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State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Southern District

PLANNED UTILIZATION OF WATER RESOURCES IN ANTELOPE VALLEY

District Report

October 1980

WATER CONSERVATION
DIVISION
DEC 15 1980



Errata for

"Planned Utilization of Water Resources
in Antelope Valley"

On page 4, column 1, paragraph 4, last line, the figures within the parentheses should be (30°F to 40°F) rather than (63°F to 72°F).

On page 56, Table 19, last column, the final number should be 5,161,480 acre-feet rather than 1,161,480 acre-feet.

State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Southern District

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**PLANNED UTILIZATION OF
WATER RESOURCES IN ANTELOPE VALLEY**

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District Report

October 1980

CONVERSION FACTORS

Metric to Customary System of Measurement

<u>Quantity</u>	<u>Metric Unit</u>	<u>Multiply by</u>	<u>To get customary equivalent</u>
Length	millimetres (mm)	0.03937	inches (in)
	centimetres (cm) for snow depth	0.3937	inches (in)
	metres (m)	3.2808	feet (ft)
	kilometres (km)	0.62139	miles (mi)
Area	square millimetres (mm ²)	0.00155	square inches (in ²)
	square metres (m ²)	10.764	square feet (ft ²)
	hectares (ha)	2.4710	acres (ac)
	square kilometres (km ²)	0.3861	square miles (mi ²)
Volume	litres (l)	0.26417	gallons (gal)
	megalitres	0.26417	million gallons (10 ⁶ gal)
	cubic metres (m ³)	35.315	cubic feet (ft ³)
	cubic metres (m ³)	1.308	cubic yards (yd ³)
	cubic metres (m ³)	0.0008107	acre-feet (ac-ft)
	cubic dekametres (dam ³)	0.8107	acre-feet (ac-ft)
	cubic hectometres (hm ³)	0.8107	thousands of acre-feet
	cubic kilometres (km ³)	0.8107	millions of acre-feet
Flow	cubic metres per second (m ³ /s)	35.315	cubic feet per second (ft ³ /s)
	litres per minute (l/min)	0.26417	gallons per minute (gal/min)
	litres per day (l/day)	0.26417	gallons per day (gal/day)
	megalitres per day (MI/day)	0.26417	million gallons per day (mgd)
	cubic metres per day (m ³ /day)	0.0008107	acre-feet per day
Mass	kilograms (kg)	2.2046	pounds (lb)
	tonne (t)	1.1023	tons (short, 2,000 lb)
Velocity	metres per second (m/s)	3.2808	feet per second (ft/s)
Power	kilowatts (kW)	1.3405	horsepower (hp)
Pressure	kilopascals (kPa)	0.145054	pounds per square inch (psi)
	kilopascals (kPa)	0.33456	feet head of water
Specific capacity	litres per minute per metre drawdown	0.08052	gallons per minute per foot drawdown
Concentration	milligrams per litre (mg/l)	1.0	parts per million
Electrical conductivity	microsiemens per centimetre (μS/cm)	1.0	micromho per centimetre
Temperature	degrees Celsius (°C)	(1.8 × °C) + 32	degree Fahrenheit (°F)

FOREWORD

Heavy reliance on the local ground water supply is characteristic of many areas in Southern California. The Antelope Valley, which lies astride the Los Angeles, Kern, and San Bernardino County lines, is no exception. Currently, about 90 percent of the total water supply comes from the Valley's ground water basins. The remainder comes from the limited local surface water and reclaimed water and increasing amounts of imported water from the State Water Project. This heavy burden on the ground water basins has resulted in marked declines in ground water levels in the Valley.

At the same time, the choice of Palmdale in Antelope Valley as the site for a proposed major regional airport is expected to result in a significant increase in population.

Recognizing the need for local agencies to develop water resources management plans to cope with these two conditions, the Department of Water Resources in 1972 undertook a comprehensive investigation in cooperation with the County of Los Angeles and the United States Geological Survey to examine various alternative plans for meeting future water demands in the Valley.

The investigation entailed an inventory of the various sources of water supply, examination of factors influencing the demand, and evaluation of management alternatives for 1975-2020.

