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DEPARTMENT OF WATER RESOURCES
Southern District
Water Projects Branch

**PRELIMINARY EVALUATION OF
STATE WATER PROJECT GROUND WATER STORAGE PROGRAM:
WHITE WOLF BASIN**

-by-

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This Technical Information Record (TIR) was prepared to document information developed during a reconnaissance-level investigation of the White Wolf Ground Water Basin to determine if inclusion of this basin in the State Water Project Ground Water Supply Program is feasible. Therefore, it should be considered as preliminary and subject to revision. This is primarily an internal office document with distribution limited to the cooperating agencies only.

WRI
REF
G456
K9-6

September 1979

A159.27



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CONVERSION FACTORS

English to Metric System of Measurement

<u>Quantity</u>	<u>English unit</u>	<u>Multiply by</u>	<u>To get metric equivalent</u>
Length	inches (in)	25.4	millimetres (mm)
		.0254	metres (m)
	feet (ft)	.3048	metres (m)
	miles (mi)	1.6093	kilometres (km)
Area	square inches (in ²)	6.4516×10^{-4}	square metres (m ²)
	square feet (ft ²)	.092903	square metres (m ²)
	acres	4046.9	square metres (m ²)
		.40469	hectares (ha)
		.40469	square hectometres (hm ²)
		.0040469	square kilometres (km ²)
	square miles (mi ²)	2.590	square kilometres (km ²)
Volume	gallons (gal)	3.7854	litres (l)
		.0037854	cubic metres (m ³)
	million gallons (10 ⁶ gal)	3785.4	cubic metres (m ³)
	cubic feet (ft ³)	.028317	cubic metres (m ³)
	cubic yards (yd ³)	.76455	cubic metres (m ³)
	acre-feet (ac-ft)	1233.5	cubic metres (m ³)
		.0012335	cubic hectometres (hm ³)
		1.233×10^{-6}	cubic kilometres (km ³)
Volume/Time (Flow)	cubic feet per second (ft ³ /s)	28.317	litres per second (l/s)
		.028317	cubic metres per second (m ³ /s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
		6.309×10^{-5}	cubic metres per second (m ³ /s)
	million gallons per day (mgd)	.043813	cubic metres per second (m ³ /s)
Mass	pounds (lb)	.45359	kilograms (kg)
	tons (short, 2,000 lb)	.90718	tonne (t)
		907.18	kilograms (kg)
Power	horsepower (hp)	0.7460	kilowatts (kW)
Pressure	pounds per square inch (psi)	6894.8	pascal (Pa)
Temperature	Degrees Fahrenheit (°F)	$\frac{t_F - 32}{1.8} = t_C$	Degrees Celsius (°C)

FOREWORD

This report summarizes information collected for a reconnaissance-level study conducted to estimate the cost of storing and recapturing State Water Project water in the White Wolf Ground Water Basin of Kern County.

The use of ground water basins is one of the alternatives being investigated under the Department's State Water Project Future Supply Program to develop the water needed to meet the maximum annual entitlements of the Project. Other ground water basins located in the San Joaquin Valley and in Southern California are currently under similar study.

This study shows that the White Wolf Basin has the capacity to store approximately 219.6 cubic hectometres (178,000 acre-feet) of State Water Project water. It also shows that a ground water storage program of this magnitude would require the construction of new conveyance, recharge, and recapture facilities. The water could be stored in the basin by the direct and/or indirect methods. The amount of water that could be stored and recaptured is based on the availability of water from the Sacramento - San Joaquin Delta, historic hydrologic conditions, excess California Aqueduct capacity and extraction criteria.

The operational mode described herein is preliminary, and for planning purposes only. All the conditions imposed by the local water agencies for State participation in White Wolf Ground Water Basin were not accommodated. The results of this reconnaissance-level study will be used in comparison with other program elements, allowing decisions to be made as to which elements will be included in subsequent feasibility level studies. The actual costs and methods of financing and repayment will be the subject of further discussions and negotiations among the water supply contractors and the Department when specific projects have been defined.

The estimated costs contained in this report are only for comparison purposes with similar costs developed for other basins. Only those costs identifiable at the beginning of the study have been included. Subsequent discussions with the local water agencies have indicated increases in local costs. These increases have not been reflected in the study. No precedent exists for evaluating what the costs may total should negotiations be initiated for a ground water basin storage program. For a 219.6 cubic hectometre (178,000 acre-foot) program, the estimated comparative cost of the average annual dry-period yield is \$85,440 per cubic hectometre (\$105 per acre-foot).

Water rights in the White Wolf Basin have not been court adjudicated, therefore, agreements between the State and local pumpers/agencies would be needed to guarantee that stored SWP water could be recaptured at a later date.

STATE OF CALIFORNIA
The Resources Agency

DEPARTMENT OF WATER RESOURCES
Southern District

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ACKNOWLEDGEMENTS

Information and assistance were provided by representatives of the following water interests in the White Wolf Basin

Arvin-Edison Water Storage District
Kern County Water Agency
Wheeler Ridge-Maricopa Water Storage District
Tejon Ranch Company

I. INTRODUCTION

Existing conservation facilities of the State Water Project (SWP) do not store enough water for all contractual commitments. The Department of Water Resources (DWR) is presently evaluating alternative management plans and operations so that these commitments can be met making maximum use of available resources.

The use of ground water basins in conjunction with surface conservation facilities could help meet these commitments and could allow DWR to defer construction of additional surface water storage facilities. Ground water basins in the San Joaquin Valley and Southern California are currently under investigation to determine their suitability for this purpose. One of the determining factors is the cost of using the various basins in comparison with the cost of other means of firming up the yield of the SWP.

Storing SWP water in a ground water basin could provide local agencies with certain benefits such as reduced pump lifts resulting from higher ground water levels and availability of stored water during drought periods and during possible outages of SWP facilities.

Objective of Study

The main objective of this study is to estimate the unit cost per cubic hectometre of dry-period yield should SWP water be stored in the White Wolf Basin in Kern County (Figure 1). To obtain this cost, a determination was made of the storage capacity available in the basin, the length of time required to store this amount, and the amount of dry-period yield possible. The information developed will be compared with that from other alternatives being studied so that the optimum combination of facilities for future supplies can be determined and considered.

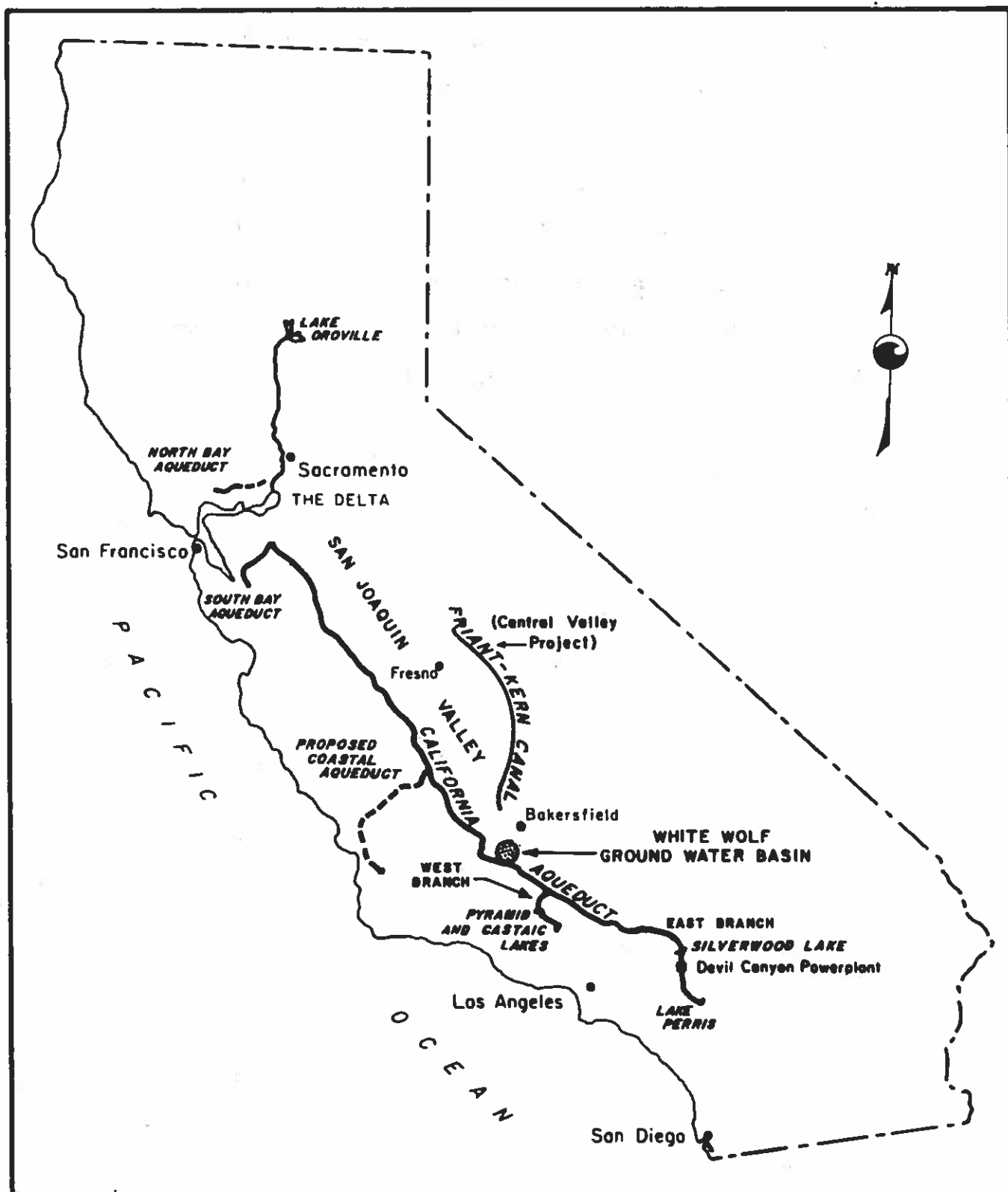


Figure 1 - STATE WATER PROJECT FACILITIES

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1970

A ground water storage program would be composed of two basic elements: (1) the storage of SWP water during periods when supplies are available in the Sacramento-San Joaquin Delta and (2) recapture of the stored water during dry periods. The recaptured water would be used instead of an equal amount of SWP water delivered on the surface; this would reduce the need for importing water during dry periods.

Storage could be accomplished directly (by using SWP water to recharge the ground water basin), indirectly (by cutting back on pumping while using an equal amount of SWP water delivered on the surface), or by using a combination of the two. No matter which storage method were used, local agencies would recapture the stored water in dry periods by pumping from the basin.

The program would require an initial fill period, during which the total amount of SWP water designated for conservation would be stored in the basin, and a 50-year operational period, during which SWP water would be recaptured and stored according to the hydrologic conditions prevailing in the Sacramento-San Joaquin Delta.

In the reconnaissance-level study reported here, a determination was made of:

1. How much water could be feasibly stored and recaptured;
2. What storage method should be used;
3. The length of the initial fill period;
4. What the costs of the program would be; and
5. The environmental and social implications of using the basin.

Assumptions

To conduct the study, certain assumptions were made. These include:

1. The Peripheral Canal would be in use;

2. Contractual deliveries of water from the Sacramento-San Joaquin Delta by both the SWP and the federal Central Valley Project would be at maximum during the operational period;
3. After contractual entitlement deliveries are made, SWP water would be delivered to the White Wolf Basin for this program ahead of all other programs (this same assumption of being first in line for the excess water is being made for each of the basins being studied);
4. During the 50-year operational period, prevailing hydrologic conditions in the Delta would be the same as those in 1922-71;
5. At the beginning, and again at the end of the operational period, the White Wolf Basin would contain the maximum amount of SWP conservation water stored in it for this program;
6. No SWP water would be recaptured during the initial fill period;
7. Existing SWP and local facilities would be used as much as possible for storing and recapturing the SWP water; and
8. The study did not take into account the conditions found in Appendix A.

Summary of Findings

During this reconnaissance-level investigation, the following findings were made:

1. The White Wolf Ground Water Basin could store approximately 219.6 cubic hectometres (178,000 acre-feet) of SWP water.
2. Only a small portion of the available ground water space, which is more than 1 850 cubic hectometres (1.5 million acre-feet), could be used because infiltration rates are relatively low and suitable land for existing and possible recharge sites is limited.
3. An estimated 5 years would be required to initially store the maximum amount of SWP water, based on the assumption that

hydrologic conditions during those 5 years would be similar to those prior to 1922.

4. Assuming that hydrologic conditions for the 50 years following the initial fill period are similar to those for the 50-year historic hydrologic period, the average dry-period yield would be 29.6 cubic hectometres (24,000 acre-feet) per year for each year of the 6 2/3-year dry period (1928-1934).
5. The total capital cost of implementing the ground water storage program is \$24,235,000. This includes \$6,782,000 for the initial fill period and \$17,453,000 for construction of pipelines, spreading basins, and wells.* The net present worth cost of the entire program, including the costs for the 5-year initial fill period and construction costs, would be \$39,865,000. From this the annual cost of the average annual dry-period yield is computed to be \$85,440 per cubic hectometre (\$105 per acre-foot).
6. Total dissolved solids (TDS) concentrations in ground water in the main part of the basin range from 500 to 800 milligrams per litre (mg/l) which meets agricultural requirements. Local surface water has TDS concentrations ranging from 300 to 2 500 mg/l with values increasing east to west.
7. Depth to ground water ranges from 135 metres (450 feet) to 305 metres (1,000 feet).
8. The storage of SWP water might decrease the amount of SWP water available as surplus water. This could affect local water agencies which want to purchase SWP surplus water for local programs.
9. Water can be stored by the direct or indirect method.

