PLAZA BUILDERS, INCORPORATED

GROUND WATER AVAILABILITY
FOR THE
PROPOSED BLACK LAKE GOLF COURSE
DEVELOPMENT PROJECT

Groundwater availability for,
The Black Lake Golf Course,
,
James M. Montgomery,
#0030, Studies and Reports,
06/01/82,

JUNE 1982

JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.

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JAMES M. MONTGOMERY, CONSULTING ENGINEERS, INC.
1000 Mill Street, San Luis Obispo, California 93401 / (805) 544-6050

June 25, 1982

Plaza Builders, Incorporated
16800 Devonshire Street
Granada Hills, California 91344

Attention: Mr. Donal D. Engen, A.I.A

Subject: Report "Ground Water Availability for the Proposed Black Lake Golf Course Development Project"

Gentlemen:

Submitted herewith is the final report "Ground Water Availability for the Proposed Black Lake Golf Course Development Project" which has been prepared by James M. Montgomery, Consulting Engineers, Inc. pursuant to our Agreement of July 24, 1981 with Plaza Builders, Incorporated and subsequent instructions, both written and oral, from your Mr. Donal D. Engen, A.I.A. In accordance with your request, ten (10) copies of the Executive Summary are being furnished to you separately.

We wish to thank Plaza Builders, Incorporated for selecting us to work on this challenging project on your behalf and for the cooperation and courtesies extended to us during this important phase of our engineering investigations. We will await further instructions before proceeding with additional work.

Respectfully submitted,

JAMES M. MONTGOMERY,
CONSULTING ENGINEERS, INC.

Charles H. Lawrance
Project Engineer

Karl H. Wiebe
Vice President

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June 1982

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TABLE OF CONTENTS

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TABLE OF CONTENTS (Contd.)

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LIST OF TABLES

LIST OF FIGURES

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EXECUTIVE SUMMARY
OF
REPORT ON GROUND WATER AVAILABILITY FOR PROPOSED BLACK LAKE PROJECT

by

James M. Montgomery, Consulting Engineers, Inc.

This is an Executive Summary of the Final Report on the technical study of ground water resources in Nipomo Mesa related to the proposed recreational-residential development known as "Black Lake Project." The purpose of the study was to determine the adequacy of available ground water in Nipomo Mesa as a source of water supply for the Black Lake Project. The following report presents pertinent information such as the occurrence of ground water supplies, the estimated water demand of the project, current regional patterns of ground water use, and estimates of the project-related impacts to the local and regional ground water conditions.

This Executive Summary employs a Question-and-Answer format. The summary presents the salient aspects of the project related to the adequacy of available ground water within the context of 13 questions. For simplicity, the answers to the 13 questions which follow are somewhat abbreviated. The following report presents more detailed discussions of the project and additional background data and supporting information.

1) **What is the total available supply of ground water for the Nipomo Mesa?**

Total available supply is hereby defined as the annual amount of ground water flowing into the Nipomo Mesa aquifer system LESS the annual amount of ground water flowing from Nipomo Mesa aquifer system to the sea. Inflow and outflow from the aquifer system are variable from year to year and may be influenced by a variety of factors. Therefore, for the purposes of this study, the long-term averages of inflow and outflow are considered to be representative. Based upon these averages, the total available ground water supply in Nipomo Mesa study area is estimated to be 4,540 acre-feet per year (AFY).

2) **How was this available supply determined?**

The California Department of Water Resources (DWR) prepared a district report in June 1979 entitled, "Ground Water in the Arroyo Grande Area." The report presented itemized estimates of the inflow and outflow for the Nipomo Mesa ground water basin. Those original estimates were revised by JMM based on the results of field investigations and consultation with DWR. The estimate of the total available supply was derived from the following calculation:

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TOTAL AVAILABLE SUPPLY (T.A.S.)

T.A.S. = INFLOW - OUTFLOW TO SEA

Inflow = Percolation of Precipitation + Subsurface Seepage + Return Water

Percolation of Precipitation	3300 AFY
Subsurface Seepage	500
Return Water	1000
INFLOW (TOTAL)	4800
OUTFLOW TO SEA	260 AFY
TOTAL AVAILABLE SUPPLY	4540 AFY

3) **How is this total available supply presently distributed?**

The present (1977) distribution of the total available supply has been estimated by DWR as follows:

Applied Irrigation	2000 AFY
Urban Supply	300 AFY
Industry Cooling Water	650 AFY
Subsurface Outflow to Arroyo Grande (North)	225-300 AFY
Subsurface Outflow to Santa Maria Valley (South)	2300-2800 AFY
TOTAL	5475-6050 AFY

In the future, the ground water distributed to subsurface outflow to the north and south will be reduced, if not eliminated, because of the manner in which the sub-basin will be operated. As a result, the ground water distributed to subsurface outflow to the north and south will be available for local basin usage (see Figure 1). On this basis, the comparison between total available supply and the present distribution does not indicate an overdraft condition.

4) **Is the Nipomo Mesa presently in an overdraft situation?**

No, it does not appear to be in an overdraft condition, based upon ground water studies performed by the DWR and JMM. In January 1980, the DWR published Bulletin 118-80 which presented the results of its State-wide evaluation of ground water basins in California. That report did not identify any ground water basins wholly within San Luis Obispo County as experiencing critical conditions of overdraft. Bulletin 118-80 stated that "A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts."

In 1979, the DWR evaluated the Arroyo Grande area and reported that the quantity of ground water in storage at elevations above sea level in Nipomo Mesa appeared to be adequate to meet the water demand until at least the year 2000. The DWR indicated that as long as ground water levels remained above sea level, saline intrusion of the coastal aquifers was not likely. Ground water levels measured from 1967 to 1980 in

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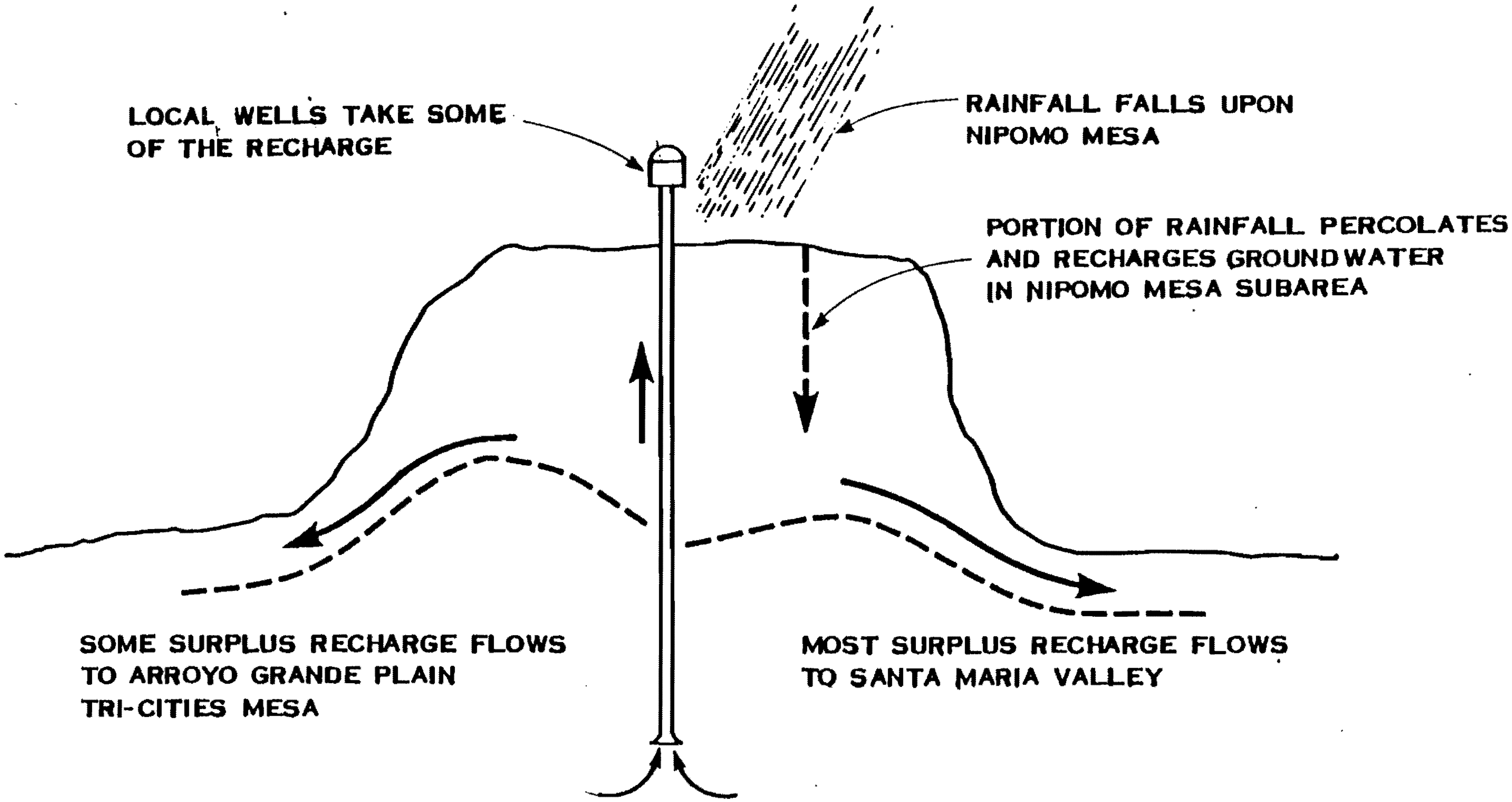

SCHEMATIC OF SURPLUS GROUNDWATER OVERFLOWING TO ADJACENT SUBAREAS

FIGURE 1

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representative coastal wells appear to be relatively stable. The coastal monitoring wells have maintained water levels above sea level from 1975 to 1981.

5) **How do supply distribution figures relate to other data on available supply from the DWR, the San Luis Obispo County Engineer and the Land Use Element?**

The estimates of outflow are based on the previously referenced report for the Arroyo Grande area prepared by the State in 1979, and on revised estimates provided to JMM by DWR. The County's Land Use Element (LUE) and the San Luis Obispo County (SLOCO) South County Planning Area document indicate that the 1979 DWR report contains the most up-to-date information on the ground water resources of Nipomo Mesa. On that basis, the supply figures presented herein are in agreement with those of DWR, the SLOCO Engineer and the LUE.

6) **Is the available supply adequate to meet the demands for agriculture and development on the Nipomo Mesa to the year 2000?**

When available basin storage is considered, there will be sufficient water as stated in the DWR 1979 report and confirmed by JMM analyses, although the supply available solely by recharge will not be adequate to meet either the DWR projected demands or those implied by the LUE.

JMM analyses of the year 2000 water demands used the following assumptions. The Land Use Element provided population projections and growth rates, irrigated agricultural acreage, historic growth rates and ultimate agricultural acreage for the South County. Although these parameters provide some input, the water use factors and irrigated acreage within land use categories other than agriculture were not provided. As a result, certain assumptions were made by JMM in order to project year 2000 water use. Combining the Nipomo and one-fifth of the South County rural (based on proportion of rural acreage in Nipomo Mesa to the South County) populations and using a water use factor of slightly over 130 gallons per capita per day (gpcd), domestic and urban water use would be approximately 1400 AFY. Assuming complete development of agricultural acreage, golf course, and cemetery acreage and 5 percent of rural and residential rural categories under irrigation, the irrigation water requirement would be about 5430 AFY. Industrial development is projected to increase at a similar rate to population and therefore the industrial water requirement would be about 975 AFY in year 2000.

There will be some returnflow to the ground water basin of about 30 percent of domestic and urban water use and 20 percent of irrigation water use, the total of which would be about 1507 AFY. There is allowed in the long term annual yield 1000 AFY of returnflow. The net additional returnflow would be about 510 AFY. Reducing the total water use on Nipomo Mesa by additional returnflow would result in a projected year 2000 water use of 7300 AF.

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7) **How much of the available supply does the existing Black Lake Public golf course facility utilize?**

The existing Black Lake Public golf facility has an estimated consumptive use requirement of approximately 400 AFY, of which effective rainfall satisfies about 13 percent. Pumpage of irrigation water is estimated to be about 464 AFY. This comprises the bulk of the golf course's consumptive use, some evaporation losses, and some returns to the ground water basin. The pumpage is not metered, but the theoretically calculated amount is 464 AFY. This is slightly over 10 percent of the total available supply of 4,540 AFY.

8) **How much supply would the proposed Black Lake Recreation/Residential Project utilize?**

The new development, which would be added to the present development, would consist of 9 holes of new public golf course (with 45 acres of irrigated fairways and greens), 38 acres of local residential landscaping (to be irrigated), 515 residences, a restaurant, a club house, an equestrian center, and a neighborhood commercial center. The increased pumpage from Nipomo Mesa attributable to the new development is estimated as 174 AFY for the additional golf course and 74 AFY for the local residential landscaping and miscellaneous "outside" uses, most of which would be consumed and evaporated. The residential and commercial water would not represent new pumpage, inasmuch as all of the resulting wastewater would be reclaimed and used for irrigation of the existing golf course in substitution of direct pumpage of well water. The existing golf course already requires some 464 AFY of ground water pumpage. The new development would increase percolation of rainfall and runoff somewhat so the consumptive losses from the new pumpage would be partially offset.

9) **How was the projected water use for the project calculated?**

The total water demand for the development is a summation of the water demand for the various project elements which comprise the projected residential and recreational aspects. The derivation of the projected water use for the project is presented diagramatically as Figure 2.

Residential use was divided into "Inside" and "Outside" uses. "Inside" use was calculated on the basis of population projections which include residents and visitors and appropriate per capita use factors. "Outside" use primarily considers irrigation of a limited area landscaped with vegetation which requires a moderate amount of water. Inside use water will ultimately be treated, blended with additional ground water, and used for irrigation on the public golf course.

Irrigation requirements for the golf course and landscape were based on the total golf course and landscape acreage, and appropriate factors for consumptive use. A modest percentage of the annual rainfall will be effective in supporting the golf course irrigated areas and other landscaped areas. Pumpage requirements for the 9 hole golf course and

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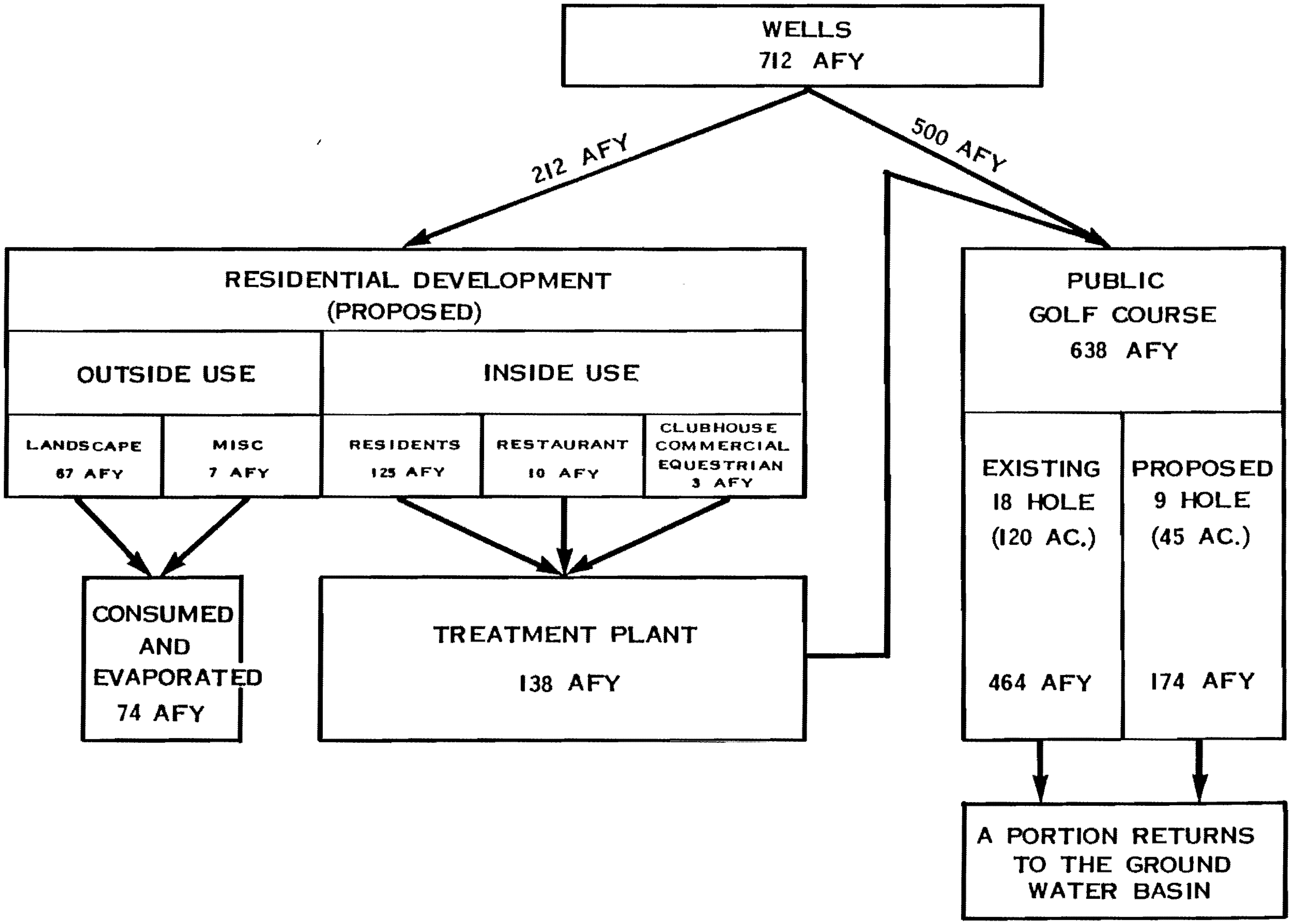

WATER USE DIAGRAM
PROPOSED BLACK LAKE PROJECT

FIGURE 2

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residential landscape area are estimated at 174 AFY and 67 AFY, respectively.

10) **Will projected water use requirements for the proposed Black Lake Project have significant effects on other water purveyors on the Mesa?**

No, based upon a JMM analysis of pumping from both the proposed Black Lake Project wells and the nearest public supply well, the Bevington Well of Nipomo Community Services District. This indicates that the increased extractions (averaging about 154 gpm on a continuous basis) attributable to the project will increase the pumping drawdown of the Bevington Well by about 2 feet over a period of 3 years after the Black Lake Project is fully developed. Other public supply wells of the District are more distant from the Black Lake wells and would experience even less effect. The wells of California Cities Water Company are also fairly remote and would not experience significant effect either.

11) **Will there be noticeable effects on the water supply or wells of nearby property owners?**

No, inasmuch as the private wells are even more distant from the Black Lake wells than the Nipomo Community Services District's Bevington Well. Drawdown impacts (if any) on these private wells are expected to be less than those calculated for the Bevington Well.

12) **What methods are available to reduce water consumption for the Black Lake Project?**

Various methods to reduce water consumption for the Black Lake project are available. These include: (1) use of reclaimed wastewater for golf course irrigation; (2) minimizing landscaped areas and use of native vegetative types with low water requirements; (3) reducing the golf course acreage which is irrigated (i.e., eliminating irrigation of rough areas); (4) use of water conserving faucets, shower heads and toilets; and (5) preparation of an evaluation of water efficiency on the existing golf course and implementation of its recommendations.

13) **Will the effluent from the proposed Black Lake project significantly pollute the ground water of the Nipomo Mesa, the Black Lake Canyon ponds and marsh areas nearby?**

No, based upon the proposed blending of secondary treatment plant effluent with native well water prior to application for golf course irrigation and the ability of the golf course and subsoil to absorb such effluent. After the irrigation return flow joins the ground water body, it will be further diluted and should have only a very minor impact, if any, on the water quality conditions of Nipomo Mesa and the Black Lake Canyon ponds and marshes. No softening of the water supply for the Project will be practiced if such would increase the salt contributions to the ground water.

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SUMMARY OF
FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The water adequacy study for the Black Lake Project consisted of review of the water requirements of the proposed development, an evaluation of local ground water conditions, a review of recent and projected land and water use involving the Nipomo Mesa, and an evaluation of impacts on the local ground water supply which would result from implementation of the Black Lake Project. A summary of the findings, conclusions, and recommendations reached as a result of this study is presented in the following paragraphs.

FINDINGS AND CONCLUSIONS

1. The project area is underlain by the Nipomo Mesa Ground Water Sub-basin. Ground water is stored and transmitted through the alluvial and marine sediments of the sub-basin. Adjacent sub-basins which receive ground waters from Nipomo Mesa Ground Water Sub-basin are Santa Maria Valley to the south and Arroyo Grande Valley to the north. Water-bearing zones of the Nipomo Mesa Ground Water Sub-basin also appear to be in hydraulic continuity with offshore aquifers.

2. The Black Lake Project covers an area of 515 acres and consists of an existing 18-hole (120-acre) golf course, a country club and restaurant, a proposed 9-hole (45-acre) golf course, a proposed equestrian center, a proposed 515 unit residential area, and a proposed neighborhood commercial center. Two water wells have been developed for irrigation of the existing golf course and limited domestic supplies. The two wells and perhaps a third well would provide the water necessary for the Black Lake Project in conjunction with the use of reclaimed wastewater for golf course irrigation purposes.

3. The California State Department of Water Resources (DWR) has estimated that in 1975, the Nipomo Mesa Ground Water Sub-basin contained 172,000 AF of ground water above sea level, and 1,000,000 AF of ground water below sea level within the aquifers. DWR also estimated that the quantity of water annually recharging the basin over the long term is 4,540 AF. These numbers have been reviewed and are accepted by JMM. In addition, there are fresh ground waters stored offshore of Nipomo Mesa.