From this study, a "No-Change-in-Storage" plan is recommended, based on an evaluation of conditions that existed during the early part of 1980. Before a final water management plan is selected by local entities, however, a final assessment of the applicability of the recommended plan, in light of conditions that prevail at that time, should be made by major water users and organizations entrusted with water-related responsibilities. The leadership should be taken by the County Board of Supervisors, with ample opportunities provided for farmers, who are most significantly affected by any water management plan, to be heard.

To make possible implementation of a selected management plan with full cooperation from all concerned, a financial arrangement would be needed to make equitable distribution of both benefits and costs. The establishment of this arrangement should be based on a study to identify the benefited and the damaged and to formulate a plan for equitable distribution. Such a study would ensure that the selected management plan indeed represents a beneficial choice.

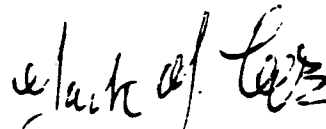

Jack J. Cpe, Chief
Southern District

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Cover photo: East Branch of California Aqueduct crosses southern end of the Antelope Valley.

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ACKNOWLEDGMENTS

The Antelope Valley Technical Advisory Committee was established at the commencement of the study in 1972 to provide guidance to the investigators. Composed of members directly involved with the future of the study area, it considered a number of significant issues which developed as the study progressed. Its member agencies and individuals who participated in the meeting were:

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SUPPLEMENTAL DATA

The following Technical Information Records (TIRs) were prepared during the course of this study to document pertinent information derived from the investigation. Copies of the TIRs may be read in the Southern District office of the Department of Water Resources, 849 South Broadway, Los Angeles.

"A Preliminary Evaluation of Adequacy of Data for the Formulation of a Mathematical Water Quality Model of Antelope Valley", TIR 1335-6-A-1, 1975.

"A Preliminary Evaluation of Geologic Bases for the Selection of Spreading Grounds in the Antelope Valley Study Area", TIR 1335-6-A-2, 1976.

"A Preliminary Evaluation of Ground Water Quality Near Littlerock and Pearblossom in Antelope Valley", TIR 1335-6-A-3, 1976.

"A Preliminary Evaluation of Ground Water in Storage in the Antelope Valley Ground Water Model Area", TIR 1335-6-A-4, 1977.

"A Preliminary Evaluation of Ground Water Quality in the Antelope Valley", TIR 1335-6-A-5, 1979.

"A Preliminary Evaluation and Inventory of Water Supplies in the Antelope Valley", TIR 1335-6-B-1, 1978.

"A Preliminary Evaluation of Projections of Ground Water Levels Under Alternative Operating Conditions of the Antelope Valley Ground Water Basin", TIR 1335-6-C-1, 1977.

"A Preliminary Evaluation of Historical and Projected Water Demand, Antelope Valley", TIR 1335-6-C-2, 1977.

In addition, the U. S. Geological Survey has prepared a report to complete the earlier phase of the investigation. (See reference 40 in back of report.)