*Subsequent discussions with Wheeler Ridge - Maricopa WSD indicate these costs could increase.

10. A large-scale State ground water basin storage program would require construction of new spreading basins and the installation of several new wells; all new construction would have to reflect future local management plans.
11. Storage of SWP water in the basin may adversely affect the hydraulic gradient in certain areas.
12. Ground water rights have not been adjudicated and there is no control over ground water pumping.
13. The program discussed in this report would not create any significant environmental impacts.
14. Benefits include reduced pump lifts from higher ground water levels and availability of stored water during drought periods and possible outages of SWP facilities.

Conclusions

Based on the previous findings, the following conclusions can be drawn:

1. The White Wolf Basin has potential for use in storing SWP water to firm up the Project yield, even though the cost per cubic hectometre of dry-period yield would be high.
2. Sufficient water would be available for this program assuming similar hydrologic conditions as in the 1917-71 period.
3. Lack of control over ground water pumping could have an effect on the recapture of stored SWP water.
4. Further discussion is needed to resolve conflicting demands for SWP water that would be used for the State's ground water basin storage program; water that would otherwise be made available to fill a local water agency's request for surplus water.*

*As noted in Appendix A, Wheeler Ridge - Maricopa WSD has stated that as a condition required for State participation in the White Wolf Basin, no water could be used for replenishment unless the District receives its annual share of surplus water from the Kern County Water Agency.

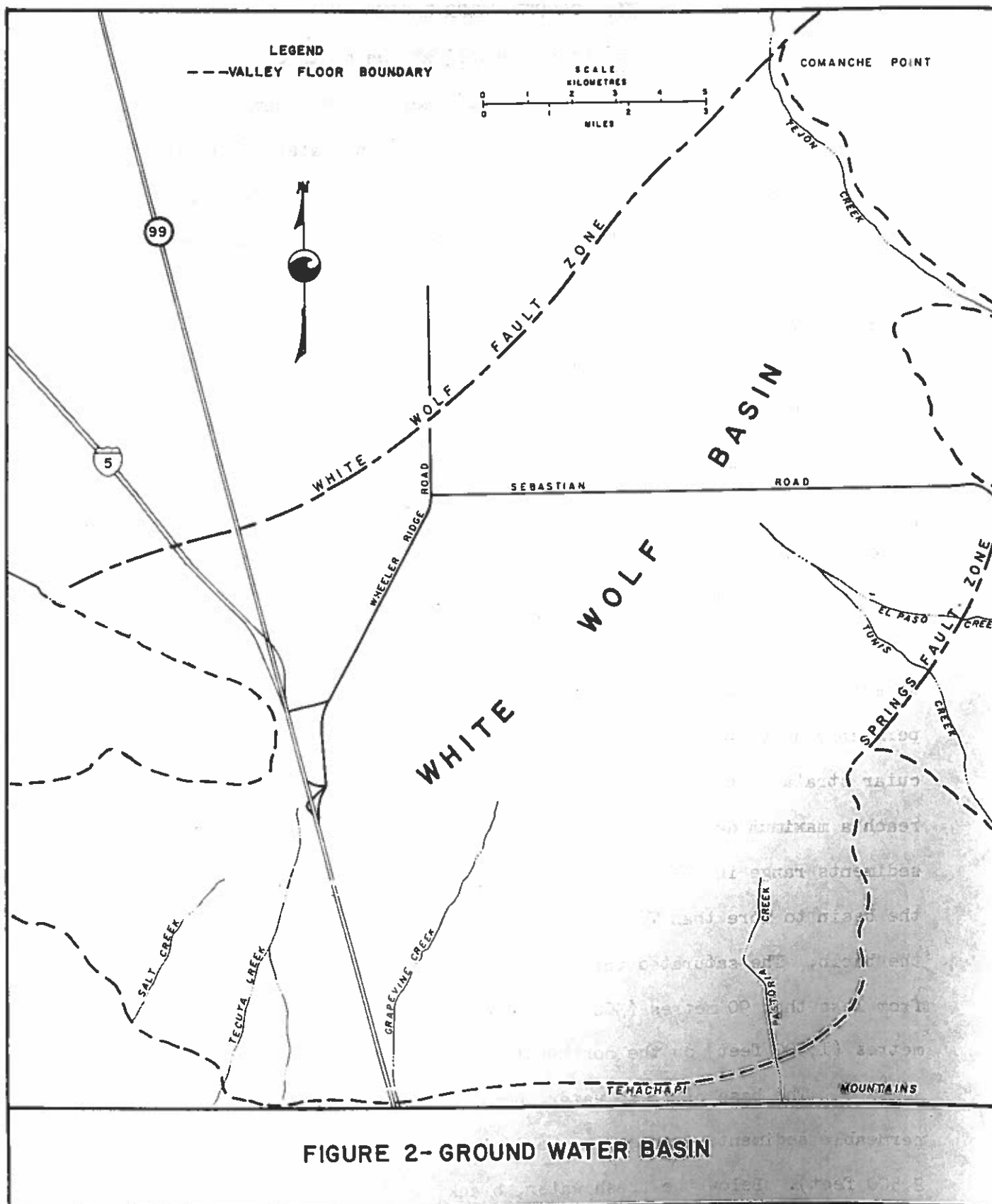
II. GROUND WATER BASIN

The White Wolf Basin is located at the south end of the San Joaquin Valley (see Figure 2). The White Wolf Fault, running from northeast to southwest, separates the White Wolf Ground Water Basin from the main San Joaquin Valley Ground Water Basin. The Springs Fault zone on the southeast forms another boundary; the Tertiary sedimentary rocks along the mountains surrounding the basin form the boundary for the remainder of the basin.

The White Wolf Basin has a valley floor area of about 22 200 hectares (54,800 acres), but the principal water-bearing area (storage unit) covers only 11 300 hectares (28,000 acres). The valley floor slopes from elevations of 460 to 540 metres (1,500 to 1,750 feet) in the south to 170 to 200 metres (550 to 650 feet) along the White Wolf Fault.

Alluvium and the upper portion of the Kern River-Chanac formation are the main water-bearing sediments. The alluvium consists of interstratified beds of gravel, sand, silt, and clay. The older and less permeable deposits of the Kern River-Chanac formation consist of lenticular strata of slightly consolidated sand, silt, clay, and gravel, which reach a maximum depth of 1 830 metres (6,000 feet). The more permeable sediments range in thickness from 150 metres (500 feet) along the sides of the basin to more than 760 metres (2,500 feet) in the northwest part of the basin. The saturated thickness of the more permeable sediments ranges from less than 90 metres (300 feet) on the east side to more than 460 metres (1,500 feet) on the northwest.

The base of fresh water, considering both permeable and less permeable sediments, ranges from a depth of 360 to 760 metres (1,200 to 2,500 feet). Below the fresh water, brackish or saline connate water is found.



DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1979

Depth to water ranges from more than 135 metres (450 feet) near the White Wolf Fault to 305 metres (1,000 feet) on the south side of the basin along the California Aqueduct.

Transmissivities of the sediments were estimated from well drillers' logs and were adjusted during calibration of the Kern County ground water model. Based on use of only seven nodes, transmissivity values were found to range from 123 000 to 370 000 cubic metres (100 to 300 acre-feet) per year. *89,263 qd/ft 267,800 qd/ft*

Specific yield values were determined for water-bearing deposits for depth intervals of 30 metres (100 feet) below the historic high ground water levels that were reached during the 1940s. Values range from a maximum of 17.6 percent to less than 10 percent. The weighted average for all depth zones throughout the entire storage unit is 13.3 to 14.3 percent.

The infiltration rate, based on a few short-time tests in small areas by Wheeler Ridge - Maricopa Water Storage District (Wheeler Ridge - Maricopa WSD), is about 0.2 metre (0.5 foot) per day. More extensive tests involving large areas and long-time periods would be necessary to determine whether other rates should be used for feasibility-level planning.

Because water levels have dropped 75 metres (250 feet) since the 1940s, when the depth to water was about 60 metres (200 feet), there are at least 90 metres (300 feet) of sediments available for ground water storage. In the area modeled, which extended from the White Wolf Fault to 0.8 kilometre to 2.4 kilometres (0.5 mile to 1.5 miles) south of the 850 Canal and contains 10 500 hectares (26,000 acres), there are about 20 cubic hectometres of storage per metre (5,000 acre-feet per foot) of aquifer depth. South of the modeled area there are another 8 500 hectares (21,000 acres) in the basin which can store about 12 cubic hectometres per metre (3,000 acre-feet per foot) of depth. These values for storage capacity are

based on a specific yield of 14.3 percent for the modeled area and 14.0 percent for the area to the south. Therefore, the available ground water storage space is more than 1 850 cubic hectometres (1.5 million acre-feet). About 3 100 cubic hectometres (2.5 million acre-feet) of water is presently in storage in the basin.

Most wells in the basin are 245 to 430 metres (800 to 1,400 feet) deep. Wells in the 245- to 305-metre (800- to 1,000-foot) depth range are near the east side of the basin. Water levels and other data indicate the wells are in a single unconfined body of ground water.

The ground water basin is recharged by stream runoff and by imported water. Very little replenishment results from subsurface inflow or precipitation on the valley floor. Most of the precipitation, which amounts to 130 to 150 millimetres (5 to 6 inches per year), is consumed by crops and native vegetation. Stream runoff to the basin averages about 8.6 cubic hectometres (7,000 acre-feet) per year. Surface runoff from the Tehachapi Mountains recharges the basin through Salt, Tecuya, Grapevine, Pastoria, Tunis, El Paso, and Tejon Creeks.

Figure 3 shows the two water districts that provide water service in the basin; they are Wheeler Ridge - Maricopa WSD and Arvin-Edison Water Storage District (Arvin-Edison WSD). Because Wheeler Ridge - Maricopa WSD is a member unit of Kern County Water Agency (KCWA), it can (and does) receive SWP water. Arvin-Edison WSD is also a member unit of KCWA, but it has not received SWP water. Since Arvin-Edison WSD is a federal Central Valley Project (CVP) contractor, it obtains water from the CVP through both the Friant-Kern and local canals. In addition, Arvin-Edison WSD occasionally purchases small amounts of Kern River water. As a result of an exchange program with various entities in Kern, Tulare, and Fresno Counties, Arvin-Edison WSD also obtains some federal water through the

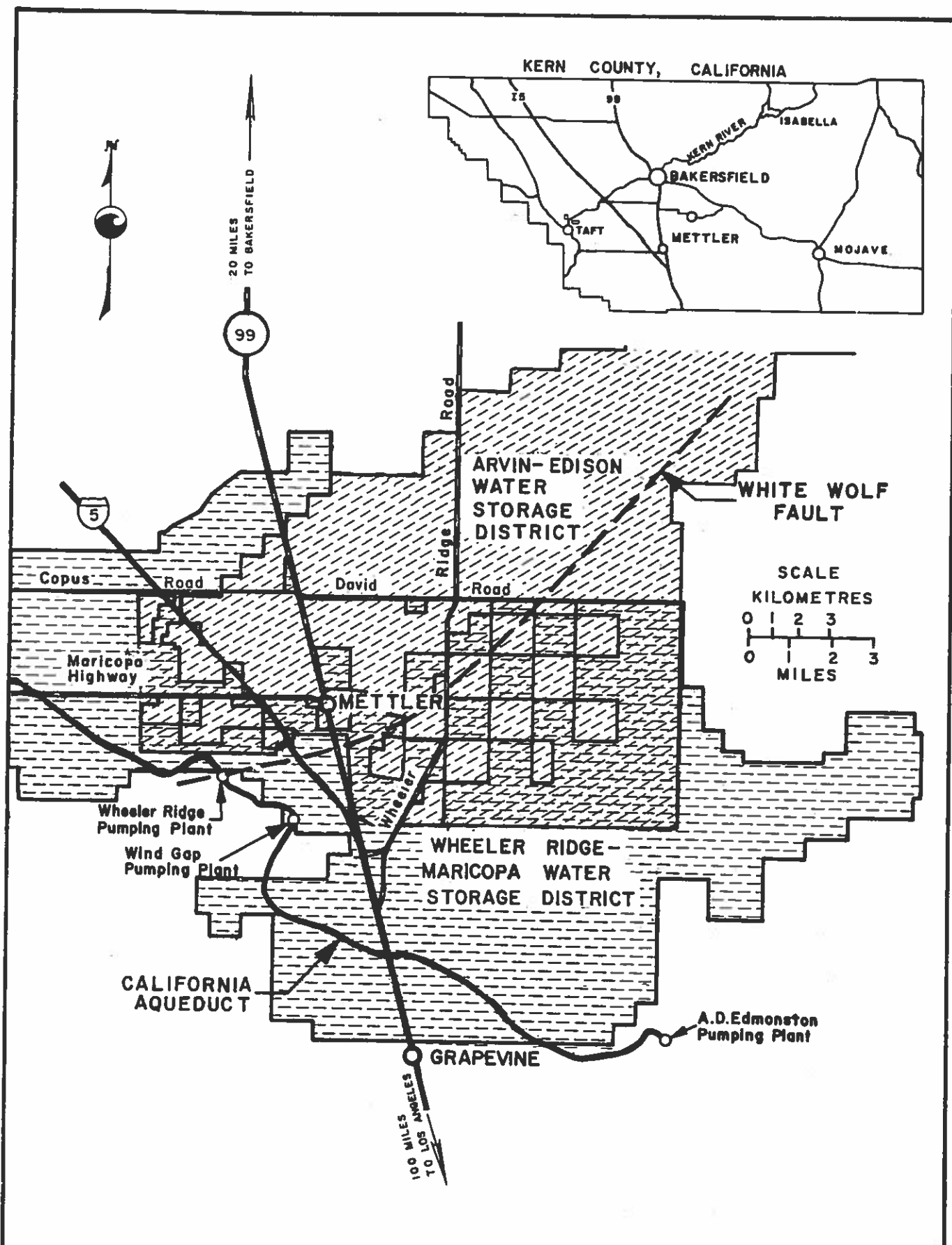


FIGURE 3-WATER STORAGE DISTRICT BOUNDARIES

SWP via the KCWA Cross Valley Canal and other local canals.

