The information packages may include the following:

- Information on water-wise versus water-wasteful practices designed to increase customer awareness of indoor and outdoor water use.

- Lawn watering guides to provide customers with easy to follow instructions on how to determine the appropriate watering time required to adequately irrigate their own turfgrass.

- Information on "Xeriscape principles" to increase customer awareness of water-saving techniques that may be implemented in residential landscapes.

TABLE 5-2

SELECTED URBAN WATER CONSERVATION MEASURES

Area	*Measure*
City of Palmdale	• Ultra Low-Flush Toilet Ordinance, New Residential • Standards for New Large Landscapes • Retrofit Kit Program • Information and Education, Residential • Seasonal Rates, Residential • Uniform or Increasing Block Rates, Residential
City of Lancaster	• Ultra Low-Flush Toilet Ordinance, New Residential • Standards for New Large Landscapes • Information and Education, Residential • Residential Water Audit and Retrofit Kit • Seasonal Rates, Residential • Seasonal Rates, Commercial • Seasonal Rates, Industrial • Uniform or Increasing Block Rates, Residential • Uniform or Increasing Block Rates, Commercial • Uniform or Increasing Block Rates, Industrial • Large Turf Irrigation Audits
Community of Rosamond	• Ultra Low-Flush Toilet Ordinance, New Residential • Standards for New Large Landscapes • Seasonal Rates, Residential • Uniform or Increasing Block Rates, Residential • System Water Audit, Leak Detection, and Repair • Residential Retrofit Kit

Seasonal Rates, Residential. This program involves implementation of higher water rates during peak water use periods and is intended to encourage customers to conserve water during summer months when consumption is high due to landscape irrigation requirements.

Uniform or Increasing Block Rates, Residential. This program involves implementation of a modified rate schedule to charge the same amount for each unit of water sold (uniform) or more per unit of water as consumption rises (increasing block). The program is intended to encourage customers to use water conserving practices and devices in order to avoid higher per unit water charges associated with increased water use.

Implementation of the Ultra-Low-Flush Toilet Ordinance and the Standards for New Large Landscapes will be the responsibility of the City of Palmdale. Implementation of the Seasonal and Block Rates will be the responsibility of the individual water purveyors. The Retrofit Kits and Information and Education measure can be implemented by both the City and the individual water purveyors.

Total water savings during the planning period (1994-2020) are estimated to be 225,800 acre-feet. The B/C ratio of the plan is 4.7. Figure 5-8 depicts projected water demand with and without the water conservation program recommended for the City of Palmdale.

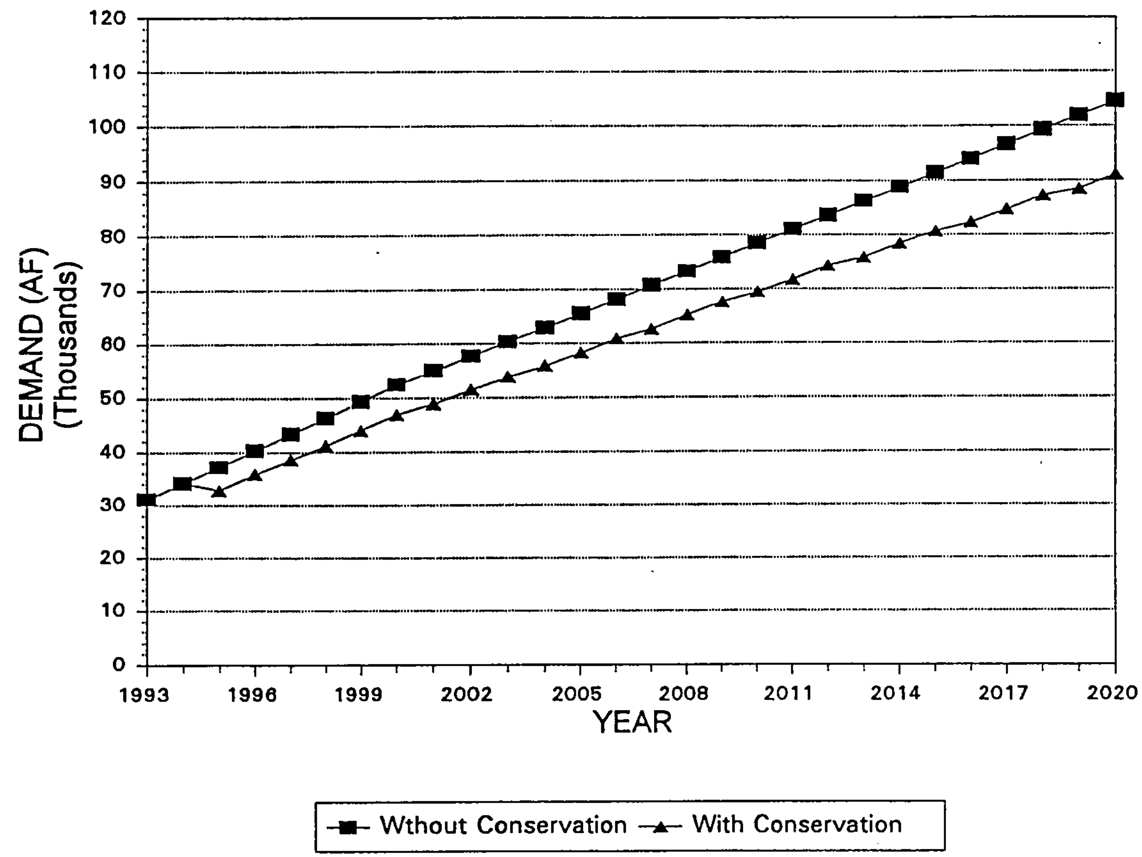
City of Lancaster

Table 5-2 identifies the conservation measures recommended for the City of Lancaster. The water conservation program for Lancaster consists of 11 measures: 2 existing and 9 potential. The two existing measures are the Ultra Low-Flush Toilet Ordinance for New Residential and Standards for New Large Landscapes, established in regulations described previously. Because commercial and industrial users comprise a large percentage of water demand in Lancaster as shown on Figure 5-5, commercial and industrial conservation programs are recommended for the City. The 9 potential conservation measures recommended for consideration by the City of Lancaster are described below.

Information and Education, Residential. Discussed under "City of Palmdale."

Residential Water Audit and Retrofit Kit. This program is conducted at the request of the homeowner and usually involves the following:

- Identification and discussion of water uses with the homeowner.
- Offer to install low-flow showerheads, tank displacement dams, and faucet aerators, and check for toilet leaks using leak detection tablets.
- Repair of toilet leaks if detected.
- Provision of guides and information on additional water conserving actions and lawn watering.



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

**Projected Water Demand
with Conservation
Palmdale**

November 1995
K/J 934620.00

Figure 5–8

Figure 5–8

Availability of free water audits is promoted through the public information program as an incentive for homeowners to request them.

Seasonal Rates, Residential, Commercial, Industrial. Discussed under "City of Palmdale."

Uniform or Increasing Block Rates, Residential, Commercial, Industrial. Discussed under "City of Palmdale."

Large Turf Irrigation Audits. This program involves prioritizing existing commercial and multi-family sites according to irrigated acreage and past water use. Targeted customers are sent an audit program letter and commercial irrigation guides. The actual audit involves the following:

- Production of a customized irrigation schedule for the customer.
- Audit follow-up including provision of weather information for updated schedules.

The intent of the program is to enable landscape managers to do timely equipment maintenance and to efficiently apply water for irrigation throughout the year.

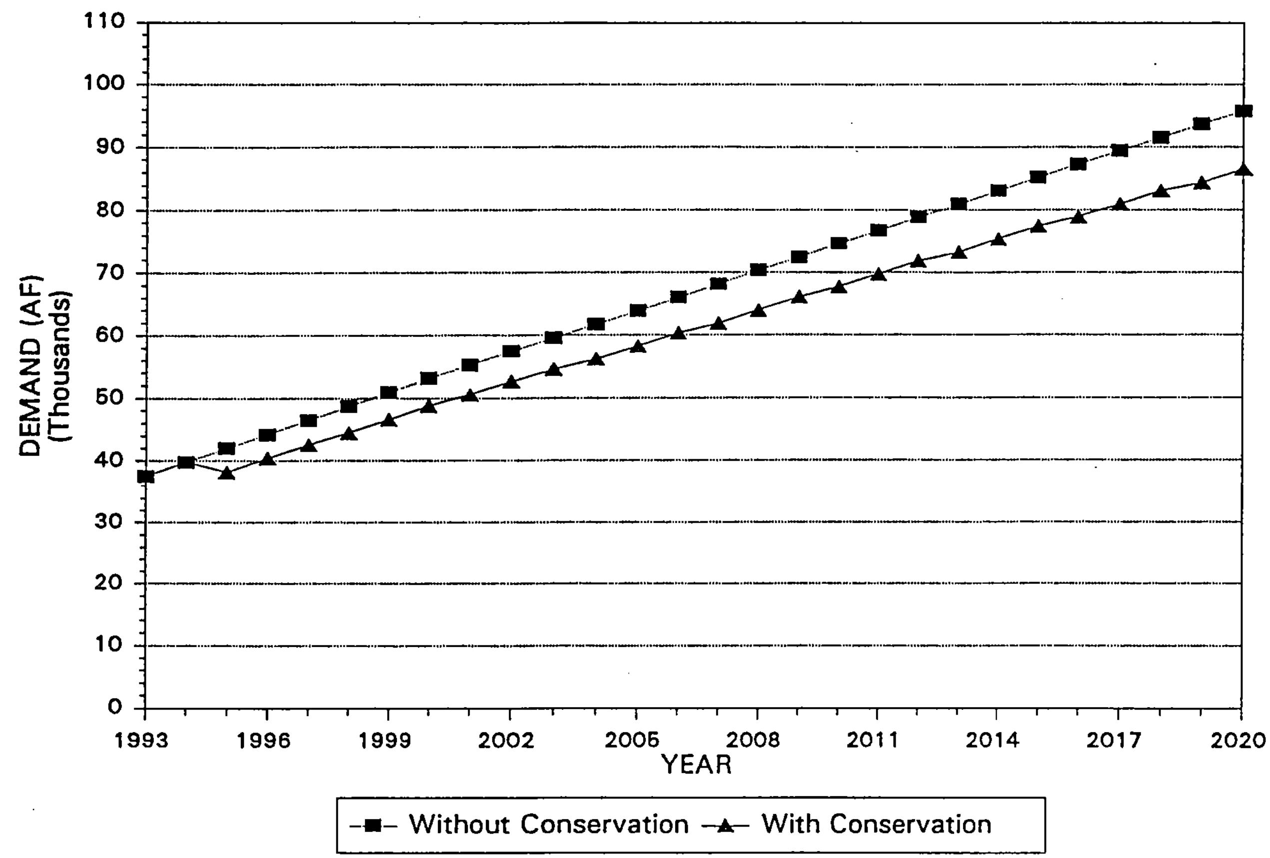
Implementation of the Ultra-Low-Flush Toilet Ordinance and the Standards for New Large Landscapes will be the responsibility of the City of Lancaster. Implementation of the Seasonal and Block Rates and the Large Turf Audits will be the responsibility of the individual water purveyors. The Retrofit Kits and Information and Education measure can be implemented by both the City and the individual water purveyors.

Total water savings during the planning period (1994 to 2020) are estimated to be 170,100 acre-feet. The B/C ratio of the plan is 3.0. Figure 5-9 depicts projected water demand with and without the water conservation program recommended for the City of Lancaster.

Community of Rosamond

Table 5-2 identifies the conservation measures recommended for the Community of Rosamond. The water conservation program for Rosamond consists of 6 measures: 2 existing and 4 potential. The two existing measures, Ultra Low-Flush Toilet Ordinance for New Residential and Standards for New Large Landscapes, are measures established in regulations previously described. The 4 potential conservation measures recommended for consideration by the Community of Rosamond are described below.

Seasonal Rates, Residential. Discussed under "City of Palmdale."



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected Water Demand with Conservation Lancaster

November 1995
K/J 934620.00

Figure 5-9

Figure 5-9

Uniform or Increasing Block Rates, Residential. Discussed under "City of Palmdale."

System Water Audit, Leak Detection, and Repair. This program involves an audit of the distribution system by the agency to determine the amount of water that is unaccounted for through inaccurate meter readings, malfunctioning valves, leakage and theft, subsequently leading to a repair program. The water audits are done once a year. DWR estimates that water savings from actions taken following a water audit can vary from 3 to 30 percent.

Residential Retrofit Kit. This program involves the provision of fixture retrofit kits to 3,000 housing units. The measure is intended to reduce residential water consumption by eliminating some of the high water using fixtures. The kits include the following:

- Lawn watering guides to provide customers with easy to follow instructions on how to determine the appropriate watering time required to adequately irrigate his or her own turfgrass.

- Two toilet tank displacement dams to reduce the volume of water used by non-conserving toilets.

- Two leak detection tablet packets to identify equipment-related leakage in residential toilets.

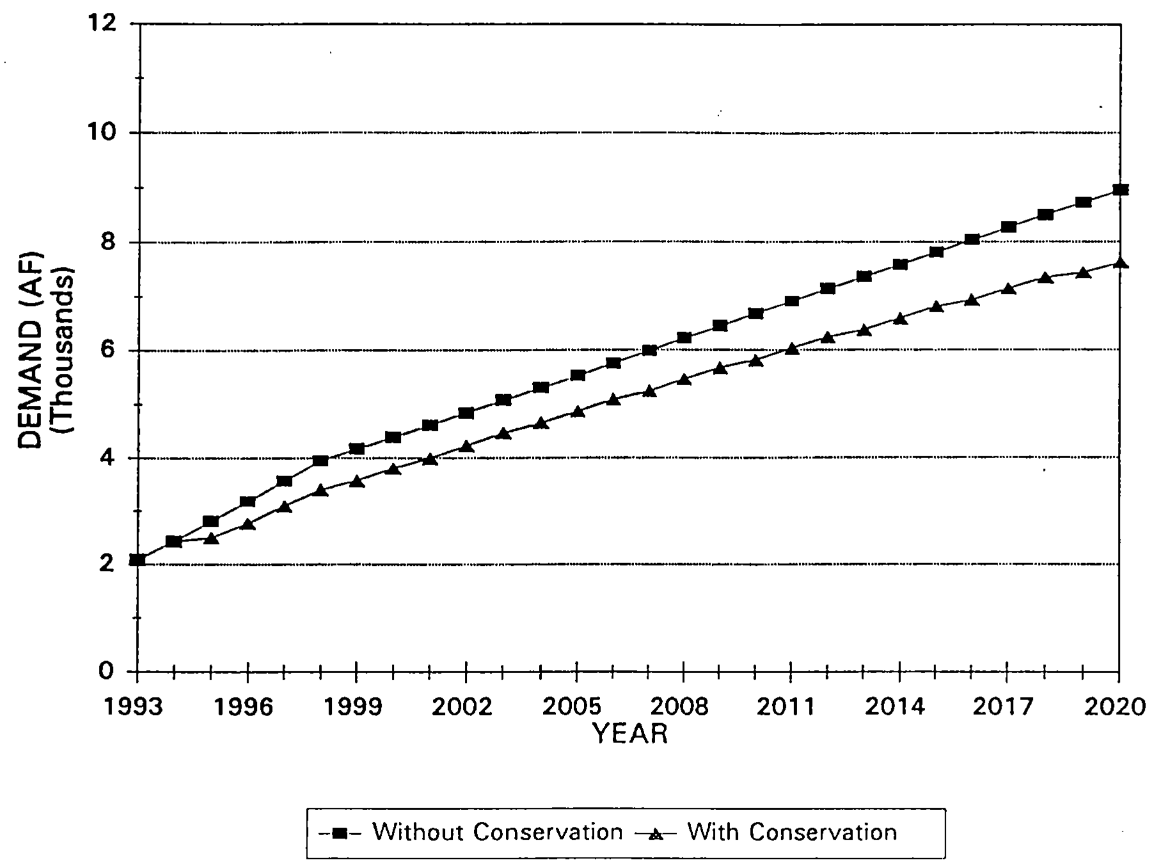
- One ultra-low flow showerhead to achieve water savings through replacement of one non-conserving showerhead.

- One faucet aerator to reduce water use.

Implementation of the Ultra-Low-Flush Toilet Ordinance and the Standards for New Large Landscapes will be the responsibility of the County of Kern. Implementation of the Seasonal and Block Rates and the System Water Audit will be the responsibility of the individual water purveyors. The Retrofit Kits can be implemented by both the County and the individual water purveyor.
Total water savings during the planning period (1994 to 2020) are estimated to be 21,700 acre-feet. The B/C ratio of the plan is 4.5. Figure 5-10 depicts projected water demand with and without the water conservation program recommended for the Community of Rosamond.

Benefit to Cost Analyses

Water conservation programs described above were evaluated utilizing the DWR Water Plan software. The Water Plan software allows the user to input specific information applicable to each service area. This information includes:



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected Water Demand with Conservation Rosamond

November 1995
K/J 934620.00

Figure 5-10

Figure 5-10

- water consumption
- water rates
- marginal cost of water
- electric rates and marginal cost
- natural gas rates and marginal cost
- sewer rates and marginal cost

The software then allows the user to select or design water conservation programs for analysis.

After a program is selected, information pertaining to each measure within the program is input. This information includes:

- Number of items delivered by year over the study period.

- Responsible party for the capital, installation, and operation and maintenance costs.

- Percentage of people expected to participate.

Once the service area and measure information are input, the B/C analysis can be run. The B/C ratio is the ratio of the present value of benefits to the present value of costs resulting from water conservation measures. An investment is cost-effective when the ratio of the present value of benefits to the present value of costs (or B/C) exceeds 1.0. Benefits of water conservation are calculated by estimating water savings from each program which are multiplied by the value of water; yielding the estimated benefits from water conservation in dollars. Costs of water conservation include device and administrative costs associated with each conservation measure. Device costs include capital, installation, and operation and maintenance. Administrative costs include salaries of personnel associated with conservation, delivery, incentive payments, and advertising.

Results of the B/C analyses for the conservation measures analyzed for each area are summarized in Table 5-3. The overall B/C ratios for the City of Palmdale, City of Lancaster, and Community of Rosamond were calculated to be 4.7, 3.0, and 4.5 respectively.

Agricultural Water Conservation Program

As discussed previously, the Agricultural Water Suppliers Efficient Water Management Practices Act requires the DWR to establish an advisory committee to evaluate EWMPs aimed at agricultural water suppliers concerning conservation of irrigation water. Because the evaluation of the EWMPs will require detailed planning by each water agency and will include analysis of technical feasibility, social and district economic criteria and legal feasibility of each practice, an assessment of the impact of implementation of EWMPs (i.e., costs and water savings) is not currently available through the DWR.

TABLE 5-3

BENEFIT TO COST RATIO SUMMARY

Program	*Agency*
City of Palmdale	
• Ultra Low-Flush Toilet Ordinance, New Residential (1)	0.1
• Standards for New Large Landscapes (1)	1.4
• Retrofit Kit Program	1.9
• Information and Education, Residential	1.8
• Seasonal Rates, Residential	327.4
• Uniform or Increasing Block Rates, Residential	545.6
Total	4.7
City of Lancaster	
• Ultra Low-Flush Toilet Ordinance, New Residential (1)	2.5
• Standards for New Large Landscapes (1)	2.7
• Information and Education, Residential	2.6
• Residential Water Audit and Retrofit Kit	2.6
• Seasonal Rates, Residential	3.1
• Seasonal Rates, Commercial	3.0
• Seasonal Rates, Industrial	3.0
• Uniform or Increasing Block Rates, Residential	3.1
• Uniform or Increasing Block Rates, Commercial	3.0
• Uniform or Increasing Block Rates, Industrial	3.1
• Large Turf Irrigation Audits	2.9
Total	3.0
Community of Rosamond	
• Ultra Low-Flush Toilet Ordinance, New Residential (1)	2.1
• Standards for New Large Landscapes (1)	1.1
• Seasonal Rates, Residential	3.3
• Uniform or Increasing Block Rates, Residential	3.3
• System Water Audit, Leak Detection, and Repair	21.0
• Residential Retrofit Kit	2.1
Total	4.5

(1) Existing regulations

In addition, due to all the variables associated with agriculture (i.e., crop type, soil type, acreage, irrigation system, management, etc.), it may be difficult to produce a software program that will provide B/C ratios for agricultural measures similar to DWR's Water Plan for urban conservation measures which uses typical values for costs and water savings obtained from historical information. Therefore, until DWR's assessment of the EWMPs is complete, analyses of potential agricultural conservation measures for the Valley cannot be provided. However, based on the available case studies, an agricultural water conservation program can be recommended on a preliminary basis. It is recommended that a Mobile Lab program be established to serve agricultural areas in the Antelope Valley. Although the RCRCD 1993 report reported a potential 20 to 50 percent water savings through the Mobile Lab program, for purposes of this report, a conservative estimate of 10 percent is used. This estimate results in total water savings during the planning period (1995-2020) of 68,800 acre-feet. Figure 5-11 depicts the projected agricultural water demands with and without the Mobile Lab program.

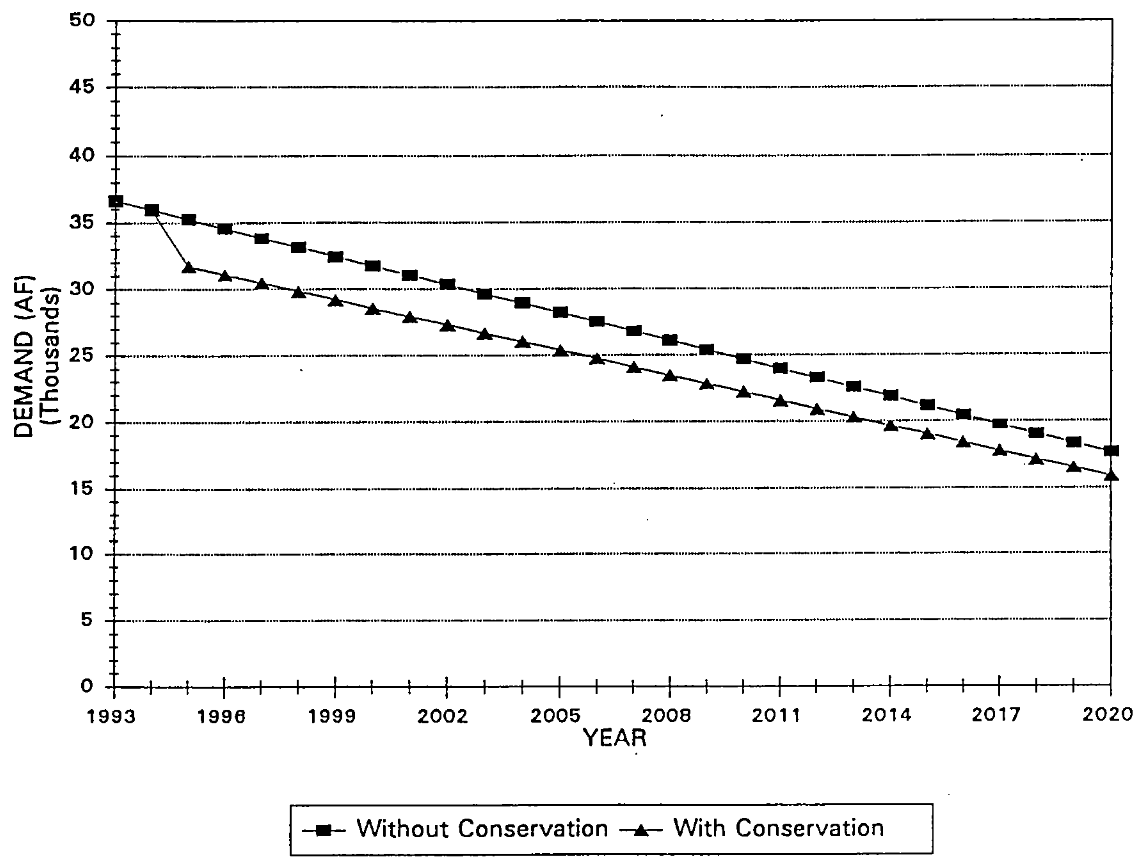
Implementation Schedule

An implementation schedule as well as the estimated water savings for each conservation measure described above is shown in Table 5-4. Implementation of the urban conservation measures is assumed to begin in 1994 and continue through the year 2020. Estimated water savings from the urban measures range from 0.67 to 87,356 acre-feet for the City of Palmdale, 0.34 to 43,775 acre-feet for the City of Lancaster, and 0.34 to 7,821 acre-feet for the Community of Rosamond. The estimated water savings is shown as the total amount of water saved over the entire implementation period (1994 to 2020). Implementation of the agricultural conservation measure is assumed to begin in 1995 and continue through the year 2020. Estimated water savings for the agricultural measure is 68,800 acre-feet over the entire implementation period (1995 to 2020).

It is important to note that a cooperative attitude from all agencies involved may help to contribute to the success of implementation of the conservation program.

EFFECTS OF WATER CONSERVATION ON WATER SUPPLY AND DEMAND

Figure 5-12 depicts the medium water demand with and without implementation of conservation measures and projected supply estimates at the 50, 80, and 90 percent probability levels. The most optimistic supply assumption (i.e., delivery of 100 percent of available water supplies) is also shown. Figure 5-12 is identical to Figure 4-16 with one exception: a second demand curve is provided to show the affect on the projected water demands from implementation of the conservation program discussed in this chapter. As shown on Figure 5-12, without exceeding groundwater extractions of 59,100 acre-feet per year, the probability of meeting the estimated 1993 water demand is approximately 73 percent. Without a conservation program, by the year 1998 (projected population of 451,000), 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2000 (projected population of 499,000), 100 percent of the



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected Water Demand
with Conservation
Agricultural

November 1995
K/J 934620.00

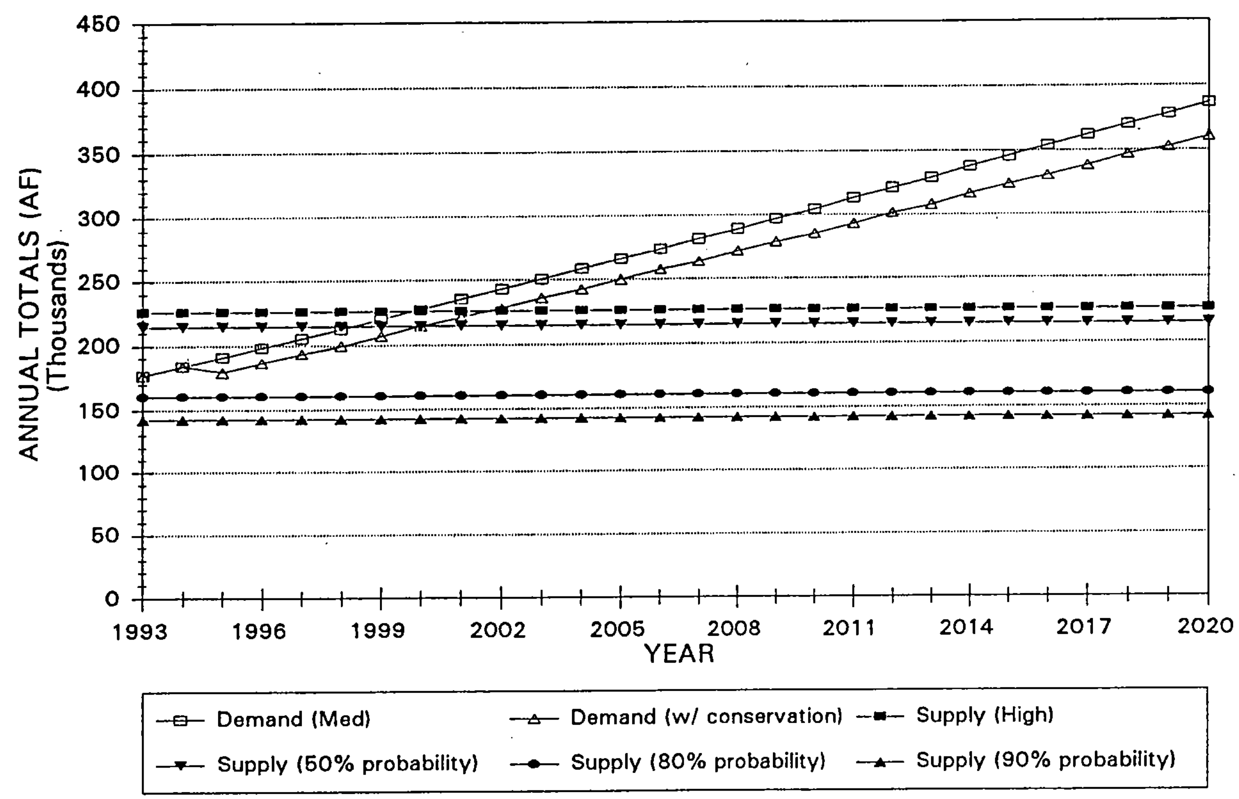
Figure 5–11

TABLE 5-4

IMPLEMENTATION SCHEDULE
AND ESTIMATED WATER SAVINGS

Conservation Measure	*Implementation Years*	*Estimated Water Savings (acre-feet)*
City of Palmdale		
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	1994-2020	0.67
• Standards for New Large Landscapes [1]	1994-2020	40
• Retrofit Kit Program	1994-2020	7,357
• Information and Education, Residential	1994-2020	78,642
• Seasonal Rates, Residential	1994-2020	52,415
• Uniform or Increasing Block Rates, Residential	1994-2020	87,356
Total		225,811
City of Lancaster		
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	1994-2020	0.34
• Standards for New Large Landscapes [1]	1994-2020	80
• Information and Education, Residential	1994-2020	25,233
• Residential Water Audit and Retrofit Kit	1994-2020	1,245
• Seasonal Rates, Residential	1994-2020	43,775
• Seasonal Rates, Commercial	1994-2020	6,575
• Seasonal Rates, Industrial	1994-2020	10,927
• Uniform or Increasing Block Rates, Residential	1994-2020	43,775
• Uniform or Increasing Block Rates, Commercial	1994-2020	10,961
• Uniform or Increasing Block Rates, Industrial	1994-2020	18,210
• Large Turf Irrigation Audits	1994-2020	9,325
Total		170,106
Community of Rosamond		
• Ultra Low-Flush Toilet Ordinance, New Residential [1]	1994-2020	0.34
• Standards for New Large Landscapes [1]	1994-2020	40
• Seasonal Rates, Residential	1994-2020	5,694
• Uniform or Increasing Block Rates, Residential	1994-2020	5,694
• System Water Audit, Leak Detection, and Repair	1994-2020	7,821
• Residential Retrofit Kit	1994-2020	2,496
Total		21,745
Agricultural • Mobile Lab Program	1995-2020	68,800
Grand Total		486,462

(1) Existing regulations



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Supply and Projected Demand
(Includes Conservation)

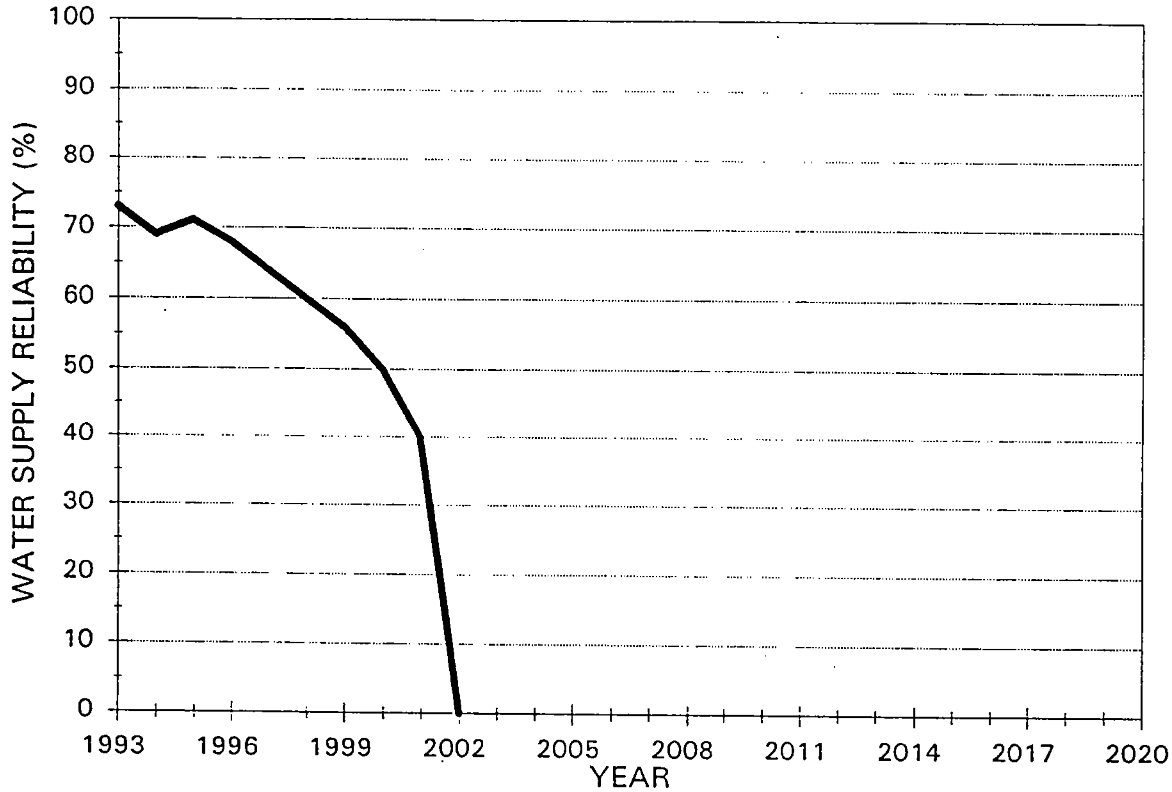
November 1995
K/J 934620.00

Figure 5-12

Figure 5-12

potential water supplies would be required to meet the water demand. With a conservation program, by the year 2000, 100 percent of the water demand is estimated to be met only 50 percent of the time and by the year 2002 (projected population of 547,000), 100 percent of the potential water supplies would be required to meet the water demand.

Figure 5-13 is based upon Figure 5-12 and shows the probable operating level of available water supplies. As shown in Figure 5-13, the water supply reliability is expected to decrease. By the year 2002, assuming that overdrafting of the groundwater basin does not occur, it is anticipated that the water demands will exceed the available supplies. This means that the probability of meeting 100 percent of the water demands is zero.



NOTE: RELIABILITY IS BASED ON NOT EXCEEDING GROUNDWATER EXTRACTIONS OF 59,100 AF/YR.

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Reliability of Available Water Supplies (Includes Conservation)

November 1995
K/J 934620.00

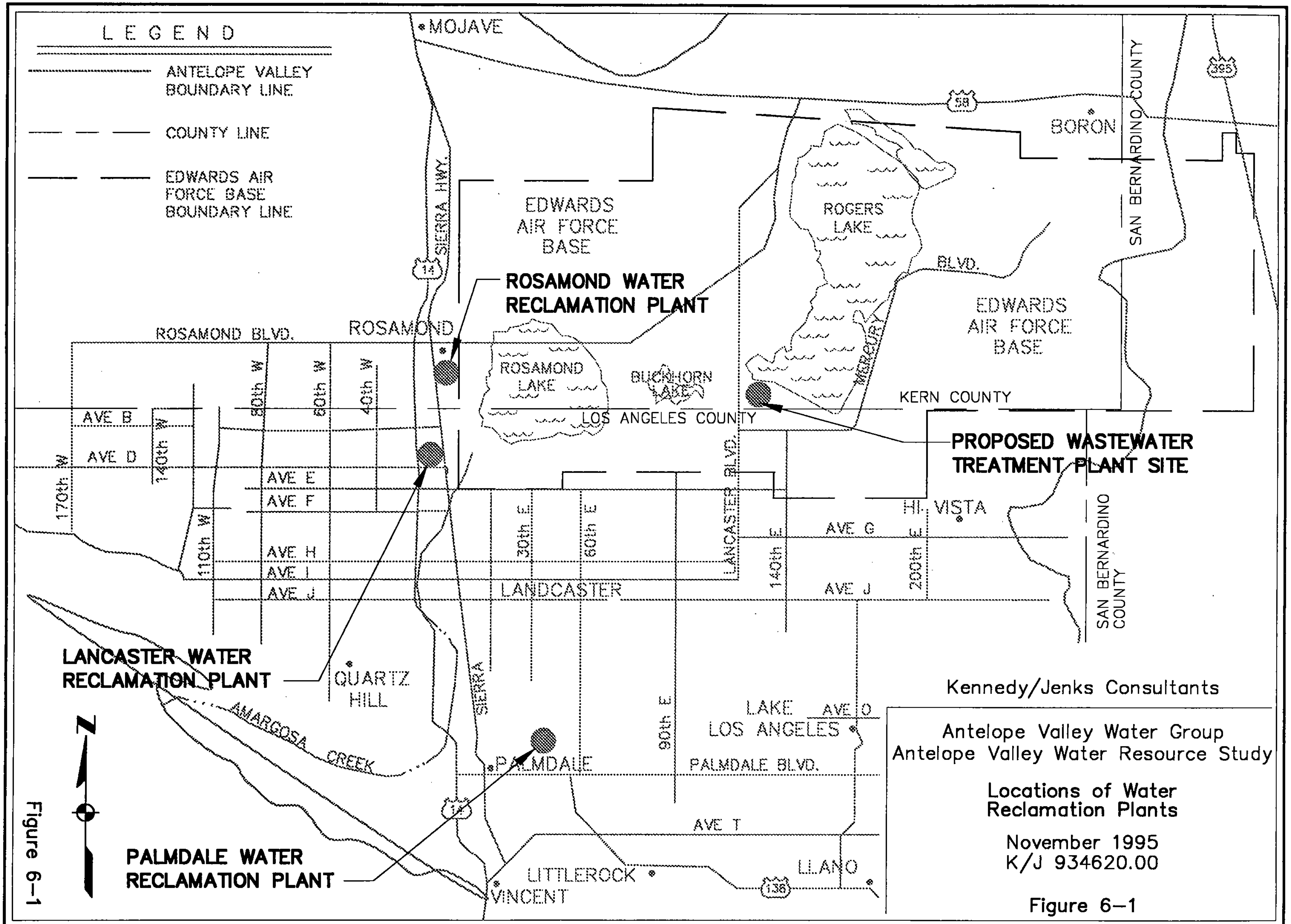
Figure 5–13

TABLE 6-1

EXISTING WASTEWATER FACILITIES IN THE ANTELOPE VALLEY

Facility Name	*Areas Served*	*Current Plant Conditions*			*Planned Plant Conditions*			
		Flow (mgd)	*Capacity (mgd)*	*Treatment Level*	*Flow (mgd)*	*Capacity (mgd)*	*Expected Year*	*Treatment Level*
Palmdale WRP	Palmdale	7.4	8.0	Secondary	9.5	15.0	1994	Secondar y
Lancaster WRP	Lancaster Quartz Hill	8.4	10.0	Secondary Tertiary	12.9	16.0	1995	Secondar y Tertiary
Rosamond WRP	Rosamond	0.8	2.0	Primary	1.0	2.0	1996	Tertiary
Edwards AFB WRP	Edwards AFB	1.7	1.5	Primary	1.8	2.5	1995	Tertiary
Mojave WRP	Mojave	0.4	0.6	Secondary	No current plans for expansions			
Plant 42 WRP	U.S. Air Force	0.25	1.0	Primary	No current plans for expansions			
Desert Lake WRP	Desert Lake	0.08	0.14	Primary	No current plans for expansions			
Boron WRP	Boron	0.12	0.21	Primary	No current plans for expansions			
Edwards AFB Missile Test Site WWTF	Edwards AFB	0.05	0.06	Primary	No current plans for expansions			
Edwards AFB N. Base Research WWTF	Edwards AFB	0.075	0.125	Primary	No current plans for expansions			
Boron Federal Prison WWTF	Boron Federal Prison	0.01	0.017	Primary	No current plans for expansions			

mgd = million gallons per day
WRP = water reclamation facility
WWTF = wastewater treatment facility



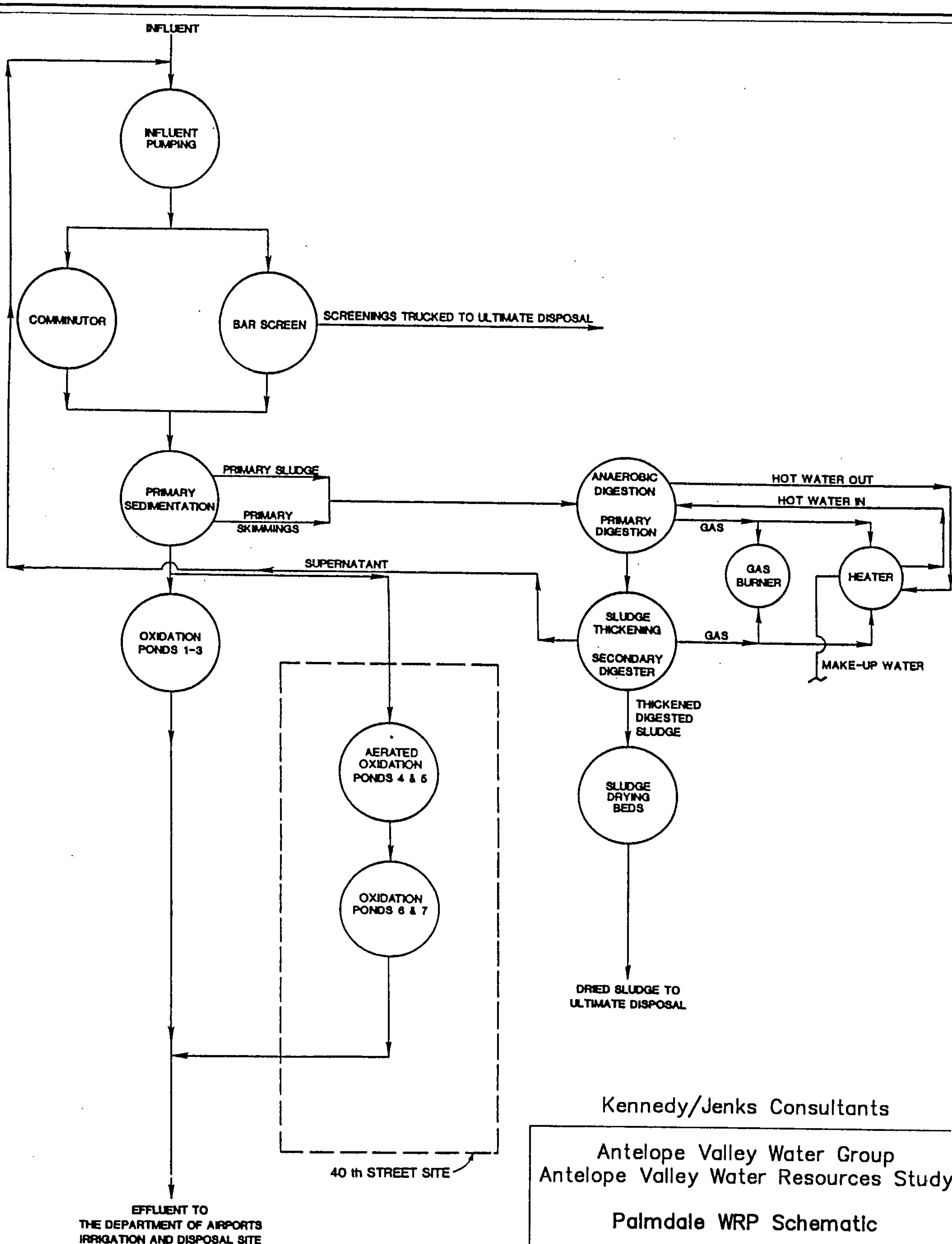
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Locations of Water Reclamation Plants

November 1995
K/J 934620.00

Figure 6-1



Source: County Sanitation Districts of Los Angeles County

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Palmdale WRP Schematic

November 1995
K/J 934620.00

Figure 6-2

plant's flow is treated to a secondary treatment level. Total capacity of the plant is 10.0 mgd. A schematic of the plant's process is presented on Figure 6-3. Undisinfected secondary effluent from the WRP is used for irrigating farmland at Nebeker Ranch. Tertiary quality effluent is used at Apollo Lakes County Parks for lake and irrigation use. The remaining effluent is disinfected and then discharged to Paiute Ponds. To accommodate anticipated growth in the Antelope Valley, CSDLAC is planning to expand the plant to a capacity of 16.0 mgd in 1995.

Rosamond WRP. Rosamond Community Services District (RCSD) operates a wastewater treatment plant located approximately 0.5 miles east of the Southern Pacific Railroad and approximately 1 mile north of the Kern County/Los Angeles County border. The Rosamond WRP is a 2.0 mgd primary treatment facility. Effluent from the Rosamond WRP is currently discharged to evaporation ponds. RCSD is planning to convert the existing system to a 2.0 mgd tertiary treatment facility in 1996.

Edwards AFB WRP. Edwards AFB operates a wastewater treatment plant located approximately 2 miles east of Lancaster Boulevard and approximately 1/4 mile north of the South Base well fields. The Edwards AFB WRP is a 1.5 mgd primary treatment facility. Effluent from the plant is currently discharged to evaporation ponds. Edwards AFB is designing a 2.5 mgd tertiary treatment facility scheduled to be constructed in 1995.

Wastewater Flow

Historic Flows. Average daily flow rates for the WRPs during the period from 1970 through 1992 are summarized in Table 6-2 and depicted on Figures 6-4 through 6-7. Average daily flow rates at all four plants have been steadily increasing over the past several years. Palmdale WRP's average flow of 7.9 mgd in 1991 approached the average daily flow design capacity of 8.0 mgd. Average daily flow rates of 1.7 mgd at the Edwards WRP were slightly above the design capacity of 1.5 mgd from 1988 through 1992.

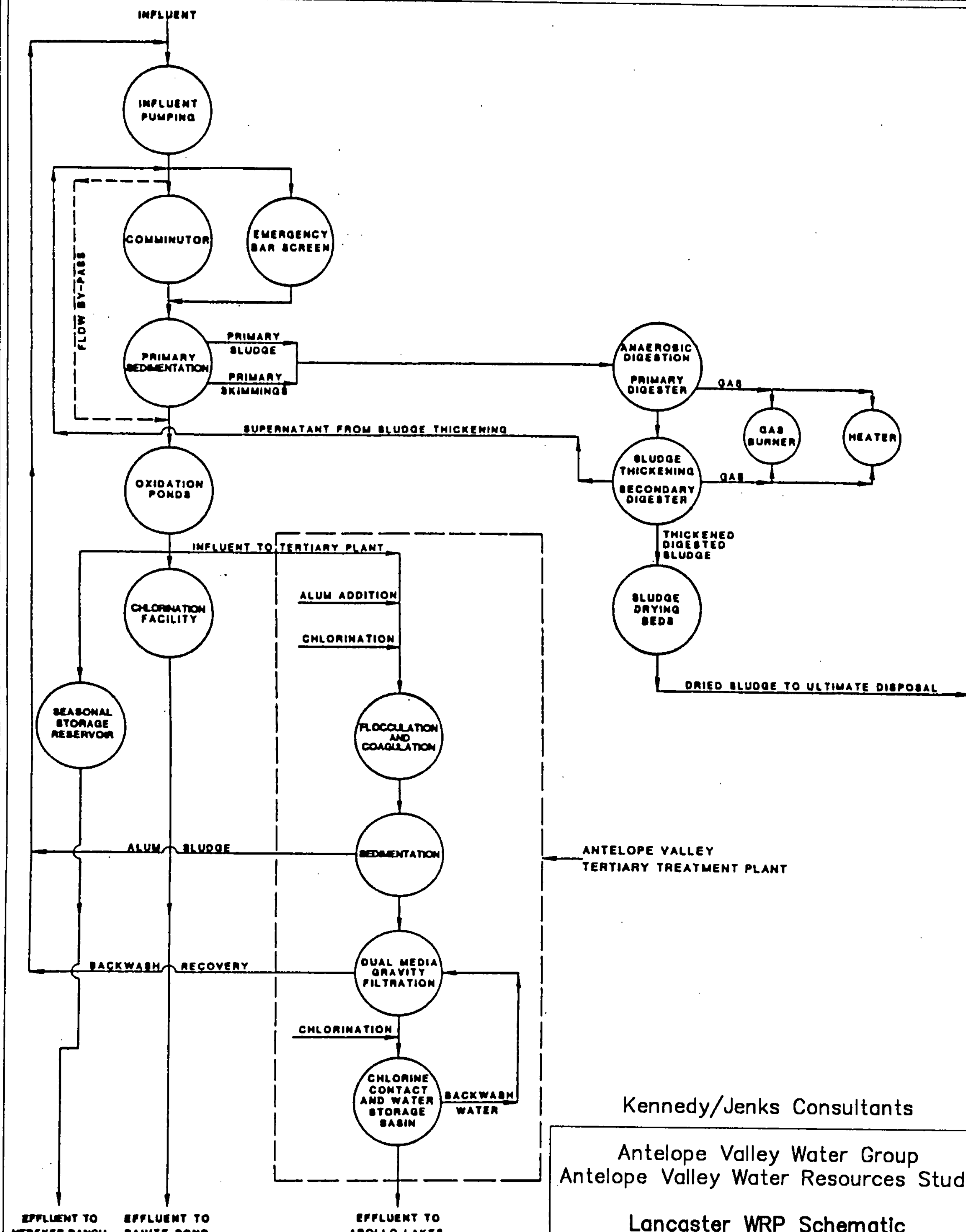
Projected Flows. The projected flows for the WRPs to the year 2020 are also depicted on Figures 6-4 to 6-7. Two projections are shown for the Palmdale and Lancaster WRPs. (See Figures 6-4 and 6-5.) The low projection for the Palmdale WRP and the high projection for the Lancaster WRP were provided by CSDLAC and are based on the adopted 1989 Growth Management Plan in the Air Quality Management Plan (AQMP/GMP) by the Southern California Association of Governments (SCAG). The other projections on Figures 6-4 and 6-5 were developed based on the medium population projections for the cities of Palmdale and Lancaster presented in Chapter 3 and the wastewater flow per capita in the AQMP/GMP. The SCAG projections are shown for comparison purposes only. Based on the medium projections developed for this study, the average daily wastewater flow in the year 2020 is estimated to be 37.2 mgd for the Palmdale WRP and 29.8 mgd for the Lancaster WRP. Similar to the Palmdale and Lancaster

TABLE 6-2

HISTORICAL AVERAGE DAILY FLOWS

Year	*Palmdale WRP (mgd)*	*Lancaster WRP (mgd)*	*Rosamond WRP (mgd)*	*Edwards AFB WRP (mgd)*
1970	1.1	3.2	NA	NA
1971	1.3	3.6	NA	NA
1972	1.3	3.7	NA	NA
1973	1.6	4.0	NA	NA
1974	1.6	3.9	NA	NA
1975	1.6	4.0	NA	NA
1976	1.6	4.0	NA	NA
1977	1.6	3.8	NA	NA
1978	1.7	3.8	NA	NA
1979	1.8	4.3	NA	NA
1980	1.9	4.7	NA	NA
1981	2.1	4.8	NA	NA
1982	2.2	4.9	NA	NA
1983	2.4	5.3	NA	NA
1984	2.8	5.7	NA	NA
1985	3.3	5.5	0.3	1.3
1986	3.8	5.8	0.3	1.3
1987	4.6	6.2	0.4	1.3
1988	4.8	6.5	0.4	1.7
1989	6.4	7.7	0.6	1.7
1990	7.2	8.3	0.7	1.7
1991	7.9	8.1	0.7	1.7
1992	7.4	8.4	0.7	1.7

NA: Not Available



Source: County Sanitation Districts of Los Angeles County

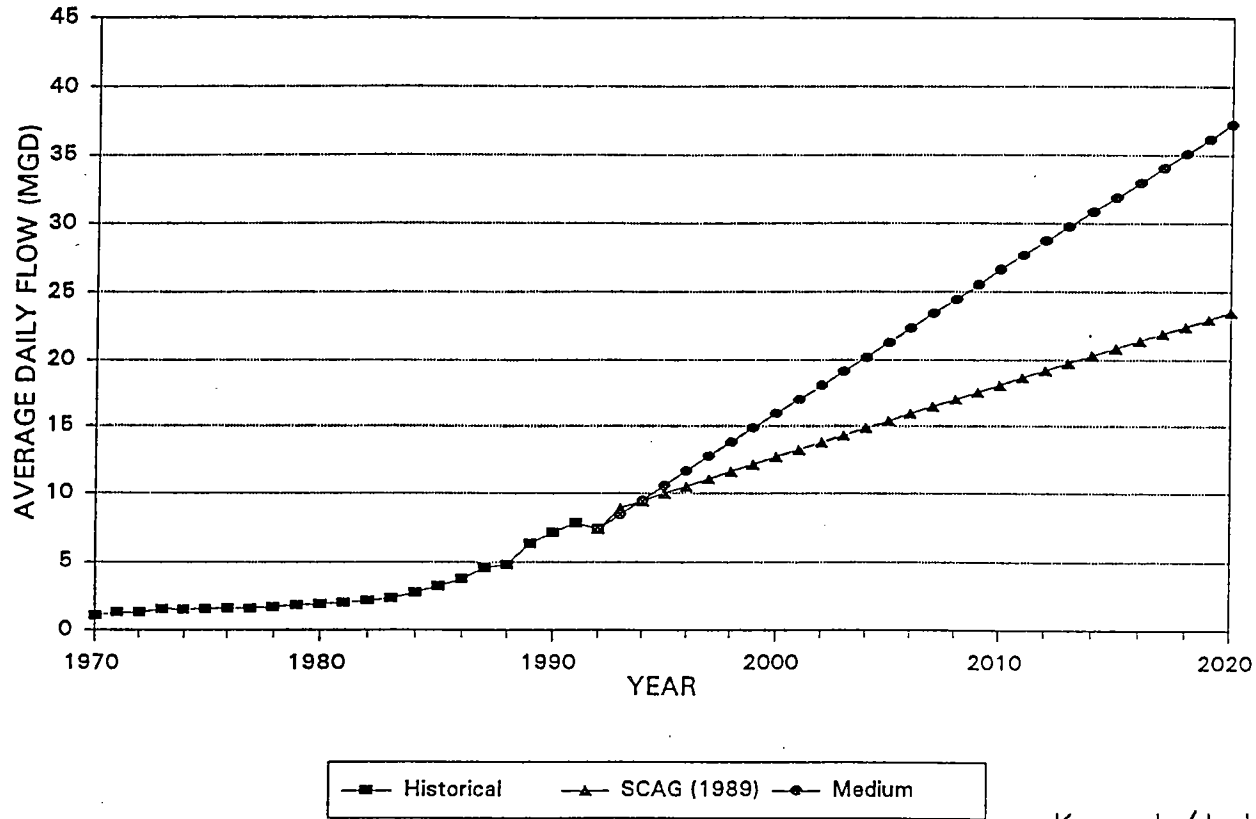
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Lancaster WRP Schematic

November 1995
K/J 934620.00

Figure 6-3



Kennedy/Jenks Consultants

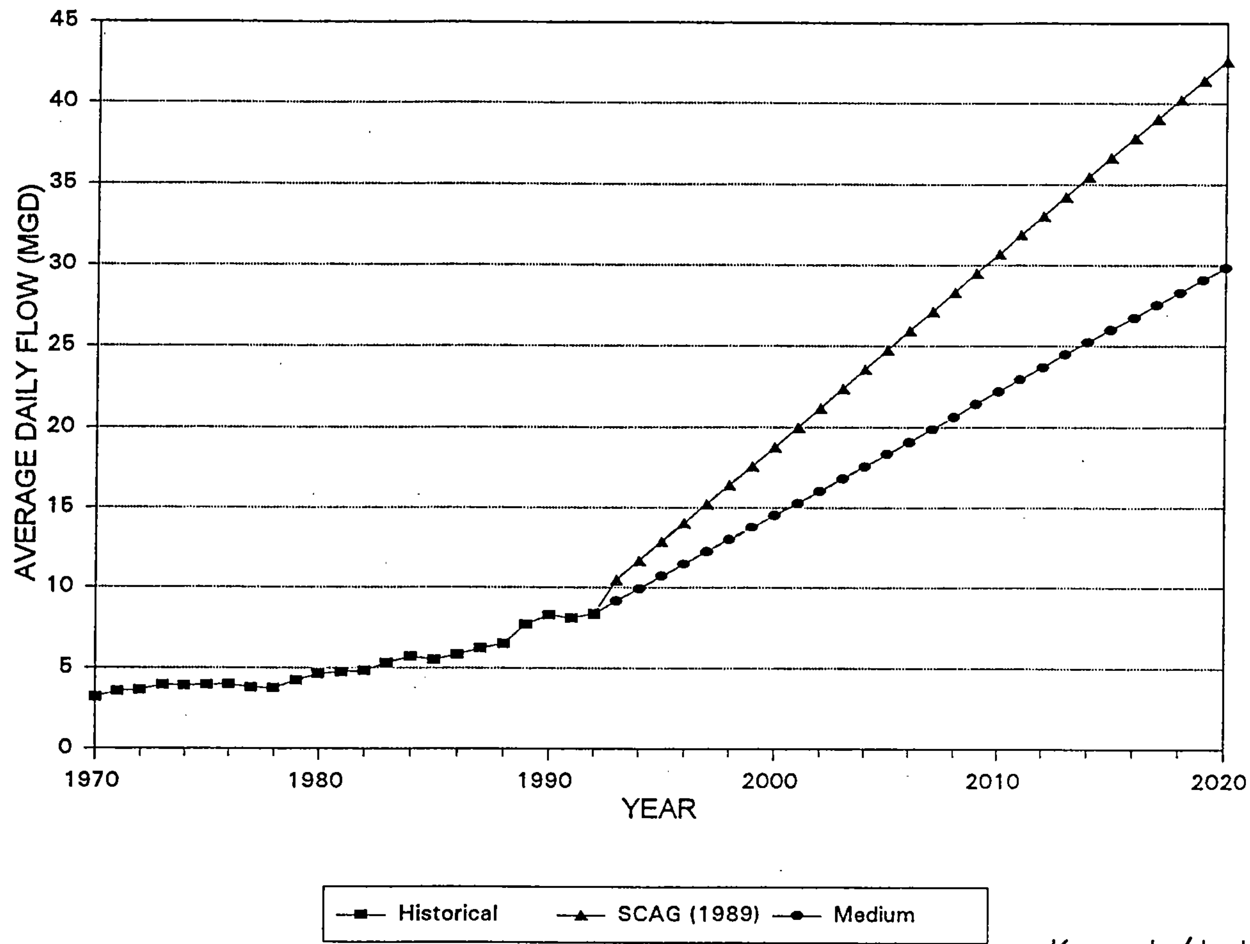
Antelope Valley Water Group
Antelope Valley Water Resources Study

Historical and Projected Flows
Palmdale WRP

November 1995
K/J 934620.00

Figure 6–4

Figure 6–4



Kennedy/Jenks Consultants

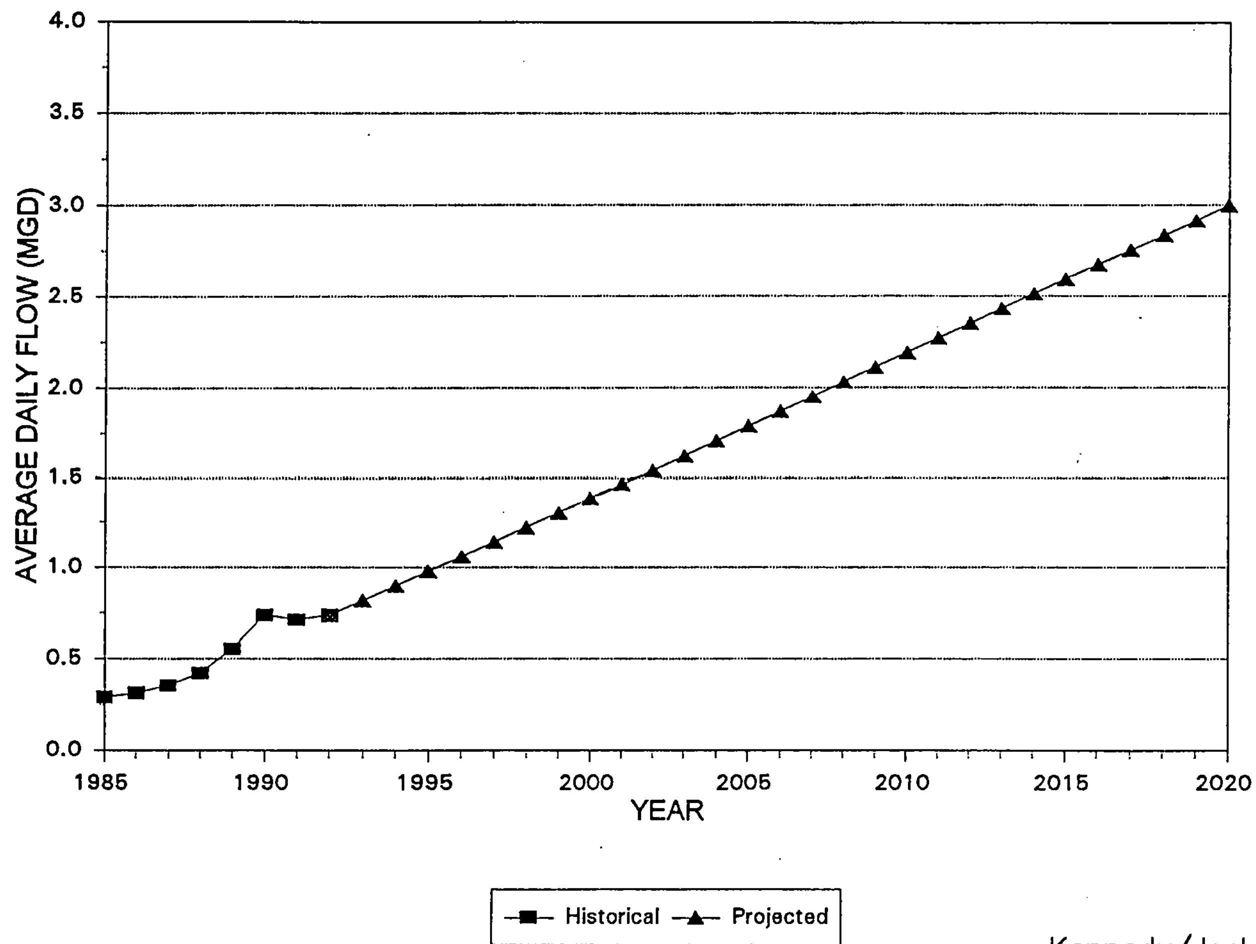
Antelope Valley Water Group
Antelope Valley Water Resources Study

Historical and Projected Flows
Lancaster WRP

November 1995
K/J 934620.00

Figure 6–5

Figure 6–5



Kennedy/Jenks Consultants

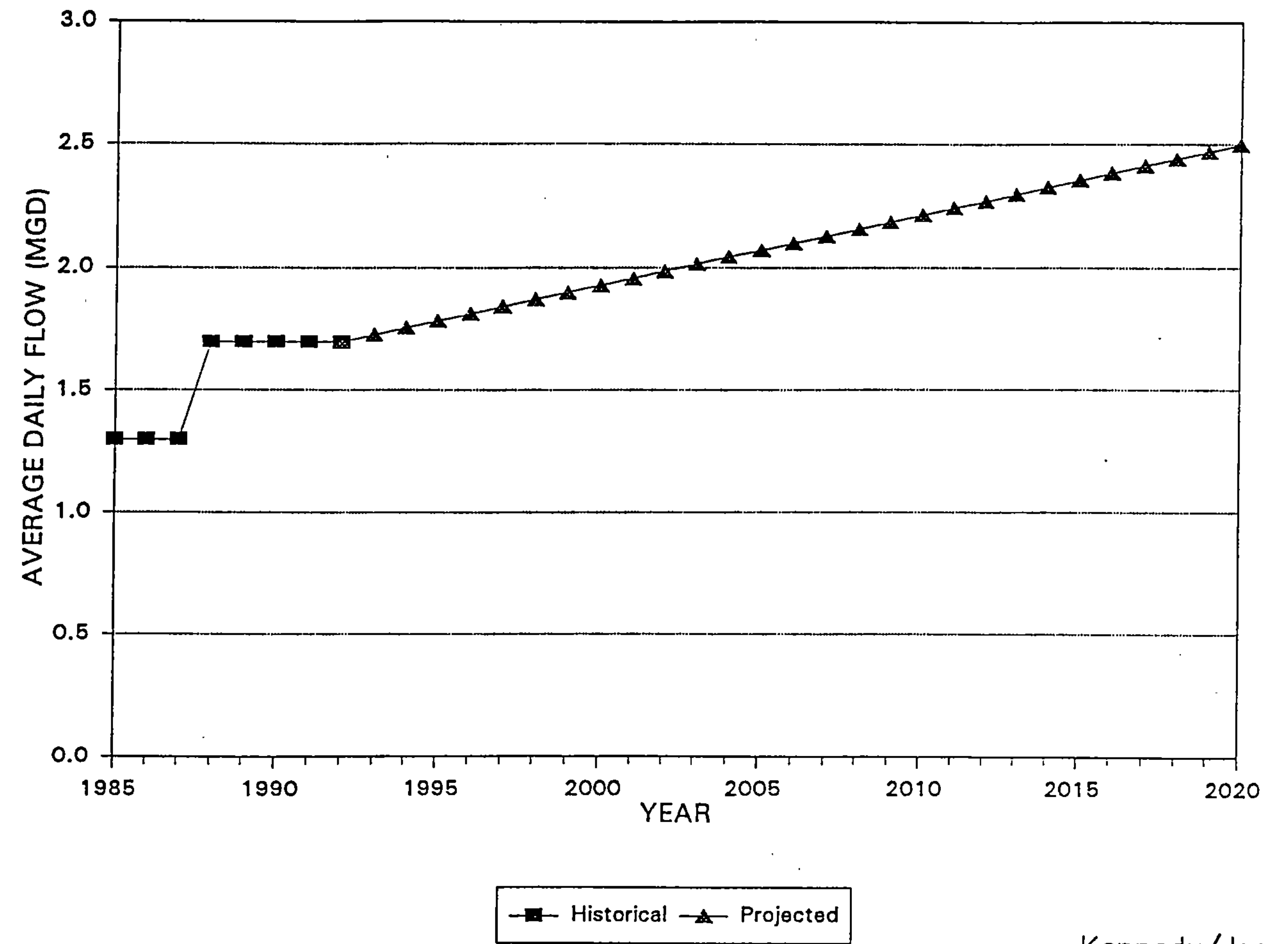
Antelope Valley Water Group
Antelope Valley Water Resources Study

Historical and Projected Flows
Rosamond WRP

November 1995
K/J 934620.00

Figure 6–6

Figure 6–6



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Historical and Projected Flows
Edwards AFB WRP

November 1995
K/J 934620.00

Figure 6-7

Figure 6-7

WRPs, projected wastewater flows for the Rosamond WRP were developed based on the medium population projection presented in Chapter 3 and the average historical wastewater flow per capita. Projected flow for the Edwards AFB WRP was obtained from a report entitled "Project Definition for U.S. Air Force Wastewater Treatment Facilities at Edwards Air Force Base" (CH2M Hill, 1991). The average daily wastewater flows in the year 2020 for the Rosamond WRP and the Edwards AFB WRP are estimated to be 3.0 and 2.5 mgd respectively.

It is important to consider seasonal wastewater flows rather than average daily flows when developing a reclaimed water system, because reclaimed water demands typically peak in the summer months and are minimal in the winter months. Figures 6-8 through 6-10 present the projected 2020 seasonal flow patterns for the Palmdale, Lancaster and Rosamond WRPs. The 2020 patterns were developed based on the current seasonal flow patterns.