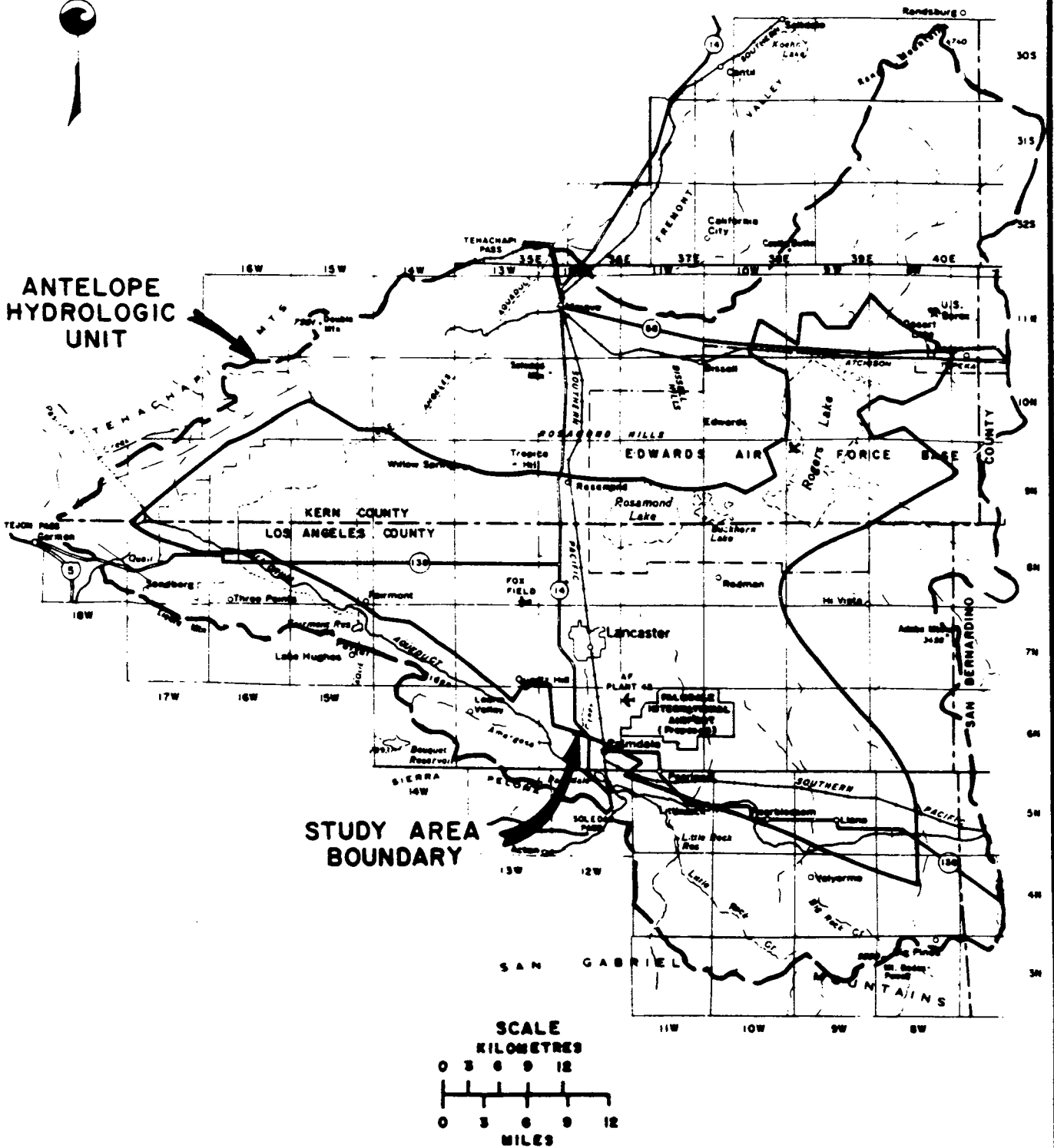


FIGURE I - STUDY AREA

I. INTRODUCTION AND SUMMARY

The Antelope Valley (Figure 1), which is one of the few remaining portions of Los Angeles County with large blocks of undeveloped level land, retains portions of the agricultural economy that once dominated the county. Location and climate have served to retard growth in the Antelope Valley, in comparison with the rapid growth which has characterized the coastal and near coastal areas. With the nearly complete urbanization of these areas, new urban development is spilling over into the Valley. The expanding aerospace industry and proposed international airport will accelerate this trend.

The arid climate of the Valley, although conducive to rapid crop growth, dictates a heavy reliance on ground water to satisfy the needs of both the agricultural and urban communities. Since 1900, when the initial steps were taken toward the full development of irrigated agriculture, ground water levels have consistently declined, especially in the heavy agricultural pumping area centered around Lancaster where as much as 60 metres (200 feet) of decline have been found. Increasing pump lifts, coupled with spreading urbanization and the high cost of imported water, will probably reduce the area farmed; however, agriculture will remain a basic part of the Valley's economy for some time to come.

Recognizing the need to prepare a feasible water resources management plan to ease the strain on the heavily burdened ground water supply, the California Department of Water Resources (DWR), the County of Los Angeles, and the U. S. Geological Survey (USGS) entered into a cooperative agreement to conduct an investigation of the Antelope Valley which was carried out in six phases. The last phase has been completed, and the results of the overall investigation are reported

here. Details on the various aspects of the study are contained in a series of technical information records, copies of which are available in the Southern District office of DWR.

Objective of Investigation

The objective of this investigation was to formulate and evaluate alternatives for operating the Antelope Valley Ground Water Basin as part of a comprehensive water management plan. These alternatives, which were developed by DWR in close coordination with a technical advisory committee (TAC), can be used by the local agencies to ensure that future water demands can be met.