4. The quality of ground waters underlying Nipomo Mesa generally conforms both to the USPHS Drinking Water Standards and to the water quality objectives of the CRWQCB with only isolated and minor exceptions. Ground water quality of supplies underlying Nipomo Mesa is generally superior to that found either to the north or south of the Mesa.

5. Based upon the results of ground water studies performed by the DWR and JMM, the Nipomo Mesa Sub-basin does not appear to be in an overdraft

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condition at the present time. However, overdraft could occur in the future if available water supply is not properly managed.

6. No evidence exists to date on the occurrence of sea water intrusion along the coast of Nipomo Mesa, based upon observations of ground water levels and mineral quality in coastal monitoring wells.

7. The water usage on Nipomo Mesa for two development conditions has been estimated as follows: (a) year 1977 - 2,950 AFY; and (b) year 2000 - 6,100 to 7,300 AFY.

8. The annual water usage of the completed Black Lake Project is estimated to be 712 AFY. The existing golf course uses an estimated 464 AFY. The increased requirement from ground water is therefore estimated at 248 AFY. The additional water usage would be approximately 5 percent of the long-term annual yield for the ground water sub-basin. Some of this additional requirement would be offset by increased percolation of rainfall and runoff attributable to the development. This increase or credit is estimated to be about 49 AFY.

9. The drawdown effects in the nearest production well due to the additional pumpage would be less than 5 feet. This effect is not considered to be significant in terms of pumping costs.

10. The return flow resulting from golf course irrigation will probably increase the total salt concentration in the underlying ground water basin by less than 1 mg/l per year at full buildout. Nitrogen and phosphorus in the reclaimed water are anticipated mostly to be taken up in the golf course vegetation and to have only a very small effect, if any, upon the ground water quality.

RECOMMENDATIONS

1. When the project expansion is undertaken, Plaza Builders should incorporate water conservation measures in the Black Lake Project in order to maximize the efficiency of the ground water used. This is particularly important on the irrigated golf course acreage and includes both the existing course and new course.

2. Plaza Builders should also maximize the facilities available for the percolation of runoff from the developed area by means of retention and percolation basins , and should minimize consumptive use losses to the extent possible.

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SECTION 1

INTRODUCTION

This report is the culmination of a ground water adequacy study for the proposed Black Lake Golf Course Development Project. The study covered the Nipomo Mesa ground water sub-basin with a particular emphasis on the project site and vicinity (see Figure 1-1). Plaza Builders retained James M. Montgomery, Consulting Engineers, Inc. (JMM), in July 24, 1981 prior to acquisition of the property to provide a professional appraisal of ground water resources and land and water use in Nipomo Mesa and vicinity.

SCOPE OF WORK

The work performed during this water adequacy study included the Stage One Work defined in the proposal/contract signed by JMM and Plaza Builders on July 24, 1981. These items are quoted below:

1. Define the Study Area.

2. Collect and review all relevant reports pertaining to local hydrology and hydrogeology.

3. Ascertain and interpret the nature of the Department of Water Resources data upon which the June 1979 Southern District Report "Ground Water in the Arroyo Grande Area" and the May 1981 Southern District Report "Water Action Plan for the San Luis Obispo-Santa Barbara Counties Area" were based.

4. Collect, review, and analyze well data on record with San Luis Obispo County for the Study Area.

5. Collect, review, and analyze rainfall data in the Study Area in conjunction with the historic ground water level data.

6. Collect and compile ground water extraction data readily available within the Study Area for public entities and private pumpers in supplementation of data available via Tasks 2 and 3.

7. Conduct a brief field reconnaissance of wells, recharge areas, and applied water areas of particular significance to the study.

8. Review relevant portions of the San Luis Obispo County General Plan (Land Use Element) and Specific Plan for the project.

9. Review relevant development reports and other information pertaining to the Black Lake Golf Course Development, including

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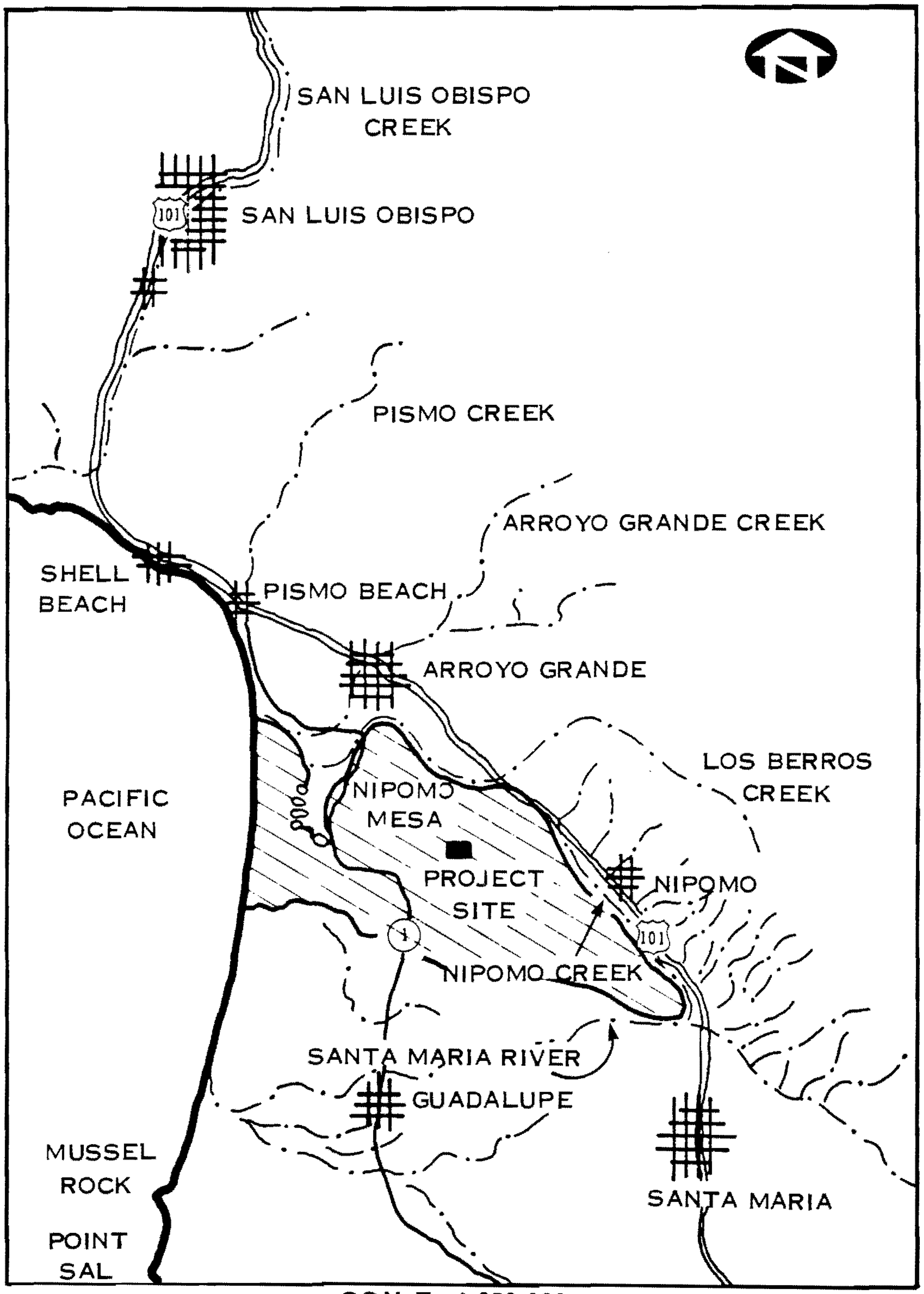

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STUDY AREA
LOCATION MAP
FIGURE 1-1

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aspects of water supply, sewage treatment and disposal, and recycling.

10. Obtain up-to-date information on water quality and wastewater effluent considerations from the Regional Water Quality Control Board, State Department of Health, Farm Advisors, and other sources as may be relevant to the Study Area and proposed project.

11. In the light of considerations of the foregoing, make a tentative finding as to the probable physical feasibility of providing adequate water supply for the proposed project to warrant proceedings with additional investigations.

12. Submit a brief progress report summarizing the work to date and findings thereof.

Upon verbal authorization from Plaza Builders, the Stage One Work was expanded to include (1) a brief investigation of the project's impact on ground water quality, (2) an elaboration of the project's water demand, (3) water balance calculations, (4) attendance at meetings by Mr. Lawrance, and (5) an executive summary and report summarizing the findings and conclusions reached during the investigation.

CONDUCT OF STUDY

This appraisal provided a basis for Plaza Builders' decision to proceed with planning for the Black Lake Project. The work performed prior to the initial appraisal included field reconnaissance, interviews with county and local officials and water purveyor representatives, review of available data, and office analyses. A progress report was presented to Plaza Builders on September 19, 1981 and an executive summary of the progress report on October 28, 1981. Further consulting for Plaza Builders was performed in the ensuing months on an "as needed" basis including reviewing the water demands required by various development plans and appearing at meetings with county planning team representatives and the Board of Supervisors.

This report presents our findings and conclusions concerning ground water availability, regional and site-specific land and water use, proposed development plans and water conservation.

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SECTION 2

PROPOSED BLACK LAKE PROJECT

The proposed Black Lake project is a residential/recreational development, located on a 515-acre parcel of land between Black Lake Canyon and Willow Road, west of Pomeroy Road. The existing improvements on this property consist of an 18-hole public golf course and country club and residences along Pomeroy Road. The proposed development would include a 9-hole addition to the existing public golf course, a new country club and restaurant, 515 residences, an equestrian center, and a neighborhood commercial site. The Envicom Corporation's January 7, 1982 Report "Development Constraints Analysis, Black Lake Golf Course, San Luis Obispo County, California," presented the project's conceptual layout and a detailed description of the environment on and surrounding the site.

The existing public golf course uses two wells to supply irrigation water. A third well is capped. These wells were initially tested by the drilling contractor and each found capable of producing about 450 gallons per minute (gpm). Both production wells have sanitary seals. Other wells are located adjacent to Pomeroy Road on the property, but no information was available concerning their construction or yield. Water is stored in a small pond and an adjacent storage tank. Currently, water production from the wells is estimated to be about 464 acre-feet per year (AFY), or 288 gpm based on continuous pumping. A large portion of the pumpage occurs during the summer months to meet irrigation demands.

The proposed development would use the existing wells and potential new well (No. 3) to produce the additional water required for the new golf course and residential uses. The wastewater resulting from residential and commercial uses would be treated, reclaimed and blended with fresh ground water for irrigation of the golf courses. The anticipated water demands for residential and golf course uses are further described in Section 4.

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SECTION 3

HYDROGEOLOGY

The proposed development is located within the Nipomo Mesa Ground Water Sub-basin which will be the source of ground water for the project. In order to evaluate the adequacy of the water supply from this source, the hydrogeologic regime and ground water in the Nipomo Mesa Ground Water Sub-basin were studied by JMM. The findings and conclusions resulting from this study are presented in this section of the report.

HYDROGEOLOGIC REGIME

The Nipomo Mesa study area is underlain by a thick section of water-bearing sediments deposited upon a base of structurally deformed, consolidated sedimentary, volcanic and metamorphic rocks of low permeability. The surficial geology has been described in detail by Dr. Clarence Hall in the California Division of Mines and Geology (CDMG) Map Sheet 24, in the Geologic Society of American Bulletin, Vol. 78, pp. 559-582, May 1967, and by Woodring and Bramlette in the U.S. Geological Survey Professional Paper 222, 1950. Subsurface geologic studies based on well logs have been made by several oil companies and the California Department of Water Resources (DWR). These reports have been compiled and are herein summarized. A generalized geologic map based upon CDMG Map Sheet 24 is presented in Figure 3-1.

Lithology

In general, the geologic formations may be classified as water-bearing or nonwater-bearing. The water-bearing formations are (from youngest to oldest): young alluvium, sand dunes, Paso Robles, Careaga and Schumann. These formations overlie nonwater-bearing rocks of the Sisquoc, Knoxville and Franciscan Formations.

The water-bearing units all consist of sand, gravel, silt and clay layers which act conjunctively to store and transmit ground water. Therefore, they may be considered as an aquifer system. The Recent sand dunes are approximately 200 feet thick. For the most part, they are unsaturated. However, they do allow rainfall to percolate and filter through the uniform porous dune sand and ultimately enter the underlying formations. Where saturated, as is the case near the coast (generally west of Highway 1), the dune deposits may yield water to wells.

The Recent alluvium is probably less than 30 feet thick and of limited regional extent. Alluvium has been deposited in the Black Lake Canyon. It has been postulated that due to the more prevalent growth and decay of plants in the canyon, the permeability of the alluvium may be somewhat less than the adjacent dunes.

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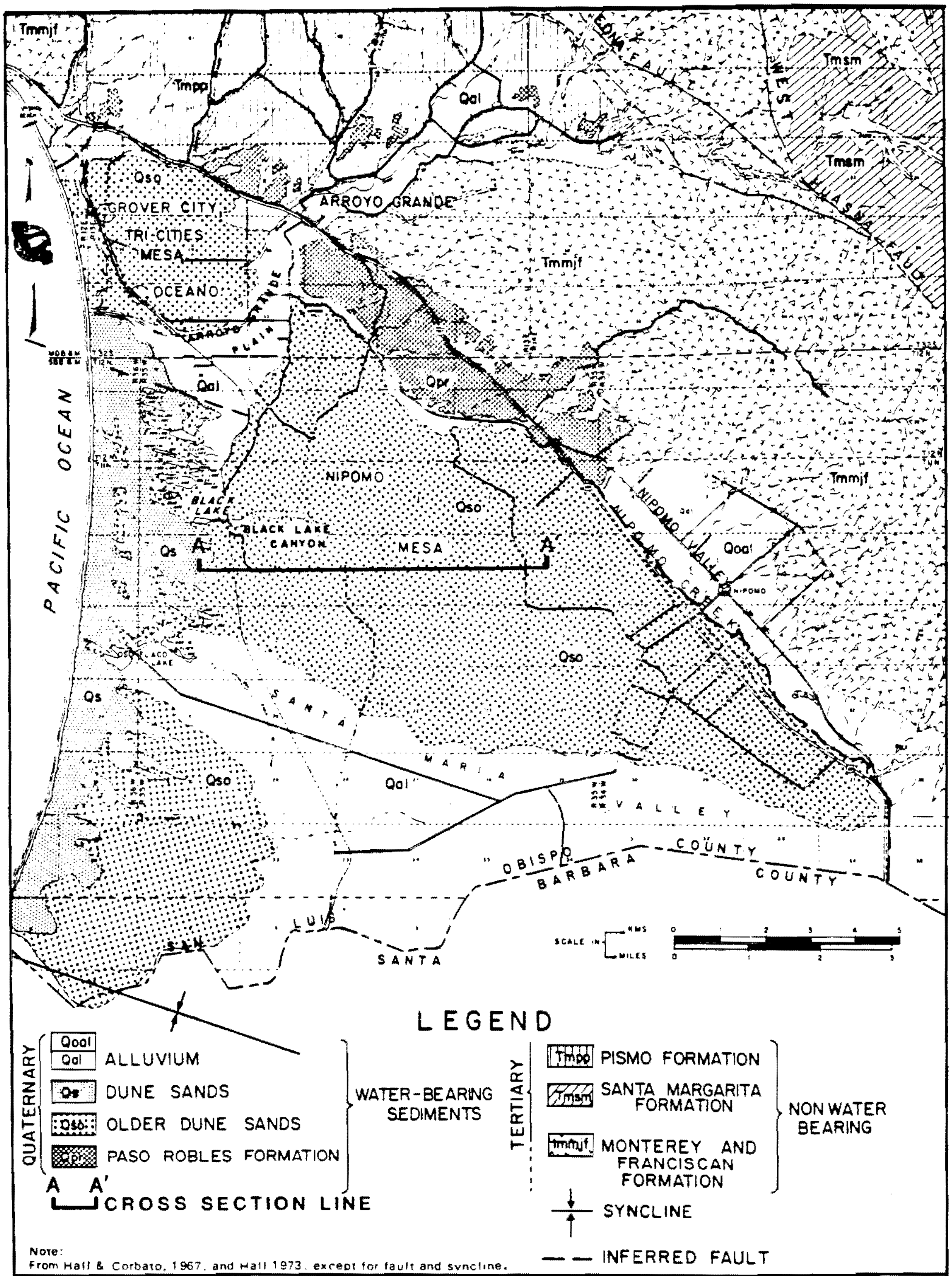

FIGURE 3-1 - GEOLOGY MAP

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1979

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The Paso Robles Formation unconformably underlies the alluvium and sand dunes, and is a major aquifer. The Paso Robles Formation consists of alluvial sand, gravel, silt and clay with clasts of Monterey shale. The formation outcrops along the northwest portion of Highway 101. Its thickness varies from 100 feet in the eastern portion of the basin to 450 feet in the west.

Below the Paso Robles Formation are the marine beds of the Careaga Sand. This formation is, in part, equivalent to the Pismo Formation. Typically, the Careaga Sand attains a thickness of 100 to 300 feet and consists of fine to medium white quartzose sand and some shell beds. The formation has a good water yielding capability and is tapped by some wells, including Wells 11N/35W-10G3, 11N/35W-10G1, 11N/35W-10J1 and 11N/35W-12E2.

The Schumann Sand is a marine formation which underlies the Careaga and is comprised of interbedded blue clay, sand deposits and some shell beds. The Schumann Sand is located west of township and range coordinates 11N/35W-Section 11. One of the Black Lake Canyon golf course wells (11N/35W-10G3) and Well 11N/35W-7R1 penetrate and are perforated in this zone.

Several formations are locally encountered within the basin beneath the Schumann Sand. The Sisquoc Formation is probably encountered in the western Nipomo Mesa area while Cretaceous Knoxville and Franciscan rocks are encountered in the eastern area. The materials comprised by these formations vary but primarily consist of shale, clay and sandstone. In general, the basin deepens to the west as shown on Figure 3-2.

Structure

The basin is a southerly dipping structure which parallels the foothills to the northeast. It appears that the basin forms one flank of a syncline mapped south of the Mesa by both the DWR and CDMG. One fault dissects the Nipomo Mesa north of Black Lake Canyon. The fault appears to exhibit vertical movement which has displaced sediments of Pleistocene (Paso Robles formation) age and older. Neither the influence of this fault on ground water movement nor its length are known at this time. It may be that this fault is a barrier to ground water movement which affects the interaction of ground waters on both sides of the fault.