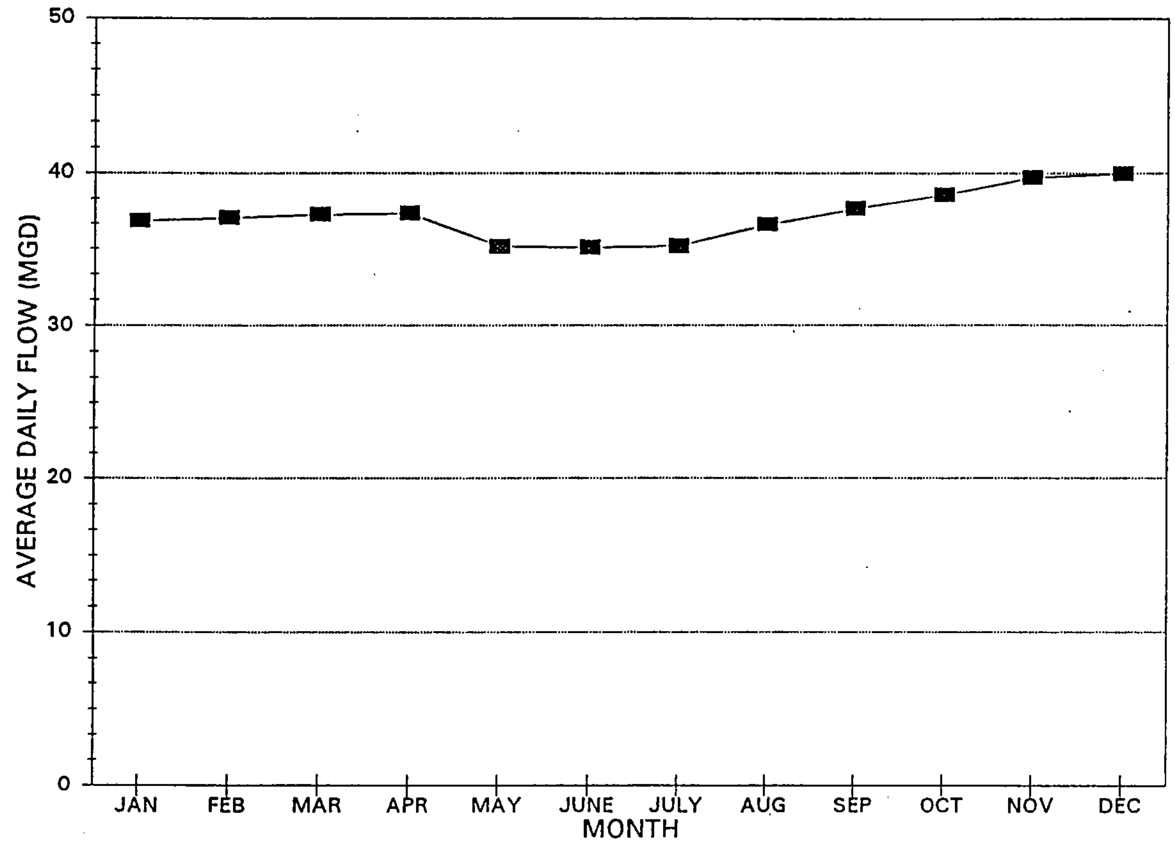
Wastewater Quality

Reclaimed Water Quality Requirements. Effluent quality from the Palmdale and Lancaster WRPs is regulated by the California Regional Water Quality Control Board - Lahontan Region (RWQCB-LH). Waste discharge requirements specifying the wastewater quality requirements for effluent discharged have been issued for these two plants (Board Order Nos. 6-93-18 and 6-93-75, respectively). The Palmdale and Lancaster WRPs also have reclamation requirements issued by the RWQCB-LH specifying wastewater quality requirements for reclamation of effluent at the Department of Airports (Board Order No. 6-90-64) and Nebeker Ranch (Board Order No. 6-86-58), respectively.

Depending on the place and purpose of reclaimed water use, the necessary treatment processes and the maximum allowable concentration of constituents vary. These variations are addressed in the reclamation permits. Reclaimed water uses are limited to the uses identified in the permits.

Effluent Quality. Average concentrations of effluent constituents measured in 1992 for the Palmdale and Lancaster WRPs are listed in Table 6-3. The tertiary-treated wastewater from Lancaster WRP is "adequately disinfected, oxidized, coagulated, clarified, filtered wastewater" as specified for use of reclaimed water in nonrestricted recreational impoundments, the use subject to the most stringent requirements under current state regulations.

Potential Irrigation Water Use. Table 6-4 lists guidelines for irrigation water quality standards and compares the effluent water quality from the Palmdale and Lancaster WRPs to the standards. From the guidelines, it can be seen that sodium and chloride contents in the effluent are relatively high and may prove toxic to some plants after repeated irrigations. If sensitive plants are to be irrigated with the effluent, application of the water by a drip system or surface system should be considered. In addition, ammonia and nitrate concentrations and boron concentrations fall in the "increasing problems" range and could prove toxic to



Kennedy/Jenks Consultants

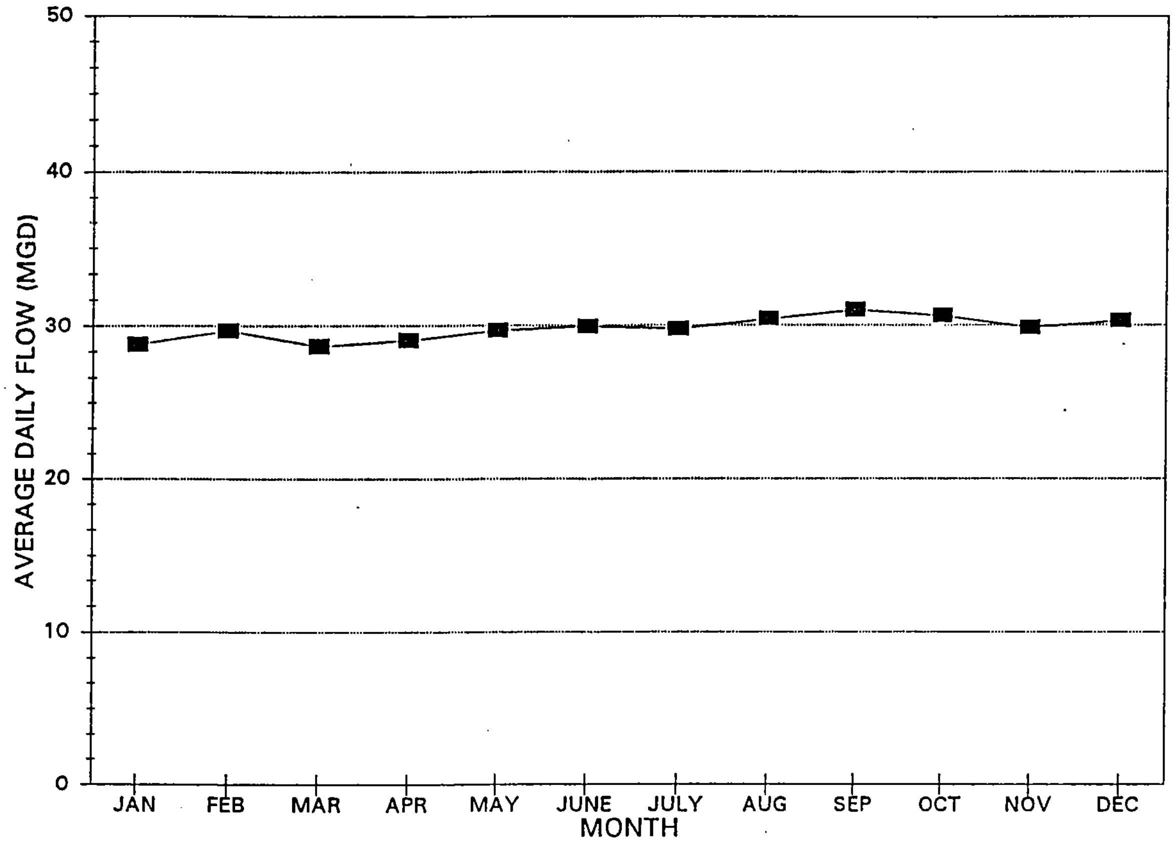
Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected 2020 Seasonal Flows
Palmdale WRP

November 1995
K/J 934620.00

Figure 6–8

Figure 6–8



Kennedy/Jenks Consultants

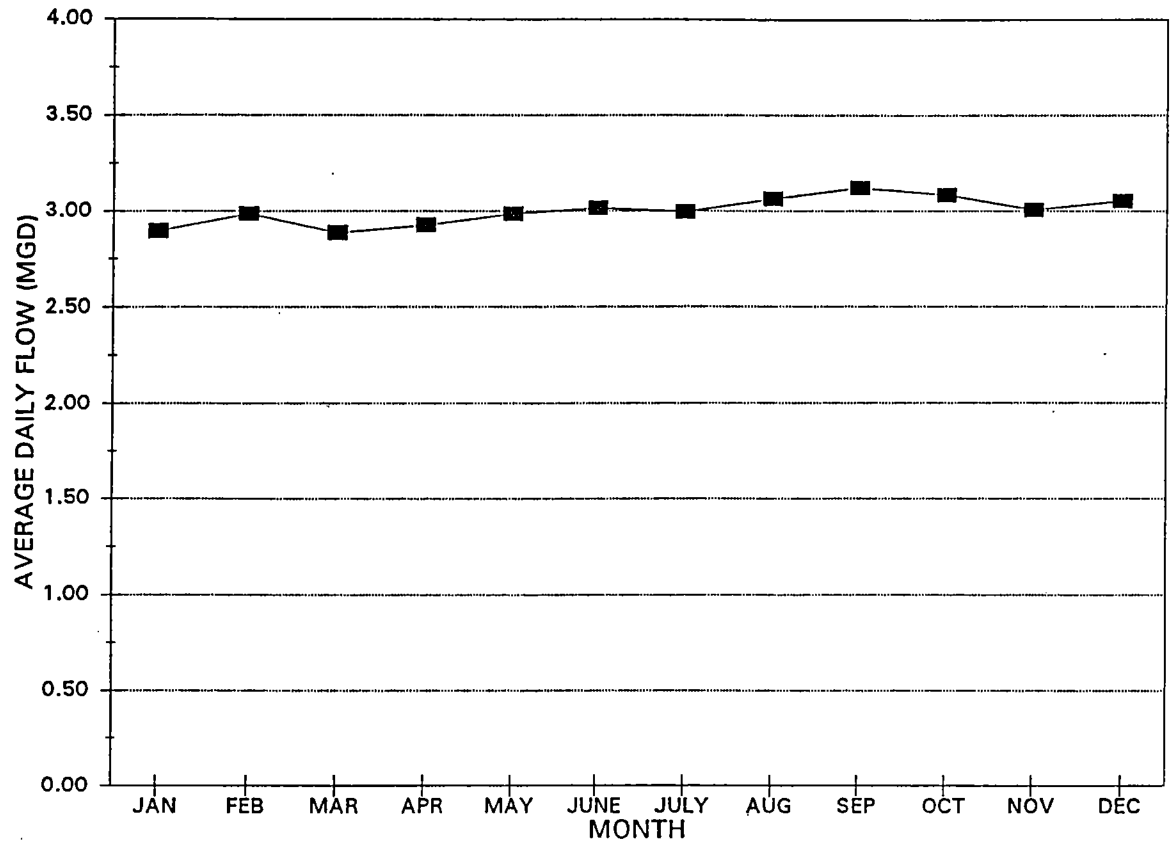
Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected 2020 Seasonal Flows
Lancaster WRP

November 1995
K/J 934620.00

Figure 6-9

Figure 6-9



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Projected 2020 Seasonal Flows
Rosamond WRP

November 1995
K/J 934620.00

Figure 6-10

Figure 6-10

TABLE 6-3
EFFLUENT QUALITY AND WATER RECLAMATION REQUIREMENTS
PALMDALE AND LANCASTER WRPs

Constituent (units)	Average Effluent Quality [1] For 1992			Maximum Limit [2]
	Palmdale WRP Secondary	Lancaster WRP Secondary	Lancaster WRP Tertiary	
Total Dissolved Solids (mg/L)	600	561	1076 [3]	1,000
Chloride (mg/L)	112	126	232 [3]	300
Sulfate (mg/L)	79	105	299 [3]	450
Coliform Group (MPN/100 ml)	NM	<2	<2	2.2
Nitrate + Nitrate (mg/L)	3.53	1.8	NM	10
Turbidity (NTU)	NM	NM	0.8	2
pH (pH units)	8.1	8.1	NM	6.0 - 9.0
Arsenic (mg/L)	<0.001	0.004	NM	0.05
Barium (mg/L)	0.03	0.02	NM	1.0
Cadmium (mg/L)	<0.01	<0.005	NM	0.010
Total Chromium (mg/L)	<0.02	<0.02	NM	0.05
Copper (mg/L)	<0.02	<0.02	NM	1.0
Lead (mg/L)	<0.04	<0.04	NM	0.05
Mercury (mg/L)	<0.0001	<0.0001	NM	0.002
Selenium (mg/L)	<0.001	<0.001	NM	0.01
Silver (mg/L)	<0.005	<0.005	NM	0.05
Zinc (mg/L)	0.22	0.07	NM	5.0
Fluoride (mg/L)	0.28	0.44	NM	1.6
Total Identifiable Chlorinated Hydrocarbons (μg/L)	0.03	0.02	NM	NS
Phenols (mg/L)	<0.01	0.006	NM	1.0

(1) Arithmetic mean of effluent analytical data (CSDLAC, Annual Monitoring Report for 1992, 15 March 1993). Frequency of analyses varies among constituents; frequency specified in the Monitoring and Reporting Programs outlined in RWQCB-LH Order Nos. 93-18 and 93-75.

(2) Reclaimed water limitations specified in RWQCB-LH Order No. 89-31 (Palmdale WRP) and RWQCB-LH Order No. 89-32 (Lancaster WRP). Trace constituent concentration limits obtained from California Department of Health Services, California Administrative Code, Title 22, Division 4, Chapter 15, "Domestic Water Quality and Monitoring" (1989)

(3) Monitored at the Apollo Park Recreational Lakes.

NS: Not Specified.
mg/L: milligrams per liter.
MPN/100 ml: Most probable number per 100 milliliters.
NTU: Nephelometric turbidity units.
μg/L: micrograms per liter.
NM: Not monitored.

TABLE 6-4

COMPARISON OF EFFLUENT WATER QUALITY TO IRRIGATION WATER QUALITY STANDARD GUIDELINES [1]

Problem	Related Constituents	Units	Water Quality Guidelines			Effluent Quality [6]	
			No Problems	Increasing Problems	Severe Problems	Palmdale WRP	Lancaster WRP
Salinity[2]	Electroconductivity	umho/cm	750	750-3,000	3,000	1003	1038
Permeability	Electroconductivity	umho/cm	500	500-200	200	1003	1038
	Adjusted SAR [3]	Ratio	6.0	6.0-9.0	9.0	(5)	(5)
Specific Ion Toxicity	Sodium (by adj. SAR)	Ratio	3	3.0-9.0	9.0	(5)	(5)
	Chloride	mg/l	142	142-355	355	112	126
	Boron	mg/l	0.5	0.5-2.0	2.0-10	0.47	0.65
Specific Ion Toxicity from Foliar Absorption	Sodium	mg/l	69	69	--	137	139
	Chloride	mg/l	106	106	--	112	126
Miscellaneous	Ammonia & Nitrate N. [4]	mg/l	5	5-30	30	11.2	7.6
	Bicarbonate, HCO_3	mg/l	90	90-520	520	(5)	(5)
	pH	pH	6.5-8.4	low or high	--	8.1	8.1

(1) Adapted from R.S. Ayres and D.W. Westcott, "Water Quality for Agriculture, Irrigation and Drainage Paper 29", FAO, Rome, 1976.
(2) Plants vary in tolerance to salinity.
(3) Adjusted Sodium Absorption Ration (SAR) is calculated to include the added effects of precipitation or dissolution of calcium and magnesium in soil and is related to CO_3 and HCO_3 concentrations.
(4) For sensitive crops.
(5) Not available.
(6) Secondary treated water.

sensitive plants over a period of time. Salinity of the WRPs effluent also falls in the "increasing problems" range. However, plants vary widely in tolerance to salinity (Nebeker Ranch has experienced no salinity problems in 6 years of reclaimed water use for irrigation of alfalfa (CSDLAC, 1994)). Provision of adequate soil drainage will help to alleviate any potential problems due to salinity.

The nutrient composition (nitrogen and phosphorus) of the effluent is actually beneficial for irrigation and may result in a reduction in fertilizer use.

REGULATORY REQUIREMENTS

Production, discharge, distribution, and use of reclaimed water are subject to federal, state, and local regulations, the primary objectives of which are to protect public health. A synopsis of the regulatory requirements and the methods of administration are included in Appendix C.

MARKET ASSESSMENT FOR RECLAIMED WATER

Potential reclaimed water users within the WRP areas are identified in the following section. For each potential user, estimates are provided for annual demand, peak monthly demand, peak daily demand, and the hourly distribution of water demand during peak months. Seasonal demand patterns for the users are also presented. Finally, the requirements for potential users to convert their existing water systems to reclaimed water are discussed.

Potential Users

Examination of city and area maps for the Antelope Valley, Restricted Materials Use Permits from the Office of Agricultural Commissioner - County of Los Angeles, Development Summary Reports from the Cities of Palmdale and Lancaster Planning Departments, Tentative Tract Activity Reports from the Kern County Planning and Development Services Department, and discussions with CSDLAC, City, County and water purveyor staff, as well as land developers, led to identification of existing and future potential users of reclaimed water from the Palmdale, Lancaster and Rosamond WRPs. Potential users of reclaimed water from the Edwards AFB WRP were identified in Boyle Engineering Corporation's November 1992 draft report titled "Effluent/Sludge Disposal Study - Edwards Air Force Base Wastewater Treatment Plant Project, Corps of Engineers, Sacramento District."

The criteria for placement on the initial list of potential reclaimed water users (for Palmdale, Lancaster and Rosamond) were as follows:

- proximity to the WRPs
- acreage greater than 100 acres for developments

TABLE 6-5

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
13	Alfalfa Farm	Existing	Secondary-U	995	185.6	6.40	2,272.3	7	12 am - 12 am	24	1,578
13A	Alfalfa Farm	Existing	Secondary-U	622	116.0	4.00	1,420.2	7	12 am - 12 am	24	986
13B	Alfalfa Farm	Existing	Secondary-U	995	185.6	6.40	2,272.3	7	12 am - 12 am	24	1,578
13C	Alfalfa Farm	Existing	Secondary-U	373	69.6	2.40	852.1	7	12 am - 12 am	24	592
15A	DOA Test Farm	Existing	Secondary-U	32	7.5	0.32	93.6	7	12 am - 12 am	24	65
15B	DOA Pistachio Farm *	Existing	Secondary-U	112	29.4	0.90	338.3	7	12 am - 12 am	24	235
15C	DOA Chestnut Farm *	Existing	Secondary-U	149	39.2	1.20	451.1	7	12 am - 12 am	24	313
15D	DOA Barley Farm *	Existing	Secondary-U	304	57.2	2.20	643.3	7	12 am - 12 am	24	447
18A	Sod Farm	Existing	Secondary-D	684	126.1	5.20	1,683.4	7	12 am - 12 am	24	1,169
173	Paiute Ponds *	Existing	Secondary-D	1,456	228.4	7.37	2,400.0	7	12 am - 12 am	24	1,667
174A	Wagas Land Duck Ponds	Existing	Secondary-D	1,558	186.0	6.00	1,954.8	7	12 am - 12 am	24	1,358
176	Young Ranch	Existing	Secondary-D	253	43.1	1.39	453.0	7	12 am - 12 am	24	315
	Secondary System Total			26,493	4,814	166	58,121				40,362
	Rosamond System										
200	Rosamond Elementary School	Existing	Tertiary	17	3.1	0.10	32.6	7	10 pm - 8 am	10	54
201	Hamilton Elementary School	Existing	Tertiary	65	11.9	0.38	125.2	7	10 pm - 8 am	10	209
202	Rosamond High School	Existing	Tertiary	66	12.1	0.39	127.2	7	10 pm - 8 am	10	212
203	Tropico Middle School	Existing	Tertiary	26	4.8	0.15	50.1	7	10 pm - 8 am	10	83
204	Rare Earth Continuation School	Existing	Tertiary	17	3.1	0.10	32.6	7	10 pm - 8 am	10	54
205	Rosamond Park	Existing	Tertiary	30	5.5	0.18	57.8	7	12 am - 6 am	6	161
206	West Park	Existing	Tertiary	15	2.8	0.09	28.9	7	12 am - 6 am	6	80
207	Desert Highlands Development	Future	Tertiary	209	29.8	1.15	373.3	6	12 am - 6 am	6	1,037
208	Desert Highlands Golf Course	Future	Secondary-D	90	16.5	0.63	206.8	6	12 am - 6 am	6	574
209	Tract 5052	Future	Tertiary	15	2.8	0.09	29.4	7	12 am - 6 am	6	82
210	Tract 5172	Future	Tertiary	58	10.7	0.35	112.6	7	12 am - 6 am	6	313
211	Tract 5188	Future	Tertiary	12	2.2	0.07	23.1	7	12 am - 6 am	6	64
212	Tract 5195	Future	Tertiary	20	3.6	0.12	38.2	7	12 am - 6 am	6	106
213	Tract 5196	Future	Tertiary	19	3.5	0.11	37.0	7	12 am - 6 am	6	103
214	Tract 5198	Future	Tertiary	19	3.5	0.11	37.0	7	12 am - 6 am	6	103
215	Tract 5204	Future	Tertiary	19	3.6	0.11	37.5	7	12 am - 6 am	6	104
216	Tract 5313	Future	Tertiary	4	0.7	0.02	7.8	7	12 am - 6 am	6	22

TABLE 6-5

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand (af/dy)	Peak Day Demand (1000 gpd)	Operating Conditions During Peak Day: Days/ week	Operating Conditions During Peak Day: From - To	Operating Conditions During Peak Day: Total Hours	Peak Hour Demand (gpm)
217	Tract 5394	Future	Tertiary	6	1.0	0.03	10.8	7	12 am - 6 am	6	30
218	Tract 5400	Future	Tertiary	38	7.0	0.23	74.0	7	12 am - 6 am	6	206
220	Tract 4558	Future	Tertiary	12	2.2	0.07	23.4	7	12 am - 6 am	6	65
	Rosamond System Total			758	130.5	4.50	1,465.0				3,661
	Edwards AFB System										
1	Wing Headquarters	Existing	Tertiary	11	1.8	0.06	19.1	7	10 pm - 8 am	10	32
16	Muroc Manner	Existing	Tertiary	19	2.8	0.09	29.7	7	10 pm - 8 am	10	50
1020	IFAST	Existing	Tertiary	19	1.9	0.06	20.3	7	10 pm - 8 am	10	34
1200	Base Operations	Existing	Tertiary	6	1.0	0.03	10.1	7	10 pm - 8 am	10	17
1220	Test Pilot School	Existing	Tertiary	5	0.7	0.02	7.8	7	10 pm - 8 am	10	13
1250	Offices	Existing	Tertiary	0	0.0	0.00	0.2	7	10 pm - 8 am	10	0
1260	Offices	Existing	Tertiary	5	0.8	0.03	8.2	7	10 pm - 8 am	10	14
1400	Engineering	Existing	Tertiary	9	1.3	0.04	13.7	7	10 pm - 8 am	10	23
1440	Ridley Mission Control Center	Existing	Tertiary	25	2.8	0.09	29.5	7	10 pm - 8 am	10	49
1600	T-38	Existing	Tertiary	13	1.1	0.03	11.1	7	10 pm - 8 am	10	19
1609	C-17	Existing	Tertiary	0	0.0	0.00	0.2	7	10 pm - 8 am	10	0
1610	Colonial Inn	Existing	Tertiary	4	0.5	0.02	5.6	7	10 pm - 8 am	10	9
1633	Offices	Existing	Tertiary	3	0.5	0.02	5.1	7	10 pm - 8 am	10	9
1830A	Enviornmental	Existing	Tertiary	5	0.7	0.02	7.1	7	10 pm - 8 am	10	12
2201	Softball Field	Existing	Tertiary	10	1.6	0.05	16.4	7	10 pm - 8 am	10	27
2419	Grass Island	Existing	Tertiary	3	0.4	0.01	4.5	7	10 pm - 8 am	10	8
2421	Civilian Personnel	Existing	Tertiary	3	0.5	0.02	4.9	7	10 pm - 8 am	10	8
2430	OSI	Existing	Tertiary	8	1.2	0.04	12.3	7	10 pm - 8 am	10	20
2453	Education Center	Existing	Tertiary	3	0.4	0.01	4.6	7	10 pm - 8 am	10	8
2500	Oasis Club	Existing	Tertiary	15	2.2	0.07	23.1	7	10 pm - 8 am	10	39
2600	Comm. Building	Existing	Tertiary	7	1.0	0.03	10.3	7	10 pm - 8 am	10	17
2650A	CSC	Existing	Tertiary	13	1.9	0.06	20.3	7	10 pm - 8 am	10	34
2656	Library Park	Existing	Tertiary	16	2.3	0.07	24.4	7	10 pm - 8 am	10	41
2665	Library	Existing	Tertiary	16	2.4	0.08	25.0	7	10 pm - 8 am	10	42
2670	Post Office	Existing	Tertiary	6	0.9	0.03	9.8	7	10 pm - 8 am	10	16
2700	Chapel	Existing	Tertiary	21	3.1	0.10	32.9	7	10 pm - 8 am	10	55

TABLE 6-5

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand (af/dy)	Peak Day Demand (1000 gpd)	Operating Conditions During Peak Day: Days/week	Operating Conditions During Peak Day: From - To	Operating Conditions During Peak Day: Total Hours	Peak Hour Demand (gpm)
2750	FTEMF	Existing	Tertiary	54	7.9	0.26	83.2	7	10 pm - 8 am	10	139
2800	Procurement	Existing	Tertiary	17	2.6	0.08	27.1	7	10 pm - 8 am	10	45
2858	Comm. Bulding	Existing	Tertiary	3	0.4	0.01	4.4	7	10 pm - 8 am	10	7
2860	Security Police	Existing	Tertiary	10	1.5	0.05	15.9	7	10 pm - 8 am	10	26
3497	Self Help	Existing	Tertiary	2	0.3	0.01	3.0	7	10 pm - 8 am	10	5
3500	Civil Engineering	Existing	Tertiary	2	0.2	0.01	2.4	7	10 pm - 8 am	10	4
3507	Dog Pound	Existing	Tertiary	6	0.8	0.03	8.7	7	10 pm - 8 am	10	15
3510	Vehicle Maintenance Shop	Existing	Tertiary	1	0.0	0.00	0.4	7	10 pm - 8 am	10	1
3535	Headquarters	Existing	Tertiary	15	2.3	0.07	23.9	7	10 pm - 8 am	10	40
3535	Off-Site (Rosamond Blvd).	Existing	Tertiary	19	2.9	0.09	30.6	7	10 pm - 8 am	10	51
3804	Jet Test Cell	Existing	Tertiary	4	0.4	0.01	3.7	7	10 pm - 8 am	10	6
3810	Jet Maintenance Facility	Existing	Tertiary	31	4.5	0.15	47.4	7	10 pm - 8 am	10	79
3920	Altitude Chamber	Existing	Tertiary	4	0.6	0.02	6.5	7	10 pm - 8 am	10	11
3940	Programs	Existing	Tertiary	3	0.4	0.01	4.5	7	10 pm - 8 am	10	8
3950	Office	Existing	Tertiary	3	0.5	0.02	4.9	7	10 pm - 8 am	10	8
3950A	Offices	Existing	Tertiary	8	1.2	0.04	12.4	7	10 pm - 8 am	10	21
Q	Dorms	Existing	Tertiary	207	30.8	0.99	323.2	7	10 pm - 8 am	10	539
R	Rosamond Blvd, So. Muroc Dr.	Existing	Tertiary	13	1.9	0.06	20.3	7	10 pm - 8 am	10	34
5201	Softball Field	Existing	Tertiary	12	1.9	0.06	19.5	7	10 pm - 8 am	10	33
5208	Wings Field	Existing	Tertiary	29	4.3	0.14	45.4	7	10 pm - 8 am	10	76
5210	Youth Center	Existing	Tertiary	15	2.3	0.07	23.9	7	10 pm - 8 am	10	40
5211	Hap Arnold Park	Existing	Tertiary	10	1.4	0.05	14.9	7	10 pm - 8 am	10	25
5213	Robers Field	Existing	Tertiary	22	3.3	0.11	34.4	7	10 pm - 8 am	10	57
5214	Bowling	Existing	Tertiary	2	0.3	0.01	3.4	7	10 pm - 8 am	10	6
5215	Little League Field	Existing	Tertiary	7	1.0	0.03	10.6	7	10 pm - 8 am	10	18
5216	Softball Field	Existing	Tertiary	12	1.8	0.06	18.8	7	10 pm - 8 am	10	31
5220	Soccar Field	Existing	Tertiary	10	1.5	0.05	16.0	7	10 pm - 8 am	10	27
5221	Little League Field	Existing	Tertiary	13	2.0	0.06	20.6	7	10 pm - 8 am	10	34
5500	Hospital	Existing	Tertiary	23	2.6	0.08	27.5	7	10 pm - 8 am	10	46
5510	Hospital Barracks	Existing	Tertiary	5	0.8	0.02	7.9	7	10 pm - 8 am	10	13
5513	Dental Clinic	Existing	Tertiary	24	3.6	0.12	37.5	7	10 pm - 8 am	10	63
5550	Veterinary Clinic	Existing	Tertiary	3	0.4	0.01	4.0	7	10 pm - 8 am	10	7
5560	Fire Station	Existing	Tertiary	7	1.1	0.04	11.6	7	10 pm - 8 am	10	19
5600	Officer's Club	Existing	Tertiary	30	4.4	0.14	46.6	7	10 pm - 8 am	10	78
5601	VIP Billeting	Existing	Tertiary	11	1.7	0.05	17.3	7	10 pm - 8 am	10	29

TABLE 6-5

HIGH POTENTIAL RECLAIMED WATER USERS

User No.	User Name	Current Status	Required Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
5602	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
5603	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
5604	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
5606	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
6000	Commissary	Existing	Tertiary	12	1.8	0.06	18.5	7	10 pm - 8 am	10	31
6002	Branch Bank	Existing	Tertiary	6	0.8	0.03	8.8	7	10 pm - 8 am	10	15
6005	Baskin Robbins	Existing	Tertiary	6	0.9	0.03	9.4	7	10 pm - 8 am	10	16
6006	Burger King	Existing	Tertiary	10	1.5	0.05	15.6	7	10 pm - 8 am	10	26
6441	Preschool	Existing	Tertiary	2	0.3	0.01	3.4	7	10 pm - 8 am	10	6
6445	Social Actions	Existing	Tertiary	1	0.1	0.00	1.2	7	10 pm - 8 am	10	2
6447	Housing Chapel	Existing	Tertiary	15	2.3	0.07	23.9	7	10 pm - 8 am	10	40
6459	Child Care Center	Existing	Tertiary	4	0.7	0.02	6.8	7	10 pm - 8 am	10	11
7020	Old Youth Center	Existing	Tertiary	26	3.8	0.12	40.4	7	10 pm - 8 am	10	67
B	Park	Existing	Tertiary	25	3.7	0.12	39.3	7	10 pm - 8 am	10	66
C	Park	Existing	Tertiary	23	3.4	0.11	35.4	7	10 pm - 8 am	10	59
F	Park	Existing	Tertiary	62	9.2	0.30	96.9	7	10 pm - 8 am	10	162
G	Park	Existing	Tertiary	4	0.6	0.02	5.8	7	10 pm - 8 am	10	10
H	Park	Existing	Tertiary	12	1.8	0.06	18.4	7	10 pm - 8 am	10	31
I	MH Park Playground	Existing	Tertiary	5	0.8	0.03	8.2	7	10 pm - 8 am	10	14
J	Famcamp	Existing	Tertiary	33	4.9	0.16	51.1	7	10 pm - 8 am	10	85
K	Schools	Existing	Tertiary	156	23.2	0.75	243.7	7	10 pm - 8 am	10	406
L	Golf Course	Existing	Tertiary	934	139.6	4.50	1,467.0	7	10 pm - 8 am	10	2,445
M	Love Avenue	Existing	Tertiary	14	2.2	0.07	22.9	7	10 pm - 8 am	10	38
N	Miscellaneous Use	Existing	Tertiary	82	3.0	0.10	31.9	7	10 pm - 8 am	10	53
O	Industrial Use	Future	Tertiary	28	3.9	0.13	41.0	7	10 pm - 8 am	10	68
P	Irrigation Use	Future	Tertiary	307	43.2	1.39	454.0	7	10 pm - 8 am	10	757
	Edwards AFB System Total			2,685	384.7	12.41	4,043.2				6,739
	GRAND TOTAL			35,624	6,335	216	74,483				79,225

* Current user of reclaimed water
Secondary-D: Disinfected Secondary
Secondary-U: Undisinfected Secondary

Reclaimed water users already receiving reclaimed water are indicated with an "*" in Table 6-5. Total annual demand, peak month demand and peak day demand for these current users of reclaimed water are 6,460, 1,192 and 41 acre-feet, respectively. Actual demand data were used when available.

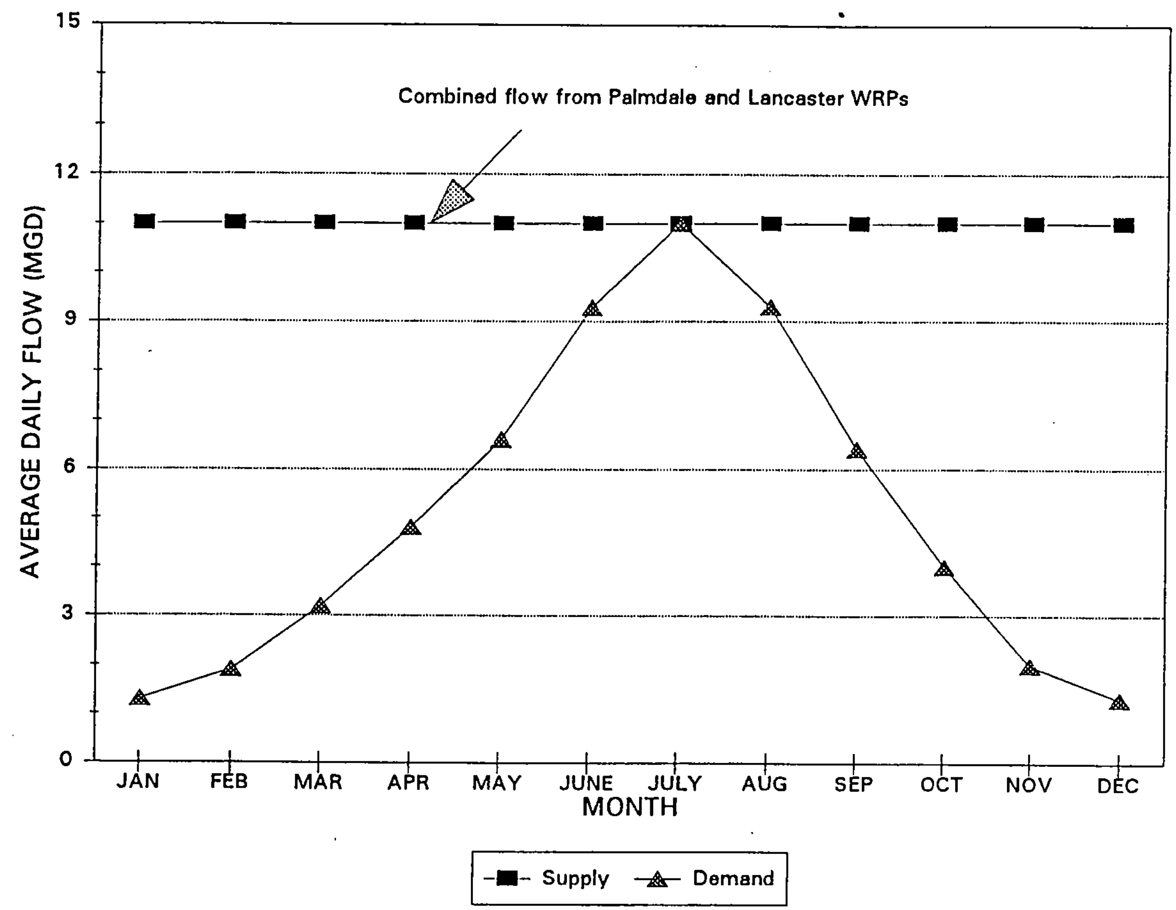
Seasonal water demand patterns were developed for Palmdale/Lancaster tertiary and secondary systems and the Rosamond system service areas based on irrigation requirements provided by SCS and conversations with existing growers of crops in the Antelope Valley. Figures 6-11, 6-12 and 6-13 present the developed seasonal water demand patterns versus the projected 2020 seasonal WRP effluent flows for the tertiary, secondary and Rosamond systems, respectively. It was assumed that partial conversion to tertiary treatment of the Palmdale and Lancaster WRPs would occur to meet peak day demands of the high potential users within the tertiary system service area. The remaining flows at the plants would be allocated to the secondary system service area. Figure 6-12 indicates that the secondary supply from the Palmdale and Lancaster WRPs cannot meet the peak day demand by approximately 4.0 mgd.

Onsite Conversion Requirements

The California Department of Health Services has prepared guidelines for use of reclaimed water which are based on the reclamation criteria set forth in Title 22. The guidelines address what steps should be taken in converting water systems to reclaimed water systems. Two primary goals of the guidelines are to prevent cross connection between the potable water and reclaimed water systems and to make the public aware that reclaimed water is being used.

For users with separate irrigation and potable water systems, the primary requirement will be to disconnect the irrigation system from the potable water service and connect it to the reclaimed water service. Reduced pressure principal backflow prevention devices will need to be installed on the potable service immediately downstream of the meter. For those users with irrigation systems that tie to their potable water systems at several locations, the systems will have to be separated. Additionally, all hose bibs on the user's reclaimed water systems will need to be replaced by quick coupling connections. Public areas, such as golf courses, parks, and schools, will need to post signs notifying the public that reclaimed water is being used for irrigation. Parks, schools, and other users with exposed drinking fountains near landscaped areas will have to provide shields to prevent reclaimed water from coming into contact with the drinking fountains.

The costs of these conversion requirements will be incurred by the users. In general, the costs are anticipated to be relatively low; however, because the cost will depend on meter size and complexity of the irrigation system, costs will vary from user to user.



Kennedy/Jenks Consultants

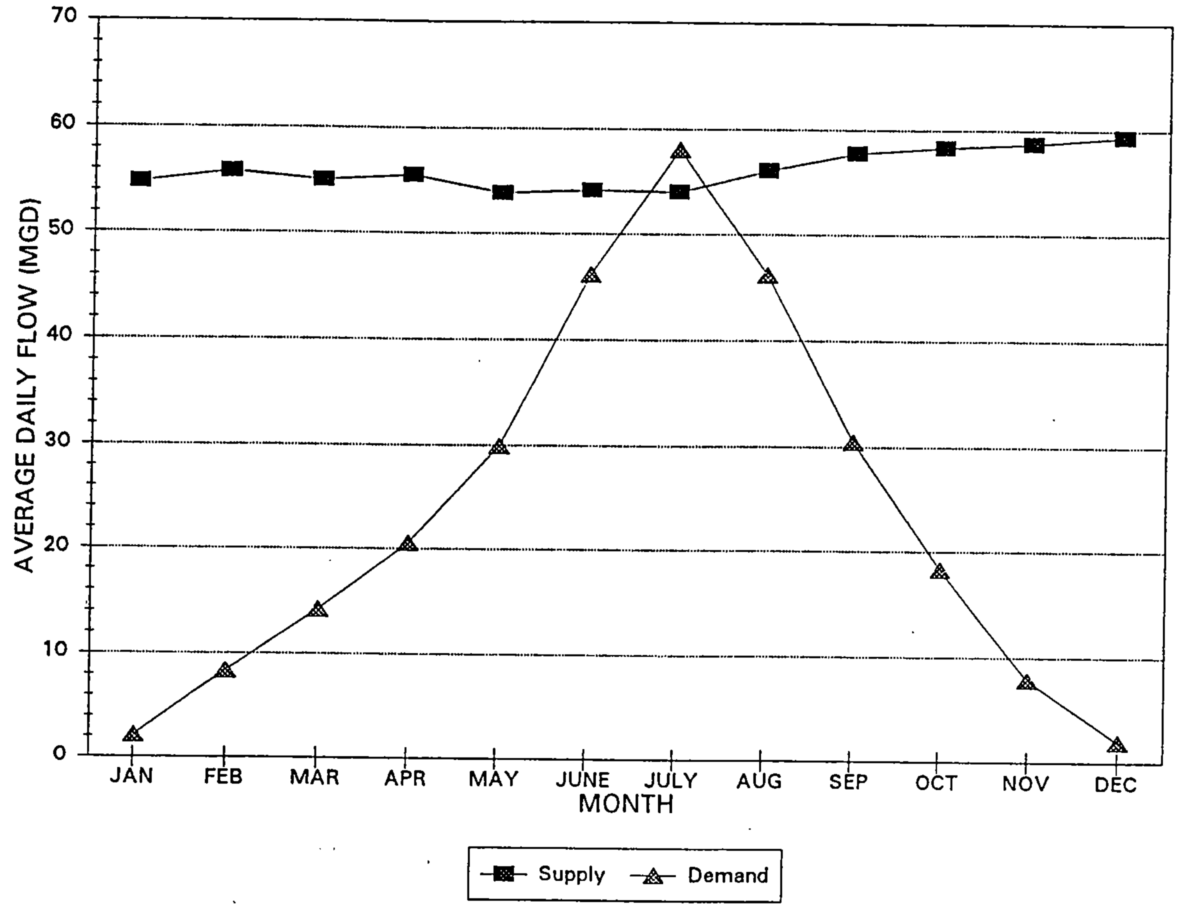
Antelope Valley Water Group
Antelope Valley Water Resources Study

Seasonal Demand Pattern Versus WRP Flow – Tertiary System

November 1995
K/J 934620.00

Figure 6–11

Figure 6–11



Kennedy/Jenks Consultants

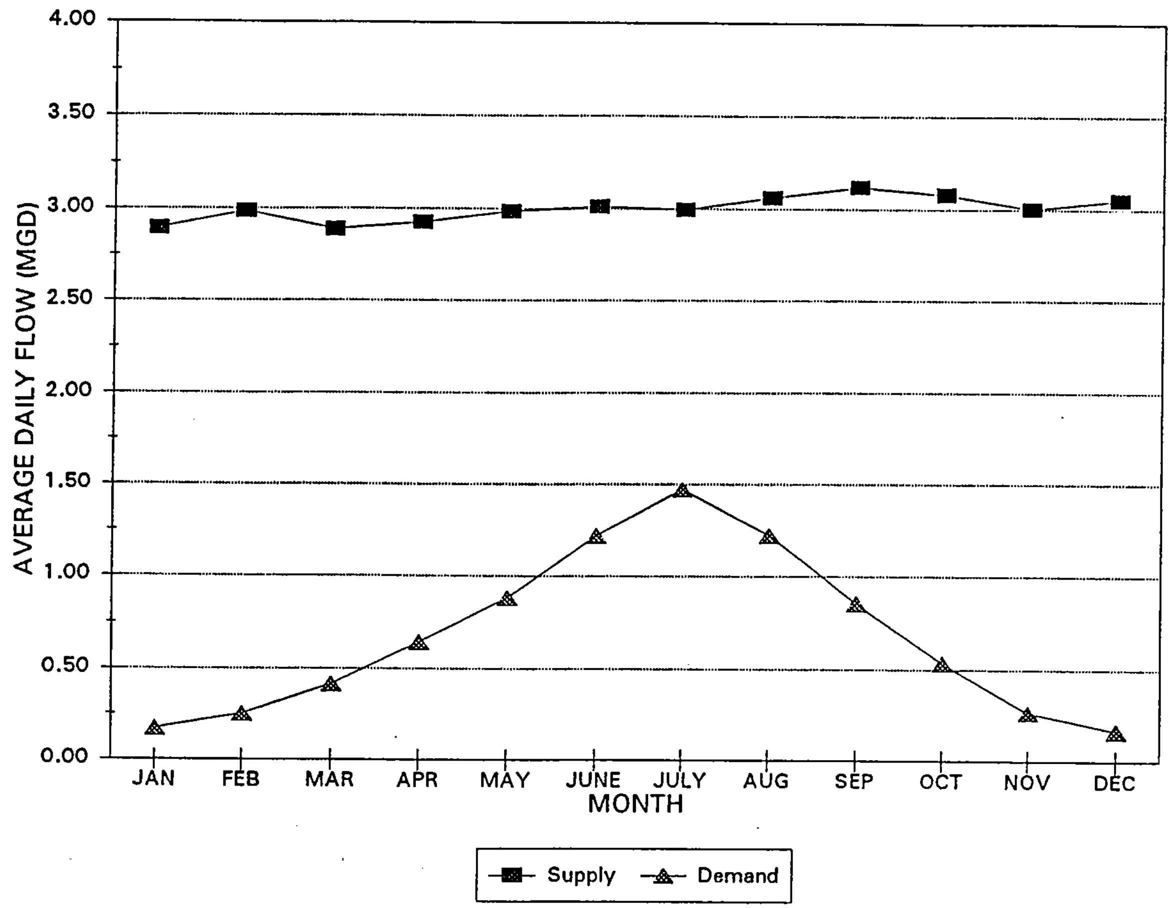
Antelope Valley Water Group
Antelope Valley Water Resources Study

Seasonal Demand Pattern Versus
WRP Flow – Secondary System

November 1995
K/J 934620.00

Figure 6–12

Figure 6–12



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Seasonal Demand Pattern Versus WRP Flow – Rosamond System

November 1995
K/J 934620.00

Figure 6–13

Figure 6–13

CONCEPTUAL PLAN

The development of the reclaimed water systems was based on established planning criteria. These criteria are the concepts and assumptions that ultimately form the service criteria of the system. The following section presents the criteria for and development of the systems, as well as the details of the conceptual plan for the reclaimed water systems. Because Edwards AFB is currently designing a tertiary treatment facility and reclaimed water system, discussion in the following section focuses on the Palmdale, Lancaster and Rosamond WRPs, followed by a brief description of the proposed facilities at Edwards AFB.

Criteria and Assumptions

Criteria and assumptions were established for each component of the Palmdale, Lancaster and Rosamond reclaimed water systems, including the reclaimed water supply, the main pump stations, the booster pump stations, the storage reservoirs, and the distribution system. These criteria and assumptions, summarized in Table 6-6, are discussed in the following sections.

Reclaimed Water Supply. Reclaimed water will be supplied to the reclaimed water systems by the four WRPs. Initially, plant production may not be adequate to meet the total demands of the systems; however, as potable water demands increase and, consequently, reclaimed water production increases, the water available to meet system demands will also increase. Projected production of the WRPs versus projected demands is depicted on Figures 6-11 to 6-13. It appears that production of the Lancaster and Palmdale WRPs cannot meet peak day demands in the year 2020. Design of the systems is based on projected plant production for the year 2020 and an assumption of equalized effluent flow.

Main Pump Stations. A main pump station will be located at each WRP to provide reclaimed water to the distribution systems. The pump station capacity is dependent upon plant production, as well as reclaimed water demands, and will be designed to meet peak day demands. Proposed storage reservoirs will provide for reductions in the required main pump station capacities by allowing peak hour demands to be met with a combination of pumped water and water from storage reservoirs. It is assumed that the pump stations will operate 24 hours per day. The main pump stations will be controlled by water level sensors in the storage reservoirs.

Booster Pump Stations. The functions of the booster pump stations are to boost the system pressure from low service zones to high service zones or, due to the relatively flat terrain, to boost delivery pressures from reservoirs to users. In order to minimize pump station and pipeline capacities, booster pump stations designed to boost system pressures from low zones to high zones will operate 24 hours per day and, therefore, will be designed to meet peak day demand of the high zone. Booster pump stations designed to boost delivery pressures from reservoirs will operate only during the users' operating hours and, therefore, will be designed to meet peak hour demands of the user served.

TABLE 6-6

SUMMARY OF RECLAIMED WATER SYSTEM CRITERIA

System Components	*Criteria*
Reclaimed Water Supply	• Assume projected plant production for year 2020. • Assume equalized effluent flow.
Main Pump Stations	• Pumps will operate 24 hours during peak day demands. • Size for peak day demands.
Booster Pump Stations	• To serve high zones, size for peak day demands. • To serve users from reservoirs, size for peak hour demands.
Storage Reservoirs	• Provide storage for peak demand. • Reservoir elevations should be adequate to provide optimum delivery pressures to most users. • Provide surface storage adequate to meet peak season demands.
Distribution System	• Size to meet the peak hour demands. • Maximum design velocity is 6 feet per second. • Maximum system pressure: 185 psi. • Optimum delivery pressure range: 55 to 150 psi. • All buried piping is "purple" high-pressure PVC (currently 24-inch diameter is maximum available) or ductile iron pipe.

Storage Reservoirs. The recommended operating storage capacity to be provided for the reclaimed water systems is equivalent to the peak day demand. Reservoir elevations will be dictated by the required system and delivery pressures as discussed below. Reservoirs provide supplemental supply during peak demand days. Capacity should be based on the supplemental supply necessary to meet all demands during the peak season.

Distribution System. Distribution system design is dependent upon flow, velocity, and pressure criteria. The distribution systems will be sized to handle the peak hour demands. High velocities, which may impair pipeline useful life and increase energy requirements to deliver water, are not desirable. Maximum design flow velocity in the system will be 6 feet per second.

Two pressure criteria were considered in the planning of the system. Defined as the pressure at any point within the distribution system, system pressure is dependent upon reservoir levels, reclaimed water demands and pumping conditions. The maximum system pressure will be 185 pounds per square inch (psi). Delivery pressure refers to the pressure at which reclaimed water is delivered to the users. Optimum delivery pressure ranges from 55 psi to 150 psi.

Components of the Plan

The development of the recommended reclaimed water system was based on the above criteria and assumptions. The recommended conceptual plan is divided into 4 main reclaimed water systems:

- Palmdale and Lancaster Tertiary System (tertiary system)
- Palmdale and Lancaster Secondary System (secondary system)
- Rosamond System
- Edwards AFB System

Plate 2 shows the conceptual plans (except for Edwards AFB), the location of the reclaimed water users and the service zones. Because a conceptual plan already exists for Edwards AFB System, it is discussed separately. The tertiary system would serve tertiary treated reclaimed water to approximately 34 users in three service zones. Service zone maximum water surface elevations are 2,620, 2,840 and 2,920 feet above sea level. The secondary system would serve secondary treated reclaimed water to approximately 23 users in one service zone (maximum water surface elevation of 2,680 feet). The Rosamond system would serve tertiary treated water to approximately 20 users in one service zone (maximum water surface elevation of 2,620 feet).

Main pump stations would be located at the reclaimed water supply. Each of the service zones would contain storage reservoirs, distribution system piping, and booster pump stations.

Reclaimed Water Supply. Reclaimed water would be supplied to the tertiary and secondary systems from the Palmdale and Lancaster WRPs. Similarly, reclaimed water would be supplied to the Rosamond system from the Rosamond WRP. The total system demand for reclaimed water is approximately 5,688 acre-feet per year for the tertiary system, 26,493 acre-feet per year for the secondary system, and 758 acre-feet per year for the Rosamond system. It is anticipated that reclaimed water would be constantly available from the WRPs.

Under normal operating conditions for the tertiary system, reclaimed water from the Lancaster WRP would serve service zone 2620, and reclaimed water from the Palmdale WRP would serve zones 2840 and 2920. An 8.0 mgd and a 3.0 mgd tertiary treatment plant would be constructed at the Lancaster WRP and the Palmdale WRP, respectively. A 2.0 mgd tertiary plant would be constructed at the Rosamond WRP. The tertiary treatment process at the plants would include oxidation, flocculation, clarification, filtration and disinfection.

Without a storage supply, the secondary supply remaining from the Palmdale and Lancaster WRPs after partial conversion to tertiary appears inadequate to meet the peak day demand of the secondary system users by approximately 3,000 gallons per minute (gpm). (See Figure 6-12.) The secondary system facilities have been planned accordingly.

Main Pump Stations. Reclaimed water pump stations would be located at the WRPs and would be used to transport the reclaimed water to the storage reservoirs and to the users in each zone. With the exception of the Secondary system main pump station, the main pump stations are designed to operate at a constant flow rate (24-hour operation) and to provide total daily flow equivalent to the peak day demand. Without a storage supply, projected secondary flows at the Lancaster and Palmdale WRPs appear inadequate to meet projected secondary peak day demands, therefore, the secondary system main pump stations are designed to provide maximum secondary flow available from the WRPs. The recommended capacities of the main pump stations are shown in Table 6-7.

Booster Pump Stations. Included in the recommended plan are seven booster pump stations (BPS) located throughout the distribution system. BPS 1 through BPS 5 are a part of the tertiary system; BPS 6 is a part of the secondary system; and BPS 7 is a part of the Rosamond system. BPS 1 is at the head of service zone 2920 to increase system and delivery pressures from the 2840 zone. Due to the relatively flat terrain in Lancaster, BPS 2 through BPS 4 are located at the reservoirs within service zone 2620 to increase delivery pressures to users in the zone. BPS 5 serves as a backup supply source for service zones 2920 and 2840 allowing reclaimed water from the Lancaster WRP to flow to these zones. BPS 6 would be located at the open reservoir (described in the next section) within service zone 2680 to provide supplemental water for peak days when WRP supply is inadequate to meet demands. BPS 7 would be required to increase delivery pressures for the Desert Highlands Development in the Rosamond system. BPS capacities range from 1,320 to 8,935 gpm. Booster pump station locations are shown on Plate 2 and capacities and operating hours are listed in Table 6-8.

TABLE 6-7

MAIN PUMP STATION CAPACITIES

System	*Capacity (gpm)*
<u>Tertiary System</u>	
Palmdale WRP	2,000
Lancaster WRP	5,600
<u>Secondary System</u>	
Palmdale WRP	25,800
Lancaster WRP	15,700
<u>Rosamond System</u>	
Rosamond WRP	1,050

<u>Storage Reservoirs</u>. The conceptual plan includes construction of eight new reclaimed water storage reservoirs and utilization of one existing storage reservoir. Each service zone would have one reservoir with the exception of the 2620 zone (tertiary system) which would have three and the 2680 zone (secondary system) which would have three reservoirs (one existing). The storage capacity in each zone would be equal to peak day demand with the exception of the 2680 zone (secondary system) which would be sized large enough to provide supply supplemental to WRP supply as required to meet peak day demands. Six of the nine reservoirs are assumed to be above-ground steel tanks and would range in size from 1.0 million gallons (MG) to 4.6 MG. Reservoir No. 6 in the 2680 zone is assumed to be open and lined and would be capable of holding a minimum of approximately 400 acre-feet of water.

Additionally, storage would be provided for the Lancaster and Palmdale WRPs to hold secondary treated water for periods when irrigation water is not required due to precipitation. In addition, storage would provide the added benefit of reducing wastewater effluent discharged to Paiute ponds during the winter. The capacity of the reservoir would allow for storage of 14 days or approximately 2,500 acre-feet of total secondary reclaimed water flow. This storage capacity is sufficient to provide the 400 acre-feet of water required to meet peak day demands.

Currently, the Lancaster WRP has storage ponds capable of holding approximately 1,535 acre-feet of water. Therefore, an additional 965 acre-feet of storage is required. Because only 400 acre-feet of water is required from storage to meet peak day demands in the 2680 zone, it is recommended that two separate reservoirs be constructed: one 400 acre-feet open, lined reservoir and one 565 acre-feet open, unlined reservoir. This would reduce capital costs. Storage reservoir locations are shown on Plate 2 and reservoir volumes are listed in Table 6-9. The maximum water surface elevations are determined by the system and delivery pressure criteria and are also listed in Table 6-9.

TABLE 6-8

BOOSTER PUMP STATION CAPACITIES

Booster Pump Station	*Zones Served*	*Operating Hours (hrs./day)*	*Capacity (gpm)*
Tertiary System			
1	2920	24	1,320
2	2620	8	1,520
3	2620	8	5,660
4	2620	8	8,935
5	2920	As required	5,600
Secondary System			
6	2680	24	3,000
Rosamond System			
7	Desert Highlands	6	1,611

Distribution System. The recommended pipeline routes for the reclaimed water systems are shown on Plate 2. The distribution systems consist of approximately 486,000 lineal feet of pipe ranging from 6 to 42 inches in diameter. The lengths and diameters of the pipeline segments for each system are presented in Table 6-10. Purple, high-pressure, polyvinyl chloride (PVC) pipe is the primary pipe type used in the tertiary and Rosamond systems. Because 24 inches is the maximum diameter currently available for purple PVC pipe, and the majority of pipeline in the secondary system is greater than 24 inches in diameter, ductile iron pipe is used in the secondary system.

Cost Estimates

Table 6-11 presents criteria used in estimating costs. Cost estimates presented in this report are order-of-magnitude type estimates expected to be accurate within ± 25 percent. The cost estimates were developed from general cost curves, information from suppliers, other studies and Kennedy/Jenks Consultants' previous experience. The main pump station costs include costs for all materials, equipment, construction and testing. Incorporated into the reservoir construction costs are the costs for grading, materials, and construction. Pipeline construction costs assume in-street construction with a moderate degree of utility crossings and include items such as valves, traffic control and road resurfacing. Booster pump station costs consist of costs for all materials, equipment, construction and testing. System flushing and testing costs assume that approximately 1,000 feet of pipe would be tested per day. Not included in the cost estimate are pipeline easements and pump station/reservoir property costs.

TABLE 6-9

RESERVOIR VOLUMES AND ELEVATIONS

Reservoir Number	*Service Zone*	*Volume (MG)*	*Maximum Water Surface Elevation (feet)*
Tertiary System			
1	2840	1.0	2840
2	2920	2.0	2920
3	2620	1.0	2620
4	2620	2.4	2620
5	2620	4.6	2620
Secondary System			
6	2680	400 AF	2680
7	2680	565 AF	2350
8	2680	1535 AF (E)	2300
Rosamond System			
9	2620	1.5	2620

(E) Existing
(AF) Acre-feet

The estimated construction cost of the reclaimed water system is shown in Table 6-12. As shown in the table, the treatment facilities for the tertiary and the Rosamond systems are $24,417,000 and $7,731,000 respectively. The distribution facilities for the tertiary, secondary, and Rosamond systems are $36,456,000, $67,486,000, and $8,296,000 respectively. The total cost for construction of the entire regional system is approximately $144,386,000 (1994 dollars). Construction costs include 15 percent for contractor overhead and profit, 20 percent for engineering/administration and 25 percent for contingencies.

TABLE 6-10

PIPELINE DIAMETERS AND LENGTHS

	Material	Diameter (In.)	Length (Ft).
Tertiary System	Ductile Iron	30	100
	PVC	24	1,600
	PVC	18	93,800
	PVC	16	9,500
	PVC	14	43,700
	PVC	12	27,600
	PVC	10	24,900
	PVC	8	7,500
	PVC	6	12,800
		Subtotal -	221,500
Secondary System	Ductile Iron	42	43,100
	Ductile Iron	36	48,800
	Ductile Iron	24	15,840
	Ductile Iron	20	14,700
	Ductile Iron	16	5,400
	Ductile Iron	14	18,700
	Ductile Iron	12	5,500
	Ductile Iron	10	20,500
	Ductile Iron	6	1,300
		Subtotal -	173,840
Rosamond System	PVC	16	2,000
	PVC	12	39,200
	PVC	10	19,400
	PVC	8	21,800
	PVC	6	8,600
		Subtotal -	91,000
Total			486,340

TABLE 6-11

COST CRITERIA

Component	*Cost Criteria*
Tertiary Treatment Plant	Based on Dave Richard's "A Summary of Wastewater Reclamation Costs in California"
Main Pump Stations	Cost curve based on historical data
Booster Pump Stations	Cost curve based on historical data
Reservoirs [2]	50¢/gal.
Open Reservoir (unlined)	2¢/gal.
Open Reservoir (lined)	7¢/gal.
Pipelines [3]	
42-inch D.I.	$210/ft.
36-inch D.I.	$180/ft.
30-inch D.I.	$150/ft.
24-inch D.I.	$120/ft.
20-inch D.I.	$100/ft.
16-inch D.I.	$80/ft.
14-inch D.I.	$70/ft.
12-inch D.I.	$60/ft.
10-inch D.I.	$50/ft.
6-inch D.I.	$30/ft.
24-inch PVC	$96/ft.
20-inch PVC	$80/ft.
18-inch PVC	$72/ft.
16-inch PVC	$64/ft.
14-inch PVC	$56/ft.
12-inch PVC	$48/ft.
10-inch PVC	$40/ft.
8-inch PVC	$32/ft.
6-inch PVC	$24/ft.
System Flushing and Testing [4]	$1/ft.

(1) All figures represent installed costs.
(2) Includes tank, foundation, appurtenances, excavation, paving, fencing, landscaping and telemetry.
(3) Assume $4.00/diameter-inch for PVC - and $5.00/diameter-inch for ductile iron.
(4) Assumes 1,000 ft./day at $1,000/day.

TABLE 6-12

PRELIMINARY COST ESTIMATE

COMPONENT	ESTIMATED COST (1994 Dollars)
I. Treatment Facilities	
A. Tertiary System	
Palmdale - 3.0 mgd	$ 6,200,000
Lancaster - 8.0 mgd	9,061,000
SUBTOTAL	$ 15,261,000
Contractor's OH & Profit (15%)	2,289,000
Engineering/Admin (20%)	3,052,000
Contingency (25%)	3,815,000
TOTAL (Tertiary System)	$ 24,417,000
B. Rosamond System	
Rosamond - 2.0 mgd	$ 4,832,000
SUBTOTAL	4,832,000
Contractor's OH & Profit (15%)	725,000
Engineering/Admin (20%)	966,000
Contingency (25%)	1,028,000
TOTAL (Rosamond System)	$ 7,731,000
TOTAL (Treatment Facilities)	$ 32,148,000
II. Distribution Facilities	
A. Tertiary System	
1. Main Pump Stations	
Palmdale - 2,000 gpm	$ 518,000
Lancaster - 5,600 gpm	1,004,000
2. Booster Pump Stations	
No. 1 - 1,320 gpm	$ 249,000
No. 2 - 1,520 gpm	275,000
No. 3 - 5,660 gpm	648,000
No. 4 - 8,935 gpm	875,000
No, 5 - 5,600 gpm	648,000
3. Reservoirs	
No. 1. - 1.0 mg	$ 500,000
No. 2. - 2.0 mg	1,000,000
No. 3. - 1.0 mg	500,000
No, 4. - 2.4 mg	1,200,000
No. 5. - 4.6 mg	2,300,000
4. Distribution Pipelines	
30-inch D.I. (100 LF)	$ 15,000
24-inch PVC (1,600 LF)	154,000
18-inch PVC (93,800 LF)	6,754,000
16-inch PVC (9,500 LF)	608,000
14-inch PVC (43,700 LF)	2,447,000
12-inch PVC (27,600 LF)	1,325,000
10-inch PVC (24,900 LF)	996,000
8-inch PVC (7,500 LF)	240,000
6-inch PVC (12,800 LF)	307,000
5. System Flushing and Testing	$ 222,000
SUBTOTAL	$ 22,785,000
Contractor's OH & Profit (15%)	3,418,000
Engineering/Admin (20%)	4,557,000
Contingency (25%)	5,696,000
TOTAL	$36,456,000

CONTINUED ON RIGHT

COMPONENT	ESTIMATED COST (1994 Dollars)
B. Rosamond System	
1. Main Pump Station	
Rosamond - 1,050 gpm	$ 324,000
2. Booster Pump Stations	
No. 7 - 1,611 gpm	$ 288,000
3. Reservoirs	
No. 9 - 1.5 mg	$ 750,000
4. Distribution Pipelines	
16-inch PVC (2,200 LF)	$ 128,000
12-inch PVC (39,200 LF)	1,882,000
10-inch PVC (19,400 LF)	776,000
8-inch PVC (21,800 LF)	698,000
6-inch PVC (8,600 LF)	206,000
5. System Flushing and Testing	$ 91,000
SUBTOTAL	$ 5,143,000
Contractor's OH & Profit (15%)	771,000
Engineering/Admin (20%)	1,029,000
Contingency (25%)	1,353,000
TOTAL (Rosamond System)	$ 8,296,000
C. Secondary System	
1. Main Pump Stations	
Palmdale - 25,800 gpm	$ 2,591,000
Lancaster - 15,700 gpm	1,846,000
2. Booster Pump Stations	
No. 6 - 3,000 gpm	$ 421,000
3. Open Reservoir	
No. 6 - 400 AF	$ 9,123,000
No. 7 - 565 AF	3,682,000
4. Distribution Pipelines	
42-inch D.I. (43,100 LF)	$9,051,000
36-inch D.I. (48,800 LF)	8,784,000
24-inch D.I. (15,840 LF)	1,901,000
20-inch D.I. (14,700 LF)	1,470,000
16-inch D.I. (5,400 LF)	432,000
14-inch D.I. (18,700 LF)	1,309,000
12-inch D.I. (5,500 LF)	330,000
10-inch D.I. (20,500 LF)	1,025,000
6-inch D.I. (1,300 LF)	39,000
5. System Flushing and Testing	$ 174,000
SUBTOTAL	$ 42,178,000
Contractor's OH & Profit (15%)	6,327,000
Engineering/Admin (20%)	8,436,000
Contingency (25%)	10,545,000
TOTAL (Secondary System)	$ 67,486,000
TOTAL (Distribution Facilities)	$112,238,000
GRAND TOTAL	$ 144,386,000

The cost estimates were developed to provide a reference for financial planning. The actual construction cost and project cost would depend on the final project scope, the schedule for construction, and market conditions at the time of construction. Feasibility of the project and funding needs must be considered and reviewed thoroughly in order to select the proper option and to provide adequate funding.

Edwards AFB System

Edwards AFB is currently designing a 2.5-mgd tertiary wastewater treatment plant, located south of the South Base entry gate and east of Switch Station #4. (See Figure 6-1.) The following is a list of facilities for the planned reclaimed water distribution system identified in Boyle Engineering Corporation's July 1993 "Early Preliminary Design Submittal, Volume 1, Design Narrative":

- A 3,125-gpm main pump station at the wastewater treatment plant.
- A 3,125-gpm booster pump station.
- A 2.2-mg storage reservoir.
- Approximately 31,740 feet of PVC pipe ranging from 4 to 18 inches in diameter.

The estimated capital cost of the planned distribution facilities is $6,300,000. Operation and Maintenance (O&M) costs were estimated to be $140,000 per year.

EXCESS RECLAIMED WATER SUPPLY

Figures 6-11 through 6-13 depict seasonal demand patterns for the tertiary, secondary and Rosamond systems. As shown in the figures, excess reclaimed water supply would be available from all three systems after demands have been met. It is estimated approximately 6,400 acre-feet from the tertiary system, 37,500 acre-feet from the secondary system (excludes 2,500 acre-feet diverted to open reservoirs in the 2680 Zone) and 2,500 acre-feet from the Rosamond system would be available from the WRPs annually. The excess supplies can be discharged through the following methods:

- Surface Spreading
- Groundwater Injection
- Evaporation

Currently, Rosamond CSD has approximately 80 acres of land near their existing WRP that could be used for spreading. In addition, the DOA owns approximately 2,600 acres that are currently used to spread wastewater from the Palmdale WRP. However, the DOA has plans to eventually farm most of the land.

Tertiary treated water from the three WRPs could be recharged into the groundwater basin. This approach would depend on factors such as availability of land, location, soil type, and percolation rates. Two potential recharge sites are shown on Plate 2. The first site, identified in Earth Systems Consultants draft February 1994 Summary Report regarding test boring along the Amargosa Creek, is located along the Amargosa Creek between 10th and 25th Street West. The second site is located on DOA's property along Little Rock Creek. Previous studies at this site could not be identified. As shown on Plate 2, both sites are located near reclaimed water pipelines outlined in the conceptual plan. Groundwater recharge potential is also discussed in Chapter 5 - Aquifer Storage and Recovery Methods.

Pan evaporation data from CSDLAC's March 1993 "Lancaster Water Reclamation Plant Water Balance" indicates that approximately 107 inches or 9 feet of evaporation occurs at the Lancaster WRP on an annual basis. Assuming a depth of 9 feet for evaporation ponds, approximately 8 square miles of land is required to evaporate 46,400 acre-feet of water.

PERMIT REQUIREMENTS

Numerous permits will be required for construction and operation of the conceptual plan. A summary of potential regulatory requirements is shown in Table 6-13.

Federal

A Nationwide 404 Permit from the United States Army Corps of Engineers (Corps) is required for activities impacting the waters of the United States. Because some construction activities may occur within the riverbed (river crossings), it is recommended that the Corps be notified in writing of the proposed activities.

State

The following state agencies may require permits and/or approvals for the reclaimed water systems:

- California Department of Fish & Game
- California Department of Transportation
- California Department of Health Services
- Regional Water Quality Control Board
- State Water Resources Control Board

The 1601 Agreement from the California Department of Fish & Game (DFG) is required for all crossings or activities which may impact a stream or natural drainage way. This requirement includes construction of pipelines on bridges if construction activity occurs within the stream. In addition, crossings of minor streams may require 1601 Agreements.

TABLE 6-13

POTENTIAL REGULATORY REQUIREMENTS
FOR THE
RECLAIMED WATER SYSTEMS

	Agency	*Type of Approval*
I. FEDERAL PERMITS	United States Army Corps of Engineers	Nationwide 404 Permit
II. STATE PERMITS	California Department of Fish and Game	1601 Agreement for impact on or activity in streams
	California Department of Transportation	Encroachment Permit
	California Department of Health Services	Cross connection control
	Regional Water Quality Control Board	NPDES Construction Activity Permit
	Regional Water Quality Control Board	Reclamation Permit
	Regional Water Quality Control Board	Engineering Report Requirements
	State Water Resources Control Board	Petition for Change in Place and Purpose of Use
III. LOCAL PERMITS	Los Angeles County Department of Health Services	Onsite (cross connection control) (user) facilities approval
	Los Angeles County Department of Health Services	Distribution system design & construction approval
	Kern County Environmental Health Department	Onsite (cross connection control) (user) facilities approval
	Kern County Environmental Health Department	Distribution system design & construction approval
	City of Palmdale	Encroachment Permit
	City of Lancaster	Encroachment Permit
	Los Angeles County Department of Public Works	Excavation Permit
	Los Angeles County Flood Control District	Encroachment Permit
	Kern County Transportation Department	Encroachment Permit

An encroachment permit from the California Department of Transportation would be required for any work done within the state right-of-way. This includes installation of a pipeline in or across a highway, installation of a pipeline in a roadway crossing under a highway, support of a pipeline on a bridge crossing over a highway, and activities that impact on-ramp and off-ramp traffic.