Scope and Conduct of the Investigation

The three cooperating agencies agreed to share the cost of the investigation as follows: The County of Los Angeles and DWR each provided 35.9 percent of the funds and USGS, 28.2 percent. Involved was a resources and requirements survey of Antelope Valley, culminating in the development of plans for coordinated use of the various supplies available--ground water, imported State Water Project (SWP) water, local surface water, and reclaimed water. The study area (Figure 1) was chosen by the TAC to facilitate the creation of a ground water basin model by USGS. The time frame for the study was 1975-2020. The six phases of the study were:

- Phase I. Collect geohydrologic data and develop mathematical ground water model.
- Phase II. Develop the study program in cooperation with the TAC.
- Phase III. Determine historical water use, update population

projections, and cooperate with the TAC in selecting water demand projections to be used in analyzing the alternative plans developed.

Phase IV. Evaluate the local and imported water supplies available including an assessment of the probability of delivering SWP water to the Valley.

Phase V. Formulate areawide alternative plans for water management and, in cooperation with the TAC, select those plans to receive detailed analysis.

Phase VI. Analyze the selected alternatives.

Phase VII. Summarize and prepare the final report.

Basic data such as ground water levels were obtained from the cooperating agencies to estimate water demand, inventory water supplies, and examine the economic costs of the various alternatives. USGS conducted field studies and developed a finite-element mathematical model of the ground water basin. This model was used to examine the flow characteristics and response of basin ground water level elevations under the various pumping and recharge patterns imposed by the alternative plans. The economic evaluations of all plans, as well as consideration of land subsidence, flood hazards, and other environmental aspects of the plans, were done by DWR in concert with the TAC.

In this study, USGS has applied the term "conditions" to the various management plans developed. Thus, in this report, the terms "alternative plans" and "alternative operating conditions" are used interchangeably.

Area of Investigation

The Antelope Valley, a desert basin with internal drainage, is about 64 kilometres (40 miles) north of downtown Los Angeles, astride the Kern, Los Angeles, and San Bernardino County lines. Its more than 5 200 square kilometres (2,000 square miles) lie in the western Mojave Desert, between the Coast Ranges to the west and the Basin and Range Province to the east. It is isolated from the densely populated coastal areas to the south by the Transverse Ranges, which include the San Gabriel Mountains. The Tehachapi Mountains bordering to the northwest separate the Antelope Valley from the rich San Joaquin Valley. The Rosamond and Bissell Hills bound the Valley to the north; a series of granitic hills and buttes form the boundary to the east.

The study area (Figure 1) was defined by the USGS in an earlier phase of the investigation (40)*. It differs from the Antelope Hydrologic Unit used in past DWR reports in that it excludes much of the surface drainage north of the Rosamond Hills including the Mojave area. The two major communities are Lancaster, with a population of 45,625, and Palmdale, with a population of 10,417.** The bulk of the population lives in the Palmdale-Lancaster-Quartz Hill triangle. A small percentage lives in the Kern County towns of Rosamond, Edwards, and Boron.

The main avenues of approach to the Valley are through Soledad Pass (State Route 14) from the south, Tejon Pass (State Route 138) from the west, and Tehachapi Pass (State Route 58) from the northwest. The Valley is served by the Santa Fe and Southern Pacific railroads. The major airfields are William J. Fox Field, northwest of Lancaster, Palmdale International Airport at Air Force Plant 42, and Edwards Air Force Base. The Edwards

* Numbers in parentheses refer to reports listed in the back of the report.
** Los Angeles County Planning Commission estimates as of July 1, 1978.

SITE of proposed Palmdale International Airport is astride the Little Rock Creek wash. In the right foreground is the community of Littlerock.

runways are strictly for military traffic. The City of Los Angeles now plans to build a major regional airport to serve the north county at a site near the present Palmdale International Airport.

Geology

Antelope Valley is part of an untilted fault block lying between the San Andreas and Garlock faults, which intersect near the community of Gorman to the west. The surrounding highlands have been uplifted considerably in recent geologic times and have contributed a large quantity of eroded debris to the Valley floor.