Imported water was first delivered to the basin in 1967 by Arvin-Edison WSD and in 1971 by Wheeler Ridge - Maricopa WSD when it imported about 0.6 cubic hectometre (500 acre-feet) of SWP water.

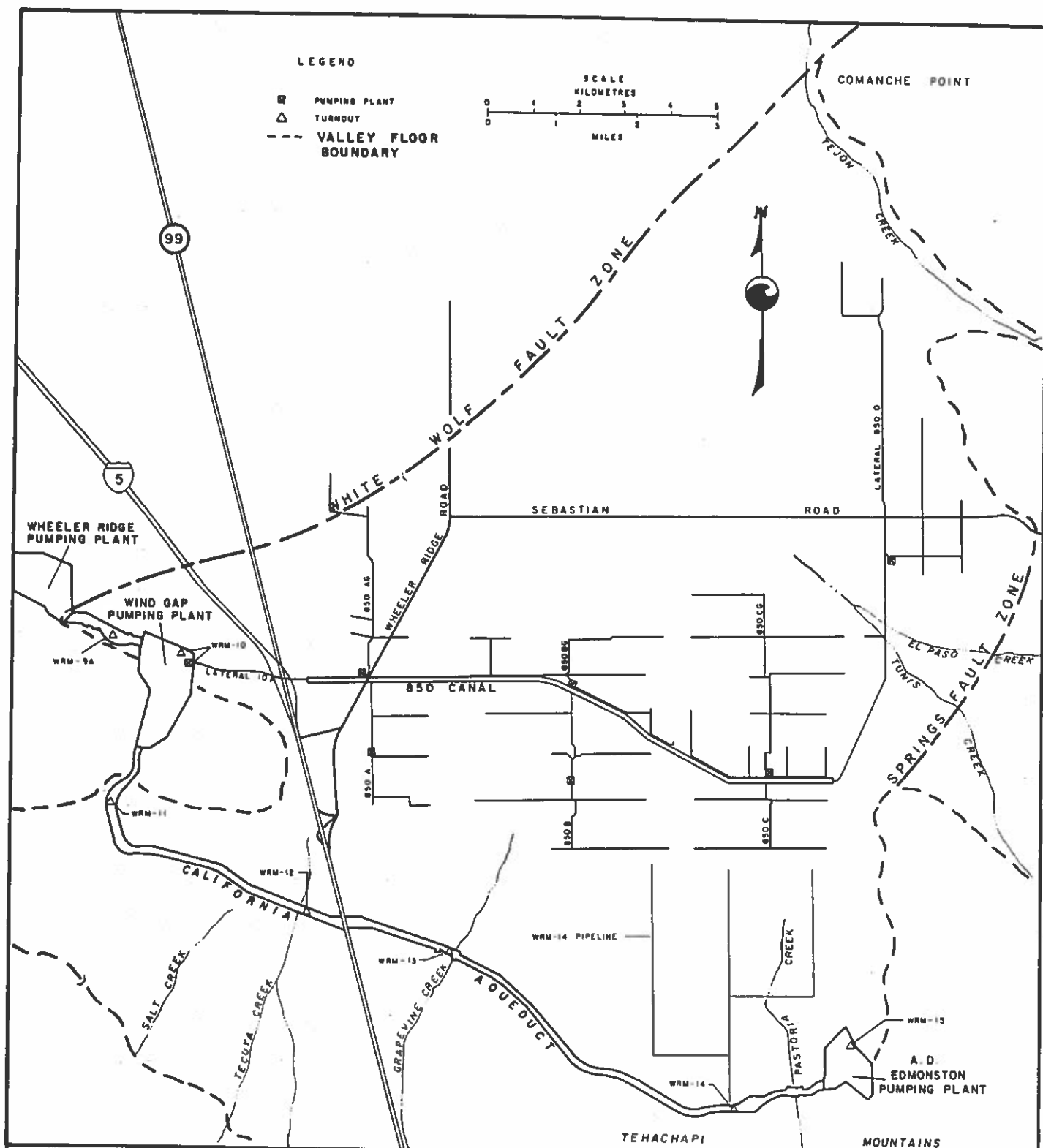
Private well owners pump ground water on agricultural lands that do not have available supplemental surface supplies. Arvin-Edison WSD also pumps ground water from outside the basin to portions of its service area when surface supplies are inadequate.

Of the 22 200 hectares (54,800 acres) in the basin, 18 200 hectares (45,000 acres) are considered to be in Wheeler Ridge - Maricopa WSD, and 4 000 hectares (9,800 acres) are considered to be in Arvin-Edison WSD.

Total lands farmed in Wheeler Ridge - Maricopa WSD include 10 700 hectares (26,500 acres) -- 7 100 hectares (17,500 acres) in the surface water service area and 3 600 hectares (9,000 acres) in the ground water service area. In the Arvin-Edison WSD, 3 500 hectares (8,700 acres) are farmed -- 3 100 hectares (7,700 acres) in the surface water service area and 400 hectares (1,000 acres) in the ground water service area. This information is based on 1976 data from Wheeler Ridge - Maricopa WSD.

In 1978, Wheeler Ridge - Maricopa WSD initiated water service through its California Aqueduct turnout number 14 system in the Pastoria Creek vicinity (Figure 4). This system was planned to provide water service to about 2 100 hectares (5,100 acres). Another system, the California Aqueduct turnout number 13 system is planned to serve an additional 2 400 hectares (5,900 acres) in the Grapevine Creek Area.

There is overlap in water service in the two districts (Figure 3). The overlap area totals 5 500 hectares (13,600 acres); of this 2 100 hectares (5,200 acres) are in the Wheeler Ridge - Maricopa WSD surface water service area; 530 hectares (1,300 acres) are in the Arvin-Edison WSD surface water



**FIGURE 4 - WHEELER RIDGE-MARICOPA WSD FACILITIES
FEASIBLE FOR USE IN STATE PROGRAM**

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1979

service area; and 2 900 hectares (7,100 acres) are in the ground water service area.

Ground water storage depletions mentioned previously, which amounted to a total of 1 850 cubic hectometres (1.5 million acre-feet) from 1945 to 1975, have been reduced by imports of surface water and decrease in use of ground water. The depletions have been reduced from 38 cubic hectometres (31,000 acre-feet) per year in 1967 to 2.5 cubic hectometres (2,000 acre-feet) per year (4-year average, 1973 to 1976).

In 1976, 82.5 cubic hectometres (66,900 acre-feet) of surface water and 48.0 cubic hectometres (38,900 acre-feet) of ground water were applied. Deep percolation was 28.7 cubic hectometres (23,250 acre-feet), resulting in a net ground water use of 19.3 cubic hectometres (15,650 acre-feet). For 1990, projected values are 136.3 hectometres (110,500 acre-feet) of imported surface water, 33.9 cubic hectometres (27,500 acre-feet) of ground water extractions, and 37.6 cubic hectometres (30,500 acre-feet) of deep percolation, resulting in 3.7 cubic hectometres (3,000 acre-feet) of recharge above extractions. With the addition of 8.6 cubic hectometres (7,000 acre-feet) of stream runoff to the basin, this results in total accumulation of 12.3 cubic hectometres (10,000 acre-feet) per year of net recharge to the ground water basin projected for 1990 and beyond.

State Water Project entitlement deliveries scheduled for 2015 to Wheeler Ridge - Maricopa WSD are 324.7 cubic hectometres (263,200 acre-feet). Of this, up to 6 percent is delivered in an area where it could be conveyed to adjoining land outside the White Wolf Basin but in another portion of the Wheeler Ridge - Maricopa WSD.

Ground water quality varies, but most ground water is suitable for irrigation of crops. Surface water and ground water quality in the main part

of the basin have total dissolved solids (TDS) concentrations ranging from 500 to 800 milligrams per litre (mg/l). Ground water on the west side of the basin has an electrical conductivity (EC) of more than 2 000 microsiemens (2,000 micromhos) per centimetre, TDS concentrations greater than 1 000 mg/l, and contains less than 0.9 mg/l of boron. This water which increases in salinity to the west, probably originates as recharge from Salt and Tecuya Creeks. It has TDS concentrations up to 2 400 mg/l and is associated with marine sediments.

Ground water moves toward a pumping depression near the northeast corner of the basin. Just east of the pumping depression is an area where in 1977 one well had a TDS concentration of more than 1 000 mg/l, while chloride concentrations were less than 100 mg/l. In other parts of the basin, the EC ranges from 400 to 1 600 microsiemens (400 to 1,600 micromhos) per centimetre. In 1977, water from 24 wells had nitrate concentrations averaging 14 mg/l (with 5 wells having concentrations greater than 45 mg/l); and boron concentrations averaging 0.34 mg/l. Most of these wells are in the northeast corner of the basin.

Between spring 1975 and spring 1977, a number of wells in the western areas that have poor quality ground water showed a rise in water levels up to 12 metres (40 feet). These changes probably reflect semi-confined aquifer conditions due to their being located on the fringes of the basin. In the central half of the basin, water levels showed a decline of up to 1.5 metres (5 feet) for the same period. Therefore, present operating methods have steepened the gradient that moves the poor quality water toward the center of the basin.

A steep gradient exists across the White Wolf fault, and some subsurface outflow probably occurs. In the Kern County ground water model study, annual subsurface outflows range from 5.4 cubic hectometres

(4,400 acre-feet) in 1961 to 1.5 cubic hectometres (1,200 acre-feet) in the early 1970's. Reductions in outflow from the White Wolf Basin resulted from the recovery of artesian heads north of the fault due to use of SWP water on the north side of the fault. Also, recharging ground water outside of White Wolf Basin by Arvin-Edison WSD may have been a contributing factor.

III. AVAILABLE FACILITIES

The California Aqueduct conveys SWP water through the southwest portion of the basin (Figure 5). Wheeler Ridge - Maricopa WSD and Arvin-Edison WSD import water to, and provide water service in, the ground water basin.

Wheeler Ridge - Maricopa WSD, as a member unit of KCWA, receives SWP water. Arvin-Edison WSD, which is also a member unit of KCWA, has not yet received SWP water. As a Friant-Kern Canal contractor, it receives some federal water through the SWP by exchange. Arvin-Edison WSD also pumps ground water from wells outside the basin.

Arvin-Edison WSD serves most of the main (north) part of the basin, where ground water is at the shallowest depths. Within its service area, Arvin-Edison serves ten sections; however, it also serves two sections within the Wheeler Ridge - Maricopa WSD. Most of the remainder of the basin pumps ground water or receives SWP water service from Wheeler Ridge - Maricopa WSD. About five sections on the north end of Wheeler Ridge - Maricopa WSD have no surface-water distribution systems; they, therefore, rely exclusively on ground water. Of the 11 300 hectares (28,000 acres) in the principal water-bearing area, 3 100 hectares (7,700 acres), or 12 sections, are served by Arvin-Edison WSD, 1 300 hectares (3,200 acres) are served by private wells, while the remainder is served by Wheeler Ridge - Maricopa WSD.

Wheeler Ridge - Maricopa WSD has conducted spreading to replenish the ground water basin. It also has tentative plans for a ground water storage program, including the development of additional spreading facilities and the construction of wells to recapture stored water. Within the District, private well owners now pump ground water to meet water-supply deficiencies (surface water) and to irrigate lands that do not have a surface-water supply.