Aquifer System Description

The formations comprising the basin are principally the Paso Robles, Careaga, and Schumann zones. The extent of the aquifers and aquitards within these formations are better understood along the coast. Inland toward the east side of Nipomo Mesa, the extent of the aquifer system is less clear. Along the coast, the aquifer system has been divided into several zones by the California DWR and a few of these zones have been individually tapped by wells and monitored in order to develop representative hydrographs for each zone (Figure 3-3). The similarity of hydrographs from Wells 12N/35W-36L1, L2 and 11N/35W-12C1, C2 confirms that the aquifers are continuous. Normal to the coast, the Schumann Sand appears to be confined by a clay aquitard while the Paso Robles and Careaga interfinger and are probably locally hydraulically connected. The Paso

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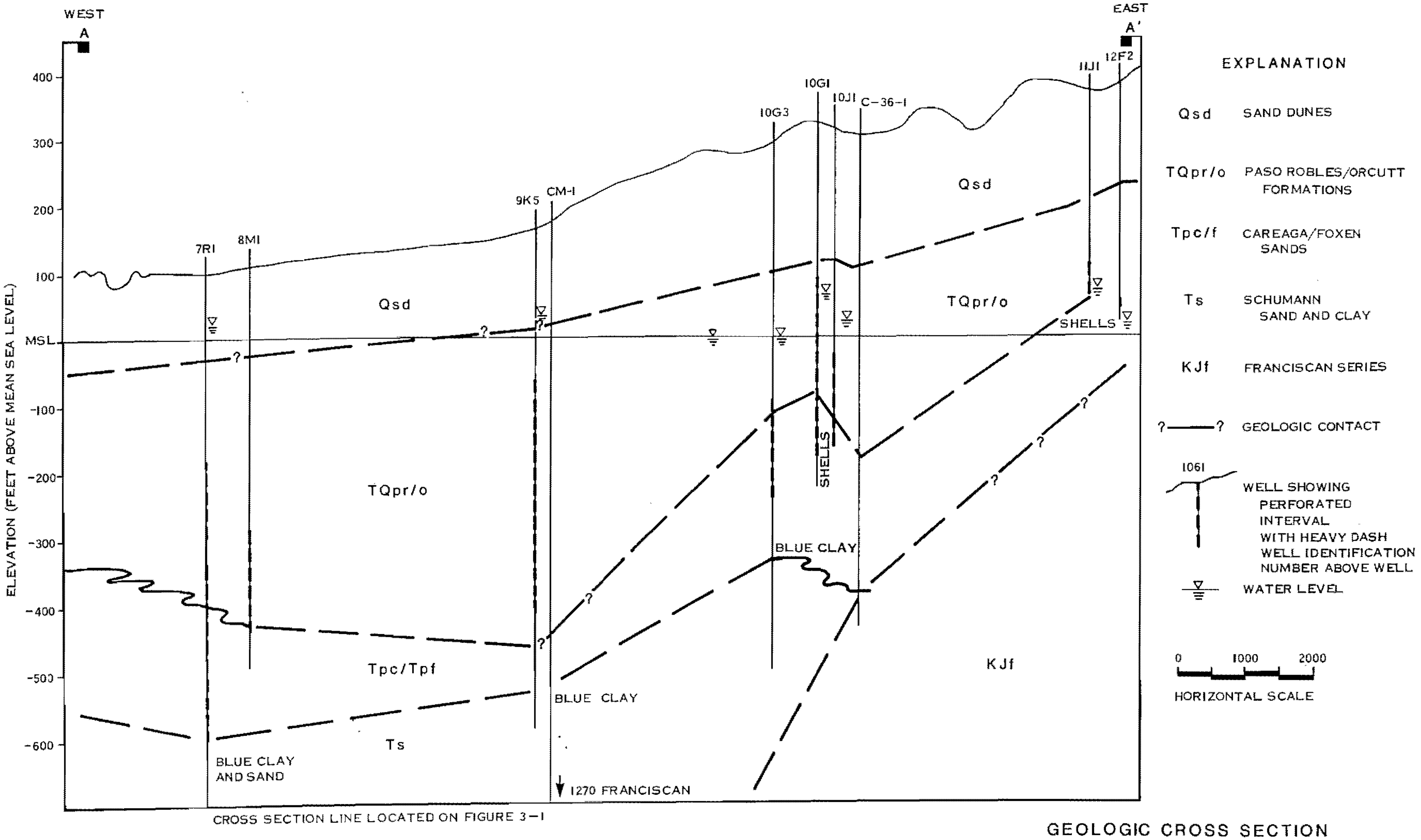

GEOLOGIC CROSS SECTION
NIPOMO MESA
FIGURE 3-2

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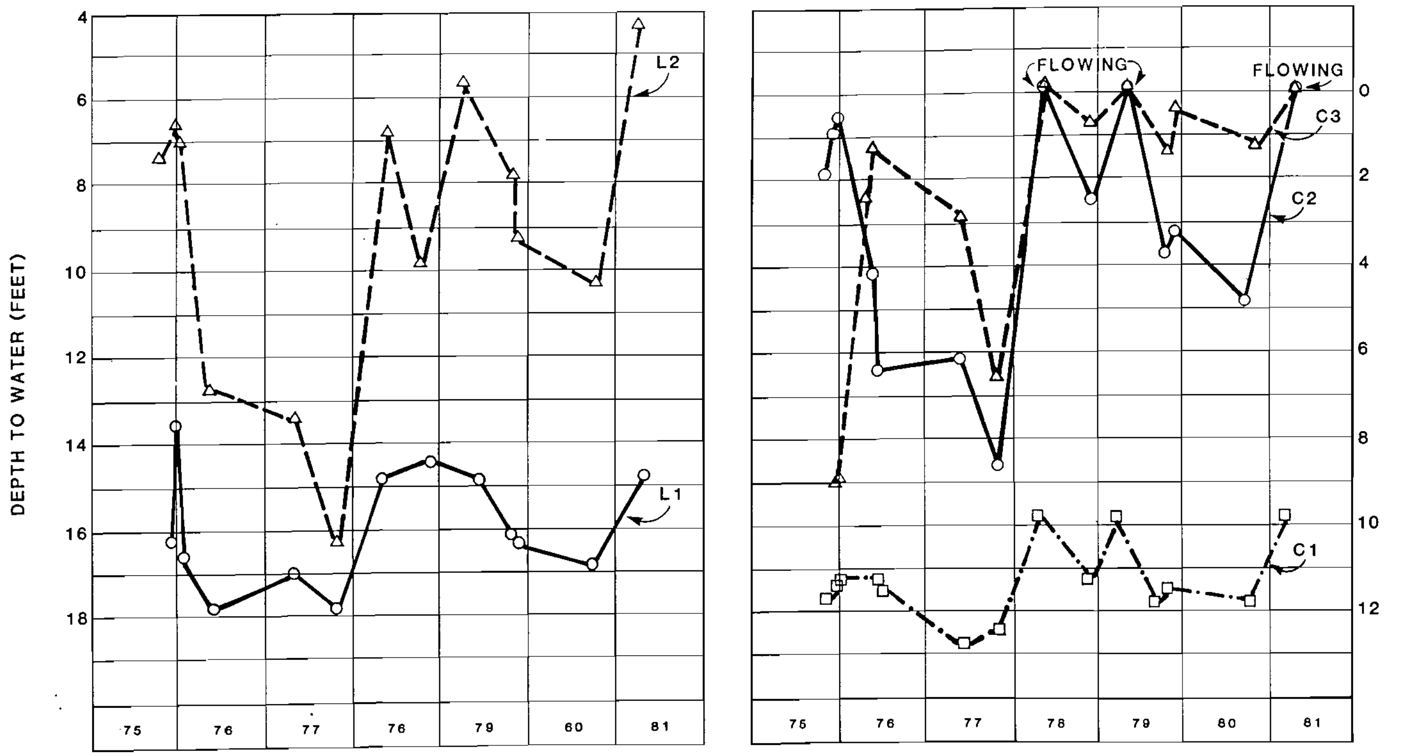
12N/36W-36 L1, L2
ELEVATION 22.3 FT
DEPTH OF PERFORATIONS
(FEET)
36 L1 227-237
36 L2 535-545

11N/36W-12 C1,C2, C3
ELEVATION 19.5 FT.
DEPTH OF PERFORATIONS
(FEET)
12 C1 280-290
12 C2 450-460
12 C3 720-730



WELL HYDROGRAPHS
ILLUSTRATING BEHAVIOR OF
WATER LEVELS IN SEPARATE AQUIFERS
FIGURE 3-3

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Robles/Careaga aquifers include a shallow unconfined aquifer. In the east the underlying aquifers are semi-confined and become confined zones toward the coast.

The aquifer system appears to extend offshore of Nipomo Mesa Ground Water Sub-Basin and may constitute a large reservoir storing considerable quantities of fresh water. The DWR 1979 report has projected the aquifer system offshore based on sea floor topography and possible outcrop patterns; 6 miles for the upper aquifer and 12 miles for the lower aquifer. The actual conditions offshore, however, are not known. There may be lithologic facies changes and faulting which could alter the configuration and hydrogeologic characteristics of the offshore aquifer system considerably and influence the interaction between fresh and salt water within the aquifers.

The permeabilities of each formation have been estimated by the California Department of Water Resources[1] with the following results:

	Permeability (gallons per day per square-foot)
Paso Robles Formation	500 to 1,700
Careaga Formation	70 to 100

These permeability values for Nipomo Mesa were not confirmed by JMM and therefore should be considered as estimates. Much lower permeability values were used by DWR to calculate outflow quantities. In addition, the DWR averaged specific yield values for all water-bearing formations and concluded that the average specific yield was 14 percent. This value appears to be based on a reasonable number of well logs and is considered justified.

GROUND WATER

The description of ground water resources in Nipomo Mesa has been divided into the following three elements: (1) occurrence and movement, (2) basin recharge and disposal; and (3) ground water storage and long-term annual yield.

Occurrence and Movement

Ground water underlying Nipomo Mesa is stored in shallow perched and deep extensive aquifers within the Paso Robles Formation, Careaga Sand, and Schumann Sand zones. These formations extend into the adjacent valleys and offshore. As a result, ground water moves to and from these adjacent areas. In the vicinity of the Mesa, ground water is typically at higher elevations than in the adjacent areas as illustrated by the water elevation contour maps prepared both by the County and the DWR. Consequently, subsurface flow occurs to the Santa Maria Valley, the Arroyo Grande Valley, and offshore. Discussions of subsurface inflow and outflow are presented in the portion of this report devoted to basin recharge and disposal.

(1)Memorandum Report 282.31, Water Quality Conditions, Coastal Region, San Luis Obispo County, California Department of Water Resources, October 6, 1969.

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Ground water in the deep extensive aquifers is unconfined along the eastern portion of the Mesa and is confined along the western portion of the Mesa and offshore. Ground water elevations of the deep aquifers are above sea level throughout the Mesa and range from several feet above sea level along the coast to 150 feet above sea level along the eastern portion of the Mesa. Annual ground water level fluctuations are usually less than 20 feet. These fluctuations vary depending on the year, the aquifer and well location. Figure 3-3 presents well hydrographs which illustrate these variations.

Individual well hydrographs are also means by which long-term ground water conditions can be evaluated. Locally, the DWR and the County have monitored several local wells. Semi-annual water level measurements are on record for the period since about 1967; however, measurements reflecting the conditions prior to 1967 are sparse.

DWR reports prepared in 1958, 1969 and 1979 have evaluated basin-wide changes in water levels on the basis of a few hydrographs. The 1958 report stated that "relatively little perennial change in water levels occurred over the past 10 years." The 1969 report confirmed that "there has been only a slight net decline between 1953 and 1958. However, most wells evidence a slight sustained water level decline with the largest occurring in Nipomo Mesa." As a basis for this latter statement, three wells were cited for water level changes through 1967: one in the southeast (12N/34W-19F1), one in the west (11N/35W-7R1), and one in the north on the Mesa. The 1979 report indicated a rise in water level at 11N/35W-7R1 for the period from 1967-1974 and used a well (11N/35W-11J1) in the center part of the basin to show a decline between 1962 and 1974. This latter conclusion is questionable because of the poor early records on that well. A review of more recent water levels (October 1979) in these same wells or adjacent wells indicates that ground water levels have slightly declined in the southeast, central and north since the October 1974 measurements. In contrast, water level data collected in the west indicates that ground water levels have risen.

On the basis of these well hydrographs, there is no absolute evidence of an overdraft condition in the Nipomo Mesa basin.

Another method of using hydrographs to evaluate basin water level trends is shown in Figure 3-4. Hydrographs for wells located along a line normal to the coast and at regularly spaced intervals illustrate basin trends between 1967 and 1979. This period of time had an average of 16.4 inches of annual rainfall. Well hydrographs show that water levels did not change significantly.

Ground Water Recharge and Disposal

Recharge to the Nipomo Mesa Ground Water Sub-basin has also been estimated in several reports. The DWR Bulletin 118 (1958) states that "Storage in Nipomo Mesa is replenished primarily from percolation of precipitation". In 1971 DWR reported that "The only significant recharge to the upper aquifers in Nipomo Mesa basin is direct deep percolation of precipitation". In his "Water Feasibility Report - Black Lake Country Club," July 5, 1976, John Mann, Jr., reported that

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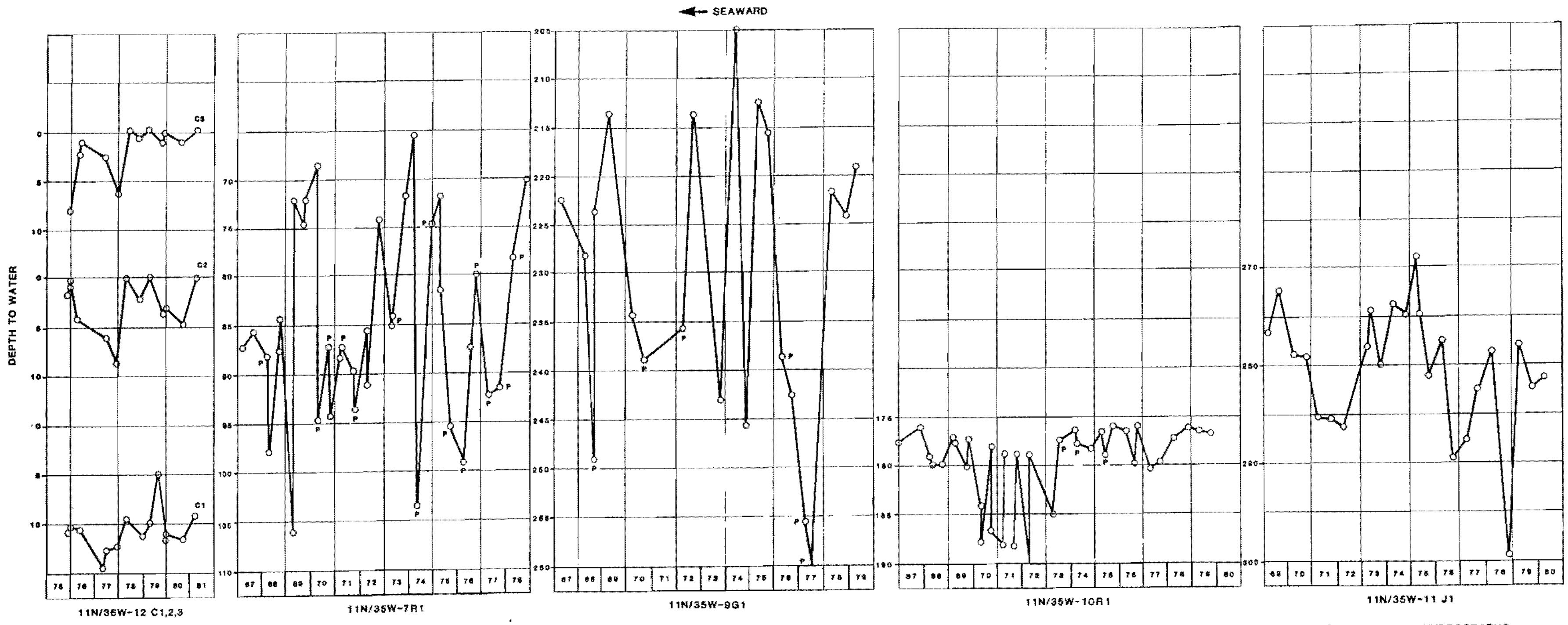

SELECTED WELL HYDROGRAPHS
FOR PERIOD FROM 1967 to 1980
FIGURE 3-4

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"whereas percolation of precipitation is the main source of recharge, small quantities of underflow may come from the alluvium of Nipomo Creek and fractures in the older rocks cropping out to the northeast of Nipomo." The most recent DWR study (1979) quantified ground water recharge from various sources as follows: deep percolation of precipitation, 3300 AFY; subsurface seepage from nonwater-bearing rocks, 500 AFY; irrigation return, 800 AFY; wastewater and percolating urban water used outdoors, 200 AFY. In addition to these quantitied inflow items, subsurface flow from Nipomo Creek may also constitute an inflow item.

Recharge to the basin from deep percolation of precipitation can clearly be seen as a major inflow item. A comparison of the accumulative departure from mean precipitation with the fluctuation in ground water levels at Well 11N/35W-7R1 in Figure 3-5 illustrates the effect. Other well hydrographs do not reflect as clearly the effects of precipitation; however general trends are still evident. The amount of recharge occurring from deep percolation of precipitation is difficult to estimate.

The percentage of the precipitation which reaches the ground water body is probably significantly higher than that which occurs in a typical alluvial basin because of the absence of surface runoff as a means of disposing of the rainfall. In a typical alluvial basin, deep percolation of precipitation could range from 5 to 15 percent of the total rainfall. With no runoff, however, this value might increase to 15 to 25 percent of the total rainfall. Evapotranspiration would also increase for the same reason. Los Berros Creek runoff, over a 10-year period, averaged roughly 10 percent of the precipitation which occurred in its watershed. The DWR value for deep percolation of precipitation used a ratio of deep percolation of precipitation to total precipitation of about 13 percent.

The annual precipitation according to the DWR must be greater than 17 inches in order to raise ground water levels under current (1979) conditions. Recharge from deep percolation of precipitation does occur during periods of lesser rainfall but may vary considerably on the basis of intensity of rainfall.

Ground water contours on the northeast edge of Nipomo Mesa appear to indicate that some recharge occurs along Nipomo Creek where the subsurface conditions appear favorable to subsurface flows. These conditions are shown on the cross sections in DWR Bulletin 118. Recharge to the ground water basin from Nipomo Creek cannot be accurately determined because of lack of data. However, recharge may be as great as 500 acre-feet per year.

Ground water disposal has been determined by DWR to consist of pumpage and subsurface outflow. Pumpage items include applied irrigation, urban supply, and industrial cooling water. Subsurface outflow items include outflow to Arroyo Grande, outflow to Santa Maria Valley and outflow to the ocean. These components have been estimated for 1977 conditions by DWR.

Most of the urban extractions from the Nipomo ground water basin are metered, however agricultural extractions are not. Inasmuch as agricultural extractions may be as much as twice as great as urban extractions there is an inherent limitation in the accuracy of the estimates of total ground water pumpage.

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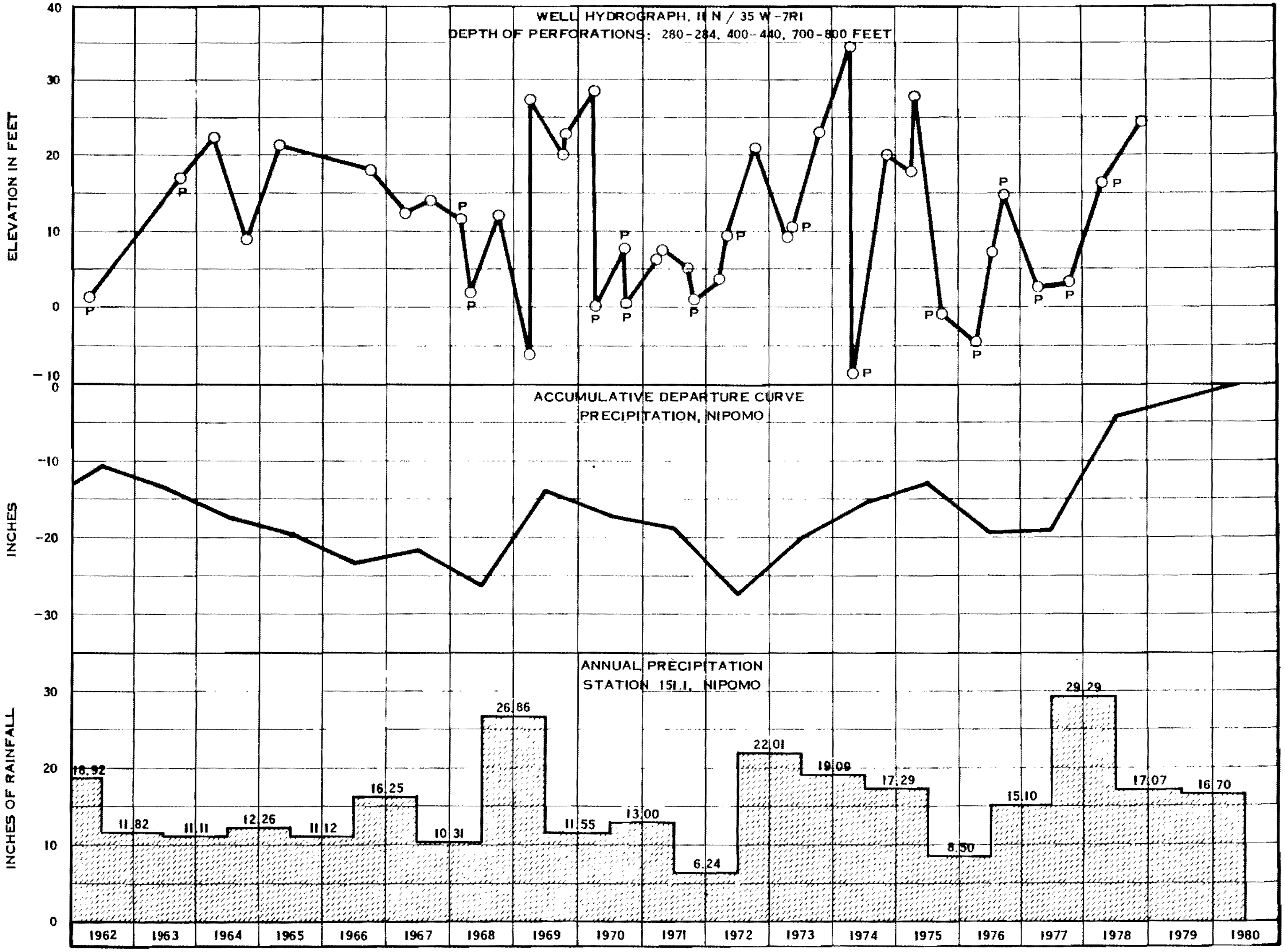

NOTE: "P" DENOTES PUMPING LEVEL

GROUND WATER LEVEL

RESPONSE TO PRECIPITATION

FIGURE 3-5

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Customarily, agricultural pumpage is estimated on the basis of the amount of irrigated land, local cropping patterns and appropriate unit factors for applied water. Basin conditions are usually assessed on the basis of cultural development prevailing at the time of the most recent agricultural pumpage appraisal and in terms of long-range mean supply.

Since the estimates of total pumpage are approximations, it was concluded that pumpage of the two major municipal water systems would be representative of the municipal and domestic extractions from the Nipomo Mesa. Appendix C presents a tabulation of municipal and industrial pumpage from Nipomo Mesa Sub-basin. This tabulation comprises pumpage from California Cities Water Company's Vista System and Nipomo Community Services District system. Also included are the DWR estimates for industrial cooling water which have been taken as the pumpage for the Union Oil Company refinery and coking plant in the coastal area north of Guadalupe. It was noted that the total municipal pumpage, obtained from SLOCO records on file, was substantially greater than had been indicated in the DWR Ground Water Report.

Agricultural pumpage, inferred from the total irrigated acreage and other factors, was reviewed in order to refine the assessment of water supply and disposal for the Nipomo Mesa Sub-basin. DWR conducted field surveys and prepared reports on land use in both Santa Barbara and San Luis Obispo Counties in 1959 and 1968. In 1975, DWR made estimates of irrigated land for eight types of crops in San Luis Obispo County, based on limited field surveys supplemented by high altitude photography. The survey totals were somewhat low. On the basis of the subsequent DWR Central Coastal land use study conducted in 1977, the 1975 estimates and projections were adjusted accordingly.