Granitic and metamorphic rocks dominate the San Gabriel Mountains, which rise to 2 865 metres (9,399 feet) at Mt. Baden-Powell on the divide. The Tehachapi Mountains attain an elevation of 2 433 metres (7,981 feet) at Double Mountain.

The Valley floor is broken by remnant peaks protruding through the alluvium and locally termed buttes. Sedimentary deposits fill the basin to depths of as much as 2 400 metres (8,000 feet). (49). Older alluvium, which composes the bulk of the water-bearing deposits, is locally as much as 1 500 metres (5,000 feet) thick (40).

The elevation of the Valley floor ranges from about 910 metres (3,000 feet) along its borders down to 690 metres (2,270 feet) above sea level at Rosamond Dry Lake and 682 metres (2,237 feet) at Rogers Dry Lake.

Unlike other closed basins in the Mojave Desert, such as Searles Lake, Antelope Valley does not generally have saline waters with dissolved solids concentrations greater than 3 000 milligrams per litre (mg/L). The



only indications of saline deposits are around Rogers Dry Lake, in the surface clay of Rosamond Dry Lake, and in the soil for several kilometres around its western and southern perimeter (38). This alkali presumably was deposited as ground water evaporated in this area.

The quality of water below the 610-metre (2,000-foot) depth penetrated by the deepest water wells is unknown. The existence of saline clays in the thick sedimentary deposits underlying the Antelope Valley other than around Rogers Dry Lake has been speculated upon; however, evidence from deep oil test holes has indicated no buried lakebeds (38).

Climate

The Antelope Valley has a semiarid desert climate with cool, moist winters and hot, dry summers. Lying in the rainshadow of the mountains, it receives less precipitation than the coastal regions of Southern California,

which benefit from orographic rainfall on the windward slopes. About three-fourths of the annual precipitation falls from December through March. Precipitation generally increases with altitude, from less than 250 millimetres (10 inches) on the Valley floor to more than 1 000 millimetres (40 inches) in the higher elevations of the San Gabriel Mountains. The highest mean annual precipitation on the Valley floor is found in the west near Fairmont Reservoir with 380 millimetres (15 inches)--adequate for dry farming. Occasionally, during summer and fall, winds from the east will bring sudden thundershowers and high humidity from the Gulf of California.

The growing season in Antelope Valley averages 215 to 245 days (61), which is not as lengthy as that in the Imperial Valley, San Joaquin Valley, or coastal plains of Southern California.

There are about 350 good flying days per year at Edwards Air Force Base (45).

Isolated from the moderating influence of the ocean, the Valley has a climate that is more extreme than that found along the coast. Temperatures often exceed 38°C (100°F) during the summer and may drop below freezing in winter. They fluctuate as widely as 17° to 22°C (63°F to 72°F) in a single day.

Variable westerly winds prevail for most of the year in Antelope Valley.

The most damaging winds scour the Valley during spring and early summer when young alfalfa is vulnerable; Arizona cypress and other shrubs are therefore planted as windbreaks.

The Valley has an annual net atmospheric-water deficiency, which is characteristic of arid regions. During 1939-59, mean annual pan evaporation at Backus Ranch (T10N, R12W, Section 20), just north of the study area, was 2.90 metres (114 inches, or 9.5 feet), as measured by the U. S. Weather Bureau (2).