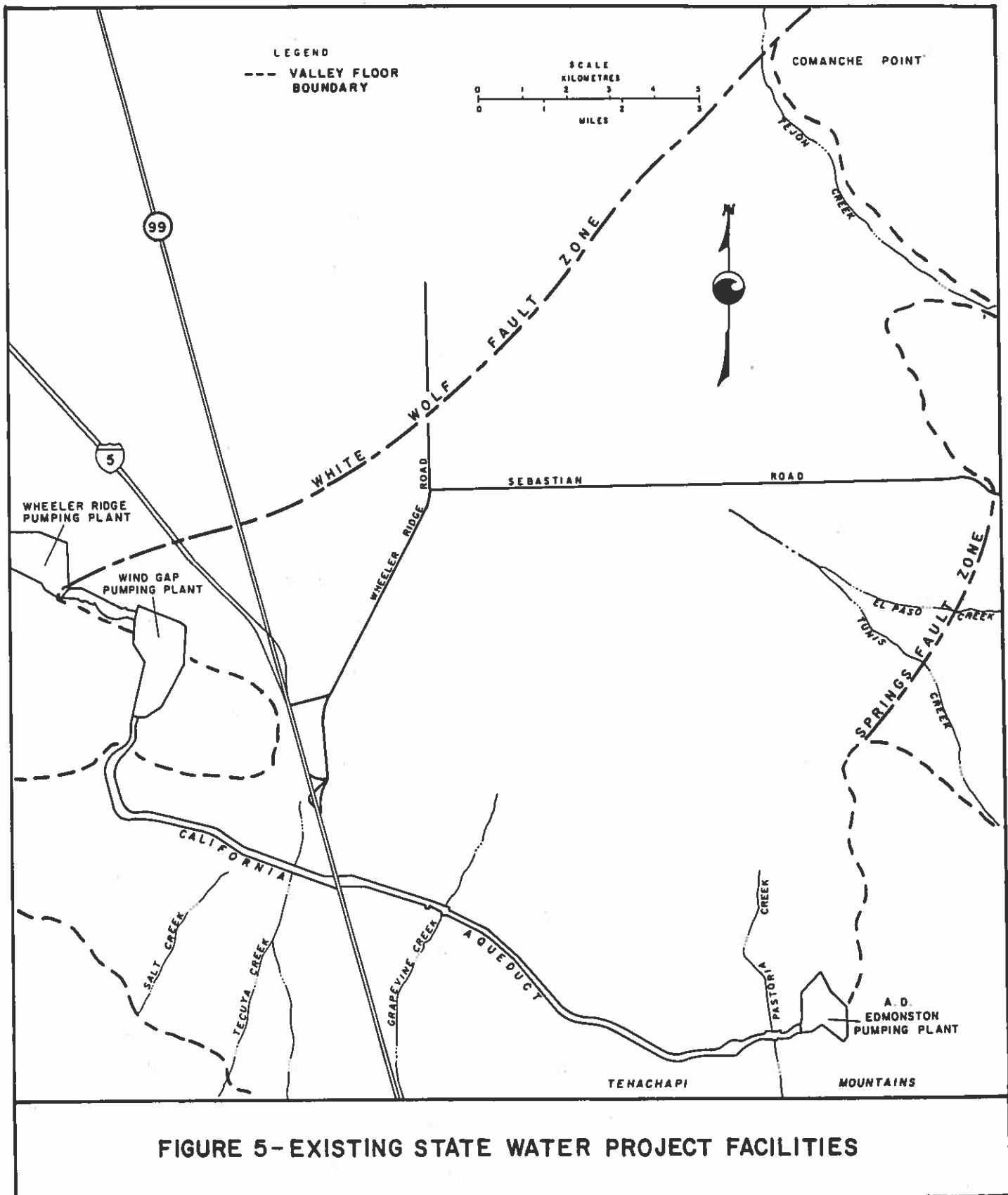


FIGURE 5-EXISTING STATE WATER PROJECT FACILITIES

DEPARMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1979

Arvin-Edison WSD also imports surface water and extracts ground water through wells it owns outside the basin. Although this District has contracted with KCWA to receive water from the SWP, the water is available only from the surplus water category and is not available on a firm, dependable basis.

White Wolf Basin is lacking in existing facilities which could be utilized in the conveyance, recharge, and recapture of SWP conservation water.

Conveyance Facilities

The California Aqueduct conveys SWP water along the west and south sides of the White Wolf Basin. The Wheeler Ridge Pumping Plant is just northwest of the basin, the Wind Gap Pumping Plant is at the northwest corner of the basin, and the A. D. Edmonston Pumping Plant is at the foot of the Tehachapi Mountains on the south side of the basin.

The California Aqueduct was designed to convey 3 080 cubic hectometres (2,497,500 acre-feet) per year to A. D. Edmonston Pumping Plant for delivery to water contractors south of the Tehachapi Mountains. KCWA has contracted with the State to deliver a maximum entitlement of 154.2 cubic hectometres (125,000 acre-feet) of water per year in 2015 to its member agencies in the reach of the California Aqueduct between the Wheeler Ridge and the A. D. Edmonston Pumping Plants. The design capacity of the Aqueduct exceeds that needed to meet present entitlement deliveries.

The average annual excess aqueduct capacity (in years 2013-17) available at Wheeler Ridge Pumping Plant is 736 cubic hectometres (596,700 acre-feet) and at Wind Gap Pumping Plant is 638 cubic hectometres (517,300 acre-feet).

Wheeler Ridge - Maricopa WSD has constructed seven turnouts to receive water from the California Aqueduct in the White Wolf Basin. Some of these turnouts would not be used for spreading and recapture because of poor ground water quality and depth to ground water areas served by them.

Wheeler Ridge - Maricopa WSD's turnout WRM-10 is a concrete structure designed to deliver 7.6 cubic metres (270 cubic feet) per second by pumping. WRM-10 delivers water through a pipeline (Lateral 10P), to the Wheeler Ridge - Maricopa WSD's 850 Canal system, which serves the central part of the basin (Figure 4). The 850 Canal system includes 11.6 kilometres (7.2 miles) of concrete-lined canal, the WRM-10 aqueduct turnout pumps, Lateral 10P, three 850 Canal pumping plants, and pumps on three main pipelines, which deliver water from the 850 Canal to the users (Figure 4). Four main pipelines deliver pumped water and another four main pipelines deliver water by gravity flow. The 850 Canal system could deliver water for spreading in the El Paso Creek Area. Table 1 shows amounts of water delivered through the system in 1975, 1976, and 1977. Table 2 shows estimated monthly water demands in the 850 Canal system for present development.

Wheeler Ridge - Maricopa WSD's turnout number 13 is completed through the aqueduct levee and could be utilized with the installation of a measuring device. A pipeline from the turnout could provide water for spreading in the Grapevine Creek area.

Wheeler Ridge - Maricopa WSD constructed its turnout number 14 in 1978 and began delivering water through it to about 2 060 hectares (5,100 acres) of land between the California Aqueduct and the 850 Canal. This turnout is a 1 320-millimetre (52-inch) concrete structure, designed to deliver about 2 cubic metres (70 cubic feet) per second. By the end of June 1978, 2.1 cubic hectometres (1,670 acre-feet) had been delivered. The turnout is located where the California Aqueduct crosses Pastoria

TABLE 1

WATER DELIVERIES FROM 850 CANAL SYSTEM

<u>System</u>	(cubic hectometres)			(acre-feet)		
	1975	1976	1977	1975	1976	1977
850A System						
Pumped flow	4.02	4.65	3.45	3,260	3,770	2,800
Gravity flow	<u>3.61</u>	<u>3.53</u>	<u>0.89</u>	<u>2,930</u>	<u>2,860</u>	<u>720</u>
Total	7.63	8.18	4.34	6,190	6,630	3,520
850B System						
Pumped flow	10.57	12.73	9.75	8,570	10,320	7,905
Gravity flow	<u>1.00</u>	<u>1.94</u>	<u>0.10</u>	<u>810</u>	<u>1,570</u>	<u>85</u>
Total	11.57	14.67	9.85	9,380	11,890	7,990
850C System						
Pumped flow	4.71	6.85	5.96	3,815	5,555	4,830
Gravity flow	<u>4.11</u>	<u>5.55</u>	<u>3.56</u>	<u>3,335</u>	<u>4,500</u>	<u>2,890</u>
Total	8.82	12.40	9.52	7,150	10,055	7,720
850D System						
Pumped flow	2.03	3.05	1.95	1,645	2,475	1,580
Gravity flow	<u>6.46</u>	<u>6.78</u>	<u>2.95</u>	<u>5,240</u>	<u>5,495</u>	<u>2,395</u>
Total	8.49	9.83	4.90	6,885	7,970	3,975
ANNUAL TOTALS	36.51	45.08	28.61	29,605	36,545	23,205

TABLE 2

ESTIMATED MONTHLY WATER DEMAND IN THE 850 CANAL SYSTEM*

<u>Month</u>	<u>Cubic Hectometres</u>	<u>Acre-feet</u>
October	2.10	1,700
November	1.23	1,000
December	2.22	1,800
January	1.23	1,000
February	2.10	1,700
March	4.07	3,300
April	4.56	3,700
May	6.54	5,300
June	7.03	5,700
July	6.78	5,500
August	4.56	3,700
September	<u>3.33</u>	<u>2,700</u>
TOTAL	45.75	37,100

*Estimated monthly water demand is the current monthly demand for the present level of development. Lands in the district's service area are 80 to 100 percent developed. Permanent crops are in various stages of maturity. As the crops mature, they require more water than when recently planted.

Creek. Water could be delivered through this turnout for spreading on land in and adjacent to the channel of Pastoria Creek.

Recharge Facilities

The District has conducted experimental spreading and anticipates future spreading. The existing turnouts, conveyance and distribution systems, including the 850 Canal system, could be utilized by the State if adequate recharge facilities were available. But under present conditions, all are inadequate for the program being studied. Arvin-Edison WSD has no recharge facilities in the White Wolf Basin. The construction of all facilities that would be required for recharge of SWP water is discussed in the Operational Mode.

Recapture Facilities

A survey by Wheeler Ridge-Maricopa WSD found that most existing wells were unsuitable for long-term use because of small diameter, shallow depth, or old age. The same is true within Arvin-Edison WSD. Therefore, recapture of SWP water would require new State wells.

Existing privately-owned wells can be cross classified as to status and area of basin served by each district as follows:

	<u>Arvin-Edison WSD</u>	<u>Wheeler Ridge- Maricopa WSD</u>	<u>Totals</u>
Active 1976 and earlier	33	24	57
Reactivated in 1977	3	6	9

New district-owned wells have been proposed by Wheeler Ridge-Maricopa WSD at 13 locations, all within 1.6 kilometres (1 mile) of the District's 850 canal.

IV. OPERATIONAL MODE

A study was made of the White Wolf Basin for a 50-year period (corresponding to the 1922-71 hydrologic conditions) to determine the feasibility of a SWP ground water basin storage program. Basically, the mode of operation for the proposed program stores SWP water in White Wolf Basin during times of plentiful supply in the Sacramento-San Joaquin Delta and recaptures the stored water during dry periods for use in place of an equal amount of SWP water delivered on the surface.

The amount of SWP water that could be stored would be limited by (1) the capacity of the spreading grounds and (2) the amount of SWP water that could be delivered to the basin. One of the assumptions made at the beginning of the study was that existing local and SWP facilities would be used as much as possible to minimize capital costs. However, because no recharge and few recapture facilities exist in White Wolf Basin, the construction of additional facilities would drastically increase the cost of a ground water basin storage program.

If local hydrologic conditions are such that the amounts scheduled to be stored or recaptured are too great, then only a minimum amount specified by an agreement or water supply contract amendment would be stored or recaptured, unless an emergency arose. This would serve to ensure the firm yield of the ground water basin.

Many factors were taken into consideration for this study. However, the three main parameters are:

1. Hydrologic Conditions.
2. Water Availability (Delta and Aqueduct Limitations).
3. Storage and Extraction Assumptions.

Hydrologic Conditions

The historic (1917-1971) hydrologic conditions and their associated classification (Table 3) was used in determining the availability of SWP water to supply the ground water storage program. These conditions are based on a four-river index for total unimpaired water year runoff. The rivers are the Sacramento River above Bend Bridge near Red Bluff, the Feather River total inflow to Oroville Reservoir, the Yuba River at Smartville, and the American River total inflow to Folsom Reservoir. Based on this index the years are classified as follows:

<u>Water Year Classification</u>	<u>Sum of Four River Runoff</u>
Wet (W)	$\geq 24\ 180$ cubic hectometres (19.6 million acre-feet) or $\geq 27\ 750$ cubic hectometres (22.5 million acre-feet) when preceding year is critical
Above Normal (AN)	$> 19\ 370$ cubic hectometres (15.7 million acre-feet)
Below Normal (BN)	$\leq 19\ 370$ cubic hectometres (15.7 million acre-feet)
Dry (D)	$\leq 15\ 420$ cubic hectometres (12.5 million acre-feet) or $\leq 19\ 370$ cubic hectometres (15.7 million acre-feet) when preceding year is critical
Critical (C)	$\leq 12\ 580$ cubic hectometres (10.2 million acre-feet) or $\leq 15\ 420$ cubic hectometres (12.5 million acre-feet) when preceding year is critical
Subnormal Snowmelt (S)	$< 7\ 280$ cubic hectometres (5.9 million acre-feet) for the forecasted April through July unimpaired runoff reported in the May issue of DWR Bulletin 120.