The California Department of Health Services (DHS) would be involved during implementation of the reclaimed water systems. The DHS is concerned with cross connections, separation of pipelines, and any activity that may result in contamination of drinking water. The DHS would review plans and specifications prior to construction.

The RWQCB-LH regulates the source and the end use of reclaimed water. Its main involvement in the tertiary and secondary reclaimed water systems would be through the CSDLAC to modify the reclamation requirements to include the specific reclaimed water users and to review the Engineering Report describing treatment and distribution facilities and users. RWQCB-LH's main involvement in the Rosamond system would be through RCSD and would be similar to tertiary and secondary system involvement. In addition, National Pollutants Discharge Elimination System (NPDES) Construction Activity Permits may need to be obtained. These permits are required for stormwater runoff from construction projects impacting an area of 5 acres or more.

Water rights and funding alternatives would require involvement from the State Water Resources Control Board (SWRCB). Approval of a Petition for Change of Place and Purpose of Use is required for any change in discharge location or quantity of wastewater. If a low interest loan is chosen as a funding alternative, applications for the Water Reclamation Loan Program and State Revolving Fund are through the SWRCB. In addition to the permits and approvals described above, compliance with the California Environmental Quality Act (CEQA) would be required.

Local

Concerned with drinking water contamination (cross connection control), the Los Angeles County Department of Health Services and the Kern County Environmental Health Department requires plan review and inspection of the distribution system and onsite user facilities. The County Department of Health Services coordinates with RWQCB-LH and State DHS.

Encroachment permits are required for all construction work done within local right-of-way. These include the Cities of Palmdale and Lancaster, the Los Angeles County Department of Public Works (Excavation Permit), the Los Angeles County Flood Control District, and the Kern County Transportation Department.

OTHER INSTITUTIONAL ISSUES

Before providing reclaimed water service, it would be necessary to secure agreements between the following entities:

- CSDLAC and purveyors
- Purveyors and users
- CSDLAC and DOA

A contract between CSDLAC and the purveyors is required for sale of reclaimed water to the purveyors. Contracts between the purveyors and users and between CSDLAC and DOA (customer service agreement) would establish the requirements for use of reclaimed water and would specify that the users understand the regulations controlling use of reclaimed water.

FINANCING ALTERNATIVES

To finance the construction cost of the reclaimed water facilities, sufficient capital may be obtained through the following funding sources:

- Water Reclamation Loan Program
- State Revolving Fund
- Small Reclamation Projects Act of 1956
- Connection Fees

Water Reclamation Loan Program

The development of cost-effective water reclamation projects for the augmentation of water supplies constitutes the main purpose of the Water Reclamation Loan Program (WRLP). The WRLP is administered by the SWRCB's Office of Water Recycling and provides $30 million to local public agencies under the Clean Water and Water Reclamation Bond Law of 1988. These funds are available to assist in the design and construction costs of water reclamation projects. Although a maximum loan amount per project is not specified in the Bond Loan, SWRCB policy limits each project to $5 million. Loans covering 100 percent of eligible costs may be provided for a maximum period of 20 years at an interest rate of one-half the rate paid by the State on the most recent sale of state general obligation bonds. The present rate is 4 percent. A water reclamation project is eligible for the WRLP under the 1988 Bond Law if it is cost-effective compared to the cost of new freshwater supply alternatives and if no federal assistance is available at the time of need. Available funds would generally be committed to those projects with completed facilities planning which have met all loan program requirements and are ready to proceed. General requirements include a completed facilities plan with a project report, a complete environmental document, and a draft revenue program. In addition, all projects must comply with CEQA prior to loan authorization. According to SWRCB staff, funds for projects in the near future are very limited.

CHAPTER 7

AQUIFER STORAGE AND RECOVERY

This chapter evaluates the feasibility of implementing an aquifer storage and recovery program within the Antelope Valley. Elements of the chapter include an overview of aquifer storage and recovery methods, followed by discussions on the hydrogeology of the Antelope Valley, hydraulic characteristics of the Antelope Valley aquifers, current condition of the aquifers, quantity and quality of available groundwater information, potential water sources for recharge, regulatory issues, and characteristics for good infiltration and injection sites. A summary of relevant studies, as well as factors specific to surface infiltration, and discussions on potential surface recharge areas, feasibility of infiltration, potential injection sites and feasibility of injection are also presented.

OVERVIEW OF AQUIFER STORAGE AND RECOVERY METHODS

One of the elements of the Antelope Valley Water Resource Study is an evaluation of the feasibility of Aquifer Storage and Recovery (ASR). For purposes of this evaluation, ASR will include the following methods of storing and recovering water from the groundwater basin:

- Spreading/Infiltration - use of surface spreading basins to allow infiltration of water into the aquifer.

- Injection - use of new or existing wells for direct injection of water into the aquifer.

- In-lieu Use - use of an alternative source of water, other than groundwater, when available, and use of groundwater when the alternative source is unavailable. In-lieu use is not discussed in this chapter but is addressed as part of the overall water resources management plan.

ASR should be considered a conjunctive use program which integrates the management of local groundwater basins with use of imported supplies of surface water. Some of the benefits of an ASR program include:

- Improved water supply reliability.

- Optimized use of alternative water supplies.

- Reduction of subsidence problems.

- Reduction of pumping lifts.

- Increased flexibility of operations.

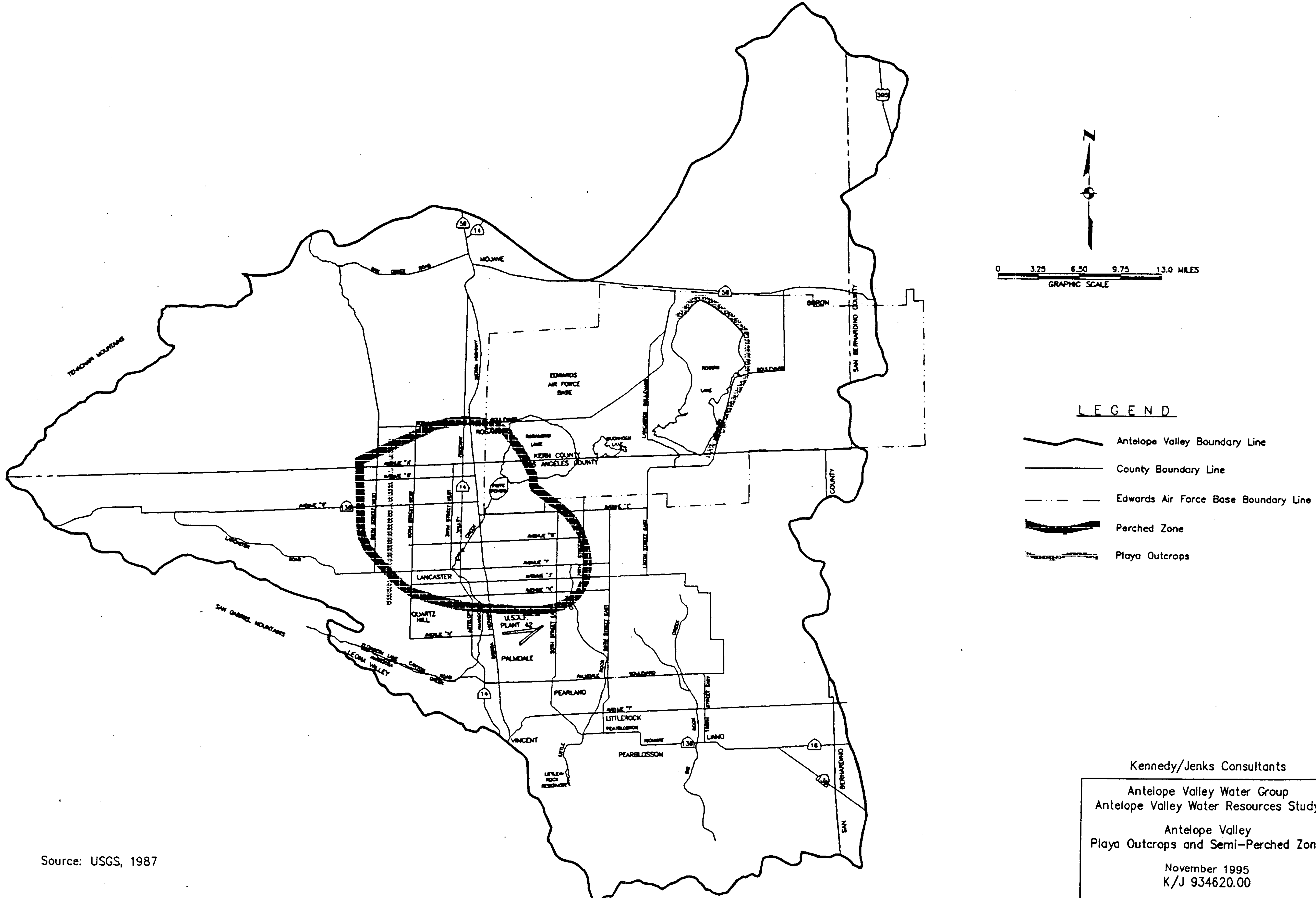
HYDROGEOLOGY OF THE ANTELOPE VALLEY

The Antelope Valley is roughly triangular in shape and approximately 2,400 square miles in area. The Tehachapi Mountains form the northwestern boundary of the Valley to an altitude of 7,981 feet while the San Gabriel Mountains form the southwestern boundary to an altitude of 9,399 feet. The San Andreas Fault runs along the base of the San Gabriel mountains on the south and the Garlock Fault runs along the base of the Tehachapi Mountains on the north. In addition to the main San Andreas and Garlock Fault systems, the Antelope Valley floor is criss-crossed with faults, dividing the Valley into many different geologic sub-units as shown on Plate 1. These faults may also act as barriers to groundwater flow as evidenced by disparities in groundwater levels across the fault zones.

The geologic formations of the Antelope Valley can be divided into two main groups: the consolidated, virtually non-water-bearing rocks along the mountainsides and at the bottom of the groundwater basin, and the unconsolidated deposits which are the principal water-bearing formations of the Valley. The consolidated rock consists mostly of igneous intrusive and metamorphic rocks of pre-Tertiary age, and basalt, continental volcanic, and marine and continental sedimentary rocks of Tertiary age. In certain areas of the Valley where the rock outcrops occur (such as on many buttes), the consolidated rock can act as a hydraulic barrier to groundwater flow.

The unconsolidated deposits include younger and older alluvium, older fan deposits, windblown dune sand, and playa deposits. Closer to the center of the Valley, the older alluvial materials consist of finer materials such as compact gravel, sand, silt, and clay interbedded with more permeable aquifer materials. These finer silts and clays can form impermeable lenses which inhibit movement of water and can result in isolated perched water tables. In addition to the isolated clay layers, a more extensive shallow perched water body exists and is shown in outline on Figure 7-1. The clay lenses that form the shallow perched zone are thought to be remnants of old lake features which can form barriers to groundwater flow at shallower depths. The shallow perched zone generally occurs within 80 feet of the ground surface and traps poorer quality water that can contain high concentrations of bacteria, chloride, dissolved solids, nitrate, and pesticides.

Below the shallow-perched zone in the main floor of the Valley, playa or old lakebed (lacustrine) deposits of Pliocene through Holocene age exist. These deposits are composed of siltstone, clay, and marl. These beds can be up to 400 feet thick and can be interbedded with coarser material of up to 20 feet in thickness. These thick layers are often described as blue clay and are a main feature of the aquifer system in the central part of the Valley. In certain areas, the lacustrine deposits divide the unconsolidated deposits into an upper principal unconfined aquifer and a lower confined deep aquifer as shown on the generalized cross-sections on Figures 7-2 and 7-3. Near the southern boundary of the Antelope Valley, the lacustrine layer is overlain by 300 to 500 feet of alluvium, while at the northern boundary of the



Source: USGS, 1987

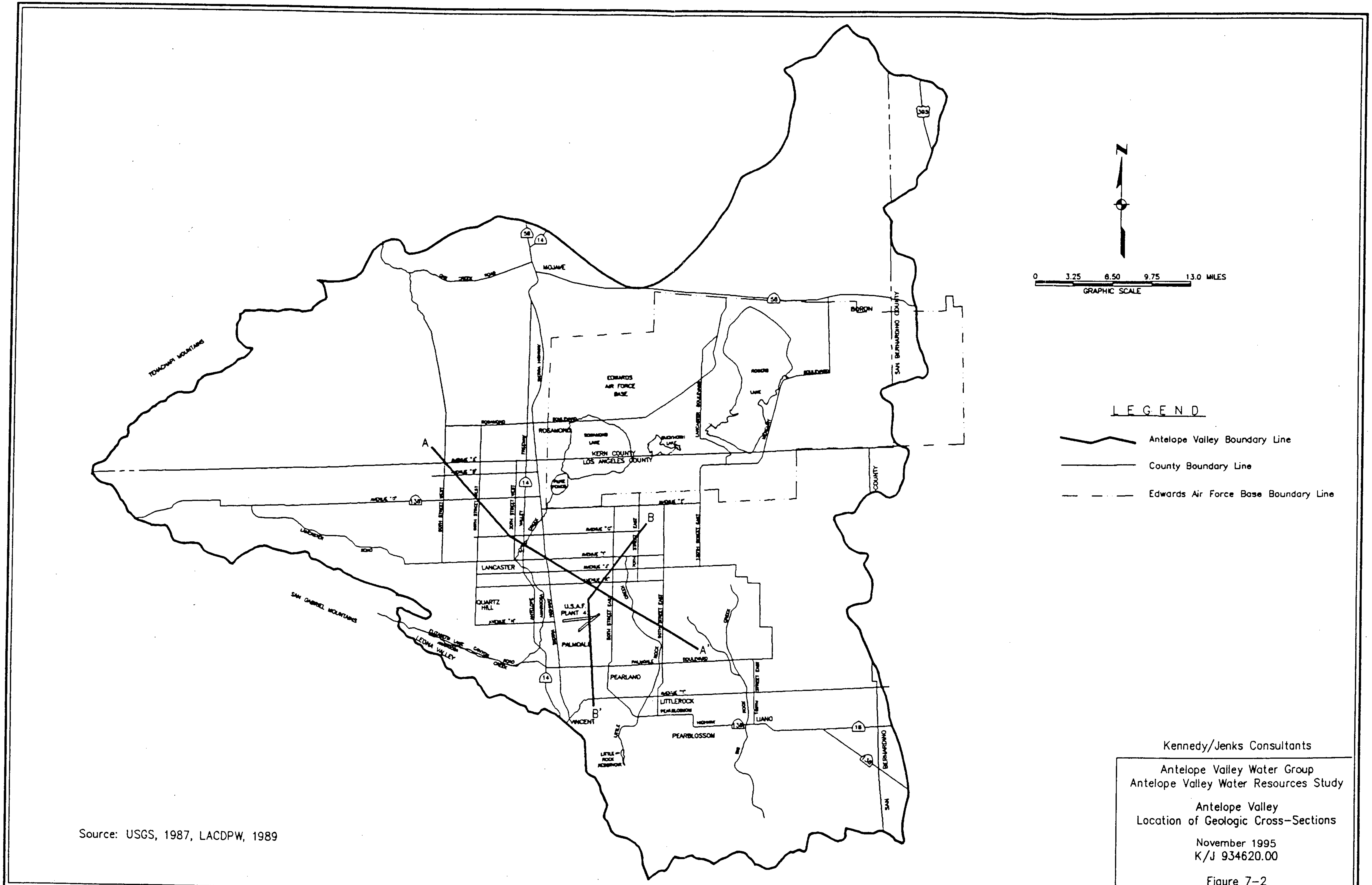
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Antelope Valley
Playa Outcrops and Semi-Perched Zone

November 1995
K/J 934620.00

Figure 7-1



Source: USGS, 1987, LACDPW, 1989

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Antelope Valley
Location of Geologic Cross-Sections

November 1995
K/J 934620.00

Figure 7-2

Valley, it is exposed at the land surface. (See Figure 7-1). In this multi-layered system, the overall thickness of the deposits can be more than 1,900 feet (USGS, 1967) and could be as great as 10,000 feet (USGS, 1960).

For the purposes of ASR, the younger and older alluvium deposits found near the base of the San Gabriel Mountains are of particular interest because of the coarse sands and gravels commonly found in those areas. In addition, those areas near the base of the mountains are in a single aquifer system because the lacustrine layer does not appear to extend that far. The alluvial deposits near the hills are estimated to be up to 900 feet thick (USGS, 1993).

The entire groundwater basin of the Antelope Valley is estimated to have 68 million acre-feet of storage of which 13 million acre-feet is currently available (DWR, 1980). Approximately 55 million acre-feet of groundwater was estimated to remain in storage as of 1975. This stored water, however, may not be entirely accessible due to 1) uneconomical pumping depths, 2) distance between the groundwater basin and current users, and 3) the potential for causing land subsidence.

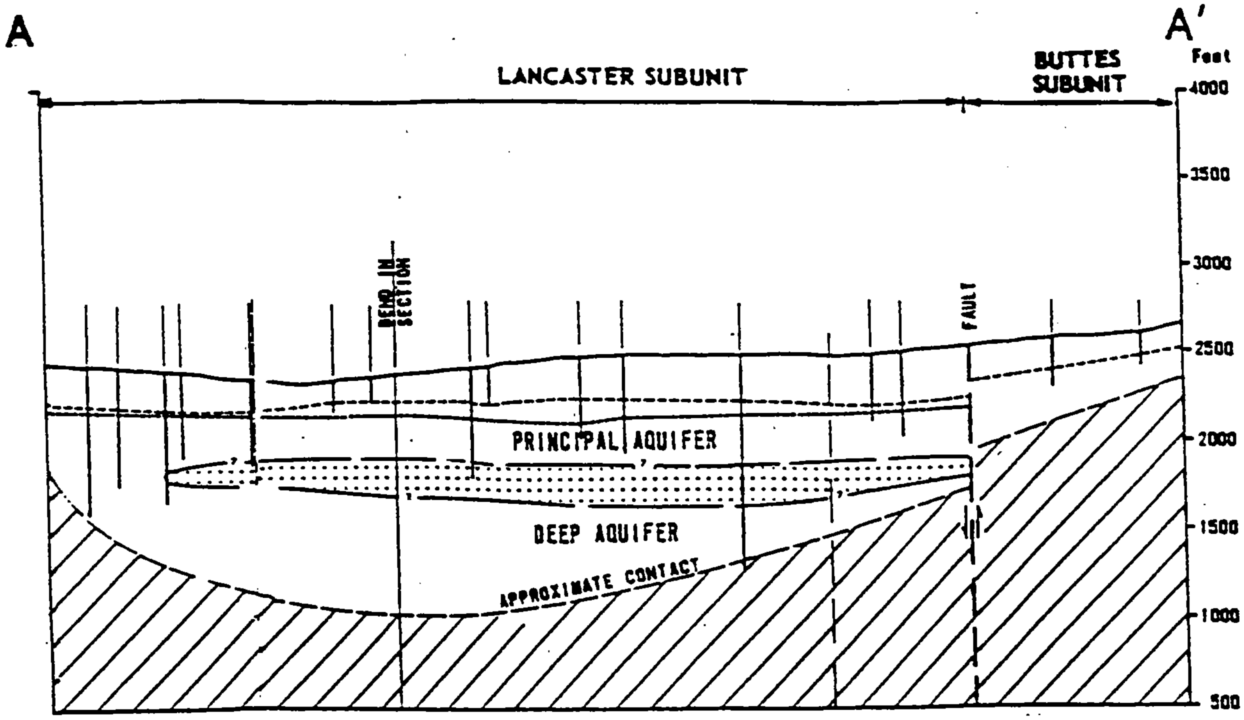
Existing Groundwater Recharge Sources

At present, the principal source of recharge of the groundwater in the Antelope Valley is runoff, principally recharged in the foothills of the mountains. Numerous studies have been conducted to estimate natural recharge since 1924, some based on little data. The most recent studies estimate natural recharge at 31,200 to 59,100 acre-feet per year (USGS, 1993). This estimate is based on the assumptions that the contribution to recharge from precipitation on the Valley floor is negligible and diversions and evaporation accounts for up to 10,000 acre-feet per year. The three main creeks that contribute runoff to the Valley are Amargosa Creek, Little Rock Creek, and Big Rock Creek. The Big Rock and Little Rock Creeks alone are estimated to contribute more than 50 percent of the runoff. Total runoff from the San Gabriel mountains (including runoff from Big Rock and Little Rock Creeks) have been estimated to contribute up to 80% of the total recharge.

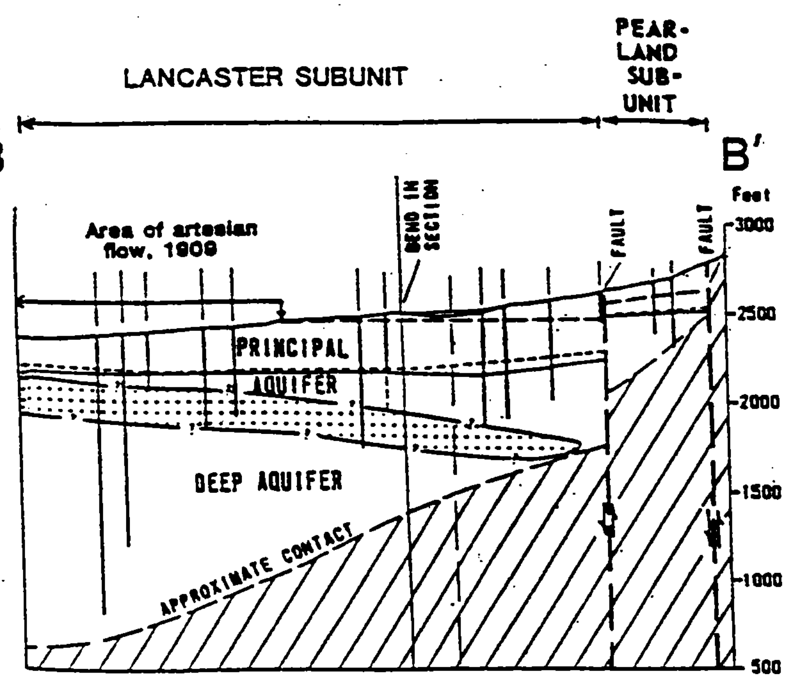
Other sources of recharge include irrigation return flow, leaking water conveyance lines, wastewater collection and treatment facilities, and artificial recharge. Depending on the thickness and characteristics of the unsaturated zone, these sources may or may not contribute to recharge of the groundwater. In addition, there have been no estimates of the quantities of these other sources that actually recharge the groundwater.

HYDRAULIC CHARACTERISTICS OF THE ANTELOPE VALLEY AQUIFERS

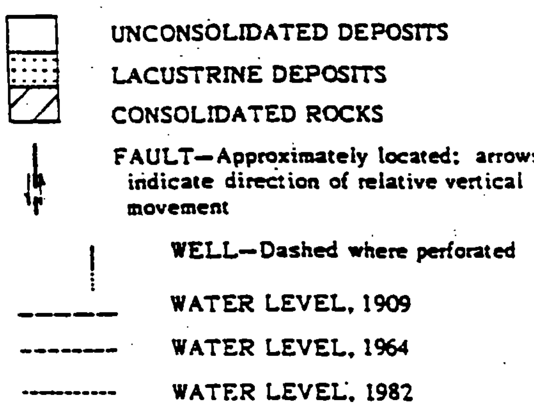
An important element of the assessment of any aquifer to its feasibility for ASR are the hydraulic characteristics of the aquifer which determine its response to pumping and recharge of outside sources of water. The primary hydraulic characteristics of interest are the hydraulic conductivity and storage available in the aquifer media.



Generalized geologic cross-section A-A'



Generalized geologic cross-section B-B'



Geology modified from Bloyd (1967) and Durbin (1978)
Lacustrine deposits shown diagrammatically

Location of section lines shown on Figure 7-2

Source: LACDPW, 1989

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Antelope Valley
Geologic Cross-Sections

November 1995
K/J 934620.00

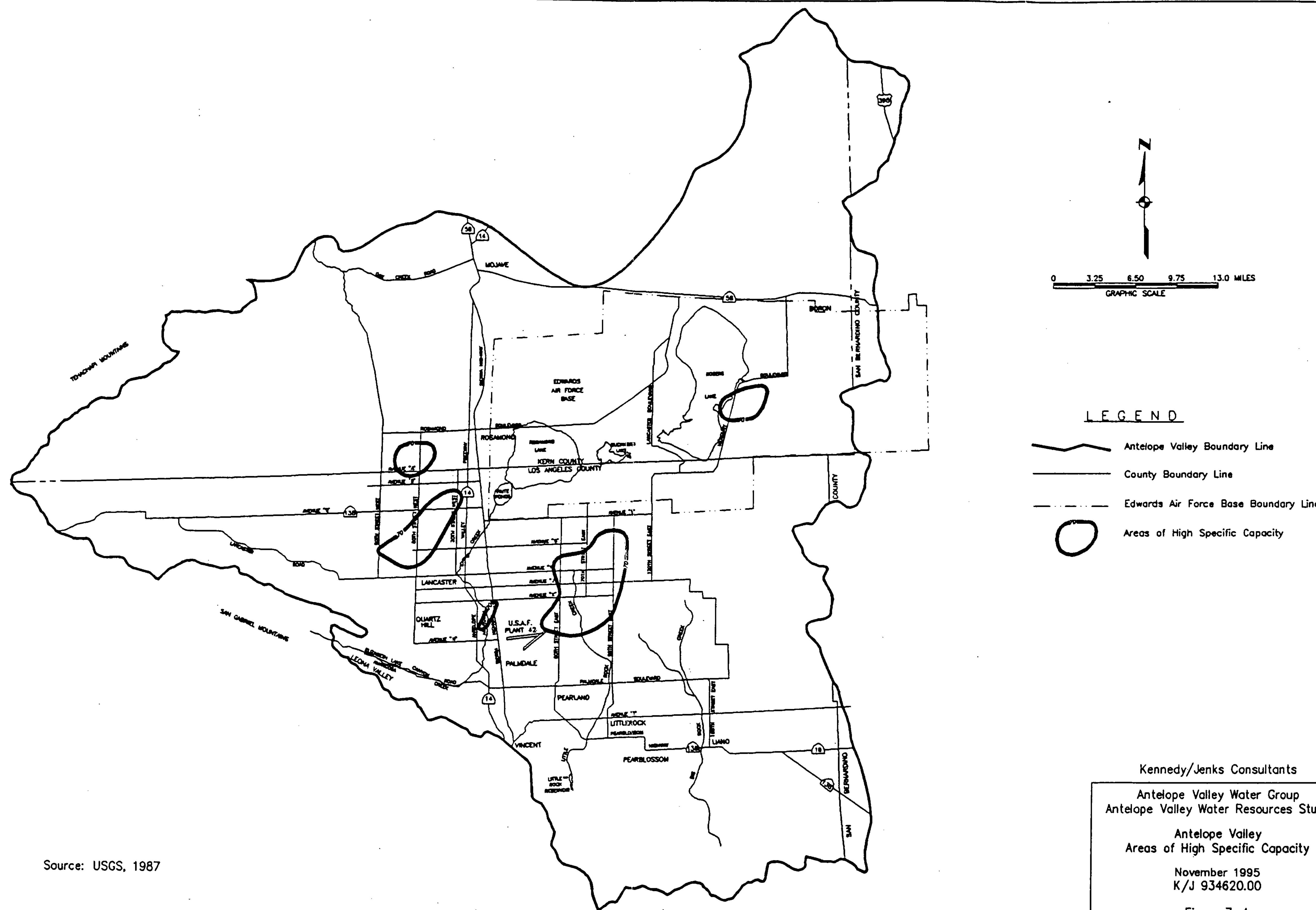
Figure 7-3

Hydraulic conductivity (K) which is commonly measured in centimeter per second (cm/sec) or feet per second (ft/sec) describes the aquifer's ability to transmit water as a function of both the porous media and the fluid. Hydraulic conductivities for alluvial materials such as sands and gravels are in the range of 10^{-2} to 10^{-3} cm/sec or 10^{-4} to 10^{-5} ft/sec. In multi-layered aquifer systems such as in Antelope Valley, the horizontal hydraulic conductivity is governed by coarse grained materials and is higher than the vertical hydraulic conductivity which is governed by the fine-grained materials.

The hydraulic conductivity multiplied by the thickness of the aquifer can be used to estimate the transmissivity (T) which is the ability of the aquifer to transmit water laterally. The transmissivity is commonly measured in gallons per day per foot (gpd/ft) or square feet per day (ft^2/day). In aquifers of 5 to 100 meters thick, values of $T > 100{,}000$ gpd/ft or 13,800 ft^2/day are good aquifers for potential ASR use. Aquifers with T values lower than 100,000 gpd/ft may be acceptable for ASR use; however, this will depend on the specific site conditions. Transmissivity and hydraulic conductivity values are good measures of the ability of the aquifer to accept additional water. The transmissivity can be used to estimate the specific capacity or productivity of a well which has the units of gallons per minute per foot of drawdown.

The ability of an aquifer to store water is described in a parameter called the storage coefficient, defined as the volume of water released by the aquifer from storage per unit surface area of aquifer per unit decline in hydraulic head. For confined aquifers, the storage coefficient is called storativity (S) which is a dimensionless coefficient that describes the water produced as a function of aquifer compaction and water expansion. For unconfined aquifers, the storage coefficient is called specific yield and describes the water yielded from the water-bearing material by gravity drainage as a percent of aquifer volume. Typical values of storativity are 0.005 to 0.00005 while typical values of specific yield are 0.01 to 0.30. Specific values for storativity and specific yield in the Antelope Valley are a function of the depositional environment and will vary from place to place.

Estimates for hydraulic conductivity, transmissivity and storage in Antelope Valley have been obtained through pump tests conducted in and around Edwards Air Force Base (AFB). Values range from 4,600 to 26,800 ft^2/day for transmissivity, 0.017 to 0.13 ft/day (2×10^{-7} to 1.5×10^{-6} ft/sec) for vertical hydraulic conductivity in the lacustrine clay, and 0.00036 to 0.13 for the storage coefficient (USGS, 1993). Estimates of transmissivity from specific capacity tests in wells range from 600 to 32,000 ft^2/day (USGS, 1994). Pump test data outside of the Edwards AFB grounds appear sparse. Other estimates of specific capacity have been compiled in earlier USGS reports such as USGS 1967 which developed a contour map of specific capacities ranging from 3,800 to 15,400 ft^2/day, primarily representing the unconfined zone. The areas of highest specific capacity are shown on Figure 7-4.



Source: USGS, 1987

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Antelope Valley
Areas of High Specific Capacity

November 1995
K/J 934620.00

Figure 7–4

Storage coefficients such as specific yields have been estimated from lithologic logs. Around Edwards AFB, the storage coefficient ranges from 3 to 15 percent, with an average of 9 percent. Estimates for other areas of the Valley have shown specific yield estimates of 5 to 20 percent (USGS, 1993).

Finally, a parameter of relevance to surface recharge is the infiltration or percolation rate in inches per minute. In areas near the alluvial fans, surface soils are generally relatively coarse which indicates relatively high percolation rates. Very few published studies have been conducted which document percolation rates; however, field testing is relatively easy to conduct.

CURRENT CONDITION OF THE AQUIFERS

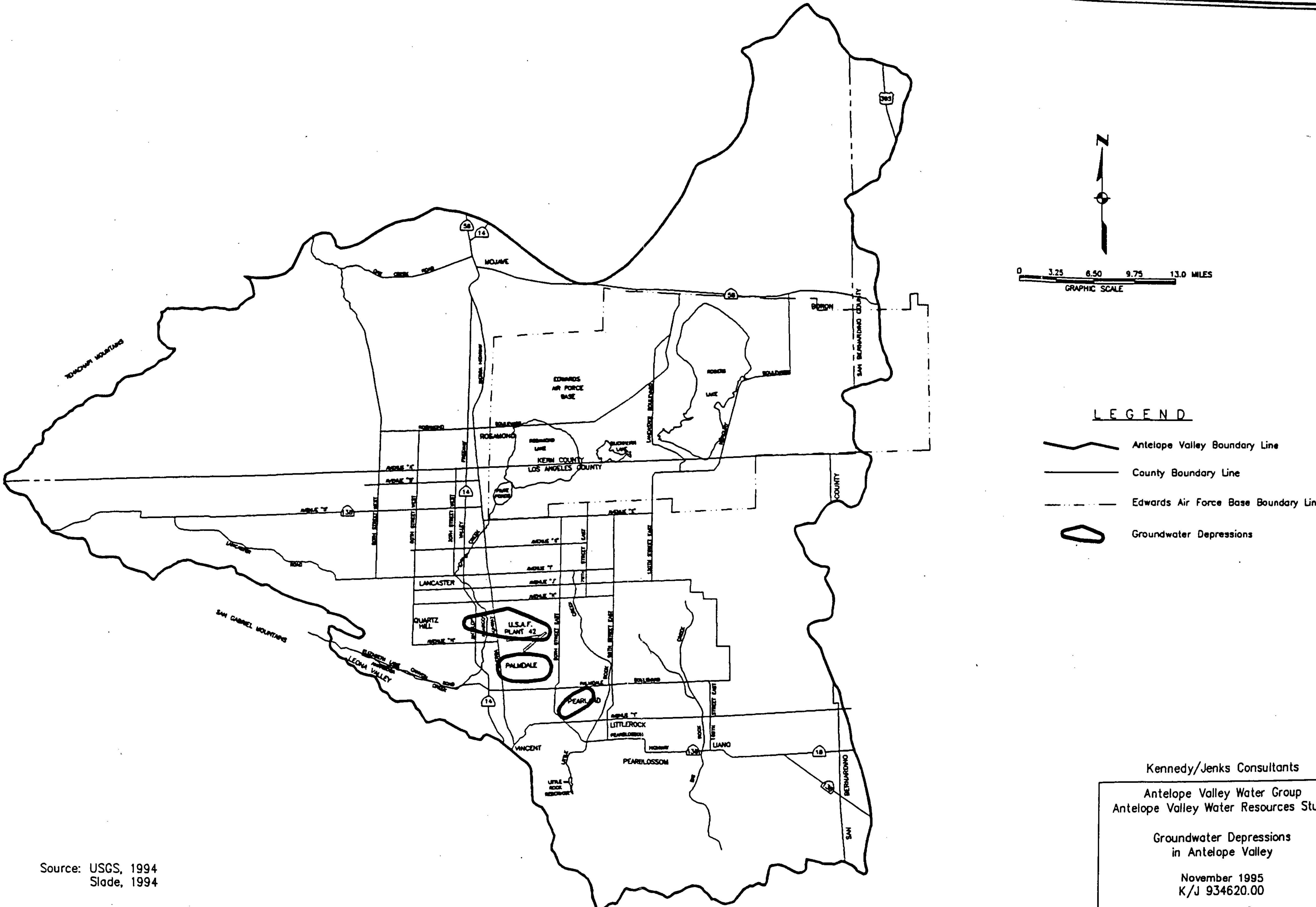
A brief description of the water levels and water quality for the groundwater aquifer in the Antelope Valley is presented below.

Water Levels

Irrigated agriculture started in the Antelope Valley in the 1890s with documented evidence of 50,000 acres of land irrigated with surface water. However, the unreliability of surface water led to the development of groundwater use starting in 1912 with the highest pumping occurring in the 1950s and 1960s. By 1919, there were an estimated 500 wells drilled in Antelope Valley with the number rising to about 600 wells in 1940 and more than 1,000 by 1950. In 1956, there were about 135,000 acres of dry and irrigated agricultural land under production in the Valley (USGS, 1967) with a peak annual water usage of about 415,000 acre-feet per year (USGS, 1993).

As the Valley has developed, many of the agricultural land uses have been converted to urban and industrial land uses. For the first time since the 1890s, groundwater pumpage for municipal supply exceeded the demand for agricultural supply in 1988 (USGS, 1993). The estimated total water demand in 1990 for the Valley was about 128,000 acre-feet per year which was met by surface water, groundwater and State Water Project (SWP) water.

Groundwater levels have declined by as much as 200 feet (USGS, 1994). This decline has significantly increased pumping costs, resulting in overdrafting of the aquifer and land subsidence. The introduction of imported water from the SWP to the Valley in 1973 reduced the demand for groundwater, thereby allowing groundwater levels to recover somewhat, which subsequently may have reduced the rate of subsidence (USGS, 1995). However, there is still a significant groundwater depression in the Valley as shown on Figure 7-5. In addition to the groundwater depression identified by the USGS, two groundwater depressions have been identified in the Lancaster and Pearland Sub-units (Slade, 1994). The locations are also shown on Figure 7-5. (Conversation with Palmdale Water District suggests that the depression in the Pearland Sub-unit may not be a groundwater depression but merely a change in gradient.)



Source: USGS, 1994
Slade, 1994

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Groundwater Depressions
in Antelope Valley

November 1995
K/J 934620.00

Figure 7-5

The high pumping rates of the 1950s and 1960s resulted in groundwater overdraft and subsidence of the ground surface as shown on Figure 7-6. Some of the areas of highest subsidence are coincident with current groundwater depressions. Studies by the USGS in 1993 indicate that the maximum estimated land subsidence from 1930 to 1992 was about 6.6 feet. In addition, there are approximately 290 square miles which have subsided by at least 1 foot, relating to a reduction in aquifer storage of about 50,000 acre-feet (USGS, 1994).

Water Quality

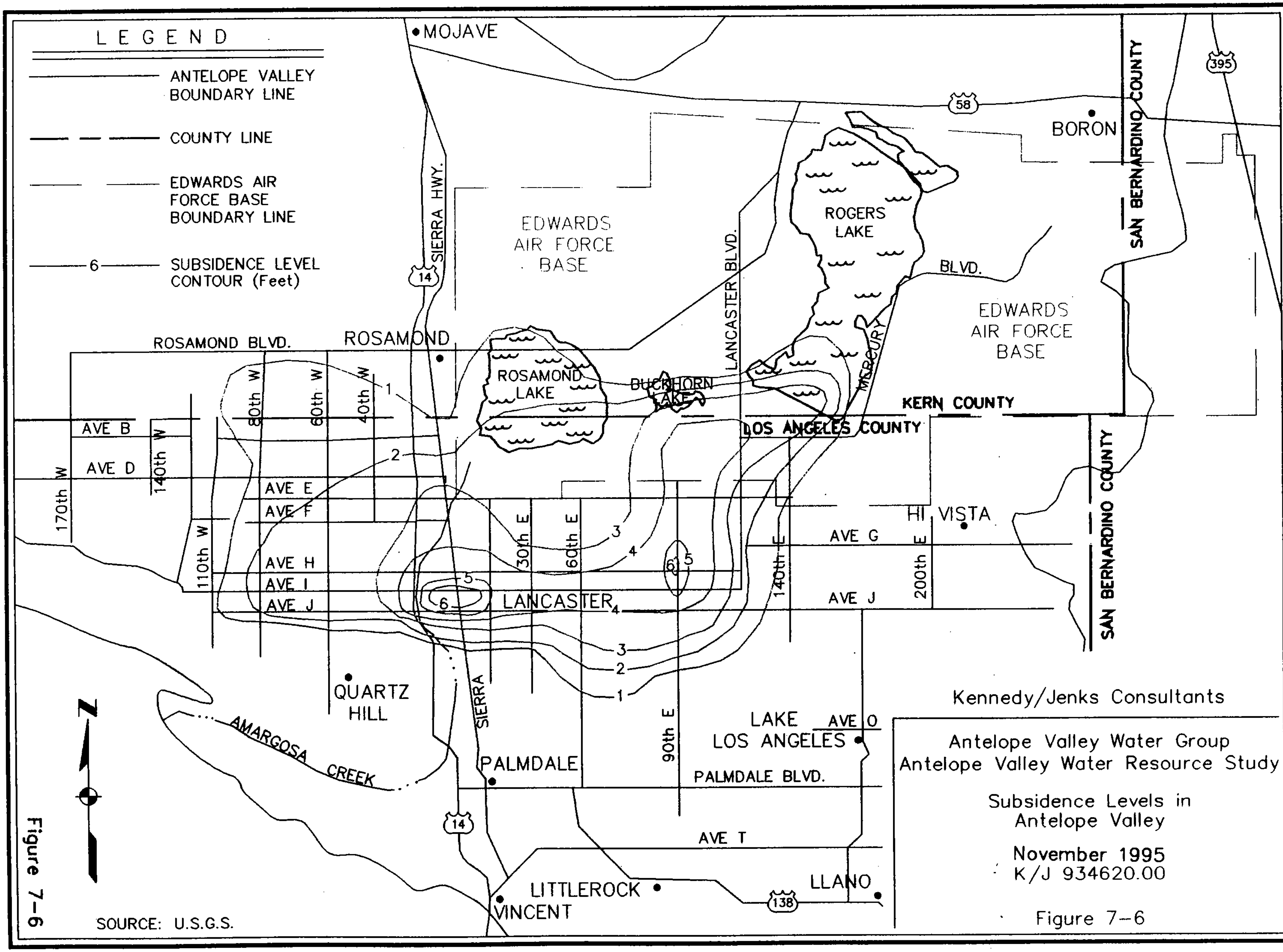
Water quality is generally good (i.e., Total Dissolved Solids (TDS) < 1000 parts per million (ppm)) Valley-wide except for the northeast part of Valley, the borders of the Lancaster Sub-unit, and some shallow wells in North Edwards and Boron. Poorer water quality appears to be associated in areas with hard-rock outcrops and areas underlain by the shallow playa deposits where evaporation has concentrated solutes. In general, the water quality over time has remained relatively unchanged over the entire Valley and generally meets maximum contaminant limits (MCLs) (USGS, 1987). The exceptions to the good groundwater quality are some high concentrations of boron associated with naturally-occurring boron deposits, and high nitrates associated with fertilizer use and poultry farming near the areas of Little Rock and Quartz Hill. Most of the groundwater withdrawals for municipal and agricultural use are drawn from the upper principal aquifer. Water quality data for specific areas are provided in later sections.

QUANTITY AND QUALITY OF AVAILABLE GROUNDWATER INFORMATION

Over three thousand wells have been drilled in Antelope Valley that have been recorded with the DWR. The USGS has prepared a computerized water-level database for these wells where the data fields include the local well number based on township, range, and section; the use of the water; the depth of well; the perforated interval; elevation of the land surface; the date of data collection, and the water level elevation. These data are not available for all of the wells and many of the wells contain measurements for only a few years. A listing of the well numbers would take many pages and therefore is not included in this report. A diskette with the well numbers and water level data is available.

In order to have a more complete picture of the aquifer characteristics at a single well, three basic pieces of information are required for that well including:

- Water level data over time.
- Water quality data over time.
- Well construction data such as geologic well logs, driller's logs, perforated intervals, construction material, and electric logs.


LEGEND
ANTELOPE VALLEY BOUNDARY LINE
COUNTY LINE
EDWARDS AIR FORCE BASE BOUNDARY LINE
6
SUBSIDENCE LEVEL CONTOUR (Feet)
MOJAVE
ROSAMOND
BORON
EDWARDS AIR FORCE BASE
EDWARDS AIR FORCE BASE
ROSAMOND LAKE
ROGERS LAKE
BUCKHORN LAKE
SIERRA HWY.
14
58
395
138
ROSAMOND BLVD.
LANCASTER BLVD.
MERCURY
BLVD.
KERN COUNTY
LOS ANGELES COUNTY
SAN BERNARDINO COUNTY
SAN BERNARDINO COUNTY
AVE B
AVE D
AVE E
AVE F
AVE G
AVE H
AVE I
AVE J
AVE J
AVE O
AVE T
170th W
140th W
110th W
80th W
60th W
40th W
30th E
60th E
90th E
140th E
200th E
HI VISTA
LANCASTER
QUARTZ HILL
AMARGOSA CREEK
SIERRA
PALMDALE
PALMDALE BLVD.
LAKE LOS ANGELES
LITTLEROCK
VINCENT
LLANO
1
2
3
4
5
6
SOURCE: U.S.G.S.
Figure 7-6
Kennedy/Jenks Consultants
Antelope Valley Water Group
Antelope Valley Water Resource Study
Subsidence Levels in Antelope Valley
November 1995
K/J 934620.00
Figure 7-6

The omission of the well-construction data make evaluations of changes to the water quality or water levels in the groundwater difficult. The situation is made even more difficult in a multi-layer aquifer system as occurs in parts of the Antelope Valley.

Water Level Data

The USGS has compiled a database of water levels from their own data as well as those of the Department of Water Resources, for over 3,000 wells in the Antelope Valley (USGS, 1994b). However, the sheer size of the Valley prevents detailed study because even the 3,000 wells results in an average well density of about 2 wells per square mile. The USGS monitors water level for about 200 of those wells, however the majority of the 3,000 wells have data from only one point in time. Only 260 wells contain long-term water level data as shown on Figure 7-7.

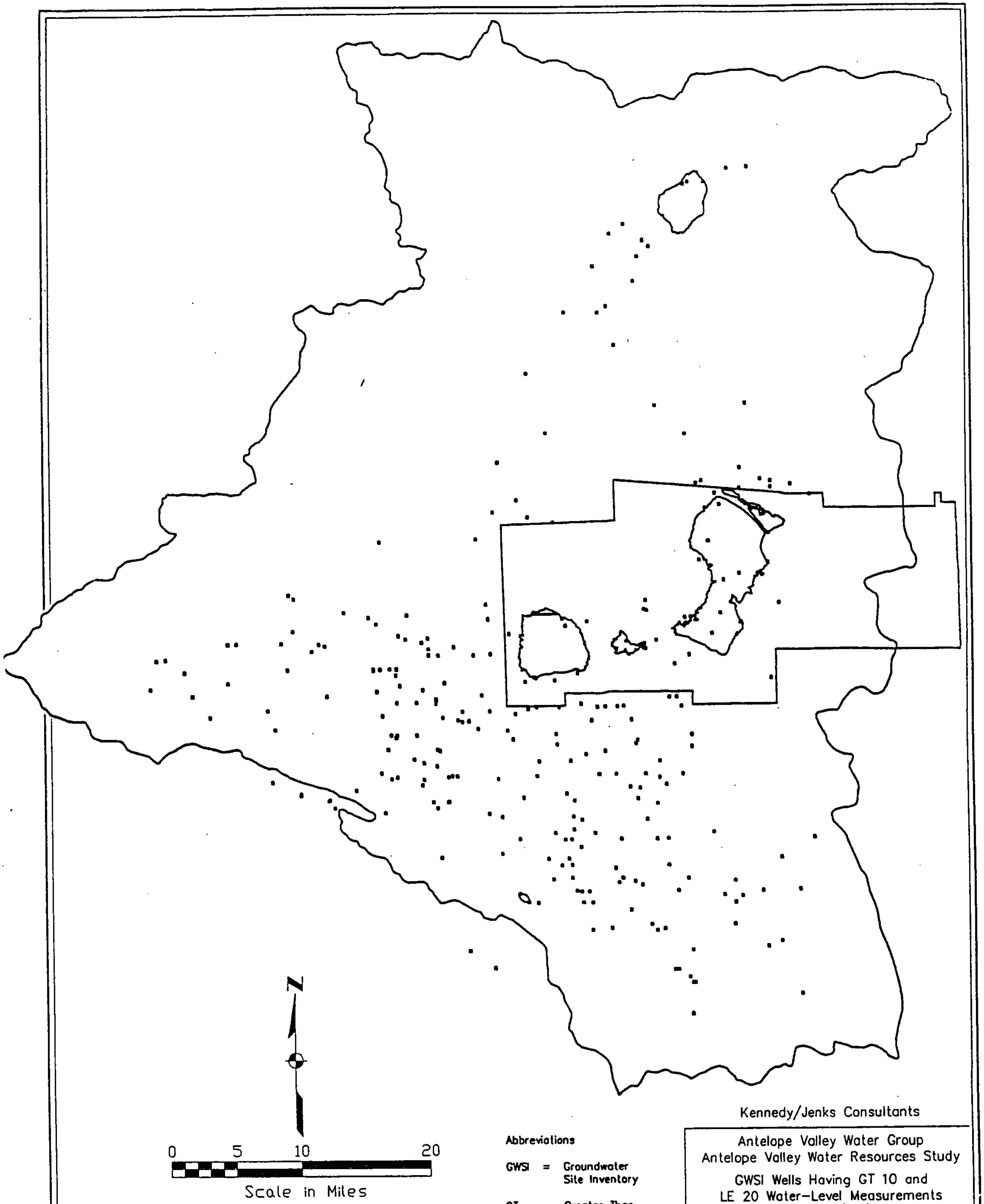
Water Quality Data

Similarly, the water quality data that were available from the USGS and from a CD-ROM of groundwater data are also quite sparse. As shown on Figure 7-8, there are over 2,500 wells with 1 water quality sample (most data were collected in the 1950s and 1960s). However, as shown on Figure 7-9, the number of wells with more than 10 water quality samples drops significantly to about 60 wells. Many of the wells of interest have water quality data that are more than 15 years old. The USGS has continued to monitor approximately 40 wells for water quality parameters in the Antelope Valley.

The water quality data that are currently available can only give a general overview of the condition of the aquifer. Additional site-specific data will be necessary to assess the condition of the aquifer and the potential impacts of recharge on the overall groundwater quality.

Well Construction Data

In addition to water quality and water level data, well data (such as lithologic logs and descriptions of construction) are also an important component. Because of the multi-layered aquifer system in the Antelope Valley, the well logs and knowledge of the depth and perforated intervals of the wells are vital to assessing the hydrogeology and the potential interactions between various aquifer zones. Based on the studies by the USGS, it appears that there are about 2,500 wells for which well construction data are available as shown on Figure 7-10. USGS, working with the Antelope Valley-East Kern Water Agency (AVEK) in the 1970s and 1980s, created a database of information for the wells in the more urbanized portions of the Valley. The database indicates whether well logs exist for specific wells. These data could provide an accessible source upon which site-specific investigations could be based.



Abbreviations

GWSI = Groundwater Site Inventory

GT = Greater Than

LE = Less Than or Equal To

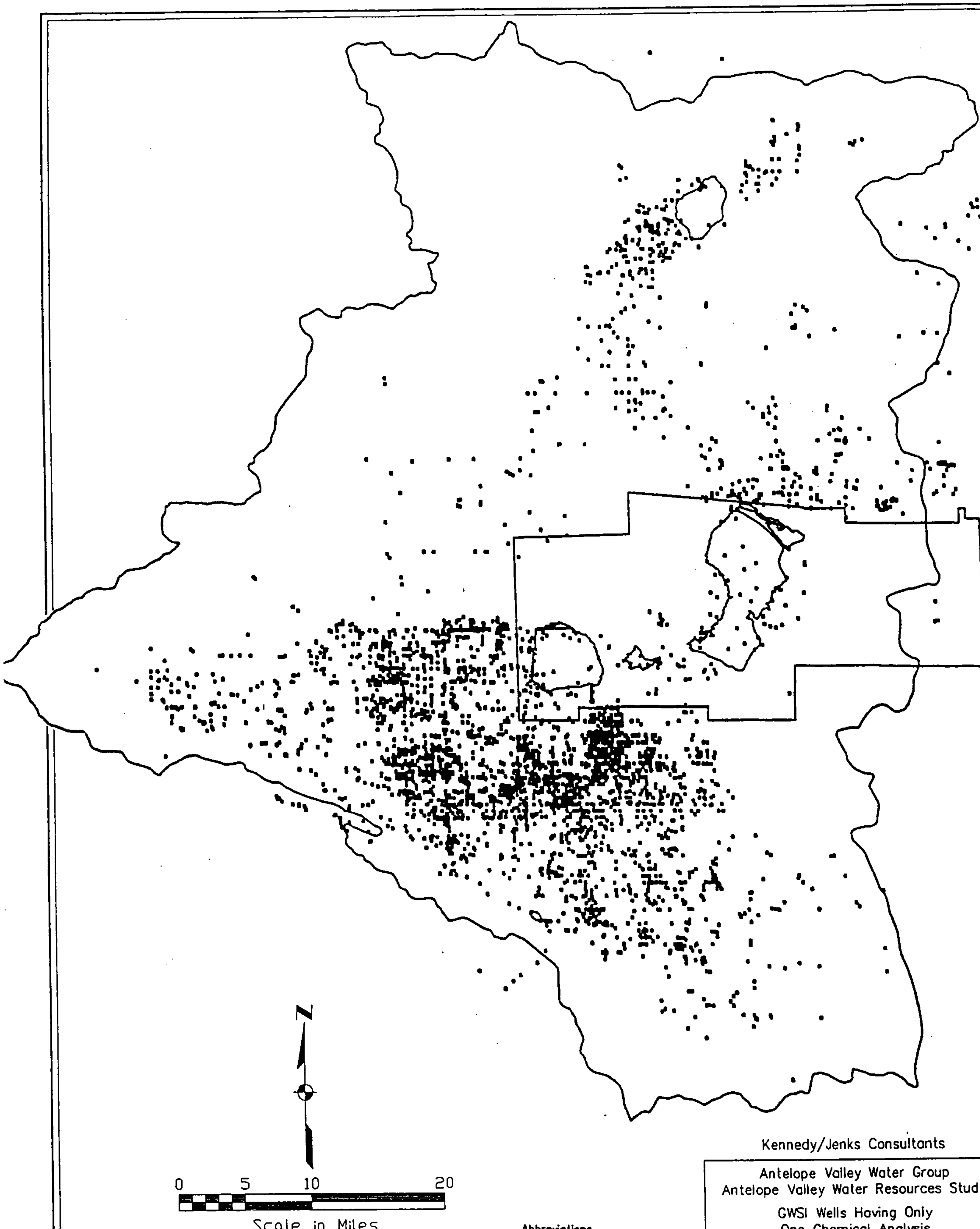
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

GWSI Wells Having GT 10 and LE 20 Water-Level Measurements as of 11/13/91

November 1995
K/J 934620.00

Figure 7-7



Source: USGS, 1994b

Abbreviations

GWSI = Groundwater Site Inventory

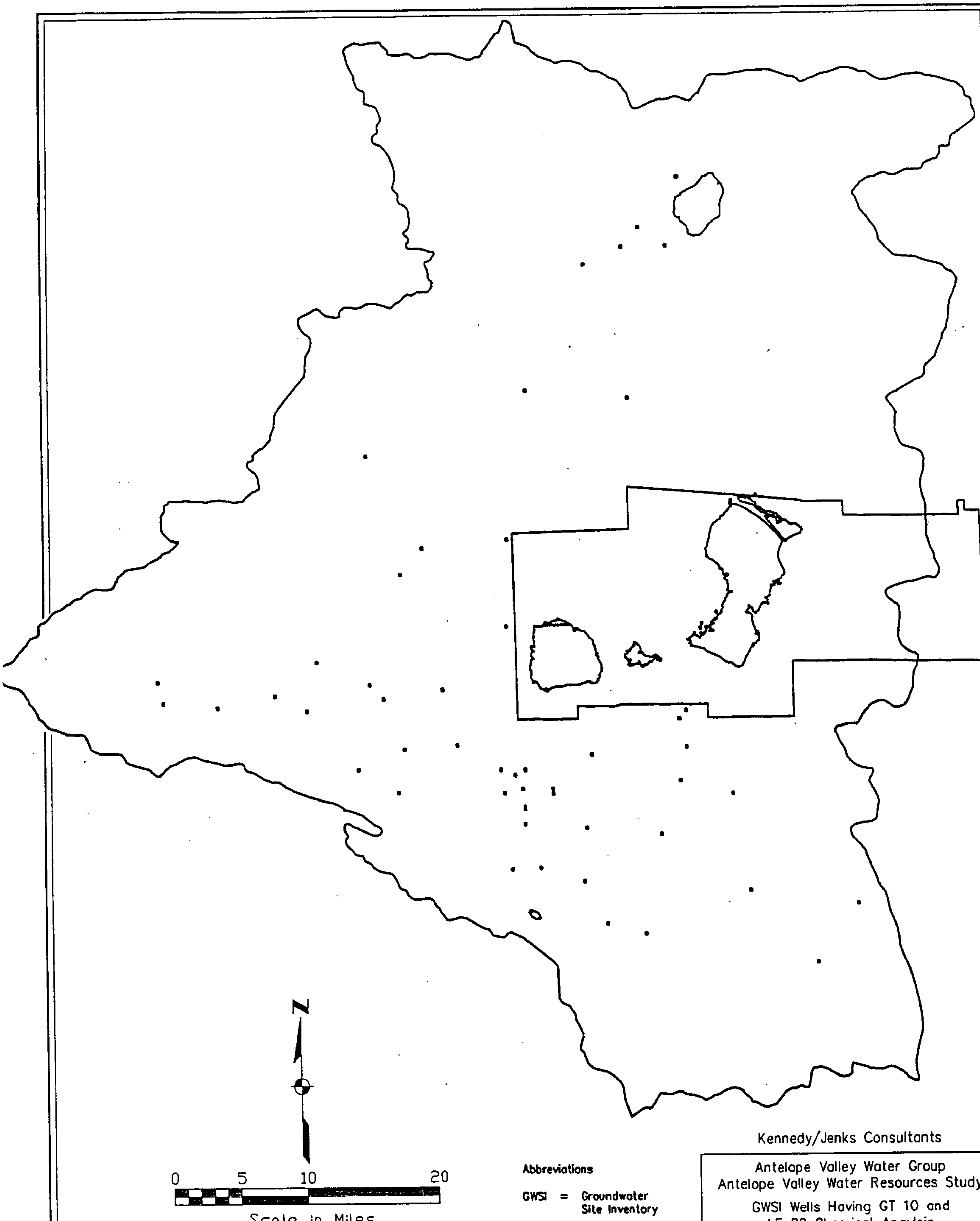
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

GWSI Wells Having Only One Chemical Analysis as of 11/13/91

November 1995
K/J 934620.00

Figure 7-8



Source: USGS, 1994b

Abbreviations

GWSI = Groundwater Site Inventory

GT = Greater Than

LE = Less Than or Equal To

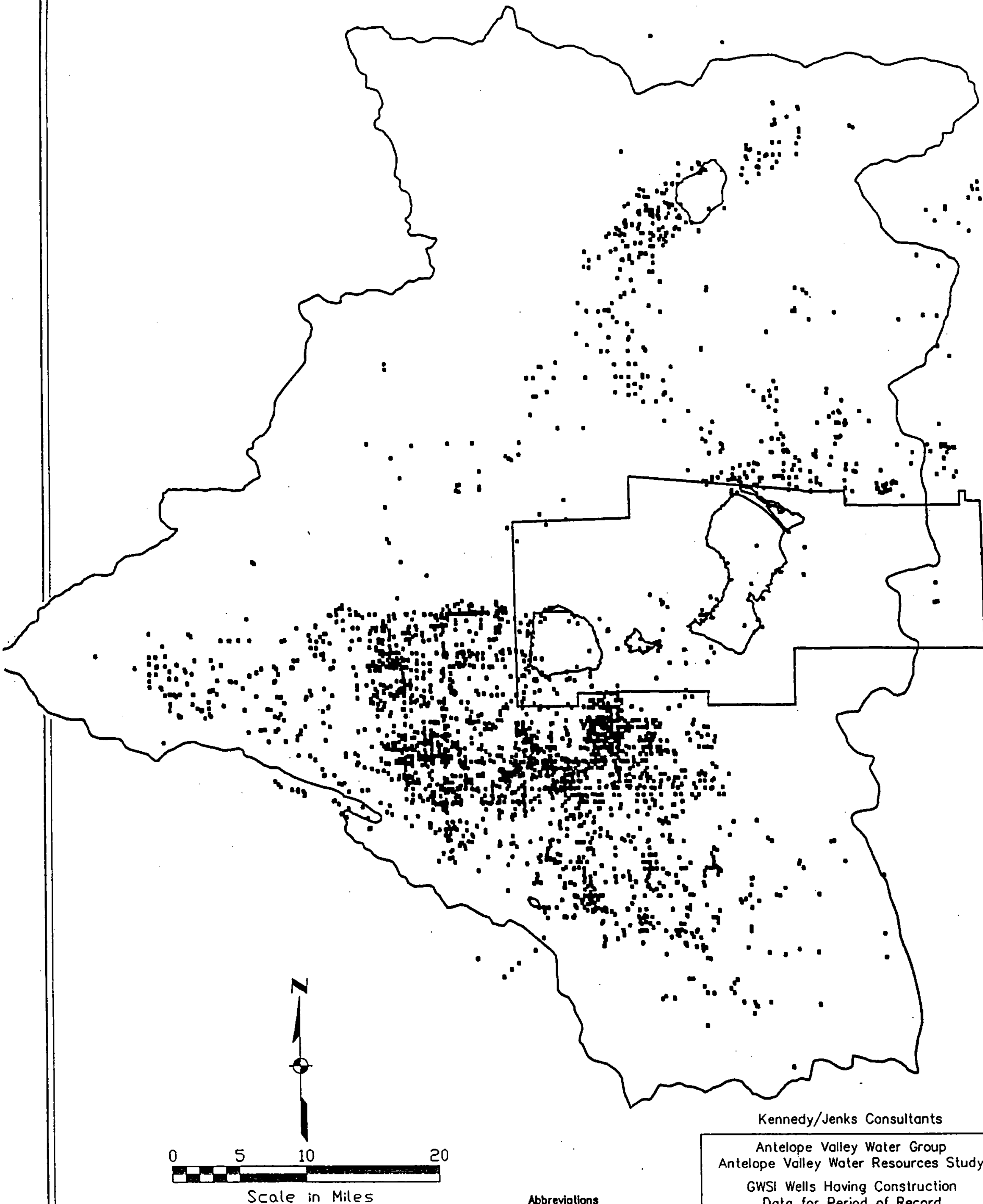
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

GWSI Wells Having GT 10 and LE 20 Chemical Anaylsis as of 11/13/91

November 1995
K/J 934620.00

Figure 7-9



Source: USGS, 1994b

Abbreviations

GWSI = Groundwater Site Inventory

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

GWSI Wells Having Construction Data for Period of Record as of 11/08/91

November 1995
K/J 934620.00

Figure 7-10

POTENTIAL WATER SOURCES FOR RECHARGE

There are a variety of source waters that could be available for recharge into the groundwater of the Antelope Valley. They include:

- SWP
  - Treated potable water
  - Untreated water directly from the California Aqueduct

- Reclaimed Water (for spreading only)
  - Secondary treatment
  - Tertiary treatment

- Surface Water
  - Little Rock Creek and Little Rock Reservoir
  - Big Rock Creek
  - Amargosa Creek

The locations of the potential sources of recharge water for the Valley are shown on Figure 7-11. In addition, the range in TDS values of the potential sources of water in the Antelope Valley is shown on Figure 7-12. The average raw SWP TDS value is an average of the annual average from 1976 to 1989 and 1993 (1993 TDS average is obtained from the average of January through June of 1993).

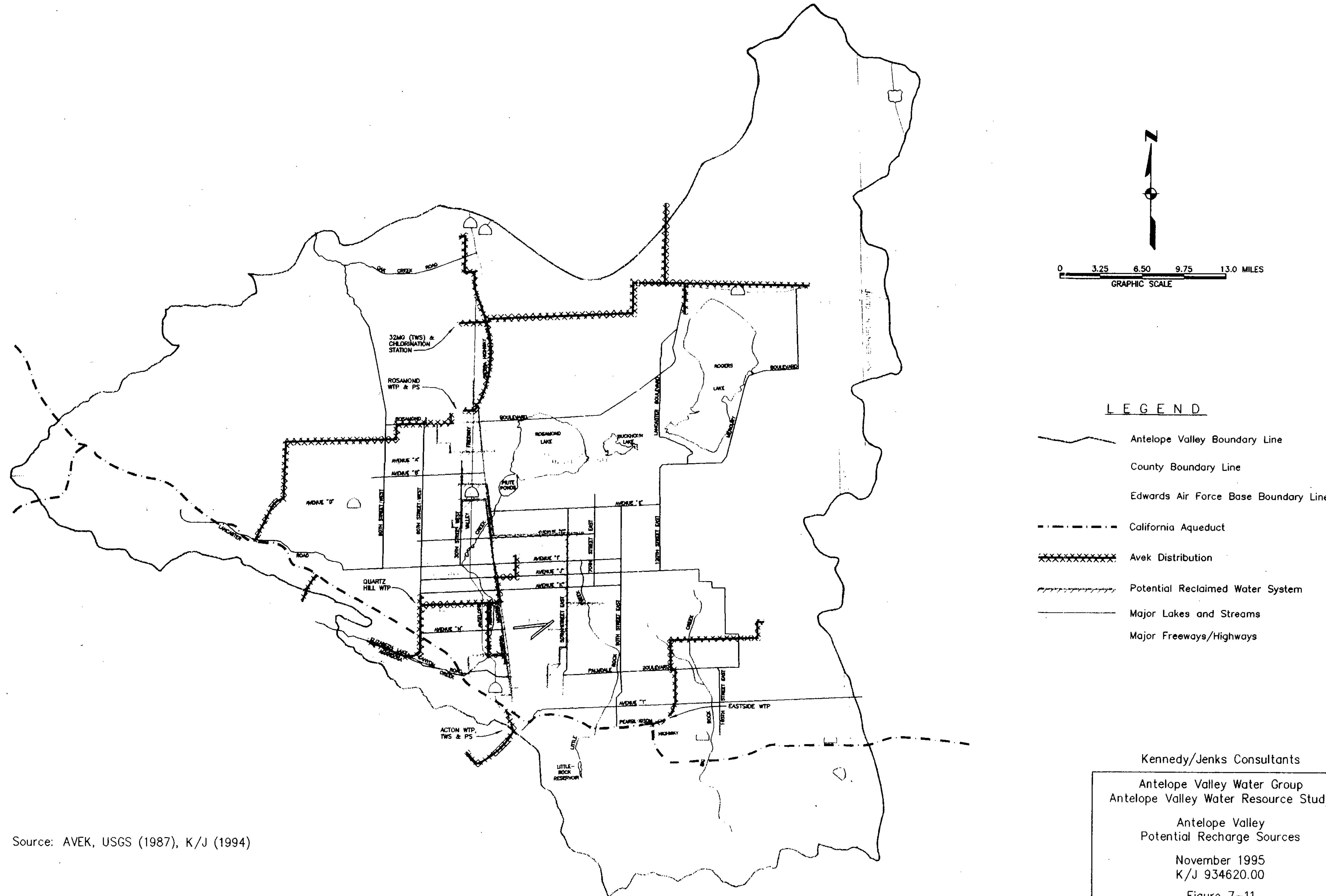
The highest groundwater TDS level within the wells for which data were evaluated was 1,840 mg/L in a well located on Edwards AFB where perched water tables and the accompanying high salts occur. The low groundwater TDS of 125 mg/L occurred in a well in the Los Angeles County Waterworks (LACWW) wellfield near Lancaster. The average TDS value was estimated at about 300 mg/L based on the wells for which water quality was evaluated.

REGULATORY ISSUES

Groundwater recharge programs are currently regulated under several jurisdictions depending on the location and type of recharge program and the nature of the source waters. At present, neither the Environmental Protection Agency (EPA) nor the California Regional Water Quality Control Board-Lahontan Region (RWQCB-LH) (agencies expected to have the greatest involvement), have set procedures for review of groundwater recharge projects. Discussions with EPA staff indicate that they review groundwater recharge programs on a case-by-case basis.