Agriculture and Industry

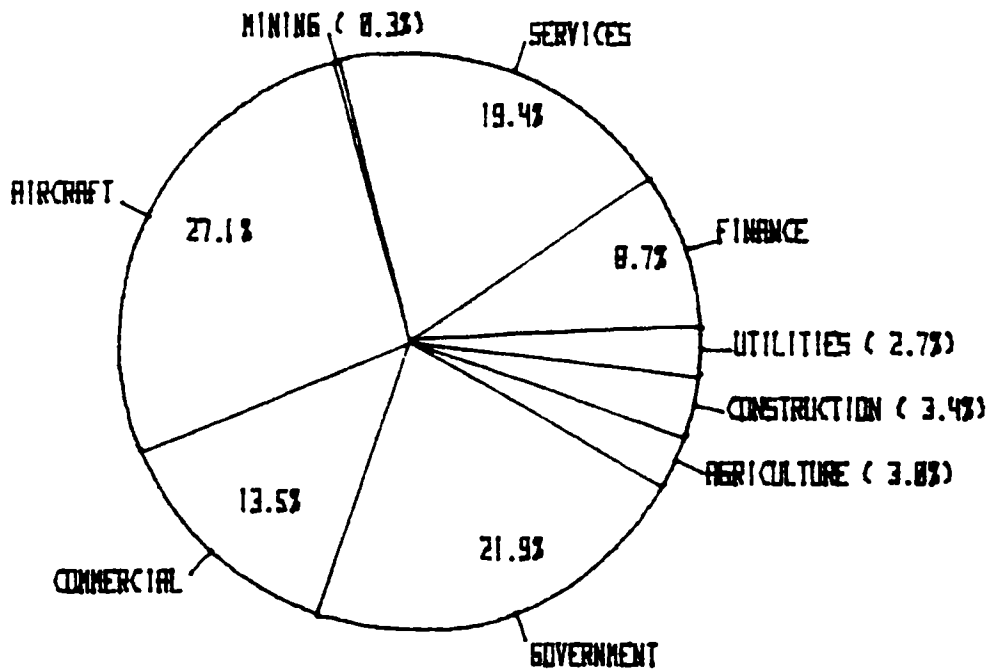
Agriculture in Antelope Valley is fairly diversified, with the emphasis on livestock and feed production. The poultry industry, although declining in recent years, is a major part of livestock production in the Valley. Some of the turkey and chicken breeding industry in Los Angeles County moved north to the Valley as the San Fernando Valley was urbanized.

Wheat and barley are dry-farmed in the western valley. These farms, which are heavily mechanized, average about 4.0 square kilometres (1,000 acres) in size (45). There was a surge in irrigated acreage when Antelope Valley-East Kern Water Agency (AVEK) introduced SWP water to the western Valley in 1972 at prices competitive with the costs of pumping ground water.

Irrigated agriculture is primarily concentrated in a band in the center of the study area, avoiding the alkaline clay of the lower Valley. Alfalfa is the main crop, often with five cuttings per year. The alfalfa hay is shipped to the Chino-Ontario dairies as well as fed to local stock. The hay market flourished during the past several years of drought because the Valley's irrigated farmlands were able to supply hay to cattlemen hurt by drought-stricken grasslands. Nonetheless, the amount of land in irrigated agriculture has generally been declining since the mid-1960s.

Manufacturing is the main economic activity in Antelope Valley. The aerospace industry, which constitutes the bulk of the manufacturing base, is concentrated in the Los Angeles County portion of the Valley. At Air Force Plant 42 near Palmdale are a number of civil aircraft production and testing facilities where much of the aircraft produced in Southern California is tested. A recent breakdown of employment in the Valley is shown in Figure 2.

FIGURE 2
ANTELOPE VALLEY EMPLOYMENT *
 ACTON TO L. B. COUNTY LINE



TOTAL EMPLOYMENT

Agriculture	1,200	Services	7,788
Construction	1,380	Mining	125
Utilities & Transportation	1,084	Aircraft Manufacture	10,829
Finance, Banking, Real Estate, Insurance	3,500	Commercial	5,431
		Government	8,804

Total = 40,141

*Source: Antelope Valley Board of Trade, 1979. Figures apply to period ending 1978.