Water Availability

The amount of SWP water that could be delivered to the basin was determined by which was lower; the amount of SWP water available for export from the Delta or the amount of excess capacity available in the California Aqueduct. Tables 4 and 5 show the amounts of SWP water

TABLE 3

HISTORIC WATER YEAR CLASSIFICATIONS
for
Storage and Recapture Operations

Water Year	Water year classification*	Project year **	Water Year	Water year classification*	Project year
1917	AN	-5	1946	AN	25
18	D	-4	47	D	26
19	BN	-3	48	AN	27
20	C	-2	49	D	28
1921	W	-1	1951	W-S	30
22	AN	1	52	W	31
23	BN	2	53	W	32
24	C	3	54	AN	33
25	AN	4	55	D	34
1926	D	5	1956	W	35
27	W	6	57	BN	36
28	AN-S	7	58	W	37
29	C	8	59	D	38
30	D	9	60	BN-S	39
1931	C	10	1961	D	40
32	D	11	62	BN	41
33	C	12	63	W	42
34	C	13	64	D	43
35	AN	14	65	W	44
1936	AN	15	1966	BN-S	45
37	BN	16	67	W	46
38	W	17	68	BN-S	47
39	C	18	69	W	48
40	AN	19	70	W-S	49
1941	W	20	1971	W	50
42	W	21			
43	W	22			
44	D	23			
45	BN	24			

*W = wet

AN = above normal

BN = below normal

D = dry

C = critical dry

-S = subnormal snowmelt

**Initial filling period is indicated by minus years.

TABLE 4

DELTA LIMITATIONS-INITIAL FILLING PERIOD
 SWP Water Available in the Delta
 for Ground Water Storage
 (1917-1921)

(cubic hectometres)					
<u>Month</u>	1917	1918	1919	1920	1921
October	49.34				49.34
November	49.34				49.34
December	49.34				49.34
January	49.34				203.53
February	49.34				203.53
March	49.34				203.53
April	49.34				203.53
May	49.34				49.34
June	49.34				49.34
July	49.34				49.34
August	49.34				49.34
September	49.34				49.34
TOTAL	592.08	NONE	NONE	NONE	1 208.84
(acre-feet)					
<u>Month</u>					
October	40,000				40,000
November	40,000				40,000
December	40,000				40,000
January	40,000				165,000
February	40,000				165,000
March	40,000				165,000
April	40,000				165,000
May	40,000				40,000
June	40,000				40,000
July	40,000				40,000
August	40,000				40,000
September	40,000				40,000
TOTAL	480,000	NONE	NONE	NONE	980,000

TABLE 5

DELTA LIMITATIONS-OPERATIONAL PERIOD
SWP Water Available in Delta
for Ground Water Storage*
(1922-1971)

Month	1927	1938	1942	1943	1951	1953	1958	1963	1970	1971
(cubic hectometres)										
October										
November										
December										
January	12.34	12.34		286.17	102.38	527.94	442.83	383.62	651.29	
February	111.01	111.01		106.08	139.39	106.08	106.08	6.17	139.39	72.78
March	41.94	41.94	76.48	34.54	106.08	81.41	81.41	81.41	106.08	111.01
April			41.94	157.89	81.41	111.01	111.01	111.01	81.41	41.94
May				41.94	64.14	41.94	41.94	41.94	64.14	
June										
July										
August										
September										
TOTALS	165.29	165.29	118.42	626.62	493.40	868.38	783.27	624.15	1 042.31	225.73
(acre-feet)										
October										
November										
December				232,000	83,000	428,000	359,000	311,000	528,000	
January				86,000	113,000	86,000	86,000	5,000	113,000	
February	10,000	10,000		28,000	86,000	66,000	66,000	66,000	86,000	59,000
March	90,000	90,000	62,000	128,000	66,000	90,000	90,000	90,000	66,000	90,000
April	34,000	34,000	34,000	34,000	53,000	34,000	34,000	34,000	52,000	34,000
May										
June										
July										
August										
September										
TOTALS	134,000	134,000	96,000	508,000	400,000	704,000	635,000	506,000	845,000	183,000

*Water is available only in those months and years shown.

available in the Delta during both the initial filling period and the 50-year operational period. The tables are different because of the assumptions upon which they are based: (1) the initial filling period will occur before maximum entitlements are being delivered; and (2) subsequent filling will take place after maximum entitlements are delivered by the system. No water is available in the months of May through November during the operational period due to required Project operation of San Luis Reservoir.

The second factor controlling the amount of SWP water available to the White Wolf Basin is the excess capacity of the California Aqueduct. This excess capacity is based on the following assumptions:

1. A median Delta Water Supply occurs.
2. The system delivers all requested entitlements.
3. The system requires a minimum of net on-peak power.
4. The Peripheral Canal and all pumps at the Delta Pumping Plant are operational.

Table 6 shows the average excess capacities available for ground water storage at both Wheeler Ridge and Windgap Pumping Plants. These numbers apply to both the initial filling period and the operational period. By comparing Tables 4 and 6, the amount of SWP water available for initial storage at either of the previously mentioned pumping plant can be determined (Tables 7 and 8). By comparing Tables 5 and 6, the amount of SWP water available during the operational period can be determined (Tables 9 and 10).

Storage and Extraction Assumptions

1. The White Wolf Basin storage program will be first in time; i.e., it will not be affected by operations of other ground water basins or surface water storage programs being considered.
2. The initial year of operation (designated year 1) is the date

TABLE 6

CALIFORNIA AQUEDUCT LIMITATIONS

Average Excess Capacities Available
for Ground Water Storage*

At Wheeler Ridge Pumping Plant:

<u>Month</u>	<u>Cubic Hectometres</u>	<u>Acre-Feet</u>
October	64.39	53,300
November	68.46	55,500
December	83.14	67,400
January	89.43	72,500
February	80.67	65,400
March	86.72	70,300
April	78.08	63,300
May	35.52	28,800
June	39.47	32,000
July	17.27	14,000
August	34.91	28,300
September	57.97	47,000
TOTAL	736.03	596,700

At Windgap Pumping Plant:

<u>Month</u>	<u>Cubic Hectometres</u>	<u>Acre-Feet</u>
October	54.89	44,500
November	50.99	46,200
December	70.93	57,500
January	77.22	62,600
February	71.91	58,300
March	75.24	61,000
April	67.97	55,100
May	26.77	21,700
June	32.69	26,500
July	17.27	14,000
August	34.91	28,300
September	51.31	41,600
TOTAL	638.10	517,300

*Based on DWR Division of Operation and Maintenance Study
78-01 LR-RV (March 20, 1978) for the years 2013 through 2017.

TABLE 7
SWP WATER AVAILABLE AT WHEELER RIDGE PUMPING PLANT

Initial Filling Period
Based on Aqueduct and Delta Limitations

(cubic hectometres)					
<u>Month</u>	1917	1918	1919	1920	1921
October	49.34				49.34
November	49.34				49.34
December	49.34				49.34
January	49.34				89.43
February	49.34				80.67
March	49.34				86.72
April	49.34				78.08
May	35.52				35.52
June	39.47				39.47
July	17.27				17.27
August	34.91				34.91
September	49.34				49.34
TOTAL	521.89	NONE	NONE	NONE	659.43
(acre-feet)					
<u>Month</u>					
October	40,000				40,000
November	40,000				40,000
December	40,000				40,000
January	40,000				72,500
February	40,000				65,400
March	40,000				70,300
April	40,000				63,300
May	28,800				28,800
June	32,000				32,000
July	14,000				14,000
August	28,300				28,300
September	40,000				40,000
TOTAL	423,100	NONE	NONE	NONE	534,600

TABLE 8
SWP WATER AVAILABLE AT WINDGAP PUMPING PLANT

Initial Filling Period
Based on Aqueduct and Delta Limitations

(cubic hectometres)					
<u>Month</u>	1917	1918	1919	1920	1921
October	49.34				49.34
November	49.34				49.34
December	49.34				49.34
January	49.34				77.22
February	49.34				71.91
March	49.34				75.24
April	49.34				67.97
May	26.76				26.76
June	32.69				32.69
July	17.27				17.27
August	34.91				34.91
September	49.34				49.34
TOTAL	506.35	NONE	NONE	NONE	601.33
(acre-feet)					
<u>Month</u>					
October	40,000				40,000
November	40,000				40,000
December	40,000				40,000
January	40,000				62,600
February	40,000				58,300
March	40,000				61,000
April	40,000				55,100
May	21,700				21,700
June	26,500				26,500
July	14,000				14,000
August	28,300				28,300
September	40,000				40,000
TOTAL	410,500	NONE	NONE	NONE	487,500

TABLE 9

SWP WATER AVAILABLE AT WHEELER RIDGE PUMPING PLANT

Operational years 1-50

Based on Aqueduct and Delta Limitations

Month	1927	1938	1942	1943	1951	1953	1958	1963	1970	1971
(cubic hectometres)										
October										
November				83.14	83.14	83.14	83.14	83.14	83.14	
December				89.43	89.43	89.43	89.43	6.17	89.43	
January				34.54	80.67	80.67	80.67	80.67	80.67	72.78
February	12.34	12.34		86.71	81.41	86.71	86.71	86.71	81.41	86.71
March	86.71	86.71	76.48							
April	41.94	41.94	41.94	41.94	64.14	41.94	41.94	41.94	64.14	41.94
May										
June										
July										
August										
September										
TOTALS	140.99	140.99	118.42	335.76	398.79	381.89	381.89	298.63	398.79	201.43
(acre-feet)										
October										
November				67,400	67,400	67,400	67,400	67,400	67,400	
December				72,500	72,500	72,500	72,500	5,000	72,500	
January				28,000	65,400	65,400	65,400	65,400	65,400	59,000
February	10,000	10,000		70,300	66,000	70,300	70,300	70,300	66,000	70,300
March	70,300	70,300	62,000							
April	34,000	34,000	34,000	34,000	52,000	34,000	34,000	34,000	52,000	34,000
May										
June										
July										
August										
September										
TOTALS	114,300	114,300	96,000	272,200	323,300	309,600	309,600	242,100	323,300	163,300

TABLE 10

SWP WATER AVAILABLE AT WINDGAP PUMPING PLANT

Operational years 1-50
Based on Aqueduct and Delta Limitations

(cubic hectometres)											
Month	1927	1938	1942	1943	1951	1953	1958	1963	1970	1971	
October											
November											
December				70.93	70.93	70.93	70.93	70.93	70.93		
January				77.22	77.22	77.22	77.22	6.17	77.22		
February	12.34	12.34		34.53	71.91	71.91	71.91	71.91	71.91	71.91	
March	75.24	75.24	75.24	75.24	75.24	75.24	75.24	75.24	75.24	75.24	
April	41.94	41.94	41.94	41.94	64.14	41.94	41.94	41.94	64.14	41.94	
May											
June											
July											
August											
September											
TOTALS	129.52	129.52	117.18	299.86	359.44	337.24	337.24	266.19	359.44	189.09	
(acre-feet)											
Month											
October											
November											
December				57,500	57,500	57,500	57,500	57,500	57,500		
January				62,600	62,600	62,600	62,600	5,000	62,600		
February	10,000	10,000		28,000	58,300	58,300	58,300	58,300	58,300	58,300	
March	61,000	61,000	61,000	61,000	61,000	61,000	61,000	61,000	61,000	61,000	
April	34,000	34,000	34,000	34,000	52,000	34,000	34,000	34,000	52,000	34,000	
May											
June											
July											
August											
September											
TOTALS	105,000	105,000	95,000	243,100	291,400	273,400	273,400	215,800	291,400	153,300	

the basin first reaches the maximum level of SWP water storage.

3. No water will be extracted during the initial filling period.
4. The amount of SWP water extracted from the basin is limited to the accumulated amount of SWP water stored.

Initial Filling Period

Hydrologic conditions and delivery capacities preceding 1922 were used to determine the number of years required to store the maximum amount of SWP conservation water in the basin. Operation year 1 has hydrologic conditions similar to 1922. Figure 6 shows that five years are required to store the desired 219.5 cubic hectometres (178,000 acre-feet) prior to the initial operation date. *on 25,400 AFY*

Dry-Period Yield

The historic dry period was from spring 1928 to October 1934 (6-2/3 years), corresponding to operation years 7 through 13. The yield for this period (dry-period yield) was determined by adding the amounts extracted each year. Figure 6 shows that the amount of water recaptured during this period is 197.4 cubic hectometres (160,000 acre-feet). Thus, the dry-period yield, 197.4 cubic hectometres (160,000 acre-feet), divided by 6-2/3 years, is the average annual dry-period yield of 29.6 cubic hectometres (24,000 acre-feet). *Recharge water 1928-1934 197.4 cubic hectometres or 160,000 acre-feet*

Water Levels

Future operation of the proposed State ground water storage program could raise water levels an average of 6.1 metres (20 feet).* The Kern County ground water model predicts that water levels on the north side of the White Wolf Fault Zone would stay the same or rise slightly under average future conditions and with existing projects.

*The actual fluctuation on ground water levels in the basin caused by a State ground water storage program would not be uniform. An analysis of the actual fluctuations is beyond the scope of this study. A State program operating at the same time as a local program might cause sufficient fluctuations to create problems for ground water pumpers.