The DWR data on both irrigated agricultural acreage and applied irrigation water published in the Water Action Plan, combined several areas adjacent to Nipomo Mesa with Nipomo Mesa. DWR provided JMM with land use data and applied water factors which would be applicable to Nipomo Mesa alone. The DWR Ground Water Report cites these factors for the Nipomo Mesa separately, using the DWR 1977 Central Coastal land use study as the basis. The results indicate that irrigated acreage increased and that the factors for applied irrigation also increased. A review of the DWR land use survey map and the appropriate unit applied water factors for various irrigation uses on Nipomo Mesa (including discussions with SLOCO Farm Advisors) indicates that the irrigation pumpage in 1977 may have been substantially higher than presented by DWR. Appendix C includes certain agricultural pumpage estimates.

The DWR pumpage estimates are used as general approximations of 1977 conditions. These are summarized below:

Applied Irrigation	2000 AFY
Urban Supply	300 AFY
Industrial Cooling	650 AFY
TOTAL PUMPAGE	2,950 AFY

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Subsurface outflow values determined by DWR were revised by JMM on the basis of discussions with DWR. In a letter from DWR to JMM dated January 14, 1982 (Appendix B), the components of total subsurface outflow were provided. These outflow estimates are presented below:

Outflow to Santa Maria	2300-2800 AFY
Outflow to Arroyo Grande	225- 300 AFY
Outflow to the Ocean	225- 350 AFY
TOTAL SUBSURFACE OUTFLOW	2800-3500 AFY

The subsurface outflow estimates were based upon the parameters of permeability, cross sectional area, and ground water gradients along the boundary of the Nipomo Mesa Ground Water Sub-Unit. Although the estimated permeability may be low, there are no more reliable data available.

Ground water gradients have changed with time perpendicular to the boundary of the Mesa with Arroyo Grande and Santa Maria due to heavy pumping in those adjacent sub-units. It may be interpreted that outflow to these adjacent sub-units has been induced to some extent. Subsurface outflow to the ocean, on the other hand, has probably not changed very much due to man's influence.

Ground Water in Storage

Estimates of ground water in storage made by the DWR (1969, 1979) and Mann (1976) vary considerably. The DWR Bulletin 118 (1958) estimated the area of the Mesa to be 16,000 acres. This estimate was employed by Mann. The DWR Memo 282.31 (1969) does not make reference to the total area but the DWR Report (1979) uses a figure of 21,100 acres. Underlying this area, the storage estimates distinguish two portions of the basin - the volume of water above sea level and the volume of water below sea level. This distinction is based on the gross assumption that the water above sea level may be extracted without allowing sea water intrusion along the coast. The most recent ground water storage estimates (DWR 1979) are likely to be the most accurate. These are 172,000 AF above sea level and 1,000,000 AF below sea level. The estimates appear reliable because the average specific yield and the depth to the base of the permeable sediments were developed specifically for the sub-basin.

Long-Term Annual Yield

The recharge and disposal estimates may be used to determine the long-term yield for Nipomo Mesa Ground Water Sub-basin. The average total annual inflow, less the average annual amount of ground water flowing from the Nipomo Mesa aquifer system to the sea, is basically equivalent to the long-term yield for Nipomo Mesa. Based on the previously determined estimates for these items, the long-term annual yield is 4540 AFY.

The County's Land Use Element (LUE) states that there is a safe yield of 1000 AFY for the Nipomo Mesa Sub-basin. This estimate was apparently interpreted from the hydrologic balance prepared for the 1979 DWR report. The DWR did not, however, come to the same conclusion within the 1979 report.

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The County LUE has concluded that the Nipomo Mesa is in an overdraft condition based upon the ground water conditions presented by the hydrologic balance in the DWR 1979 report. This interpretation needs to be modified in light of the DWR's position on the subject and "safe yield/long-term yield" discussion in this report.

Based upon the results of ground water studies performed by DWR and JMM, the Nipomo Mesa does not appear to be in an overdraft condition. In January 1980, DWR published Bulletin 118-80, which presented the results of its State-wide evaluation of ground water basins in California. That report did not identify any groundwater basins wholly within San Luis Obispo County which were experiencing critical conditions of overdraft. Bulletin 118-80 stated that: "A basin is subject to critical conditions of overdraft when continuation of present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts."

The 1979 DWR report does not directly address the issue of a current overdraft but implies that there is a possibility of an overdraft in the future. One issue that is included in the concept of overdraft which was addressed by the DWR in 1979 is the degradation of the aquifer system due to sea water intrusion. The DWR indicated that as long as ground water levels remained above sea level, saline intrusion of the coastal aquifers was not likely. The DWR also reported that the quantity of ground water in storage at elevations above sea level in Nipomo Mesa appeared to be adequate to meet the water demand until at least the year 2000. Ground water levels measured from 1967 to 1980 in representative coastal wells appeared to be relatively stable. The coastal monitoring wells have maintained water levels above sea level from 1975 to 1981.

The safe yield/long-term yield discussion alters the interpretation of the ground water balance for 1977 on Nipomo Mesa. It may be interpreted that there was a surplus of ground water in the Nipomo Mesa Sub-basin in 1979 rather than a deficit and that this surplus ground water was flowing into the adjacent sub-basins. This surplus would be the difference between the total inflow (4800 AFY) and loss due to pumpage (2950 AFY) and outflow to the ocean (260 AFY) or 1,590 AFY.

GROUND WATER QUALITY

JMM abstracted mineral quality data from the several referenced reports and also obtained selected water well analyses data from Mr. Tim Mazzacano, SLOCO Sanitarian, and from Messrs. Robert Gregg and D. Frank Kostas, Chief Engineer and Sanitary Engineer, respectively, of Southern California Water Company. General information pertaining to water quality control was obtained from Messrs. William Leonard and Rick Aleshire of the Central Coastal Regional Water Quality Control Board (RWQCB). Supplementary information on State well numbers for certain municipal water wells was obtained from Mrs. Perry Garfingkel of the State Department of Health.

Ground water quality information can be used to interpret the movement of ground water and the effects upon local ground water quality from surface development and activities, including pumpage, irrigation, ground water and

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wastewater disposal. In addition, water quality investigations can indicate the suitability of the ground water for many uses, including drinking, and may be used to determine typical water quality conditions of distinct aquifers, to the extent that available data will permit.

Appendix D, "Ground Water Quality Aspects" summarizes current ground water quality, reclaimed water quality, and effects of the latter upon the former for Nipomo Mesa Sub-basin". Included are the water quality objectives presented by the RWQCB in its Water Quality Control (Basin) Plan as well as surface water quality for Los Berros Creek, which has modest recharge effects upon the sub-basins and coastal lakes between Nipomo Mesa and the Pacific Ocean.

In brief, the review of the available ground water quality data has indicated the following:

- With only isolated exceptions, ground water withdrawn from the various wells in the Nipomo Mesa Sub-basin conforms to both the USPHS Drinking Water Standards and to the water quality objectives of the RWQCB.

- Some increases in mineral content have been noted in one private well (11N/35W-12E) and two wells of California Cities Water Company (11N/34W-19L1 and 11N/34W-19L3, the former now abandoned). However, the significance of this trend has not been established. In general, the mineral quality remains good.

- Only two wells (11N/35W-6H and 12N/35W-29R), of over 60 wells for which sampling data were available, exhibited nitrate concentrations in excess of Drinking Water Standards.

- Surface water in Los Berros Creek appears to provide some subsurface recharge to the Nipomo Mesa Sub-basin. Based upon a limited number of samples reported in the DWR 1969 memorandum report to the RWQCB, there was a considerable variation in water quality. Mineral content was inversely related to the amount of runoff. DWR's suggested water quality objectives for the creek were achieved in only one of the three samples reported in the 1961-67 period of sampling. Ground water quality should not be influenced to any great degree since Los Berros Creek is not a major recharge factor.

- Ground water quality both north (Arroyo Grande Sub-basin) and south (Santa Maria Valley Sub-basin) of Nipomo Mesa Sub-basin is generally inferior to that of Nipomo Mesa from the standpoint of total mineral content.

- Surface water quality in the coastal lakes between Nipomo Mesa and the Pacific Ocean, as evidenced by mineral analyses from isolated samples taken during the period 1960-67 and reported in the DWR 1969 memorandum report to the RWQCB, generally conformed to DWR-suggested water quality objectives for these lakes. The coastal lakes exhibit a somewhat brackish character (TDS approaching 2,500 mg/l).

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The bicarbonate concentration normally is significant in comparison to the chloride concentration, suggesting that the relatively high mineral content results from drainage waters and evaporation rather than from the invasion of sea water.

- Water quality data and information derived from analyses of ground water from the coastal wells do not indicate any evidence of sea water intrusion.

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SECTION 4

LAND USE, POPULATION AND WATER REQUIREMENTS

GENERAL

The County has prepared planning documents for the South County which consider the availability of water as a critical aspect of future development. Nipomo Mesa has been zoned in the Land Use Element (LUE) into appropriate land use categories on the basis of development for year 2000. These documents, combined with the DWR 1977 Land Use Survey and the 1979 DWR Report, provide data upon which water use on Nipomo Mesa may be estimated and projected. The Black Lake Project water requirements have been reviewed in light of overall water usage on Nipomo Mesa.

The Nipomo Mesa study area encompasses 21,100 acres and is divided into several land use categories. The County planning document does not specifically separate Nipomo Mesa from other portions of the South County. Therefore, total acreages for each category have been revised from land use maps and DWR estimates. The categories include: Rural, Agriculture, Recreation, Residential Rural, Industrial, and Urban and Village Residential Reserves. Water use estimates for each of these categories are based on population, irrigated acreage, and industrial use. The current estimate of actual water use, projected year 2000 water use and ultimate water use for all categories are presented in this section of the report.

PRESENT (1977) WATER DEMAND

The DWR 1977 and 1979 reports conclude that the irrigation water demand by far exceeds municipal and industrial (M&I) water demands. In 1977, irrigation water demand was estimated to be 2000 AFY and M&I water demands were estimated to total 950 AFY. SLOCO Department of Engineering provided ground water production information for Nipomo Community Services District and California Cities Water Company. The information indicated that M&I water demand could be significantly higher than the DWR estimate (Appendix C).

As mentioned previously, the DWR estimate of agricultural development and water use was based on the 1977 land use study and amounted to 2000 AFY.

YEAR 2000 PROJECTED WATER USE

Two approaches were taken to estimate the year 2000 projected water use: (1) using DWR projections; and (2) using LUE projections. Simply stated, the DWR 1979 report included estimates for domestic and urban water demand and irrigation water demand for year 2000, while the present (1977) industrial water demand was assumed to remain constant. The resulting year 2000 projected water use would be 6100 AF.

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The Land Use Element provided population projections and growth rates, irrigated agricultural acreage, historic growth rates and ultimate agricultural acreage for the South County. Although these parameters provide some input, the water use factors and irrigated acreage within land use categories other than agriculture were not provided. As a result, certain assumptions were made by JMM in order to project year 2000 water use. Combining the Nipomo and one-fifth of the South County rural (based on proportion of rural acreage in Nipomo Mesa to the South County) populations and using a water use factor of slightly over 130 gallons per capita per day (gpcd), domestic and urban water use would be approximately 1400 AFY. Assuming complete development of agricultural acreage, golf course, and cemetery acreage and 5 percent of rural and residential rural categories under irrigation, the irrigation water requirement would be about 5,430 AFY. Industrial development is projected to increase at a similar rate to population and therefore the industrial water requirement would be about 975 AFY in year 2000.

There will be some returnflow to the ground water basin of about 30 percent of domestic and urban water use and 20 percent of irrigation water use, the total of which would be about 1,507 AFY. There is allowed in the long term annual yield 1000 AFY of returnflow. The net additional returnflow would be about 510 AFY. Reducing the total water use on Nipomo Mesa by additional returnflow would result in a projected year 2000 water use of 7,300 AF.

The San Luis Obispo County planning document has estimated that population, industry and recreation will increase in the South County area to 1.5 times the 1980 estimates by the year 2000. The populace (combining the urban and rural land use areas) for Nipomo Mesa is projected to consume less water per capita than at present. The estimated demand is approximately 941 AFY. Recreation water demand will increase to 746 AFY and industrial water demand is estimated to be 975 AFY. The total M&I water demand would be about 2662 AFY.

Local agriculture is also expected to expand by the year 2000. By applying a factor of 1.37 (growth rate from 1959-1979) to the period from year 1980 to 2000, and assuming that much of the agriculture will be in orchards with a unit water use of 2.2 AFY, the calculated irrigation water demand is 4400 AFY.

The total JMM projected water use for year 2000 on Nipomo Mesa would therefore be approximately 7,100 to 7,300 AF. The DWR 1979 report estimate for year 2000 was 6100 AFY.

PROPOSED BLACK LAKE PROJECT

The proposed Black Lake public golf course is anticipated in the LUE as a recreation/residential area. In light of the LUE objectives established for the Black Lake project, an approach has been prepared to minimize water consumption and allow for recreational/residential development within existing water resources constraints. The following analysis compares the Black Lake Project to the entire Nipomo Mesa in terms of acreage, population and water use.

The land used for the proposed development is approximately 2½ percent of the total land area in the Nipomo Mesa and comprises a very large percentage of the

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recreation/residential area for the entire South County. Black Lake Public Golf Course is the only facility of its type in the South County.

The projected population for the residential development in the proposed project is 1,290 people. This would be 13 percent of the total population projected for the Nipomo Mesa in the year 2000. This residential population plus the 70,000 persons per year already utilizing the existing public golf course is a significant part of the public recreation opportunity available for South County residents and visitors.

The current irrigation water requirement for the existing public golf course is estimated to be 464 AFY. This is calculated on the basis of 120 acres, consumptive demands of 3.33 ft/yr, and water loss and returnflow (29 percent) minus the water demand supplied by effective precipitation. The project plans indicate that the development would include an area of 515 acres. It is projected that the project's annual water use would be 712 AFY. Figure 4-1 explains the water usage for the proposed project. It is understood that the project sponsors will strive for further water conservation particularly as pertains to the existing golf course.

The project will use reclaimed water from the residential uses to meet a portion of the irrigation demand for public golf course. Consumption and evaporation water requirements for the residential water use (74 AFY) will be for landscape irrigation and miscellaneous outside uses. Minimal landscaped areas would be irrigated and would be planted with vegetation which requires little to moderate quantities of water. The proposed 45-acre, 9-hole addition to the existing public golf course will require 174 AFY of irrigation water. Total additional ground water pumpage for the proposed development will be 248 AFY or approximately 5 percent of the long-term annual yield for the ground water sub-basin.

From these comparisons, it is evident that the proposed project is efficient in its use of a small percentage of the total available water supply to serve a high level of public recreation use and residential use within the South County Planning Area.

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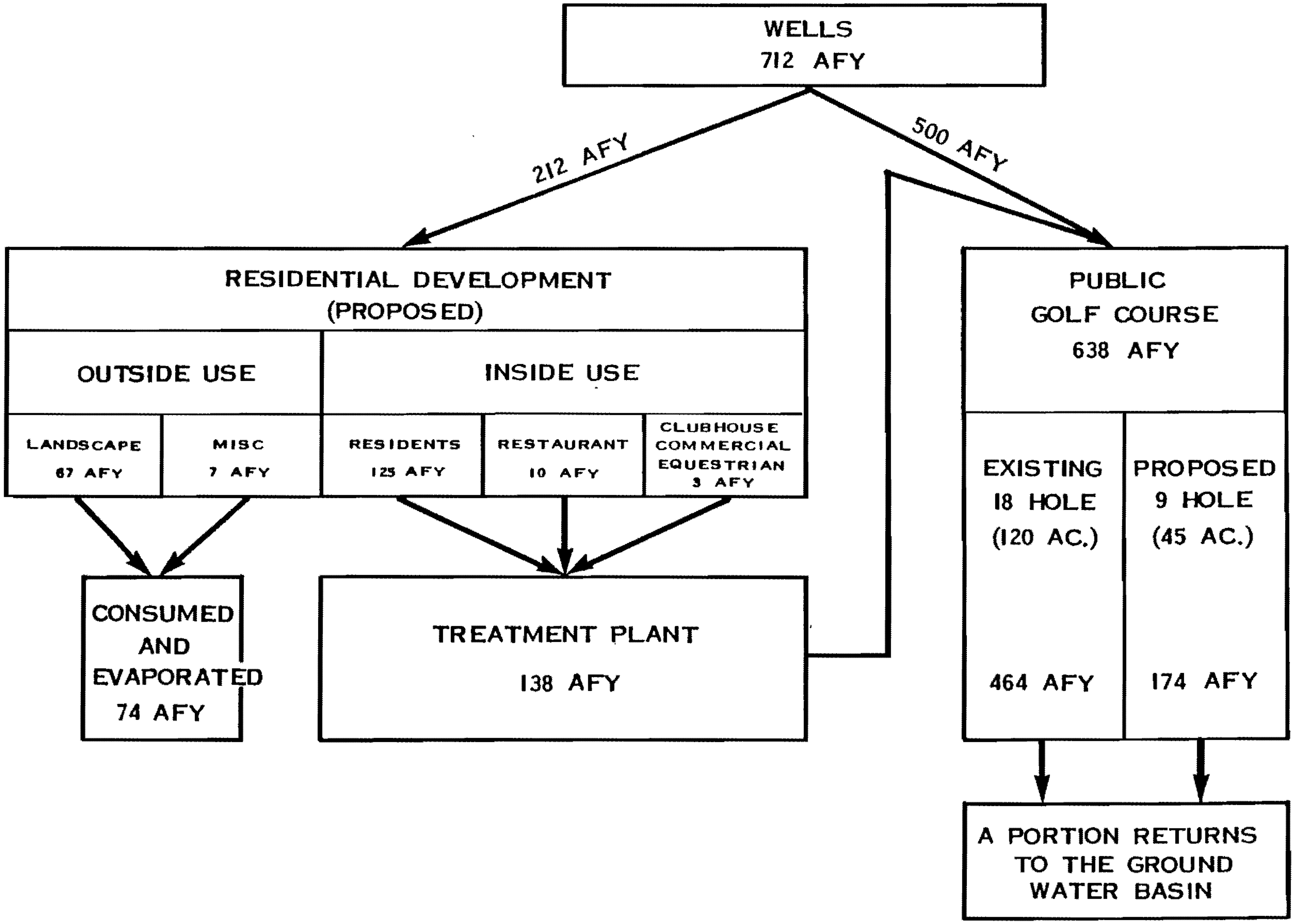

WATER USE DIAGRAM
PROPOSED BLACK LAKE PROJECT
FIGURE 4-1

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SECTION 5

WATER AVAILABILITY AND IMPACTS

Previous sections of this report have quantified and described the ground water resources and have estimated or projected the present and future water requirements for the project. This information indicates that there is currently a surplus of ground water underlying Nipomo Mesa, some of which is flowing out of Nipomo Mesa to the Santa Maria and Arroyo Grande Sub-basins. The projected development of Nipomo Mesa (including the proposed Black Lake Project), will require the use of this surplus ground water during the period from 1980 to the year 2000. Therefore, it will be necessary for the County to encourage conservation measures and consider the need for each type of land use on the basis of water consumption and benefit to the South County. When approving development projects, the impacts on other ground water users will also require study.

IMPACT ON GROUND WATER USERS

JMM has reviewed the impacts of the additional ground water production on adjacent wells. The adjacent ground water users were identified on the basis of the County Engineering Department well location map and well logs. The proximity of these wells to the existing Black Lake Golf Course production wells was determined as presented in Table 5-1.

In the vicinity of the proposed Black Lake Project, the closest producing well is owned by Nipomo Community Services District and is known as the Bevington Well (State Well No. 11N/35W-10J1). The estimated drawdown effects of the Black Lake Golf Course wells on the Bevington Well were calculated based on non-verified estimates of transmissivity (35,000 gallons per day per foot), the Storage Coefficient (0.14), and new long-term pumping rates of various durations. For the purposes of these calculations, the two Black Lake Golf Course wells were combined and analyzed together. Total average ground water extraction from the two wells was estimated to be 442 gpm, which is an increase of 154 gpm from the current rate of extraction. This increase is the amount of ground water which would be necessary to satisfy the water demand of the project. On the basis of this analysis, the increased ground water withdrawal from the two Black Lake golf course wells is expected to result in an additional 2 feet of drawdown at the Bevington Well after a period of 3 years of continuous, non-stop pumping. These drawdown effects are not considered to be significant in terms of lost production or increased lift at the Bevington Well.

In view of the fact that the other nearby wells are more distant from the project than the Bevington Well, drawdown impacts (if any) at these wells are expected to be less than those calculated for the Bevington Well. Shallow wells could experience greater drawdown than deep wells which withdraw ground water from unconfined aquifers. However, available well data suggests that the nearby wells

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TABLE 5-1

WELLS IN THE VICINITY OF THE BLACK LAKE PROJECT

Distance from Black Lake Project Wells (Feet)	State Well Identification No.[a]	Owner
	10 G1	Black Lake Golf Course
	10 G3	Black Lake Golf Course
1300	10 J1	NCSD[b] (Bevington Well)
3000	2 N1	NCSD[b] (Black Lake Canyon Well)
3000	10 Q	Valentine
3700	10 R1	Turkey Farm
3700	10 R2	Turkey Farm
4100	9 J1	
4200	11 C1	Erwin Farms
4200	11 C2	Erwin Farms
4700	9 G1	Taylor Farms
4700	9 G2	Taylor Farms
5000	9 K4	
5400	9 H1	Shortleff
5500	9 K5	NCSD[b]
5500	9 K2	
5500	11 B1	Erwin Farms
5700	9 Q1	Yokoyama
6300	11 H	Gates[c]
6300	11 H	Fuatelio[c]
6300	11 R1	Andres
6600	11 J1	Camancho
7300	11 J2	NCSD[b]

[a] All well numbers are prefaced by Township 11 North and Range 35 West of the San Bernardino Base and Meridian.