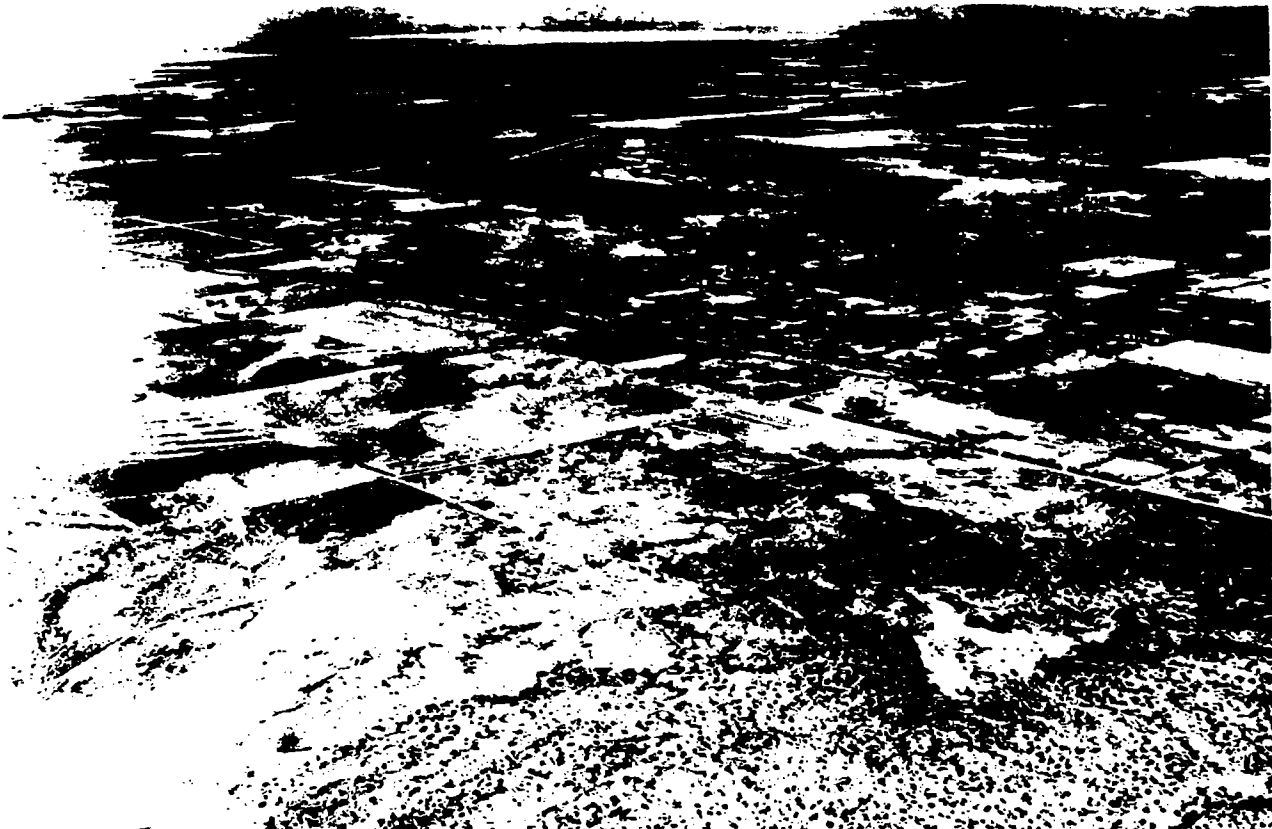
Edwards Air Force Base covers 1 200 square kilometres (300,000 acres), much of it within the northeastern part of the study area. Established by the Army as a bombing range in the 1930s, it was converted into a flight test center for military aircraft following World War II. There are now production facilities as well as sites for missile research located at Edwards.

Gold is no longer mined at Tropic in the Rosamond Hills, and the mining area is now operated as a tourist attraction. Borax is actively mined near Kramer. Rock and gravel quarrying is conducted in the southeastern part of the Valley along the mountainfront. Clay used for drilling mud formerly was mined from Rosamond and Rogers Dry Lakes.

Summary of Findings

Findings obtained in the Antelope Valley investigation include:

1. The population in Antelope Valley is projected to grow from 94,000 in 1975 to 320,000 by 2020; the amount of irrigated land cannot be reliably projected because of the drastic changes in energy and water costs.
2. Assuming that present trends continue, the projected annual water demand would rise from an estimated 238 000 cubic dekametres (192,600 acre-feet) in 1975 to 316 000 cubic dekametres (255,900 acre-feet) in the year 2020, an average growth rate of 1 800 cubic dekametres (1,500 acre-feet) per year. The increase in demand is expected to be derived solely from growth in municipal and industrial water use because agricultural use is predicted to remain at present levels for the duration of the study period.
3. Urban demand in the study area could be reduced significantly through institution of conservation measures. In a recent study, this reduction was estimated to be as much as 21 percent by 2000 and 23 percent by 2020. Under these projections, the per capita demand would drop from the present 950 litres (250 gallons) per capita per day to 746 litres (197 gallons) per day by 2000 and to 730 litres (193 gallons) per day by the year 2020. Therefore, the adjusted total water demand in Antelope Valley would rise to 290 000 cubic dekametres (235,400 acre-feet) rather than 316 000 cubic dekametres (255,900 acre-feet), by the end of the study period in 2020.
4. In 1975, the Antelope Valley's sources of supply were ground water (92.8 percent of the total), imported water from the SWP (4.5 percent), local surface runoff (2.1 percent), and reclaimed water (0.6 percent), to make up a total 237 580 cubic (192,600 acre-feet).
5. In 1976, 1 540 cubic dekametres (1,250 acre-feet) of reclaimed water was used beneficially for irrigation and recreation. Los Angeles County Sanitation Districts are planning to provide an additional 2 800 cubic dekametres (2,200 acre-feet) annually of waste water from District 14 Water Reclamation Plant near Lancaster, currently discharged to ponds, to an alfalfa ranch to the west.
6. Little Rock and Big Rock Creeks provide approximately 5 060 cubic dekametres (4,100 acre-feet) of local surface water supply annually. One element of this supply network, Little Rock Dam, which now stores 1 233 cubic dekametres (1,000 acre-feet), is currently being investigated by DWR Safety of Dams Division with respect to its safety. The removal of this dam would increase the amount of flood runoff in Little Rock and Big