Federal Regulations

The EPA regulates the discharges of waste to the subsurface under its Underground Injection Control (UIC) program as part of the Safe Drinking Water Act (SDWA). The UIC program divides injection wells into 5 classes. Wells that inject potable water or reclaimed water would be classified as Class V wells which would require, at present, only documentation of the injection. However, EPA staff indicate that



Source: AVEK, USGS (1987), K/J (1994)

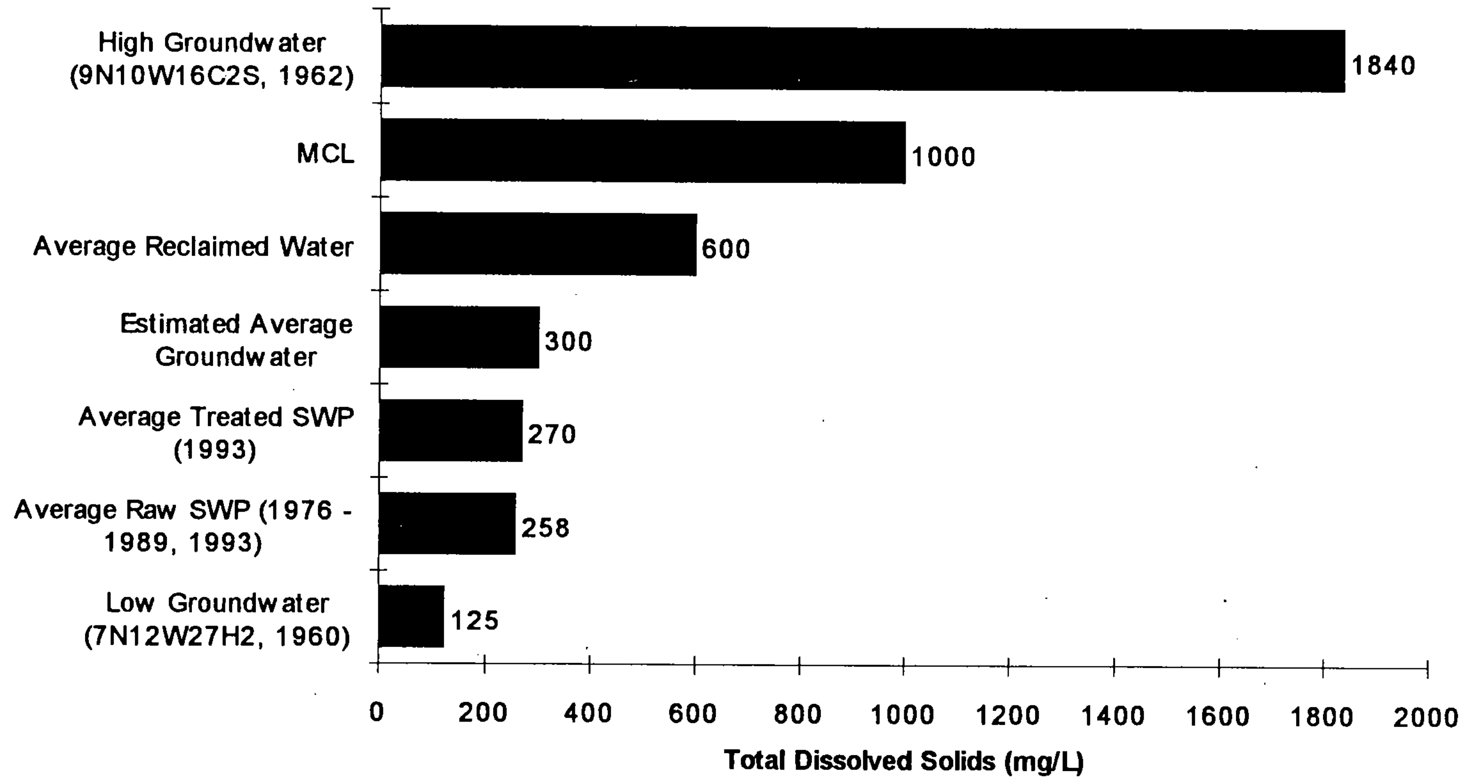
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Antelope Valley
Potential Recharge Sources

November 1995
K/J 934620.00

Figure 7-11



Note: Groundwater samples collected between 1960 - 1992 at wells in Antelope Valley

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Comparison in Antelope Valley

November 1995
K/J 934620.00
Figure 7-12

they are concerned with potential degradation of the aquifer by salts and TDS, but assess the injection or recharge on a case-by-case basis, taking into account the potential beneficial uses of the recharged water. Discharges to dry creek beds, particularly of reclaimed water, may require a National Pollutant Discharge Elimination System (NPDES) permit which is administered by the RWQCB-LH.

State Regulations

A groundwater recharge program for the Valley may be regulated by the RWQCB-LH and the Department of Health Services. Both are discussed below.

RWQCB-LH. The RWQCB-LH Water Quality Control Plan for the South Lahontan Basin (Basin Plan) lists no numerical Water Quality Objectives for groundwater. However, narrative objectives for groundwater contained in the Basin Plan include:

- Non-degradation policy which allows changes to water quality if:
  - The change is consistent with maximum benefit to the people of the State.
  - The change does not unreasonably affect present and anticipated beneficial uses of water.
  - The change does not result in water quality less than that prescribed in water quality control plans or policies.

- Groundwater shall not contain taste or odor-producing substances that cause a nuisance or adversely affect beneficial uses.

- Groundwater used for domestic or municipal supply shall have a median concentration of coliform organisms over a seven-day period of less than 2.2/100 milliliters.

- Groundwaters designated for domestic or municipal supply shall not contain concentrations of chemical constituents in excess of the specified MCL.

- Groundwaters designated for domestic or municipal supply shall not contain concentrations of radionuclides in excess of the specified MCL.

If reclaimed water is discharged to spreading grounds that are within the dry creek beds of any of the creeks, the discharge may be regulated under the NPDES program that the RWQCB-LH administers for the EPA.

In the past, the RWQCB-LH has issued either waste discharge requirements or waivers of waste discharge requirements for implementation of groundwater recharge programs. The RWQCB-LH will also be concerned with the potential degradation of the aquifer by salts and TDS but also assesses the individual recharge or injection on a case-by-case basis.

Department of Health Services. The Department of Health Services (DHS) regulates drinking water quality, hazardous waste and reclaimed water use and may advise the RWQCB-LH on discharge requirements. In addition, the DHS is currently working on revising the requirements for recharge of reclaimed water in Title 22. For direct injection, requirements are expected to include 1) oxidized, filtered and disinfected water as well as organics removal through granular activated carbon (GAC) absorption or reverse osmosis (RO) treatment, 2) a maximum groundwater basin contribution of 50 percent for reclaimed water, 3) a minimum retention time of 12 months in the basin prior to withdrawal at a domestic supply well, and 4) a minimum horizontal distance of 2,000 feet between the point of injection and the point of withdrawal at a domestic supply well.

For surface spreading, different requirements are expected to be applied to different levels of treated wastewater. There are expected to be three categories of treated wastewater acceptable for spreading:

- Category I (oxidation, filtration, disinfection and organics removal through GAC or RO treatment).
- Category II (oxidation, filtration, and disinfection).
- Category III (oxidation and disinfection).

Category I would require 1) a maximum groundwater basin contribution of 50 percent for reclaimed water, 2) a depth to groundwater of 20 feet if percolation rates are less than 0.3 inches per hour (in/hr) (a depth of 10 feet if percolation rates are less than 0.2 in/hr), 3) a minimum retention time of 6 months in the basin prior to withdrawal at a domestic supply well, and 4) a minimum horizontal distance of 500 feet between the point of injection and the point of withdrawal at a domestic supply well. Category II would require 1) a maximum groundwater basin contribution of 20 percent for reclaimed water, 2) a depth to groundwater of 20 feet if percolation rates are less than 0.3 in/hr (a depth of 10 feet if percolation rates are less than 0.2 in/hr), 3) a minimum retention time of 6 months in the basin prior to withdrawal at a domestic supply well, and 4) a minimum horizontal distance of 500 feet between the point of injection and the point of withdrawal at a domestic supply well. Category III would require 1) a maximum groundwater basin contribution of 20 percent for reclaimed water, 2) a depth to groundwater of 50 feet if percolation rates are less than 0.3 in/hr (a depth of 20 feet if percolation rates are less than 0.2 in/hr) 3) a minimum retention time of 12 months in the basin prior to withdrawal at a domestic supply well, and 4) a minimum horizontal distance of 1,000 feet between the point of injection and the point of withdrawal at a domestic supply well.

An engineering report on the proposed groundwater recharge project will be required to be submitted to the RWQCB-LH and the DHS. Monitoring wells will be required to detect the influence of the recharge operation.

Other Concerned Agencies

Other agencies that may require notification and permits are the Los Angeles County Environmental Health Department, the Kern County Environmental Health Department, the affected water agencies, and Edwards AFB.

CHARACTERISTICS FOR GOOD INFILTRATION AND INJECTION SITES

Certain characteristics affect economic viability and technical feasibility and are a keys to a successful ASR program. If the aquifer is unsuitable for groundwater extraction, it is likely to be unsuitable for groundwater infiltration or injection. The following characteristics are desirable for both infiltration and injection programs and are described in greater detail below:

- Suitable surface and sub-surface hydrogeologic conditions.
- Adequate storage capacity.
- Proximity to potential recharge water sources.
- Proximity to existing groundwater production sites.
- Impermeable faults to impound groundwater.
- Compatible water quality.

Suitable Surface and Sub-surface Hydrogeologic Conditions

Both infiltration and injection require aquifer materials that have a high ability to accept and transmit water. These materials include sands and gravels at the surface for rapid infiltration and in the subsurface for rapid acceptance of injected water. Infiltration conducted by the Department of Agriculture indicated an average infiltration rate of 3 acre-feet per wetted acre per day during a 115 day spreading test at the Kings Canyon percolation basin west of Fairmont in Antelope Valley (USGS, 1967). Using this infiltration rate, with percolation occurring for 365 days per year, approximately 41 acres would be required to infiltrate 45,000 acre-feet per year. The areal requirements may vary as a function of the depth of water in the impoundment, clogging of the pond bottom, etc. As mentioned earlier, there is a significant deposit of alluvial materials at the base of the San Gabriel Mountains.

For subsurface injection, aquifer hydraulic characteristics appropriate for groundwater withdrawal would also be appropriate for injection. However, more detailed, site-specific studies would have to be conducted to determine hydraulic characteristics for both infiltration and injection.

Adequate Storage Capacity

Both infiltration and injection require aquifer materials that can store the excess water that will be recharged. Specific yield of 0.01 to 0.30 in an unconfined aquifer would provide good storage characteristics (Freeze, 1979). As discussed earlier, there is an estimated available storage of 13 million acre-feet in the Antelope Valley aquifer. A more detailed, site-specific study would be required to evaluate storage at a specific location.

Proximity to Potential Recharge Water Sources

In order to have a cost-effective recharge program, the potential recharge sites should be located within a reasonable distance and hydraulic gradient of the potential source waters. In general, potential recharge sites were selected to be downgradient from potential source waters to minimize capital construction costs (pipelines and channels) and pumping costs.

Proximity to Existing Groundwater Production Sites

Both LACWW and the Palmdale Water District (PWD) have existing wellfields with facilities such as wells, pump stations, and distribution piping already in place. Potential infiltration and injection sites are being assessed relative to the location of the existing facilities in order to minimize capital costs.

Impermeable Faults and Bedrock to Impound Groundwater

In certain instances where it is necessary to control the ultimate storage location of the infiltrated or injected groundwaters, fault and bedrock control of the groundwater impound may be a necessary characteristic that will need to be investigated further. Some of the reasons for wanting control of the groundwater storage are to 1) prevent blending with lower quality waters, 2) reduce the infrastructure requirements for extracting the water, and 3) prevent other users from taking advantage of the recharged waters.

Compatible Water Quality

It is important that the potential recharge site has good quality groundwater that will not compromise the quality of the water to be infiltrated or injected. Therefore, each potential infiltration or injection site requires an in-depth water quality analysis and comparison with the potential source waters.

SUMMARY OF RELEVANT STUDIES

There have been a number of studies conducted that discuss potential sites for ASR projects. These studies and reports were used to identify the higher potential sites. The studies are summarized in Table 7-1.

It should be noted that the majority of the detailed, site-specific studies have been conducted only for the Amargosa Creek area. The other potential ASR areas are only described in general terms and will require more detailed studies.

FACTORS SPECIFIC TO SURFACE INFILTRATION

As described above, the basic characteristics of a good surface infiltration site requires good soils, adequate storage, compatible water quality, location relative to potential source waters, and locations near wellfields. In addition, surface infiltration sites require consideration of both the potential losses to evaporation and

TABLE 7-1
SUMMARY OF PREVIOUS STUDIES IDENTIFYING POTENTIAL RECHARGE AREAS

Source	***Area***	***Purpose***	***Status***
USGS (Bloyd), 1967	W. Antelope Valley, 10 other areas in AV	Underground Reservoir	No further studies conducted
LACFCD, 1970	Little and Big Rock Creeks	Water Conservation and Flood Control	--
DWR, 1979		Storage and recapture of SWP water in AV	Spreading not feasible because all faults are not good barriers
DWR (District), 1980	Upper reaches of Little and Big Rock Creeks	Alternatives for comprehensive water management plan	--
LACFCD, 1983	Big Rock Creek Drainage, near apex of fan and SE portion of Valyermo Basin	Feasibility for recharge	—
LACFCD, 1985/85	Hunt Canyon in Little Rock Creek Basin	Feasibility for spreading grounds	Area should be good spreading ground
Geosoils, 1987	Amargosa Creek	Retention Basin	Follow-up work by Robert Bein, William Frost & Associates, 1993
LACDPW, 1987	Valley-wide	Comprehensive Flood Control and Water Conservation Plan, includes mention of 6 groundwater recharge preserves	More detailed plans for Palmdale and Lancaster have been prepared
USGS/SWRCB/RWQCB (Duell), 1987	Valley-wide	Groundwater Monitoring Network	Sampling of 200 wells has been coordinated by USGS
DWR (Southern District), 1988	Little Rock Creek and Reservoir	Water Supply and Management Investigation, Dam Safety analysis	LCID and PWD have recently completed dam improvements and increased the storage in the reservoir
LACDPW-Land Development Division, 1989	Antelope Valley (LA County portion) (prepared for Hydraulics and Water Conservation Division for LACWWW)	Spreading Grounds Study - Phase I Preliminary Report	Selected alluvial fans of Little and Big Rock Creeks and Amargosa Creek as prospective areas for runoff recharge
LACDPW-Materials Engineering Division, 1991	Amargosa Creek/Air Force Site (prepared for Hydraulics and Water Conservation Division for LACWWW)	Phase 2 - Detailed surface and sub-surface hydrogeologic investigation	Assessed high potential of site for recharge basin and/or injection
LACDPW-Hydraulics and Water Conservation Division, 1992	Amargosa Creek/Air Force Creek (prepared for Waterworks and Sewer Maintenance Division)	Groundwater Recharge Concept Plan	Recommended site for pilot injection program (underway by USGS) and pilot percolation recharge program using Amargosa Creek runoff
Robert Bein, William Frost & Associates, 1993	Amargosa Creek (prepared for City of Palmdale)	Creek Improvement Project with flood control/detention basins	Draft EIR prepared, flood control basins could function as recharge basins
Earth Systems, 1994	Amargosa Creek (prepared for City of Palmdale)	Assess most likely areas of potential recharge in Amargosa Creek channel	Report concludes that significant groundwater recharge occurs in Amargosa Creek channel

the long travel time of the recharged water through the unsaturated zone. The Lancaster Water Reclamation Plant has an estimated evaporation rate of 107 inches or 9 feet of evaporation each year. This rate could significantly impact the total volume of water recharged. More detailed analysis of evaporation at the specific

site may be required to better assess the impact of evaporation and to develop criteria for when the spreading grounds should be used.

Although the surface soils in many parts of Antelope Valley are favorable for surface infiltration, the distance to the water table will influence when the infiltrated water is available to be pumped out.. Depending on the hydraulic conductivity of the soils and the hydraulic gradient, it is estimated that travel times through the unsaturated zone may take 5 to 50 years. This factor needs to be considered in selecting potential surface recharge areas.

POTENTIAL SURFACE RECHARGE AREAS

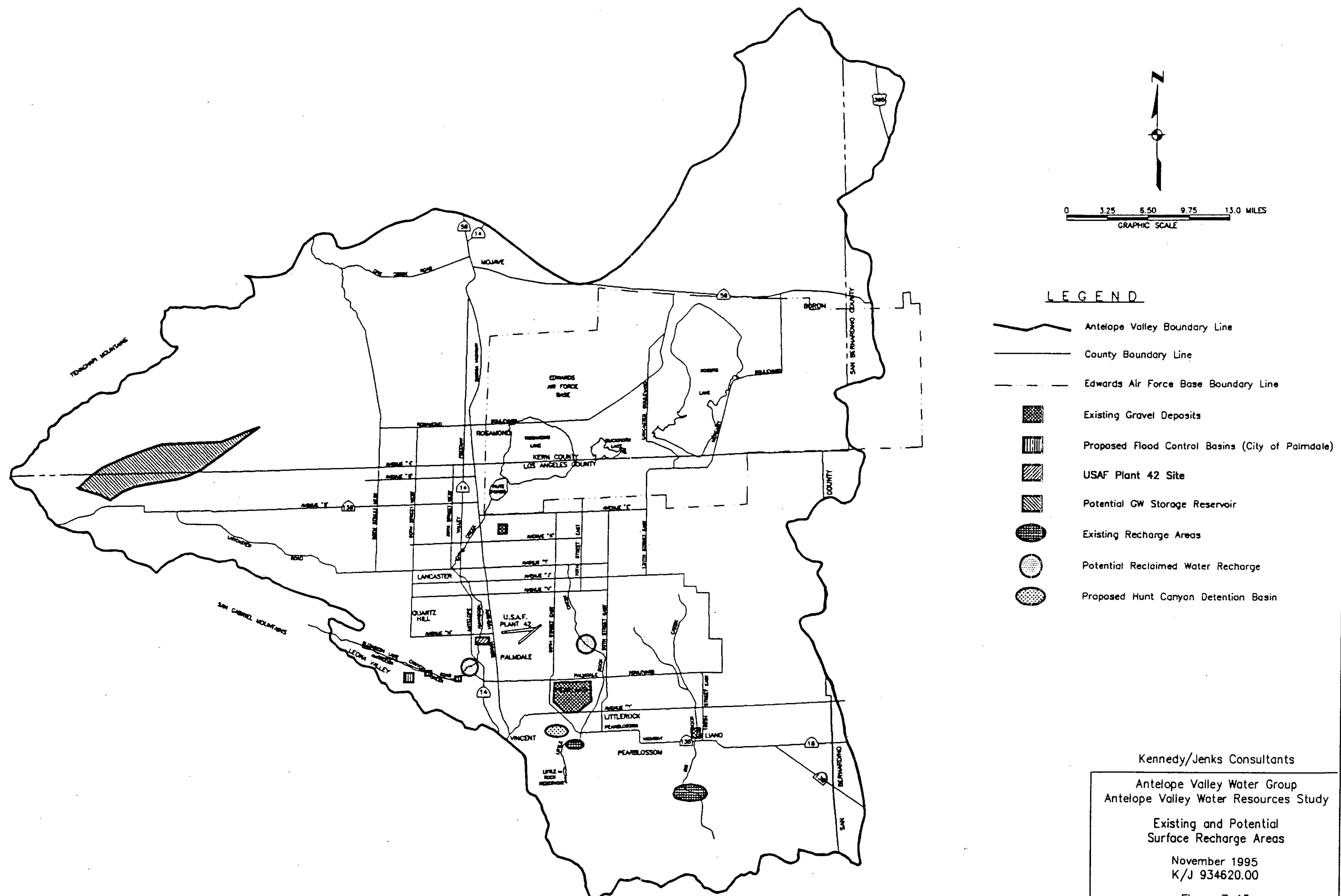
Based on the characteristics favorable to a good surface infiltration site described above, and previous work that has been conducted in assessing infiltration sites, the following areas have been focussed on for more detailed analysis:

- Little Rock Creek
- Big Rock Creek
- Amargosa Creek
- West Antelope Sub-unit
- Groundwater recharge zones described in the Los Angeles County Department of Public Work (LACDPW) "Final Report on the Antelope Valley Comprehensive Plan of Flood Control and Water Conservation" dated June 1987.

The general location of existing and potential recharge sites can be found on Figure 7-13. Each of the potential recharge sites for which there is sufficient information are described in further detail below with respect to the specific area selected, the potential source waters that could serve the recharge area, and a comparison of water quality for the potential sources and the groundwater of the potential recharge areas.

Little Rock Creek

There are several potential surface recharge sites within the Little Rock Creek watershed which have many of the favorable characteristics for surface recharge. The creek has a watershed area of about 50 square miles and water within the watershed is impounded in the Little Rock Reservoir. The average annual runoff from the watershed for a period from 1931 to 1989 is 14,870 acre-feet (DWR, 1988).



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Existing and Potential
Surface Recharge Areas

November 1995
K/J 934620.00

Figure 7-13

The Little Rock Reservoir is operated jointly by the PWD and the Little Rock Creek Irrigation District (LCID). The Little Rock Dam has recently undergone a seismic retrofit and construction to increase its height for greater storage volume (3,500 acre-feet). Historical annual diversions (1956 to 1990) for PWD and LCID have averaged approximately 1,300 and 1,400 acre-feet respectively (LAW Environmental, 1991). These numbers will most likely change based on the increased storage now available. According to a 1922 agreement between the two Districts, all water from within the watershed are allocated and accounted for.

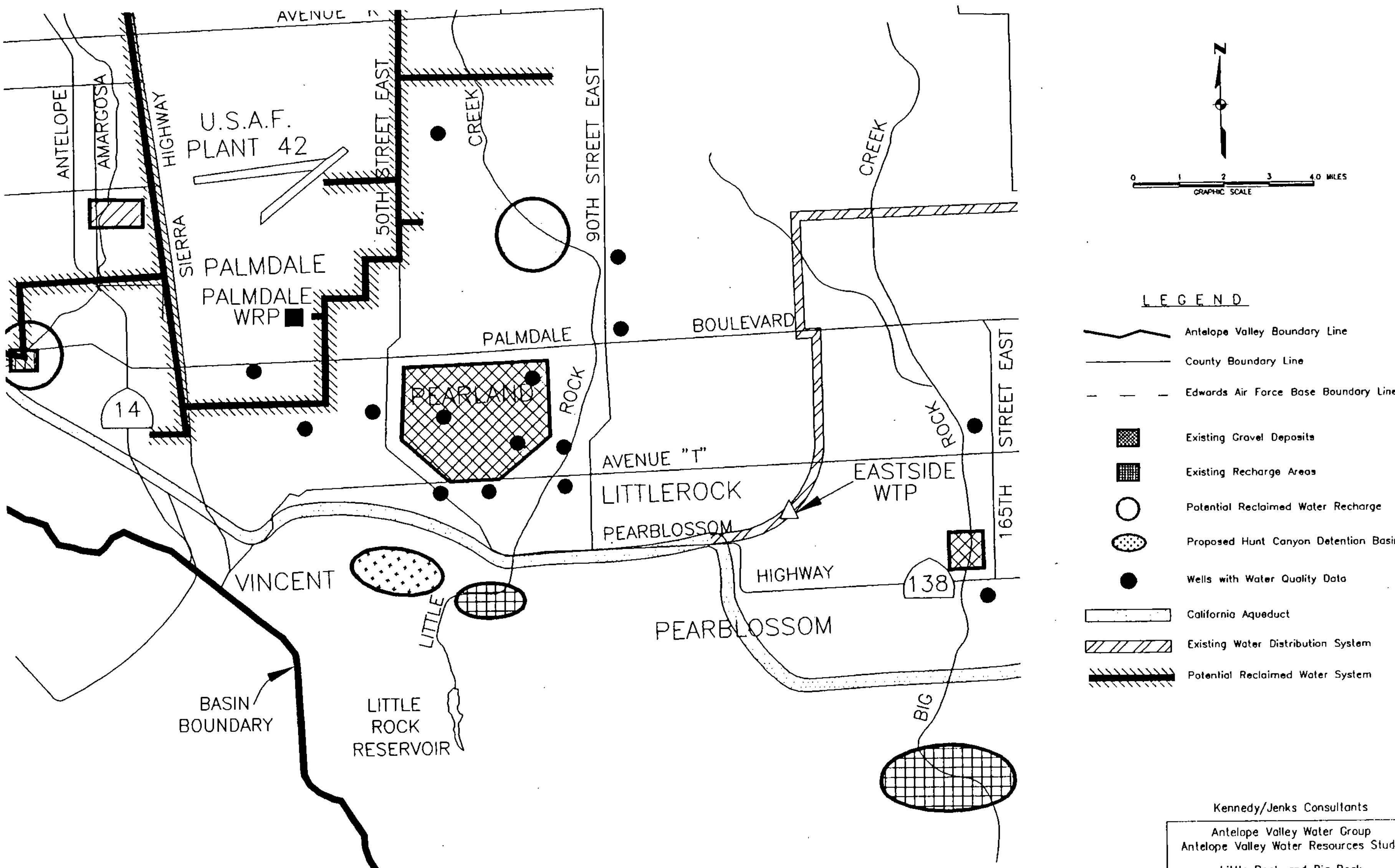
In addition to the water in the Little Rock Reservoir, both Districts also use groundwater and imported water from the SWP to meet their water demands. The PWD stores Little Rock Reservoir water and SWP water in the Palmdale Lake prior to treatment and distribution to their service area.

There is one existing (Cienega area) and several potential recharge areas near Little Rock Creek as shown on Figure 7-14 and listed as follows:

- Cienega Area (T4NR9W, Sections 10,11, 16 and 17).
- Gravel Deposits Site (T5NR11W, Sections 2 and 3; T6NR11W, Sections 35 and 36).
- Hunt Canyon Detention Basin.
- Department of Airport Property (T6NR11W, Sections 2 and 11).

Descriptions of the above sites are presented below. Additional data such as percolation tests and exploratory borings with pump test, geophysical logging, and water quality data may be required at the sites.

<u>Cienega Area</u>. The LCID uses about 300 acre-feet annually to recharge the Cienega area (DWR, 1988), a small aquifer located about 2 miles downstream of the Little Rock Dam. (See Figure 7-14.) This water is later pumped and used to serve domestic users within the LCID service area. The Cienega area should be investigated further to assess available storage in the aquifer and the volume of available water for recharge. Because of the existing facilities for recharge, extraction and distribution, this area may be a good candidate for additional storage of excess Little Rock Creek waters. The Cienega area is upgradient from the California Aqueduct and the reclaimed water system as shown on Figure 7-14. Due to the potential water quality impacts from mixing those waters with Little Rock Creek waters, these water supplies should not be considered potential recharge sources for the Cienega area. By restricting the recharge source waters to Little Rock Creek, the regulatory requirements would be significantly reduced and/or eliminated. No water quality data were located for the Cienega area.



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Little Rock and Big Rock
Creek Areas

November 1995
K/J 934620.00

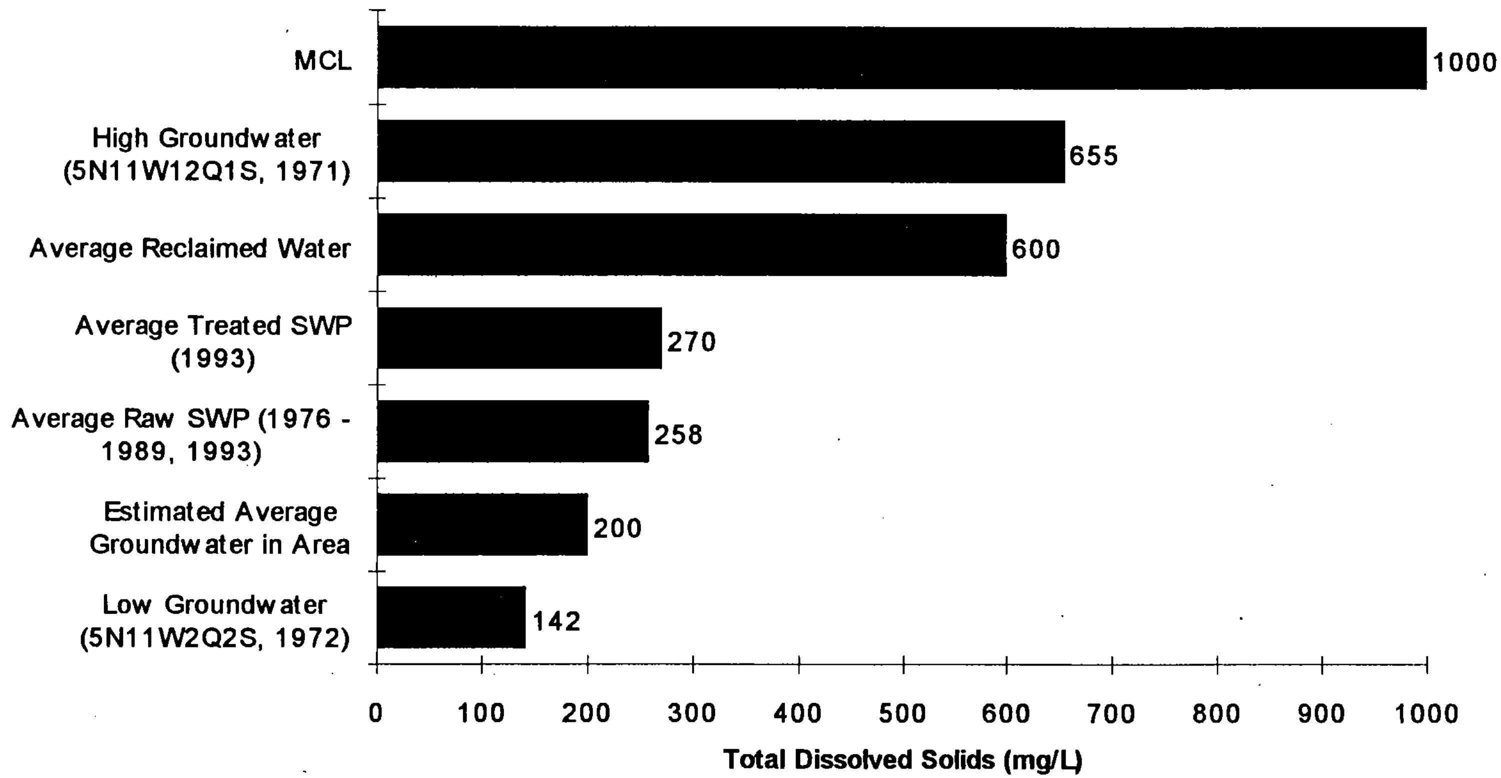
Figure 7-14

Gravel Deposits Site. Another area that has good potential for recharge is located in Township 5 North, Range 11 West, Sections 2 and 3, and Township 6 North, Range 11 West, Sections 35 and 36. (See Figure 7-14.) These areas have known gravel deposits which generally indicates good infiltration rates. The gravel deposits are west of the Little Rock Creek wash and therefore should not require an NPDES permit for surface discharge of reclaimed water. These areas could easily be served by a turnout from the California Aqueduct. The proposed reclaimed water line that would serve the area near Palmdale Boulevard and 40th Street West is about 3.5 miles from and 140 feet below the elevation of the gravel pits and would therefore require piping and pumping facilities to serve the area. If there is sufficient flow in Little Rock Creek, waters from the creek could be diverted to the gravel areas. The gravel deposits are located within a mile of a known PWD well (T6NR11W34N1S) and are also within a mile of other wells that are of unknown use. (See Figure 7-14.)

Based on readily available data, the wells found in Table 7-2 were referenced for water quality data. The wells are located on Figure 7-14. As shown in Table 7-2, there is little recent water quality data. The water quality of the wells has been compared to average water quality for potential source waters of the SWP and reclaimed water as shown on Figure 7-15. There is a single well (5N11W12Q1S) with high TDS and high nitrates in the area. The poor water quality is probably attributable to the intense poultry farming that occurred there in the 1950s to 1960s. However, the TDS levels in other wells in the area are generally lower than the potential recharge sources of reclaimed or SWP waters.

The available data are insufficient to assess the overall impacts to groundwater quality of the recharge of SWP or reclaimed waters to this area. Well construction data and water quality samples from the wells should be collected and analyzed to assess the present day condition of the water quality in the aquifers.

Hunt Canyon Detention Basin. The Los Angeles County Flood Control District's (LACFCD) Hunt Canyon Detention Basin Site is another potential recharge site in the Little Rock Creek area (LACFCD, 1985-86). Several borings and wells were installed to a depth of 180 feet for a proposed basin which appears to be feasible for a spreading ground. However, the site is several hundred feet above and several miles from both the California Aqueduct and any reclaimed water facilities. Therefore, the only economic supply source will be Little Rock Creek. There do not appear to be any water supply wells that could be used to extract water from the basin. No water quality data were located for this area.



Note: Groundwater samples at 8 wells collected from 1950, 1960 - 1978, 1992.

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Near Little Rock Creek Gravel Deposits

November 1995
K/J 934620.00

Figure 7-15

TABLE 7-2

WELL SUMMARY NEAR LITTLE ROCK CREEK GRAVEL DEPOSITS

Well Number	*Length of Water Quality Data Collected*	*Well Owner*	*Approximate distance from proposed recharge site (miles)*
5N11W1M1S	1992, Specific Conductivity only	Little Rock Sand and Gravel	< 1
5N11W2Q2S	1971 - 1977	Lane	< 1
5N11W8H1S	1992	unknown	1
5N11W9A3S	1964 - 1975	PWD	1
5N11W12Q1S (1)	1963 - 1978	LCID	1
6N11W20G2S	1972 - 1974	PWD (out of service?)	4
6N11W32P1S	1950, 1973 - 1974	PWD (out of service?)	< 1
6N11W34N1S	1967, 1971, 1973	PWD	< 1
6N11W36G1S	1964, 1992	unknown	< 1

(1) Indicated high nitrates due to poultry farming.

Department of Airport Property. A site that has potential for recharge of reclaimed water is located near Little Rock Creek on the Department of Airport (DOA) property along Avenue "N" between 60th Street east and 70th Street east (Township 6 North, Range 11 West, Sections 2 and 11). This site should have permeable surface soils because it straddles the Little Rock Creek. It is also located near the terminus of the reclaimed water pipeline conveying secondary treated water. Any excess water from Little Rock Creek would also be fed to this area as could SWP water if appropriate conveyance structures are constructed. At present, there appear to be no extraction and distribution systems in this area. The discharge of reclaimed water to this site may require an NPDES permit since the creek may be considered an ephemeral surface water. This site may be problematic if a wetlands is created as a result of the recharge activity due to the wildfowl that may nest there. The wildfowl could pose a threat to aircraft flying operations at the United States Air Force (USAF) Plant 42 airfield.

There are very few water quality samples in the area. The water quality data that were located are summarized below in Table 7-3.

TABLE 7-3

WELL SUMMARY NEAR DEPARTMENT OF AIRPORT SITE

Well Number	*Length of Water Quality Data Collected*	*Well Owner*	*Approximate distance from proposed recharge site (miles)*
6N11W3P1S	1965	unknown	1
7N11W33Q1S	1973 - 1982	unknown	2.5
7N11W34H1S	1972, 1973	unknown	1

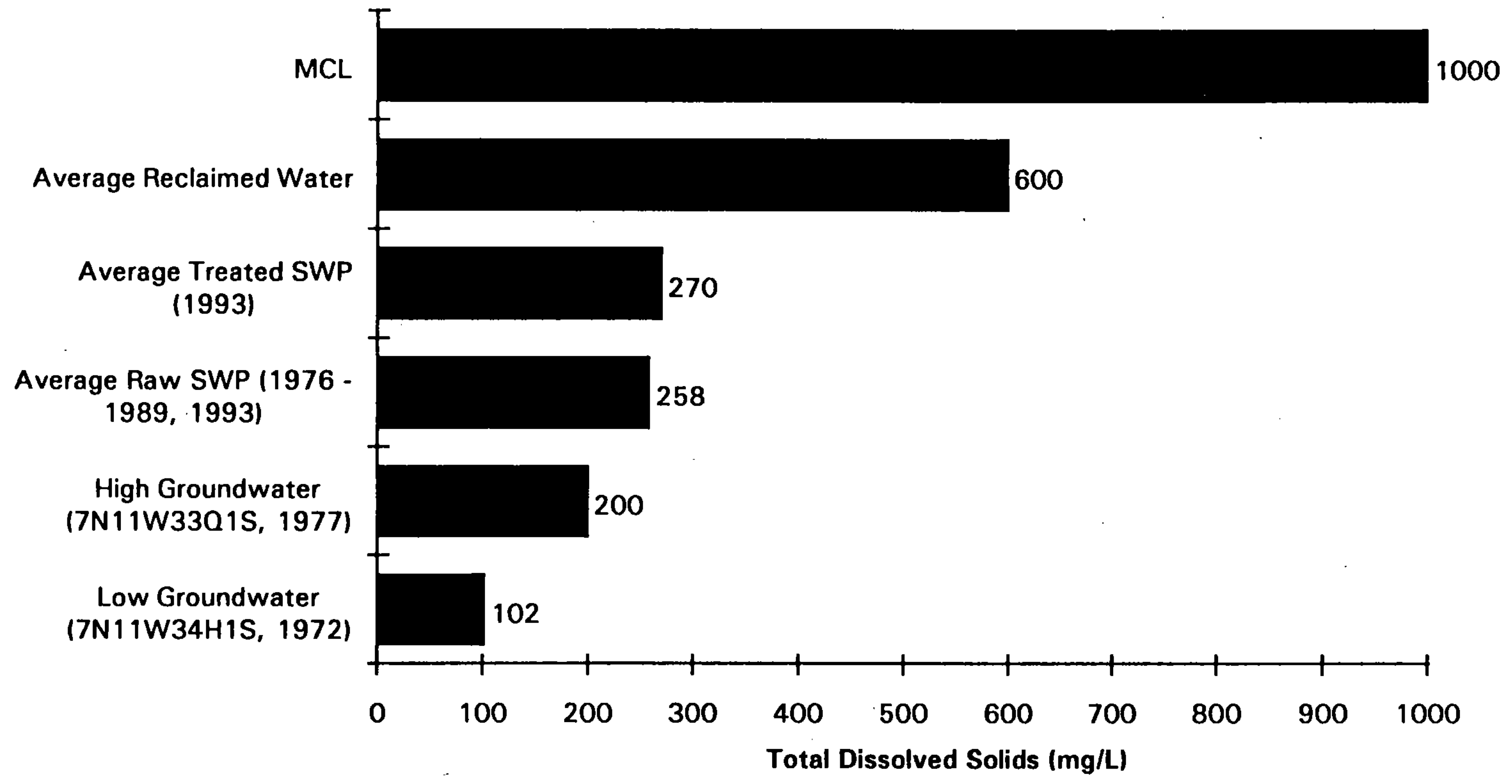
The quality of the groundwater in this area as compared to potential source waters is shown on Figure 7-16. The TDS levels in the groundwater vary from 102 to 200 mg/L while the TDS in the source waters ranges from 258 to 600 mg/L. However, the available data are insufficient to assess the overall impacts to groundwater quality of the recharge of SWP or reclaimed waters to these areas. Well construction data and water quality samples from the wells should be collected and analyzed to assess the present day condition of the water quality in the aquifers.

Big Rock Creek

There are a few potential surface recharge sites within the Big Rock Creek watershed which may be appropriate for surface recharge. The creek has a watershed area of about 23 square miles (USGS, 1967) and has an average flow of 13,200 acre-feet per year with a maximum discharge of 64,830 acre-feet per year measured in 1978 - 1979. There are wells in the Valyermo area with water level data; however, there are little other data presently available. It is unknown if there are any large municipal users of the water, or whether the users of groundwater are strictly single family homes.

There is one existing (Valyermo Basin) and one potential recharge area near Big Rock Creek as shown on Figure 7-14 and listed as follows:

- Valyermo Basin (T4NR9W, Sections 7, 8, 9, 10, 16, 17)
- Gravel Deposits Site (T5NR9W, Section 18)



Note: Groundwater samples at 3 wells collected from 1965, 1972, 1973, 1977, 1979

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Near Little Rock Creek Potential Reclaimed Site

November 1995
K/J 934620.00
Figure 7-16

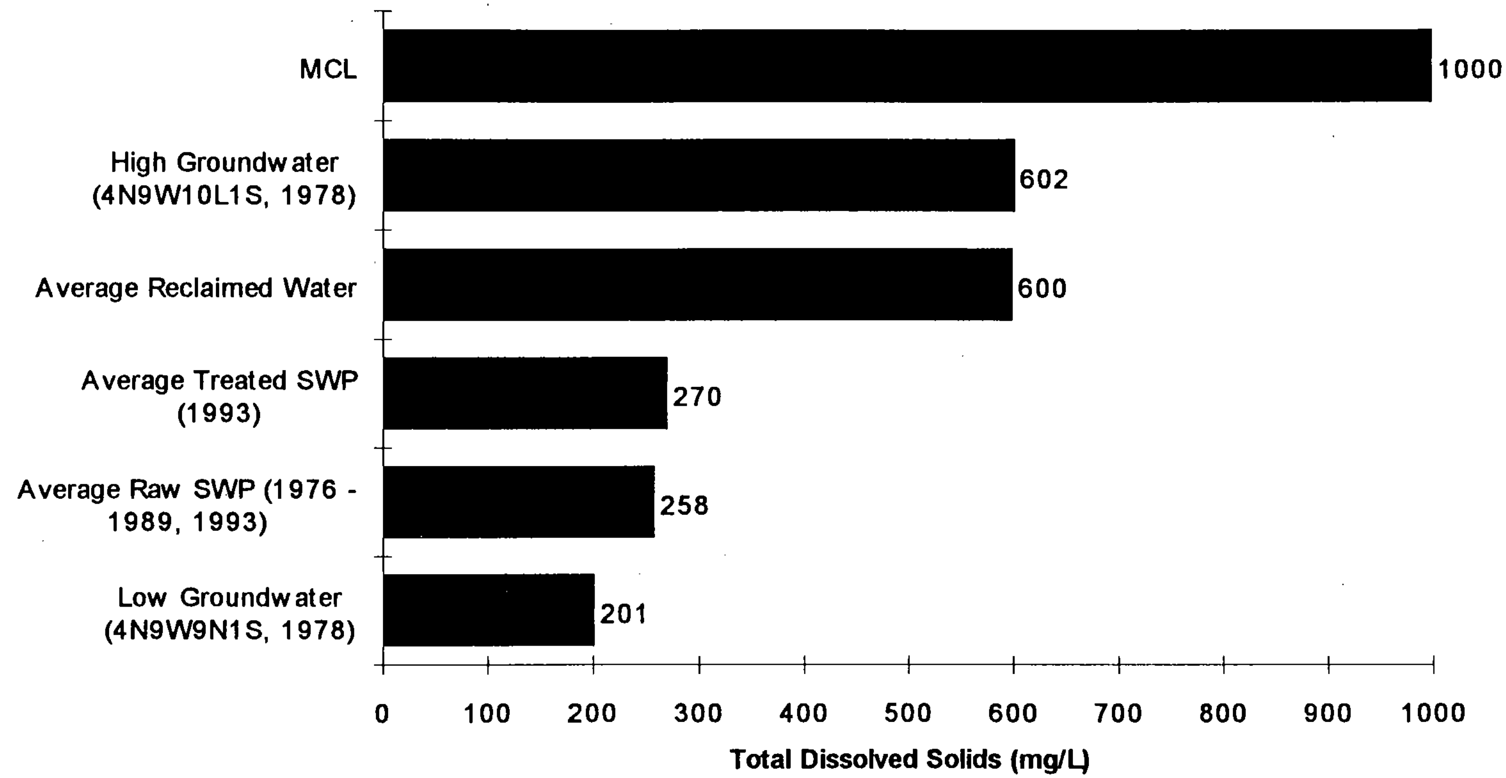
Descriptions of the two sites are presented below. Well construction data and water quality samples from the wells should be collected and analyzed to assess the present day condition of the water quality in the aquifers. In addition, other data such as percolation tests and exploratory borings with pump test and geophysical logging would be required at each site.

Valyermo Basin. Although there appears to be no continuous measurement of waters being recharged at the spreading grounds, the Hydraulic and Water Conservation Division of the LACDPW periodically measures inflow to the Valyermo Basin (LACDPW-LDD, 1989). At present, excess Big Rock Creek water appears to be the only potential recharge source. This is due to the Valyermo Basin being upgradient and over two miles away from the California Aqueduct. The recommended reclaimed water systems are even further away and would require even more pumping of source water than from the California Aqueduct. The use of Big Rock Creek water for additional recharge to Valyermo should require little or no regulatory approvals.

Water quality data for the wells in Table 7-4 were reviewed for applicability for recharge. A comparison of the quality of the groundwater with other potential recharge sources is shown on Figure 7-17. The limited water quality data indicate a range of TDS from 201 mg/L to 602 mg/L which is similar to the range of TDS values for the potential recharge sources. However, the available data are insufficient to assess the overall impacts to groundwater quality of the recharge of SWP or reclaimed waters to these areas.

Gravel Deposits Site. In addition to the existing spreading grounds in the Valyermo Basin, there is an area of gravel deposit (Township 5 North, Range 9 West, Section 18) in the Big Rock Creek which suggests good infiltration capacities. (See Figure 7-14.) This area could be served with untreated SWP water with the construction of a turnout. It is a considerable distance from the reclaimed water system and therefore does not appear economical to recharge with reclaimed water at this site. There are only a few wells in the area that could provide water quality data as shown in Table 7-5.

A comparison of the TDS values between the groundwater, SWP and reclaimed waters is shown on Figure 7-18. The TDS for the wells range from 209 to 424 mg/L. Based on the water quality data that are available, there are insufficient data to assess the overall impacts to groundwater quality of the recharge of SWP or reclaimed waters to these areas.



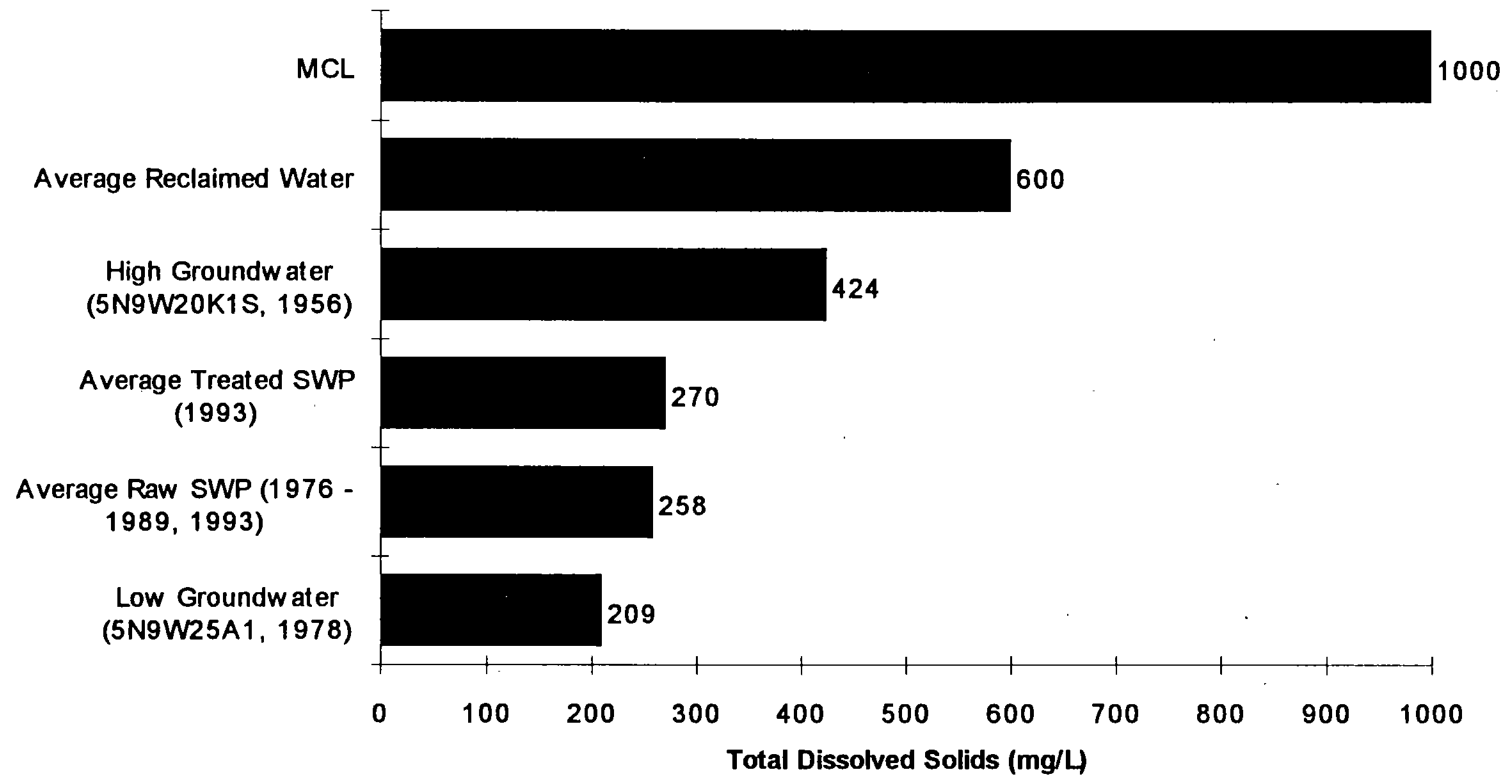
Note: Groundwater samples at 3 wells collected from 1956 -1959, 1964, 1971-1972, 1977- 1978

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Near Big Rock Creek - Valyermo Area

November 1995
K/J 934620.00
Figure 7-17



Note: Groundwater samples at 4 wells collected from 1969, 1971-1978

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Near Big Rock Creek Gravel Deposits

November 1995
K/J 934620.00
Figure 7-18

TABLE 7-4

WELL SUMMARY FOR BIG ROCK CREEK NEAR VALYERMO

Well Number	*Length of Water Quality Data Collected*	*Well Owner*	*Approximate distance from proposed recharge site (miles)*
4N9W9N1S	1971, 1972, 1974, 1977, 1978	unknown	< 1
4N9W9N4S	1969	unknown	< 1
4N9W10L1S	1976 - 1978	unknown	< 1
4N9W10M2S	1973 - 1975	unknown	< 1

TABLE 7-5

WELL SUMMARY NEAR BIG ROCK CREEK GRAVEL DEPOSITS

Well Number	*Length of Water Quality Data Collected*	*Well Owner*	*Approximate distance from proposed recharge site (miles)*
5N9W5C1	1972 - 1977	unknown	2.5
5N9W20K1S	1956, 1958, 1959	unknown	1
5N9W25A1	1964 - 1978	unknown	7

Amargosa Creek

The Amargosa Creek watershed is approximately 20 square miles and although there are no stream gages, estimated runoff varies from 800 acre-feet per year to 9,000 acre-feet per year with an estimated storm discharge from the creek of 23,000 cubic feet per second (cfs) (LACDPW-LDD, 1989). The discharge from the creek is relatively low when compared to Big Rock and Little Rock Creeks because the watershed does not extend to the snow line. However, the potentially high volumes of storm flows have led to flooding problems in the flatter portions of the creek bed near Lancaster. In addition, extensive flood detention and flood control measures are currently being proposed. Of the watersheds, Amargosa Creek has had the most detailed study of potential recharge areas.

Although there are some users of groundwater from Amargosa Creek in the Leona Valley, there do not appear to be significant diversions of the surface flows out of the creek and very few other users of the water. If allowed to flow unrestricted, the waters, which do not naturally recharge the groundwater from the channel bottom, would eventually flow to the Piute Ponds.

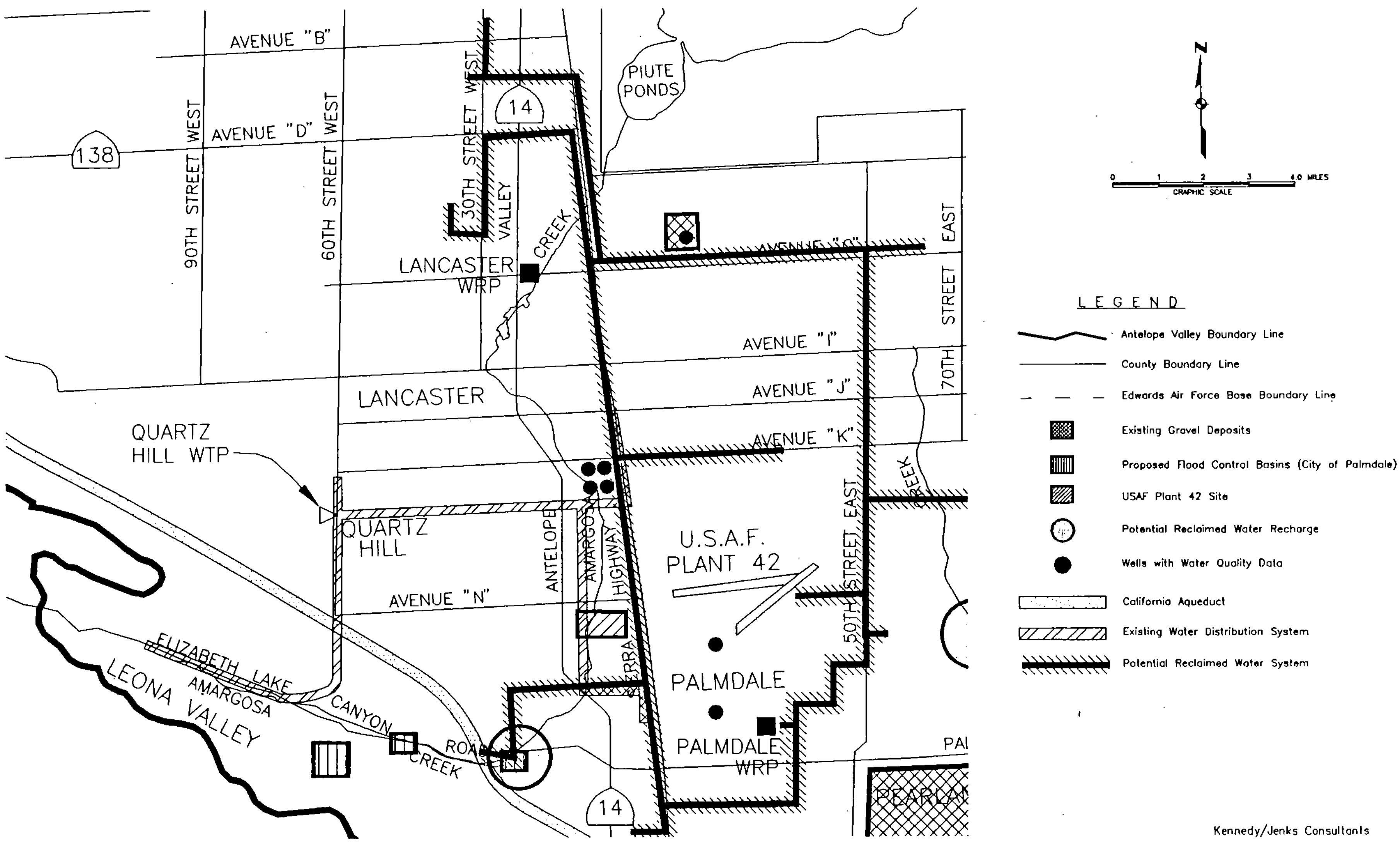
There are no existing groundwater recharge basins in use in the Amargosa Creek area. However, several possible locations are shown on Figure 7-19 and listed as follows:

- City of Palmdale's Proposed Flood Detention Basins.
- Amargosa Creek between 15th and 25th Streets West.
- USAF Plant 42 Site.
- Gravel Deposits Site near 8N12W Section 35.

Descriptions of the above sites are presented below. Well construction data and water quality samples from the wells should be collected and analyzed to assess the present day condition of the water quality in the aquifers. In addition, other data such as percolation tests and exploratory borings with pump test and geophysical logging would be required at each site.

City of Palmdale's Proposed Flood Detention Basins. Three detention basins with a total storage of about 2,150 acre-feet are planned by the City of Palmdale. These flood detention facilities could function as recharge basins if operated properly and if recharge did not interfere with the normal operations of the facility. The three proposed basins are located close to Amargosa Creek in Leona Valley, near Elizabeth Lake Road as shown on Figure 7-19. The main drawback to the basins are that they are in areas where there are no existing groundwater extraction facilities. They could be easily served by Amargosa Creek water, when available. Only one small basin (40 acre-feet), could be easily served by the California Aqueduct, the other two basins are upgradient of the Aqueduct. Reclaimed water service would also require piping and pumping facilities to the two upgradient detention basins.

There have been significant soils investigation (Earth Systems, 1994) of the stream channel because of groundwater users concerns that channelization of Amargosa Creek for flood control would result in reduced recharge of groundwater. No water quality data for wells near the flood detention facilities have been located. The available data are insufficient to assess the overall impacts to groundwater quality of the recharge of SWP or reclaimed waters to these areas.



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Amargosa
Creek Areas

November 1995
K/J 934620.00

Figure 7-19

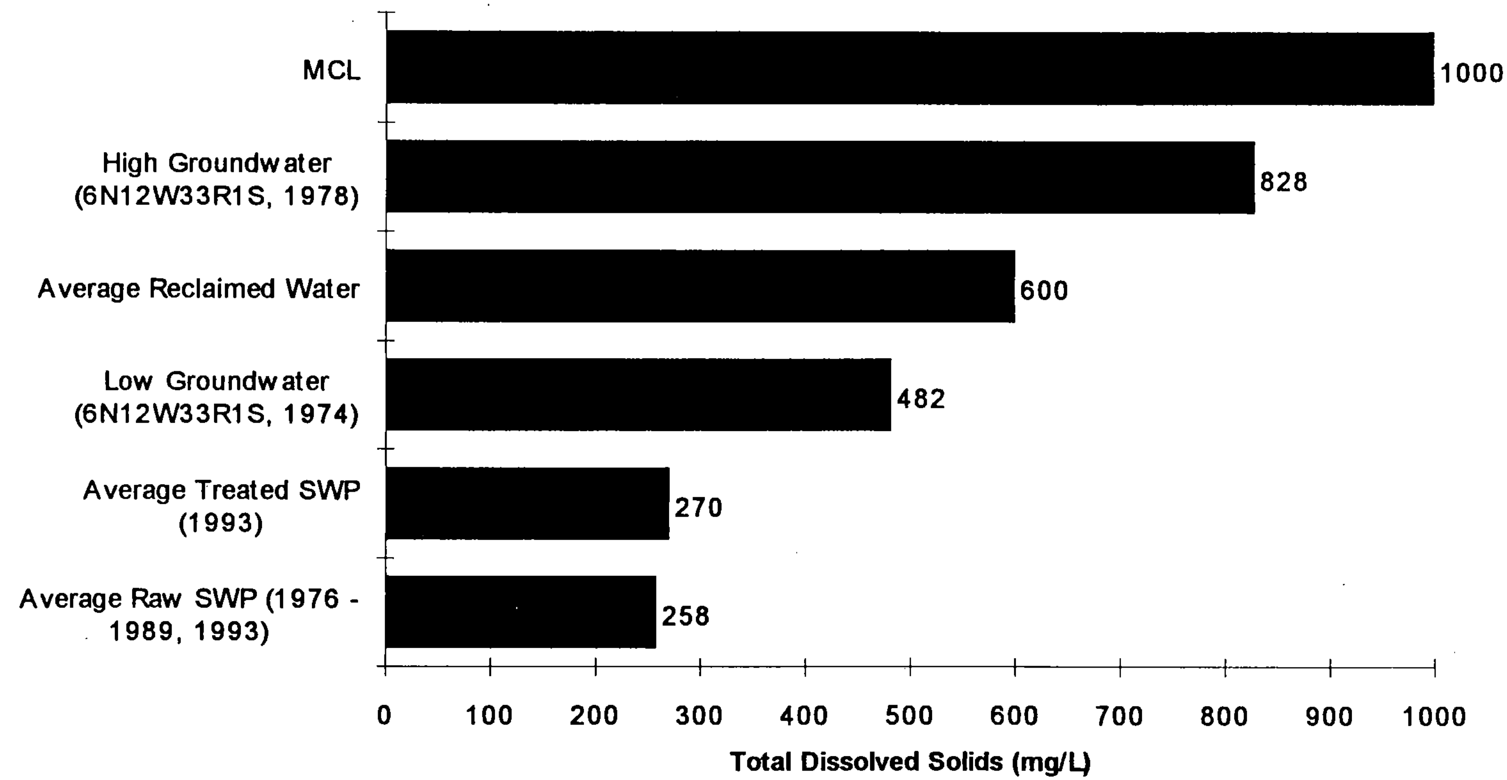
Amargosa Creek between 15th and 25th Streets West. This area is close to the City of Palmdale's proposed flood detention facilities and has been identified because of the favorable conditions identified in the soils investigation mentioned above (Earth Systems, 1994). In addition, this area is quite close to both the potential reclaimed water facilities and the California Aqueduct, as well as the Amargosa Creek channel, and could therefore be served by these potential sources. (See Figure 7-19.) It should be noted that this site may require an NPDES permit for reclaimed water recharge because Amargosa Creek appears to be an ephemeral creek.

There are few wells in the area of the potential recharge area (Township 6 North, Range 12 West, Sections 27, 28, 29). The only well in the area (6N12W30R1S) was located about one mile from the proposed recharge area and had TDS levels ranging from 482 to 828 mg/L for samples collected from 1974 to 1978. In addition, the well also had high nitrates varying from 32.4 to 340 mg/L. A comparison of the TDS in the well to SWP and reclaimed waters is found on Figure 7-20. The available data are insufficient to assess the overall impacts to groundwater quality of the recharge of SWP or reclaimed waters to these areas.

USAF Plant 42 Site. The LACDPW investigated the USAF Plant 42 site located south of Avenue "N" between 10th Street East and Division Street (the north half of Township 6 North, Range 12 West of Section 10) in 1991 for hydraulic parameters and feasibility for recharge (LACDPW-MED, 1991). Through 3 deep borings ranging from 640 to 800 feet in depth, 11 shallow borings ranging from 30 to 70 feet in depth, 5 shallow percolation tests, soil sampling, electric logs, and other field and laboratory data, the infiltration/surface percolation was estimated at 10^{-2} cm/sec, and the hydraulic conductivity ranged from 10^{-2} cm/sec to 10^{-5} cm/sec in the first 100 feet of material below the sub-surface. In addition, the transmissivity was estimated at 55,000 gpd/ft.

These sample parameters were sufficient to recommend a proposed pilot percolation program on the east side of the site to better assess the site's capabilities with respect to actual field conditions. The proposed percolation test could use Amargosa Creek waters after the flood control projects are completed. The LACDPW report mentions that there may be shallow low-permeability zones in the subsurface that could reduce the percolation rate. This possibility needs to be investigated further. In addition, the report notes that the presence of migratory fowl in this area could pose a hazard to the aircraft flying operations at the USAF Plant 42 airfield.

The study did not collect any water quality samples. There were two wells that were within a few miles of the proposed site for which water quality data could be obtained. The wells are summarized in Table 7-6.



Note: Groundwater samples at 1 well collected from 1974 - 1978

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Near Amargosa Creek Potential Reclaimed Site

November 1995
K/J 934620.00
Figure 7-20

A comparison of the groundwater quality with data for the potential sources is shown on Figure 7-21. The data indicate that the groundwater quality is quite good relative to the potential recharge sources with a range of TDS values from 129 to 268 mg/L. However, the available data are insufficient to assess the overall impacts to groundwater quality of the recharge of SWP or reclaimed waters to these areas.

TABLE 7-6

WELL SUMMARY NEAR USAF GROUNDWATER RECHARGE SITE

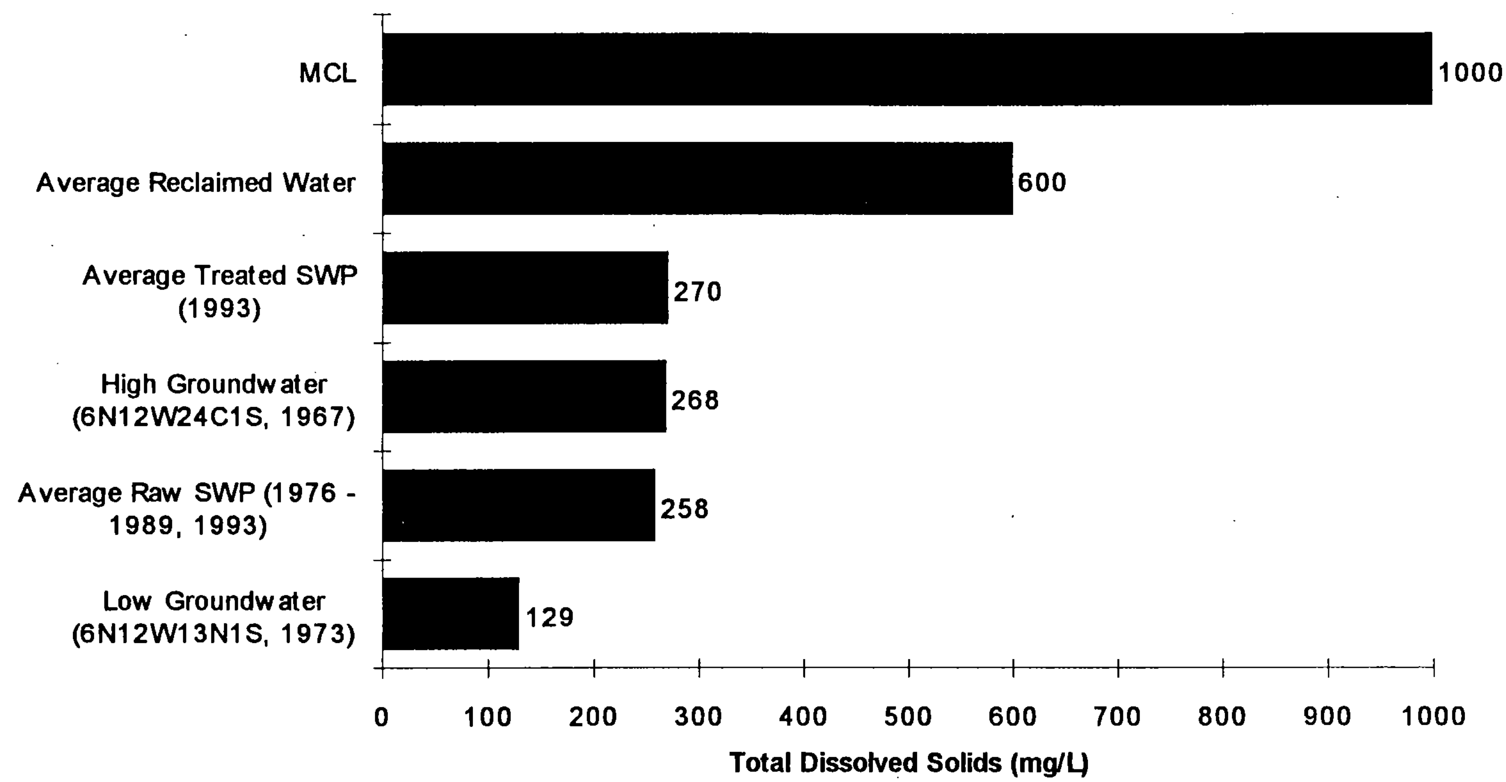
Well Number	*Length of Water Quality Data Collected*	*Well Owner*	*Approximate distance from proposed recharge site (miles)*
6N12W13N1S	1967, 1968, 1972 - 1978	PWD	3
6N12W24C1S	1963, 1967, 1969, 1972 - 1973	PWD (out of service?)	4

Gravel Deposits Site. In addition to the potential facilities described above, there are gravel deposits further north within two miles of Amargosa Creek near Avenue "F" and 10th Street East (Township 8 North, Range 12 West, Section 35). This site is close to the proposed reclaimed water distribution system as shown on Figure 7-19 but would require conveyance of Amargosa Creek and/or SWP waters to the site. Very little is known about this site. There is one well (8N12W35N1S) that has been located in the vicinity for which information is summarized in Table 7-7.

TABLE 7-7

WELL SUMMARY NEAR AMARGOSA CREEK GRAVEL DEPOSITS

Well Number	*Length of Water Quality Data Collected*	*Well Owner*	*Approximate distance from proposed recharge site (miles)*
8N12W35N1S	1970 - 1972	unknown	< 1



Note: Groundwater samples at 2 wells collected from 1963, 1967 - 1978

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Near Amargosa Creek Surface Recharge Sites

November 1995
K/J 934620.00
Figure 7-21

The water quality data that were collected have been compared to the reclaimed water and SWP water on Figure 7-22. TDS levels in the groundwater are generally lower than in the potential source waters. The available data are insufficient to assess the overall impacts to groundwater quality of the recharge of SWP or reclaimed waters to these areas.

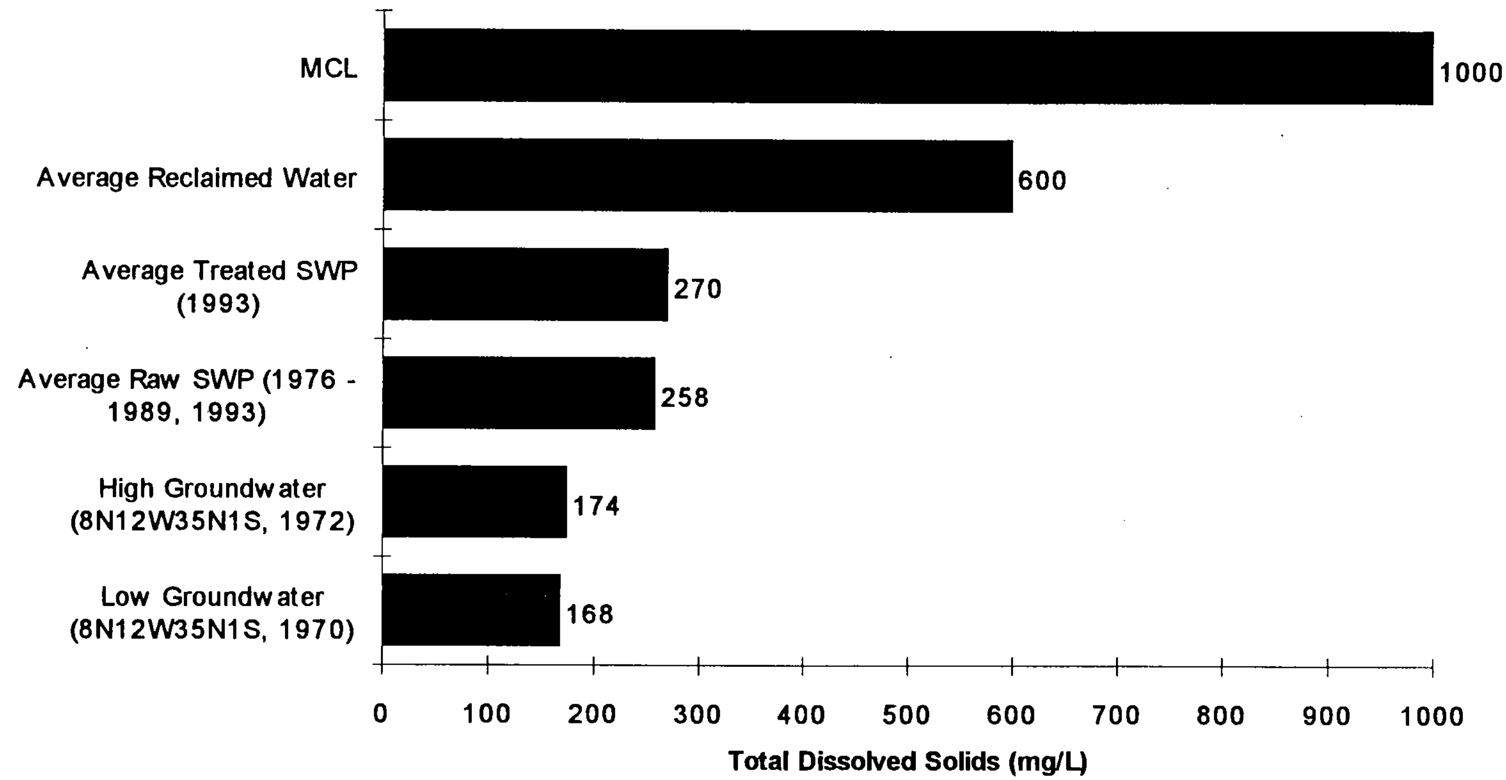
West Antelope Sub-unit

As described in the hydrogeology section of this chapter, the Antelope Valley is criss-crossed with faults which divide the Valley into sub-units as shown on Plate 1. The West Antelope Sub-unit is bounded on the southwest by consolidated rock, on the south and southeast by the Randsburg/Mojave fault, and on the north by an unnamed fault (USGS, 1967). The presence of these faults and the consolidated rock appear to provide groundwater barriers which would give hydraulic control over the sub-unit. That is, any waters that may be recharged in the sub-unit would remain in the sub-unit and would not flow into adjacent sub-units.