1000 ACRE - FEET

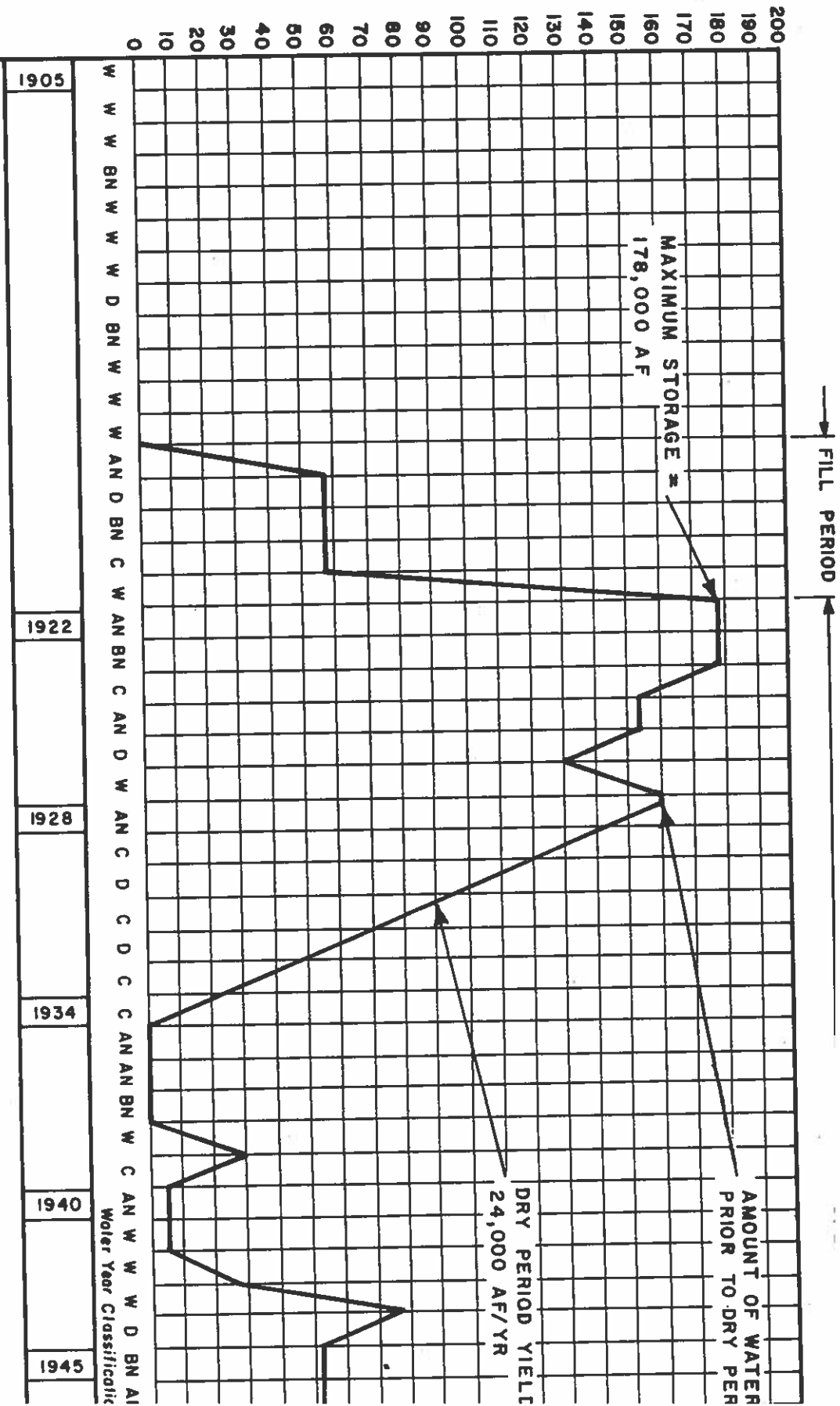


Figure 6-WHITE WOLF BASIN ACCUMI

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1976

Consequently, subsurface outflows would be about 4.9 cubic hectometres (4,000 acre-feet) per year.*

The ground surface elevations are above 150 metres (500 feet), and no rising water would occur until water levels have risen more than 120 metres (400 feet). Therefore, no surface flow is expected. It should be noted that raising the water level south of the White Wolf Fault Zone changes two parameters that affect the amount of losses due to subsurface flow. First, the area of the fault plane that transmits water is increased and the head difference across the fault plane is increased. The second parameter may not be linear since the younger near-surface strata may show little or no offset from the faulting and, therefore, the fault may be less effective as a barrier. However, losses through the fault could be recovered by the Arvin-Edison WSD or Wheeler Ridge-Maricopa WSD.

Recharge Facilities (Proposed)

About 1 540 hectares (3,800 acres) in the three areas described below are using ground water supplies. The applied water requirements for these lands is 12.6 cubic hectometres (10,200 acre-feet) per year. None of the lands supplied by the 850 Canal system are using ground water, but during the 1977 drought, some wells were reactivated. If there were an indirect storage program, using the 850 Canal system could provide some surface water to lands that are on ground water in exchange for ground water not extracted. It would be necessary to construct one turn-out or more on Wheeler Ridge - Maricopa WSD's laterals depending on the distances between lands to be served. Wheeler Ridge - Maricopa WSD estimates it would cost \$5,000 for each 64.8 hectares (160 acres) of land to be served if the lands were less than 0.8 kilometres (one-half mile) apart.

*For this study it was assumed the ground water storage program would be 100 percent efficient with no losses. The determination and allocation of increased losses caused by addition of water to the basin are beyond the scope of this study.

The White Wolf Ground Water Basin presently does not have all the facilities, such as recharge areas, recapture wells, turnouts, pipelines, etc., that would be needed to conduct a successful direct ground water storage program.* The following is a discussion on the three proposed recharge facilities by area.

Grapevine Creek Area

The Grapevine Creek area (Figure 7) would require construction of a pipeline, road crossing, access roads, spreading grounds, and fencing.

In the Grapevine Creek area, about 5.2 cubic hectometres (4,170 acre-feet) of water could be spread per month. The State would need to provide a turnout capacity of 2 cubic metres (70 cubic feet) per second above that needed by Wheeler Ridge - Maricopa WSD, a 0.4 kilometre (0.25-mile) pipeline, and 111 hectares (274 acres) of spreading ponds. About 4.5 hectares (11 acres) of additional land would be needed for roads, spreading basin banks and slopes, and fencing. Five 22.2 hectare (54.8-acre) ponds would be provided.

The cost for additional facilities required to spread this water is \$3,290,400.

The advantages of using this area are: (1) it is one of the areas where there is maximum infiltration of applied water; (2) it is near the California Aqueduct; and (3) water can be delivered by gravity flow. The disadvantages are: (1) depth to water is more than 305 metres (1,000 feet); (2) the site is about 2.4 kilometres (1-1/2 miles) from potential recapture areas; and (3) Tejon Ranch Company plans to develop land in the area for irrigated crops.

The Grapevine Creek area may be used for a Wheeler Ridge - Maricopa WSD ground water storage program. This would reduce the availability of this area for a State ground water storage program.

*It should be noted that the Wheeler Ridge - Maricopa WSD has embarked upon an indirect recharge program in the White Wolf Basin.

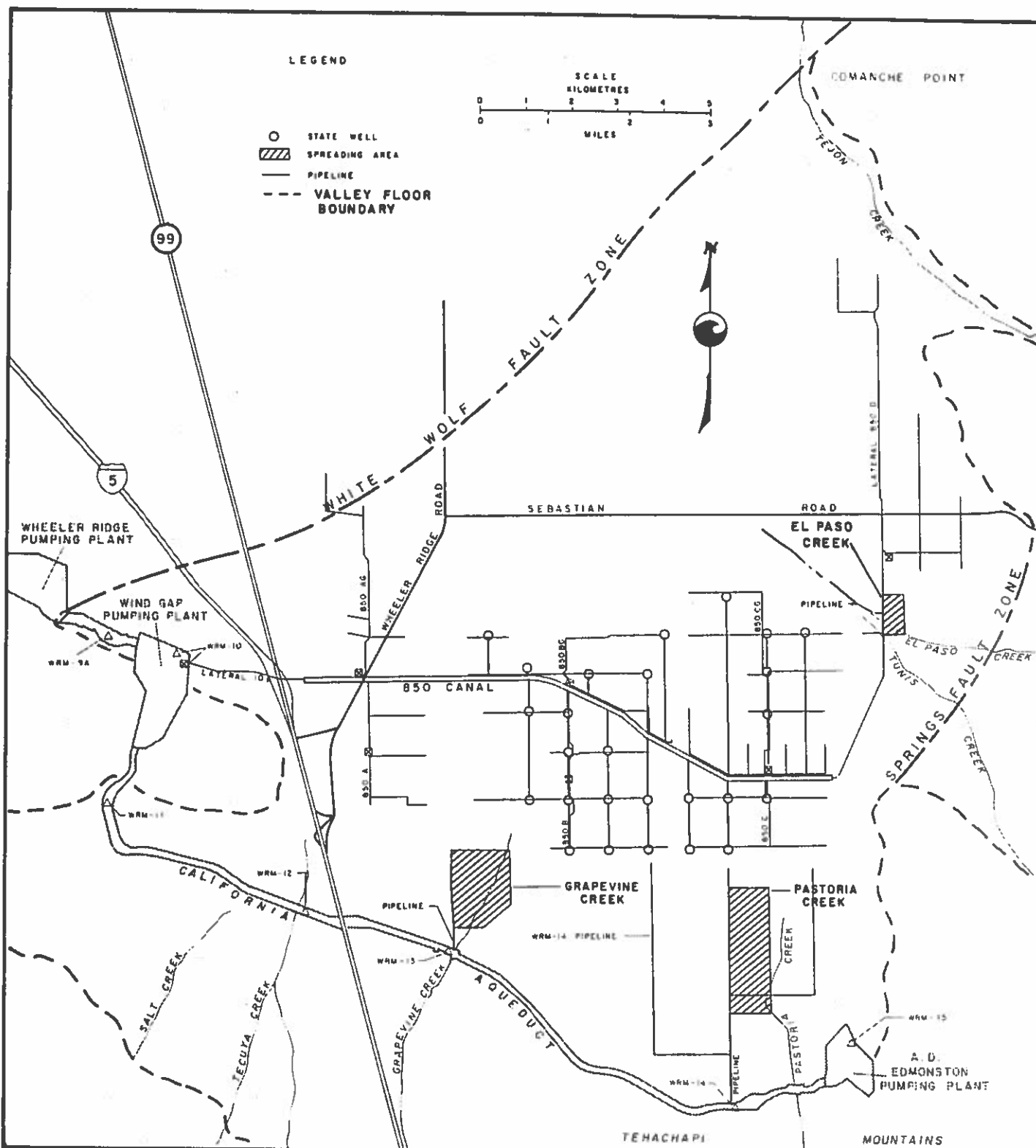


FIGURE 7 — POTENTIAL RECHARGE AND RECAPTURE FACILITIES

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1979

Pastoria Creek Area

The Pastoria Creek area (Figure 7) is served by water from Wheeler Ridge - Maricopa WSD's turnout number 14, a 1 320-millimetre (52-inch) concrete gravity turnout with a design capacity of 2 cubic metres (70 cubic feet) per second. The State would need to obtain land and construct a pipeline, spreading facilities, roads, and fencing.

In the Pastoria Creek area, about 6.0 cubic hectometres (4,830 acre-feet) of water could be spread per month. The State would need to provide additional turnout capacity of 1.7 cubic metres (60 cubic feet) per second to supplement capacity of the existing Wheeler Ridge - Maricopa WSD turnout. About 129 hectares (318 acres) of spreading basins would be required plus additional land for access roads, spreading basin banks and slopes, and fencing.

The cost for additional facilities required to spread this water is \$4,214,300.

The advantages of using the Pastoria Creek area are: (1) water can be delivered from the California Aqueduct by gravity flow; (2) there is already water service to the area; and (3) it is one of the areas where there is maximum infiltration of surface water.

The disadvantages are: (1) the land has been developed by Tejon Ranch Company and irrigation systems have been installed and are in use; (2) depth to water is more than 305 metres (1,000 feet); (3) it is about 2.0 kilometres (1-1/4 miles) from the California Aqueduct; (4) it is about 1.6 kilometres (1 mile) to areas that have potential as recapture areas; (5) channel modification would be required to minimize or prevent erosion of surface materials; and (6) the possibility of saline water exists in dewatered zones along the fringe of the basin.

El Paso Creek Area

Land in the El Paso Creek area (Figure 7) could be served from the 850 Canal through the 850D Lateral. This lateral of the canal system has capacity to convey 1.4 cubic metres (50 cubic feet) per second by gravity flow to lands west and north of the El Paso Creek area. Just as in the case of Grapevine and Pastoria Creeks, spreading areas would have to be obtained and developed.

About 1.2 cubic hectometres (1,000 acre-feet) of water could be spread per month using excess capacity in the 850D Lateral. Water could be spread on 26.7 hectares (66 acres) of land at a rate of 0.5 cubic metre (17 cubic feet) per second. Additional land would be needed for access roads, embankments, and fencing.

The cost for additional facilities required to spread this water is \$784,000. Costs for conveying water through the 850 Canal system (Table 11) including operations and maintenance costs would be \$125.95 per cubic hectometre per kilometre (\$.25 per acre-foot per mile).