[b] NCSD is the abbreviation for Nipomo Community Services District.

[c] Well is within area to be purchased for proposed project.

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will not be significantly affected by the increased ground water extraction from the project wells.

IMPACT ON GROUND WATER QUALITY

The impacts of treated effluent and ground water return flow on the shallow ground water were also studied in light of possible ground water quality degradation. The wastewater treatment plant effluent will be used for irrigation water and fertilizer on the golf course. The effluent would have an estimated 30 mg/l of nitrogen. This concentration is equivalent to 68 lb/acre/year when applied to the full 165-acre golf course. In comparison to the maximum application allowable for agricultural land under the Basin 4B Plan of 500 lb/acre/year, the anticipated application would be acceptable. The phosphate phosphorous concentration in the effluent used for irrigation would be in the order of 7 mg/l, representing the bulk of total phosphorus. When applied to the 165-acre golf course, this would be equivalent to 16 lb/acre/yr, in comparison with the Basin 4B Plan limit of about 300 lb/acre/yr; obviously, there is considerable latitude in the application of effluent when diluted with well water. The phosphorus would largely be adsorbed or otherwise immobilized in moist soils (Appendix D).

Considering that some of the irrigation water will become return flow to the ground water basin, there will be some increased mineralization of the ground water. The wastewater will be diluted with natural ground water at a ratio of 1 part effluent to 3.6 parts ground water prior to application for long-range conditions. Consequently, the irrigation water quality will be much less distinctive than the original effluent. The blend will probably have up to about 60 mg/l more TDS than the native well water. JMM's calculations indicate that TDS increase attributable to the Black Lake Project will be in the order of 0.3 mg/l annually.

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APPENDIX A

REVIEW OF SEA WATER INTRUSION STUDIES

STATUS OF SEA WATER INTRUSION

1. DWR Bulletin 63-5 (Excerpt)

p. 234 Arroyo Grande Basin-Basin 176

Offshore geology - Alluvium and older water-bearing sediments continue offshore and may be in hydraulic continuity with the ocean at a considerable distance offshore. These reservoir conditions favor an extensive and thick accumulation of offshore fresh water.

Sea water intrusion - No evidence of intrusion. For the most part, the hydraulic gradient is seaward. Sufficient fresh water flows into the coastal part of the valley to hold ground water levels at or above sea level and maintain a seaward hydraulic gradient. Increased pumping could create a threat of sea water intrusion. Chlorides in shallow ground water bodies in the coastal part of the valley range from 100 to 200 ppm, and appear to be related to a surface source not sea water.

p. 235 Santa Maria River Valley-Basin 177

Offshore geology - Alluvium and older water-bearing sediments continue offshore and may be in hydraulic continuity with the ocean for a considerable distance offshore. These reservoir conditions favor an extensive and thick accumulation of offshore fresh water.

Sea-water intrusion - No evidence of intrusion. A seaward hydraulic gradient exists. Wells in the coastal portion flow when water levels are high. Presently, sufficient fresh water flows into the coastal part of the valley to maintain safe ground water levels. Increased pumping may reverse the hydraulic gradient and encourage sea-water intrusion. Shallow ground water with chlorides ranging from 100 to 200 ppm appears to be moving toward the sea. These chloride waters do not originate from intruded sea water.

p.391 Mechanics of Sea-water Intrusion

...Along a coastal aquifer, the intruding saline water assumes the shape of a prism having an inclined surface that always slopes landward and that advances or recedes in response to changes in the hydraulic gradient. Because of its shape, this prism of ocean water is called the sea-water wedge. Advance and retreat of the wedge commences at its toe, the position of the upper end of the fresh-water/sea-water interface remaining fixed at the shoreline until all fresh water near the coast is depleted to sea level. At that time, the upper end of the interface commences its advance and the entire edge moves as a body...

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2. DWR Bulletin 63-3 "Sea-Water Intrusion: Pismo-Guadulupe area," 2/70.

3. USGS Water-Resources Investigations 76-128 "Evaluation of Ground-Water Quality in the Santa Maria Valley," by Jerry L. Hughes, July 1977

p. 1 Abstract (excerpted)

Pumpage of ground water for agricultural, municipal, and industrial uses has exceeded recharge by about 10,000 acre-feet per year (12.3 cubic hectometers per year). Most of the ground water pumped in the Santa Maria Valley is for agriculture. The result of pumping in excess of recharge is a declining potentiometric surface, an accumulation of solutes, and an increase in nitrogen in ground water. At present (1976), the area of confined water is most severely affected by this degradation. Nitrogen concentrations in ground water have reached as much as 50 milligrams per liter in isolated areas, with concentrations in excess of 10 milligrams per liter occurring through most of the area of confined water. Continued pumping in excess of recharge may also lower the potentiometric surface sufficiently to permit intrusion of seawater into the fresh-water zones.

p. 26

The potentiometric surface in the valley is above sea level, indicating discharge to the ocean and no apparent sea water intrusion. Miller and Evenson (1966, p.14) estimated underflow to the ocean from the ground water basin to be 11,000 acre-ft/yr (13.6 hm^3/yr) for 1918-58 and 8,000 acre-ft/yr (9.9 hm^3/yr) for 1950-58. At a ground water gradient of 4.5 ft/mi (0.85 m/Km), the present (1976) discharge to the ocean would be approximately 7,000 acre-ft/yr (8.6 hm^3/yr), a reduction of 1,000 acre-ft/yr (1.2 hm^3/yr) since 1958.

p. 29 (Figure 9- Diagrammatic section showing potentiometric surface in 1907, 1918, 1936, 1944, 1967, and 1975.)

This section is taken along B-B', from the Pacific Ocean to above the Town of Sisquoc (See p. 4-3). It shows that in 1918, the water levels were apparently at an historic high. In contrast, the 1967 water levels were apparently at an historic low.

(See subsequent discussion for interpretations.)

4. DWR Bulletin No. 130-75 "Hydrologic Data-1975, Volume V: Southern California," March 1977

p. 4 "Representative Precipitation Characteristics for San Luis Obispo"

This figure depicts precipitation in inches by water year (October 1-September 30) and cumulative deviation from mean precipitation as a percent of mean, for water years 1869-70 through 1974-75. The 50-year mean period was 1920-21 through 1959-70, for which mean preceipitation was 21.46 inches. See page A-4. For 1915-17, it is noted that a cumulative deviation summit had been reached, being about 55-60% above zero (Page A-4).

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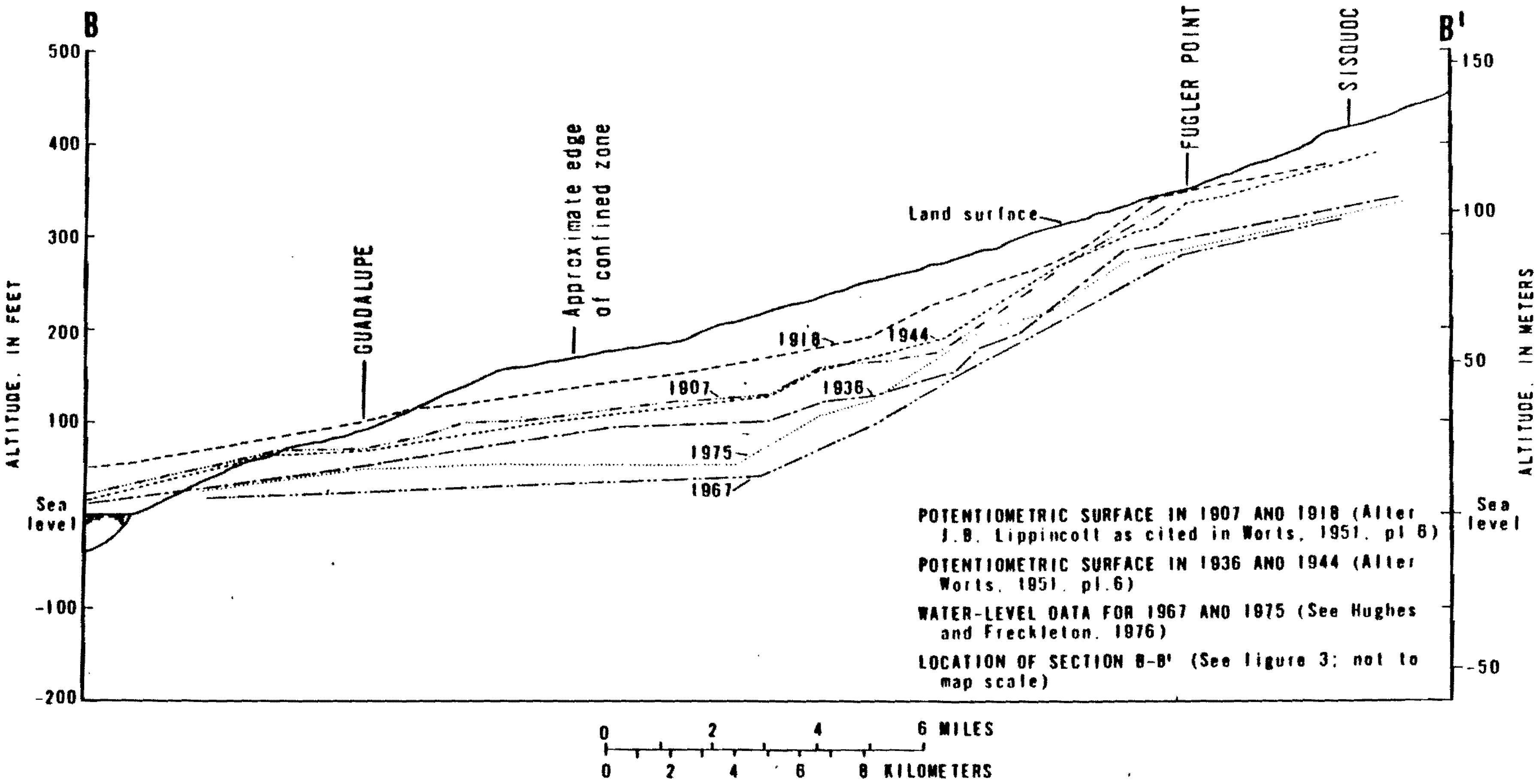

FIGURE 9.--Diagrammatic section showing potentiometric surface in 1907, 1918, 1936, 1944, 1967, and 1975.

From USGS Water-Resour
Investigations 76-128
Evaluation of Ground-w
Quality in the Santa Ma

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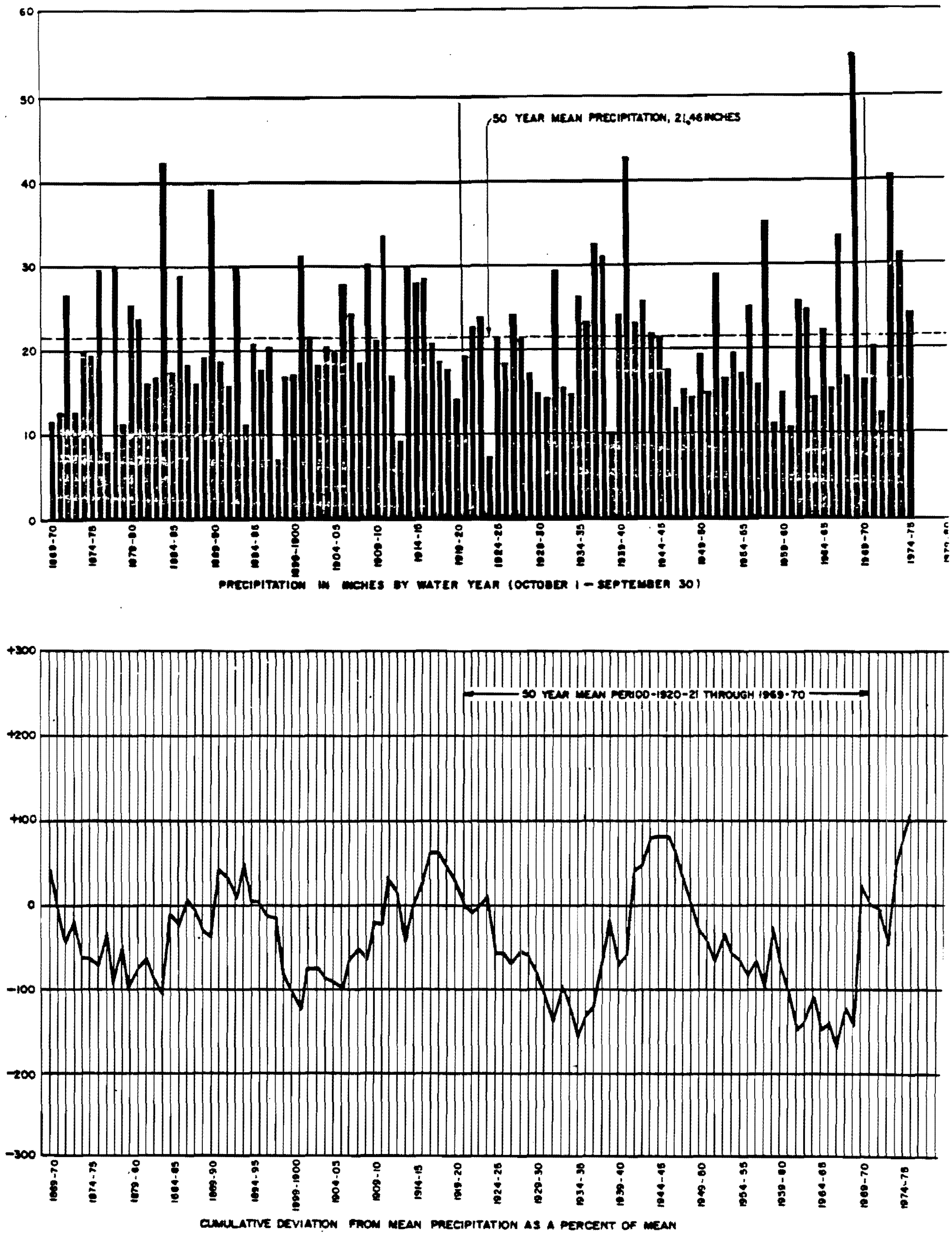
FIGURE A-1



REPRESENTATIVE PRECIPITATION CHARACTERISTICS FOR SAN LUIS OBISPO

DEPARTMENT OF WATER RESOUCES, SOUTHERN DISTRICT, 1976

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If it is assumed that generally the precipitation pattern at Santa Maria Valley is comparable to that at San Luis Obispo, it appears that the 1918 high water levels in SMV corresponded to the end of a wet period, the largest one on record to that time. It is surmised that large urban and, (especially) large agricultural, development had not yet commenced in the SMV.

p. 66 Figure C-7 (page A-6) "Fluctuation of Water Level in Wells."

This depicts hydrographs for three relevant wells:

a) 32S/13E-28G1(MDB&M) "Arroyo Grande Hydrologic Subunit (T-10.CO) 1942-1975

b) 10N/34W-14E3,14E2, 14E5(SBB&M) "Santa Maria Hydrologic Subunit (T012.AO)" 1917-1975 (located E. of Santa Maria)

c) 10N/35W-7F1(SBB&M) "Santa Maria Hydrologic Subunit (T-12.AO)" 1930-1975 (located W. of Guadalupe)

d) T-12.AO shows a declining trend with peaks and valleys corresponding to Figure 3-4. Also corresponds to potentiometric surfaces (qualitatively).

See page A-6 for Figure C-7

5. Toups Corporation "Santa Maria Valley Water Resources Study," 1976.

Figure 12 from this report "Precipitation Characteristics at Santa Maria" (see page A-7) show that these characteristics are, in fact, quite comparable to those of San Luis Obispo (page A-4). It may thus be supposed that hydrologic supply conditions for the Arroyo Grande Area Ground Water Basin (including Nipomo Mesa Sub-basin) have tended to follow those for Santa Maria Valley (although Nipomo Mesa is primarily reliant upon direct precipitation, while Santa Maria Valley GWB has large surface inflows as well.)

P. 122 - "The depth of the interface between ground water, etc. ..." Sheets A-8, A-9 (Fig. 9-3 "Relationship between A-10, A-11, A-12, A-13 (Fig. 9-4 "Relationship of Hydraulic Gradient to Fresh Water Head at the Coast"_ A-14, & A-15. The thesis of these sheets is that:

- Fresh water head at the coast required to block sea water intrusion is proportional to the thickness of the alluvial deposit, 40 ft of sea water being held at bay by one foot of fresh water surcharge.

- Maximum fresh water head was probably experienced in 1918, which also was believed to have witnessed maximum subsurface outflow and seaward hydraulic gradient, which was about 10 ft/mi. At that time, the salt water wedge would have extended shoreward from the aquifer intersection with the ocean floor about 1.5 mi., for an outflow of about 16,000 AFY.

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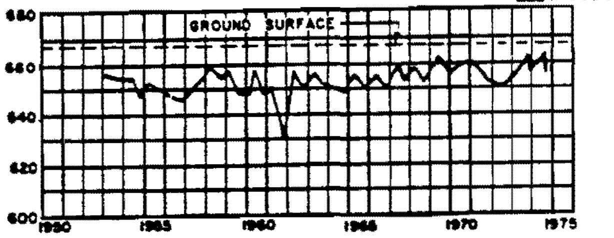
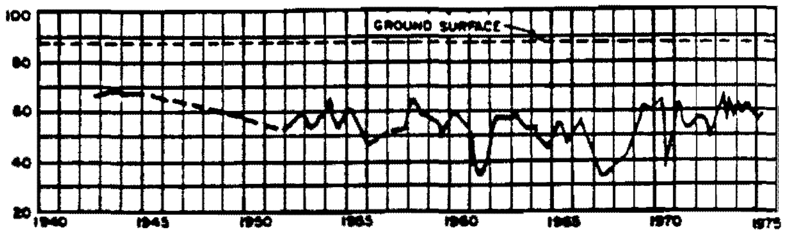
PASO ROBLES HYDROLOGIC SUBUNIT (T-09.HO)

WELL 26S/12E-9M2, M.D.B.&M.



ARROYO GRANDE HYDROLOGIC SUBUNIT (T-10.CO)

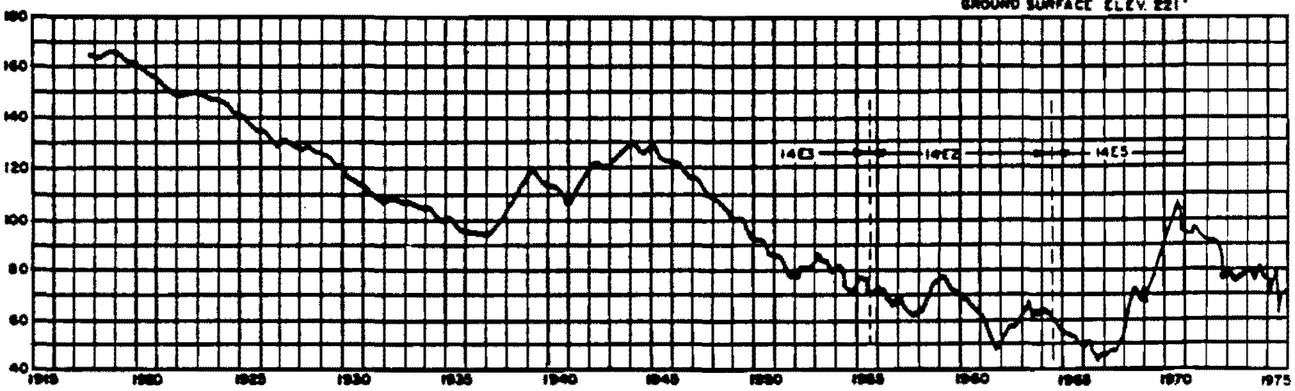
WELL 32S/13E-28G1, M.D.B.&M.



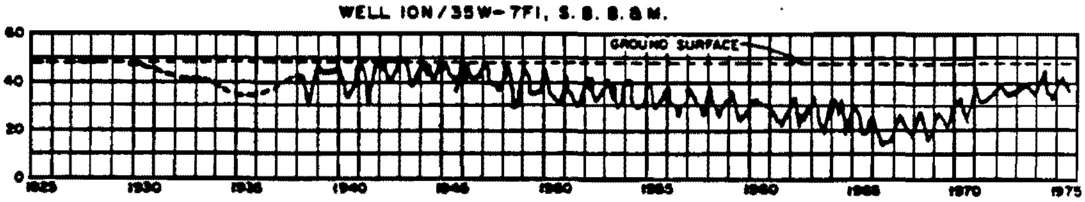
ELEVATION IN FEET U.S.G.S. DATUM

SANTA MARIA HYDROLOGIC SUBUNIT (T-12.AO)

WELLS 10N/34W-14E3,14E2,14E5,S.B.B.&M.



WELL 10N/35W-7F1, S.B.B.&M.