The West Antelope Sub-unit is located in a sparsely populated portion of the Valley and straddles the Kern and Los Angeles County lines near the California Aqueduct. (See Figure 7-23.) Although there are few natural sources of water in the sub-unit, Bloyd suggested that the sub-unit would be a suitable repository for temporary, long-term storage of water (USGS, 1967). In 1965, the USGS, in cooperation with AVEK, conducted a test-well drilling program to determine the feasibility of using the sub-unit to store water. It was estimated at the time that a 10 square mile portion of the entire sub-unit that extended 200 feet above the water table could store 1,280,000 acre-feet. The USGS/AVEK feasibility study indicated that recharge could be efficiently accomplished by using a spreading-basin or by constructing injection wells.

The feasibility study indicated that there were insufficient data to assess the ability to recover the water in an efficient and economic manner. Bloyd mentions that large pumping yields are obtained in part of the West Antelope Sub-unit. There were two wells for which groundwater data were available. The wells are summarized below in Table 7-8 and shown on Figure 7-23.

A comparison of the groundwater quality with the potential source waters of the SWP are shown on Figure 7-24. The TDS levels in the groundwater are generally higher than the SWP water which indicates that the SWP water will be a good potential recharge source for this site. The available data are insufficient to assess the overall impacts to groundwater quality of the recharge of SWP waters to this area. Well construction data and water quality samples from the wells should be collected and analyzed to assess the present day condition of the water quality in the aquifers. In addition, other data such as percolation tests and exploratory borings with pump test and geophysical logging would be required.



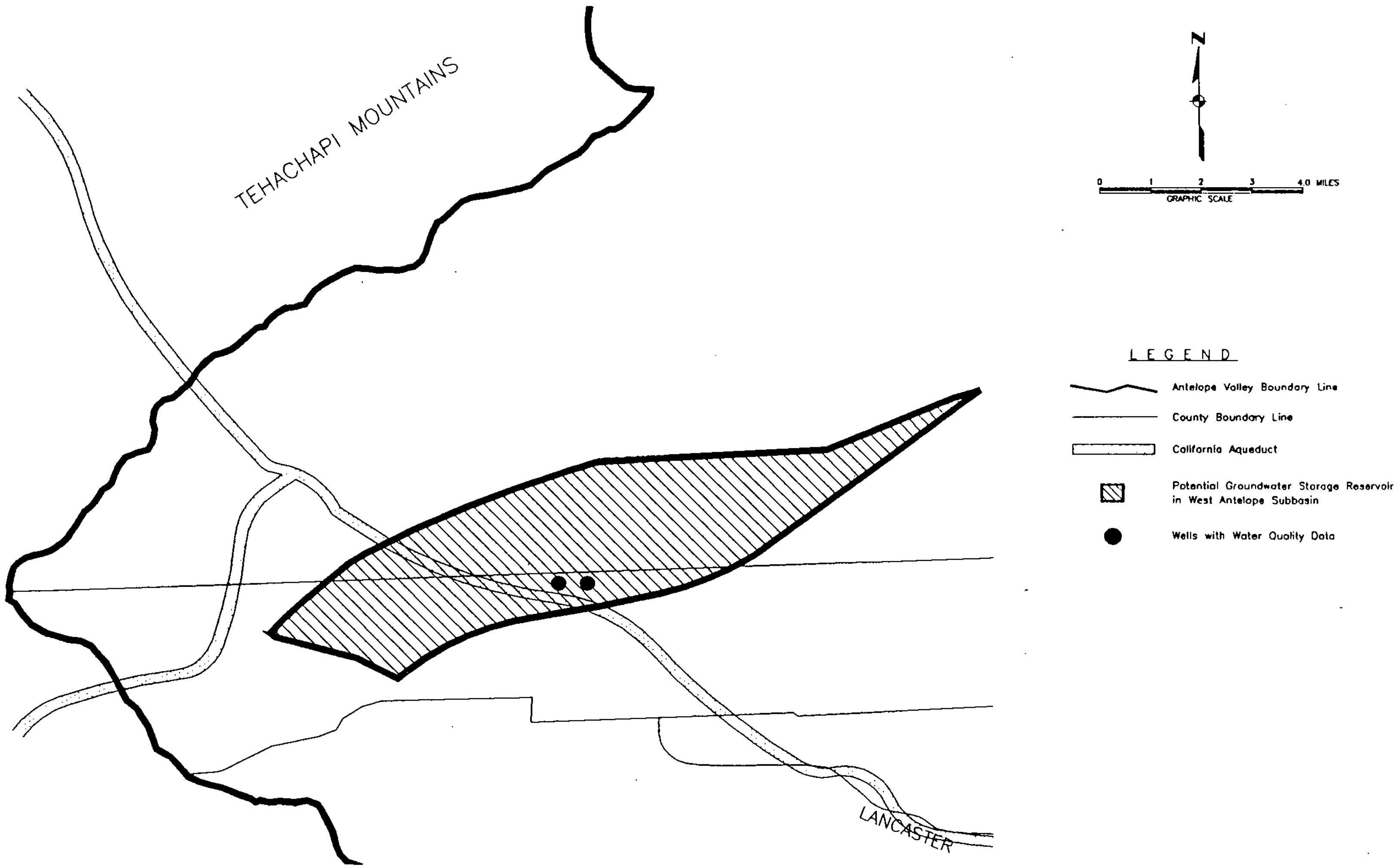
Note: Groundwater samples at 1 well collected from 1970 to 1972

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Near Amargosa Creek Gravel Deposits

November 1995
K/J 934620.00
Figure 7-22



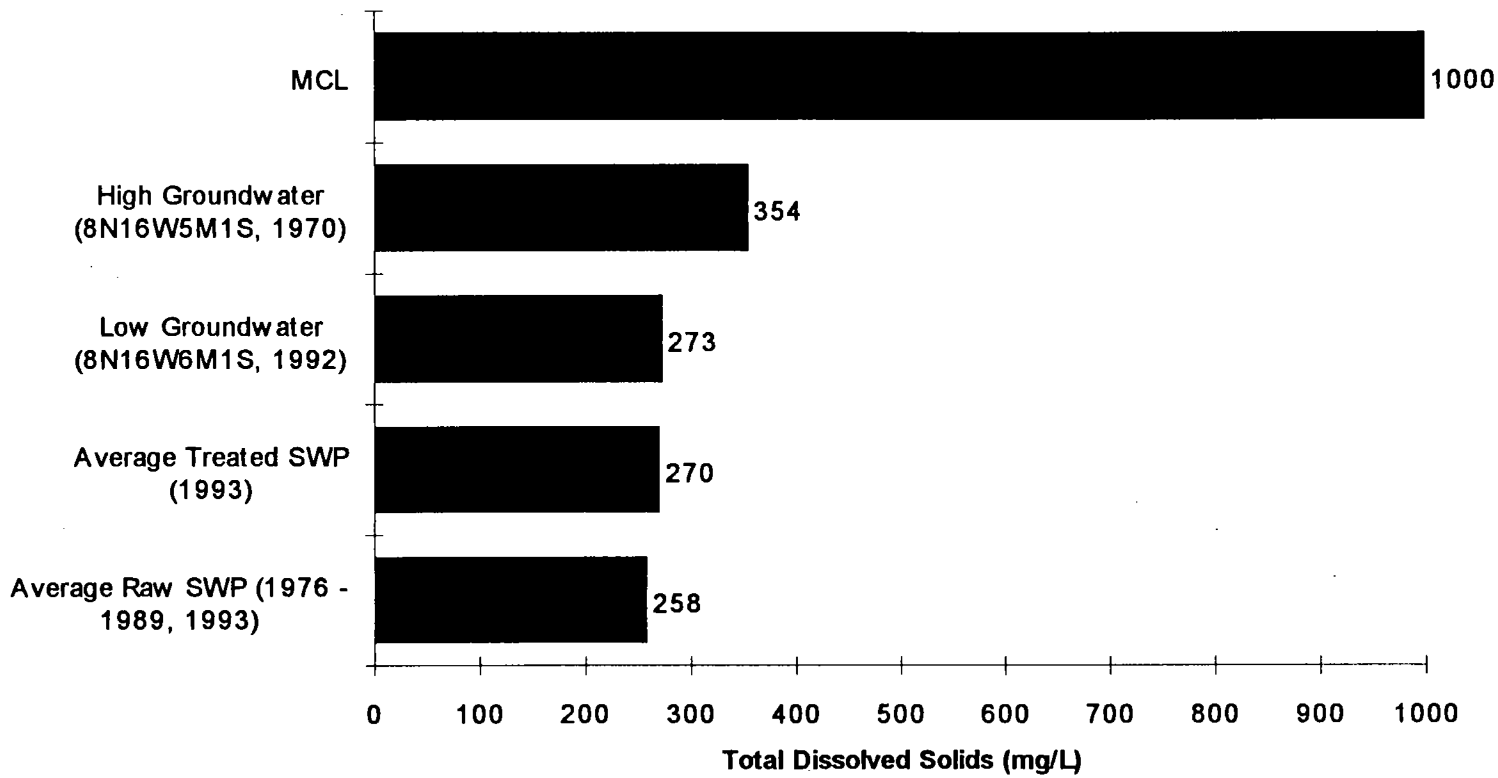
Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

West Antelope Subunit

November 1995
K/J 934620.00

Figure 7-23



Note: Groundwater samples at 2 wells collected in 1965, 1970 - 1972, and 1992

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality in West Antelope Subunit

November 1995
K/J 934620.00
Figure 7-24

TABLE 7-8

WELL SUMMARY NEAR WEST ANTELOPE Sub-unit

Well Number	*Length of Water Quality Data Collected*	*Well Owner*	*Approximate distance from proposed recharge site (miles)*
8N16W5M1S	1967, 1970 - 1972	unknown	< 1
8N16W6M1S	1992	unknown	< 1

This site, however, is far from the majority of the existing water users and has no distribution system that would connect to the users. This site may be best operated as a storage facility which would be served by a new turnout from the California Aqueduct that leads to either spreading grounds or injection/extraction wells. When the water is needed, the extraction wells could pump into the California Aqueduct to convey the water to the potential use areas. The economic viability of this type of operating scenario would have to be explored in detail and is closely tied to the availability and reliability of the SWP waters.

FEASIBILITY OF INFILTRATION

Based on the information presented above, infiltration as a mechanism to recharge groundwater appears to be technically feasible. There are good potential recharge areas available in several locations. The sites with the highest potential for recharge by spreading appear to be:

- Amargosa Creek south of Avenue "N" between 10th Street West and Division Street (LACDPW Site).
- Little Rock Creek near Avenue "N" between 60th Street and 70th Street East (DOA Property).
- Amargosa Creek near Elizabeth Lake Road and 25th Street West.

There are several potential recharge sources including SWP water, reclaimed water, and natural recharge waters which should be generally acceptable for infiltration from a water quality perspective. More detailed water quality analyses should be conducted at the potential recharge sites to gather current information on the condition of the aquifer in these specific locations. Until those data are available, comparisons of water quality with the potential recharge sources cannot be reliably made. If specific areas for recharge are selected that have water quality that is worse than the potential source waters, the recharge program may benefit the aquifer.

In addition, the potential formation of wetlands at the USAF Plant 42 site and the DOA site could result in increased wildfowl activity that could interfere with airfield operations. Depending on the timing of the operation of spreading ponds at the sites, this concern could be mitigated or reduced by developing an operation plan that accounts for migration patterns of the wildfowl.

Overall, further investigation will be required at each of the specific sites and should include, at a minimum, the following:

- Water quality of source waters and groundwater.
- Quantity and timing of availability of source waters.
- Hydrogeologic characteristics including travel times through unsaturated zones and percolation rates.
- Concerns of wildfowl interference at airfield operations.
- Location of extraction sites and travel times to those sites.

POTENTIAL INJECTION SITES

Characteristics important to a potential injection site were discussed previously. In addition, selection of potential injection sites for this study were also based on their location relative to existing groundwater depressions. The following section discusses issues associated with injection and describes potential injection areas.

Issues Associated With Injection

Some of the technical issues associated with injection into groundwater basins restrict the types of water that can be used for injection. For example, the water needs to be free of suspended matter/bacteria which could clog screens. In addition, injecting untreated SWP water may fall under the area of groundwater under the direct influence of surface water, and therefore may become subject to the Surface Water Treatment Rule (SWTR). The SWTR would require additional treatment of the water for potable uses. Additional treatment would reduce the cost-effectiveness of an injection program. For these reasons, it is recommended that only treated water be injected. Another issue that has been raised is that treated SWP that has been disinfected with chlorine, can be subject to trihalomethane (THM) formation in excess of the MCL. At present, it appears that the concentration of THMs in the groundwater is usually low. Therefore, the injection of treated SWP water could result in groundwater degradation. Treated SWP water may require alternative disinfection methods that would reduce or eliminate the problem of THM formation.

The issue of injection versus extraction rate will also need to be addressed. Due to the fact that injection rates are 50 to 100% of extraction rates, operational plans to account for the rate of injection, rate of extraction, volume of water available, and period of when the waters are available for injection and extraction will be required. In addition, new ASR facilities can be quite expensive because of the construction of new wells and pumping facilities. However, the relatively high cost for new ASR facilities can be offset by the reduced pumping costs as a result of increased water levels.

Potential Injection Areas

Based on the constraints and criteria described above, the municipal wellfields within the existing LACWW and PWD municipal wellfields were considered potential injection areas. (See Figure 7-25.) Specific areas that have been assessed include:

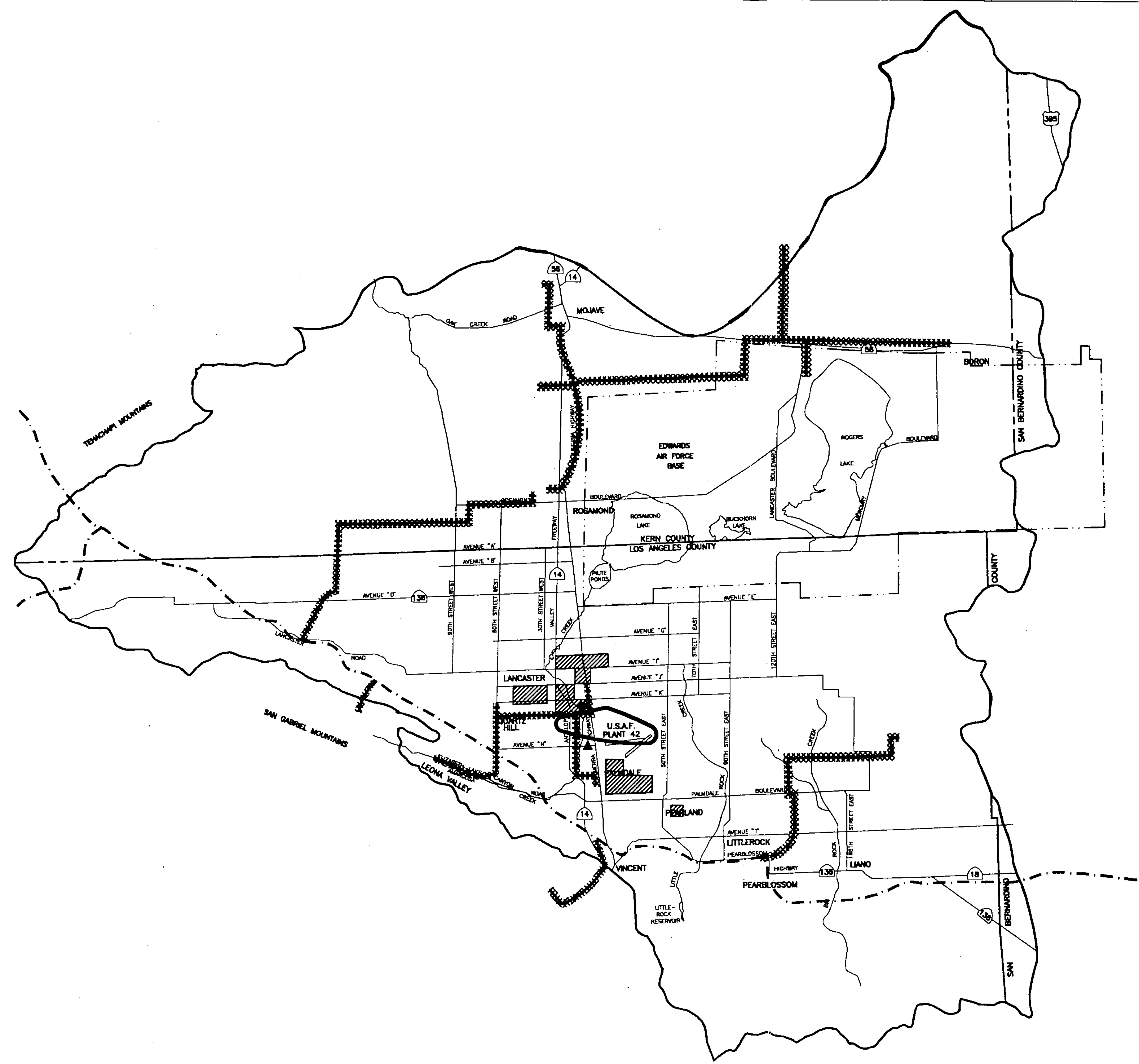
- USAF Plant 42 Site.

- Wells in USGS/LACWW/AVEK Injection Study.

Injection has not been extensively studied in the Valley. The areas listed above are discussed below.

USAF Plant 42 Site. A study performed in 1991 by the Los Angeles County Department of Public Works (LACDPW) evaluated the water recharge potential of the USAF Plant 42 site (LACDPW-MED, 1991). The site is bounded by 10th Street West, Avenue N and Division Street. The study, which included percolation, permeability and pumping tests, concluded that injection into the saturated zone at a depth of 460 to 600 feet appeared feasible from a geological point of view. According to the study, the acceptance rate of injected water into the saturated zone was approximately 70 percent of the pumping extraction rate. A later study performed by LACDPW (LACDPW-HWCD, 1992) proposed using LACWW District No. 4's production well No. 8 as a test injection well (See USGS/LACWW/AVEK Injection Study below). If the test results are favorable, LACWW District's wells No. 13, 33 and 42 would be converted to ASR wells. In addition, the report noted that new ASR wells could be constructed at the USAF Plant 42 site if additional water were available for recharge.

USGS/LACWW/AVEK Injection Study. The USGS, LACWW, and AVEK participated jointly in an injection study. The purpose of the study was to determine field-scale estimates of multi-aquifer and well hydraulic parameters governing the storage and movement of groundwater near the wells. These parameters included injection rates, storage coefficients, transmissivities, and a general assessment of aquifer responses to the injection. The field portion of the study was completed around June 1, 1994 and preliminary results are expected in August 1994. Discussion with USGS staff indicates that unexpected changes to land surface occurred during the injection program and that complete results would be available within two months (USGS, 1994b). The USGS/LACWW/AVEK study did not include a water quality component. However, water quality analyses of the injected, native and recovered water of the injection test were conducted by LACWW.



LEGEND

- Antelope Valley Boundary Line
- County Boundary Line
- Edwards Air Force Base Boundary Line
- California Aqueduct
- AVEK Distribution
- Existing Wellfields
- USGS Injection Study (1994)
- LACDPW Injection Site (1991)
- Groundwater Depression

0 3.25 6.50 9.75 13.0 MILES
GRAPHIC SCALE

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resources Study

Antelope Valley
Potential Injection Areas

November 1995
K/J 934620.00

Figure 7-25

Although there are many wells in the area, the readily available water quality information was relatively limited. The wells that were evaluated in the vicinity of the potential injection sites are summarized in Table 7-9. The water quality data that were available indicate that the TDS levels in the groundwater are generally lower than the SWP or reclaimed water as shown on Figure 7-26. The available data are insufficient to assess the overall impacts to groundwater quality of the recharge of SWP or reclaimed waters to these areas. Well construction data and water quality samples from the wells should be collected and analyzed to assess the present day condition of the water quality in the aquifers. In addition, other data such as percolation tests and exploratory borings with pump test and geophysical logging may be required.

FEASIBILITY OF INJECTION

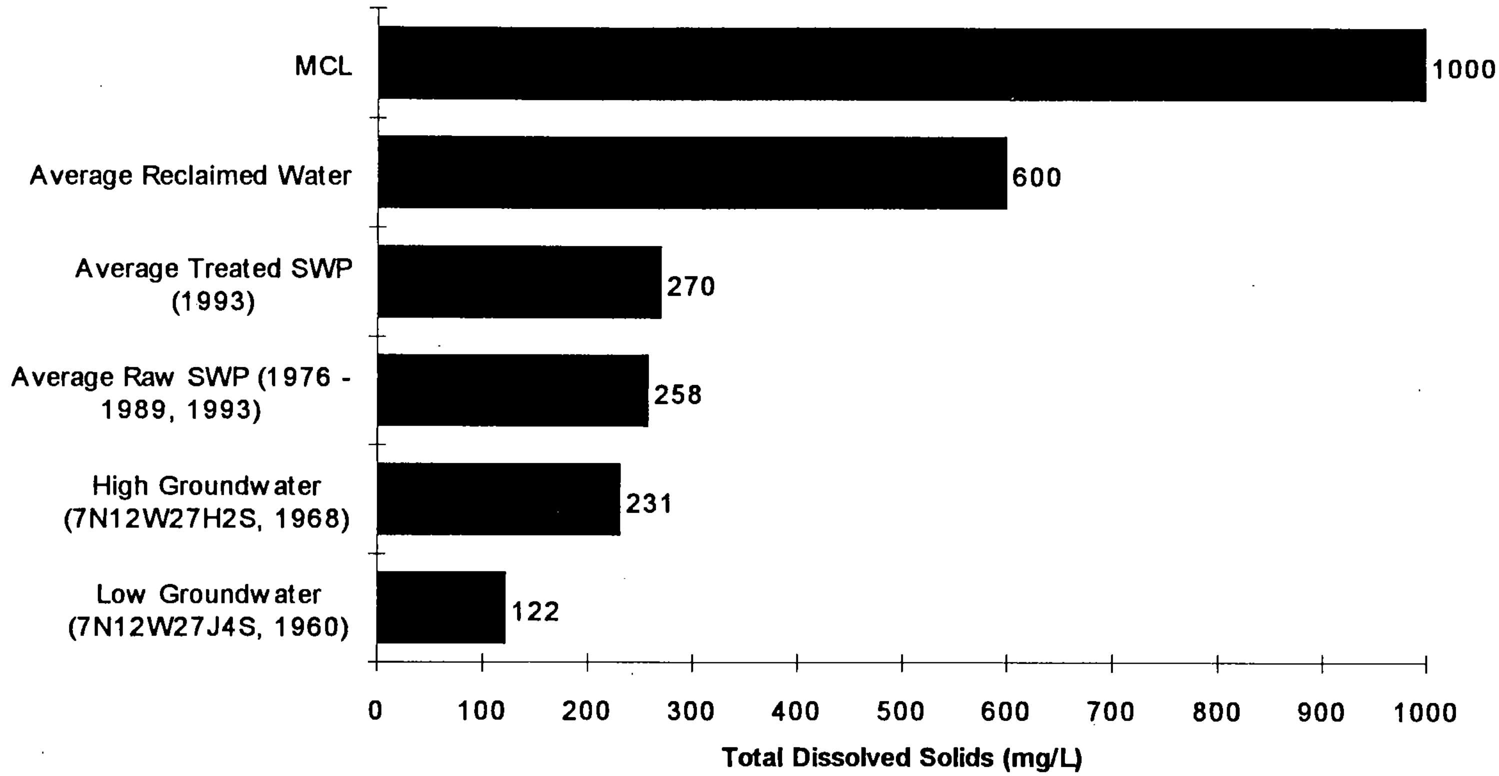
Based on the information presented above, groundwater recharge by injection appears to be technically feasible. The existing wellfields could provide both the injection and extraction facilities necessary to conduct such a program. The specific areas that should be explored further because of their proximity to the distribution system and potential treated SWP water are:

- LACWW wells located:
    - South of Avenue "K" between 10th Street West and Division Street (where USGS is conducting its injection study).
    - South of Avenue "L" between 10th Street West and Division Street (adjacent to the area above).
- PWD wells south of Avenue "P" between 20th Street East and 40th Street East.

TABLE 7-9

WELL SUMMARY NEAR POTENTIAL INJECTION SITES

Well Number	*Length of Water Quality Data Collected*	*Well Owner*	*Approximate distance from proposed recharge site (miles)*
7N12W27H2S	1960, 1961, 1964 - 1970, 1992	LACWW	< 1
7N12W27J4S	1957 - 1970	LACWW	< 1
7N12W27J5S	1953, 1960 - 1970	LACWW	< 1



Note: Groundwater samples at 3 wells collected from 1957, 1960, 1964 - 1970, 1992

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Water Quality Near Amargosa Creek Potential Injection Sites

November 1995
K/J 934620.00
Figure 7-26

It appears that treated SWP water should be generally acceptable for injection from a water quality perspective. The presence of THMs in the treated SWP water may require treatment and/or alternative disinfection methods. Although higher concentrations of THM in the injected water than in the groundwater could be considered a violation of the RWQCB-LH's non-degradation policy for water quality, injection of treated SWP water has been allowed in other groundwater basins. However, more detailed water quality analyses will have to be conducted at the potential injection sites to gather current information on the condition of the aquifer water quality in these specific locations. Until those data are available, comparisons of water quality with the potential recharge source cannot be reliably made. If specific areas for recharge are selected that have water quality that is worse than the potential source waters (i.e., higher nitrates), the recharge program may benefit the aquifer.

Depending on the results of the USGS's injection study, significant additional work will be required and should include, at a minimum, the following:

- Estimation of the actual volumes that could be injected at each site.
- Evaluation of aquifer behavior during injection and extraction and a determination of aquifer characteristics at specific sites.
- Evaluation of potential ground surface effects during injection and extraction.
- Determination of upgrades that may be required at each well and pump station.
- Evaluation of the operation of the injection/extraction system based on the availability of treated SWP water.
- Evaluation of the potential changes to water treatment plant operations that may be required to continue injection and extraction over the long-term.

It is noted that an ASR test was completed in 1992 for the North Las Posas Basin as part of a cooperative study agreement between Calleguas Municipal Water District and Metropolitan Water District of Southern California. Potable treated surface water from the SWP was injected into the groundwater basin through an ASR well, stored for a short time, and then extracted. Findings of the ASR demonstration project included 1) an injection rate of up to 620 gpm was achieved, 2) the groundwater basin was capable of a significant amount of recharge by injection wells, 3) the groundwater in storage and the injected water were compatible, and 4) the quality of the recovered water met all federal and state drinking water standards.

CHAPTER 8

EFFECTS OF CHANGES IN GROUNDWATER LEVELS

This chapter discusses the effects of changes in groundwater levels in the Antelope Valley. A brief introduction as well as discussions on potential damages attributable to changes in groundwater levels, land subsidence in California, and changes in groundwater levels in the Antelope Valley are presented.

INTRODUCTION

According to the United States Geological Survey (USGS), groundwater levels in the Lancaster area have declined by as much as 200 feet from 1915 to 1988 (USGS, 1994). Conversely, well hydrographs maintained by Antelope Valley-East Kern Water Agency (AVEK) and in cooperation with the USGS, indicate groundwater levels in portions of the Valley have risen in recent years. Appendix E presents figures from a recent USGS report showing the potentiometric head (representative of groundwater levels) in the Antelope Valley from 1957 through 1992. As shown in the USGS figures, groundwater levels generally declined from 1957 to 1975. However, between 1975 and 1981, groundwater levels in the eastern portion of the valley changed only slightly, in the central portion declined, and in the western portion increased. From 1981 to 1992, groundwater levels in the Valley generally increased although they continued to decline in the Lancaster area. An August 1994 report entitled "Hydrogeologic Assessment of Palmdale Business Park Center, Antelope Valley, Los Angeles County, California" by Richard C. Slade & Associates indicates that although groundwater levels are declining in the Lancaster area, the rate of decline has decreased since 1977. Hydrographs collected for 18 wells near the report project showed groundwater levels rising in about half of the wells. The remaining wells still indicated declining levels but at a slower rate of decline.

Declining groundwater levels over a long period of time generally indicate over-extraction from a groundwater basin; conversely, increasing groundwater levels over a long period of time may indicate under-extraction from a basin (or recovery from over-extraction). In addition to these obvious indications, changes in groundwater levels are of concern, because a variety of damages can result. These potential damages are discussed in the following section.

POTENTIAL DAMAGES ATTRIBUTABLE TO CHANGES IN GROUNDWATER LEVELS

Potential damages attributable to changes in groundwater levels include land subsidence, increased pumping costs, waterlogging, and water quality degradation. Damages can range from minor structural damage to major physical damage to the ground surface rendering land virtually useless. Table 8-1 lists potential damages attributable to changes in groundwater levels.

TABLE 8-1

POTENTIAL DAMAGES ATTRIBUTABLE TO CHANGES IN GROUNDWATER LEVELS

Declining Groundwater Levels	*Increasing Groundwater Levels*
Land subsidence resulting in the following: • Development of cracks, fissures, sinklike depressions and softspots. • Change in natural drainage patterns often resulting in increased areas of flooding or increased erosion. • Degradation of groundwater quality. • Permanent reduction in groundwater storage capacity. • Change in gradient in gravity pipelines (sanitary and storm sewers) or canals often resulting in lost capacity. • Damage to well casings, pipelines, buildings, roads, railroads, bridges, levees, etc. • Costs associated with repairs and rebuilding. • Costs associated with construction of new facilities such as pumping stations for gradient changes. • Reduction in land value. • Lawsuits. Increased pumping costs.	Waterlogging resulting in the following: • Increased liquefaction potential. • Structural damage. • Rendering septic systems useless. • Costs associated with repairs and rebuilding. • Reduction in land value. Water quality degradation.

Potential Damages Attributable to Declining Groundwater Levels

As indicated in Table 8-1, declining groundwater levels potentially result in two primary damages: 1) land subsidence and 2) increased pumping costs. These two types of damages are discussed in greater detail below.

Land Subsidence. Land subsidence is defined by USGS as the vertical lowering of the land surface over an area of many square miles (USGS, 1991) and may be the result of a variety of causes. Poland (1984) lists the following common causes of land subsidence:

- Solution of underlain common soluble components such as salt, gypsum, and limestones where the components are slowly dissolved and the surface sinks.

- Subsurface erosion where subsurface flow tunnels (piping) are developed, transporting grains of silt and sand along a horizontal path to an outlet. Enlargement of the tunnel reduces the support capacity of the surface materials and the ground surface collapses.

- Tectonic activity where slow earth movements and earthquakes cause downward displacement of the land surface.

- Compaction of low-density sedimentary deposits due to loading where settling of construction fill or natural sediment deposits cause surface to subside.

- Compaction of low-density sedimentary deposits due to hydrocompaction where application of water to low density, moisture deficient deposits produce volume loss, creating a rapid "shallow subsidence."

- Compaction of low-density sedimentary deposits due to extraction of fluids such as oil, gas, and water.

- Compaction of low-density sedimentary deposits due to drainage of the water table for mining and/or farming operations where peat deposits are extensive. Peat is a type of soil that contains more than 50 percent organic matter (USGS, 1991). Dewatering shallow peat deposits allows the peat to dry, leading to oxidation and decomposition. In addition, changes in physical and chemical characteristics of peat result in extreme volume reductions.

Regardless of the cause of land subsidence, the resulting damages are similar. (See Table 8-1.) In general, damages will be most pronounced when subsidence gradients (change in subsidence levels over a given distance) are high.

Development of cracks, fissures, sinklike depressions and softspots are indications on the ground surface of subsidence and can result in damages to existing structures, decreases in land values, changes in drainage patterns, and degradation of groundwater quality. Cracks are narrow openings less than 0.1 feet wide, fissures are large cracks as long as 9 miles, sinklike depressions are localized holes and depressions with underground voids enlarged as a result of vertical and lateral movement of water (often called piping), and softspots are areas or spots that have lost load-bearing capacity (USGS, 1992).

Changes in drainage patterns are caused by formation of cracks, fissures, and sinklike depressions, as well as changes in the ground surface slope. These changes can result in new areas vulnerable to flooding or an increase in existing areas vulnerable to flooding, as well as an increase or change in erosion.

Degradation of groundwater quality may result from formation of fissures. Fissures may extend to the water table, providing a direct conduit between the ground surface and the groundwater table (USGS, 1992). Contamination of groundwater could occur through transport of stormwater directly to the groundwater basin. Stormwater runoff contains various contaminants such as petroleum products, metals, salts, silts, fertilizers, and bacterial contaminants from human and animal sources. Common constituents found in storm water runoff are listed below:

- Total Suspended Solids
- Biochemical Oxygen Demand
- Chemical Oxygen Demand
- Total Phosphorus
- Soluble Phosphorus
- Total Kjeldahl Nitrogen
- Nitrate - Nitrogen
- Total Copper
- Total Lead
- Total Zinc

Reduction in groundwater storage may result from compaction of de-watered, low-density, sedimentary deposits.

In addition to changes in the physical properties of the land or groundwater, land subsidence can cause damages to man-made structures and can result in a cost to agencies or individuals.

Differential amounts of subsidence can result in changes in the gradient of gravity pipelines (sewer and storm sewer) and canals. Changing the gradient of these facilities can reduce their capacities and may require modifications to existing pumping stations or construction of new ones.

Damage to well casings, pipelines, buildings, roads, railroads, bridges, levees, and other structures may result from compaction of low-density, sedimentary deposits; formation of cracks, fissures, sinklike depressions, and softspots; and changes in the ground surface and subsurface slopes and elevations. Well casing collapses in subsidence areas are generally considered to be a result of changes in pressure exerted on the casing due to compaction of low-density sedimentary deposits. In addition, well pads protruding above the ground surface may result from formation of sinklike depressions or lowering of ground surface elevations. Separation or cracking of structures, such as pipelines, building walls and foundations, roads, railroads, bridges, and levees, may result due to formation of cracks, fissures and sinklike depressions, as well as changes in ground surface and subsurface slopes. The structural integrity of foundations may be damaged as a result of softspots.

Depending on the extent of damages to facilities, there will be costs associated with repair, replacement, or construction of required new facilities. In addition, reductions in land value may occur primarily as a result of development of cracks, fissures, sinklike depressions, and softspots. Depending upon the degree of ground surface damage, the land may be rendered virtually useless for development. Lawsuits may be filed against agencies thought to be responsible for the subsidence by property owners experiencing damaged structures or reduced land values.

Although subsidence is generally associated with decreasing groundwater levels, there may also be subsidence due to increasing groundwater levels. This is evident in the case of the groundwater mound north of the City of Lancaster. The mound is located near the terminus of Amargosa Creek and the wastewater treatment ponds near Rosamond Lake. According to USGS, rates of subsidence from 1975 to 1981 were higher near the mound than in surrounding areas. USGS's hypothesis for this observation is as follows:

> "If wastewater effluent discharged to ponds and water from other recharge sources are perched on fine-grained sediment layers, that water is not hydraulically connected to the water table. In this case, the perched water would cause an increase in geostatic stress without a corresponding increase in pore pressure and thus would result in increased effective stress and compaction in both the principal and deep aquifers...If the ground-water-level contours represent a water-table mound in the principal aquifer and not perched water, the pore spaces would be saturated, and the higher pore pressure probably would counteract the increased geostatic stress resulting from loading by the ground-water-mound. However, because the hydraulic connection between the deep aquifer and the water table (principal aquifer) is impeded by a confining bed of low permeability, compaction would occur at depth as a result of increased effective stress caused by the disparity between the increased geostatic stress and the negligible increase in pore pressure in the deep aquifer. Thus compaction would result..."

Increased Pumping Costs. Increased pumping costs result directly from declining groundwater levels. As the pumping lift increases so does the power cost to lift the water. As groundwater declines, additional pump bowls and larger motors may be necessary.

Potential Damages Attributable to Increasing Groundwater Levels

Potential damages attributable to increasing groundwater levels include waterlogging and water quality degradation. (See Table 8-1.) These potential damages are discussed below.

Waterlogging. Waterlogging is defined as saturation of soil with water. The effects of waterlogging are dependent not only upon the elevation of the groundwater table but also on the soil type. Generally, the effects of waterlogging will be most noticeable in granular soils.

Increased liquefaction potential results when the water table is high in a loosely compacted, granular soil. Liquefaction is the sudden drop in bearing capacity in soils of saturated non-cohesive particles, such as sand, during ground movement (i.e., seismic events). The soil essentially turns into a liquid allowing structures previously supported by the soil to sink. Proximity to faults is an important consideration when evaluating the potential for liquefaction to occur.

Structural damage due to waterlogging may result in "floating" of foundations or other structures or differential settlement upon dewatering of waterlogged soils. Floating occurs when structures have greater buoyancy than weight and upward forces are greater than downward forces. Floating is most likely to occur with granular soils. Differential settlement will most likely occur with dewatering of low-density soils which will result in compaction.

Septic systems may become useless with waterlogging because saturated soils will not allow infiltration of liquid from septic system leach fields.

Depending on the extent of damages to facilities, there will be costs associated with repair or replacement of facilities. In addition, reductions in land values may occur. Depending upon the degree of waterlogging, the land may be rendered virtually useless for development.

Water Quality Degradation. Water quality degradation can result from nitrates being drawn down into the aquifers by rising groundwater levels and then being spread by depressions caused from overpumping. Nitrate nitrogen is the most highly oxidized form of nitrogen found in wastewater. Nitrates are the end product of aerobic stabilization of organic nitrogen, and as such occur in polluted waters that have undergone self-purification. Nitrate in groundwater can come from fertilizer, poultry manure, or domestic wastewater. Nitrates can cause blue baby syndrome which can be fatal for infants. In blue baby syndrome, nitrates interfere with the blood's ability to distribute oxygen to the tissues. Also, nitrates can cause cancer by reaction to certain foods and water.

LAND SUBSIDENCE IN CALIFORNIA

Because noticeable land subsidence has occurred in the Antelope Valley in the last 40 years, a survey of land subsidence in California was conducted to indicate the potential degree of subsidence and the damages associated with subsidence.

According to Poland (1984), California has the largest area of subsidence in the United States (nearly 6,000 square miles). In addition, the three areas in the United States with the most severe problems are 1) the Houston-Galveston area in Texas, 2) the San Joaquin Valley in California, and 3) the Santa Clara Valley in California. Figure 8-1 depicts areas in California identified to have had or currently have land subsidence problems. Land subsidence in these areas has been attributed to extraction of groundwater or petroleum or, in some cases, has not yet been tied to either. Table 8-2 lists the subsidence areas in California along with the maximum subsidence, area of subsidence, time of principal occurrence and problems/damages within those areas. Brief discussions on the two principal areas which have had the greatest levels of subsidence due to groundwater withdrawal are included below. Information was primarily obtained from Poland's 1984 Guidebook.

Santa Clara Valley

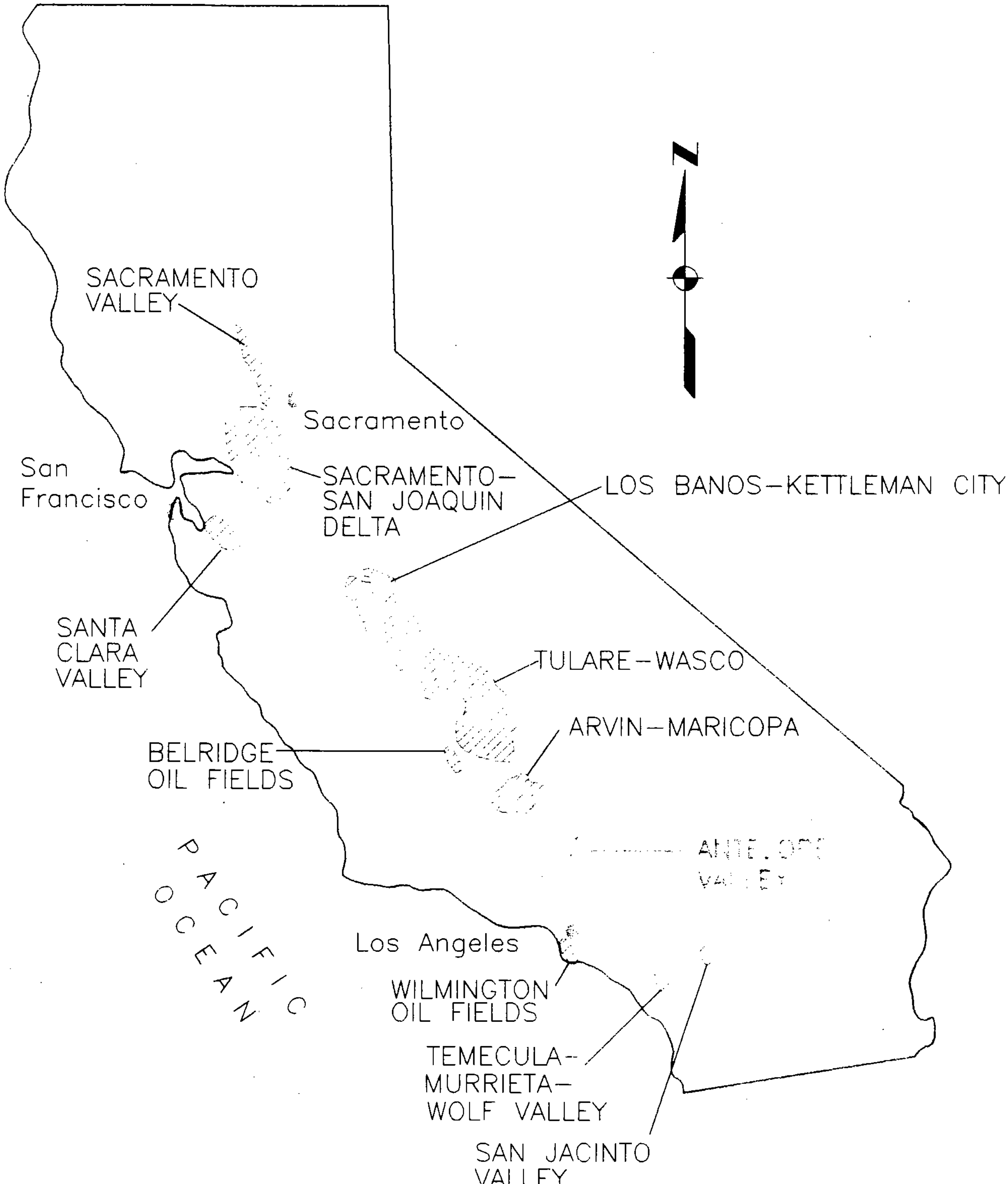
Land subsidence in the Santa Clara Valley was first noted in 1933. By 1969 the central part of the City of San Jose had subsided approximately 13 feet. The land subsidence was in response to a major decline in artesian head of the underlying groundwater basin. Groundwater pumping peaked in the early to mid-1960s, reaching nearly 200,000 acre-feet per year. By 1966, the artesian head in one well was approximately 180 feet below land surface compared to 12 feet above land surface in 1916. Recovery of artesian head in 1970-75 was due to increase in surface water imports, favorable rainfall supply, and decreased pumping of groundwater.

Partial estimates of the costs attributed to subsidence in the Santa Clara Valley indicate total costs were in excess of $35 million.

San Joaquin Valley

By 1966, yearly extraction of groundwater for irrigation in the San Joaquin Valley reached nearly 10 million acre-feet per year. This excessive withdrawal created an overdraft of approximately 4 million acre-feet per year in the 1950s and early 1960s. The potentiometric surface in some areas was drawn down nearly 600 feet. Importation of surface water resulted in groundwater withdrawal decrease, and, by the early 1970s, hundred of wells were unused, artesian heads were recovering, and subsidence was sharply reduced.

Partial estimates of the costs attributed to subsidence in the San Joaquin Valley indicate total costs were in excess of $50 million.



Kennedy/Jenks Consultants

LEGEND

Approximate Areas of Subsidence

Note: Subsidence areas shown are those potentially related to extraction of underground fluids.

Antelope Valley Water Group
Antelope Valley Water Resource Study

Areas of Land Subsidence
in California

November 1995
K/J 934620.00

Figure 8–1

TABLE 8-2

AREAS OF LAND SUBSIDENCE
IN CALIFORNIA (1)

Location	*Maximum Subsidence (ft)*	*Area of Subsidence (mi^2)*	*Time of Principal Occurrence*	*Problems/Damages*
Antelope Valley	6.6	463	1955-78 +	Collapsed well casings. Structural damages to buildings. Increase in areas subject to flooding. Development of fissures, cracks, and sinkholes, some of which affect the lakebed runway at Edwards Air Force Base.
Sacramento Valley	2.3	193	1955-78 +	NA
Sacramento-San Joaquin Delta	21	NA	NA	Increased maintenance required on joints and foundations of the Molkelumne Aqueduct. Potential additional pumping requirements for transport of water enroute to central and southern California (due to changed aqueduct slopes). Increased agricultural drainage requirements to maintain sufficient unsaturated zone below land surface for crop production. Increased potential for levee failures and flooding.
Santa Clara Valley	13.5	251	1918-70	Failure of hundreds of irrigation wells. Damage to railroads, roads, bridges, storm and sanitary sewers. Required construction of a new pumping station at a regional sewage treatment plant. Reduction in value of 17 square miles of land which previously stood above sea level. Required construction of new levees and repeated raising of levees to restrain landward movement of bay waters. Required raising of roads and railroads to stay above flood waters.

TABLE 8-2
AREAS OF LAND SUBSIDENCE
IN CALIFORNIA (1)
(Continued)

Location	***Maximum Subsidence (ft)***	***Area of Subsidence (mi^2)***	***Time of Principal Occurrence***	***Problems/Damages***
San Joaquin Valley				Repairs and remedial work of water transport structures (i.e. Delta-Mendota Canal and Friant-Kern Canal).
Los Banos-Kettleman City	29.5	2,394	1930-75	Gradient changes in the San Joaquin river which affected the transport characteristics of the river and altered levee requirements.
Tulare-Wasco	14.1	1,421	1930-70	Failure of hundreds of irrigation wells.
Arvin-Maricopa	9.2	695	1940-70	
San Jacinto Valley	3.2	4+	1950-75+	Collapsed well casings. Collapsed piping at wells protruding above the ground. Flooding. Aggravation and leaking of MWD's Casa Loma Siphon, leading to replacement with flexible joint piping in the 1970's. Damage to MWD's San Diego pipeline at the San Jacinto Reservoir. Increased repairs and rebuilding of roads. Cracking of sewer pip

TABLE 8-2
AREAS OF LAND SUBSIDENCE
IN CALIFORNIA (1)
(Continued)

Location	Maximum Subsidence (ft)	Area of Subsidence (mi^2)	Time of Principal Occurrence	Problems/Damages
Temecula-Murrieta-Wolf Valley	NA	15	1987 +	Severe structural damage to residential and business park areas, requiring abandonment and/or major repairs. Lawsuits alleging over $25 million in damages filed against the developers, County of Riverside, local water district, and several geological and soils engineering consulting firms. Slower rate of appreciation for residential land value.
Belridge Oil Fields	3-5	3	1986-89	Damage to oil production well equipment.

NA = Data not available at this time.
MWD = Metropolitan Water District of Southern California.
ft = feet.
mi^2 = square miles.
(1) = Subsidence areas described are those potentially related to extraction of underground fluids.

CHANGES IN GROUNDWATER LEVELS IN ANTELOPE VALLEY

The Antelope Valley has experienced declining and increasing groundwater levels. Damages attributable to declining groundwater levels have been identified within the study area; and damages attributable to increasing groundwater levels have been identified. Studies conducted related to both declining and increasing groundwater levels are described below.

Declining Groundwater Levels

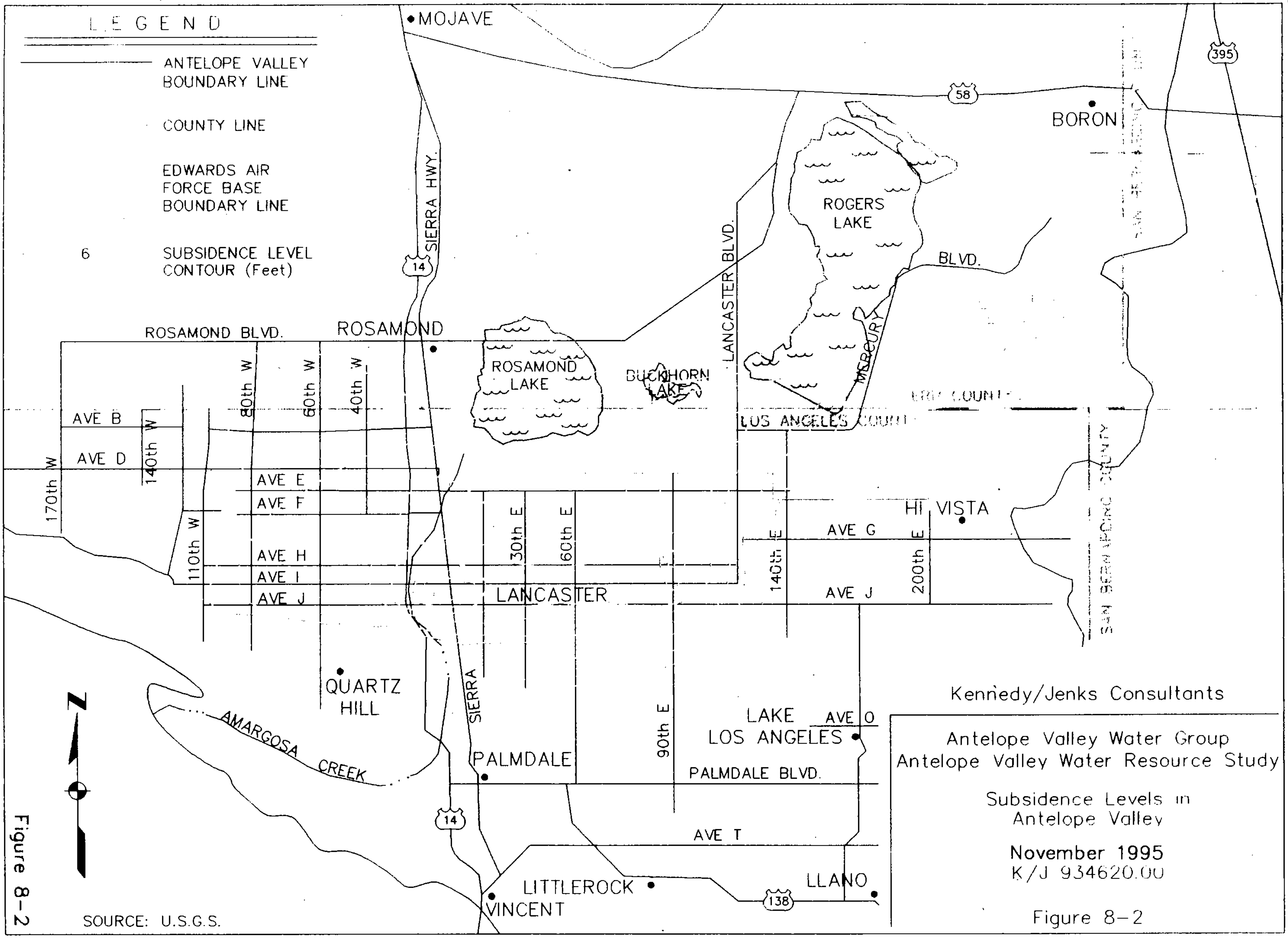
Groundwater use in the Antelope Valley was at its highest in the 1950s and 1960s as a result of agricultural demands (USGS, 1994a). According to USGS, land subsidence in Antelope Valley was first reported by Lewis and Miller in the 1950s (USGS, 1992). Since then, studies have shown subsidence levels of up to 7 feet occurring in some areas of Antelope Valley. (See Figure 8-2.) Conversations held with various agencies and companies indicate that within the Antelope Valley, the Lancaster and Edwards Air Force Base (AFB) areas are currently experiencing problems or damages that appear to be related to land subsidence. (See Figure 8-3 for locations of areas.) Table 8-3 lists land subsidence problems identified in Antelope Valley.

The following paragraphs present brief discussions on several studies done on land subsidence in Antelope Valley.

<u>USGS Report 92-4035</u>. USGS (1992) reported that as much as 2 feet of land subsidence had affected Antelope Valley by 1967 and was causing surface deformations at Edwards AFB. Fissures, cracks and depressions on Rogers Lakebed were affecting the use of the lakebed as a runway for airplanes and space shuttles. Appendix F provides pictures of various problems Edwards AFB is currently experiencing. In addition, depressions, fissures and cracks on the lakebed may not be detected until aircraft or space shuttles exceed the load capacity of the soil. Another concern was potential contamination of the water table through fissures which can provide direct access for toxic materials.

To determine the significance of land subsidence conditions, bench marks were surveyed using the Global Positioning System (GPS) in 1989. Differential levels were surveyed for 65 bench marks from 1989-1991. It was discovered that total land subsidence ranged from 0.3 to 3.0 feet.

<u>USGS Report 93-4114</u>. USGS (1993b), reported that land subsidence effects had been noted on Rogers Lake in the form of depressions, fissures and cracks. The report identified pumping of groundwater as the cause of the land subsidence. As much as 90 feet of groundwater level decline has occurred in the South Base well field, and an average annual compaction rate of 5.57×10^{-2} feet was measured at the Holly site near the South Track well field. (See Location 3 on Figure 8-3.)



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Subsidence Levels in
Antelope Valley

November 1995
K/J 934620.00

Figure 8-2

Figure 8-2

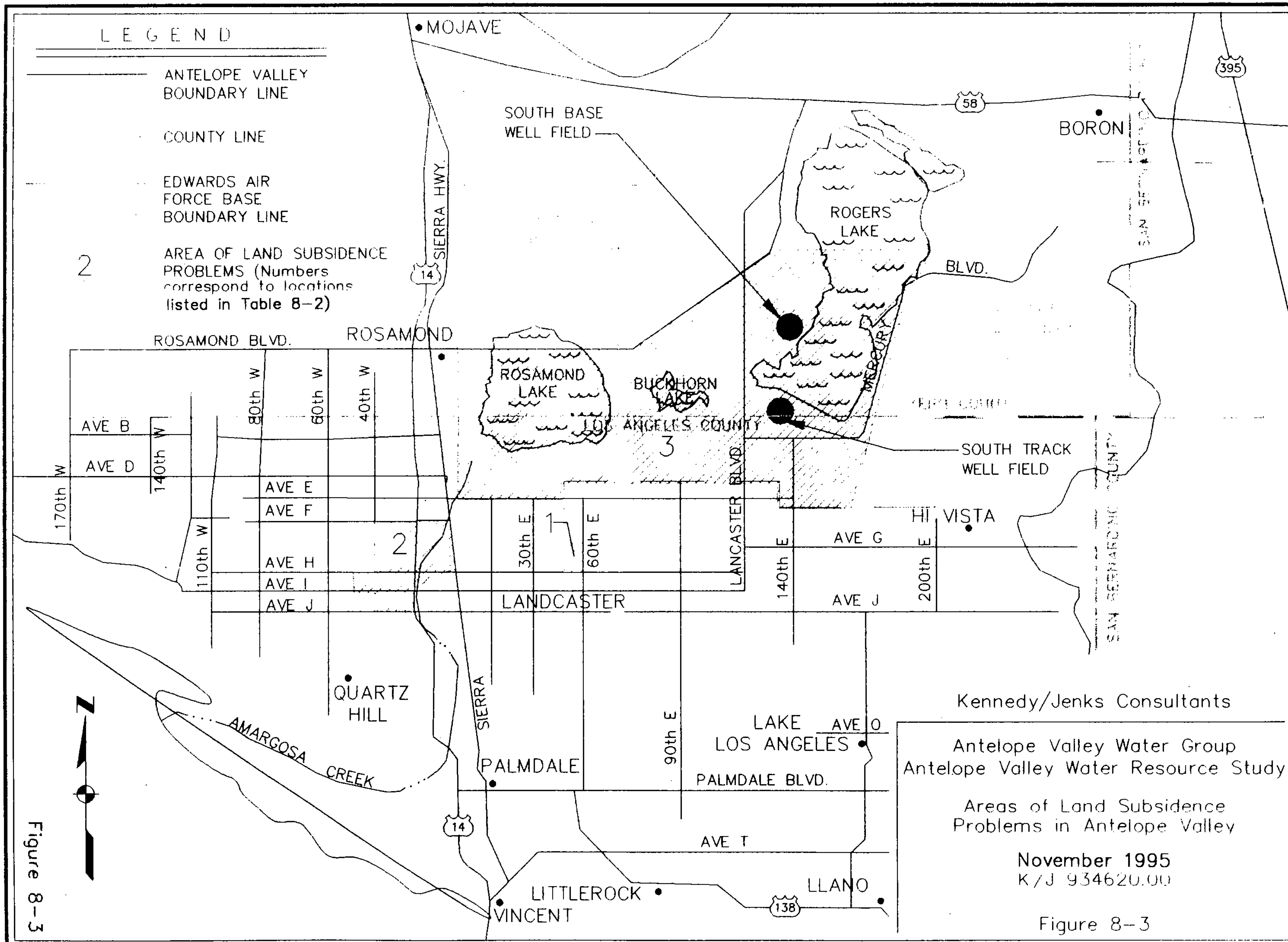

LEGEND
ANTELOPE VALLEY BOUNDARY LINE
COUNTY LINE
EDWARDS AIR FORCE BASE BOUNDARY LINE
2
AREA OF LAND SUBSIDENCE PROBLEMS (Numbers correspond to locations listed in Table 8-2)
MOJAVE
BORON
ROSAMOND
ROSAMOND BLVD.
SIERRA HWY.
SOUTH BASE WELL FIELD
SOUTH TRACK WELL FIELD
ROGERS LAKE
ROSAMOND LAKE
BUCKHORN LAKE
BLVD.
MERCURY
LOS ANGELES COUNTY
SAN BERNARDINO COUNTY
3
1
2
AVE B
AVE D
AVE E
AVE F
AVE G
AVE H
AVE I
AVE J
AVE O
AVE T
170th W
140th W
110th W
80th W
60th W
40th W
30th E
60th E
90th E
140th E
200th E
LANCASTER BLVD.
LANDCASTER
HI VISTA
QUARTZ HILL
AMARGOSA CREEK
SIERRA
PALMDALE
PALMDALE BLVD.
LAKE LOS ANGELES
LITTLEROCK
VINCENT
LLANO
14
58
395
138
N
Kennedy/Jenks Consultants
Antelope Valley Water Group
Antelope Valley Water Resource Study
Areas of Land Subsidence Problems in Antelope Valley
November 1995
K/J 934620.00
Figure 8-3

Figure 8-3

TABLE 8-3
LAND SUBSIDENCE PROBLEMS IDENTIFIED
IN ANTELOPE VALLEY

Location	*Description*	*Maximum Subsidence (ft)*	*Problems/Damages/Concerns*
1	Area bounded by 50th and 60th Streets east and Avenues G and H (T7N-R11W-S3)	3-4	Development of cracks and fissures.
2	Northwest portion of City of Lancaster	4-5	Development of cracks, fissures and sinkholes in the following areas (Geolabs, 1991): In the vicinity of KAVL and KBVM radio towers Near the proposed site for High Desert Hospital complex East of a residential project at the southeast corner of 30th St. West and Ave. "I" In the vicinity of LA County Detention Facility south of Ave. "I" The "H" Street Bridge over Amargosa Creek where up to 4" of lateral separation is present across the central expansion joint [1].

TABLE 8-3
LAND SUBSIDENCE PROBLEMS IDENTIFIED
IN ANTELOPE VALLEY
(Continued)

Location	*Description*	*Maximum Subsidence (ft)*	*Problems/Damages/Concerns*
3	Edwards Air Force Base	3.3	Failure of several well casings. Increase in area subject to flooding. Structural damage to wastewater treatment plant building. Wells protruding above the ground. Development of cracks, fissures, sinkholes and softspots on Rogers Lakebed, affecting use of the lakebed as a runway for planes and space shuttles.

(1) Geolabs reports that the separation may be due to differential settlement, or may be related to the same mechanism which is causing the fissuring in the area.

USGS Report 93-148. USGS (1993a) was completed as part of USGS's study to determine the relation between groundwater withdrawals and land subsidence at Edwards AFB (Report 4114). The report is a compilation of drilling, construction, and subsurface data collected during the installation of 40 piezometers at 13 sites on the base in 1991 and 1992.

USGS 1994 Draft Report. USGS (1994) revealed that land subsidence throughout Antelope Valley has reached nearly 7 feet. As shown on Figure 8-2, USGS indicated that subsidence levels of 6.6 feet have occurred near Avenue I and Division Street, and Avenue H and 90th Street East. The draft report stated that there was a general correlation between groundwater level declines and the distribution and rate of subsidence. In addition, the report estimated a conservative loss of approximately 50,000 acre-feet of storage in the groundwater sub-unit in the area that has been affected by 1 foot or more of land subsidence.

Holzer and Clark, January 1981. A paper by Thomas L. Holzer and Malcolm Clark titled "Earth Fissure in T7N, R11W, Section 3 near Lancaster, California" in January 1981, identified a fissure measuring approximately 0.35 miles long, up to 7.5 feet deep and 3 feet wide located between Avenues G and H and between 50th and 60th Streets East. (See Location 1 on Figure 8-3.) The paper identified the owner of the property who stated that fissures became evident in early 1978 near Little Rock Creek. Upon flooding from the Little Rock Creek in 1980, the fissures further appeared. The owner had occupied the property since 1928 and stated that neither irrigation nor floods in 1938 or 1969 had caused any fissures to appear. The paper hypothesized that the crack was caused by differential subsidence related to groundwater withdrawal.

Geolabs, February 1991. A study done by Geolabs - Westlake Village (1991) studied a 10 square mile area in Lancaster identified to have fissures and sinklike depressions. (See Location 2 on Figure 8-3). The report identified fissures ranging in width from one inch to slightly over one foot. The lengths of the fissures ranged mainly between 50-200 feet, with the longest continuous fissures in the 600-700 foot range. Sinkholes ranged mainly between one to five feet deep and less than four feet in diameter. One sinkhole measured 20 feet long and 15 feet wide. Appendix F provides pictures of the fissures. The report concluded that the fissures were due to tensional forces created by subsidence, which may be related to groundwater withdrawal due to the correlation between areas of significant subsidence and areas of pronounced groundwater level decline. Areas of concern identified in the report are included in Table 8-3.

Current Study. In addition to reviewing the reports summarized above, as a part of this study, companies and agencies within the Antelope Valley were surveyed regarding potential damages attributable to groundwater level declines and field visits of affected areas were conducted. Companies and agencies surveyed include the following:

- Antelope Valley-East Kern Water Agency
- CALNEV Pipelines
- City of Lancaster, Redevelopment Center
- City of Lancaster, Road Maintenance Department
- City of Palmdale, Engineering Department
- City of Palmdale, Road Maintenance Department
- County Sanitation Districts of Los Angeles County
- Edwards AFB
- Kern County Flood Plain Management Section
- Los Angeles County Waterworks District, Sewer Department
- Rosamond Community Services District
- Southern California Gas Company
- Southern Pacific Railroad
- State Fire Marshall, Pipeline Safety Division

Other than those damages identified in the reports summarized above, structural damage to the wastewater treatment plant building on Edwards AFB was the only other potentially significant damage identified and may or may not be attributable to land subsidence. Other minor existing damages that may or may not be attributable to groundwater level declines include cracked sidewalks and pavement.

To assess existing and potential degradation to the groundwater supply, an attempt was made to correlate typical stormwater runoff constituents and similar constituents in the groundwater supply. The hypothesis was that areas of fissuring should show higher degrees of contamination if runoff was reaching the aquifers through the fissures.

The Los Angeles County Water Quality Section monitors surface water; however it does not monitor typical stormwater constituents, only general minerals. Therefore, it is currently unknown whether groundwater degradation due to subsidence is occurring in Antelope Valley. However, should fissuring continue, degradation to the groundwater supply could be a potential problem and should be investigated. Individual water purveyors servicing the area where fissuring is occurring may test for some of the constituents found in stormwater, from which data may be obtained.

In addition to subsidence-related problems, groundwater level declines of up to 200 feet in the Valley have resulted in increased pumping costs. USGS (1994) cites the increased pumping costs as the primary reason for a decline in agricultural production during the 1970s. The Los Angeles County Waterworks believes that attractive land prices along with increased pumping costs have also contributed to the decline in agricultural production.

It is recommended that monitoring of subsidence levels and groundwater levels continue in the Antelope Valley as indicators of future problems due to subsidence and current progress toward balancing groundwater use. Monitoring of groundwater quality for typical stormwater constituents in areas of fissures is recommended as an indicator of the degradation potential due to fissures.

Increasing Groundwater Levels

Increasing groundwater levels have occurred in portions of the Valley. For most of these areas, no damage related to these increases has been identified, due to the fact the groundwater level is still significantly below the ground surface. However, for the Leona Valley area in the southern portion of the Valley, damages potentially attributable to increasing groundwater levels were identified in April 1993. (Note that although the Leona Valley does not overlie the Antelope Valley groundwater basin, precipitation contributes to the groundwater basin through the Amargosa Creek. Therefore, the Leona Valley is hydrologically connected to the groundwater basin and is considered a part of the Antelope Valley).

Following the winter rains of 1992/93, springs began to appear in Leona Valley. Some springs appeared in locations where springs existed prior to the recent drought. In other cases, springs appeared in locations for which there was no record of prior springs. The cause of the springs has not been determined, although residents speculated the cause was movement of the north branch of the San Andreas Fault, which extends through Leona Valley; the USGS speculated the cause was increased groundwater recharge from the heavy winter rains. Chemical analyses of the spring water was performed by USGS in order to determine if the water was recharge water or deep water forced to the surface by fault movements. Water exposed to the atmosphere since 1941 (recharge water) would contain tritium, a by-product of nuclear weapons testing. According to discussions with USGS (USGS, 1994b), results of the chemical analysis indicate the spring water is not deep water forced up by the faults. USGS attempted to obtain funding to further study the springs but was unsuccessful. However, County of Los Angeles took aerial photos and infrared to locate the springs.

Regardless of the cause of the increasing groundwater levels in Leona Valley, the apparent damages appear to be typical and include waterlogging and water quality degradation. (See Table 8-1.) Springs surfaced under at least two homes and water from springs threatened the structural integrity of a barn. Coincident to the appearance of the springs, high nitrate levels were discovered in the primary well used by the Antelope Valley Water Company to serve Leona Valley. A representative of the Department of Health Services indicated nitrates in groundwater supplies usually increase as the water table rises.

To assess impacts on groundwater quality due to rising groundwater levels in other areas of the Valley, an attempt to correlate rising nitrate problems and rising groundwater levels was made. Hydrographs maintained by the Antelope Valley - East Kern Water Agency (AVEK) for wells in the Antelope Valley were reviewed to locate wells with rising groundwater levels. Water quality information maintained by AVEK were also reviewed. Historical trends in nitrate levels of the wells were reviewed to find correlations. Based on the investigation, it was discovered that most wells were not tested for nitrates and, for the wells that were, not enough data were available to determine whether or not there was a correlation. Therefore, it is currently unknown whether nitrate problems due to rising groundwater levels are occurring in the Valley.

If groundwater levels should continue to rise (especially in areas of farmland), groundwater quality should be closely monitored. Individual water purveyors servicing the areas where groundwater levels are rising may test for nitrates, from which data may be obtained.