SAME VIEW IN 1936 AND 1979, looking northeast across the Valley and the community of Palmdale. Major changes include increased development along old Sierra Highway (in middle of both photos), completion of new freeway (lower left in lower photo), and construction of major facilities at Air Force Plant 42, such as the Lockheed plant (upper left in lower photo).



Rock Creeks, posing a threat to facilities in the floodplain.

7. In Antelope Valley, there are three major contractors for State Water Project water: the largest, AVEK, had an entitlement of 43 170 cubic dekametres (35,000 acre-feet) in 1975, which will increase to a maximum of 170 720 cubic dekametres (138,400 acre-feet) in 1991; Littlerock Creek Irrigation District, with 640 cubic dekametres (520 acre-feet) in 1975 rising to 2 840 cubic dekametres (2,300 acre-feet) in 1991; and Palmdale Water District, whose entitlement increases from 6 880 (5,580 acre-feet) in 1975 to 21 340 cubic dekametres (17,300 acre-feet) in 1991.

8. The Antelope Valley ground water basin is subdivided by faults and other physical features into West Antelope, Neenach, Buttes, Finger Buttes, Lancaster, Pearland, and North Muroc subbasins. However, knowledge of the basin is incomplete.

The largest subbasin, Lancaster, is the only one composed of a two-aquifer system, the principal (upper) aquifer and the deep (lower) aquifer. The aquifers are separated by a series of layers which are mostly clay. In 1975, the principal aquifer supplied 213 200 cubic dekametres (172,800 acre-feet) and the confined deep aquifer 7 200 cubic dekametres (5,900 acre-feet) of water to the Valley.

9. The total ~~ground-water~~ storage capacity of Antelope Valley is estimated to be 84 million cubic dekametres (68 million acre-feet). In 1975, the amount of fresh water estimated to be in storage was 68 million cubic dekametres (55 million acre-feet).
10. Approximately 16 million cubic dekametres (13 million acre-feet)

of storage was above the water table, a large part of which is available for future recharge operations. Because the average annual precipitation is less than 250 millimetres (10 inches) on the Valley floor, direct rainfall does not contribute recharge to the ground water basin. Natural recharge is derived largely from streamflow and near surface percolation whose source is precipitation in the surrounding mountains. Mean annual recharge to the basin is estimated to be 50 200 cubic dekametres (40,700 acre-feet).

11. The ground water is generally of good quality, with total dissolved solids (TDS) concentrations less than 500 mg/L. The water is characteristically calcium bicarbonate near the source mountains tending toward sodium bicarbonate in the north. The water from the deep aquifer tends to be sodium bicarbonate in character.

Water with TDS concentration of 1 000 mg/L or more is found in the North Muroc Subbasin, around the borders of the Lancaster Subbasin, and in shallow wells scattered through the basin.

12. The sampling of wells has led to the discovery of elevated nitrate concentrations around the orchards of Littlerock and Quartz Hill.
13. From the evaluation of the various management alternatives (which covered options ranging from total reliance on ground water to meet demands to recharge of the basin with imported water to restore historic water levels) the following results were found:

- a. Use of the ground water model indicated that the Maximum Pumping Plan (Condition 4),