The advantages of using the area are: (1) it is one of the areas where infiltration of surface water is the greatest; (2) the 850 Canal system delivers water in the vicinity; (3) the land has not been developed for irrigation; and (4) depth to water is about 185 metres (600 feet), which is less than in other potential recharge areas. Disadvantages of using the El Paso Creek site are: (1) water would have to be conveyed more than 18 kilometres (10 miles) through the 850 Canal system and costs including energy would be large (see Table 11); (2) water could only be delivered during months when 850 Canal system capacity is available, and available capacity is limited; and (3) the site is about 1.6 kilometres (1 mile) from potential recapture areas.

The El Paso Creek area may be used for a Wheeler Ridge -

TABLE 11

COSTS FOR CONVEYANCE TO EL PASO CREEK SPREADING AREA

From WRM - 10 Turnout through the 850 Canal

Item	(English Units)			(Metric Units)		
	Unit charge per acre-foot	Distance	Cost per acre-foot	Unit charge per cubic hectometre	Distance	Cost per cubic hectometre
Conveyance	\$0.15/mile	10 miles	\$1.50	\$75.56/kilometre	16.1 kilometres	\$ 1,216.05
Operation and Maintenance	0.10/mile	10 miles	1.00	50.38/kilometre	16.1 kilometres	810.70
Power			<u>4.30</u>			<u>3,486.02</u>
TOTAL			\$6.80/AF*			\$ 5,512.77/hm ³ *

*Subsequent discussions with Wheeler Ridge - Maricopa WSD indicate that \$19.00/AF (\$15,403/hm³) is charged other entities for conveyance of water. These charges include repayment of capital costs of facilities plus operations, maintenance, and replacement. Also, power costs have increased to \$8.50/AF (\$6,891/hm³). Therefore, the total cost for conveyance to El Paso Creek Spreading Area is now \$27.50/AF (\$22,294/hm³). This increased cost is not reflected in ensuing calculations.

Maricopa WSD ground water storage program. This would reduce the availability of the 850 Canal, the 850D Lateral, and the El Paso Creek Spreading Area for a State ground water storage program.

Spreading Operation and Maintenance Costs

Operations and maintenance costs for spreading are estimated to be \$2,432 per cubic hectometres (\$3 per acre-foot). The monthly and annual amounts would depend on the amount of water available for spreading and the number of months water could be obtained for spreading.

Recapture Facilities

The State would need to construct wells to recapture stored SWP water. Existing private wells are used by their owners and would not be available for the program. However, it may be possible for the State to share the cost of constructing some new wells to replace existing wells that need to be replaced and to share the use of these wells with well owners.

A preliminary proposal for State operations would require 26 wells. The number of wells is based on extraction of the average annual dry-period yield values of 29.6 cubic hectometres (24,000 acre-feet) with 19.4 percent delivered in the peak month and ten percent downtime.

Tentative well locations (see Figure 7) are at least 0.8 kilometre (0.5 mile) from existing or proposed wells to avoid interference with local pumping. The well locations are adjacent to Wheeler Ridge - Maricopa WSD's pipelines.

Wheeler Ridge - Maricopa WSD may develop 13 wells for a local ground water storage program in this area. It is possible that State wells, when added to a District well field, could cause interference with existing wells or proposed District wells.

All well characteristics are as follows: The wells could be

457 metres (1,500 feet) deep, gravel packed, and have a 406-millimeter (16-inch) casing. It is expected that the average yield would be 5 680 litres (1,500 gallons) per minute and the average depth to water would be 244 metres (800 feet).

A 298-kilowatt (400-horsepower) motor was selected to lift 5 680 litres (1,500 gallons) per minute from 244 metres (800 feet). 328 kilowatts (440 horsepower) would lift 5 262 litres (1,390 gallons) per minute from 274 metres (900 feet) (ten percent overload is permitted). Future lifts should be less since water levels are expected to rise about 0.6 metre (2 feet) per year, and when the full State amount, 219.6 cubic hectometres (178,000 acre-feet), is in storage, it will temporarily raise water levels over 6.1 metres (20 feet).

Power requirements are as follows: With an overall plant efficiency of 65 percent, 4 189 kilowatt hours per cubic hectometre per metre (1.575 kilowatt hours per acre-foot per foot) of lift are required. With 26 wells to produce 29.6 cubic hectometres (24,000 acre-feet), each well produces 1.14 cubic hectometres (923 acre-feet). With a 244-metre (800-foot) lift, each well uses 1,162,980 kilowatt hours per year (4 189 x 244 metres x 1.14 cubic hectometres = 1,162,980).

The previously described well and pumping unit would cost:

Initial Cost Per Well

1. Drill, case, log and develop 457-metre (1,500-foot) well at \$197 per metre (\$60 per foot).

$$457\text{m (1,500 feet)} \times \$197/\text{m } (\$60/\text{foot}) = \$ 90,000$$

2. Pump, motor, and accessories

298 kilowatts (400 horsepower) at \$322 per kilowatt (\$240 per horsepower).

$$298 \text{ kW (400 hp)} \times \$322/\text{kW } (\$240/\text{hp}) = \underline{96,000}$$

Subtotal \$186,000*

*Subsequent discussions with the Wheeler Ridge - Maricopa WSD indicate the initial cost per well may be \$230,000. This increased cost is not reflected in ensuing calculations.

Total initial cost for 26 proposed wells and equipment = \$4,836,000.

Annual Cost Per Well

1. Operations, maintenance, and repair

\$8.04 per kilowatt (\$6 per horsepower)

\$8.04 per kW (\$6 per hp) x 298 kW (400 hp) = \$ 2,400

2. Energy cost (PG and E Schedule PA-1, dated

April 12, 1977)

a. Service charge

298 kilowatts (400 hp) x 0.5 + \$16.30/mo x
12 months = 2,596

b. Energy charge

(1) First 400,000 kilowatt hours x 0.01442 5,768

(2) Next 400,000 kilowatt hours x 0.01032 4,128

(3) Remaining 362,980 kilowatt hours x 0.00642 = 2,330

c. Energy cost and fuel collection balance

adjustments (0.03064 - 0.00047) 1,162,980 = 35,087

Subtotal 52,309

Total annual cost for proposed 26 wells = \$1,360,034

Recapture Costs

Operations, Maintenance, and Repair

of Wells, Motors, Pumps and

Collection Facilities (OM&R):

\$8.04/kW (\$6/hp) x 298 kW (400 hp)

per well x 26 wells = \$ 62,400

\$62,400 24,000 AF = \$ 2.60/AF

Power = Power Cost @ \$49,909/well x

26 wells = 1,297,634

\$1,297,634 24,000 AF = 54.07/AF

Total \$1,360,034 \$56.67/AF

Collection Facilities

The collection facilities to carry the water from wells to the 850 Canal for distribution will consist of 29 kilometres (18 miles) of various sized pipes. They will cost \$4,276,800 (Table 12).*

Allocation of Costs

In order to compare using this basin as an element in the SWP future supply with other proposed elements, preliminary cost evaluations were made to determine those costs and savings, which could be estimated at this time, of a program implemented according to the storage and recapture plan shown in Figure 6. As with the other ground water basin storage reconnaissance level studies, only costs above and beyond that of normal operation, which could be developed at this time, were considered. All costs are based on January 1978 price levels except the Variable Portion of the SWP Transportation Charge which is at 1984 unit prices to reflect the anticipated higher energy costs.** The actual costs and methods of financing and repayment will be the subject of further discussions and negotiations among the water supply contractors and DWR when specific projects have been defined.

The preliminary cost evaluations include costs for the five-year initial fill period as well as the 50-year operational period.

*The development of a ground water storage program by Wheeler Ridge - Maricopa WSD would fulfill much of the requirements of the overlying lands. Therefore, recapture in a State ground water storage program would require conveyance of a portion of the extracted water to the California Aqueduct for export at additional cost.

**It should be noted that any power rate changes that may influence the SWP Variable OMP&R Transportation Charge are not taken into account. Also not taken into account is the increase in the Delta Water Charge due to the distribution of the costs of this program among the water supply contractors. The ground water basin would be considered a SWP conservation storage facility.

TABLE 12

COLLECTION FACILITIES

Between proposed State wells and the 850 Canal

Well Location	Location Code*	Distance to 850 Canal		Cost**
		Metres	Feet	
11N/18W-19	w			
-30	w			
-30	nw	2,897	9,504	\$427,680
11N/18W-31	w	483	1,584	71,280
11N/18W-19	c	2,897	9,504	427,680
11N/19W-13	s	3,701	12,144	546,480
11N/19W-21	c	805	2,640	118,800
11N/19W-22	sw	80	264	11,880
11N/19W-22	se	483	1,584	71,280
11N/19W-23	e	2,253	7,392	332,640
11N/19W-23	s	1,287	4,224	190,080
11N/19W-27	w			
-34	w	2,494	8,184	368,280
11N/19W-27	c			
-27	s			
-34	c			
-34	s	3,219	10,560	475,200
11N/19W-26	sw			
-35	w			
-35	sw	2,816	9,240	415,800
11N/19W-35	c			
-35	s	2,253	7,392	332,640
11N/19W-36	w			
-36	sw	1,851	6,072	273,240
11N/19W-36	c			
-36	s	1,448	4,752	213,840
TOTALS		28,967	95,040	\$4,276,800
*c - center of section s - due south of center of section e - due east of center of section w - due west of center of section sw - due southwest of center of section nw - due northwest of center of section se - due southeast of center of section		** Cost per metre is \$147.64, which is equal to \$45.00 per foot.		

Total costs, including construction, storage, and energy, were determined for each year and were brought forward or discounted to the initial operation date (present worth year). The interest or discount rate used was six percent. The cost evaluations were based on information from local agencies and DWR.

Initial construction costs for all recharge and recapture facilities are summarized in Table 13 and operational costs in Table 14. Table 15 summarizes the results of the preliminary cost evaluation and shows that the net present worth cost of the program to the State would be about \$39,865,000. These estimated costs are only for comparison with similar costs developed for other reconnaissance-level studies. No precedent exists for evaluating what the costs may total once negotiations are completed for a long-term ground water basin storage program.

The annual cost of the average annual dry-period yield would be \$85,430 per cubic hectometre (\$105 per acre-foot). This cost was obtained by dividing the total present worth cost times the capital recovery factor over 50 years by the average annual dry-period yield. The total capital cost of implementing the ground water storage program would amount to \$24,235,000. This includes \$6,782,000 for the cost of water and energy for the initial fill period and \$17,453,000 for construction of pipelines, spreading basins, wells, and installation of pumps, motors, and other equipment.

Table 13
INITIAL CONSTRUCTION COSTS

Facilities	Cost
<u>Recharge Facilities</u>	
Grapevine Spreading Basin	\$3,290,400
Pastoria Creek Spreading Basin	4,214,300
El Paso Creek Spreading Basin	784,000
TOTAL	\$8,288,700
<u>Recapture Facilities</u>	
Wells, Pumps, Motors and Accessories	
26 wells x \$186,000 each =	\$4,836,000
Collection Facilities	
29 kilometres (18 miles) of pipeline x	
\$148/lineal metre (\$45/lineal foot) =	4,276,800
Well Sites and Road	
6.9 hectares (17 acres) x \$7,413/hectare	
(\$3,000/acre) =	51,000
TOTAL	\$9,163,800

Table 14
OPERATIONAL COSTS

Operational Years	Operation	Amount in \$/AF
-5 to -1	Recharge	\$38.10 ^{a/}
1 to 50	Recharge	3.68 ^{b/}
1 to 50	Recapture	56.67 ^{c/}

- ^{a/} Includes variable portion of the SWP Transportation Charge and the incremental charge for 850 canal (\$35.10/AF) plus spreading basin O&M cost (\$3/AF).
^{b/} Includes 850 canal incremental charge plus spreading basin O&M costs.
^{c/} Includes OM&R (\$2.60/AF) plus power (\$54.07).