CHAPTER 9

WATER RESOURCE PROTECTION PLAN

The previous chapters of this report evaluate the existing water resources of the Antelope Valley as well as the need to develop additional water resources or implement additional water management techniques. This chapter integrates these evaluations into a water resource protection plan so that a consensus approach to providing an acceptable level of water resource reliability for the Antelope Valley can be developed. A description of recommended monitoring programs is also presented.

CONCLUSIONS OF PREVIOUS CHAPTERS

Based on the evaluations presented in previous chapters, the following general conclusions and observations are summarized:

1. The Antelope Valley encompasses approximately 2,400 square miles. The area has an arid environment and precipitation varies widely.

2. Since the mid-1980s, the population in the Antelope Valley has grown rapidly. Significant growth is expected to continue in all areas, except Edwards Air Force Base (AFB) and Boron, during the study period (1993 to 2020).

3. As the population increases, corresponding water demands are expected to increase. Increased water demands can be attributed almost exclusively to the expected development of the Valley. Agricultural water demands are expected to decline during the study period. These demands would be expected to decline even further if the areas were not necessary for wastewater disposal purposes.

4. The Valley currently has several available water resources, including groundwater, imported State water, diversions from Little Rock Creek, and reclaimed water. Of these, all are currently being utilized; however, imported State water and reclaimed water are not being utilized at their full capability. Unfortunately, unlike groundwater, the lack of use results in a loss of the water resource. Little Rock Dam is currently being modified and this modification is expected to increase the ability to utilize stormwater diversions from Little Rock Creek.

5. The Antelope Valley Groundwater Basin is divided into twelve subunits and is comprised of two primary aquifers: the principal aquifer and the deep aquifer. The groundwater quality is generally considered excellent. The recharge of the groundwater has been estimated to be 31,200 to 59,100 acre-feet per year.

6. With the exception of the groundwater supply, the available water resources are subject to delivery fluctuations. The reliability of the groundwater supply is generally considered to have a 100 percent delivery reliability when operating within the range of natural recharge. Because of limitations on Delta exports of water as well as fluctuations in hydrologic conditions, there is considerable delivery uncertainty associated with State water deliveries. Similarly, fluctuations in hydrologic conditions and limitations of diversion capabilities affect the delivery reliability of water from Little Rock Creek. Reclaimed water reliability is affected by the uncertainty associated with wastewater generation projections but generally has a 100 percent reliability when reclaimed water use is much lower than wastewater generation.

7. Based on the water supplies currently utilized in the Antelope Valley, without exceeding groundwater extractions of 59,100 acre-feet per year, the probability of meeting the estimated 1993 water demand is approximately 73 percent. This delivery reliability is generally below the objectives of comparable water utilities. Based on the water demand projections derived from population projections, the probability of meeting the projected water demand is expected to decline to zero by the year 2000 (i.e., demand exceeds the total available supplies), unless additional water management programs are implemented.

8. The water purveyors currently compensate for the lack of water supply reliability by groundwater extractions in excess of prior recharge estimates.

9. A review of historical groundwater levels indicates that the transition from agricultural to urban land use causes a decline in groundwater levels but the delivery of State water can offset adverse effects on groundwater levels. The delivery of State water to agricultural areas can result in rising groundwater levels.

10. Full development of the identified water conservation program is estimated to save nearly 500,000 acre-feet of water over the 1994 to 2020 planning period; however, the program would not affect the water demand until the year 1995. Without the water conservation program, the probability of meeting the 1995 water demand is estimated to be approximately 66 percent. With the water conservation program, the probability increases to approximately 71 percent. The date at which demand exceeds the total available supply would be extended to the year 2002.

11. Potential expansion of existing reclaimed water uses appears feasible. The identified reclaimed water system would distribute both secondary and tertiary treated wastewater. The projected reclaimed water use of high potential users is 35,600 acre-feet per year.

12. Full development of the identified reclaimed water potential would increase the delivery reliability of water supplies. Without the identified reclaimed water system or the water conservation program, the probability of meeting the 1995 water demand is estimated to be approximately 66 percent. With both the reclaimed water program and the conservation program, the probability increases to approximately 72 percent. The date at which demand exceeds the total available supply would be extended to the year 2004.

13. Aquifer storage and recovery (ASR) involves groundwater recharge by spreading or injection. Recovery would be accomplished by wells, primarily existing wells. ASR can also be accomplished by in lieu delivery of alternative water sources. Based on the hydrogeologic characteristics of the Antelope Valley, groundwater recharge by both spreading and injection appears feasible. Potential water sources for recharge include State water, reclaimed water, and local stormwater. The areas having the most potential for spreading are Amargosa Creek south of Avenue "N" between 10th Street West and Division Street, Little Rock Creek near Avenue "N" between 60th Street and 70th Street East, and Amargosa Creek near Elizabeth Lake Road and 25th Street West. The areas having the most potential for injection are Los Angeles County Waterworks (LACWW) wells located south of Avenue "K" between 10th Street West and Division Street; LACWW wells located south of Avenue "L" between 10th Street West and Division Street; and Palmdale Water District (PWD) wells south of Avenue "P" between 20th Street East and 40th Street East. Site specific evaluations will be required to evaluate the recharge potential and technical, economic and environmental feasibility of each site.

14. Groundwater levels have declined significantly in certain areas of the Antelope Valley. In these areas, land subsidence has generally accompanied the declining groundwater levels. Although damages attributed to land subsidence have been relatively modest when compared to subsidence problems identified in other parts of California, significant problems can occur as demonstrated in the San Joaquin Valley. Similarly, rising groundwater levels can also cause problems such as waterlogging and water quality degradation.

BASIC WATER RESOURCE PROTECTION STRATEGY

Based on the identified water resource problems as well as the evaluations presented in the previous chapters, a basic water resource protection strategy has been developed. The strategy focuses on minimizing demand growth, protecting and optimizing the use of existing water resources, and developing additional water resources to meet projected future demands. Specific elements of the recommended strategy are presented below:

- Improve Utilization of Available Water Supplies. Because groundwater moves slowly, under-utilization generally does not result in a significant loss of this resource. Conversely, under-utilization of reclaimed water, stormwater or imported State water could result in irretrievable resource losses unless capabilities to store and recover these water supplies are available. The recent modifications to Little Rock Dam and Reservoir and potential aquifer storage and recovery programs are activities which should improve utilization of the available water supplies. Direct utilization of the reclaimed water, stormwater, and imported State water in lieu of groundwater would minimize the requirements of potential ASR programs.

- Manage the Groundwater Basin. The Antelope Valley Groundwater Basin has a large capacity to store water. Over the last several decades, the volume of water in storage has declined significantly but is still large. As agriculture decreases, it is expected that urbanization will be the primary cause of increased water demands. Accordingly, to bring groundwater extractions more in line with the estimated safe yield of the Basin, the first phase of this element should be to limit any further reductions in groundwater levels. When this objective has been accomplished, the second phase of this element should be to replenish the Basin to the extent feasible so that it can be utilized to compensate for delivery fluctuations in other water supplies, particularly the delivery of State water.

- Protect Groundwater Quality. The Antelope Valley Groundwater Basin is an important component of the water resources for the Valley. Not only does the Basin provide a reliable yield but it also can serve as a reservoir to optimize the use of the Valley's other water resources. One of the primary threats to the use of this valuable resource is potential water quality degradation. Generally, the groundwater quality is excellent. To maintain this water quality, it is important to protect the Basin from contamination by industrial activities and other land uses, introduction of foreign water with a lower quality, or rising groundwater levels that free contaminants adsorbed onto soil particles.

- Reduce Long Term Water Demands. The need for additional water supplies can be mitigated by long-term reductions in water demands. By implementation of selected water conservation programs, the existing water resources can be extended cost-effectively. Furthermore, the ability to obtain and transfer supplemental water supplies may be facilitated by the efficient use of available supplies.

- Improve State Water Project (SWP) Reliability. Of the water resources available to the Antelope Valley, imported State water is by far the most significant and has the greatest potential for providing additional future water supplies. Unfortunately, this water supply also currently has the greatest delivery uncertainty. Issues related to environmental concerns in the Bay-Delta, SWP financing and water supply allocations are being addressed by Federal and State agencies. Because the resolution of these issues will have a significant affect on the water supply/demand balance in the Antelope Valley, active participation in these negotiations is essential.

- Obtain Additional Imported Water Supplies. Regardless of whether the utilization of existing water resources is optimized, additional imported water supplies will be necessary to meet projected water demands. To minimize groundwater overdraft, these additional supplies should be obtained in timely increments. In order to acquire additional water supplies, the necessary financial resources must be available and water agencies in the Antelope Valley must be ready to act. The greatest opportunity to acquire additional imported water appears to be through water transfers among SWP or Central Valley Project contractors.

RECOMMENDED ACTIONS

To implement the basic strategy outlined above, the water purveyors in the Antelope Valley must initiate several institutional, engineering, financial, and public education activities. The recommended actions that appear to be the most important are:

1. Create an institutional framework to manage the development and use of water supplies.

To maintain equity among the competing water users and manage the utilization of the available water supplies, an institutional framework is desirable. The selected framework must be capable of accommodating the large number of water interests in the Antelope Valley. There are basically four approaches to the creation of multi-jurisdictional groundwater management:

- coordinated agreement by the water purveyors
- joint exercise of powers
- codified special districts
- special act legislation

Each of these approaches are discussed in the following paragraphs.

Coordinated Agreement by the Water Purveyors. Through a contract arrangement among the purveyors, the functions of groundwater management can be accomplished. This arrangement would require agreement between the signatory parties to exercise any power, including enforcement, or collect any levies. This approach has been utilized by other water utilities, particularly investor-owned utilities, to resolve specific groundwater utilization disputes. It should be noted, however, that agreements with investor-owned utilities should receive the approval of the California Public Utilities Commission to support their validity. The primary difficulties with this approach are as follows:

- Although the approach may be appropriate to resolve individual issues, it would be difficult to utilize this approach for issues as complex as groundwater management.

- Unanimous agreement among the parties would be necessary to perform any groundwater management function, and specific agreements among the parties would be necessary for each new function. This process could be time-consuming and cumbersome.

- Because groundwater rights are similar to property rights, parties other than the current water purveyors could initiate groundwater use within the basin. To continue effective groundwater management, it would be necessary for these parties to also become signatories to the agreements.

For these reasons, coordinated agreement among the water purveyors does not appear to be a viable approach to groundwater management unless the issues are relatively well-defined. Recent legislation (AB 255) may make this approach viable if the basin is in critical overdraft as identified in Department of Water Resources (DWR) Bulletin 118. AB 255, enacted in 1991, authorizes any local agency whose jurisdiction includes groundwater basins subject to critical overdraft to establish, by ordinance or resolution, programs for the management of groundwater resources within the area in which water service is being provided. The bill authorizes the local agency to fix and collect fees, subject to voter approval, for the extraction of groundwater and to levy a water replenishment assessment. The measure also requires local agencies with overlapping boundaries which conduct groundwater management programs to meet, at least annually, to coordinate their programs. AB 3030, enacted in 1992, repeals AB 255 and expands the authority contained in AB 255 for local agencies to manage groundwater. (See Appendix G for Synopsis of AB 3030.) AB 3030 provides the authority and procedures to develop and implement groundwater management plans. Groundwater management authority created under AB 3030 generally has the powers granted to a water replenishment district. The characteristics and powers contained in AB 3030 are summarized in Table 9.1.

Joint Exercise of Powers. Under the provisions of Article 1 of Chapter 5, Division 7, Title 1, of the Government Code, public agencies in California can exercise any powers common to the parties. If the water purveyors were public agencies, this approach could be utilized to perform certain groundwater management functions. Recent legislation (AB 2014) also allows mutual water companies to participate with public agencies in joint powers agreements. Water interests in the Antelope Valley include the County of Los Angeles, cities, special districts, investor-owned water companies, mutual water companies, Federal government, and individual water users. The County of Los Angeles, Kern County or certain special districts could be utilized to represent unincorporated areas overlying the sub-basins.

The primary difficulty with this approach is that the powers of the joint powers authority would be limited to the powers common to the Cities, special districts, mutual water companies, and the County. In addition, joint powers authorities are generally formed so that unanimity is required to take actions. The adequacy of the authority's powers will depend on the specific approach to groundwater management desired by the authority. A joint powers authority could also exercise the powers provided in AB 3030.

Codified Special Districts. The California Water code contains provisions for the formation of several types of special water districts. Based on a review of these enabling acts, water replenishment districts appear to be the most appropriate codified special district to perform groundwater management activities. The characteristics and powers of a water replenishment district are summarized in Table 9.1.

The primary function of a water replenishment district is to obtain supplemental water supplies to directly or indirectly replenish an overdrafted groundwater basin. This approach to groundwater management is somewhat reactive in that it focuses on mitigating overdraft conditions rather than other water management techniques such as conjunctive operation of the basin.

Special Act Legislation. Because each special legislative act is customized for a particular situation, a groundwater management agency formed by special act legislation tends to be unique. Upon passage these acts are usually codified in the Water Code Appendix. An example of a special act groundwater management agency is the Orange County Water District which was created in 1933.

Based on a review of these acts, enabling legislation generally contains the following provisions:

TABLE 9.1

SUMMARY OF GROUNDWATER MANAGEMENT AUTHORITIES

Formation				Internal Organization		Powers											Financial Authority				Enforcement Authority			
Agency	Reference	Year	By	Directors	Board	GW Studies	GW Manage-ment	Design & Operating Standards	GW Replenish-ment	Regulation of Extraction	Regulation of Export	Regulation of Beneficial Uses	Protection of GW Quality	Other Significant Powers	Water Rates	Taxes	Replenishment Extraction Assessment	Benefit Assess-ment	Standby Charges	Special Charges	Injunctive Relief	Penalties/ Interest	Suit	Lien
Water Replenishment District	Div 18 of WC	1955	Petition by 10% of voter election	5	elected by division	X			X	X		X	X	(1)	X	X	X	X			X	X	X	X
Orange County Water District	Chapter 40 WC Appendix	1933	Special Act	10	7 elected by division: 3 appointed by cities comprising division	X	X		X	X	X		X	(2)		X	X			X	X	X	X	X
Monterey Peninsula WMD	Chapter 118 WC Appendix	1977	Special Act	7	5 elected at large or by division 1 Supervisor 1 appointed by cities	X	X		X	X		X	X	(3)	X	X	X	X	X		X	X	X	X
Fox Canyon GMA	Chapter 121 WC Appendix	1982	Special Act	5	5 appointed (1 each by Ventura County, UWCD, cities & mutual & special Districts; 4 members choose 1)	X	X	X		X		X	X				X			X	X	X	X	
Pajaro Valley WMA	Chapter 124 WC Appendix	1984	Special Act	7	4 elected by division 3 appointed (1 each by Monterey County, Santa Cruz County & City of Watsonville)	X	X	X	X	X		X	X				X	X	X	X	X	X	X	X
Mono County Tri-Valley GMD	Chapter 128 WC Appendix	1989	Special Act	7	1 appointed by Supervisors 3 elected at large 3 property owners w/ extraction facilities elected at large (can designate substitute)	X	X	X	X	X	X	X						X			X	X	X	
Honey Lake Valley GMD	Chapter 129 WC Appendix	1989	Special Act	5	4 elected at large 1 appointed by Supervisors	X	X	X	X	X	X	X					X	X			X	X	X	X
Ojai Basin GMA	SB534	1991	Special Act	5	5 appointed (1 each by City of Ojai, CMWD, Ojai WCD, SCWC & mutuals)	X	X	X	X	X	X	X	X				X		X	X	X	X	X	X
Local Agencies (4)	AB 3030 Part 2.75 of WC	1992	Local Agency providing water service and overlying a GW Basin	(5)	(5)	X	X	X	X	X		X	X		X	X	X	X			X	X	X	X

Notes:

(1) Actions Outside District
(2) Hydro, Recreation, Wastewater, and Storm Drainage
(3) Conjunctive use of Groundwater and surface water; water storage outside district; water reclamation; water rights protection; and contract for groundwater remediation.
(4) Could be joint powers authority
(5) Depends on local agency

a. formation
b. internal organization
c. powers
d. financing authority
e. enforcement

Special act groundwater management agencies are formed by action of the legislature. Until the enactment of AB 255 and AB 3030, special act legislation was the most common non-judicial approach to formation of a groundwater management agency. Generally, these agencies are governed by a board of directors consisting of five to seven members. The selection method for board members varies widely. In most cases the board of directors is appointed or is composed of a combination of appointed and elected members. Depending on their unique role in local water regulation, the agencies have differing powers. Generally, the agencies are empowered to conduct groundwater studies and perform groundwater management by regulation of both extractions and beneficial uses of extracted water. Usually, these agencies can also perform groundwater replenishment activities. Like watermasters established by adjudication, assessments for extraction or replenishment are the most common form of financing authority, although other authorities such as benefit assessments and standby charges are usually provided. The authority to enforce its powers is also provided through a variety of enforcement powers.

The enabling legislation of several special act groundwater management agencies was reviewed. The characteristics and powers of these agencies are summarized in Table 9.1. As indicated, the powers and organization of each agency has been customized for the individual political and technical situation of that area. Consequently, each agency differs from the others. Because these agencies are designed for the unique conditions of an area, special act legislation has become the most common non-judicial approach to groundwater management.

Recommended Institutional Approach. Based on the forgoing discussion of the alternative institutional approaches to groundwater management, it is apparent that the most desirable approach is to utilize AB 3030 or special act legislation to create a groundwater management agency. By utilizing special act legislation, the board and its powers can be customized to the unique political and hydrogeologic conditions of the area.

The procedures to implement the powers authorized under AB 3030 are outlined in the legislation (codified in Part 2.75 of the Water Code). Cooperation among the water purveyors overlying a groundwater basin are strongly encouraged and groundwater management powers are limited to the local agencies service area.

To initiate special act legislation, the water purveyors in the Antelope Valley should initiate discussions regarding the general form of the agency, with particular focus on the composition of the board of directors and groundwater management powers.

If general consensus is achieved, draft legislation can be prepared and circulated for review by the individual water purveyors. When the provisions of the legislation have been mutually agreed upon, a legislative sponsor to carry the legislation can be selected.

2. Determine the safe yield of the Antelope Valley Groundwater Basin.

In its study plan to develop a groundwater management model for the Antelope Valley, USGS estimates that the estimated natural recharge of the groundwater basin ranges from 31,200 to 59,100 acre-feet per year based on equalizing adjustments to recharge estimates of previous investigations. Although this range is relatively narrow compared to the projected water demands of the Antelope Valley, it is important to develop the foundation upon which a consensus safe yield estimate can be based.

The USGS study plan presents a sophisticated approach that utilizes hydrologic monitoring, chemical tracers, and remote sensing to develop estimates of natural recharge. These estimates would be incorporated into a proposed groundwater flow model which could be utilized to provide safe yield estimates based on the selected groundwater management strategy.

Whether this management modeling approach or a less sophisticated hydrologic approach is utilized, a single safe yield estimate for the groundwater basin, or preferably a single safe yield estimate for each sub-unit, would be desirable. This estimate would provide the basis upon which consensus can be achieved and upon which a water management plan can be based. In the absence of a consensus estimate, conflict among the groundwater users is likely to occur as the cost of alternative water supplies increase. Accordingly, it is recommended that the water interests in the Antelope Valley review alternative approaches to developing safe yield estimates, determine the most appropriate approach, and perform the necessary studies.

3. Continue the current groundwater monitoring program and publish an annual report on basin conditions.

As part of a cooperative effort of the Antelope Valley-East Kern Water Agency (AVEK) and Edwards AFB, USGS currently conducts a comprehensive monitoring program in the Antelope Valley. Monitoring activities include groundwater levels, groundwater quality, land surface deformation (subsidence), aquifer compaction, and streamflow. The Survey Division of the County of Los Angeles Department of Public Works maintains records of destroyed benchmarks, and sets new benchmarks within the unincorporated portion of the County as needed. In addition, benchmarks have been set on all existing and will be set on all future LACWW water wells.

Groundwater levels are currently monitored as part of the cooperative AVEK network in conjunction with groundwater studies at Edwards AFB. The AVEK network is comprised of about 150 wells within the Antelope Valley. Water levels are measured annually or semiannually. Forty Piezometers were installed at Edwards AFB by the USGS, 12 of which are currently monitored continuously (every 15 minutes), the other 28 are measured by hand every six weeks. Combined, these networks are fairly sparse, given the size of the Valley (about 2,400 square miles). Making best use of available wells and existing monitoring efforts by various entities, and installing monitoring wells in key areas could improve the groundwater level network substantially.

USGS measures groundwater quality in 5 to 10 wells per year from the AVEK network described above. Other agencies, notably the DWR and the Los Angeles County Sanitation Districts, also measure groundwater quality. In addition, public water suppliers perform analyses of their water supplies as required by the California Department of Health Services and Title 22 of the California Code of Regulations.

USGS has collected geodetic data using the Global Positioning System (GPS) for the purpose of determining land subsidence at Edwards AFB in 1989, and Valley-wide in 1992. The Valley-wide network consists of 85 benchmarks. Unfortunately, several of these benchmarks have been destroyed since 1992 because of various construction-related causes (e.g., installation of Metro Line tracks, and road widening). Accordingly, it is recommended that remaining benchmarks be protected, or that new "offset" benchmarks be provided by marking them in such a way that construction crews would not destroy them without approval. In addition, the network could be expanded to include tighter control in subsidence-prone areas by including all existing and future production wells in these areas.

Three extensometers have been installed at two sites at Edwards AFB for the direct and continuous measurement of aquifer-system compaction, which results in land subsidence. GPS surveys are typically done on an annual or less frequent basis, which could be inadequate for monitoring to avoid land subsidence. Extensometers provide a real-time measurement of aquifer-system compaction, which can aid in making decisions regarding the daily distribution of groundwater withdrawals.

USGS currently operates 8 rain gages in Antelope Valley, which supplement the Los Angeles County and National Oceanic and Atmospheric Administration networks. Precipitation data are important for estimating groundwater recharge as well as rainfall/runoff relationships for flood control purposes.

Streamflow data are sparse in the Antelope Valley. USGS currently operates 8 continuous gages, but only one of them is on the three primary sources of groundwater recharge from the San Gabriels (Big Rock, Little Rock, and Amargosa Creeks), and that gage is in the upper reaches of Big Rock Creek before the creek passes through Valyermo. Accordingly, installation of additional continuous-monitoring gages is recommended. In addition, it is recommended that water use data (including groundwater usage) be collected over a long term period.

The municipal and industrial (M&I) and major agricultural groundwater pumpers generally measure their groundwater extractions and submit this information to the Department of Water Resources. It is recommended that these data be regularly collected and compiled. The pumpers that do not measure groundwater extractions are anticipated to be agricultural and small domestic water users. Because USGS projects that agricultural land use in the Antelope Valley (other than agriculture irrigated with reclaimed water) is expected to decline significantly, the effect of these unmonitored extractions should be limited. Accordingly, for pumpers that do not monitor groundwater extractions, indirect methods, such as estimates based on power or consumption use can be utilized for groundwater management purposes.

A significant volume of data is collected annually. These data provide limited value without technical interpretation. Accordingly, it is recommended that the data be published on an annual basis, together with a summary report of the Basin conditions and groundwater management activities. This document should be informative to both water managers as well as the public.

4. Develop a program to optimize the use of available water supplies.

To optimize the use of groundwater, annual extractions should be reduced to safe yields or economic disincentives sufficient to allow groundwater recharge should be implemented. In lieu of groundwater, other water supplies should be utilized to the extent feasible. In the use of alternative water supplies, priority should be given to utilization of supplies which may be lost by non-use. Currently, the supplemental water supply whose use could be better utilized is imported State water. When State water is available, it should be fully utilized, thereby reserving the groundwater for periods of reduced delivery of State water. Similarly, when made available, reclaimed water should be utilized to the maximum extent allowed by the distribution system, and groundwater recharge should remain an important consideration in all stormwater management plans. To the extent that direct use of these resources cannot be accomplished, facilities to recover the resources and store them in underground aquifers should be provided.

The primary barriers to reducing groundwater use are the lower cost of groundwater compared to surface water and access to alternative water supplies. To overcome these barriers it is recommended that the groundwater management authority implement or facilitate the implementation by others of the water conservation, reclaimed water, stormwater management, and aquifer storage and recovery programs recommended in this study. These activities are discussed in the following recommended action. In addition, it is recommended that the authority consider the application of groundwater replenishment assessments to fund a portion of the program costs. A replenishment assessment is typically levied on extractions beyond an allocated annual volume. These allocations are usually limited to the safe yield of the Basin, although transition periods to achieve this level are often utilized. To implement this assessment, the available safe yield of the Basin must be allocated equitably among the competing users. At a minimum, replenishment assessments should be levied on new or increased groundwater use.

The primary barrier to shifting groundwater use to alternative supplies such as imported State water is again economic (i.e., the lower cost of groundwater). Accordingly, it is recommended that the groundwater management authority also consider the application of basin equity assessments. A basin equity assessment is typically an assessment levied on one water source (e.g., groundwater) to reduce the cost of another source (e.g., State water or reclaimed water); thus, basin equity assessments are revenue neutral. The amount of these assessments are dependent upon the magnitude of the desired water use shift as well as the urgency of the shift.

5. Develop the recommended water conservation, reclaimed water, stormwater management, and aquifer storage and recovery programs.

Previous chapters of this report describe water conservation, reclaimed water, stormwater management, and aquifer storage and recovery programs. These programs are intended to reduce water demands or improve the utilization of the available water supplies, thereby reducing the need and extending the timing for additional imported water supplies. Accordingly, it is recommended that the groundwater management authority implement or facilitate the implementation by others of these programs.

To implement these programs, more detailed program-specific planning studies will be necessary. In these studies, one of the key issues that should be addressed is the cost allocation between the water management elements of the program and the other institutional beneficiaries. With the exception of the water conservation program for which only cost-effective water management activities are included, the programs provide benefits to related activities. For example, the reclaimed water, together with the aquifer storage and recovery program, is expected to reduce the cost of wastewater disposal. Similarly, stormwater recharge activities may be necessary to implement flood control facilities. Accordingly, the relative benefits of the recommended programs should be evaluated so that an equitable distribution of costs can be determined.

6. Actively encourage the California Department of Water Resources to complete the State Water Project and/or improve reliability.

The reliability of imported water from the State Water Project has been undergoing significant changes. These changes are primarily the result of environmental concerns in the Bay-Delta and possible revisions to the water and cost allocation procedures of the DWR.

As a result of a series of biological opinions issued by the United States Fish and Wildlife Service, water exports from the Bay-Delta have been restricted and are currently interrupted by ongoing estimates of "takings" of endangered species. This operating procedure has created considerable uncertainty over the amount of water that may be exported by the SWP as well as over operational reservoir releases or potential water transfers from north of the Delta. Accordingly, it is recommended that the State water contractors in the Antelope Valley continue to monitor the development of Federal-State Bay Delta protection plans and encourage the development of consistent operating procedures for Delta water exports.

The issues related to DWR's water allocation procedures involve Article 18(a) of the SWP contract which specifies the procedures for water shortage allocations, and the issues related to DWR's cost allocation procedures involve the need of the SWP agricultural contractors to receive repayment relief, particularly for the water supply diverted for Bay-Delta water quality improvements. Article 18(a) of the SWP contract specifies that water supply reductions are proportioned according to the contractor's entitlement and applied to the contractor's request. Historically, DWR has proportioned the reductions based on the contractor's request and also applied the reduction to the contractor's request. Because demands for State water are increasing and the available supply is restricted, the water shortage provisions of Article 18(a) will become increasingly more important. Similarly, as the agricultural contractors continue to advocate repayment relief, the cost of State water to the municipal and industrial contractors may increase. The California Research Bureau has recently evaluated alternative approaches to SWP financing. Several of these alternatives would significantly increase the future cost of imported water. For these reasons, it is recommended that the State water contractors in the Antelope Valley actively participate in discussion with DWR over water and cost allocation issues.

7. Obtain additional imported water supplies.

Water demand projections for the Antelope Valley indicate that the underlying water demands are expected to range from 363,000 to 420,000 acre-feet by the year 2020. Even with an active water conservation program, the medium water demand projection is 361,000 acre-feet in the year 2020. If the recommended reclaimed water program is implemented, the maximum available water supply is estimated to be 256,000 acre-feet in the year 2020; however, reliability issues related to imported State water are likely to result in deliveries below this level. Therefore, it is apparent that additional imported water supplies will be necessary. The probable source of additional imported water supplies will be other State water contractors with excess or unaffordable entitlements. Furthermore, it would be desirable for the State water contractors in the Antelope Valley to immediately initiate the acquisition of these water supplies and complete the acquisition of some additional water prior to the year 2000. In acquiring additional water supplies, it is recommended that the State water contractors implement a phased water acquisition program as cost-effective water supplies become available. By utilizing a phased program, additional water supplies can be obtained prior to the development needs of the area while minimizing the financial impact of the new water supplies.

To implement a water acquisition program, sufficient financial resources will be necessary. Because the need for additional imported water is caused primarily by new development, it is recommended that the cost of these water supplies be incorporated into the facility capacity fees levied on new development.

8. Develop a revenue plan to implement the recommended programs.

To implement the recommendations of this study, the costs associated with the recommendations must be allocated equitably among the beneficiaries (i.e., local vs. regional, water supply vs. wastewater disposal, and groundwater recharge vs. stormwater management). In addition, the costs allocated to water management activities must be distributed equitably among the competing water interests (i.e., new vs. existing, groundwater vs. surface water, agricultural vs. municipal, and retail vs. wholesale). The allocated costs are anticipated to include the costs of the recommended programs, acquisition costs of additional water supplies, equalization of water supply costs, and administration costs of water management. To provide sufficient revenues to fund these costs, the following revenue sources are recommended:

> Replenishment Assessments. Replenishment assessments are assessments imposed on groundwater extractions in excess of the safe yield allocation. It is recommended that these assessments be used to fund the portion of the recommended programs allocated to water management.
>
> Basin Equity Assessments. Basin equity assessments are revenue-neutral assessments imposed on groundwater users that have access to alternative water supplies. It is recommended that these assessments be used to encourage the utilization of alternative water supplies.
>
> Production Assessments. Production assessments are assessments imposed on all groundwater use or all water use regardless of the source. It is recommended that these assessments be used to support the administration costs of water management.
>
> Facility Capacity Fees. Facility capacity fees are fees imposed on new development to offset the economic impact on public facilities. It is recommended that these fees by utilized to acquire the additional imported water supplies to serve the new development.
>
> Standby Charges. Standby charges are charges imposed on landowners on a per parcel or per acre basis. It is recommended that these charges be considered as an alternative to replenishment, basin equity, or production assessments when groundwater extractions are not or cannot be metered.

9. Initiate a public education program.

The water resources protection plan includes recommendations that the proposed groundwater management authority and the water purveyors in the Antelope Valley implement several programs to improve water management. Improvements include reductions in projected water demands, better use of the available water resources, and acquisition of additional imported water supplies. These programs will require new revenue sources to equitably fund the recommended programs. To effectively communicate the objectives and activities of the new water management institution, an active public education program is recommended.

There are two levels to the recommended public education program. One level would focus on the need for integrated water management in the Antelope Valley, the framework of the recommended programs, and the financial resources required. The other level would focus on the implementation issues of the individual programs. To obtain public support for a new water management institution as well as its associated fees and charges, the public must understand the legitimacy and nature of complex water issues and the effectiveness of the recommended institutions and programs. Furthermore, each of the recommended programs is also complex, and the public must understand the justification and activities of the individual programs.

The success of the public education program will depend on the unanimity and credibility of the existing water institutions in the Antelope Valley in presenting the information necessary to understand these complex issues. This credibility is developed not only through public education but also through public participation in the development of the programs to address the wide range of water issues facing the Antelope Valley.

ANTELOPE VALLEY WATER RESOURCE STUDY

REFERENCES

1. ACI. June 8, 1993. Desert Highlands Irrigation Water Projections.

2. American Society of Civil Engineers. Ground Water Management. Third Edition. ASCE Manuals and Reports on Engineering Practice No. 40. Pages 184-191.

3. Antelope Valley-East Kern Water Agency. Ongoing Hydrographs of Wells in the Antelope Valley.

4. Boyle Engineering Corporation. November 1992. Draft Effluent/Sludge Disposal Study - Edwards Air Force Base Wastewater Treatment Plant Project, Corp of Engineers, Sacramento District.

5. Boyle Engineering Corporation. July 1993. Early Preliminary Design Submittal, Volume 1, Design Narrative.

6. California Department of Water Resources, Southern District. 1968. Ground Water and Waste Water Quality Study, Antelope Valley, Los Angeles and Kern Counties.

7. California Department of Water Resources, Southern District. 1980. Planned Utilization of Water Resources in Antelope Valley.

8. California Department of Water Resources, Southern District. 1988. Little Rock Creek Watershed Water Supply and Management Investigation, Reconnaissance Study Discussion Report.

9. California Department of Water Resources. December 1992. Management of the California State Water Project.

10. California Department of Water Resources. November 1993. Draft California Water Plan Update. Bulletin 160. Two Volumes.

11. California Regional Water Quality Control Board - Lahontan Region. May 15, 1986. Reclamation Requirements for Nebeker Ranch Irrigation Site.

12. California Regional Water Quality Control Board - Lahontan Region. October 11, 1990. Revised Reclamation Requirements for Department of Airports Irrigation Site.

13. California Regional Water Quality Control Board - Lahontan Region. March 11, 1993. Revised Waste Discharge Requirements for Palmdale Water Reclamation Plant.

REFERENCES
(Continued)

14. California Regional Water Quality Control Board - Lahontan Region. August 12, 1993. Revised Water Discharge Requirements for Lancaster Water Reclamation Plant.

15. CH2M Hill. May 31, 1991. Project Definition for U.S. Air Force Wastewater Treatment Facilities at Edwards Air Force Base.

16. CH2M Hill, March 1992. North Los Posas Basin ASR Demonstration Project.

17. City of Lancaster. 1992. State of the City Report. Lancaster, California.

18. City of Lancaster. Second (2nd) Quarter 1993. Development Summary Report.

19. City of Palmdale. General Plan. Adopted January 25, 1993 by Resolution 93-10. Palmdale, California.

20. City of Palmdale. July 1, 1993. Development Summary - Commercial and Industrial.

21. City of Palmdale. July 1, 1993. Development Summary - Residential.

22. City of San Jose. January 1989. Evaluation of 1986 and 1987 Water Conservation Retrofit Programs.

23. Corwin, E.J.; Alhadeff, S.C.; Oggel, S.P.; and Shleman, R.J. May 12-18, 1991. Earth Fissures, Urbanization and Litigation: A Case Study from the Temecula Area, Southwest Riverside County, California. Fourth International Symposium on Land Subsidence; Houston, Texas.

24. County of Kern. Amended 1992. Rosamond Specific Plan. County of Kern, California.

25. County Sanitation Districts of Los Angeles County. Fiscal Year 1992-93. Annual Status Report on Reclaimed Water Use.

26. County Sanitation Districts of Los Angeles County. February 1992. Lancaster Water Reclamation Plant Stage IV Expansion, Project Report and Revenue Program.

27. County Sanitation Districts of Los Angeles County. February 1992a. Palmdale Water Reclamation Plant Stage IV Expansion, Project Report and Revenue Program.

REFERENCES
(Continued)

28. County Sanitation Districts of Los Angeles County. July 1992. South Coast Air Quality Management District Rule 1179, Conformity Information for Small - Capacity POTWS.

29. County Sanitation Districts of Los Angeles County. March 1993. Lancaster Water Reclamation Plant Water Balance. Draft.

30. County Sanitation Districts of Los Angeles County. March 15, 1993. Lancaster Water Reclamation Plant 1992 Annual Monitoring Report.

31. County Sanitation Districts of Los Angeles County. March 15, 1993. Palmdale Water Reclamation Plant 1992 Annual Monitoring Report.

32. County Sanitation Districts of Los Angeles County. 1994. Personal Communication.

33. Department of Community Development. May 1993. Demographic Information for the City of Lancaster.

34. East Bay Municipal Utility District. August 1992. Residential Landscape Comparison Study.

35. Earth Systems Consultants. March 30, 1994. Summary Report for Primary Zone of Surface Water Percolation at Amargosa Creek from 27th Street West to Hansa Street, Palmdale, Los Angeles County, California.

36. Freeze, R. Allan and Cherry, John A. 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, N.J.

37. Geolabs-Westlake Village. February 4, 1991. City of Lancaster-Geological Reconnaissance to Determine Extent of Ground Fissures, 10 Square Miles, Northwest Portion of Lancaster.

38. Holzer, Thomas L. and Clark, Malcolm. January 26, 1981. Earth Fissures in T7N, R1W, Section 3 near Lancaster, California.

39. James M. Montgomery, Consulting Engineers. June 1991. City of Pomona Water Department-Final Report on Nitrate Feasibility Study.

40. Kern County Planning and Development Services Department. Tentative Tract Activity Summary, February 1990 to Present.

41. Law Environmental. November 25, 1991. Water Supply Evaluation. Antelope Valley, California. Prepared for Palmdale Water District. Palmdale, California.

REFERENCES
(Continued)

42. Los Angeles County Department of Public Works. June 1987. Final Report on the Antelope Valley Comprehensive Plan of Flood Control and Water Conservation.

43. Los Angeles County Department of Public Works - Land Development Division. 1989. Antelope Valley Spreading Ground Study - Phase 1 Preliminary Report.

44. Los Angeles County Department of Public Works - Materials Engineering Division. 1991. Antelope Valley Groundwater Recharge Study - Phase 2 Air Force Site Along Amargosa Creek.

45. Los Angeles County Department of Public Works - Hydraulic/Water Conservation Division. 1992. Antelope Valley Groundwater Recharge Concept Plan Air Force Site Along Amargosa Creek.

46. Los Angeles County Waterworks. 1994. Personal Communication.

47. Metropolitan Water District of Southern California. July 1993. Strategic Plan. Preliminary.

48. Montgomery Watson. September 1993. City of Chino-Final Report-Nitrate Treatment Feasibility Study.

49. Nelson, John Olaf. March 1987. AWWA Journal. Water Conserving Landscapes Show Impressive Savings.

50. Nelson, John Olaf. January 1990. Initial Findings of Home Water Savings Pilot Project. Presented to Conservation Management Committee's Mid-Year "Mini-Conference", January 29, 1980, Phoenix, AZ.

51. Poland, Joseph F. June 1981. Subsidence in the United States Due to Ground-Water Withdrawal. A paper in the Journal of the Irrigation and Drainage Division. Vol. 107, No. IR2.

52. Poland, Joseph F. 1984. Guidebook to Studies of Land Subsidence Due to Ground-Water Withdrawal.

53. Richard C. Slade & Associates. August 8, 1994. Hydrogeologic Assessment of Palmdale Business Park Center, Antelope Valley, Los Angeles County, California.

54. Richard, Dave. 1993. A Summary of Wastewater Reclamation Costs in California. A paper presented at University of California Extension Course.

REFERENCES
(Continued)

55. Riverside-Corona Resource Conservation District. March 1993. Irrigation Water Management on Agricultural Lands of Western Riverside County.

56. Robert Bein, William Frost & Associates. May 1993. Draft Environmental Impact Report for Amargosa Creek Improvement Project.

57. Southern California Association of Governments. Draft Final Growth Forecast Dated 9/16/93 for Palmdale and Lancaster. Four page fax.

58. U.S. Department of Agriculture, Soil Conservation Services. Seasonal Water Requirements for Various Crops.

59. U.S. Geological Survey, 1960. Gravity Survey of the Western Mojave Desert, California: Professional Paper 316-D.

60. U.S. Geological Survey. 1967. Water Resources of the Antelope Valley-East Kern Water Agency Area, California.

61. U.S. Geological Survey. 1987. Geohydrology of the Antelope Valley Area California and Design for Groundwater-Quality Monitoring Network.

62. U.S. Geological Survey. 1991. Water Fact Sheet-Land Subsidence in the Sacramento-San Joaquin Delta, California. Report 91-452.

63. U.S. Geological Survey. 1992. Land Subsidence and Problems Affecting Land Use at Edwards Air Force Base and Vicinity, California, 1990. Report 92-4035.

64. U.S. Geological Survey. 1993. Draft Study Plan for the Geohydrologic Evaluation of Antelope Valley, and Development and Implementation of Ground-Water Management Models.

65. U.S. Geological Survey. 1993a. Drilling, Construction, and Subsurface Data for Piezometers on Edwards Air Force Base, Antelope Valley, California, 1991-92. Report 93-148.

66. U.S. Geological Survey. 1993b. Hydrogeology and Land Subsidence, Edwards Air Force Base, Antelope Valley, California, January 1989-December 1991. Report 93-4114.

67. U.S. Geological Survey. 1994. Determination of Land Subsidence Related to Ground-Water-Level-Declines Using Global Positioning System and Leveling Surveys in Antelope Valley, Los Angeles and Kern Counties, California, 1992. Draft Report 94-XXXX.

REFERENCES
(Continued)

68. U.S. Geological Survey. 1994a. Land Use and Water Use in the Antelope Valley, California. Draft report 94-XXXX.

69. U.S. Geological Survey. 1994b. Personal Communication.

70. U.S. Geological Survey. 1995. Personal Communication.

APPENDIX A

Description of BMPs

EXHIBIT 1

BEST MANAGEMENT PRACTICES, IMPLEMENTATION SCHEDULES, ASSUMPTIONS AND POTENTIAL BEST MANAGEMENT PRACTICES FOR URBAN WATER CONSERVATION IN CALIFORNIA

SECTION A. BEST MANAGEMENT PRACTICES

This section contains those Best Management Practices ("BMPs") that signatory water suppliers commit to implementing. Suppliers' water needs estimates will be adjusted to reflect estimates of reliable savings from this category of BMPs. For some BMPs, no estimate of savings is made.

It is recognized by all parties that a single implementation method for a BMP would not be appropriate for all water suppliers. In fact, it is likely that as the process moves forward, water suppliers will find new implementation methods even more effective than those described. Any implementation method used should be at least as effective as the methods described below.

1. INTERIOR AND EXTERIOR WATER AUDITS AND INCENTIVE PROGRAMS FOR SINGLE FAMILY RESIDENTIAL, MULTI-FAMILY RESIDENTIAL, AND GOVERNMENTAL/INSTITUTIONAL CUSTOMERS.

   Implementation methods shall be at least as effective as identifying the top 20% of water users in each sector, directly contacting them (e.g., by mail and/or telephone) and offering the service on a repeating cycle; providing incentives sufficient to achieve customer implementation (e.g., free showerheads, hose end sprinkler timers, adjustment to high water use bills if customers implement water conservation measures, etc.). This could be a cooperative program among organizations that would benefit from its implementation.

2. PLUMBING, NEW AND RETROFIT.

   a. ENFORCEMENT OF WATER CONSERVING PLUMBING FIXTURE STANDARDS INCLUDING REQUIREMENT FOR ULTRA LOW FLUSH ("ULF") TOILETS IN ALL NEW CONSTRUCTION BEGINNING JANUARY 1, 1992.

Implementation methods shall be at least as effective as contacting the local building departments and providing information to the inspectors; and contacting major developers and plumbing supply outlets to inform them of the requirement.

b. SUPPORT OF STATE AND FEDERAL LEGISLATION PROHIBITING SALE OF TOILETS USING MORE THAN 1.6 GALLONS PER FLUSH.

c. PLUMBING RETROFIT.

Implementation methods shall be at least as effective as delivering retrofit kits including high quality low-flow showerheads to pre-1980 homes that do not have them and toilet displacement devices or other devices to reduce flush volume for each home that does not already have ULF toilets; offering to install the devices; and following up at least three times.

3. DISTRIBUTION SYSTEM WATER AUDITS, LEAK DETECTION AND REPAIR.

Implementation methods shall be at least as effective as at least once every three years completing a water audit of the water supplier's distribution system using methodology such as that described in the American Water Works Association's "Manual of Water Supply Practices, Water Audits and Leak Detection;" advising customers whenever it appears possible that leaks exist on the customers' side of the meter; and performing distribution system leak detection and repair whenever the audit reveals that it would be cost effective.

4. METERING WITH COMMODITY RATES FOR ALL NEW CONNECTIONS AND RETROFIT OF EXISTING CONNECTIONS.

Implementation methods shall be requiring meters for all new connections and billing by volume of use; and establishing a program for retrofitting any existing unmetered connections and billing by volume of use; for example, through a requirement that all connections be retrofitted at or within six months of resale of the property or retrofitted by neighborhood.

5. LARGE LANDSCAPE WATER AUDITS AND INCENTIVES.

Implementation methods shall be at least as effective as identifying all irrigators of large (at least 3 acres) landscapes (e.g., golf courses, green belts, common areas, multi-family housing landscapes, schools, business parks, cemeteries, parks and publicly owned landscapes on or adjacent to road rights-of-way); contacting them directly (by mail and/or telephone); offering landscape audits using methodology such as that described in the Landscape Water Management Handbook prepared for the California Department of Water Resources; and cost-effective incentives sufficient to achieve customer implementation; providing follow-up audits at least once every five years; and providing multi-lingual training and information necessary for implementation.

6. LANDSCAPE WATER CONSERVATION REQUIREMENTS FOR NEW AND EXISTING COMMERCIAL, INDUSTRIAL, INSTITUTIONAL, GOVERNMENTAL, AND MULTI-FAMILY DEVELOPMENTS.

Implementation methods shall be enacting and implementing landscape water conservation ordinances, or if the supplier does not have the authority to enact ordinances, cooperating with cities, counties and the green industry in the service area to develop and implement landscape water conservation ordinances pursuant to the "Water Conservation in Landscaping Act" ("Act") (California Government Code §§ 65590 et seq.). The ordinance shall be at least as effective as the Model Water Efficient Landscape Ordinance being developed by the Department of Water Resources. A study of the effectiveness of this BMP will be initiated within two years of the date local agencies must adopt ordinances under the Act.

7. PUBLIC INFORMATION.

Implementation methods shall be at least as effective as ongoing programs promoting water conservation and conservation related benefits including providing speakers to community groups and the media; using paid and public service advertising; using bill inserts; providing information on customers' bills showing use in gallons per day for the last billing period compared to the same period the year before; providing public information to promote other water conservation practices; and coordinating with other governmental agencies, industry groups and public interest groups.

8. SCHOOL EDUCATION.

Implementation methods shall be at least as effective as ongoing programs promoting water conservation and conservation related benefits including working with the school districts in the water supplier's service area to provide educational materials and instructional assistance.

9. COMMERCIAL AND INDUSTRIAL WATER CONSERVATION.

Implementation methods shall be at least as effective as identifying and contacting the top 10% of the industrial and commercial customers directly (by mail and/or telephone); offering audits and incentives sufficient to achieve customer implementation; and providing follow-up audits at least once every five years if necessary.

10. NEW COMMERCIAL AND INDUSTRIAL WATER USE REVIEW.

Implementation methods shall be at least as effective as assuring the review of proposed water uses for new commercial and industrial water service and making recommendations for improved water use efficiency before completion of the building permit process.

11. CONSERVATION PRICING.

Implementation methods shall be at least as effective as eliminating nonconserving pricing and adopting conserving pricing. For signatories supplying both water and sewer service, this BMP applies to pricing of both water and sewer service. Signatories that supply water but not sewer service shall make good faith efforts to work with sewer agencies so that those sewer agencies adopt conservation pricing for sewer service.

<u>Nonconserving pricing</u> provides no incentives to customers to reduce use. Such pricing is characterized by one or more of the following components:

a. Rates in which the unit price decreases as the quantity used increases (declining block rates);

b. Rates that involve charging customers a fixed amount per billing cycle regardless of the quantity used;

c. Pricing in which the typical bill is determined by high fixed charges and low commodity charges.

<u>Conservation pricing</u> provides incentives to customers to reduce average or peak use, or both. Such pricing includes:

a. Rates designed to recover the cost of providing service; and

b. Billing for water and sewer service based on metered water use.

Conservation pricing is also characterized by one or more of the following components:

c. Rates in which the unit rate is constant regardless of the quantity used (uniform rates) or increases as the quantity used increases (increasing block rates);

d. Seasonal rates or excess-use surcharges to reduce peak demands during summer months;

e. Rates based upon the long-run marginal cost or the cost of adding the next unit of capacity to the system;

f. Lifeline rates.

12. LANDSCAPE WATER CONSERVATION FOR NEW AND EXISTING SINGLE FAMILY HOMES.

Implementation methods shall be at least as effective as providing guidelines, information and incentives for installation of more efficient landscapes and water saving practices (e.g., encouraging local nurseries to promote sales and use of low water using plants, providing landscape water conservation materials in new home owner packets and water bills, sponsoring demonstration gardens); and enacting and implementing landscape water conservation ordinances or, if the supplier does not have the authority to enact ordinances, cooperating with cities, counties, and the green industry in the service area to develop and implement landscape water conservation ordinances pursuant to the "Water Conservation in Landscaping Act ("Act") (California Government Code §§ 65590 et seq.). The ordinance shall be at least as effective as the Model Water Efficient Landscape Ordinance being developed by the Department of Water Resources.

13. WATER WASTE PROHIBITION.

Implementation methods shall be enacting and enforcing measures prohibiting gutter flooding, sales of automatic (self-regenerating) water softeners, single pass cooling systems in new connections, nonrecirculating systems in all new conveyer car wash and commercial laundry systems, and nonrecycling decorative water fountains.

14. WATER CONSERVATION COORDINATOR.

Implementation methods shall be at least as effective as designating a water conservation coordinator responsible for preparing the conservation plan, managing its implementation, and evaluating the results. For very small water suppliers, this might be a part-time responsibility. For larger suppliers this would be a full-time responsibility with additional staff as appropriate. This work should be coordinated with the supplier's operations and planning staff.

15. FINANCIAL INCENTIVES.

Implementation methods shall be at least as effective as:

a. Offering financial incentives to facilitate implementation of conservation programs. Initial recommendations for such incentives will be developed by the Council within two years of the initial signing of the MOU, including incentives to improve the efficiency of landscape water use; and

b. Financial incentives offered by wholesale water suppliers to their customers to achieve conservation.

16. ULTRA LOW FLUSH TOILET REPLACEMENT.

Water suppliers agree to implement programs for replacement of existing high-water-using toilets with ultra-low-flush toilets (1.6 gallons or less) in residential, commercial, and industrial buildings. Such programs will be at least as effective as offering rebates of up to $100 for each replacement that would not have occurred without the rebate, or requiring replacement at the time of resale, or requiring replacement at the time of change of service. This level of implementation will be reviewed by the Council after development of the assumptions included in the following two paragraphs using the economic principles included in paragraphs 3 and 4 of Exhibit 3.

a. Assumptions for determining estimates of reliable savings from installation of ultra-low-flush toilets in both existing and new residential, commercial, and industrial structures will be recommended by the Council to the State Water Resources Control Board ("State Board") by December 31, 1991 for use in the present Bay/Delta proceedings.

b. Should the Council not agree on the above assumptions, a panel will be formed by December 31, 1991 to develop such assumptions. The panel shall consist of one member appointed from the signatory public advocacy group; one member appointed from the signatory water supplier group; and one member mutually agreed to by the two appointed members. The assumptions to be used for this BMP will be determined by a majority vote of the panel by February 15, 1992 using the criteria for determining estimates of reliable savings included in this MOU. The decision of the panel will be adopted by the Council and forwarded to the State Board by March 1, 1992.

APPENDIX B

Urban Water Management Planning Act and Subsequent Amendments

(1)

Assembly Bill No. 797

CHAPTER 1009

An act to add and repeal Part 2.6 (commencing with Section 10610) to Division 6 of the Water Code, relating to water conservation.

[Approved by Governor September 21, 1983. Filed with Secretary of State September 22, 1983.]

LEGISLATIVE COUNSEL'S DIGEST

AB 797, Klehs. Water: management planning.

(1) Under existing law, local water suppliers may, but are not required to, adopt and enforce water conservation plans.

This bill would require every urban water supplier providing water for municipal purposes to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually to prepare and adopt, in accordance with prescribed requirements, an urban water management plan containing prescribed elements. The bill would require the plan to be filed with the Department of Water Resources, and would require the department to annually prepare and submit to the Legislature a report summarizing the status of the plans. The bill would require each supplier to periodically review its plan in accordance with prescribed requirements, would specify requirements for actions or proceedings arising under the bill, and would specify related matters.

The bill would make legislative findings and declarations in this connection.

The provisions of the bill would remain in effect only until January 1, 1991.

(2) Article XIII B of the California Constitution and Sections 2231 and 2234 of the Revenue and Taxation Code require the state to reimburse local agencies and school districts for certain costs mandated by the state. Other provisions require the Department of Finance to review statutes disclaiming these costs and provide, in certain cases, for making claims to the State Board of Control for reimbursement.

This bill would impose a state-mandated local program as its requirements would be applicable to local public agencies.

However, the bill would provide that no appropriation is made and no reimbursement is required by this act for a specified reason.

The people of the State of California do enact as follows:

SECTION 1. Part 2.6 (commencing with Section 10610) is added to Division 6 of the Water Code, to read:

4681-100 Reprinted 1-25-84 500

PART 2.6. URBAN WATER MANAGEMENT PLANNING

CHAPTER 1. GENERAL DECLARATION AND POLICY

10610. This part shall be known and may be cited as the "Urban Water Management Planning Act."

10610.2. The Legislature finds and declares as follows:

(a) The waters of the state are a limited and renewable resource subject to ever increasing demands.

(b) The conservation and efficient use of urban water supplies are of statewide concern; however, the planning for that use and the implementation of those plans can best be accomplished at the local level.

10610.4. The Legislature finds and declares that it is the policy of the state as follows:

(a) The conservation and efficient use of water shall be actively pursued to protect both the people of the state and their water resources.

(b) The conservation and efficient use of urban water supplies shall be a guiding criterion in public decisions.

(c) Urban water suppliers shall be required to develop water management plans to achieve conservation and efficient use.

CHAPTER 2. DEFINITIONS

10611. Unless the context otherwise requires, the definitions of this chapter govern the construction of this part.

10611.5. "Conservation" means those measures that limit the amount of water used only to that which is reasonably necessary for the beneficial use to be served.

10612. "Customer" means a purchaser of water from a water supplier who uses the water for municipal purposes, including residential, commercial, governmental, and industrial uses.

10613. "Efficient use" means those management measures that result in the most effective use of water so as to prevent its waste or unreasonable use or unreasonable method of use.

10614. "Person" means any individual, firm, association, organization, partnership, business, trust, corporation, company, public agency, or any agency of such an entity.

10615. "Plan" means an urban water management plan prepared pursuant to this part. A plan shall describe and evaluate reasonable and practical efficient uses and conservation activities. The components of the plan may vary according to an individual community or area's characteristics and its capabilities to efficiently use and conserve water. The plan shall address measures for residential, commercial, governmental, and industrial water management as set forth in Article 2 (commencing with Section 10630) of Chapter 3. In addition, a strategy and time schedule for implementation shall be included in the plan.

10616. "Public agency" means any board, commission, county, city and county, city, regional agency, district, or other public entity.

10617. "Urban water supplier" means a supplier, either publicly or privately owned, providing water for municipal purposes either directly or indirectly to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually. An urban water supplier includes a supplier or contractor for water, regardless of the basis of right, which distributes or sells for ultimate resale to customers. This part applies only to water supplied from public water systems subject to Chapter 7 (commencing with Section 4010) of Part 1 of Division 5 of the Health and Safety Code.

CHAPTER 3. URBAN WATER MANAGEMENT PLANS

Article 1. General Provisions

10620. (a) Every urban water supplier serving water directly to customers shall, not later than December 31, 1985, prepare and adopt an urban water management plan in the manner set forth in Article 3 (commencing with Section 10640).

(b) Every person that becomes an urban water supplier after December 31, 1984, shall adopt an urban water management plan within one year after it has become an urban water supplier.

(c) An urban water supplier indirectly providing water to customers may adopt an urban water management plan or participate in areawide, regional, watershed, or basinwide urban water management planning; provided, however, an urban water supplier indirectly providing water shall not include planning elements in its water management plan as provided in Article 2 (commencing with Section 10630) that would be applicable to urban water suppliers or public agencies directly providing water, or to their customers, without the consent of those suppliers or public agencies.

(d) An urban water supplier may satisfy the requirements of this part by participation in areawide, regional, watershed, or basinwide urban water management planning where those plans will reduce preparation costs and contribute to the achievement of conservation and efficient water use.

(e) The urban water supplier may prepare the plan with its own staff, by contract, or in cooperation with other governmental agencies.

10621. Each urban water supplier shall periodically review its plan at least once every five years. After the review, it shall make any amendments or changes to its plan which are indicated by the review. Amendments or changes in its plan shall be adopted and filed in the manner set forth in Article 3 (commencing with Section 10640).

Article 2. Contents of Plans

10630. It is the intention of the Legislature, in enacting this part, to permit levels of water management planning commensurate with the numbers of customers served and the volume of water supplied.

10631. A plan shall include all of the following elements:

(a) Contain an estimate of past, current, and projected water use and, to the extent records are available, segregate those uses between residential, industrial, commercial, and governmental uses.

(b) Identify conservation measures currently adopted and being practiced.

(c) Describe alternative conservation measures, if any, which would improve the efficiency of water use with an evaluation of their costs and their environmental and other significant impacts.

(d) Provide a schedule of implementation for proposed actions as indicated by the plan.

(e) Describe the frequency and magnitude of supply deficiencies, including conditions of drought and emergency, and the ability to meet short-term deficiencies.

10632. In addition to the elements required pursuant to Section 10631, a plan projecting a future use which indicates a need for expanded or additional water supplies shall contain an evaluation of the following:

(a) Waste water reclamation.

(b) Exchanges or transfer of water on a short-term or long-term basis.

(c) Management of water system pressures and peak demands.

(d) Incentives to alter water use practices, including fixture and appliance retrofit programs.

(e) Public information and educational programs to promote wise use and eliminate waste.

(f) Changes in pricing, rate structures, and regulations.

10633. The plan shall contain an evaluation of the alternative water management practices identified in Sections 10631 and 10632, taking into account economic and noneconomic factors, including environmental, social, health, customer impact, and technological factors.

Evaluation of the elements in Section 10632 shall include a comparison of the estimated cost of alternative water management practices with the incremental costs of expanded or additional water supplies, and in the course of the evaluation first consideration shall be given to water management practices, or combination of practices, which offer lower incremental costs than expanded or additional water supplies, considering all the preceding evaluation factors.

Article 3. Adoption and Implementation of Plans

10640. Every urban water supplier required to prepare a plan pursuant to this part shall prepare its plan pursuant to Article 2 (commencing with Section 10630).

The supplier shall likewise periodically review the plan as required by Section 10621, and any amendments or changes required as a result of that review shall be adopted pursuant to this article.

10641. (a) An urban water supplier required to prepare a plan may consult with, and obtain comments from, any public agency or state agency or any person who has special expertise with respect to water conservation and management methods and techniques.

(b) In order to assist urban water suppliers in obtaining needed expertise as provided for in subdivision (a), the department, upon request of an urban water supplier, shall provide the supplier with a list of persons or agencies having expertise or experience in the development of water management plans.

10642. Prior to adopting a plan, the urban water supplier shall make the plan available for public inspection and shall hold a public hearing thereon. Prior to the hearing, notice of the time and place of hearing shall be published within the jurisdiction of the publicly owned water supplier pursuant to Section 6066 of the Government Code. A privately owned water supplier shall provide an equivalent notice within its service area. After the hearing, the plan shall be adopted as prepared or as modified after the hearing.

10643. An urban water supplier shall implement its plan adopted pursuant to this chapter in accordance with the schedule set forth in its plan.

10644. An urban water supplier shall file with the department a copy of its plan no later than 30 days after adoption. Copies of amendments or changes to the plans shall be filed with the department within 30 days after adoption.

The department shall annually prepare and submit to the Legislature a report summarizing the status of the plans adopted pursuant to this part.

CHAPTER 4. MISCELLANEOUS PROVISIONS

10650. Any actions or proceedings to attack, review, set aside, void, or annul the acts or decisions of an urban water supplier on the grounds of noncompliance with this part shall be commenced as follows:

(a) An action or proceeding alleging failure to adopt a plan shall be commenced within 18 months after that adoption is required by this part, or within 18 months after commencement of urban water service by a supplier commencing that service after January 1, 1984.

(b) Any action or proceeding alleging that a plan, or action taken pursuant to the plan, does not comply with this part shall be commenced within 90 days after filing of the plan or amendment thereto pursuant to Section 10644 or the taking of that action.

10651. In any action or proceeding to attack, review, set aside, void, or annul a plan, or an action taken pursuant to the plan by an urban water supplier on the grounds of noncompliance with this part, the inquiry shall extend only to whether there was a prejudicial abuse of discretion. Abuse of discretion is established if the supplier has not proceeded in a manner required by law or if the action by the water supplier is not supported by substantial evidence.

10652. The California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) does not apply to the preparation and adoption of plans prepared and adopted under this part. Nothing in this part shall be interpreted as exempting projects for implementation of the plan or for expanded or additional water supplies from the provisions of the California Environmental Quality Act.

10653. The adoption of a plan shall satisfy any requirements of state law, regulation, or order, including those of the State Water Resources Control Board, for the preparation of water management plans or conservation plans; provided, that if the State Water Resources Control Board requires additional information concerning water conservation to implement its existing authority, nothing in this part shall be deemed to limit the board in obtaining that information. The requirements of this part shall be satisfied by any water conservation plan prepared to meet federal laws or regulations after the effective date of this part, and which substantially meets the requirements of this part, or by any existing water management or conservation plan which includes the contents of a plan required under this part.

10654. All costs incurred by an urban water supplier in developing or implementing its plan shall be borne by it unless otherwise provided for by statute.

10655. If any provision of this part or the application thereof to any person or circumstances is held invalid, that invalidity shall not affect other provisions or applications of this part which can be given effect without the invalid provision or application thereof, and to this end the provisions of this part are severable.

10656. This part shall remain in effect only until January 1, 1991, and as of that date is repealed, unless a later enacted statute, which is chaptered before January 1, 1991, deletes or extends that date.

SEC. 2. No appropriation is made and no reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution or Section 2231 or 2234 of the Revenue and Taxation Code because the local agency or school district has the authority to levy service charges, fees, or assessments sufficient to pay for the program or level of service mandated by this act.

O

Assembly Bill No. 2661

CHAPTER 355

An act to amend Sections 10631, 10632, and 10644 of, to add Section 10645 to, and to repeal Section 10656 of, the Water Code, relating to water.

[Approved by Governor July 18, 1990. Filed with Secretary of State July 19, 1990.]

LEGISLATIVE COUNSEL'S DIGEST

AB 2661, Klehs. Water management planning.

(1) Under the Urban Water Management Planning Act, which is to remain in effect only until January 1, 1991, every urban water supplier providing water for municipal purposes to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually is required to prepare and adopt, in accordance with prescribed requirements, an urban water management plan containing prescribed elements. The plan is required to be filed with the Department of Water Resources, and the department is required to annually prepare and submit to the Legislature a report summarizing the status of the plans. Each supplier is required to periodically review its plan in accordance with prescribed requirements.

This bill would delete the January 1, 1991, termination date, thereby imposing a state-mandated local program since the requirements of the act are specifically applicable to local public agency water suppliers. The bill would revise the required elements of the plan and would make related changes. The bill would require the water supplier and the department to make the plan available for public review within 30 days after filing of the plan with the department. The bill would require the department in its annual report to highlight the outstanding elements of individual plans and would also require the department to prepare reports and provide data for specified legislative hearings. The bill would require the department to provide a copy of the report to each supplier which has filed its plan with the department.

(2) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act for a specified reason.

The people of the State of California do enact as follows:

SECTION 1. Section 10631 of the Water Code is amended to

94 60

read:

10631. A plan shall include all of the following elements:

(a) Contain an estimate of past, current, and projected water use and, to the extent records are available, segregate those uses between residential, industrial, commercial, and governmental uses.

(b) Identify conservation measures currently adopted and being practiced.

(c) Describe alternative conservation measures, including, but not limited to, consumer education, metering, water saving fixtures and appliances, lawn and garden irrigation techniques, and low water use landscaping, which would improve the efficiency of water use with an evaluation of their costs and their environmental and other significant impacts.

(d) Provide a schedule of implementation for proposed actions as indicated by the plan.

(e) Describe the frequency and magnitude of supply deficiencies, based on available historic data and future projected conditions comparing water supply and demand, including a description of deficiencies in time of drought and emergency, and the ability to meet deficiencies.

(f) To the extent feasible, describe the method which will be used to evaluate the effectiveness of each conservation measure implemented under the plan.

(g) Describe the steps which would be necessary to implement any proposed actions in the plan.

SEC. 2. Section 10632 of the Water Code is amended to read:

10632. In addition to the elements required pursuant to Section 10631, a plan projecting a future use which indicates a need for expanded or additional water supplies shall contain an evaluation of the following alternatives:

(a) Waste water reclamation.

(b) Exchanges or transfer of water on a short-term or long-term basis.

(c) Management of water system pressures and peak demands.

(d) Issues relevant to meter retrofitting for all uses.

(e) Incentives to alter water use practices, including fixture and appliance retrofit programs.

(f) Public information and educational programs to promote wise use and eliminate waste.

(g) Changes in pricing, rate structures, and regulations.

SEC. 3. Section 10644 of the Water Code is amended to read:

10644. An urban water supplier shall file with the department a copy of its plan no later than 30 days after adoption. Copies of amendments or changes to the plans shall be filed with the department within 30 days after adoption.

Plans filed under this section shall describe the basis for the decision of the urban water supplier to add, change, or retain conservation measures.

The department shall annually prepare and submit to the Legislature a report summarizing the status of the plans adopted pursuant to this part. The report prepared by the department shall highlight the outstanding elements of individual plans. The department shall provide a copy of the report to each urban water supplier which has filed its plan with the department. The department shall also prepare reports and provide data for any legislative hearings designed to consider the effectiveness of plans submitted pursuant to this part.

SEC. 4. Section 10645 is added to the Water Code, to read:

10645. Not later than 30 days after filing a copy of its plan with the department, the urban water supplier and the department shall make the plan available for public review during normal business hours.

SEC. 5. Section 10656 of the Water Code is repealed.

SEC. 6. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the local agency or school district has the authority to levy service charges, fees, or assessments sufficient to pay for the program or level of service mandated by this act. Notwithstanding Section 17580 of the Government Code, unless otherwise specified in this act, the provisions of this act shall become operative on the same date that the act takes effect pursuant to the California Constitution.

O

Assembly Bill No. 11

Passed the Assembly September 13, 1991

Chief Clerk of the Assembly

Passed the Senate September 11, 1991

Secretary of the Senate

This bill was received by the Governor this 27th day of September, 1991, at 1:40 o'clock P.M.

Private Secretary of the Governor

①

CHAPTER _____

An act to amend Sections 10620, 10621, 10631, and 10652 of, and to add Section 10656 to, the Water Code, relating to water.

LEGISLATIVE COUNSEL'S DIGEST

AB 11, Filante. Urban water management plans.

(1) Existing law requires every urban water supplier serving water directly to customers to, not later than December 31, 1985, prepare and adopt an urban water management plan. Existing law authorizes an urban water supplier indirectly providing water to customers to adopt an urban water management plan or to participate in urban water management planning.

This bill would, instead, require every urban water supplier, whether serving water directly or indirectly to customers, to prepare and adopt an urban water management plan, as prescribed.

(2) Existing law requires the urban water management plan to include a prescribed description of water supply deficiencies.

This bill would delete that provision and would require the urban water management plan to include an urban water shortage contingency plan, as specified. The bill would require each urban water supplier to coordinate the preparation of its urban water shortage contingency plan with other urban water suppliers and public agencies in the area to the extent practicable. The bill would require each urban water supplier, not later than January 31, 1992, to prepare, adopt, and submit to the Department of Water Resources an amendment to its urban water management plan which meets the requirements relating to the preparation of the urban water shortage contingency plan. The bill would make an urban water supplier that does not submit the amendment by that date ineligible to receive drought assistance from the state until the urban water management plan is submitted, as prescribed.

(3) Existing law exempts the preparation and

adoption of urban water management plans from the California Environmental Quality Act.

This bill would exempt the implementation of urban water shortage contingency plans from that act. The bill would provide that the exemption provisions do not exempt specified projects from the requirements of that act.

The people of the State of California do enact as follows:

SECTION 1. Section 10620 of the Water Code is amended to read:

10620. (a) Every urban water supplier shall prepare and adopt an urban water management plan in the manner set forth in Article 3 (commencing with Section 10640).

(b) Every person that becomes an urban water supplier after December 31, 1984, shall adopt an urban water management plan within one year after it has become an urban water supplier.

(c) An urban water supplier indirectly providing water shall not include planning elements in its water management plan as provided in Article 2 (commencing with Section 10630) that would be applicable to urban water suppliers or public agencies directly providing water, or to their customers, without the consent of those suppliers or public agencies.

(d) (1) An urban water supplier may satisfy the requirements of this part by participation in areawide, regional, watershed, or basinwide urban water management planning where those plans will reduce preparation costs and contribute to the achievement of conservation and efficient water use.

(2) Each urban water supplier shall coordinate the preparation of its urban water shortage contingency plan with other urban water suppliers and public agencies in the area, to the extent practicable.