YEAR

NOTE LOCATION OF WELLS SHOWN ON PAGE 55

FLUCTUATION OF WATER LEVEL IN WELLS

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1976

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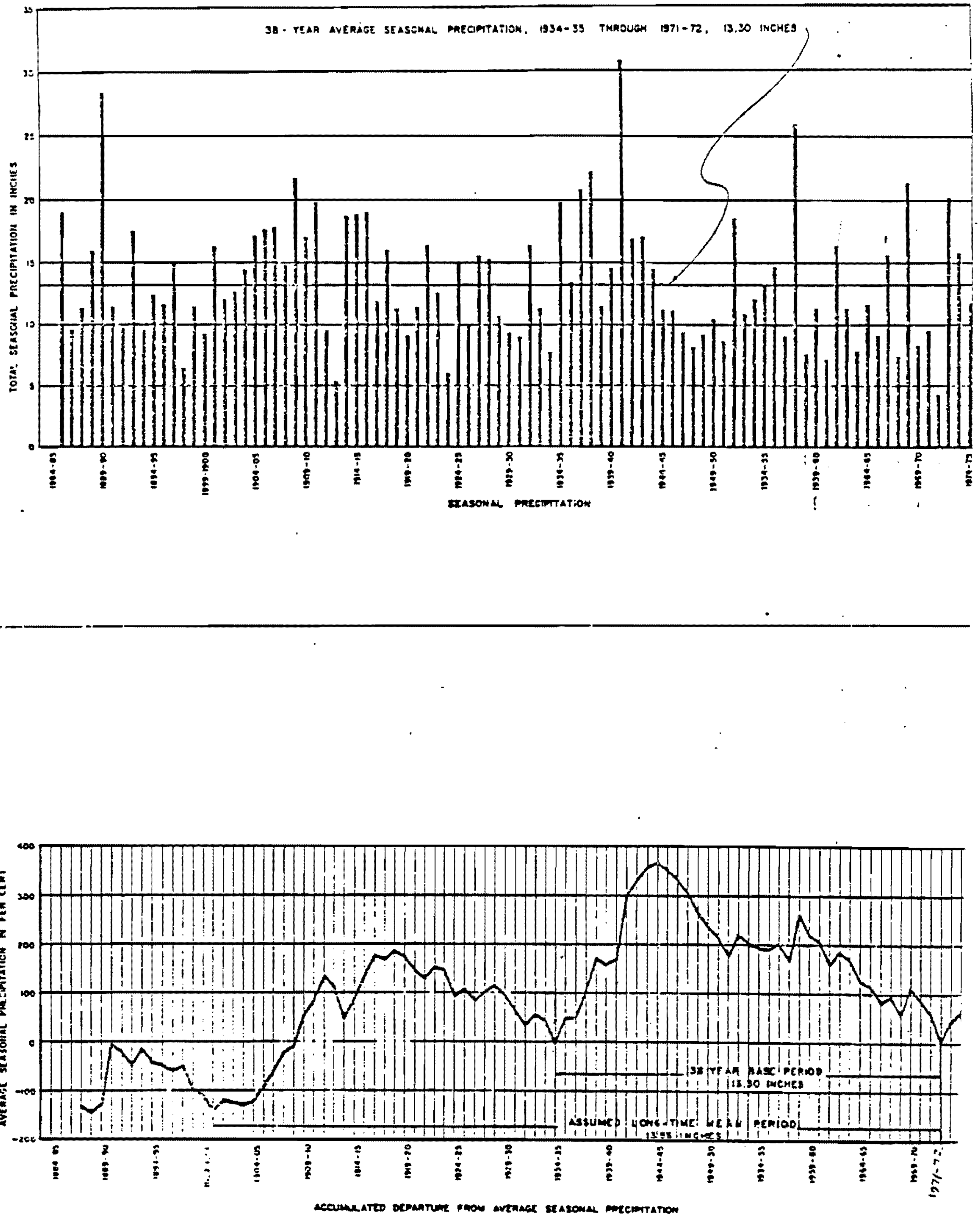

FIG. - 1-3 PRECIPITATION CHARACTERISTICS AT SANTA MARIA

Figure 12 - Taken from Toups (1)

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The depth of the interface between groundwater and salt water in an aquifer undergoing seawater intrusion is determined theoretically by applying the principal of differential density between fresh and salt water. In proportion to the slightly greater density of seawater the contact between the two will be depressed about 40 feet below sea level for each foot of fresh water head above sea level, assuming the specific gravity of sea water to be 1.025.

The alluvial deposits along the coast are estimated to attain a maximum thickness of about 1,500 feet along the axis of the Santa Maria syncline [USGS 1951; Santa Barbara County 1974; DWR 1971] Therefore, a fresh water head at the coast of about 38 feet would be necessary to completely block seawater intrusion. Figure 9-3 shows the relationship between fresh water head at the coast in 1907, 1918, 1936, 1944, 1959, 1966, and 1975, and the depth of the potential fresh water/salt water interface.

A maximum head of about 55 feet above sea level occurred in 1918, and this is believed to represent a maximum condition. The 1918 hydraulic gradient of about ten feet per mile is also believed to be a maximum. The fresh water head along the coastline now is about ten feet above sea level. This head would theoretically cause a potential fresh water/salt water interface to be about 400 feet below sea level at the coast, which would not prevent the intrusion of sea water into the deep aquifer system. Recent water quality analyses show that seawater intrusion has not occurred in the onshore groundwater basin. However, the analyses were from depths too shallow to detect the presence of a wedge intruding the deep aquifer system, if such a wedge were present. The trend in recent years has been toward both reduced head at the coast and reduced potential depth of the fresh water/salt water interface.

The length of an intruded seawater wedge into an aquifer is theoretically dependent upon the length of the wedge is directly proportional to the

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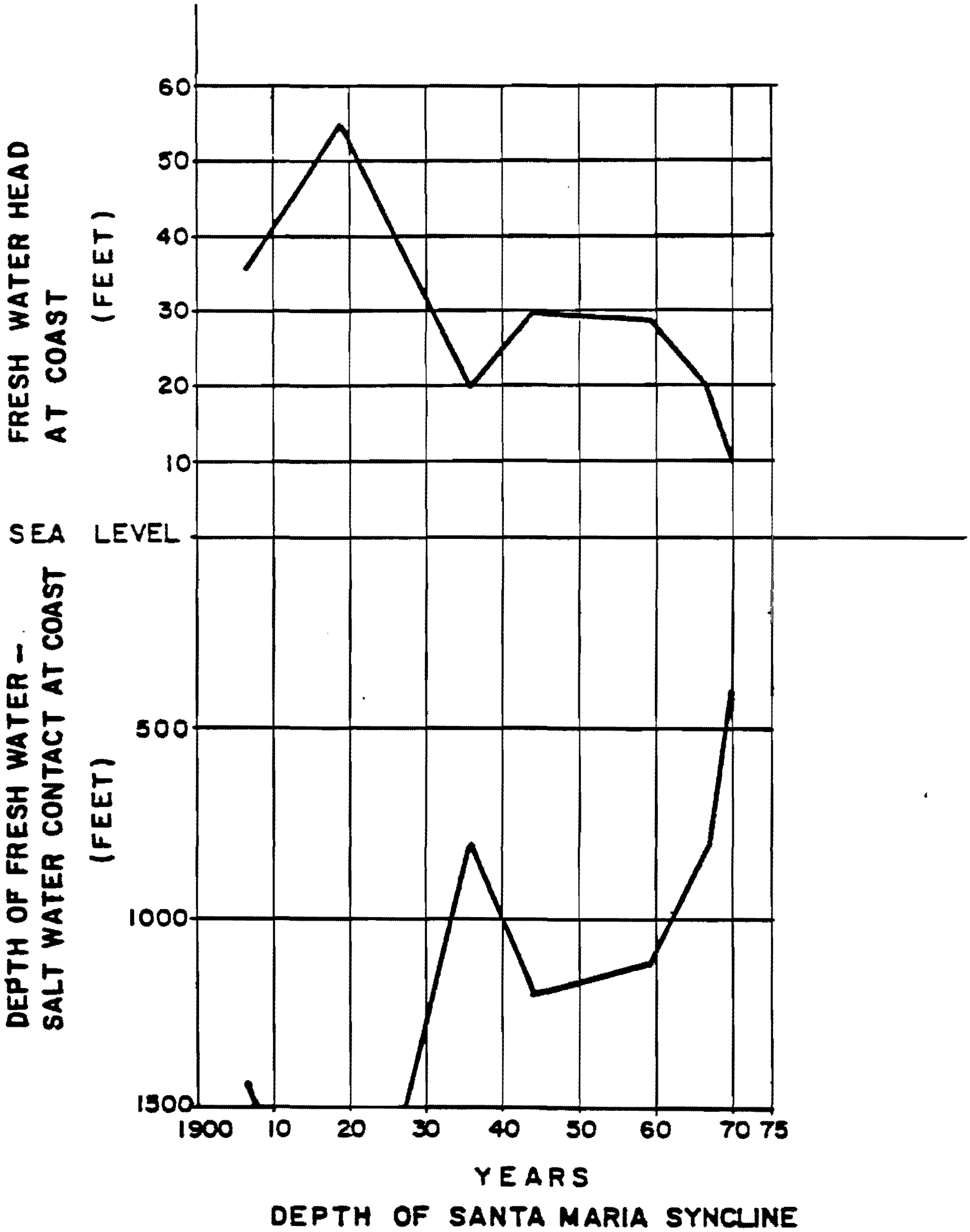

FIG. 9-3 RELATIONSHIP BETWEEN FRESH WATER HEAD AND DEPTH OF FRESH WATER - SALT WATER CONTACT

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thickness of the aquifer. It is inversely proportional to the hydraulic gradient of the groundwater discharge. These relationships are expressed by the following mathematical equation:

$$L = \frac{(S-1)m}{2I} \qquad (1)$$

where

L = length of intruded seawater wedge (ft)

m = thickness of pressure aquifer (ft)

$S = \frac{w_s}{w} = \frac{1.025}{1}$ = ratio of unit weight of sea water to fresh water (w_s is density of sea water; w is density of fresh water

I = hydraulic gradient (in ft per ft).

Using the above equation, it is possible to estimate the length of the intruded seawater wedge if thickness of the aquifer is assumed. At the coastline the maximum thickness of water bearing deposits below the confining layer is about 1,200 feet. Assuming this maximum thickness throughout the entire offshore aquifer system with the year 1918 gradient of ten feet per mile, the salt water wedge developed under these conditions would extend shoreward about 1.5 miles from the location offshore where the fresh water aquifer discharges from the ocean floor. The estimated groundwater outflow to maintain the wedge in this location was 16,000 acre-feet annually.

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In 1935, the beginning of the base period, the hydraulic gradient was about six feet per mile. The length of the intruded salt water wedge under this gradient would be about 2.5 miles from the ocean floor fresh water discharge area. The estimated groundwater outflow to maintain the wedge in this location was 9,500 acre-feet annually.

The average hydraulic gradient in 1972, the end of the base period, was no more than two feet per mile. The length of the salt water wedge under this gradient would be about 7.5 miles. The estimated groundwater outflow to maintain the wedge in this location was 2,000 acre-feet annually.

The above analysis indicates a rate of advance of the salt water wedge between 1918 and 1935 of 0.85 feet per day, and between 1935 and 1972 of 1.90 feet per day. The 1935 to 1972 rate appears excessive when compared to measured rates of sea water intrusion into coastal aquifers in Los Angeles and Orange Counties, which amount to about 1.0 feet per day and 1.15 feet per day, respectively. Because a salt water wedge in the Santa Maria off-shore aquifer would be moving under an adverse gradient, a rate of one-half foot per day is assumed for the years 1935 through 1972. This would place the intruded salt water wedge about two and one-half miles from the ocean floor fresh water discharge area.

The difference in volume between the 1935 wedge and the 1972 wedge represents the amount of fresh water lost by the aquifer to seawater intrusion during the base period. If it is assumed that the offshore aquifer system maintains its coastal configuration throughout the offshore portion, the amount of fresh water lost to seawater intrusion amounts to well over 5,000 acre-feet annually during the base period. The above analysis shows clearly that while fresh groundwater outflow is occurring, underlying salt water is flowing landward. This seawater intrusion will continue unless the hydraulic gradient of the aquifer is stabilized. The fresh water head at the coast, if sufficiently high, would hold out

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seawater intrusion, but it too is related to the hydraulic gradient; as the gradient diminishes, the fresh water head lowers. This relationship is shown on Figure 9-4.

It is not possible to predict the amount of fresh water remaining in storage in the offshore aquifer system, since the extent and porosity of the system are unknown. The quality of this water is also unknown.

Based on the above theoretical analysis it can be concluded that the offshore aquifer system is being intruded by seawater, which will accelerate in the future, as the hydraulic gradient in the semi-confined area is further reduced.

ON-SHORE AQUIFER

The hydrologic equations summarized in Chapter 8 for future levels of groundwater development in the Santa Maria Valley point to a condition of overdraft. This situation will serve to further depress the seaward gradient in the coastal portion of the on-shore aquifer system. Hence, the process of seawater flow into the off-shore fresh groundwater system will continue. Since it is apparent that the confining clay layer in the on-shore regime is not totally impervious to percolation, it is overly-optimistic to assume that the same strata immediately offshore would exhibit extremely different properties. Therefore, seawater is anticipated to appear as infiltration through the offshore clay layer as well as in the form of additional movement of the classic seawater wedge or wedges.

The off-shore system has historically protected the valley from intrusion by seawater. The most practical and economical course of action available to water users in the Santa Maria Valley is to maintain the current practice of overdraft. This will result in exploitation of the offshore freshwater resource to the greatest possible extent.

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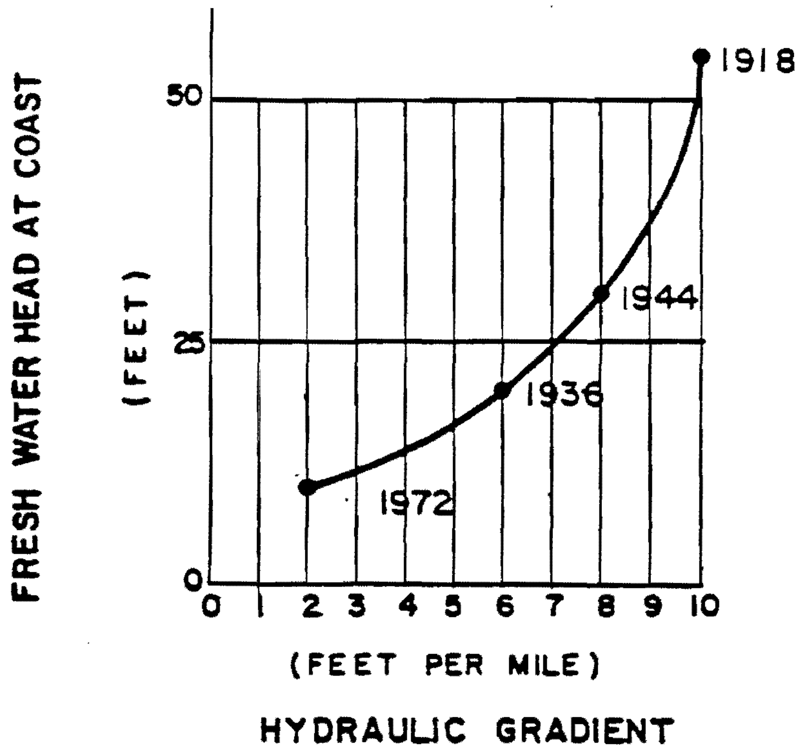

FIG. 9-4 RELATIONSHIP OF HYDRAULIC GRADIENT TO FRESH WATER HEAD AT THE COAST

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At the time seawater is detected in producing on-shore wells, management strategies can be implemented which will maintain the productivity of the groundwater basin. A number of general stratagies can be implemented which will prevent or control seawater intrustion at such time when it is detected [DWR 1975c]. These strategies include:

- Raising the off-shore trending gradient above sea level by reductions in extractions, by rearrangement of the areal pattern of pumping, or by a combination thereof.
- Direct recharge of depressed aquifers to maintain groundwater levels above sea level.
- Development of a fresh water injection barrier along the coast.
- Maintenance of a pumping trough between saline water and the principal areas of groundwater extraction.
- Implementation of a combination injection-extraction barrier.
- Construction of a static subsurface physical barrier.

All of the foregoing control measures require that basin groundwater be managed in a coordinated manner. A primary emphasis of any strategy for seawater intrusion control is the assurance of an adquate water supply to lands whose economy depends on groundwater. Control measures differ from one another principally with regard to the degree they permit storage capacity of the groundwater basin to be utilized. The option of reduced extraction is especially limiting in this regard. Implicit in strategies incorporating recharge is acquistion of source water through additional local water resources development, water importation, or redistribution of groundwater from forebay areas.

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A practical course of action that could be pursued in the Santa Maria Valley to maintain the integrity of the groundwater basin in light of seawater intrusion involves implementation of a two-phase program of salt water extraction and reduced or curtailed pumping in the area of semiconfined groundwater. Production wells along the coast would be converted to extraction wells once seawater has intruded their radius of influence. It would be desirable to incorporate new wells into the extraction barrier. Experience obtained in similar seawater control operations indicates that it is nessary to space barrier wells about 500 feet apart. In relatively permeable formations, closer spacing may be required.

To effectively control the intrusion problem the extraction operation would be complimented by a coordinated program of restricted pumpage in the semiconfined area and delivery of groundwater extracted from the forebay to users over the clay cap. Because of the dynamic interrelationship among these various hydrologic components, a mathematical model of the basin would become an indispensable aid in program management. If properly implemented, the strategy of barrier maintenance and managed pumping would make a large volume of groundwater available for mining from the reservoir in the basin forebay. This resource should be adequate to satisfy water requirements projected to 2025.

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- In 1935, the estimated hydraulic gradient was about 6 ft/mi., the salt water wedge about 2.5 mi shoreward from its origin (intersection of aquifer with ocean floor), and the outflow was about 9,500 AFY.

- In 1972, the average hydraulic gradient was 2 ft/mi., max, the salt water wedge was 7.5 mi. shoreward, and the outflow was 2,000 AFY.

- The (theoretical) analysis indicates a rate of advance of the saltwater wedge

  1918-35 - 0.85 ft/day
  1935-72 - 1.90 ft/day

- The theoretical advance rate appears unreasonably high when compared with measured advance rates in coastal LA Co. (1.0 ft/day) and Orange Co. (1.15 ft/day).

- In view of the existence of a positive offshore gradient during 1935-72, Toups assumed the advance for this period averaged 0.5 ft/day. (When added to the 1935 condition, this would imply about 1.3 mi., for 1935-72, plus 2.5 mi at 1935 equals about 3.8 mi. total intrusion by 1972.)

6. Santa Barbara County Water Agency "Final Report, Adequacy of the Santa Maria Groundwater Basin," November 1977.

p. 29 Subsurface Outflow.

"Groundwater moving down gradient, etc..." (See pages A-17, A-18, A-19, and A-20).

The gist of these pages is:

- The subsurface outflow is a function of hydraulic gradient seaward and is computed via flow across a known cross-section less the consumptive use of extractions between that cross-section and the coastline. This latter is taken as 11,000 AFY for agriculture plus 1,000 AFY for Union Oil Company's Oso Flaco Refinery, making 12,000 AFY total cons. use.

- The computed 1975 value of subsurface outflow is 18,000 AFY (across the cross-section) less 12,000 AFY (coastal cons. use) or 6,000 AFY.

- The 1959-75 period average subsurface outflow is taken as 7,000 AFY.

- A 1975 condition of 6,000 AFY subsurface outflow would imply a total seawater intrusion of 4 mi. ± to date from the point where the fresh water is discharged on the ocean floor.

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25 percent over the 1959-75 period. Net consumption of applied water thus amounted to 61,700 AFY during this period. As compared to average base period conditions, recent increases in agricultural acreage have occurred primarily in the unconfined portion of the groundwater basin. This has resulted in an increase in the weighted average irrigation returns in the basin. Thus, under current (1975) conditions, 27 percent returns accounted for a net agricultural water consumption of 82,700 AFY. Projected demands for the year 2000 similarly assume an increase in irrigation returns to 28 percent of the total applied water.

Subsurface Outflow

Groundwater moving downgradient beneath the confining beds is eventually discharged to the ocean, where the unconsolidated deposits are exposed on the ocean floor about two to four miles offshore (1). Because of the lack of well logs in the offshore area, the precise configuration of the submarine extension of the groundwater basin is unknown.

The method used to estimate groundwater discharge by outflow is based on Darcy's law of saturated flow, patterned after the methodology used by the USGS [1951 (1)]. Geologic cross-section D-D' (see Fig. 5) which cuts the basin just west of Guadalupe, defines an area through which water being discharged at the coast must move. The water-bearing deposits cut by this section include the Careaga sand, Paso Robles formation, the lower part of the Orcutt formation and the lower member of the Alluvium. The actual cross-sectional area and the permeabilities of the various formations were previously determined by the USGS [1951 (1)] from well-logs and laboratory tests. These data are presented in Table 5. As thus defined, the total saturated cross-sectional area is about 43 million square feet. Water level changes in the confined area do not significantly affect the cross-sectional area since the top of the saturated zone remains within the confining layer.

Given the information on the cross-sectional area and permeabilities of the affected formations, the hydraulic gradient across this section will determine the seaward flow potential. The calculated flow across this section less any demands west of this line of section will equal the subsurface outflow.

The hydraulic gradient was computed from a 1975 water level map prepared by the Water Agency. A gradient of 11 feet per mile, corresponding to a flow of approximately 18,000 AFY was found to coincide with the gradient derived from a 1975 water level map independently prepared by the USGS. Because of consumptive extractions seaward of this section, the actual subsurface outflow must be somewhat less than 18,000 AFY. Agricultural acreage

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Table 8 5

SUBSURFACE OUTFLOW
SANTA MARIA GROUNDWATER BASIN[a]

Formation	Permeability (gpd/ft.^{2})	Saturated Cross-Section (ft.-miles)
Alluvium (lower member)	450	2,000
Paso Robles & Orcutt	5,500	65
Careaga Sand	2,200	75

Hydraulic Gradient (ft./mile)	Wedge Length (ft.)	Discharge (AFY)
1	79,200	1,600
2	39,600	3,200
3	26,400	4,800
4	19,800	6,400
5	15,800	8,000
6	13,200	9,600
7	11,300	11,200
8	9,900	12,800
9	8,800	14,400
10	7,920	16,000
11	7,200	17,600
12	6,600	19,200

$$L = \frac{(S-1)m}{2I} = \frac{(0.025)(1200 \text{ ft thk pr. aquifer})}{2 \text{ hydraulic gradient (ft/mi)}}$$

$$= \frac{15 \text{ ft}}{\text{slope (ft/mi)}} = \frac{15(5280)}{(\text{ft/mi})} = \frac{79,200}{\text{ft/mi}}$$

[a]Cross-sectional area and permeability from Worts, Geology and Groundwater Resources of the Santa Maria Valley, CA. USGS Water Supply Paper #1000, 1951.