TABLE 15

COSTS FOR OPERATION OF GROUND WATER STORAGE PROGRAM

PROJECT YEAR	CONSTRUCTION COSTS	AMOUNT STORED (ACRE-FEET)*	STORAGE COSTS	AMOUNT RECAPTURED (ACRE-FEET)*	RECAPTURE COSTS	COST FOR PROJECT YEAR	PRESENT WORTH FACTOR	PRESENT WORTH (\$ x 10 ³)
-6	\$8,288,700					\$8,288,700	1.3382	\$11,092
-5		58,000	\$2,209,800			2,209,800	1.2625	2,790
-4							1.1910	
-3							1.1236	
-2							1.0600	
-1	9,163,800	120,000	4,572,000			13,735,800	1.0000	13,736
1					\$ 15,000	15,000	0.9434	14
2					15,000	15,000	0.8900	13
3				24,000	1,360,080	1,360,080	0.8396	1,142
4					15,000	15,000	0.7921	12
5				24,000	1,360,080	1,360,080	0.7473	1,016
6		30,000	110,400		15,000	125,400	0.7050	88
7				16,000	906,720	906,720	0.6651	603
8				24,000	1,360,080	1,360,080	0.6274	853
9				24,000	1,360,080	1,360,080	0.5919	805
10				24,000	1,360,080	1,360,080	0.5584	759
11				24,000	1,360,080	1,360,080	0.5268	716
12				24,000	1,360,080	1,360,080	0.4970	676
13				24,000	1,360,080	1,360,080	0.4688	638
14					15,000	15,000	0.4423	7
15	2,496,000				15,000	2,511,000	0.4173	1,048
16					15,000	15,000	0.3936	6
17		30,000	110,400		15,000	125,400	0.3714	46
18				24,000	1,360,080	1,360,080	0.3503	476
19					15,000	15,000	0.3305	5
20	2,340,000				15,000	2,355,000	0.3118	734
21		20,000	73,600		15,000	88,600	0.2942	26
22		50,000	184,000		15,000	199,000	0.2775	55
23				24,000	1,360,080	1,360,080	0.2618	356
24					15,000	15,000	0.2470	4
25					15,000	15,000	0.2330	3
26				24,000	1,360,080	1,360,080	0.2198	299
27					15,000	15,000	0.2074	3
28				24,000	1,360,080	1,360,080	0.1956	266
29					15,000	15,000	0.1846	3
30	2,496,000	50,000	184,000		15,000	2,695,000	0.1741	469
31					15,000	15,000	0.1643	2
32		50,000	184,000		15,000	199,000	0.1550	31
33					15,000	15,000	0.1462	2
34				24,000	1,360,080	1,360,080	0.1379	188
35					15,000	15,000	0.1301	2
36					15,000	15,000	0.1227	2
37		50,000	184,000		15,000	199,000	0.1158	23
38				24,000	1,360,080	1,360,080	0.1092	149
39	2,340,000				15,000	2,355,000	0.1031	243
40				24,000	1,360,080	1,360,080	0.0972	132
41					15,000	15,000	0.0917	1
42		45,000	165,600		15,000	180,600	0.0865	16
43				24,000	1,360,080	1,360,080	0.0816	111
44					15,000	15,000	0.0770	1
45	2,496,000				15,000	2,511,000	0.0727	183
46					15,000	15,000	0.0685	1
47					15,000	15,000	0.0647	1
48					15,000	15,000	0.0610	1
49		50,000	184,000		15,000	199,000	0.0575	11
50		25,000	92,000		15,000	107,000	0.0543	6
TOTAL PRESENT WORTH COST								\$39,865,000

*SEE OVER FOR EXPLANATION OF COSTS.

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EXPLANATION OF COSTS ON TABLE 15

1. During the initial filling period (project years -5 to -1) the cost per acre-foot to store water would be \$38.10 (Table 14). During the 50-year operational period, the cost per acre-foot to store water would only be \$3.68 (See Table 14).
2. During recapture, the cost for energy, as well as operation and maintenance, would amount to \$56.67 per acre-foot. For the years when the wells aren't in use (times of storage) a \$15,000 annual maintenance fee would be incurred.
3. In project year -6, the construction of turnouts, pipelines, and spreading facilities would cost \$8,288,700 (See Table 13).
4. In project year -1, the construction of wells (with pumps, motors, and pipelines) would cost \$9,164,000 (See Table 13).
5. In project years 15, 30, and 45 (15-year intervals) well pumps and motors would be replaced (See page 46 for cost per well).
6. In project years 20 and 40, all 26 wells would be reconstructed (See page 46 for cost per well).

V. ENVIRONMENTAL ASSESSMENT

A cursory environmental assessment of the proposed ground water storage program impacts that implementation of this program might have on the environment reveals the following possible effects. A general description of the environmental setting is provided in Chapter II, "Ground Water Basin".

Power Requirements

Power would be required to pump SWP water, designated for storage, from the Sacramento-San Joaquin Delta to the A. D. Edmonston Pumping Plant. This power would be required regardless of whether this ground water storage program is implemented or not. SWP water for direct storage would flow by gravity from the California Aqueduct to Grapevine Creek and Pastoria Creek spreading grounds, but additional power would be required to deliver water via the 850 Canal to the El Paso Creek spreading grounds. Additional power would also be required when stored SWP ground water is extracted from White Wolf Basin instead of SWP water being released from the California Aqueduct for delivery to Kern County Water Agency.

Each cubic hectometre of water in storage would raise water levels in the basin. As a result of higher ground water levels, while SWP water is in storage, pumping lifts would decrease. A significant increase in the volume of storage in White Wolf Basin could directly benefit local ground water users by reducing the power demand involved in pumping ground water.

Ground Water Basin Impacts

The spreading of SWP water and extraction of stored water in White Wolf Basin during a ground water storage program would change the amount of water which would otherwise be in storage. The possibility exists that the spreading and extraction operations could modify the characteristics of the alluvium (i.e. permeability) in the basin. However, it is

expected that such effects would be minimal. Operation of the basin as a ground water storage facility could also alter the present hydraulic gradient. In addition, the present direction of flow could be affected by spreading a large amount of SWP water. The recapture of stored SWP water could result in the development of pumping depressions near the sites of extraction.

White Wolf Basin has a ground water level and quality monitoring program. In the event a large-scale ground water basin storage program is undertaken in the basin, the monitoring program would have to be expanded to record any significant changes in water levels or water quality that might result.

Major Construction Impacts

Construction required for direct storage would consist of the installation of turnouts, water-conveyance facilities, spreading grounds, wells, and distribution facilities.

The usual construction impacts, such as dust and noise, can be expected. However, due to rural location, construction hazards to the public, such as open excavation and traffic obstruction, would be minimal. The noise and dust would only affect the construction workers and the local wildlife. Sprinkling of water would reduce the dust. The construction equipment used would comply with noise standards in the California Occupational Safety and Health Act of 1973. Local wildlife, however, could still be displaced. It is expected that when construction ceases, the wildlife would return.

Social Impacts

Potential or existing agricultural production area would decrease by 690 acres should all the proposed spreading grounds be built.

Valley fever (coccidioidomycosis) is endemic to the Southern San

Joaquin Valley. Residents of the area seem to be immune to the disease, but for construction workers, who may be nonresidents, valley fever poses a special problem. The infection, transmitted by inhaling the infectious spores, is characterized by fever, cough, chest pain, headache, and malaise.

Construction workers can prevent spore inhalation by wearing light-weight dust masks. Also, before any work begins, all workers should be informed about valley fever and given a valley fever skin test. This test determines if a person is resistant to, or currently infected with, the disease.

The main vector that could cause problems is the mosquito. Direct recharge facilities could be mosquito breeding areas. Use of mosquito abatement techniques would keep the mosquitos under control. In Kern County, spraying with parathion is often used.

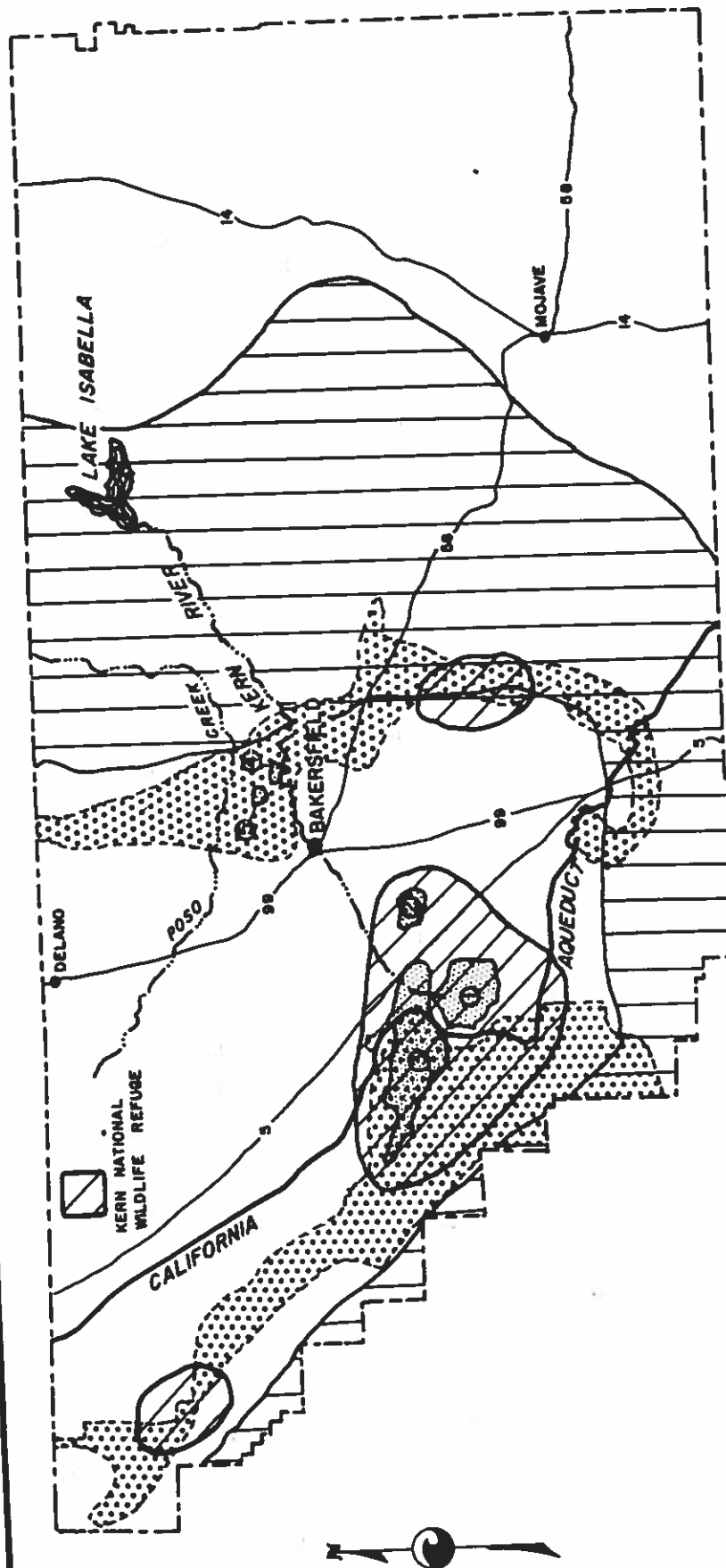
Endangered Species (Plants and Animals)

This area is open range land and the only animals which would be displaced are rabbits, field mice, and other rodents.

The area along the southern fringes of the White Wolf Basin supports both the rare San Joaquin kit fox (Vulpes macrotis mutica), and the endangered American peregrine falcon (Falco peregrinus anatum). The blunt-nosed leopard lizard (Crotaphytus wislizenii silus) may be found in the vicinity of the northeast boundary of the basin (Figure 8).

The American peregrine falcon is a medium-sized blue-gray hawk that breeds along the coast and higher inland mountains. Due to food chain contamination by persistent pesticides, illegal taking by falconers, shooting by hunters, and destruction of its habitat, the breeding population has declined since the 1940s. There were only eight known breeding pairs in California in 1975.

The blunt-nosed leopard lizard is a gray or brown lizard



NATURAL AREAS

- | | |
|---|-------------------------------------|
| AMERICAN PEREGRINE
FALCON BREEDING RANGE | ① BUENA VISTA LAKE AREA |
| NORMAL SAN JOAQUIN
KIT FOX RANGE | ② BUENA VISTA MESQUITE AREA |
| BLUNT-NOSED LEOPARD
LIZARD RANGE | ③ ELK HILLS NAVAL PETROLEUM RESERVE |
| | ④ KERN RIVER BLUFFS |
| | ⑤ SHARK TOOTH HILL |

FIGURE 8 - SIGNIFICANT NATURAL AREAS

measuring 3-1/2 to 5 inches from nose to vent. It inhabits sparsely vegetated plains, alkali flats, grasslands, foothills, and arroyos of Kern and Tulare Counties. Subdivisions, water control, and expanding agricultural developments have caused the lizard's decline.

Since the area of the proposed spreading facilities (690 acres) is approximately one percent of the total White Wolf Basin, and because all possible precautionary measures would be taken, there would be no major effect on this area. In fact, various migratory birds could use the spreading facilities as a resting area -- especially when there is water in the basins.

APPENDICES

APPENDIX A

CONDITIONS REQUIRED FOR STATE PARTICIPATION IN WHITE WOLF GROUND WATER BASIN

1. No water to be used for ground water replenishment in any year unless District receives full Table 1 supply under its contract with the Kern County Water Agency.
2. Department approves increase in buildup of Kern County Water Agency Table A and Agency approves increases in Table 1 firm as requested by Wheeler Ridge.
3. No replenishment water transmitted in canal at a time it will interfere with delivery of water on demand basis to District (or surplus water for District program).
4. Water to be delivered to District in same manner as if ground water program were not in existence - District not required to pump project ground water in lieu of surface supply.
5. No interference with any program, now or in the future, of District and landowners, with respect to use of ground water basin.
6. There must be proof that ground water table has risen as a result of Department replenishment before any water withdrawn for project purposes.
7. Department must recognize and acknowledge that District has an ongoing direct ground water operation in White Wolf Basin and must fully recognize rights of District and overlying landowners.
8. Under no condition shall State withdraw water in any one year in sufficient quantity to cause a drop in ground water level of more than 20 feet.
9. No well constructed for removing stored ground water shall be within one-half mile of landowner or District well.
10. Program must receive concurrence of Board of Directors of both Wheeler Ridge and Arvin-Edison Districts, as representatives of overlying landowners.
11. State facilities to be available to local Districts for local use when needed.

APPENDIX B

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