(e) The urban water supplier may prepare the plan with its own staff, by contract, or in cooperation with other governmental agencies.

SEC. 2. Section 10621 of the Water Code is amended to read:

10621. (a) Each urban water supplier shall, not later than January 31, 1992, prepare, adopt, and submit to the department an amendment to its urban water management plan which meets the requirements of subdivision (e) of Section 10631.

(b) Each urban water supplier shall periodically review its plan at least once every five years. After the review, it shall make any amendments or changes to its plan which are indicated by the review. Amendments or changes in its plan shall be adopted and filed in the manner set forth in Article 3 (commencing with Section 10640).

SEC. 3. Section 10631 of the Water Code is amended to read:

10631. A plan shall do all of the following:

(a) Include an estimate of past, current, and projected water use and, to the extent records are available, segregate those uses between residential, industrial, commercial, and governmental uses.

(b) Identify conservation measures currently adopted and being practiced.

(c) Describe alternative conservation measures, including, but not limited to, consumer education, metering, water saving fixtures and appliances, lawn and garden irrigation techniques, and low water use landscaping, which would improve the efficiency of water use with an evaluation of their costs and their environmental and other significant impacts.

(d) Provide a schedule of implementation for proposed actions as indicated by the plan.

(e) Provide an urban water shortage contingency plan which includes all of the following elements which are within the authority of the urban water supplier:

(1) Past, current, and projected water use and, to the extent records are available, a breakdown of those uses on the basis of residential single family, residential multifamily, industrial, commercial, governmental, and agricultural use.

(2) An estimate of the minimum water supply available at the end of 12, 24, and 36 months, assuming the

worst case water supply shortages.

(3) Stages of action to be undertaken by the urban water supplier in response to water supply shortages, including up to a 50 percent reduction in water supply, and an outline of specific water supply conditions which are applicable to each stage.

(4) Mandatory provisions to reduce water use which include prohibitions against specific wasteful practices, such as gutter flooding.

(5) Consumption limits in the most restrictive stages. Each urban water supplier may use any type of consumption limit in its water shortage contingency plan that would reduce water use and is appropriate for its area. Examples of consumption limits that may be used include, but are not limited to, percentage reductions in water allotments, per capita allocations, an increasing block rate schedule for high usage of water with incentives for conservation, or restrictions on specific uses.

(6) Penalties or charges for excessive use.

(7) An analysis of the impacts of the plan on the revenues and expenditures of the urban water supplier, and proposed measures to overcome those impacts, such as the development of reserves and rate adjustments.

(8) A draft water shortage contingency resolution or ordinance to carry out the urban water shortage contingency plan.

(9) A mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency plan.

(f) To the extent feasible, describe the method which will be used to evaluate the effectiveness of each conservation measure implemented under the plan.

(g) Describe the steps which would be necessary to implement any proposed actions in the plan.

SEC. 4. Section 10652 of the Water Code is amended to read:

10652. The California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) does not apply to the preparation and adoption of plans pursuant to this part or to the implementation of subdivision (e) of Section 10631. Nothing in this part shall be interpreted as exempting from the California Environmental Quality Act any project that would significantly affect water supplies for fish and wildlife, or any project for implementation of the plan, other than projects implementing subdivision (e) of Section 10631, or any project for expanded or additional water supplies.

SEC. 5. Section 10656 is added to the Water Code, to read:

10656. An urban water supplier that does not submit an amendment to its urban water management plan pursuant to subdivision (a) of Section 10621 to the department by January 31, 1992, is ineligible to receive drought assistance from the state until the urban water management plan is submitted pursuant to Article 3 (commencing with Section 10640) of Chapter 3.

Approved October 13, 1991

Peter Wilson

Governor

①

10TH DOCUMENT of Level 1 printed in FULL format.

THE STATE OF CALIFORNIA
BILL TEXT
STATENET

CALIFORNIA 1991-92 REGULAR SESSION

ASSEMBLY BILL 1869

ASSEMBLY BILL NO. 1869
CHAPTER 938

1991 CA A.B. 1869

VERSION: Enacted

DATE-INTRO: March 8, 1991

SYNOPSIS:

An act to amend Sections 10615, 10621, 10631, 10825, 10826, and 10841 of the Water Code, relating to water.

[Approved by Governor October 13, 1991. Filed with Secretary of State October 14, 1991.]

DIGEST:

LEGISLATIVE COUNSEL'S DIGEST

AB 1869, Speier. Water resources: urban water management.

(1) Existing law requires every urban supplier serving water directly to customers to prepare and adopt an urban water management plan, and to periodically review the plan, in a specified manner. Existing law requires an urban water management plan to describe and evaluate reasonable and practical efficient water uses and water conservation activities. A copy of the plan is required to be filed with the Department of Water Resources.

This bill would require an urban management plan to describe and evaluate water reclamation activities.

(2) Existing law requires each urban water supplier to periodically review its plan at least once every 5 years.

This bill would require the urban water supplier to update its plan once every 5 years.

(3) Existing law requires an urban management plan to include prescribed elements.

This bill would revise those elements to require the urban management plan to include an estimate of projected potable and reclaimed water use, to identify reclamation measures being practiced and the method used to evaluate the effectiveness of those measures, to describe the use of any pool covers, to describe findings, actions, and planning relating to prescribed water audits and incentives and leak detection and repair, to describe actions and planning to eliminate the use of specified water systems, and to include certain information relating to reclamation measures and the use of reclaimed water.

(4) Existing law, requires every agricultural water supplier serving water directly to customers to prepare a prescribed informational report and requires certain agricultural water suppliers to prepare and adopt a specified agricultural water management plan.

This bill would, to the extent information is available, require the reports to identify reclamation practices used by the agricultural water supplier and the agricultural water management plans to describe any water reclamation programs, including treatment and distribution facilities and to identify the quantity and source of reclaimed water delivered to and by the supplier and economically feasible measures for water reclamation.

(5) Existing law authorizes an agricultural water supplier required to prepare a plan to consult with public agencies or persons with expertise relating to conservation.

This bill would authorize the agricultural water suppliers to consult with public agencies or persons with expertise relating to water reclamation.

TEXT: The people of the State of California do enact as follows:

SECTION 1. Section 10615 of the Water Code is amended to read:

10615. "Plan" means an urban water management plan prepared pursuant to this part. A plan shall describe and evaluate reasonable and practical efficient uses and reclamation and conservation activities. The components of the plan may vary according to an individual community or area's characteristics and its capabilities to efficiently use and conserve water. The plan shall address measures for residential, commercial, governmental, and industrial water management as set forth in Article 2 (commencing with Section 10630) of Chapter 3. In addition, a strategy and time schedule for implementation shall be included in the plan.

SEC. 2. Section 10621 of the Water Code is amended to read:

10621. (a) Each urban water supplier shall periodically update its plan at least once every five years. After the review, it shall make any amendments or changes to its plan which are indicated by the review.

(b) The amendments to, or changes in, the plan shall be adopted and filed in the manner set forth in Article 3 (commencing with Section 10640).

SEC. 3. Section 10631 of the Water Code is amended to read:

10631. A plan shall do all of the following:

(a) Include an estimate of past, current, and projected potable and reclaimed water use and, to the extent records are available, segregate those uses between residential, industrial, commercial, and governmental uses.

(b) Identify conservation and reclamation measures currently adopted and being practiced.

(c) Describe alternative conservation measures, including, but not limited to, consumer education, metering, water saving fixtures and appliances, pool covers, lawn and garden irrigation techniques, and low water use landscaping, which would improve the efficiency of water use with an evaluation of their costs and their environmental and other significant impacts.

(d) Provide a schedule of implementation for proposed actions as indicated by the plan.

(e) Describe the frequency and magnitude of supply deficiencies, based on available historic data and future projected conditions comparing water supply and demand, including a description of deficiencies in time of drought and emergency and the ability to meet deficiencies.

(f) To the extent feasible, describe the method which will be used to evaluate the effectiveness of each conservation and reclamation measure implemented under the plan.

(g) Describe the steps which would be necessary to implement any proposed actions in the plan.

(h) Describe findings, actions, and planning relating to all of the following:

(1) The use of internal and external water audits for single-family residential, multifamily residential, institutional, commercial, industrial, and governmental customers, and the use of incentive programs to encourage customer audits and program participation.

(2) The use of distribution system water audits.

(3) Leak detection and repair.

(4) The use of large landscape water audits and incentives for conversion to water reuse.

(5) Methods to increase the use of reclaimed water in areas in which the use of potable water is not required.

(i) Describe financial incentives used to encourage the use of reclaimed water and the results of these actions in terms of acre-feet per year used.

(j) Describe water reclamation measures for agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, and other appropriate uses.

(k) Identify actions and incentives to facilitate the development of dual water systems for the use of reclaimed water in new construction, for flushing toilets and urinals, landscaping, golf courses, cemetaries, irrigation, and other appropriate purposes.

(l) Describe actions and planning to eliminate the use of once-through cooling systems, nonrecirculating water systems, and nonrecycling decorative water fountains, and to encourage the recirculation of water if proper public health and safety standards are maintained.

(m) Describe actions and plans to enforce conservation and reclamation measures.

(n) To the extent feasible, describe the amount of water saved through water conservation and reclamation measures employed by user groups.

SEC. 4. Section 10825 of the Water Code is amended to read:

10825. To the extent information is available, the reports shall address all of the following:

(a) The quantity and source of water delivered to, and by, the supplier.

(b) Other sources of water used within the service area, such as groundwater and other diversions.

(c) A general description of the supplier's water delivery system and service area, including a map.

(d) Total irrigated acreage within the service area.

(e) The amount of acreage of trees and vines grown within the service area.

(f) An identification of all of the following:

(1) Current water conservation and reclamation practices being used.

(2) Plans for changing current water conservation plans.

(3) Conservation educational services being used.

(g) A determination of whether the supplier, through improved irrigation water management, has a significant opportunity to do one or both of the following:

(1) Save water by means of reduced evapotranspiration, evaporation, or reduction of flows to unusable water bodies that fail to serve further beneficial uses.

(2) Reduce the quantity of highly saline or toxic drainage water.

SEC. 5. Section 10826 of the Water Code is amended to read:

10826. To the extent information is available, the plans shall address all of the following:

(a) The quantity and source of surface water, groundwater, and reclaimed water delivered to and by the supplier.

(b) A description of all of the following:

(1) The water delivery system used in the area supplied.

(2) The beneficial uses of the water supplied, including noncrop beneficial uses.

(3) Conjunctive use programs.

(4) Incidental and planned groundwater recharge.

(5) Water reclamation programs, including treatment and distribution facilities.

(6) The amounts of the delivered water that are lost to further beneficial use to unusable bodies of water or moisture-deficient soils through the following:

(A) Crop evapotranspiration.

(B) Noncrop evapotranspiration.

(C) Evaporation from water surfaces.

(D) Surface flow or percolation.

(c) An identification of cost-effective and economically feasible measures for water conservation and reclamation, their resulting detriments and benefits, and the impacts on amounts of downstream surface water supply and immediately adjacent groundwater supply.

(d) An evaluation of other significant impacts, including impacts within the service area and downstream on fish and wildlife habitat, water quality, energy use, and other factors of either local or statewide concern or interstate concern, where applicable. Alternatives should be designed to minimize impacts on other beneficial users currently being served both within and without the service area and to result in improved overall water management.

(e) A schedule prepared by the supplier to implement those water management practices that it determines to be cost-effective and economically feasible. Priority shall be given to those water management practices, or combination of practices, that offer lower incremental costs than expanded or additional water supplies.

SEC. 6. Section 10841 of the Water Code is amended to read:

10841. (a) An agricultural water supplier required to prepare a plan may consult with, and obtain comments from, any public agency or state agency or any person who has special expertise with respect to water conservation and reclamation and management methods and techniques.

(b) In order to assist agricultural water suppliers in obtaining needed expertise as provided for in subdivision (a), the department, upon request of an agricultural water supplier, shall provide the supplier with a list of persons or agencies having expertise or experience in the development of water management plans.

(c) The department shall prepare by July 1, 1988, an outline of model informational reports and water management plans which an agricultural water supplier may use in complying with the requirements of this part.

SPONSOR:
Speier

THE STATE OF CALIFORNIA
BILL TEXT
STATENET

CALIFORNIA 1993-94 REGULAR SESSION

ASSEMBLY BILL 892

ASSEMBLY BILL NO. 892
CHAPTER 720

1993 CA A.B. 892

VERSION: Enacted

VERSION-DATE: October 4, 1993

SYNOPSIS:

An act to amend Section 10631 of the Water Code, relating to wate

[Approved by Governor October 2, 1993. Filed with Secretary of State October 4, 1993.]

DIGEST:

LEGISLATIVE COUNSEL'S DIGEST

AB 892, Frazee. Urban water management planning.

Existing law requires every urban water supplier, as defined, to prepare and adopt an urban water management plan, and requires the plan to include specified elements.

This bill would revise the requirements relating to the elements to be included in the plan.

TEXT: The people of the State of California do enact as follows:

SECTION 1. Section 10631 of the Water Code is amended to read:

10631. A plan shall do all of the following:

(a) Include an estimate of past, current, and projected potable and reclaimed water use and, to the extent records are available, segregate those uses between residential, industrial, commercial, and governmental uses.

(b) (1) Identify conservation and reclamation measures currently adopted and being practiced.

(2) Urban water suppliers that are members of the California Urban Water Conservation Council and submit annual reports to that council in accordance with the "Memorandum of Understanding Regarding Urban Water Conservation in California," dated September 1991, may submit the annual reports for the

purposes of identifying conservation measures as required by paragraph (1).

(c) Describe alternative conservation measures, including, but not limited to, consumer education, metering, water saving fixtures and appliances, pool covers, lawn and garden irrigation techniques, and low water use landscaping, that would improve the efficiency of water use with an evaluation of their costs and their environmental and other significant impacts.

(d) Provide a schedule of implementation for proposed actions as indicated by the plan.

(e) Provide an urban water shortage contingency plan that includes all of the following elements that are within the authority of the urban water supplier:

(1) Past, current, and projected water use and, to the extent records are available, a breakdown of those uses on the basis of single-family residential, multifamily residential, commercial, industrial, governmental, and agricultural use.

(2) An estimate of the minimum water supply available at the end of 12, 24, and 36 months, assuming the worst case water supply shortages.

(3) Stages of action to be undertaken by the urban water supplier in response to water supply shortages, including up to a 50 percent reduction in water supply, and an outline of specific water supply conditions that are applicable to each stage.

(4) Mandatory provisions to reduce water use that include prohibitions against specific wasteful practices, such as gutter flooding.

(5) Consumption limits in the most restrictive stages. Each urban water supplier may use any type of consumption limit in its water shortage contingency plan that would reduce water use and is appropriate for its area. Examples of consumption limits that may be used include, but are not limited to, percentage reductions in water allotments, per capita allocations, an increasing block rate schedule for high usage of water with incentives for conservation, or restrictions on specific uses.

(6) Penalties or charges for excessive use.

(7) An analysis of the impacts of the plan on the revenues and expenditures of the urban water supplier, and proposed measures to overcome those impacts, such as the development of reserves and rate adjustments.

(8) A draft water shortage contingency resolution or ordinance to carry out the urban water shortage contingency plan.

(9) A mechanism for determining actual reductions in water use pursuant to the urban water shortage contingency plan.

(f) Describe the frequency and magnitude of supply deficiencies, based on available historic data and future projected conditions comparing water supply and demand, including a description of deficiencies in time of drought and emergency and the ability to meet deficiencies.

(g) To the extent feasible, describe the method which will be used to evaluate the effectiveness of each conservation and reclamation measure implemented under the plan.

(h) Describe the steps which would be necessary to implement any proposed actions in the plan.

(i) Describe findings, actions, and planning relating to all of the following:

(1) The use of internal and external water audits for single-family residential, multifamily residential, institutional, commercial, industrial, and governmental customers, and the use of incentive programs to encourage customer audits and program participation.

(2) The use of distribution system water audits.

(3) Leak detection and repair.

(4) The use of large landscape water audits and incentives for conversion to water reuse.

(5) Methods to increase the use of reclaimed water in areas in which the use of potable water is not required.

(j) Describe financial incentives used to encourage the use of reclaimed water and the results of these actions in terms of acre-feet per year used.

(k) Describe water reclamation measures for agricultural irrigation, landscape irrigation, wildlife habitat enhancement, wetlands, industrial reuse, groundwater recharge, and other appropriate uses.

(l) Identify actions and incentives to facilitate the development of dual water systems for the use of reclaimed water in new construction, for flushing toilets and urinals, landscaping, golf courses, cemeteries, irrigation, and other appropriate purposes.

(m) Describe actions and planning to eliminate the use of once-through cooling systems, nonrecirculating water systems, and nonrecycling decorative water fountains, and to encourage the recirculation of water if proper public health and safety standards are maintained.

(n) Describe actions and plans to enforce conservation and reclamation measures.

(o) To the extent feasible, describe the amount of water saved through water conservation and reclamation measures employed by user groups.

(p) Describe actions and planning to ensure the involvement of community members within the service area with regard to water management planning.

SPONSOR:
Frazee

APPENDIX C

Synopses of Regulatory Requirements

Federal Requirements

Two Federal Acts regulate the discharge and use of reclaimed water or wastewater: the Clean Water Act and the Safe Drinking Water Act.

Clean Water Act. Federal requirements impacting the discharge of reclaimed water, or wastewater, (and any other liquid wastes) to "navigable waters" are contained in the 1972 amendments to the Federal Water Pollution Control Act of 1956, commonly known as the Federal Clean Water Act (CWA) (Public Law 92-500). The CWA created the Environmental Protection Agency (EPA) and established the National Pollutant Discharge Elimination System (NPDES), a permit system for discharge of contaminants to navigable waters. NPDES requires that all municipal and industrial dischargers of liquid wastes apply for and obtain a permit prior to initiating discharge.

Safe Drinking Water Act. Federal requirements impacting the use of reclaimed water for groundwater recharge are contained in the 1986 amendments to the Safe Drinking Water Act (SDWA) of 1974 (Public Law 93-523). The SDWA focuses on regulation of drinking water and control of public health risks by establishing and enforcing maximum contaminant levels for various compounds in drinking water. The 1986 amendments also established requirements for protection of groundwater supplies through wellhead protection programs and regulation of underground injection of wastes.

Administration. In the State of California, the administration and enforcement of the NPDES and SDWA programs have been delegated to the State.

State Requirements

State requirements for production, discharge, distribution, and use of reclaimed water are contained in the California Water Code, Division 7 - Water Quality, Sections 1300 through 13999.16 (Water Code); the California Administrative Code, Title 22 - Social Security, Division 4 - Environmental Health, Chapter 3 - Reclamation Criteria, Sections 60301 through 60475 (Title 22); and the California Administrative Code, Title 17 - Public Health, Chapter 5, Subchapter 1, Group 4 - Drinking Water Supplies, Sections 7583 through 7630 (Title 17). In addition, guidelines for production, distribution, and use of reclaimed water have been prepared or endorsed by State agencies administering the reclaimed water regulations.

Water Code. The Water Code contains requirements for the production, discharge, and use of reclaimed water. The Porter-Cologne Water Quality Control Act (Division 7 of the California Water Code), which was promulgated in 1969, established the State Water Resources Control Board (SWRCB) as the State agency with primary responsibility for the coordination and control of water quality, water pollution, and water rights (Division 7, Chapter 1). Established in 1967, the SWRCB assumed the functions of the former State Water Rights Board and the State Water Quality Control Board, which were abolished.

Nine Regional Water Quality Control Boards (RWQCB) were established to represent the SWRCB regionally and carry out the enforcement of water quality and pollution control measures (Division 7, Chapter 4). In addition, each RWQCB was required to formulate and adopt water quality control plans and establish requirements for waste discharge to waters of the State. In 1972, Chapter 5.5 was added to Division 7 to provide the RWQCBs with the authority to carry out the provisions of the Federal CWA. The RWQCB-La Hontan has jurisdiction over the Antelope Valley.

Division 7, Chapter 7 - Water Reclamation, was included in the Porter-Cologne Water Quality Control Act in 1969. Subsequent amendments required the California Department of Health Services (DHS) to establish water reclamation criteria, gave the RWQCB the responsibility of prescribing specific water reclamation requirements for water which is used or proposed to be used as reclaimed water, provided for the regulation of injection of waste into the ground, and required the use of reclaimed water, if available, rather than potable water for irrigation of greenbelt areas.

In addition to Division 7, Chapter 7, Sections 1210 through 1212 of the Water Code, added in 1980, focus on the ownership of treated wastewater and require that the owner of a wastewater treatment plant obtain approval from the SWRCB prior to making any change in the point of discharge, place of use, or purpose of use of treated wastewater.

Title 22. In 1975, Title 22 was prepared by the California Department of Health Services (DHS) in accordance with the requirements of Division 7, Chapter 7 of the Water Code. In 1978, Title 22 was revised to conform with the 1977 amendment to the Federal CWA. The requirements of Title 22, as revised in 1978 and again in 1990, regulate production and use of reclaimed water in California today.

Title 22 established three categories of wastewater treatment effluent (reclaimed water):

- Primary effluent
- Adequately disinfected, oxidized effluent (commonly called secondary effluent)
- Adequately disinfected, oxidized, coagulated, clarified, filtered effluent (commonly called tertiary effluent)

Within the second and third categories, criteria for maximum numbers of coliforms within the effluent were established for various reclaimed water uses.

In addition to reclaimed water uses and treatment requirements, Title 22 addresses sampling and analysis requirements at the treatment plant, preparation of an engineering report prior to production or use of reclaimed water, general treatment design requirements, reliability requirements, and alternative methods of treatment.

The DHS has developed proposed revisions to the existing reclamation regulations. These revisions are intended to expand the range of allowable uses of reclaimed water and clarify some of the ambiguity contained in the existing regulations.

Title 17. Title 17 regulates one aspect of the distribution of reclaimed water. The focus of Title 17 is protection of drinking (potable) water supplies through control of cross-connections with potential contaminants. Examples of potential contaminants to potable water supplies are sewage; nonpotable water supplies such as reclaimed water, irrigation water, and auxiliary water supplies; fire protection systems; and hazardous substances.

Title 17, Group 4, Article 2 - Protection of Water System, Table 1 specifies the minimum backflow protection required on the potable water system for situations in which there is potential for contamination to the potable water supply. Reclaimed water is addressed twice as follows:

- An air-gap separation is required on "Premises where the public water system is used to supplement the reclaimed water supply".
- An air-gap separation is required on "Premises where reclaimed water is used and there is no interconnection with the potable water system. A [reduced pressure principle backflow prevention device] may be provided in lieu of an [air gap] if approved by the health agency and water supplier."

An air-gap separation is defined as "a physical break between the supply line and a receiving vessel". A reduced pressure principle backflow prevention device is defined as "a backflow preventer incorporating not less than two check valves, an automatically operated differential relief valve located between the two check valves, a tightly closing shut-off valve on each side of the check valve assembly, and equipped with necessary test cocks for testing".

<u>Guidelines</u>. To assist in compliance with Title 22, the DHS has prepared a number of guidelines for production, distribution, and use of reclaimed water. Additionally, for distribution of reclaimed water, DHS recommends use of guidelines prepared by the California-Nevada Section of the American Water Works Association (AWWA). These guidelines are summarized below.

<u>Guideline for the Preparation of an Engineering Report on the Production, Distribution, and Use of Reclaimed Water</u>. According to Title 22, prior to implementation of a water reclamation project (production, distribution, or use) an engineering report must be prepared and submitted to DHS. This guideline, prepared by DHS and dated 10 June 1988, specifies the contents of an engineering report. The report should describe the production process, including the treated (effluent) water quality, the raw water quality, the treatment process, the plant reliability features, the supplemental water supply, the monitoring program, and a contingency plan to prevent distribution of inadequately treated water. The report should include maps of the distribution system and describe how the system will comply with DHS and AWWA guidelines and Title 17. The report should include maps of proposed use areas and should describe the use areas, the types of uses proposed, the people responsible for supervising the uses, the design of the user systems, and the proposed user inspection and monitoring programs.

<u>Manual of Cross Connection Control/Procedures and Practices</u>. This manual, dated July 1981, focuses on establishing a cross-connection control program to protect the public against backflow and back-siphonage of contamination. Main elements of the manual include areas where protection is required; causes of backflow; approved backflow preventers; procedures, installation, and certification of backflow preventers; and water shutoff procedures (for conditions which pose a hazard to the potable water supply).

Guidelines for the Distribution of Nonpotable Water. These guidelines were prepared by the California-Nevada Section of AWWA. The purpose of these guidelines is to provide guidance for planning, designing, constructing, and operating nonpotable water systems, including reclaimed water systems. Distribution lines, storage and supply, pumping, on-site (user) applications, and system management are discussed. DHS guidelines reference these guidelines.

Guidelines for the Use of Reclaimed Water. These DHS guidelines, dated 10 June 1988, are an expansion of Title 22 and focus on the distribution and use of reclaimed water. They cover general use requirements, such as confinement of reclaimed water to the user site and protection of drinking water supplies, and specific use requirements. The specific uses covered include landscape irrigation, impoundments, and agricultural reuse. Guidelines for worker protection, providing warning signs, limiting access, confining reclaimed water to the site, and scheduling irrigation are provided.

Guidelines for the Use of Reclaimed Water for Construction Purposes. These DHS guidelines, dated 10 June 1988, provide information relating to the production, hauling and use of reclaimed water for construction purposes. Included in the guidelines are controls to be maintained at the treatment plant and during hauling and use.

Administration. In the State of California, reclamation requirements are administered by the SWRCB, the RWQCB, and the DHS. The direct involvement of each agency during a reclamation project is summarized below:

SWRCB

- Issue loans in accordance with the Water Code.
- Approve petitions for the change in place and purpose of use of treated wastewater in accordance with the Water Code.

RWQCB

- Prepare or revise reclamation requirements in accordance with the Water Code.
- Review and approve engineering report required under Title 22.
- Review and approve recharge projects using reclaimed water in accordance with the Water Code.

DHS

- Review and approve engineering report as requested by RWQCB.
- Review and approve final plans for cross connection control and pipeline separations in accordance with Title 17, and inspect distribution system prior to operation.

- In conjunction with local health agencies, review and approve final on-site (user) system plans for cross connection control in accordance with Title 17, and inspect system prior to operation.

The DHS has delegated a portion of its administrative duties to local health agencies and becomes more involved at the request of the local health agencies.

Local Requirements

Local requirements focus on the distribution and use of reclaimed water and, primarily, the onsite (user) systems, with emphasis on cross-connection control. State regulations and guidelines discussed above are the governing requirements. The County Department of Health Services establishes more specific requirements for the separation and construction of potable and reclaimed waterlines, guidelines for on-site (user) systems, and identification of reclaimed water facilities.

<u>Administration</u>. Local requirements are administered by the County DHS. The County DHS's direct involvement in a reclaimed water project is as follows:

- Review as-built drawings of users' potable water system.
- Perform an onsite survey of the users' water system.
- Guide users in methods of identifying potable and reclaimed water systems.
- Review and approve design drawings of users' reclaimed water systems.
- Inspect user's potable and reclaimed water systems following construction.

APPENDIX D

Potential Reclaimed Water Users

POTENTIAL RECLAIMED WATER USERS

User Node	User Name	Current Status	Required Water Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand (af/dy)	Peak Day Demand (1000 gpd)	Operating Conditions During Peak Day: Days/Week	Operating Conditions During Peak Day: From - To	Operating Conditions During Peak Day: Total Hours	Peak Hour Demand (gpm)
	Palmdale										
2	Alfalfa Farm	Existing	Secondary	1,151	214.6	7.40	2,627.4	7	12 am - 12 am	24	1,825
2A	Alfalfa Farm	Existing	Secondary	1,306	243.6	8.40	2,982.4	7	12 am - 12 am	24	2,071
5	Alfalfa Farm	Existing	Secondary	2,706	504.6	17.40	6,177.9	7	12 am - 12 am	24	4,290
12A	Christmas Tree & Landscape Farm	Existing	Secondary	81	18.8	0.80	233.9	7	12 am - 12 am	24	162
12B	Christmas Tree & Landscape Farm	Future	Secondary	61	14.1	0.60	175.4	7	12 am - 12 am	24	122
13	Alfalfa Farm	Existing	Secondary	995	185.6	6.40	2,272.3	7	12 am - 12 am	24	1,578
13A	Alfalfa Farm	Existing	Secondary	622	116.0	4.00	1,420.2	7	12 am - 12 am	24	986
13B	Alfalfa Farm	Existing	Secondary	995	185.6	6.40	2,272.3	7	12 am - 12 am	24	1,578
13C	Alfalfa Farm	Existing	Secondary	373	69.6	2.40	852.1	7	12 am - 12 am	24	592
15A	DOA Test Farm	Existing	Secondary	32	7.5	0.32	93.6	7	12 am - 12 am	24	65
15B	DOA Pistachio Farm	Existing	Secondary	112	29.4	0.90	338.3	7	12 am - 12 am	24	235
15C	DOA Chestnut Farm	Existing	Secondary	149	39.2	1.20	451.1	7	12 am - 12 am	24	313
15D	DOA Barley Farm	Existing	Secondary	304	57.2	2.20	643.3	7	12 am - 12 am	24	447
15E	DOA Pistachio Farm	Future	Secondary	37	9.8	0.30	112.8	7	12 am - 12 am	24	78
15F	DOA Chestnut Farm	Future	Secondary	3,024	796.7	24.39	9,169.0	7	12 am - 12 am	24	6,367
15G	DOA Alfalfa Farm	Future	Secondary	10,618	1,672.9	51.21	19,251.6	7	12 am - 12 am	24	13,369
18A	Sod Farm	Existing	Secondary	684	126.1	5.20	1,683.4	7	12 am - 12 am	24	1,169
18B	Sod Farm	Future	Secondary	263	48.5	2.00	647.5	7	12 am - 12 am	24	450
62	Lusk Commercial Development	Future	Tertiary	48	8.8	0.28	92.5	7	12 am - 6 am	6	257
63	Wms. Property Development	Future	Tertiary	36	6.5	0.21	68.7	7	12 am - 6 am	6	191
65A	Palmdale Business Park	Future	Tertiary	118	16.6	0.54	174.6	7	12 am - 6 am	6	485
65B	Palmdale Business Park Golf Course	Future	Secondary	453	50.9	1.64	535.3	7	12 am - 6 am	6	1,487
100	Antelope Valley Country Club	Existing	Secondary	375	68.8	2.22	722.5	7	10 pm - 6 am	8	1,505
101	Palmdale High School	Existing	Tertiary	138	25.3	0.82	265.9	7	12 am - 6 am	6	739
102	Desert Aire Golf Course	Existing	Secondary	120	22.0	0.71	231.2	7	10 pm - 8 am	10	385
103A	Desert Lawn Memorial Park	Existing	Secondary	21	3.9	0.15	48.2	6	8 am - 4 pm	8	101
103B	Desert Lawn Memorial Park	Future	Secondary	120	22.0	0.85	275.7	6	8 am - 4 pm	8	574
104	McAdam Park	Existing	Tertiary	72	13.2	0.43	138.7	7	10 pm - 8 am	10	231
105	Courson Park	Existing	Tertiary	23	4.1	0.13	43.4	7	10 pm - 8 am	10	72
106	Palms Park	Future	Tertiary	75	13.8	0.44	144.5	7	10 pm - 8 am	10	241
107	Desert Sands Park	Existing	Tertiary	68	12.5	0.40	131.0	7	10 pm - 8 am	10	218
108	Joshua Hills Park	Existing	Tertiary	11	2.0	0.06	21.0	7	10 pm - 8 am	10	35

POTENTIAL RECLAIMED WATER USERS

User Node	User Name	Current Status	Required Water Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand (af/dy)	(1000 gpd)	Operating Conditions During Peak Day Days/ Week	From - To	Total Hours	Peak Hour Demand (gpm)
109	Palmdale Park	Future	Tertiary	8	1.4	0.04	14.5	7	10 pm - 8 am	10	24
110	Tejon Park	Future	Tertiary	56	10.2	0.33	106.9	7	10 pm - 8 am	10	178
111	60th East/Ave S-8 Park Site	Future	Tertiary	60	11.0	0.35	115.6	7	10 pm - 8 am	10	193
112	72nd East/Ave R-8 Park Site	Future	Tertiary	30	5.5	0.18	57.8	7	10 pm - 8 am	10	96
113	70th East/Ave R Park Site	Future	Tertiary	30	5.5	0.18	57.8	7	10 pm - 8 am	10	96
114	Manzanita Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
115	Chaparral Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
116	Mesquite Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
117	Joshua Hills Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
118	Desert Rose Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
119	Tamarisk Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
120	Tumbleweed Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
121	Yucca Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
122	Cactus K-8 School	Existing	Tertiary	23	4.3	0.14	45.1	7	12 am - 6 am	6	125
124	Mesa Intermediate School	Existing	Tertiary	36	6.7	0.22	70.1	7	12 am - 6 am	6	195
125	Ocotillo Elementary School	Existing	Tertiary	52	9.5	0.31	100.2	7	12 am - 6 am	6	278
126	Juniper Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
127	Juniper Middle School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
128	Highlands High School	Existing	Tertiary	52	9.5	0.31	100.2	7	12 am - 6 am	6	278
129	Rancho Vista Elementary School	Existing	Tertiary	100	18.3	0.59	192.7	7	12 am - 6 am	6	535
130	Manzanita Heights Park	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
133	Hill View Middle School	Existing	Tertiary	15	2.8	0.09	28.9	7	10 pm - 8 am	10	48
134	Summerwind Elementary School	Existing	Tertiary	52	9.5	0.31	100.2	7	12 am - 6 am	6	278
		Future	Tertiary	42	7.6	0.25	80.2	7	12 am - 6 am	6	223
	Palmdale Total			26,004	4,759.6	155.22	55,868.9				46,159
	Lancaster										
3	Peach Farm	Existing	Secondary	8	1.9	0.08	23.4	7	12 am - 12 am	24	16
4	Grain & Alfalfa Farm	Existing	Secondary	2,895	540.6	18.90	6,553.8	7	12 am - 12 am	24	4,551
6A	Alfalfa Farm	Existing	Secondary	1,866	348.0	12.00	4,260.6	7	12 am - 12 am	24	2,959
6B	Alfalfa Farm	Existing	Secondary	1,120	208.8	7.20	2,556.4	7	12 am - 12 am	24	1,775
7	Peach Farm	Existing	Secondary	52	11.7	0.50	150.4	7	12 am - 12 am	24	104
8	Nebeker Ranch	Existing	Secondary	4,229	788.8	27.20	9,657.3	7	12 am - 12 am	24	6,706

POTENTIAL RECLAIMED WATER USERS

User Node	User Name	Current Status	Required Water Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
9	Alfalfa Farm	Existing	Secondary	1,617	301.6	10.40	3,692.5	7	12 am - 12 am	24	2,564
9A	Alfalfa Farm	Existing	Secondary	746	139.2	4.80	1,704.2	7	12 am - 12 am	24	1,184
10	Alfalfa Farm	Existing	Secondary	603	112.5	3.88	1,377.6	7	12 am - 12 am	24	957
10A	Alfalfa Farm	Existing	Secondary	1,244	232.0	8.00	2,840.4	7	12 am - 12 am	24	1,973
11	Alfalfa Farm	Existing	Secondary	1,244	232.0	8.00	2,840.4	7	12 am - 12 am	24	1,973
17	Barley Farm	Existing	Secondary	104	19.5	0.75	219.3	7	12 am - 12 am	24	152
50	Centennial Estates Development	Future	Tertiary	25	4.7	0.15	49.0	7	12 am - 6 am	6	136
52	Lancaster Business Park	Existing	Tertiary	55	10.0	0.32	105.6	7	12 am - 6 am	6	293
53A	Serrano Ranch	Future	Tertiary	329	60.3	1.95	633.9	7	12 am - 6 am	6	1,761
53B	Serrano Ranch Golf Course	Future	Secondary	633	116.1	3.74	1,219.7	7	12 am - 6 am	6	3,388
54	K&B Development (Tract 49864)	Future	Tertiary	47	8.6	0.28	90.2	7	12 am - 6 am	6	250
55	Lincoln Land Development	Future	Tertiary	53	9.7	0.31	101.7	7	12 am - 6 am	6	283
56	K&B Development (Tract 46111)	Future	Tertiary	67	12.3	0.40	129.5	7	12 am - 6 am	6	360
57	Presley of Southern Cal Development	Future	Tertiary	26	4.8	0.15	50.4	7	12 am - 6 am	6	140
58	K&B Development (Tract 46612)	Future	Tertiary	18	3.4	0.11	35.6	7	12 am - 6 am	6	99
59	Wain-Bardley Development	Future	Tertiary	18	3.2	0.10	34.0	7	12 am - 6 am	6	94
60	Presley of Southern Cal Development	Future	Tertiary	32	5.8	0.19	61.3	7	12 am - 6 am	6	170
64	Fox Airfield Commercial Development	Future	Tertiary	1,920	352.0	11.35	3,699.5	7	12 am - 6 am	6	10,276
150	Antelope Valley College	Existing	Tertiary	320	58.7	1.89	616.6	7	12 am - 6 am	6	1,713
151A	Rawley Duntley Park	Future	Tertiary	16	2.9	0.11	36.8	6	10 pm - 6 am	8	77
151B	Rawley Duntley Park	Existing	Tertiary	28	5.1	0.20	64.3	6	10 pm - 6 am	8	134
152A	Lancaster City Park	Existing	Tertiary	150	23.5	0.91	295.0	6	10 pm - 6 am	8	615
152B	Lancaster City Park	Future	Tertiary	32	5.9	0.23	73.5	6	10 pm - 6 am	8	153
153	Jane Reynolds Park	Existing	Tertiary	30	5.2	0.20	64.6	6	10 pm - 6 am	8	135
154	Mariposa Park	Existing	Tertiary	28	6.2	0.24	78.3	6	10 pm - 6 am	8	163
155	Eastside Park	Existing	Tertiary	71	10.3	0.40	129.5	6	10 pm - 6 am	8	270
156	El Dorado Park	Existing	Tertiary	40	6.5	0.25	81.0	6	10 pm - 6 am	8	169
157	Tierra Bonita Park	Existing	Tertiary	96	17.6	0.68	220.5	6	10 pm - 6 am	8	459
158	Skytower Park	Existing	Tertiary	48	8.8	0.34	110.3	6	10 pm - 6 am	8	230
159	Apollo Lakes County Park	Existing	Tertiary	129	30.4	1.44	470.0	7	12 am - 6 am	6	1,306
160	Antelope Valley High School	Existing	Tertiary	130	23.8	0.77	250.5	7	12 am - 6 am	6	696
161	Desert Winds High School	Existing	Tertiary	8	1.4	0.05	14.8	7	12 am - 6 am	6	41
162	Piute Intermediate High School	Existing	Tertiary	38	7.0	0.22	73.2	7	12 am - 6 am	6	203
163	Parkview Intermediate High School	Existing	Tertiary	65	11.9	0.38	124.9	7	12 am - 6 am	6	347

POTENTIAL RECLAIMED WATER USERS

User Node	User Name	Current Status	Required Water Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ Week	From - To	Total Hours	
164	Cory Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
165	Sierra Elementary School	Existing	Tertiary	26	4.7	0.15	49.3	7	12 am - 6 am	6	137
166	Sunnydale Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
167	Monte Vista Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
168	Desert View Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
169	Mariposa Elementary School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
170	Joshua Elementary School	Existing	Tertiary	38	7.0	0.22	73.1	7	12 am - 6 am	6	203
171	El Dorado Elementary School	Existing	Tertiary	56	10.3	0.33	108.7	7	12 am - 6 am	6	302
172	Linda Verde Elementary School	Existing	Tertiary	25	4.6	0.15	48.6	7	12 am - 6 am	6	135
173	Paiute Ponds	Existing	Tertiary	28	5.1	0.16	53.6	7	12 am - 6 am	6	149
174A	Wagas Land Duck Ponds	Existing	Secondary	1,456	228.4	7.37	2,400.0	7	12 am - 12 am	24	1,667
174B	Wagas Land Irrigation	Existing	Secondary	1,558	186.0	6.00	1,954.8	7	12 am - 12 am	24	1,358
175A	Joshua Memorial Park	Existing	Tertiary	480	89.0	2.87	935.4	7	12 am - 12 am	24	650
175B	Joshua Memorial Park	Existing	Secondary	90	16.5	0.53	173.4	7	12 am - 6 am	6	482
176	Young Ranch	Future	Secondary	21	3.9	0.12	40.5	7	12 am - 6 am	6	112
177	Valley View Elementary School	Existing	Secondary	253	43.1	1.39	453.0	7	12 am - 12 am	24	315
179	Walker Middle School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
180	George Lane Park	Existing	Tertiary	52	9.5	0.31	100.2	7	12 am - 6 am	6	278
181	Quartz Hill High School	Existing	Tertiary	54	9.9	0.32	104.0	7	12 am - 6 am	6	289
182	Meadowlark Golf Course	Existing	Tertiary	160	29.3	0.95	308.3	7	12 am - 6 am	6	856
183	Lancaster Elementary School	Existing	Tertiary	30	5.5	0.18	57.8	7	12 am - 6 am	6	161
184	Lancaster High School	Existing	Tertiary	26	4.8	0.15	50.1	7	12 am - 6 am	6	139
185	Eastside High School	Future	Tertiary	110	20.2	0.65	211.9	7	12 am - 6 am	6	589
186	New Vista Elementary School	Future	Tertiary	134	24.6	0.79	258.2	7	12 am - 6 am	6	717
187	Lincoln Elementary School	Future	Tertiary	43	7.9	0.26	83.2	7	12 am - 6 am	6	231
		Future	Tertiary	28	5.1	0.17	54.1	7	12 am - 6 am	6	150
	Lancaster Total			24,978	4,644.8	152.91	52,559.0				58,489
	Rosamond										
200	Rosamond Elementary School	Existing	Tertiary	17	3.1	0.10	32.6	7	10 pm - 8 am	10	54
201	Hamilton Elementary School	Existing	Tertiary	65	11.9	0.38	125.2	7	10 pm - 8 am	10	209
202	Rosamond High School	Existing	Tertiary	66	12.1	0.39	127.2	7	10 pm - 8 am	10	212
203	Tropico Middle School	Existing	Tertiary	26	4.8	0.15	50.1	7	10 pm - 8 am	10	83

POTENTIAL RECLAIMED WATER USERS

User Node	User Name	Current Status	Required Water Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand (af/dy)	Peak Day Demand (1000 gpd)	Operating Conditions During Peak Day: Days/week	Operating Conditions During Peak Day: From - To	Operating Conditions During Peak Day: Total Hours	Peak Hour Demand (gpm)
204	Rare Earth Continuation School	Existing	Tertiary	17	3.1	0.10	32.6	7	10 pm - 8 am	10	54
205	Rosamond Park	Existing	Tertiary	30	5.5	0.18	57.8	7	12 am - 6 am	6	161
206	West Park	Existing	Tertiary	15	2.8	0.09	28.9	7	12 am - 6 am	6	80
207	Desert Highlands Development	Future	Tertiary	209	29.8	1.15	373.3	6	12 am - 6 am	6	1,037
208	Desert Highlands Golf Course	Future	Secondary	90	16.5	0.63	206.8	6	12 am - 6 am	6	574
209	Tract 5052	Future	Tertiary	15	2.8	0.09	29.4	7	12 am - 6 am	6	82
210	Tract 5172	Future	Tertiary	58	10.7	0.35	112.6	7	12 am - 6 am	6	313
211	Tract 5188	Future	Tertiary	12	2.2	0.07	23.1	7	12 am - 6 am	6	64
212	Tract 5195	Future	Tertiary	20	3.6	0.12	38.2	7	12 am - 6 am	6	106
213	Tract 5196	Future	Tertiary	19	3.5	0.11	37.0	7	12 am - 6 am	6	103
214	Tract 5198	Future	Tertiary	19	3.5	0.11	37.0	7	12 am - 6 am	6	103
215	Tract 5204	Future	Tertiary	19	3.6	0.11	37.5	7	12 am - 6 am	6	104
216	Tract 5313	Future	Tertiary	4	0.7	0.02	7.8	7	12 am - 6 am	6	22
217	Tract 5394	Future	Tertiary	6	1.0	0.03	10.8	7	12 am - 6 am	6	30
218	Tract 5400	Future	Tertiary	38	7.0	0.23	74.0	7	12 am - 6 am	6	206
219	Tract 5546	Future	Tertiary	6	1.2	0.04	12.3	7	12 am - 6 am	6	34
220	Tract 4558	Future	Tertiary	12	2.2	0.07	23.4	7	12 am - 6 am	6	65
	Rosamond Total			765	131.7	4.53	1,477.4				3,695
	Edwards AFB										
1	Wing Headquarters	Existing	Tertiary	11	1.8	0.06	19.1	7	10 pm - 8 am	10	32
16	Muroc Manner	Existing	Tertiary	19	2.8	0.09	29.7	7	10 pm - 8 am	10	50
1020	IFAST	Existing	Tertiary	19	1.9	0.06	20.3	7	10 pm - 8 am	10	34
1200	Base Operations	Existing	Tertiary	6	1.0	0.03	10.1	7	10 pm - 8 am	10	17
1220	Test Pilot School	Existing	Tertiary	5	0.7	0.02	7.8	7	10 pm - 8 am	10	13
1250	Offices	Existing	Tertiary	0	0.0	0.00	0.2	7	10 pm - 8 am	10	0
1260	Offices	Existing	Tertiary	5	0.8	0.03	8.2	7	10 pm - 8 am	10	14
1400	Engineering	Existing	Tertiary	9	1.3	0.04	13.7	7	10 pm - 8 am	10	23
1440	Ridley Mission Control Center	Existing	Tertiary	25	2.8	0.09	29.5	7	10 pm - 8 am	10	49
1600	T-38	Existing	Tertiary	13	1.1	0.03	11.1	7	10 pm - 8 am	10	19
1609	C-17	Existing	Tertiary	0	0.0	0.00	0.2	7	10 pm - 8 am	10	0
1610	Colonial Inn	Existing	Tertiary	4	0.5	0.02	5.6	7	10 pm - 8 am	10	9

POTENTIAL RECLAIMED WATER USERS

User Node	User Name	Current Status	Required Water Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ Week	From - To	Total Hours	
1633	Offices	Existing	Tertiary	3	0.5	0.02	5.1	7	10 pm - 8 am	10	9
1830A	Enviornmental	Existing	Tertiary	5	0.7	0.02	7.1	7	10 pm - 8 am	10	12
2201	Softball Field	Existing	Tertiary	10	1.6	0.05	16.4	7	10 pm - 8 am	10	27
2419	Grass Island	Existing	Tertiary	3	0.4	0.01	4.5	7	10 pm - 8 am	10	8
2421	Civilian Personnel	Existing	Tertiary	3	0.5	0.02	4.9	7	10 pm - 8 am	10	8
2430	OSI	Existing	Tertiary	8	1.2	0.04	12.3	7	10 pm - 8 am	10	20
2453	Education Center	Existing	Tertiary	3	0.4	0.01	4.6	7	10 pm - 8 am	10	8
2500	Oasis Club	Existing	Tertiary	15	2.2	0.07	23.1	7	10 pm - 8 am	10	39
2600	Comm. Building	Existing	Tertiary	7	1.0	0.03	10.3	7	10 pm - 8 am	10	17
2650A	CSC	Existing	Tertiary	13	1.9	0.06	20.3	7	10 pm - 8 am	10	34
2656	Library Park	Existing	Tertiary	16	2.3	0.07	24.4	7	10 pm - 8 am	10	41
2665	Library	Existing	Tertiary	16	2.4	0.08	25.0	7	10 pm - 8 am	10	42
2670	Post Office	Existing	Tertiary	6	0.9	0.03	9.8	7	10 pm - 8 am	10	16
2700	Chapel	Existing	Tertiary	21	3.1	0.10	32.9	7	10 pm - 8 am	10	55
2750	FTEMF	Existing	Tertiary	54	7.9	0.26	83.2	7	10 pm - 8 am	10	139
2800	Procurement	Existing	Tertiary	17	2.6	0.08	27.1	7	10 pm - 8 am	10	45
2858	Comm. Bulding	Existing	Tertiary	3	0.4	0.01	4.4	7	10 pm - 8 am	10	7
2860	Security Police	Existing	Tertiary	10	1.5	0.05	15.9	7	10 pm - 8 am	10	26
3497	Self Help	Existing	Tertiary	2	0.3	0.01	3.0	7	10 pm - 8 am	10	5
3500	Civil Engineering	Existing	Tertiary	2	0.2	0.01	2.4	7	10 pm - 8 am	10	4
3507	Dog Pound	Existing	Tertiary	6	0.8	0.03	8.7	7	10 pm - 8 am	10	15
3510	Vehicle Maintenance Shop	Existing	Tertiary	1	0.0	0.00	0.4	7	10 pm - 8 am	10	1
3535	Headquarters	Existing	Tertiary	15	2.3	0.07	23.9	7	10 pm - 8 am	10	40
3535	Off-Site (Rosamond Blvd).	Existing	Tertiary	19	2.9	0.09	30.6	7	10 pm - 8 am	10	51
3804	Jet Test Cell	Existing	Tertiary	4	0.4	0.01	3.7	7	10 pm - 8 am	10	6
3810	Jet Maintenance Facility	Existing	Tertiary	31	4.5	0.15	47.4	7	10 pm - 8 am	10	79
3920	Altitude Chamber	Existing	Tertiary	4	0.6	0.02	6.5	7	10 pm - 8 am	10	11
3940	Programs	Existing	Tertiary	3	0.4	0.01	4.5	7	10 pm - 8 am	10	8
3950	Office	Existing	Tertiary	3	0.5	0.02	4.9	7	10 pm - 8 am	10	8
3950A	Offices	Existing	Tertiary	8	1.2	0.04	12.4	7	10 pm - 8 am	10	21
Q	Dorms	Existing	Tertiary	207	30.8	0.99	323.2	7	10 pm - 8 am	10	539
R	Rosamond Blvd, So. Muroc Dr.	Existing	Tertiary	13	1.9	0.06	20.3	7	10 pm - 8 am	10	34
5201	Softball Field	Existing	Tertiary	12	1.9	0.06	19.5	7	10 pm - 8 am	10	33
5208	Wings Field	Existing	Tertiary	29	4.3	0.14	45.4	7	10 pm - 8 am	10	76

POTENTIAL RECLAIMED WATER USERS

User Node	User Name	Current Status	Required Water Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ Week	From - To	Total Hours	
5210	Youth Center	Existing	Tertiary	15	2.3	0.07	23.9	7	10 pm - 8 am	10	40
5211	Hap Arnold Park	Existing	Tertiary	10	1.4	0.05	14.9	7	10 pm - 8 am	10	25
5213	Robers Field	Existing	Tertiary	22	3.3	0.11	34.4	7	10 pm - 8 am	10	57
5214	Bowling	Existing	Tertiary	2	0.3	0.01	3.4	7	10 pm - 8 am	10	6
5215	Little League Field	Existing	Tertiary	7	1.0	0.03	10.6	7	10 pm - 8 am	10	18
5216	Softball Field	Existing	Tertiary	12	1.8	0.06	18.8	7	10 pm - 8 am	10	31
5220	Soccer Field	Existing	Tertiary	10	1.5	0.05	16.0	7	10 pm - 8 am	10	27
5221	Little League Field	Existing	Tertiary	13	2.0	0.06	20.6	7	10 pm - 8 am	10	34
5500	Hospital	Existing	Tertiary	23	2.6	0.08	27.5	7	10 pm - 8 am	10	46
5510	Hospital Barracks	Existing	Tertiary	5	0.8	0.02	7.9	7	10 pm - 8 am	10	13
5513	Dental Clinic	Existing	Tertiary	24	3.6	0.12	37.5	7	10 pm - 8 am	10	63
5550	Veterinary Clinic	Existing	Tertiary	3	0.4	0.01	4.0	7	10 pm - 8 am	10	7
5560	Fire Station	Existing	Tertiary	7	1.1	0.04	11.6	7	10 pm - 8 am	10	19
5600	Officer's Club	Existing	Tertiary	30	4.4	0.14	46.6	7	10 pm - 8 am	10	78
5601	VIP Billeting	Existing	Tertiary	11	1.7	0.05	17.3	7	10 pm - 8 am	10	29
5602	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
5603	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
5604	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
5606	Billeting	Existing	Tertiary	10	1.5	0.05	15.2	7	10 pm - 8 am	10	25
6000	Commissary	Existing	Tertiary	12	1.8	0.06	18.5	7	10 pm - 8 am	10	31
6002	Branch Bank	Existing	Tertiary	6	0.8	0.03	8.8	7	10 pm - 8 am	10	15
6005	Baskin Robbins	Existing	Tertiary	6	0.9	0.03	9.4	7	10 pm - 8 am	10	16
6006	Burger King	Existing	Tertiary	10	1.5	0.05	15.6	7	10 pm - 8 am	10	26
6441	Preschool	Existing	Tertiary	2	0.3	0.01	3.4	7	10 pm - 8 am	10	6
6445	Social Actions	Existing	Tertiary	1	0.1	0.00	1.2	7	10 pm - 8 am	10	2
6447	Housing Chapel	Existing	Tertiary	15	2.3	0.07	23.9	7	10 pm - 8 am	10	40
6459	Child Care Center	Existing	Tertiary	4	0.7	0.02	6.8	7	10 pm - 8 am	10	11
7020	Old Youth Center	Existing	Tertiary	26	3.8	0.12	40.4	7	10 pm - 8 am	10	67
B	Park	Existing	Tertiary	25	3.7	0.12	39.3	7	10 pm - 8 am	10	66
C	Park	Existing	Tertiary	23	3.4	0.11	35.4	7	10 pm - 8 am	10	59
F	Park	Existing	Tertiary	62	9.2	0.30	96.9	7	10 pm - 8 am	10	162
G	Park	Existing	Tertiary	4	0.6	0.02	5.8	7	10 pm - 8 am	10	10
H	Park	Existing	Tertiary	12	1.8	0.06	18.4	7	10 pm - 8 am	10	31
I	MH Park Playground	Existing	Tertiary	5	0.8	0.03	8.2	7	10 pm - 8 am	10	14

POTENTIAL RECLAIMED WATER USERS

User Node	User Name	Current Status	Required Water Treatment Level	Annual Demand (af/yr)	Peak Month Demand (af/mo)	Peak Day Demand		Operating Conditions During Peak Day			Peak Hour Demand (gpm)
						(af/dy)	(1000 gpd)	Days/ week	From - To	Total Hours	
J	Famcamp	Existing	Tertiary	33	4.9	0.16	51.1	7	10 pm - 8 am	10	85
K	Schools	Existing	Tertiary	156	23.2	0.75	243.7	7	10 pm - 8 am	10	406
L	Golf Course	Existing	Tertiary	934	139.6	4.50	1,467.0	7	10 pm - 8 am	10	2,445
M	Love Avenue	Existing	Tertiary	14	2.2	0.07	22.9	7	10 pm - 8 am	10	38
N	Miscellaneous Use	Existing	Tertiary	82	3.0	0.10	31.9	7	10 pm - 8 am	10	53
O	Industrial Use	Future	Tertiary	28	3.9	0.13	41.0	7	10 pm - 8 am	10	68
P	Irrigation Use	Future	Tertiary	307	43.2	1.39	454.0	7	10 pm - 8 am	10	757
	Edwards AFB Total			2,685	384.7	12.41	4,043.2				6,739
	GRAND TOTAL			54,432	9,920.8	325.08	113,948.5				115,082
	(MGD)			48.6							

APPENDIX E

Historical Potentiometric Head in the Antelope Valley

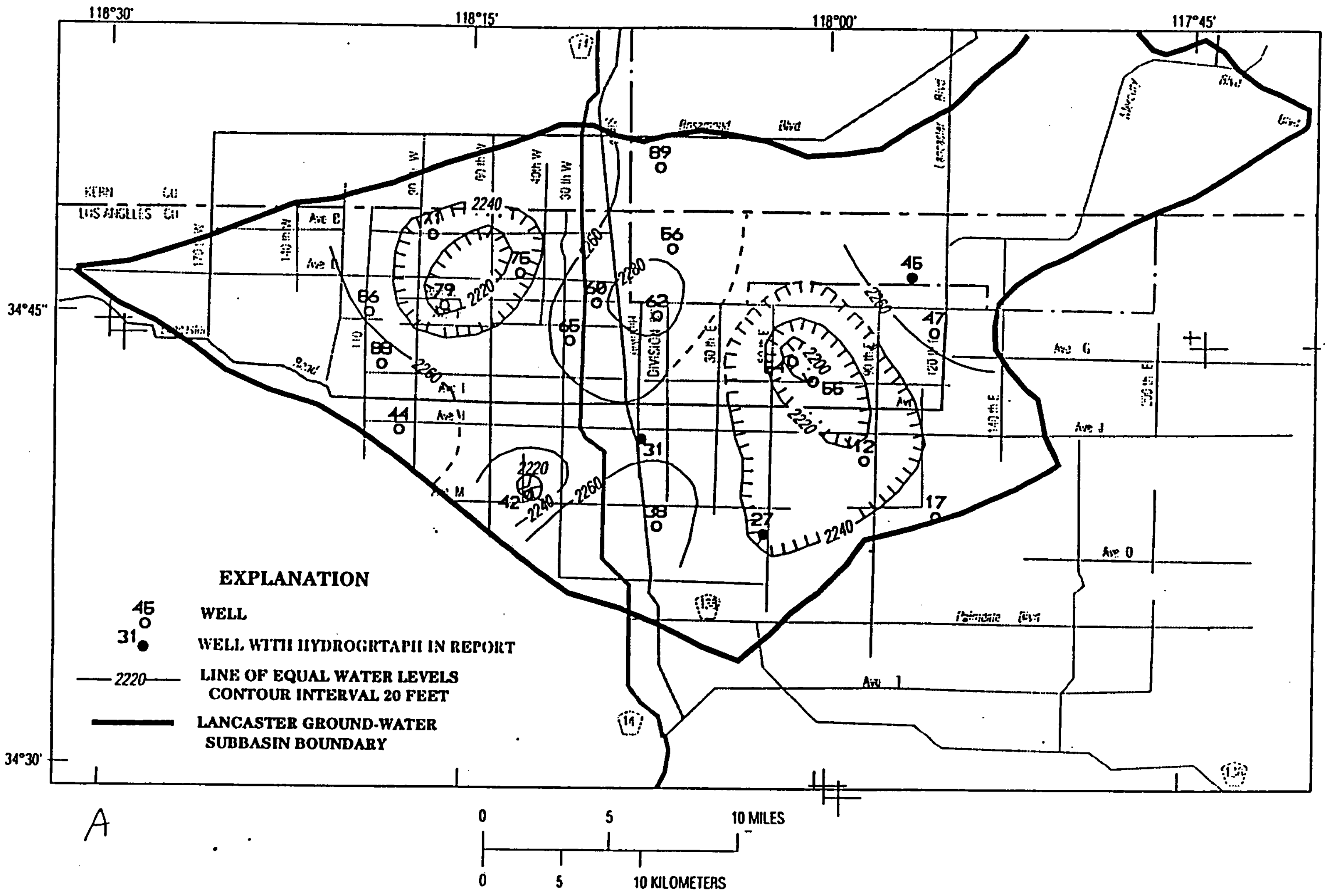
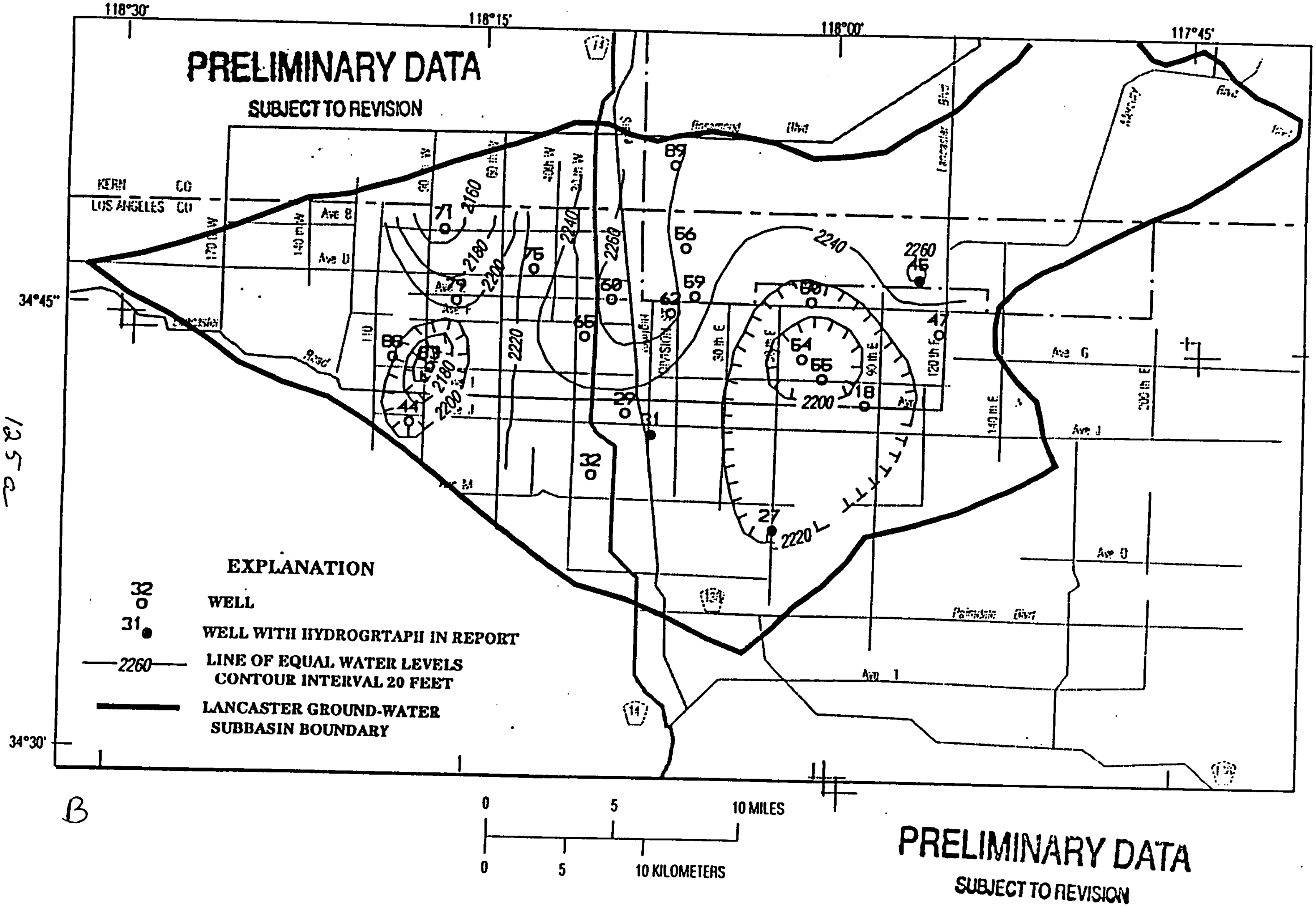


Figure 13. Potentiometric surface of principal aquifer in Lancaster ground-water subbasin for (*A*) 1957, (*B*) 1962, (*C*) 1965, (*D*) 1972, (*E*) 1975, (*F*) 1981, and (*G*) 1992.



B

Figure 13. Continued.

125a

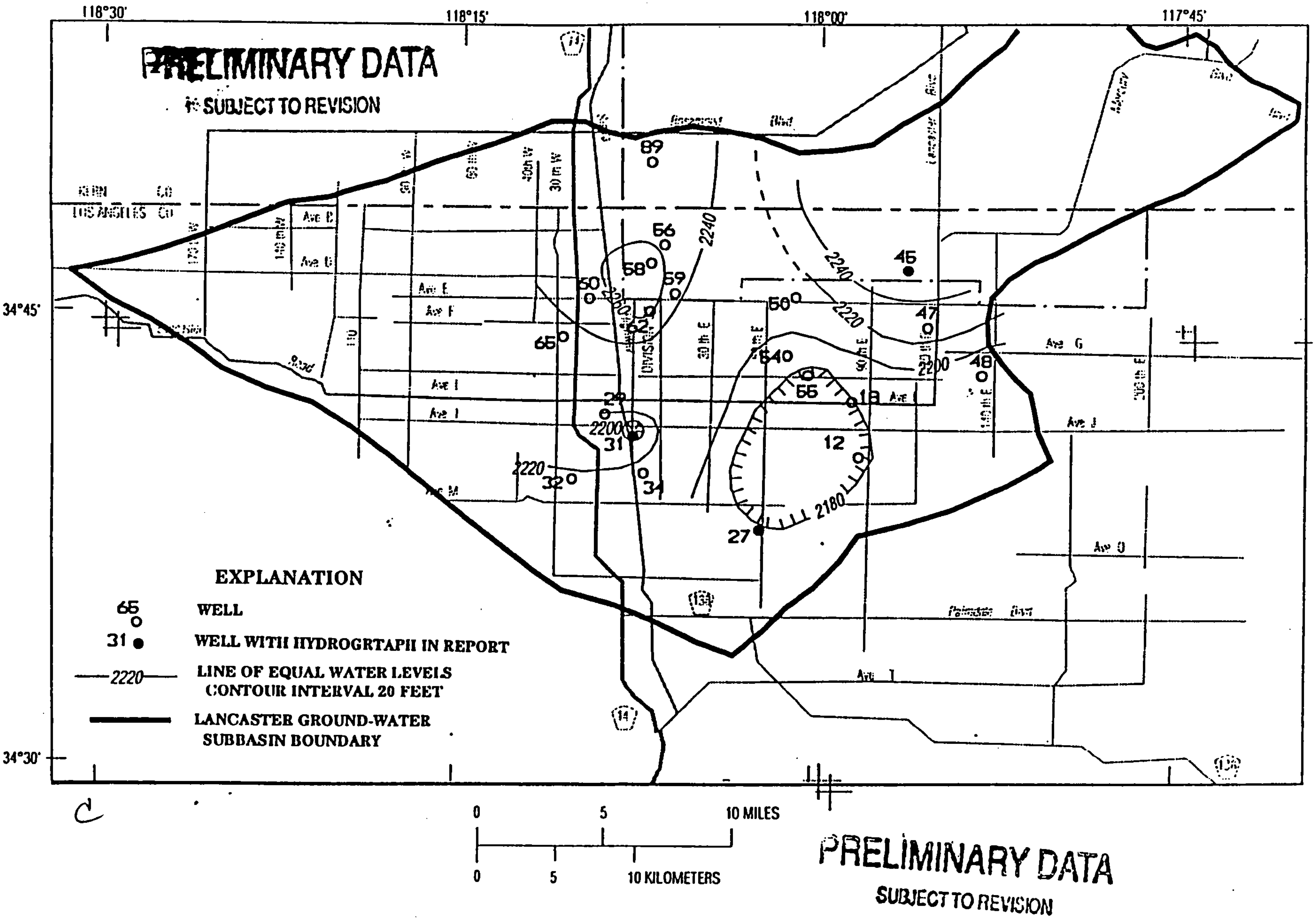


Figure 13. Continued.

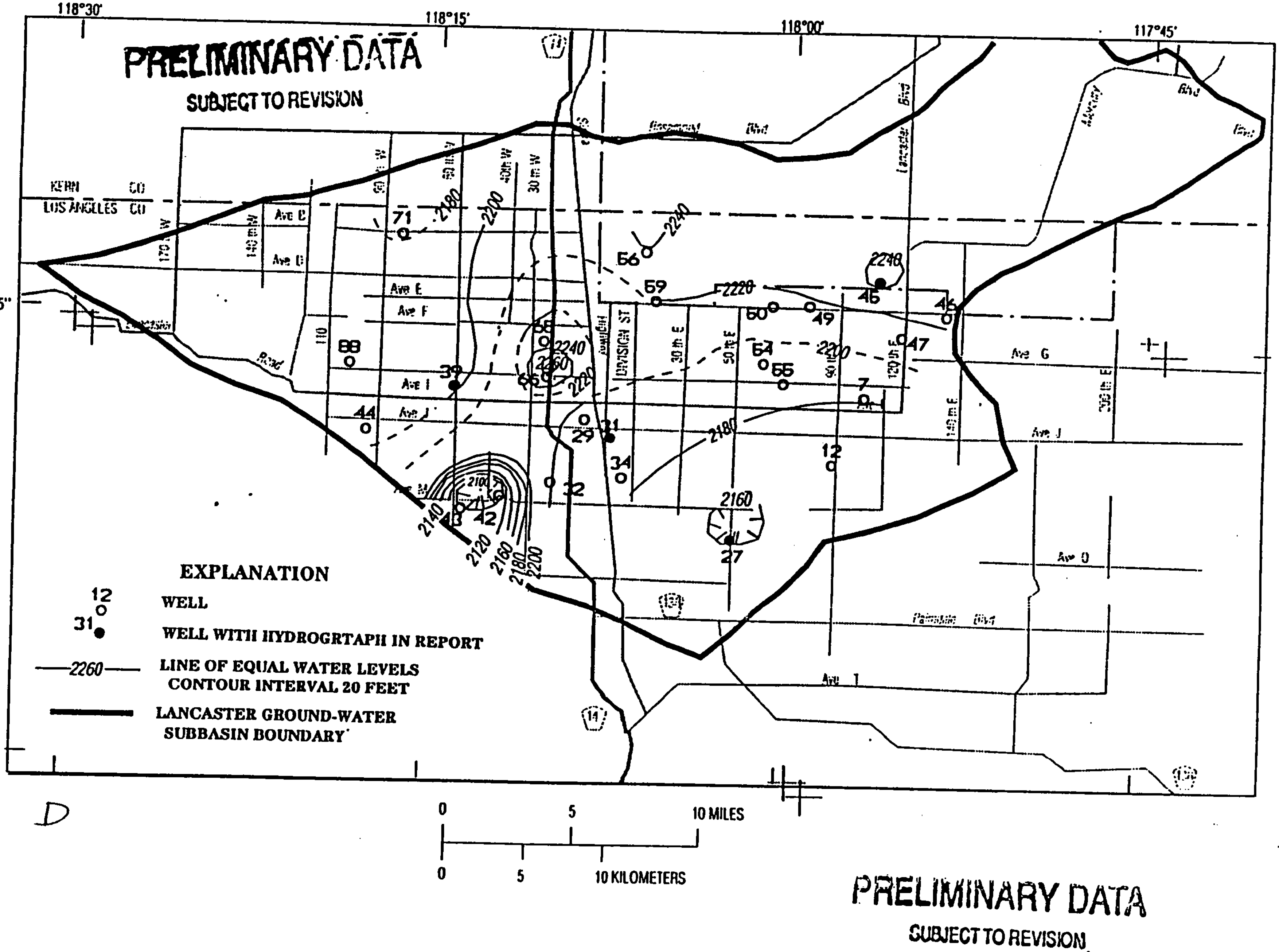


Figure 13. Continued.