A = [illegible]

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west of D-D' was planimetered from the GRSU 1975 agricultural land-use maps and found to total approximately 6,000 acres. Most of this land is intensively farmed truck crops. Due to the relatively low evaporation potential and fine-grained soils along the coastal fog belt, ET of these crops is somewhat less than the overall basin average. Applying a water duty of 2.0 AF/ac/yr Toups 1976, Table D-6 (4) to this acreage and accounting for five percent return flow yields a consumptive use figure of 11,000 AFY. Combined with an estimated 1,000 AFY of water use by Union Oil's Oso Flaco Refinery [Toups 1976 (4)], total consumptive extractions west of D-D' are approximately 12,000 AFY. Therefore, subsurface outflow from the basin under 1975 conditions was about 6,000 AF. Since subsurface outflow in 1959 as estimated by the USGS [1966 (2)] was 8,000 AF, average annual outflow during the period 1959-75 is considered to be 7,000 AFY. A recent study by the USGS (16) has concluded that subsurface outflow presently totals 7,000 AFY.

Miller and Evenson [USGS (2)] suggested that with continuing overdraft, underflow to the ocean would decrease from 8,000 AFY to 3,000 AFY as the hydraulic gradient decreased from five feet to two feet per mile. Toups [1976 (4)] estimated that on the basis of their 1975 water level contours that the hydraulic gradient had been reduced to two feet per mile, and consequently concluded that this would result in subsurface outflow totaling 2,000 AFY. The substantial difference in hydraulic gradients determined by the Water Agency and the Toups Corporation study [1976 (4)] is related to the respective areas over which the gradient was calculated. Toups calculated the gradient over the entire basin while the present study determined the gradient between the 30 and 50 foot water level contours which roughly straddle section D-D' (11). Because concentrated areas of demand within the unconfined area can produce significant water level fluctuations, use of the basin-wide hydraulic gradient does not necessarily reflect groundwater conditions at the coast. The piezometric level within the confined area is less subject to variations induced by pumping stresses, and therefore calculation of the hydraulic gradient near the coast is more likely to reflect actual conditions of discharge.

The prediction by the USGS that continuing overdraft conditions would bring about a 5,000 AFY reduction in subsurface outflow appears not to have been substantiated by recent data (2). While some lowering of head in the confined area has undoubtedly occurred, this does not necessarily imply a reduction in gradient. A more or less uniform lowering of water levels near the coast could tend to establish the same gradient at a new equilibrium level.

A subsurface outflow to the ocean has decreased under continuing overdraft, some mining of the offshore extension of the groundwater basin has occurred. The magnitude of this loss of fresh

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water storage is indeterminable because of the unknown volume of the offshore aquifer. If the subsurface outflow from the basin has declined from 8,000 AFY in 1959 to 6,000 AFY in 1975, this would imply that the salt-water wedge within the main aquifer has moved about one mile landward from its former position. Subsurface outflow at the rate of 6,000 AFY would mean that the salt-water wedge would have intruded the offshore aquifer system by a total of approximately four miles from the point where fresh water is discharged on the ocean floor. Water quality analyses of wells to date have not shown any abnormally high chloride levels which would indicate that seawater intrusion of the onshore portion of the basin had occurred. However, progressive lowering of water levels along the eastern margins of the confined area will tend to reduce the seaward hydraulic gradient, thereby causing a landward movement of seawater. The potential for brackish water contamination of near shore wells is currently being assessed in a coastal well monitoring program by the USGS in cooperation with the SBWCA

Early detection of seawater contamination of the onshore aquifer system is essential to the timely implementation of mitigation measures.

The Hydrologic Equation

The previously quantified elements of recharge and discharge are applied in the hydrologic equation for the period 1959-75 shown in Table 6. The equation displays relatively good agreement between estimates of recharge and discharge and calculations of net depletion of storage. These figures indicate an annual overdraft of about 10,000 AFY in the Santa Maria Groundwater Basin. Because this is an average depletion over the base period, increases in M & I and agricultural water extractions have probably resulted in an increasing rate of storage loss in recent years.

Also presented in Table 6 are the elements of supply and disposal for the 1935-72 base period. In particular, the computed values for the various sources of recharge during this period, plus the average incremental yield from Twitchell Reservoir operations, are equated to the long-term source of supply to the basin. Under 1975 basin cultural conditions, average annual groundwater recharge is estimated at nearly 82,000 AFY.

All the estimates for the various elements of the hydrologic equation are subject to a range of error. This is apparent from the change in storage calculations as compared to the difference between total recharge and total discharge over the same time period. Errors in the estimated recharge may be due to underestimation of rainfall infiltration and additional unknown sources of recharge. Errors in estimated net pumpage may be due to inaccurate estimates of return irrigation water.

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7. John F. Mann, Jr. "Water Feasibility Report, Black Lake Country Club," July 5, 1976.

pp. 4-5 "...As there was very little ground water development in the Nipomo Mesa as of 1954, we may assume that 1954 represented conditions close to those that occurred historically..."

pp. 13-14 "Status of Sea-Water Intrusion

"There is no evidence, etc. ..." (See pages A-22, A-23, & A-24)

The gist of these pages is:

- Inasmuch as there was no significant development of ground water prior to 1954, there must have been significant subsurface outflow to the ocean sufficient to prevent sea water intrusion (this is implied).

- Even with the alteration of historical status by initial ground water development, there was not yet (1976) a commencement of sea water intrusion offshore from Nipomo Mesa.

- "It is difficult to imagine that the front of intruding sea water could reach the coastline in the next 50 years."

- Projections of the lower aquifers of the Paso Robles formation beneath the ocean indicate that the closest submarine outcrops are about 10 miles from the present coastline.

8. DWR "Ground Water in the Arroyo Grande Area, District Report (Southern District)," June 1979

p. 52 - Figure 35 - Conceptual Drawing of the Offshore Aquifers" (See page A-25)

p. 51 - "Because these forebay areas have probably maintained a seaward hydraulic gradient in the ground water, the aquifers offshore probably contain fresh water. Secondly, the geology offshore can be constructed by extending the geology on land offshore..."

p. 53 - "The cross section on the beach showed that there were two aquifer systems and that if these aquifers were projected westward offshore without a dip to where they surface on the ocean floor they would have the following dimensions:

The upper aquifer would measure 15 Km (9 mi) along the beach from Arroyo Grande Creek to Santa Maria River and 10 Km (6 mi) seaward from the beach. It would have an average thickness of 60 m (190 ft). The lower aquifer would measure the same distance along the beach and 19 Km (12 mi) seaward at its furthest point, and it would have an average thickness of 130 m (430 ft). The aquifers are thickest at the south end near the San Luis Obispo County line..." "There is an estimated 3 million AF of water in storage offshore between Arroyo Grande Creek and San Luis Obispo County line with about 500,000 AF in the

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more mineralized than the well water used for the irrigation. Also, treated domestic sewage is expected to be about 250 to 300 ppm higher in TDS than the delivered water. When the treated domestic sewage is used for irrigation, there will be a further increase in the salinity of the irrigation return waters. Within the expected pumping hole, a certain amount of re-circulation must be anticipated. The net result of the project will be a slow increase in the salinity of the underlying ground waters. Such an increase will be slow -- no more than a few per cent per year.

In situations such as this, nitrates particularly should be watched. Heavy use of nitrates in grass fertilizers should be avoided. After treatment, domestic sewage will have an appreciable nitrate content. An important mitigating factor in the potential nitrate problem is the use of the treated domestic sewage for golf course irrigation. Much of the nitrate will be utilized by the grass, and only the remainder will be able to percolate downward in the return water.

<u>Status of Sea-Water Intrusion</u>

There is no evidence of sea-water intrusion beneath the Nipomo Mesa area. The Pismo-Guadalupe report (Reference 4) concluded that sea-water intrusion was not a problem (as of 1970) onshore anywhere in this coastal reach. As of now there is a seaward water-level gradient beneath the Nipomo Mesa and fresh water is being wasted to the ocean, especially from the shallower aquifers. With increased pumping, water-level gradients may be expected to flatten and in time produce pumping holes which are

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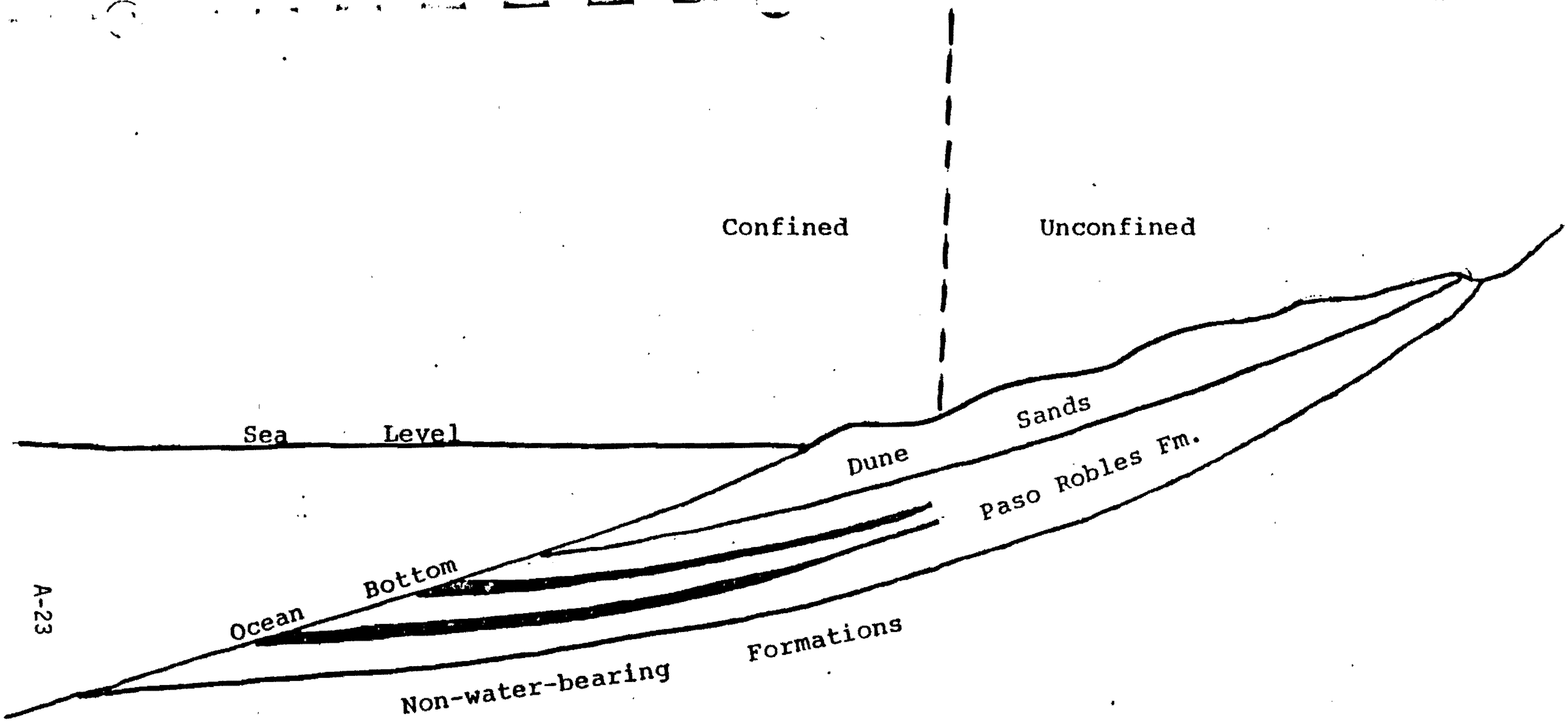

Figure 1. - Generalized geologic conditions under the Nipomo Mesa and offshore.

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below sea level. Under the last condition, intrusion of sea water into the subsea outcrops of the Paso Robles formation may be expected. The sea bottom topography to the west of Nipomo Mesa is shown on the United States Coast and Geodetic Survey Chart 1306N-20, Cape San Martin to Point Conception. This chart shows the ocean floor to be gently sloping and smooth, with no submarine canyons. Projections of the lower aquifers of the Paso Robles formation beneath the ocean indicate that the closest submarine outcrops are about ten miles from the present coastline. In nearby Santa Maria Valley, Toups Engineering (Reference 6, page 119) has estimated that sea-water intrusion into the offshore aquifers for the period 1935 to 1972 has advanced at a rate of one-half foot per day. This is equivalent to an advance of 1 mile in about 29 years. Sea-water intrusion offshore from Nipomo Mesa has not yet started and it is difficult to imagine that the front of intruding sea water could reach the coastline in the next 50 years. However, as a measure of vigilance, the Department of Water Resources has already installed monitor wells along the coast in the Nipomo Mesa area. These monitor wells are numbered 12N/36W-36L1,2 and 11N/36W-12C1,2,3. The 36L well has a total depth of 846 feet and is perforated in two zones at depths of 226-236 feet and 534-544 feet. The 12C well found the bottom of the fresh water at 770 feet and is perforated in three zones at depths of 280-290, 450-460, and 720-730 feet. There is an earlier monitor well in the Oso Flaco Lake area (11N/36W-13k2-6) which is perforated in 5 different zones (Reference 4, page 20).

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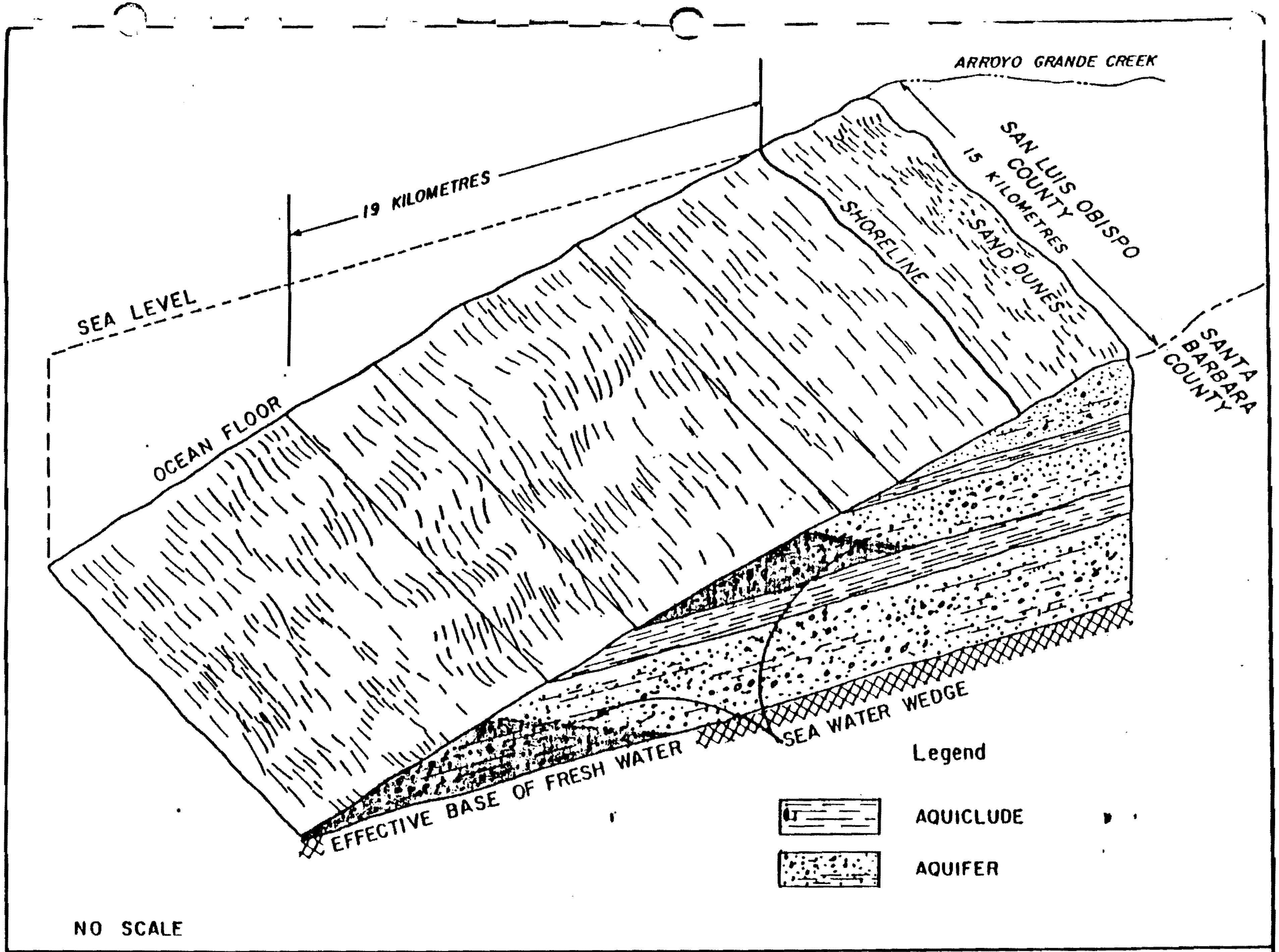

Figure 35 - CONCEPTUAL DRAWING OF THE OFFSHORE AQUIFERS

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upper aquifer and 2,500,000 in the lower aquifer. However, not all the water in offshore storage is fresh. A sea water wedge exists in aquifers exposed on the ocean floor due to the differential in density between that of sea water and fresh water... The extent of sea water encroachment into the aquifer is a function of the hydraulic gradient within the aquifer and the thickness of the aquifer. If the seaward hydraulic gradient were 10 ft/mi in the vicinity of hole GO-2, the sea water wedge in the upper aquifer would extend landward 1.5 mi and in the lower aquifer 5.3 mi. With a similar hydraulic gradient the wedge would be shorter to the north where the aquifers are not as thick. The quality of the freshwater offshore cannot be determined but may be similar to that in wells near the beach. Because the water from deeper sediments in this area is generally higher in TDS concentration, the quality could also deteriorate with distance offshore."

p. 6 "An offshore seismic profile, coupled with what is known about the onshore geology, points to an offshore extension of fresh water-bearing aquifers.

pp. 6-7 "Not all the water (in offshore aquifers) would be potable, however, because a wedge of sea water intrudes and displaces fresh water in all aquifers offshore. The size of the wedge depends upon the hydraulic conditions in individual aquifers. The quality of the water in the aquifers offshore cannot be determined directly with the available data... The amount of offshore fresh ground water estimated in this study is speculative. Accordingly, it presents a possibility that intrusion may not be observed onshore for a number of years to come but, on the other hand, provides no assurance that intrusion is not imminent..."

9. Considerations of Storage Changes Nipomo Mesa Sub-Basin and Offshore

a. Extractions (cumulative) since initial development of Nipomo Mesa (1950-55+)(Refer to page C-12). Approximation of total extractions through 1981 is 82,000 AF. Allow for cons. use and export ~ 60,000 AF.

b. Supply (1952-53 to present) is about:

plus 220% to plus 180% (page A-7)(10 yrs) and minus 10% to zero (page A-3)(18 years) or 30% loss in 28 yrs or 1% loss per year below normal.

c. Assuming that DWR deep percolation of precipitation of 3,300 AFY (p.48, 6/79 report) is correct as well as 500 AFY of subsurface seepage, the supply from natural sources during the period ('53-'81) would be about 3800 x 28 = 106,000 AF for average rainfall. The actual supply would not have been significantly different.

d. Assuming (for simplicity) that DWR's 1977 subsurface outflows of 3,300 AFY are also correct for that earlier period (2,300 to 2,800 to Santa Maria Valley and 225 to 300 AFY to Arroyo Grande-Tri-Cities Mesa), then the ocean outflow would have been higher (under normal supply) when the Nipomo Mesa Sub-basin water levels were higher but the outflows to SMV (especially) would probably have been lower because the ground water levels in SMV were higher too.

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e. For 1967, DWR estimated 194,000 AF in storage in Nipomo Mesa above sea level. For 1974, DWR estimated 172,000 AF (p.30,6/79). Drop is 22,000 AF or 3,000 AFY in 7 yrs.

f. Rainfall during 1967-74.

- o Sheet A-4 indicates the supply increased from a minus 130% to a plus 80% or 210% divided by 7 = 30%/yr above-average rainfall (San Luis Obispo).

- o Sheet A-7 indicates the supply decreased from a plus 80% to a plus 700% or 10% divided by 7 = 1%/yr below-average rainfall (Santa Maria). This is not a significant difference.

- o Figure 3-5 indicates the supply increased from a minus 22% to a minus 15% or 7% divided by 7 = 1%/yr above-average rainfall (Nipomo). This is probably not a significant difference either.

- o The rainfall differences are small enough and imprecise enough to ignore. The supply can be considered average for this period.

g. Trial hydraulic gradients of ground water seaward for 1965 and 1967.

- o For 1965, DWR shows (Fig. 10, 6/79) contours sloping seaward near the coast from which a general approximation indicates a slope of about 0.3% to 0.5%, say, 0.4% average.

- o For 1975, similar contours (Fig. 11, 6/79) slope seaward near the coast in somewhat less uniform manner, so that the gradient could be interpreted as anywhere between 0.2% and 0.6% with an average of, say, 0.35% but 0.2% being also representative (for closest to the coast).

h. Theoretical subsurface ocean outflow for 1965 and 1975-77

- o The cross sectional area is taken as 787 ft deep and 2.2 mile wide = 9.1×10^6 sq ft.