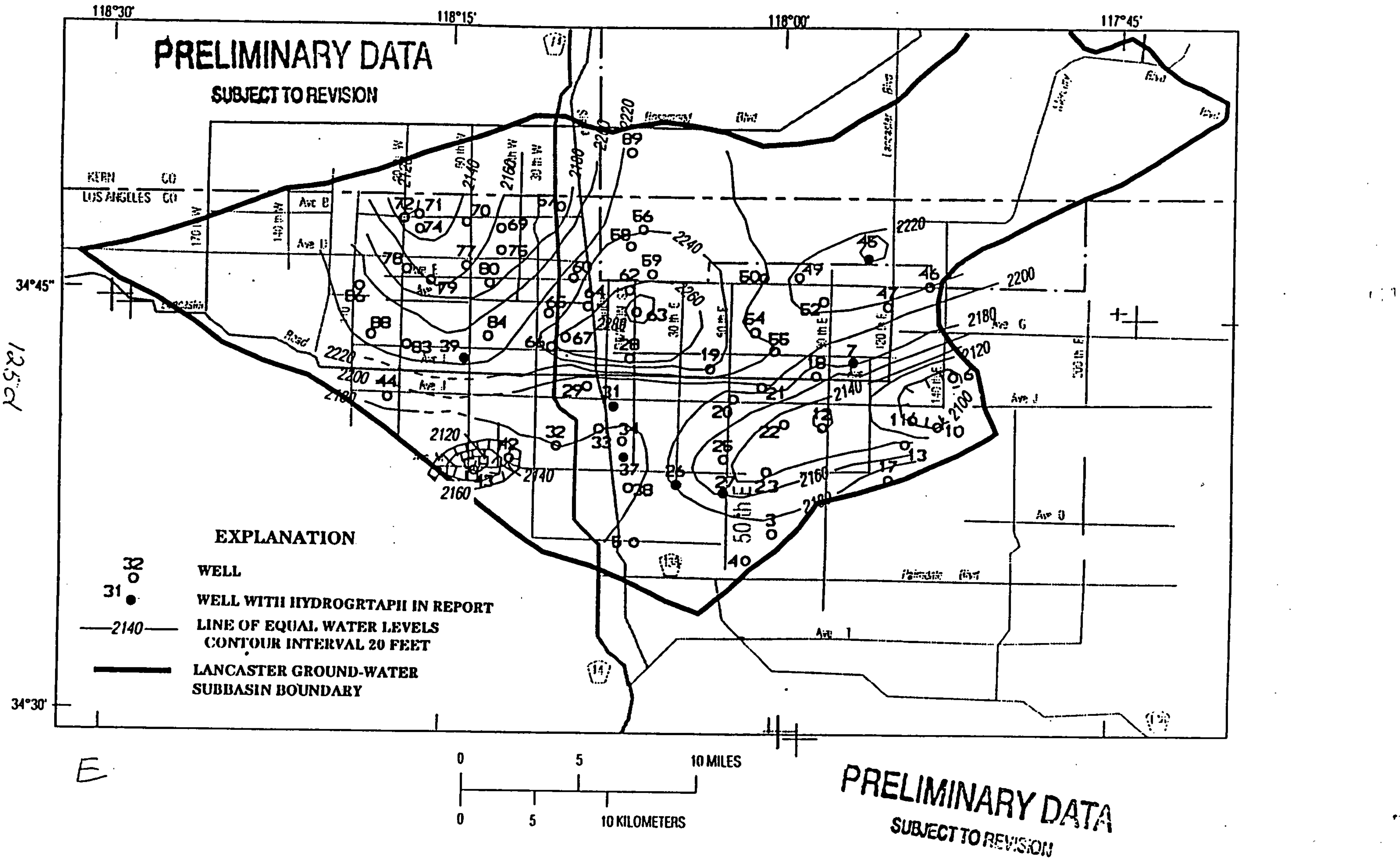
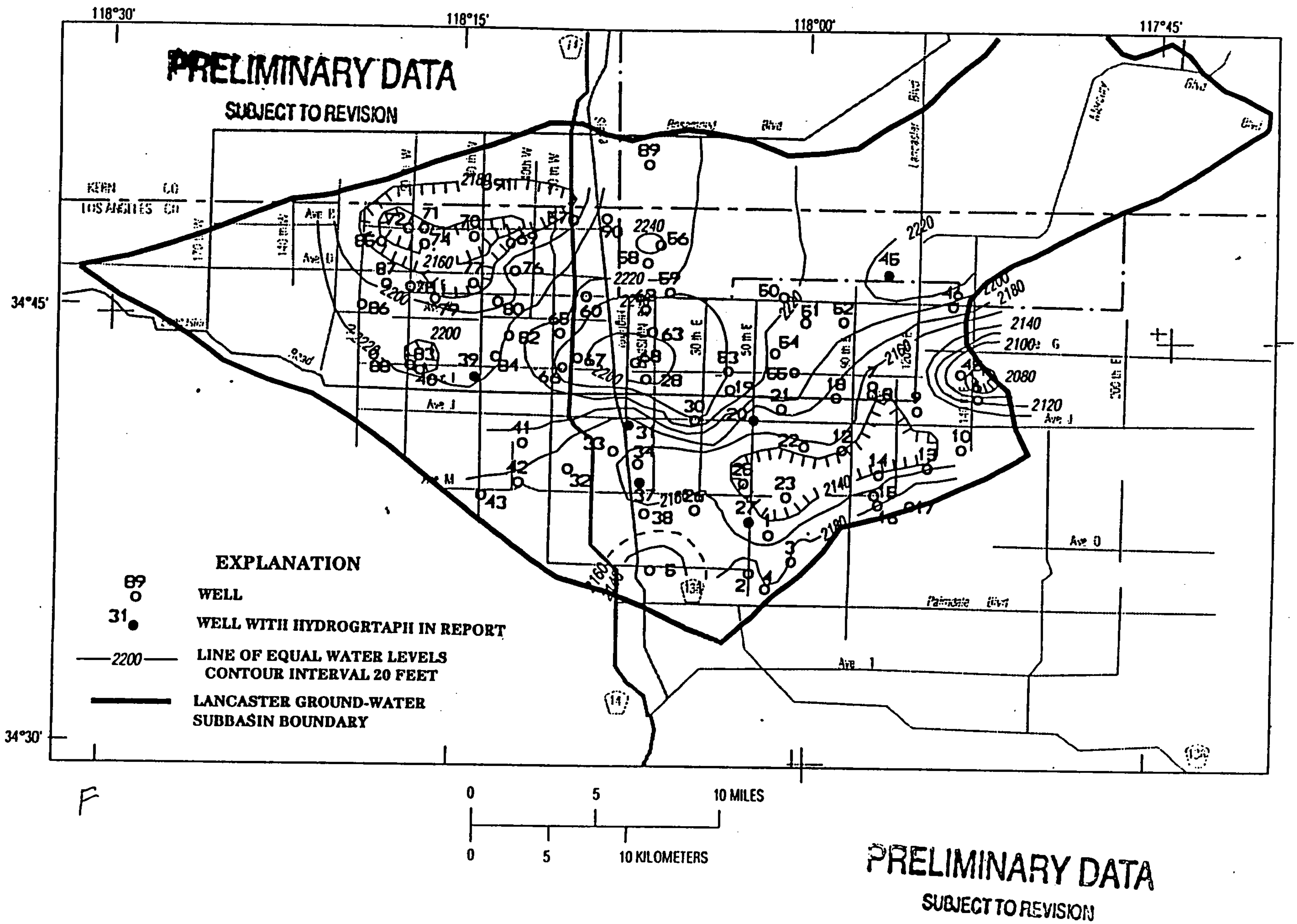


Figure 13. Continued.

125d



F

Figure 13. Continued.

125e

PRELIMINARY DATA
SUBJECT TO REVISION

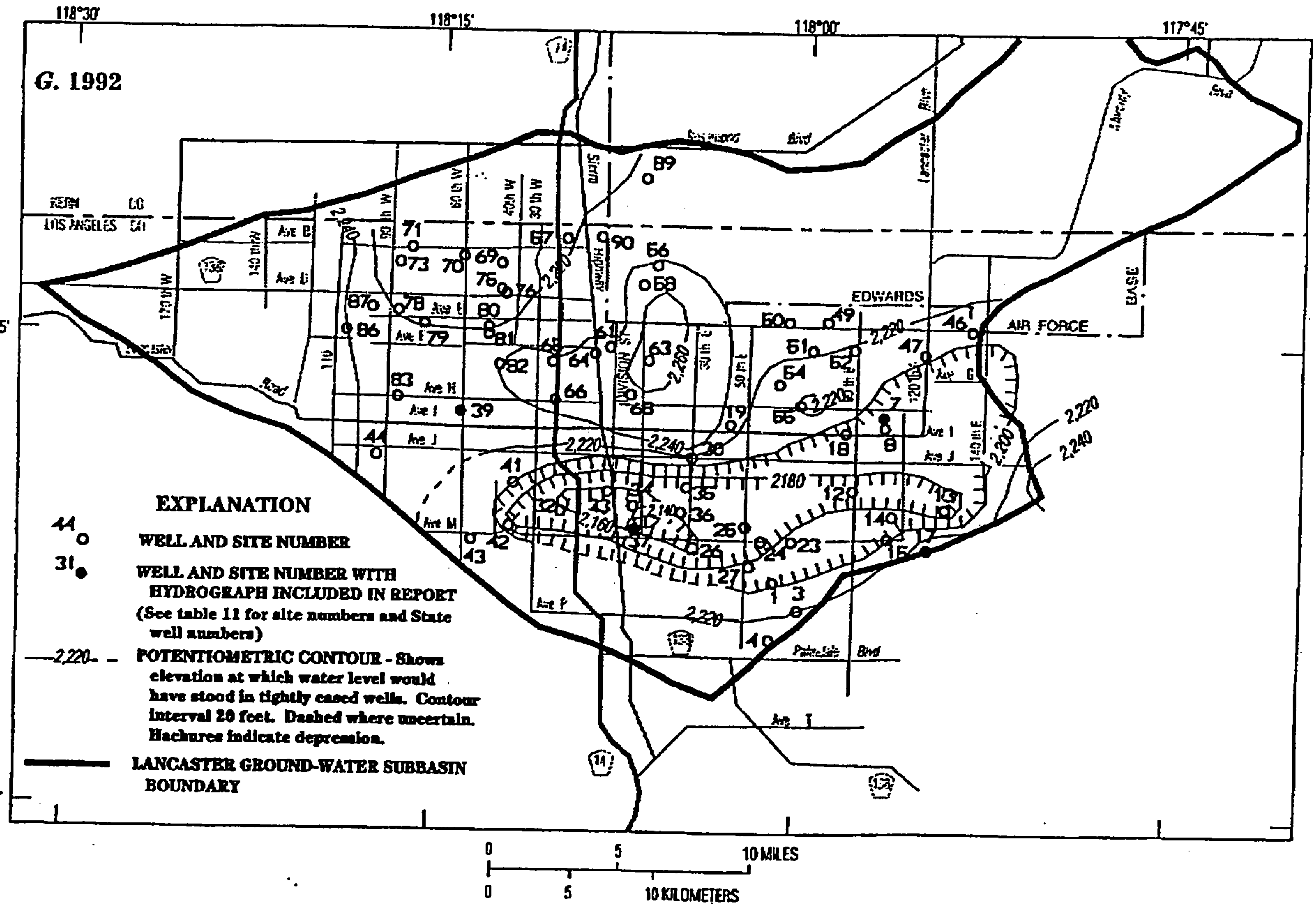
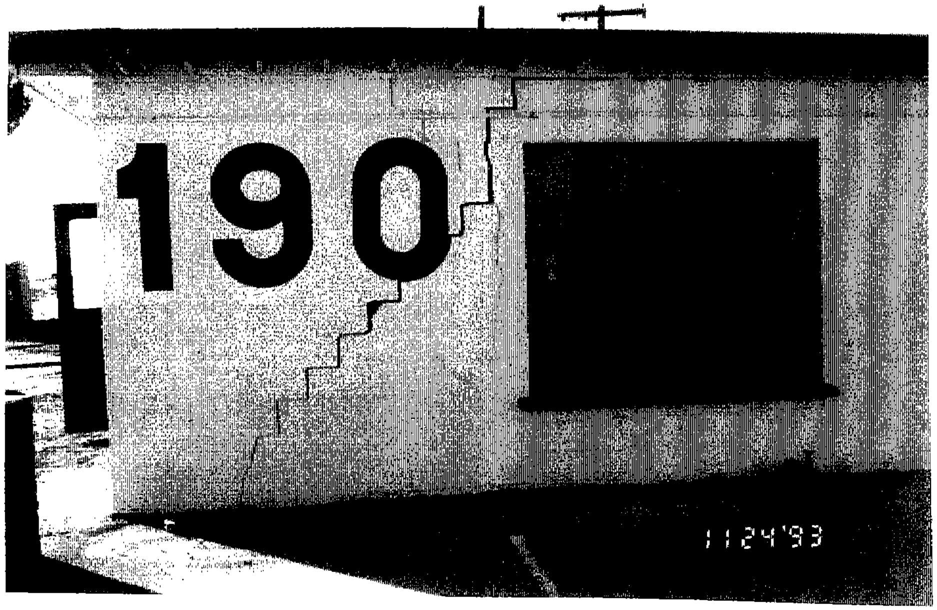


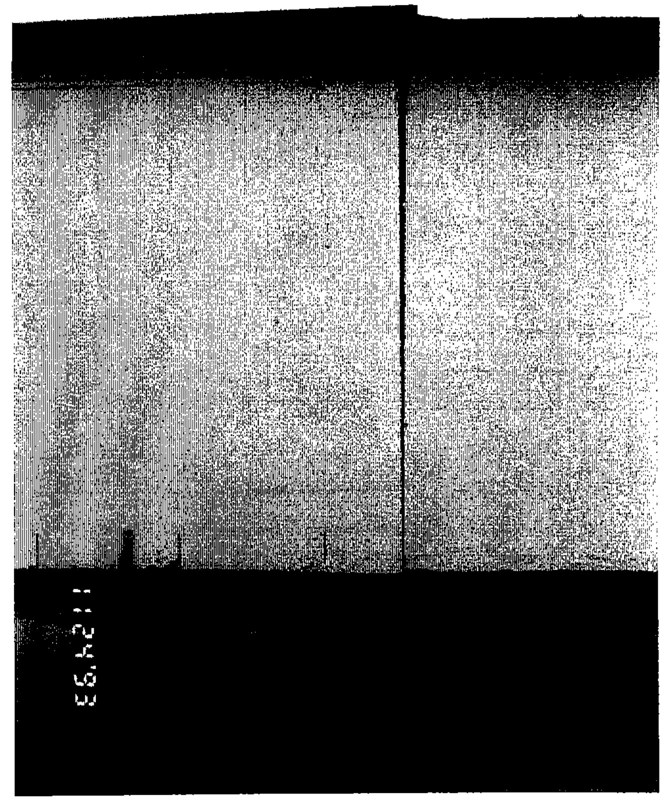
Figure 13. Continued.

APPENDIX F

Photographs of Subsidence Problems in the Antelope Valley



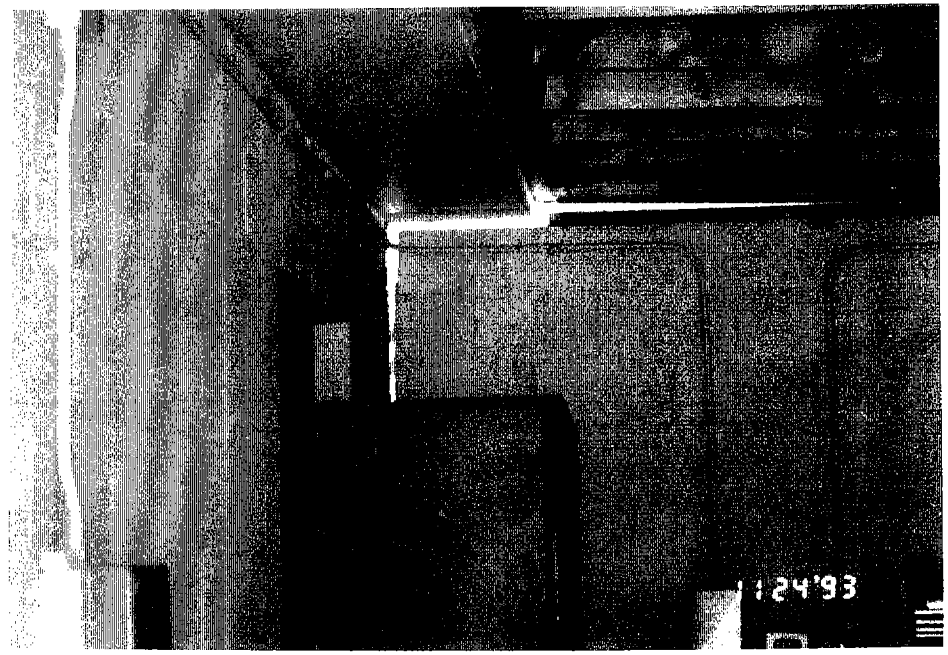
East Wall - Outside



North Wall - Outside

Edwards Air Force Base Abandoned Wastewater Treatment Plant Building

East Wall - Inside



North Wall - Inside

Edwards Air Force Base Abandoned Wastewater Treatment Plant Building

Protruding Well Casing Near Abandoned Broadcast Building

Fissure On Rogers Lakebed

Edwards Air Force Base


Looking Northwest

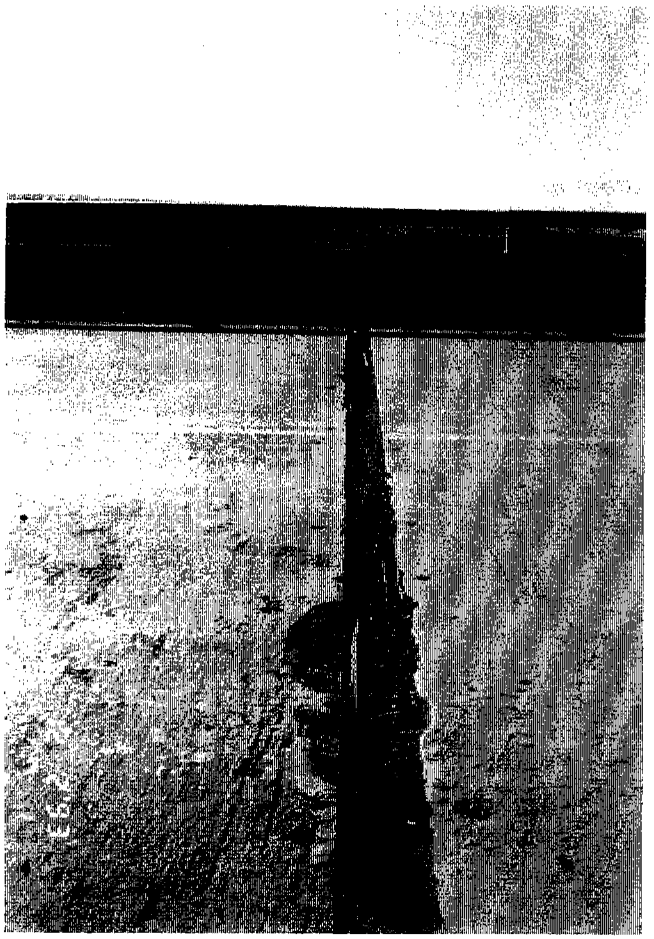

Looking Northwest

Fissures in Area Bounded by Avenues G and H, 30th Street West and Interstate-14

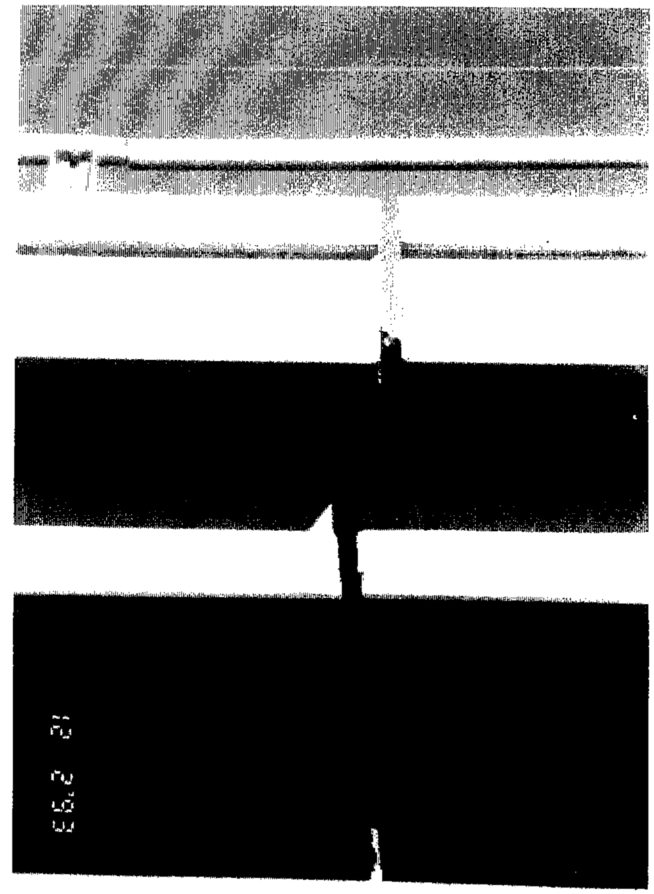
Looking East

Looking West

Fissures in Area Bounded by Avenues G and H, 30th Street West and Interstate-14



Road Surface of Bridge



Underside of Bridge

Central Expansion Joint of the Avenue H Bridge over Amargosa Creek

APPENDIX G

Synopsis of AB 3030

SYNOPSIS OF AB 3030
(SWC Sec. 10750 et seq.)
Procedures and Technical Components

AB 3030 (Water Code Sections 10750 - 10767)

I. Purpose of AB 3030

A. Local agency

B. Management area and agency power

1. May exercise many of the powers of a Water Replenishment District (SWC §60220 AND §60300)

C. Procedures

1. Publish notice of public hearing
2. Conduct a hearing on whether to adopt a ground water management plan
3. May adopt a resolution of intention to adopt a ground water management plan
4. Must publish notice
5. Must prepare a ground water management plan within 2 years
6. If not, return to step 1
7. Hold a 2d hearing after the plan is prepared
8. Consider protests
9. A majority protest consists of more than 50% of the assessed value of the land within the agency
10. If a majority protest exists, the plan shall not be adopted
11. No new plan for the same area may be considered for 1 year
12. If there is no majority protest, the ground water management plan may be adopted within 35 days after the 2d public hearing

D. Rules and regulations

E. Finances

F. Proposed fees

G. Coordination with other agencies

II. Water Code Section 10753.7 states that a ground water management plan may include components relating to all of the following:

A. The control of saline water intrusion

B. Identification and management of wellhead protection areas and recharge areas

C. Regulation of the migration of contaminated ground water

D. The administration of a well abandonment and well destruction program

E. Mitigation of conditions of overdraft

F. Replenishment of ground water extracted by water producers

G. Monitoring of ground water levels and storage

H. Facilitating conjunctive use operations

I. Identification of well construction policies

J. The construction and operation by the local agency of ground water contamination cleanup, recharge, storage, conservation, water recycling and extraction projects

K. The development of relationships with state and federal regulatory agencies

L. The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of ground water contamination

III. Additional powers granted under SWC Part 4 starting with §60220 and Part 6 starting with §60300 include levying assessments, conducting technical studies, protecting ground water supplies, taking action outside the district to protect ground water, water replenishment assessments, and water measuring devices

IV. Section 3 requires DWR to publish a bulletin no later than 1 January 1998 that reports on the ground water management plans that have been adopted by local agencies.

V. Benefits of ground water management

A. The basin is managed efficiently as a ground water reservoir.
B. Water supply is maximized.
C. Long term water supply is assured
D. Costs, benefits and water shortages are shared equitably

Carl Hauge, Department of Water Resources (916) 327-8861
Steve Bachman, Integrated Water Technologies, Inc. (805) 565-0996

DRAFT OUTLINE FOR REPORT ON AB 3030 PLANS

Section 3, Chapter 947, Statutes of 1993: The Department of Water Resources shall, on or before January 1, 1998, prepare and publish, in a bulletin of the department published pursuant to Section 130 of the Water Code, a report on the status of ground water management plans adopted and implemented pursuant to Part 2.75 (commencing with Section 10750) of Division 6 of the Water Code.

Draft Table of Contents

I. Name of local agency

II. County

III. Name, number and description of ground water basin
- A. Size.
- B. Major stream.
- C. Water bearing material (s).

IV. Does the agency include the entire ground water basin?
- A. If not, how many other agencies are partially or wholly within the same basin?
- B. Map showing agency boundaries and ground water basin boundaries.

V. Status of Ground Water Management Plan
- A. Adopted a resolution of intention to develop a ground water management plan. Date.
- B.. Entered into Memorandum of Understanding, Joint Powers Agreement, or other agreement with 1 or more local water service entities to develop a ground water management plan.
- C. Ground water plan adopted. Date.
- D. Ground water plan voted down. Date.
- E. Date when new resolution of intention to develop a ground water management plan can be adopted.

VI. Contents of plan:
- A. Control of saline water intrusion.
- B. Identification and management of wellhead protection areas and recharge areas.
- C. Regulation of the migration of contaminated ground water.
- D. Administration of a well abandonment and well destruction program.
- E. Mitigation of conditions of overdraft.
- F. Replenishment of ground water extracted by water producers.
- G. Monitoring of ground water levels and storage.
- H. Facilitating conjunctive use operations.
- I. Identification of well construction policies.

J. Construction and operation by the local agency of ground water contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.
K. Development of relationships with state and federal regulatory agencies.
L. Review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of ground water contamination.
M. Other.

VII. Rules and regulations adopted to implement and enforce the ground water management plan
A. Limitation on extraction and/or water purchasing requirements.
B. Other.

VIII. Fees and assessments propose
A. Date voted on.
B. Passed/failed.
C. Amount of fee.

IX. Purpose of the fee
A. Ground water extraction.
B. Replenishment water.
C. Administrative and operating costs.
D. Construction costs for capital facilities.

X. Time schedule for implementing the plan's objectives. Identify phases.

XI. Hydrogeologic characteristics of the basin.
A. Well yields in gpm: Maximum and average
B. Depth zone in feet
C. Storage capacity in acre feet
D. Usable storage capacity in acre feet
E. Extraction in acre feet per year
F. Perennial yield in acre feet per year
G. Overdraft in acre feet per year
H. Estimated pump lift in feet
I. Number of wells monitored: Water level and quality

XII. Degree of knowledge

XIII. Most recent study

XIV. Problems

XV. Management and status of basin

Carl Hauge, (916) 327-8861
DWR, June 3, 1994

California Department of Water Resources
2 February 1993

WATER RESOURCES CHECKLIST--

SUBJECTS TO CONSIDER IN WATERSHED AND BASIN STUDIES FOR

WATER MANAGEMENT PLANS

Includes surface water, ground water, and recycled water.

This checklist can be used when planning and undertaking studies of watersheds and ground water basins. The checklist includes all subjects that could be considered relevant in studies of water resources to ensure effective and efficient water management.

Some of the subjects on the check list may not be relevant in some areas of the state and therefore may not require the same degree of study as in other areas. All of the subjects are included on the checklist to allow water managers to decide whether to include all subjects in their study or to exclude some subjects because consideration of those subjects may not be necessary in that watershed and basin.

The checklist is organized into 5 phases for ease in contracting with government agencies or private vendors to complete the work, and to allow management decisions as portions of the work are completed. At the end of any one of the first 3 phases you may decide to change the scope of the following phase before beginning the work, or you may decide to go no further with the project.

Phase 1

I. Identify management goals

II. Water Management Plan (Local Water Purveyors' plans)
   A. Conservation practices
   B. Conjunctive use
   C. Plans for future phase 2 and phase 3 activities

III. Institutional Issues
   A. Water Rights
   B. Water Quality
   C. Water management jurisdiction
      1. Statutory authority
      2. Boundaries

IV. "Process" Issues
   A. Interagency Coordination
   B. Planning Process
   C. Staffing
   D. Funding

V. Data Availability
   A. Surface water
   B. Ground water
   C. Water quality
   D. Precipitation
   E. Geology
   F. Land use
   G. Land ownership
   H. Habitat designation

Phase 2

VI. Previous studies
   A. Surface water
   B. Ground water
   C. Water quality
   D. Protection of recharge areas
   E. Health
   F. Sewage treatment
   G. Waste water discharge
   H. Solid waste disposal
   I. Environmental projects
   J. Wetlands
   K. Habitat restoration
   L. Desalination

VII. Regional Water Budget (surface and ground water)
   A. Basin boundaries
   B. Precipitation
   C. Surface water runoff
   D. Ground water recharge
   E. Ground water outflow
   F. Evapotranspiration
   G. Inflow - outflow = change in storage

VIII. Hydrogeology
   A. Well inventory
      1. Drillers logs
         a. Construction information
         b. Lithology
      2. Canvass (field reconnaissance)
      3. Other sources
         a. Local agencies
         b. State, federal agencies
   B. Historical ground water data
      1. Ground water levels
      2. Ground water quality
      3. Change in ground water levels or quality
   C. Regional hydrogeology
      1. Recharge areas
         a. Recharge characteristics
            (1) Distribution
            (2) Quality
         b. Land use
         c. Hydraulic continuity between recharge and discharge areas
      2. Discharge areas
      4. Aquifer geometry
      5. Aquifer characteristics
         a. Transmissivity (T)
         b. Storativity (S)

IX. Water demands
   A. Present
      1. Population
      2. Land use
      3. Water demand

   B. Projected
      1. Assumptions
      2. Land use
      3. Population
      4. Water demand

X. Existing surface water delivery, drainage, and sewage systems
   A. Locations
   B. Capacities

XI. Water Quality
- A. Surface
- B. Ground water
  1. Protection of recharge areas
     - a. Land use zoning
     - b. Well Head Protection Areas (WHPAs)
- C. Sources of contamination
  1. Non-point sources
     - a. Fertilizer
     - b. Sewer leakage
     - c. Other
  2. Point sources
     - a. Industrial
     - b. Sewage Treatment Plants
     - c. Mining
     - d. Others

XII. Recycled water
- A. Sources
  1. Amount
  2. Wheeling capability
- B. Facilities
  1. Treatment plants
  2. Pipelines
  3. Storage
     - a. Surface
       - (1) Location
       - (2) Capacity
     - b. Ground water recharge
       - (1) Location
       - (2) Capacity
- C. Potential uses
  - 1. Ground water recharge
  - 2 Landscape irrigation
  - 3 Industrial
  - 1. Agricultural
  - 2. Recreation
  - 3. Firefighting
  - 4. Construction
  - 5. Dual plumbing systems
     - a. Toilets/urinals in high rises
     - b. Cooling plants/towers

XIII. Environmental Impacts
   A. Enhancement
      1. Stream flow augmentation
      2. Habitat restoration
      3. Aesthetics
      4. Other

   B. Damage
      1. Causes
      2. Extent
      3. Mitigation

XIV. Economics of water management and conjunctive use
   A. Benefits
      1. Water demands (see item VIII)
      2. Direct and indirect impacts
         a. Income
         b. Employment
      3. Environmental value
      4. Mitigation of damages
   B. Costs
      1. Project scale
      2. Regional/local comparisons
      3. Project timing
         a. Integration with local activities
         b. Local project assistance
      4. Environmental damage
         a. Foregone value
         b. Mitigation costs
   C. Net project benefits

XV. Other study issues
   A. GIS capability
   B. Staffing or expertise in the following fields
      1. Ground water
      2. Surface water
      3. Urban/agricultural water demand economics
      4. Environment/ecology
      5. Social impacts
      6. Water recycling
      7. Public participation and workshops
      8. CEQA/NEPA documentation

Phase 3

Selection and design of a surface water allocation model and a ground water model. This phase can begin while phase 2 is underway. While conceptual and/or computer models are being developed they are useful in helping to increase the understanding of surface water and ground water flow in the basin and in helping to evaluate data collection programs for effectiveness at assessing the resource.

Phase 4

Selection of the preferred water management alternative(s)

A. Surface water
B. Recycled water
   1. Test program to prove the suitability of the recycled water for recharge
C. Ground water
   1. Conjunctive use
   2. Recharge
      a. In-channel
      b. Off-stream spreading basins
      c. Injection wells
      d. In-lieu use of surface water
   3. Identification of recharge sites that are available for a reasonable price
   4. Test programs to certify that available recharge sites have adequate:
      a. Infiltration rates
      b. Hydraulic continuity with discharge areas

Phase 5

Implementation of a water management program that will increase the amount of water available through more efficient use of all water supplies, including surface water, ground water, and recycled water.

AB 3030
GROUND WATER MANAGEMENT MANUAL

ELEMENTS OF A GROUND WATER MANAGEMENT PLAN

Produced by:

Ground Water Committee
Association of California Water Agencies

MARCH 1994

AB 3030
THE GROUND WATER MANAGEMENT ACT

GROUND WATER MANAGEMENT PLAN ELEMENTS

AB 3030, the Ground Water Management Act, authored by California State Assemblyman Jim Costa (D-Fresno) and signed into law in 1992, lists 12 components that may be included in a ground water management plan. Each component would play some role in evaluating or operating a ground water basin so that ground water can be managed to maximize the total water supply while protecting ground water quality.

Department of Water Resources' Bulletin 118-80 (pg. 9) defines ground water basin management as including planned use of the ground water basin yield, storage space, transmission capability, and water in storage. Ground water basin management includes:

(1) protection of natural recharge and use of intentional recharge;

(2) planned variation in amount and location of pumping over time;

(3) use of ground water storage conjunctively with surface water from local and imported sources; and,

(4) protection and planned maintenance of ground water quality.

The 12 components listed in Section 10753.7 of the Ground Water Management Act (AB 3030) form a basic list of data collection and operation of facilities that may be undertaken by an agency operating under this act.

Data collection will provide information to evaluate the water resources in the basin within the boundaries of the district. The construction of facilities will allow operation of the basin to protect ground water quality and to maximize the water supply by means of recharge of surface water and extraction of ground water at appropriate times and locations.

Specific comments about each of the 12 items listed in Section 10753.7 are included in the discussion that follows. For specific information about any issue, contact the Association of California Water Agencies, the California State Water Resources Control Board, the U.S. Environmental Protection Agency, or the California Department of Water Resources. Names and telephone numbers of appropriate experts are listed at the end of each discussion.

GROUNDWATER MANAGEMENT PLAN ELEMENTS AS SET FORTH IN AB 3030

10753.7 A groundwater management plan may include components relating to all of the following:

a) The control of saline water intrusion.

b) Identification and management of wellhead protection areas and recharge areas.

c) Regulation of the migration of contaminated groundwater.

d) The administration of a well abandonment and well destruction program.

e) Mitigation of conditions of overdraft.

f) Replenishment of groundwater extracted by water producers.

g) Monitoring of groundwater levels and storage.

h) Facilitating conjunctive use operations.

i) Identification of well construction policies.

j) The construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects.

k) The development of relationships with state and federal regulatory agencies.

l) The review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination.

The Control of Saline Water Intrusion

Saline water can slowly degrade a ground water basin and ultimately render all or part of a basin unusable. Several sources can contribute to increased salinity in ground water. In addition to sea water intrusion, saline degradation of ground water can be caused by use and re-use of the water supply; lateral or upward migration of saline water; downward seepage of sewage and industrial wastes; downward seepage of mineralized surface water from streams, lakes, and lagoons; and interzonal or interaquifer migration of saline water (see illustration).

1. Increase in salt content dissolved from earth materials:
   Salts present in soil, sediment and rocks are dissolved by water that flows through those materials, increasing the salt content of that ground water.
   Control:
   This is a natural process and can not be prevented.

2. Lateral or upward migration of saline water:
   High quality ground water in an aquifer can be degraded if a ground water gradient is created that induces lower quality water to flow either laterally or vertically into the aquifer. This can occur through natural or manmade pathways. In some areas this may occur naturally when confining layers in the aquifer system are deposited in discontinuous lenses. The most common manmade pathway is a well. If wells are not built according to adequate standards, the ground water gradient may induce movement of lower quality water to flow into an aquifer with high quality water.
   Control:
   When the problem is naturally occurring, the method of control is to change the gradient so that the lower quality water does not flow into the aquifer containing high quality water. This can be accomplished by reduction of extraction from the aquifer, recharging the aquifer with good quality water, or by importing surface water to use in lieu of ground water. When the problem is caused by wells, enforcement of adequate well standards in well construction, renovation, and destruction can prevent such interzonal movement of lower quality ground water. Every ground water management plan should include provisions to ensure that wells in the basin do not become conduits for contamination of the aquifer.

3. Downward seepage of sewage, agricultural, or industrial waste:
   Sewage, agricultural and industrial waste that is disposed of indiscriminately will seep downward and eventually enter the aquifer and contaminate the ground water. By law such discharges must be permitted by the Regional Water Quality Control Boards under waste discharge permits. Discharges that occurred in the past, however, are revealing themselves today.
   Control:
   The first step in control is to be sure that such discharges are no longer taking place. Such steps include more rigorous enforcement of waste discharge permits on all industrial and agricultural operations, and a better understanding of the relationship between land use, discharge of pollutants, and ground water contamination.

4. Downward seepage of mineralized surface water:
Mineralized surface water from streams, lakes and lagoons can enter the aquifer and contaminate ground water.
Control:
If the mineralization is human-caused, better discharge control should be implemented. If the mineralization is natural, management options may include treatment, diversion, or replacement of the water.

5. Interzonal or interaquifer migration of saline water:
If wells are not built according to adequate standards, the ground water gradient may induce movement of lower quality water to flow into an aquifer with high quality water. In some areas this may occur because confining layers in the aquifer system were deposited in discontinuous lenses.
Control:
Enforcement of adequate well standards in well construction, renovation, and destruction can prevent interzonal movement of lower quality ground water through well borings. Every ground water management plan should include provisions to ensure that wells in the basin do not become conduits for contamination of the aquifer.

If discontinuous confining or perching layers in the aquifer provide openings through the clay layer that act as conduits for interzonal contamination, ground water managers should consider managing the basin to maintain interaquifer gradients that prevent or minimize such contamination."

6. Sea water intrusion (not shown in illustration):
Sea water intrudes inland into coastal aquifers when the head in the aquifer is reduced by ground water extraction inland (up-gradient) of the coast.
Control:
Three methods are available to control sea water intrusion. First, extraction of ground water up gradient can be reduced. In California, where the population is continuously increasing, this has proven to be unworkable. Second (and most common), a sea water intrusion barrier can be built that injects water into the aquifer. The barrier consists of fresh water at a higher head than the sea water so that the sea water can not flow inland into the aquifer. Some of the fresh water injected into the barrier flows seaward while some of the injected water flows inland and may be extracted by wells that are perforated in the aquifer. Third, a sea water intrusion barrier can be built that extracts water along the coast which lowers the ground water levels along the coast below sea level and below the level of nearby fresh ground water. The mix of fresh water and sea water is then pumped back to the ocean.

For more information on this topic, please contact:
State
Department of Water Resources, Carl Hauge 916/327-8861

Key to Illustration

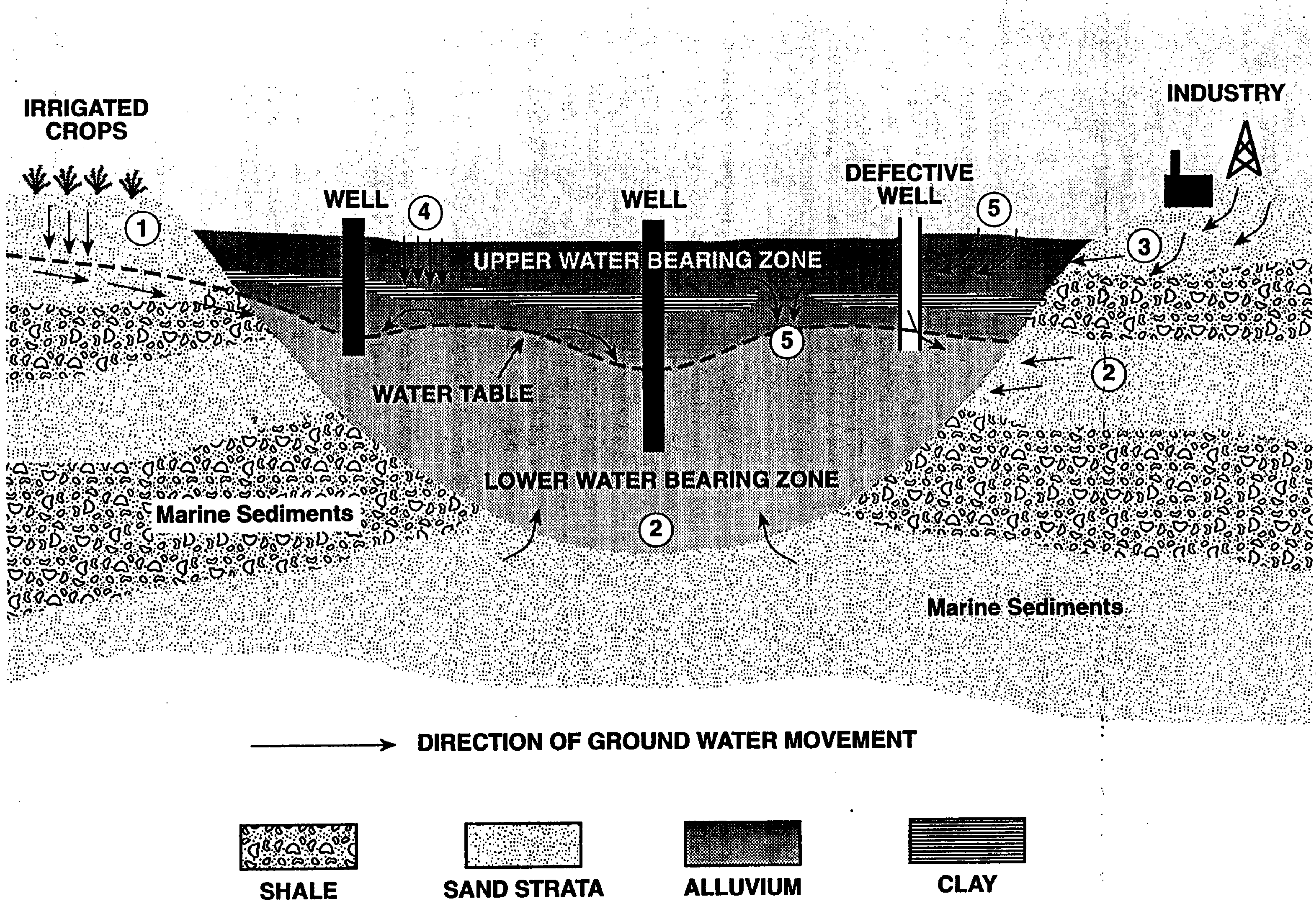
1. **Degradation of Ground Water Through Use and Re-use**
   Example: Irrigation water applied to crops is increased in salinity through evaporation. The seepage, unconsumed by vegetation, returns to the ground water and is further degraded en route by leaching salts from the soil.

2. **Degradation of Ground Water Through Lateral or Upward Migration of Saline Waters**
   Example: The sand strata illustrated were deposited in the ocean and were subsequently elevated to their present positions. Sea water contained within these sediments since their deposition migrates to the alluvium under influence of the hydraulic gradient created by pumping of the wells. Prior to exploitation of ground water such migration was generally negligible.

3. **Degradation of Ground Water Through Downward Seepage of Sewage and Industrial Wastes**
   Example: Sewage and industrial waste seeping from cesspools or permeable sumps ultimately migrates to the ground water supply.

4. **Degradation Through Downward Seepage of Mineralized Surface Waters From Streams, Lakes and Lagoons**
   Example: Mineralized surface water migrates to the ground water supply.

5. **Degradation Through Interzonal Migration of Saline Waters**
   Example: Degraded water with the upper water-bearing zone enters the lower productive water-bearing zone through an opening in the clay layer that separates the two zones or through defective, improperly constructed or abandoned wells.



Schematic Section Across an Alluvium-Filled Ground Water Basin Underlain and Flanked by Less Permeable Sediments of Marine Origin

Identification and Management of Wellhead Protection Areas and Recharge Areas

The federal Wellhead Protection Program was established by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the program is to protect ground water sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. The program is based on the concept that the development and application of land-use controls (usually applied at the local level in California) and other preventative measures can protect ground water.

A Wellhead Protection Area (WHPA), as defined by the 1986 Amendments is, "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield". The WHPA may also be the recharge area that provides the water to a well or wellfield. Unlike surface watersheds that can be easily determined from topography, WHPAs can vary in size and shape depending on geology, pumping rates, and well construction. There are several different methods which can be used to delineate the lateral boundaries of a WHPA. These include simple fixed radius techniques, analytical equations, numerical modeling, and geologic mapping.

Under the Act, states are required to develop an EPA-approved Wellhead Protection Program. To date, California has no formal state-mandated program, but instead relies on local agencies to plan and implement programs. For this reason, AB 3030 was enacted. A number of local governments, including Santa Clara Valley Water District, Descanso Community Water District, West San Bernardino County Water District, and Monterey County Water Management District, are in various stages of developing local ground water management programs that include WHPAs. Wellhead Protection Programs are not regulatory by nature, nor do they address specific sources. They are designed to focus on the management of the resource rather than control a limited set of activities or contamination sources.

A complete Wellhead Protection Program should consist of seven elements:

1. Form a committee of participants and determine the roles of various state agencies, local governments, and public water suppliers. The committees should prepare a summary and purpose describing how the WHP goal will be achieved;

2. Delineation of Wellhead Protection Areas (WHPAs) based on reasonably available hydrogeologic information on ground water flow, recharge and discharge, and other information deemed necessary to adequately determine the wellhead protection area;

3. Identification of potential sources of contaminants within each WHPA. Current, past, and future land uses should be considered when developing the contamination source inventory;

4. Development of management approaches to protect the ground water from contaminants, including technical assistance, financial assistance, implementation of control measures, education, training, and demonstration projects;

5. Development of a contingency plan to provide alternate drinking water supplies in case a well or wellfield becomes contaminated;

6. Development of a plan to prevent new well drilling from contaminating or spreading the contamination of ground water; and,

7. Development of a public participation program so that local citizens can be involved throughout the planning process.

For more information on this topic, please contact:

State

Department of Water Resources
For California ground water information, call:
Carl Hauge at 916/327-8861

Federal

U.S. Environmental Protection Agency
For specific WHP information, call:
Sunny Kuegle at 415/744-1830 or
Susan Whichard at 415/744-1924

To obtain a listing of WHP documents, call 800/ 426-4791.

For California ground water information, call:
Tony Lewis at 415/744-1913 or
Susan Whichard at 415/744-1924

U.S. Geological Survey, Water Resources Division, Sacramento
For California ground water information.

Regulating Contaminant Migration In Ground Water

Ground water contamination originates from a number of sources or activities, such as leaking tanks discharging petroleum products or solvents, or the application of pesticides and fertilizers. Effective control and clean-up of contaminated ground water requires a coordinated effort between all regulatory agencies involved, source control, understanding of the hydrogeology, and delineation of the contamination.

Agencies with a role to play in mitigating ground water contamination generally include the Regional Water Quality Control Board (Regional Water Board), Department of Toxic Substances Control, U.S. Environmental Protection Agency, and now the ground water management agency (GMA). Each agency has a unique set of regulatory authorities and expertise to contribute. The degree to which they participate depends on the nature and magnitude of the problem. What ever role the GMA decides to play, it should insure its actions are in concert with those of the other involved agencies.

Typically, source control is the identification of current and past users of hazardous materials, and verification of the proper storage and disposal of these materials. In many cases the Regional Water Board conducts this activity. If, during the verification process, evidence of any uncontrolled discharge or spill of these materials is found, then the Regional Water Board can order investigation of the extent of contamination and its subsequent cleanup. Usually, these activities are conducted on a site basis and generally do not consider regional identification and control of contamination. The GMA should remain in close contact with the Regional Water Board during the source investigations and site cleanups.

In the event that the source(s) of contamination is not found, the GMA can have a role in finding, containing, and removing the contamination, usually on a regional scale. Controlling the migration of contamination requires an understanding of the hydrogeology of the basin and delineating the lateral and vertical extent of the contaminant plume(s). Technical information for many basins is available from a number of sources such as the United States Geological Survey and Department of Water Resources. The most common tool for delineating the boundaries of a plume is the monitoring well. Monitoring wells can tap one aquifer or many, depending on the design and need. Very often, monitoring wells used for contaminant control are made part of a larger data collection effort for the GMA (for example, a series of wells to monitor water levels throughout the basin).

Once the location of contamination is verified, the GMA can choose to monitor its migration, contain it from moving further into clean aquifers, or remove it from the aquifer. Containment is often an interim step to protect downgradient aquifers and drinking water supplies and/or to provide time to complete investigations and construct a more comprehensive long-term treatment system.

Complete removal of some contaminants, such as solvents and nitrates, is often difficult, if not impossible. The level of effort undertaken by the GMA to deal with the contamination depends on several factors, including available funds, risk to drinking water supplies and public health, the extent and concentration of contamination, the ability to use the ground water that is removed and treated, and state and federally mandated clean-up levels.

For more information on this topic, please contact:

Local
San Gabriel Basin Water Quality Authority
Jim Goodrich 818/859-7777

State
Regional Water Quality Control Board for your area.
Department of Toxic Substances Control District Office for your area.

Federal
U.S. Environmental Protection Agency, Region 9

The Administration Of A Well Abandonment And Well Destruction Program

All wells should be properly destroyed or decommissioned if they are not to be used in the future. Wells that are abandoned or improperly destroyed can pollute ground water to the point where it is unusable or requires expensive treatment. There are three general means by which this occurs: 1) pollutants enter the well from the surface, 2) the well establishes vertical communication and allows poor quality ground water and pollutants to move from one aquifer to another, and (3) the well is used for illegal waste disposal . Ground water contamination is not the only threat to public health due to abandoned wells. These wells also pose a serious physical hazard to humans and animals. A survey of wells in Fresno County found about 10% of abandoned wells were not properly destroyed.

Property owners or lessees who do not properly destroy an abandoned well on their land may be guilty of a misdemeanor (under Section 24400 of the Health and Safety Code). Wells do not have to be destroyed if future use is anticipated, but they must be properly capped and maintained, as specified in the Code. Criminal penalties do not apply unless the well presents a public health hazard or a probable preferential pathway for the movement of pollutants, contaminants, or poor quality water.. In any case, the owner can be assessed clean-up costs if the well causes a ground water contamination problem.

Sections 13700 through 13806 of the California Water Code require proper destruction of wells. Minimum standards for the destruction of wells are specified in Department of Water Resources Bulletins 74-81 and 74-90. These standards apply to all water wells, cathodic protection wells, and monitoring wells. The only significant exception is oil, gas, and geothermal wells, which are regulated by the Department of Conservation. If a local agency does not have its own well standards ordinance, it must enforce the State's Model Well Ordinance (State Water Resources Control Board Resolution No. 89-98). Local agency requirements may exceed State standards.

For more information on this topic, please contact:

<u>State</u>

State Water Resources Control Board
Ken Harris 916/657-0876

For copies of DWR Bulletins call 916/653-1097.

Mitigation Of Groundwater Overdraft

Uncontrolled overdraft, long-term depletion of storage or groundwater mining in a ground water basin can cause several problems, including subsidence, degradation of ground water quality, and increased cost in pumping. In addition, if the storage in a ground water basin is depleted and not replaced naturally or by an artificial recharge program, this source of supply cannot be counted upon when surface water sources are limited, as in a prolonged drought. A Ground Water Management Plan under AB 3030 would provide a tool to assist in developing methods to control and manage ground water overdraft.

Mitigation of ground water overdraft can occur through the cessation or regulation of extractions and/or the increase of recharge to offset over extraction. This could take the form of restrictions through strict regulations of amounts extracted. Another form would be the use of financial incentives to control the amounts extracted, i.e. significant surcharges on quantities extracted in excess of a prescribed limit.

Controlling ground water overdraft may be accomplished through active replenishment of the basin. Surface water may be acquired by the ground water management agency and used to recharge the basin supplies. Some enhancement of natural replenishment may be appropriate, or a more intensive system of spreading grounds, off-stream recharge basins, and/or injection wells could be employed to introduce the recharge water into the basin.

Managing ground water overdraft may also be accomplished through conjunctive use. The establishment of a conjunctive use program would use surface water to recharge the basin in times of surplus, and rely more on ground water pumping in times of shortage of surface water. The use of surface water "in-lieu" of ground water, and the ability to extract ground water to replace limited or depleted surface water supplies, necessitates redundant systems and a certain investment in infrastructure to maximize the efficiency of this type of program.

For more information on this topic, please contact:

Local
Orange County Water District
William R. Mills Jr. 714/378-3200

State
Department of Water Resources
Carl Hauge 916/327-8861

Replenishment Of Ground Water Extracted By Producers

The replenishment of ground water extracted by producers is an important management technique of a ground water agency because it can increase the yield of the basin.

Replenishment of ground water can be achieved through recharge of either natural water supplies or water acquired from outside the basin by the ground water management agency. Maximizing the use of naturally occurring supplies can be accomplished through effective management of those resources. A ground water management agency may develop facilities to retain rainfall and runoff, and to capture surplus flows in natural streams or rivers, in order to have supplies to replenish the ground water basin.

An assessment of local geology is necessary to determine the areas or sites where surface water may be most efficiently percolated into the ground water basin. A careful examination should be performed of surplus quarry sites or abandoned excavations, which may have the requisite geologic characteristics and provide for a minimal cost opportunity for establishing recharge facilities.

A ground water management agency may also acquire water supplies, through purchase or diversion, to replenish a ground water basin. This method may require the securing of water rights to a supply. If the ground water management agency is unable to use naturally occurring stream beds for the delivery of surface water, the construction of facilities, such as canals or pipelines, may be necessary to deliver the water to other facilities used to replenish the basin.

Replenishment of a ground water basin may be in the following ways: 1) through natural percolation of surface water through the soil to the basin, 2) the delivery of surface water to spreading grounds or basins which are maintained to allow maximum percolation into the ground water; or 3) through injection of surface water into the ground water basin through injection wells.

The ground water management agency may have the need for funds to purchase surface water, construct facilities to deliver surface water, or purchase, construct or maintain replenishment facilities. A Replenishment Assessment (RA) is often levied by ground water management agencies to fund the purchase of replenishment water and to finance facilities for replenishment. A tiered assessment may be considered in which a lower RA rate is used for water pumped below the safe yield and a higher RA rate used to offset the additional burdens on the resource caused by overdraft.

For more information on this topic, please contact:

Local
Orange County Water District
William R. Mills Jr. 714/378-3200

State
Department of Water Resources
Carl Hauge 916/327-8861

Monitoring Of Ground Water Levels And Storage

The purpose of a ground water level monitoring program is to provide information that will allow computation of the change of ground water in storage. The information needed includes spring and fall ground water levels, the hydraulic properties of the aquifer(s) (such as permeability and specific yield), and the land area covered by the basin.

An adequate monitoring well network includes wells that are representative of the vertical and lateral dimensions of the aquifer(s). Establishing the network of monitoring wells requires that each well be designed to tap individual aquifers in the basin.

Data collected from each monitoring well should be entered into a computer data base. These data can then be used to create hydrographs, ground water elevation contour maps, and ground water change contour maps that will provide the tools to evaluate ground water levels and determine changes in ground water in storage.

While AB 3030 does not mention monitoring of ground water quality, monitoring for water quality should be included in any ground water management plan. Water quality and water quantity can not be separated. Changes in ground water quality can only be detected by comparison with earlier ground water quality data.

For more information on this topic, please call:

State
Department of Water Resources
Carl Hauge 916/327-8861

Identification Of Well Construction Policies

Improperly constructed wells can result in poor yields, but more importantly may result in contaminated ground water by establishing a pathway for pollutants entering a well for drainage from the surface, allow communication between aquifers of varying quality, or the unauthorized disposal of waste into the well.

Well construction policies should be identified which ensure that well drillers comply with local ordinances and State law. A county permit is required for drilling, deepening, modifying, or repairing a well. Whoever performs the work must have an active C-57 Contractor's license. In most cases, an inspection is required prior to sealing the well.

Sections 13700 through 13806 of the California Water Code requires proper construction of wells. Minimum standards for the construction of wells are specified in Department of Water Resources Bulletins 74-81 and 74-90. These standards apply to all water wells, cathodic protection wells, and monitoring wells. The only significant exception is oil, gas, and geothermal wells, which are regulated by the Department of Conservation. If a local agency does not have its own well standards ordinance, it must enforce the State's Model Well Ordinance (State Water Resources Control Board Resolution No. 89-98). Local agency requirements may exceed State standards.

For more information on this topic, please contact:
State
State Water Resources Control Board
Ken Harris 916/657-0876

For copies of DWR Bulletins call 916/653-1097

Construction and Operation of Ground Water Management Facilities

Effectively managing a ground water basin requires the planning and construction of projects that protect the quality of ground water and assures that the quantity of ground water in storage is managed to meet long-term demands. Where conjunctive use is practiced, water distribution facilities must be planned to deliver both ground water and surface water, depending on the hydrologic conditions in the region or state. Following are examples of facilities which aid in efficient management of ground water resources.

Ground Water Contamination Cleanup Projects
Contamination of ground water not only results in unusable water supply, but also poses a hazard for ground water supplies within the same basin caused by the migration of the contamination. In some cases, it may cause a decrease in operational storage and yield of the basin. Projects within the basin to cleanup contaminated ground water protect the entire basin from further contamination, and are also capable of producing water.

Ground Water Recharge Facilities
An agency may find it necessary to acquire, establish or construct ground water recharge facilities to quickly replace ground water extracted by producers. These facilities, which can increase the operational yield of the basin, may include: stream beds or spreading grounds, percolation basins, injection wells, and surface water delivery systems.

Water Recycling Projects
Demand management can be achieved by the replacement of irrigation supplies with non-potable, recycled water. Water recycling projects can relieve demands on the ground water basin by lowering the demand for ground water supplies for irrigation of landscaping, some agriculture and some industrial uses. Although water recycling projects are capital and O&M intensive, they do provide a reliable source of water.

Ground Water Extraction Projects
Conjunctive use programs deliver surface water in-lieu of ground water during surpluses, in exchange for increased extraction of ground water during dry periods. The trade off may result in users being asked to expand the capacity of their ground water extraction facilities. Ground water extraction projects may also be required by the shifting of extractions from one part of the basin to another as a result of contamination, hydrologic conditions, or recharge efforts. An agency may also construct extraction projects in order to entice the users to switch the source of their ground water.

For more information on this topic, please contact:

Local
Orange County Water District
William R. Mills Jr. 714/378-3200

State
Department of Water Resources
Carl Hauge 916/327-8861

The Development of Relationships With State and Federal Regulatory Agencies

The formation of a ground water management district involves the development of relationships and communication strategies with a variety of state and federal regulatory agencies. Working effectively with each of these agencies requires a local ground water management district to understand the rōle of these players in regulating and managing ground water resources.

Ground water planning, as defined in AB 3030, is a state led activity. The State Water Resources Control Board (State Water Board), as the lead state water agency responsible for maintaining water quality standards, provides the framework and direction for California's ground water protection efforts. Through its Regional Water Quality Control Boards, the State Water Board initiates state-wide planning and protection programs. Local communities should consider work with the State Water Board and Regional Boards in actually designing and implementing their ground water protection programs.

National policy direction and consistency in ground water protection efforts is provided by the Environmental Protection Agency (EPA). EPA provides both national guidance in state-led comprehensive ground water protection plans and a portion of the resources needed to carry out those planning efforts. While states are provided the flexibility to design programs that make sense on a regional and local basis, EPA guidelines ensure that all ground water protection plans and programs are preventive in nature, comprehensive in scope and consistent in maintaining a high level of protection across the nation.

For more information on these agencies and their roles and responsibilities, please contact:

<u>State</u>
State Water Resources Control Board
Ken Harris 916/657-0876

<u>Federal</u>
U.S. Environmental Protection Agency
Tony Lewis 415/744-1913

The Review Of Land Use Plans And Coordination With Land Use Planning Agencies To Assess Activities Which Create A Reasonable Risk Of Ground Water Contamination

An important component of developing a ground water management plan is the review of land use plans for the surrounding area or basin, and coordinating efforts with regional, sub-regional, and local land use planning agencies. In California, the majority of land use decisions are made by city and county government agencies. Undoubtedly, land activities and how they are managed can affect both ground water quality and quantity. The threat that a certain land use may pose to a ground water resource is a function of the ground water aquifer properties, management practices associated with the individual land use, and actual use of surrounding land (cumulative impact of all activities). As an example, hydrologic conditions may dictate that in certain areas, the aquifer is more vulnerable to pollution. This may be due to the permeability of the underlying soils and/or a shallower depth to the water table. To assure protection of ground water quality in the basin, this type of information may be taken into consideration when making land use decisions regarding zoning.

Examples of common land uses with a potential to adversely impact ground water supplies include large scale unsewered residential development, and industrial development without proper control measures or management practices. Cumulative impacts to a basin and relative land development density should also be evaluated. The use of shallow drainage wells to dispose of surface run off from streets, highways, parking lots, and agricultural areas, if determined to be of concern for the area, can also be addressed in the management plan. In this instance, the risk of a major roadway accident or spill, or the potential for the well being used as an illegal disposal site for hazardous substances, could be factored into the planning process.

A key aspect of ground water management is maintaining quantity or supply. Land use planning decisions that lead to covering up large portions of land with impervious surfaces can increase storm water runoff. This can lead to excessive down cutting and erosion in stream channels and flooding in the lower part of the watershed. The amount of natural recharge to the ground water basin can be significantly reduced. Land use decisions such as maintaining green space in areas of high recharge and encouraging the use of pervious materials will have a net benefit to the ground water basin.

The process of developing a ground water management plan can allow for information exchange between several parties, including agricultural and industrial water users, citizens, and resource, regulatory and planning agencies. The ground water management plan ultimately assists local planners, and local planners assist in the process of developing a comprehensive plan which can be realistically implemented resulting in effective protection and management of the ground water resource.

For more information on this topic, please contact:

State

San Francisco Bay Regional Water Quality Control Board, Dyan Whyte 510/286-1324

STEPS TO APPLY AB 3030

1) Local Agency holds noticed public hearing on Resolution of Intention to draft a Groundwater Management Plan.

2) After hearing, local Agency drafts Resolution of Intention to adopt a Groundwater Management Plan.

3) Publish Resolution of Intention.

4) Prepare a draft Groundwater Management Plan (within two years).

5) After draft Groundwater Management Plan is completed, Local Agency holds second noticed public hearing.

6) Land owners affected by Plan may file protests to the Plan.

7) If majority protest occurs (**representing more than 50% of assessed valuation of the land only, excluding structures**), the Ground Water Management Plan shall <u>not</u> be adopted.

8) Otherwise, Plan may be adopted.

9) A Local Agency may fix and collect fees and assessments for groundwater management costs associated with the implementation of the Groundwater Management Plan, **if such authority is approved by a majority of votes cast in a popular election.**

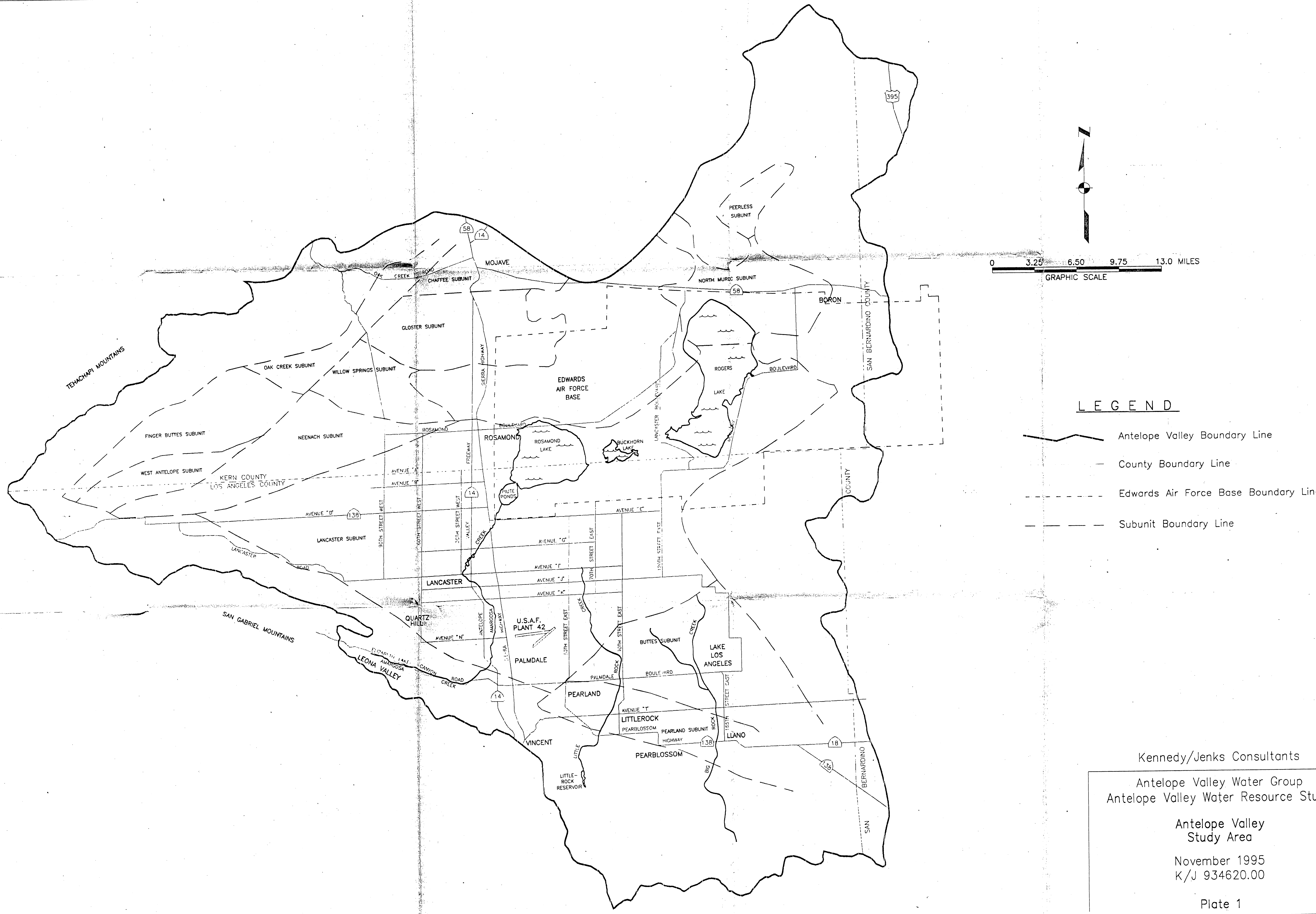
ACKNOWLEDGEMENTS

The following persons contributed to this report:

William R. Mills Jr.	Orange County Water District
James Goodrich	San Gabriel Basin Water Quality Authority
Dyan Whyte	San Francisco Bay Regional Water Quality Control Board
Carl Hauge	Department of Water Resources, State of California
Ken Harris	State Water Resources Control Board, State of California
Doris Betuel	U.S. Environmental Protection Agency, Region 9
Tony Lewis	U.S. Environmental Protection Agency, Region 9
Susan Whichard	U.S. Environmental Protection Agency, Region 9
Mark Leyes	Orange County Water District
Dana Wisehart	Association of California Water Agencies

Printed at Association of California Water Agencies

March 1994



Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Antelope Valley
Study Area

November 1995
K/J 934620.00

Plate 1

Kennedy/Jenks Consultants

Antelope Valley Water Group
Antelope Valley Water Resource Study

Reclaimed Water System

November 1995
K/J 934620.00

Plate 2