- o DWR used an assumed permeability of 10 gpd/sq ft for the aquifers leading offshore in their analysis of 1977 conditions (summarized in Table 11, p. 48, 6/79). (Permeability value is for 100% slope.)

- o Assuming 50 gpd/sq ft, the following outflows to the ocean from Nipomo Mesa Sub-basin would be calculated as:

  · 1965 Q(gpd) = 50 gpd/sq ft x 9.1×10^6 sq ft x slope
  Q,AFY = 455 x (365 days/326,000 gal) x Slope x 10^6
  = 0.51 (slope) x 10^6 AFY
  At Slope = 0.004, AFY = 2,000

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1975 Q,AFY = 0.51 (0.002)(10^6) = 1,000 AFY (0.2% slope)
or 0.51 (0.0035)(10^6) = 1,800 AFY (0.35% slope)

It is noted that DWR's computed values for 1977 show only about 1/8th of the higher 1975 (JMM) value, but somewhat different cross section and 1/5th of the permeability. (The true permeability would be expected to be at least 50 or 100 gpd/sq ft.)

i. Possible Reconciliation of Various Factors

- 1952-53 to present, supply was ~ 106,000 AF (cumulative)

  1952-53 loss to cons. use/export ~ 60,000 AF (cumulative)

  1952-53 available for outflow 46,000 diff. (assuming no change in storage)

- Change in storage 1967-75 (8 yrs) (DWR, 6/79) 22,000 AF loss

- Assumed changes in storage not documented:

  1952-1967 Total extractions ~ 26,000 AF (Page C-12) 26/15=1.7KAFY (<2.9 avg.)

  1952-1967 Rainfall about 200-100=100% undersupply in 15 yrs (6.7% below avg.)

  John Mann (p. 6) "DWR preliminary evaluation of 1965 water level contours showed basic pattern of outflow unchanged from 1954 contours, but some pumping holes and ground water mounds had developed."

  As a result of the foregoing, assume that the loss in storage in the 15 years 1952-67 was only 5,000 AF cumulative.

  For the 7 years since 1974, assume the above-average supply has nearly compensated for the above-average consumptive use, and the loss in storage is thus assumed as negligible.

- Total change in storage, 1952-53 to present ~
  5,000 + 22,000 = 27,000 AF

- Total subsurface outflow, 1952-53 to present (ocean, SMV, Arroyo Grande etal)

  46,000 + 27,000 = 73,000 AF
  73,000/28 years = 2,600 AFY avg.

- A more detailed analysis would be required to better estimate the subsurface outflow and its division among the offshore aquifer, the SMV, and Arroyo Grande etal sub-basins.

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- It appears reasonable to assume that the Nipomo Mesa Sub-basin subsurface outflow to the offshore aquifer:
  - Has never been less than DWR-estimated value of 225 AFY, applicable to 1977 water levels.
  - Has normally exceeded the 225 AFY value, perhaps by several times, especially prior to 1965
  - Will be maintained at at least 225 AFY for several years unless greatly increased extractions cause significant lowering of the water table.

10. Location of Salt Water Wedge off Nipomo Mesa
Length of Wedge (Shoreward from aquifer discharge on ocean floor) = L(ft)

$$L = \frac{(S-1)\ in}{2I} \quad (1) \qquad \text{(Sheet A-10)}$$

$$= \frac{(1.025-1)\ (787\ ft)}{2I} = \frac{0.025}{2}\ (787)/I = 9.8/I$$

I,%	L(ft)	L(mi)	Min. Outflow*	Max(?) Outflow**
0.2	4,900	0.9	200 AFY	1,000 AfY
0.3	3,300	0.6	300 AFY	1,500 AFY
0.4	2,500	0.5	400 AFY	2,000 AFY
0.5	2,000	0.4	500 AFY	2,500 AFY
0.6	1,600	0.3	600 AFY	3,000 AFY
0.7	1,400	0.3-	700 AFY	3,500 AFY
0.8	1,200	0.2+	800 AFY	4,000 AFY
0.9	1,100	0.2	900 AFY	4,500 AFY
1.0	1,000	0.2-	1000 AFY	5,000 AFY

* Using 10 gpd/sq ft permeability (DWR value)
** Using 50 gpd/sq ft permeability (JMM value)

11. Summary

1. It appears unlikely that the salt water wedge in the offshore aquifer from Nipomo Mesa Sub-basin has intruded even as much as one (1) mile from the point of fresh water discharge on the ocean floor.

2. If there had been an intrusion of 5,280 feet in 28 years (1953 to present) this would correspond to 5,280/(28)(365)   0.5 ft/day. This is probably excessive when compared with the value assumed by Toups for Santa Maria Valley where coastal gradients have been generally flatter than for Nipomo Mesa (the Mesa ground water is higher than that of coastal Santa Maria Valley). Therefore, the existing intrusion is likely <u>considerably less than</u> one (1) mile.

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3. Even with reduced gradients (less than 0.2%) there is prospect of many years of pumpage before the salt water wedge would likely approach the coast line of Nipomo Mesa.

4. Additional study would be required to "quantify" the future prospects for partial dewatering of fresh water storage above sea level in Nipomo Mesa Sub-basin and above the salt water wedge offshore without jeopardizing the sub-basin water quality.

   Due to data limitations, such "quantification" would, of necessity, be very approximate at best. It could be indicative, however, and might assist water planners.

5. As in the case of offshore interpretations by all hydrologic investigators (DWR, USGS, Toups, Mann, etc.), it has been necessary to rely upon theoretical concepts to provide interpretations and estimates. This is the only possibility under these conditions. The tentative conclusions reached thereby are subject to the inherent limitations of such analyses.

6. It is noted that SLOCO LUE (p. 31) addresses the aspect of partially dewatering the onshore and offshore fresh water of Nipomo Mesa Sub-basin and concludes:

   "A policy decision to use the offshore resource would have potential major consequences since that aquifer is apparently not rechargeable, and since existing onshore supplies would have to be heavily mined to reach the offshore reservoir. Over the long term, the result would be to effectively deplete both water sources. Consequently, the possibility of using offshore supplies should be carefully evaluated before any decision. It may be most appropriate to consider the offshore aquifer as only a long range solution to water supply problems."

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APPENDIX B

GROUND WATER RECHARGE CREDITS FROM BLACK LAKE PROJECT IMPROVEMENTS

Credit in exchanging weeds and brush for irrigated lands with increased ability to percolate rainfall.

SBCWA Model*

With brush and weeds, 17-18" of rainfall required before percolation occurs.
With irrigated lands, 11-12" of rainfall required before percolation occurs.

In effect, for an average annual precipitation of 14.7 inches, it might be anticipated that 3.7 inches, say 0.3 feet of additional percolation from rainfall should be realized 0.3 x 45 = 14 AFY.

Impervious Area Runoff-Enhanced Percolation

Sht. S-4 (1/25/82) 1988 total bldg. floor plans is 20 ac

Assume that roof, sidewalk, driveway, patio impervious area 30 ac
Asssume that newly developed acreage is:

525 ac
-60 ac golf course new
-80 ac (parks no irrig.)
-122 ac exist, country club
263 ac New Development

Allow 10% of this in roads 26 ac

Total assumed impervious acreage = 56 ac

Avg. rainfall 14.7"
Evap. imperv surf 6" diff. 8.7" runoff, concentrated area, percolate

$\frac{8.7}{12}$ (56) = 41 AFY imperv surf credit

Less evaporation allowance of 15 percent during percolation 41 AFY-6 AFY = 35 AFY

Total Credit Due to Development:	a)	Moist Soil	14	AFY
	b)	Impervious Area	35	AFY
		Total	49	AFY

* Appendix C, p. C-3 report on "Adequacy of the Ground Water Basins of Santa Barbara County." December 15, 1977. (11" irrig. land 17" native veget.) Also, if annual precip. >30 inches, the excess amount is considered ineffective for recharge.

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CHARLES H. LAWRANCE

REPORT ON

ADEQUACY OF THE GROUNDWATER BASINS OF SANTA BARBARA COUNTY

Prepared for the

BOARD OF DIRECTORS

SANTA BARBARA COUNTY WATER AGENCY

By the Staff of

Santa Barbara County Water Agency

December 15, 1977

SANTA BARBARA COUNTY WATER AGENCY

105 East Anapamu Street

Santa Barbara, California 93101

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Appendix B

WATER BUDGET MODEL

A mathematical input-output model was developed by the Water Agency staff and was adapted for use in the evaluation of the hydrologic equation for each of the Santa Barbara County groundwater basins. This model allowed the Water Agency staff to verify existing estimates of groundwater recharge and discharge as well as to develop new data in some instances. The water budget model is particularly helpful in assessing the impacts of current cultural development on the safe yield of a groundwater basin. Once the historical base period conditions within a particular basin are reasonably well determined, current conditions of water supply, disposal, and land use can be superimposed over the base period rainfall, giving an estimate of the long-term safe yield assuming current cultural development. A similar approach can also be used to approximate projected groundwater availability.

Basic data input to the model includes net subsurface inflow, precipitation data, gross M&I and agricultural pumpage, and imports. These data must be specified for each year of the base period and are further modified by several percentage factor inputs which must be specified for incremental three-year periods. Included in the list of factors are rainfall, stream seepage, M&I pumpage returns, agricultural pumpage returns, and imported water returns. Irrigated and non-irrigated acreage within the basin must also be input as part of a subroutine which determines rainfall infiltration. These factors allow one to adjust the various data over the historical period in reponse to changing conditions of supply and disposal. Additional flexibility in the use of the model exists in the form of multipliers which act upon the underflow, rainfall, and stream seepage data and can be used to uniformly scale these inputs up or down.

Once the data inputs are complete, the computer calculates net supply and disposal for each year of the base period,

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and accumulates the annual change in storage. This enables the elements of recharge and disposal to be calibrated against a given change in storage over a particular base period.

The model can also accommodate estimates of recharge losses due to the filling of the basin over a series of wet years. The program can be set to begin at any level below full, thus simulating historic conditions. In addition, losses from the basin are simulated in an elastic fashion since each basin has a specified "fringe area," over which losses occur. In other words, the basin does not simply reach a full state and then begin to reject additional recharge. Once groundwater sotrage capacity reaches the "fringe area," losses begin slowly and they increase prportionally as the basin reaches a full state. In the opposite sense, if the basin is nearly full in a particular year, and the following year is one of little or no recharge, the basin will continue to spill although at a decreasing rate.

Based on the above parameters, the model calculates average annual recharge, disposal, weighted average return flows from M&I and agricultural pumpage, imported water returns, and the safe yield for extractions and consumptive use. A sample computer printout is presented on the following page.

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VALUE/FACTOR LIST

PERIOD	UFVAL	RAINF	SEEPF	M&I F	AG F	IMPTF	IRR AC	NIRR AC
1937	113	1.00	1.00	0.180	0.150	0.000	1500	5650
1940	122	1.00	1.00	0.180	0.150	0.000	1700	5453
1943	133	1.00	1.00	0.180	0.150	0.000	2100	5050
1946	39	1.00	1.00	0.163	0.150	0.000	2500	4650
1949	63	1.00	1.00	0.120	0.150	0.000	2900	4250
1952	92	1.00	1.00	0.072	0.150	0.136	3100	4050
1955	99	1.00	1.00	0.066	0.150	0.132	3150	4000
1958	103	0.99	1.00	0.060	0.150	0.120	3000	4150
1961	81	0.95	1.00	0.060	0.150	0.110	2600	4550
1964	94	0.92	1.00	0.060	0.150	0.092	2000	5150
1967	97	0.88	1.00	0.060	0.150	0.077	1500	5650
1970	115	0.86	1.00	0.060	0.150	0.069	1300	5250
1973	82	0.85	1.00	0.060	0.150	0.067	1225	5925

YEAR	RAIN	IMPORT	PUMPAGE M&I	PUMPAGE AG	YEAR	RAIN	IMPORT	PUMPAGE M&I	PUMPAGE AG
1936	19.38	0	403	2637	1937	27.04	0	414	3476
1938	27.67	0	426	4084	1939	14.15	0	437	4183
1940	15.84	0	493	5737	1941	47.92	0	505	5715
1942	13.64	0	530	3860	1943	25.83	0	567	4453
1944	19.03	0	604	5106	1945	16.14	0	699	4591
1946	12.01	0	739	5281	1947	14.15	0	780	6080
1948	9.90	0	833	9317	1949	11.06	0	887	8543
1950	13.94	0	1019	6841	1951	11.97	0	1092	8338
1952	33.07	0	1100	6590	1953	13.76	1500	1200	5790
1954	16.24	1500	1400	6040	1955	18.09	2000	1600	3580
1956	20.77	3000	1800	2440	1957	14.72	3843	1600	2270
1958	33.86	8174	1400	1710	1959	9.60	8961	1209	2380
1960	11.47	6266	1100	1810	1961	10.59	7750	1000	1170
1962	27.79	8100	900	940	1963	16.67	6700	800	1480
1964	10.80	7000	700	1500	1965	19.59	9250	600	1090
1966	15.15	11000	500	1020	1967	26.46	10900	432	858
1968	14.49	10950	450	1480	1969	32.30	11200	450	1720
1970	12.75	11000	810	2090	1971	14.36	12800	1260	2040
1972	9.16	14350	1100	2370	1973	24.73	12250	1350	1680
1974	18.07	9800	2450	1370					

	RAINFALL	IMPORTS	M&I PUMPAGE	AG PUMPAGE	UNDERFLOW
TOTALS	724.57	132894	35710	143160	3879
MEAN	18.58	4690	916	3671	99

YEAR	INFILTRATION OF RAIN	INFILTRATION OF STREAM	INFILTRATION OF OTHER	NET PUMPAGE M&I	NET PUMPAGE AG	BASIN SPILL	DELTA STORAGE	BELOW FULL
1936	1459	2471	118	330	2241	0	1476	-6524
1937	4699	3654	118	339	2955	228	4949	-1575
1938	4961	3828	118	349	3471	3511	1575	0
1939	282	870	122	358	3556	11	-2651	-2651
1940	412	365	122	404	4876	0	-4381	-7031
1941	6064	4872	122	414	4858	257	5529	-1502
1942	300	661	133	425	3281	0	-2621	-4123
1943	4512	3741	133	465	3785	756	3380	-744
1944	1569	2453	133	495	4340	207	-887	-1631
1945	660	1583	89	582	3902	0	-2151	-3782
1946	172	853	89	615	4489	0	-3990	-7773
1947	415	1114	89	649	5168	0	-4199	-11972
1948	0	35	63	733	7919	0	-8555	-20527
1949	73	104	63	781	7262	0	-7801	-28328
1950	453	400	63	897	5815	0	-5795	-34123
1951	207	35	92	1013	7037	0	-7767	-41890
1952	6942	4002	92	1095	5602	0	4340	-37551
1953	459	261	296	1114	4922	0	-5019	-42569
1954	655	557	297	1308	5134	0	-4733	-47303
1955	1538	132	363	1494	3843	0	-2515	-49817
1956	2757	835	495	1681	2074	0	332	-49485
1957	576	244	1169	1504	1930	0	-1445	-50929
1958	6821	4176	1089	1316	1454	0	9317	-41613
1959	0	365	1183	1128	2023	0	-1602	-43215
1960	115	157	836	1034	1539	0	-1465	-44680
1961	11	157	934	940	995	0	-834	-45514
1962	5517	3654	972	846	799	0	8498	-37016
1963	609	452	710	752	1258	0	-238	-37254
1964	27	139	732	658	1275	0	-1020	-38233
1965	1716	387	853	564	1607	0	1236	-36997
1966	317	2158	944	470	867	0	2032	-34915
1967	4110	2871	936	406	729	0	6782	-28133
1968	272	418	940	423	1253	0	-51	-28184
1969	5340	4350	880	423	1462	0	8593	-19591
1970	133	1409	974	761	1777	0	-121	-19713
1971	253	1044	998	1184	1734	0	-618	-20331
1972	0	435	1043	1034	2015	0	-1570	-21901
1973	3323	3184	983	1269	1599	0	4443	-17456
1974	795	1218	739	2303	1390	0	-1141	-16399
TOTAL	68220	[illegible]	19960	32567	121682	4970	-10539	
MEAN	1757	1542	512	835	3120	127		

AVE % RETURN FLOWS	M&I	AG	M&I+AG WEIGHTED	AVE IMPORT
	8.3	15.0	13.8	[illegible]

SAFE YIELD [illegible] FOR CONSUMPTIVE USE [illegible] FOR EXTRACTIONS

3665 4271

Sample Run for Goleta Groundwater Basin

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Appendix C

RAINFALL INFILTRATION MODEL

The deep percolation of precipitation in the several groundwater basins of Santa Barbara County is one of the more difficult items of groundwater recharge to quantify. Of the total gross seasonal precipitation over an area, the major proportion of rainfall is disposed of through surface runoff and transpiration. A small quantity of the total rainfall may percolate to an underlying aquifer system under the proper conditions. The major factors which influence the quantity of deep percolation are:

1. Soil type and underlying rock type.
2. Topography (increasing slope increases surface runoff).
3. Vegetative cover (irrigated vs. non-irrigated).
4. Field capacity (the amount of water held in the soil after the rate of downward movement of water has materially decreased).
5. Rainfall intensity, duration and chronological distribution.

Several methods of evaluating deep percolation of precipitation have been presented in previous hydrologic investigations. Indirect methods can be applied by using the residual of all the components of water supply to a basin after the requirements of water use and disposal have been satisfied. If such quantities are roughly equivalent to the yearly changes of groundwater in storage, such estimates may approximate the amount of deep infiltration of precipitation. Such analysis has typically been in basins where extensive basic data on precipitation variations, stream flow, land use and consumptive use are available.

Perhaps the only available empirical data on deep percolation of rainfall in Southern California is that developed by H. F. Blaney in Ventura County [1934 (11)]. He concluded that in the semi-arid coastal basins of Southern California, rainfall reaches the groundwater table only

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during years of average or above average precipitation. This is because a portion of infiltrating rainfall is retained within the soil profile against the force of gravity, or is intercepted by plants and is returned to the atmosphere by evapotranspiration. Thus, the amount of water which can percolate below the root zone is controlled by the consumptive use of local vegetation, soil field capacity, and the chronological distribution of rainfall. In areas of deeply rooted native vegetation, where a relatively large soil moisture depletion is maintained, very little water is able to penetrate below the root zone. However, more rainfall is available for deep percolation on irrigated farmland since the application of irrigation water tends to maintain the soil moisture at or near field capacity.

The chronological distribution of rainfall also has a significant effect on deep percolation of rainfall. Precipitation which occurs in the early part of the rainy season will be readily taken up by vegetation or used to satisfy soil moisture deficiencies. Subsequent rainfall will have a much greater chance of percolating below the root zone if the field capacity has been satisfied by previous storms. Thus, high-intensity storms will quickly satisfy the soil field capacity, allowing for a greater proportion of rainfall infiltration to the water table. However, there must be some threshold level at which the soil becomes 100 percent water saturated, and therefore, prevents downward percolation of rainfall. Incremental precipitation above this threshold level would be expected to become surface runoff. Similar observations in the Carpinteria Basin also indicate an upper limit on rainfall which effectively increases the quantity of deep percolation (7).

Since information on storm intensity and duration is generally lacking, previous studies have attempted to relate rainfall infiltration to vegetative cover. Little improvement has been made on the method of estimating rainfall infiltration proposed by Blaney (11). The results of this study were graphically summarized in infiltration curves relating rainfall to deep percolation on irrigated and non-irrigated land. A subsequent study by Blaney et al. in 1963 showed that rainfall infiltration in the Lompoc Uplands also occurs only during years of average or above average precipitation, essentially confirming his earlier conclusions in addition to developing new empirical data (12).

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Although many groundwater investigations have cited the Blaney study as a basis for calculating rainfall infiltration, certain inconsistencies in the figures so derived have become apparent. For example, rainfall infiltration in the Montecito Basin was determined by the USGS to average 1,800 AFY (10). However, a report by Geotechnical Consultants, Inc., on the Carpinteria Groundwater Basin, which has a larger recharge area and substantially more irrigated acreage than Montecito, showed the calculated base period rainfall infiltration at 1,560 AFY (7). Even though annual precipitation is slightly greater in the Montecito area, deep percolation of rainfall should be greater in the Carpinteria Basin on the basis of size of the recharge area and irrigated acreage.

In order to avoid this problem, the Water Agency sought to develop a rainfall infiltration model which could be uniformly applied to all Santa Barbara County groundwater basins. Rainfall infiltration curves used in this report were patterned after those developed by Blaney in his Ventura County investigation, thus, distinguishing between rainfall infiltration on irrigated and non-irrigated land (11). These curves were modified to incorporate subsequent information gathered in the Lompoc Uplands study [Blaney et al.(12)] as well as additional data generated by a mathematical model of the Carpinteria Basin in the Geotech report (7). They are shown in Figure C-1 and were simplified into a mathematical function which was used as the basis for a computerized rainfall infiltration model.

The assumptions inherent in the model are that no deep percolation occurs if rainfall is less than 11 inches in irrigated land, or if rainfall is less than 17 inches on areas of native vegetation. Furthermore, it is assumed that annual rainfall over 30 inches does not contribute any additional deep percolation. Precipitation above this level is expected to contribute only to surface runoff.

As concerns the delineation of the respective recharge and confined areas, certain allowances were made for limited deep percolation of rainfall over the confined area. This allowance was made in light of the often discontinuous nature of the clay strata which comprise the confined area and the potential for perched water to be shed off the edges of the confining layer. In addition, the delineation of a confined area involves the assignment of a definite dividing line where in actuality

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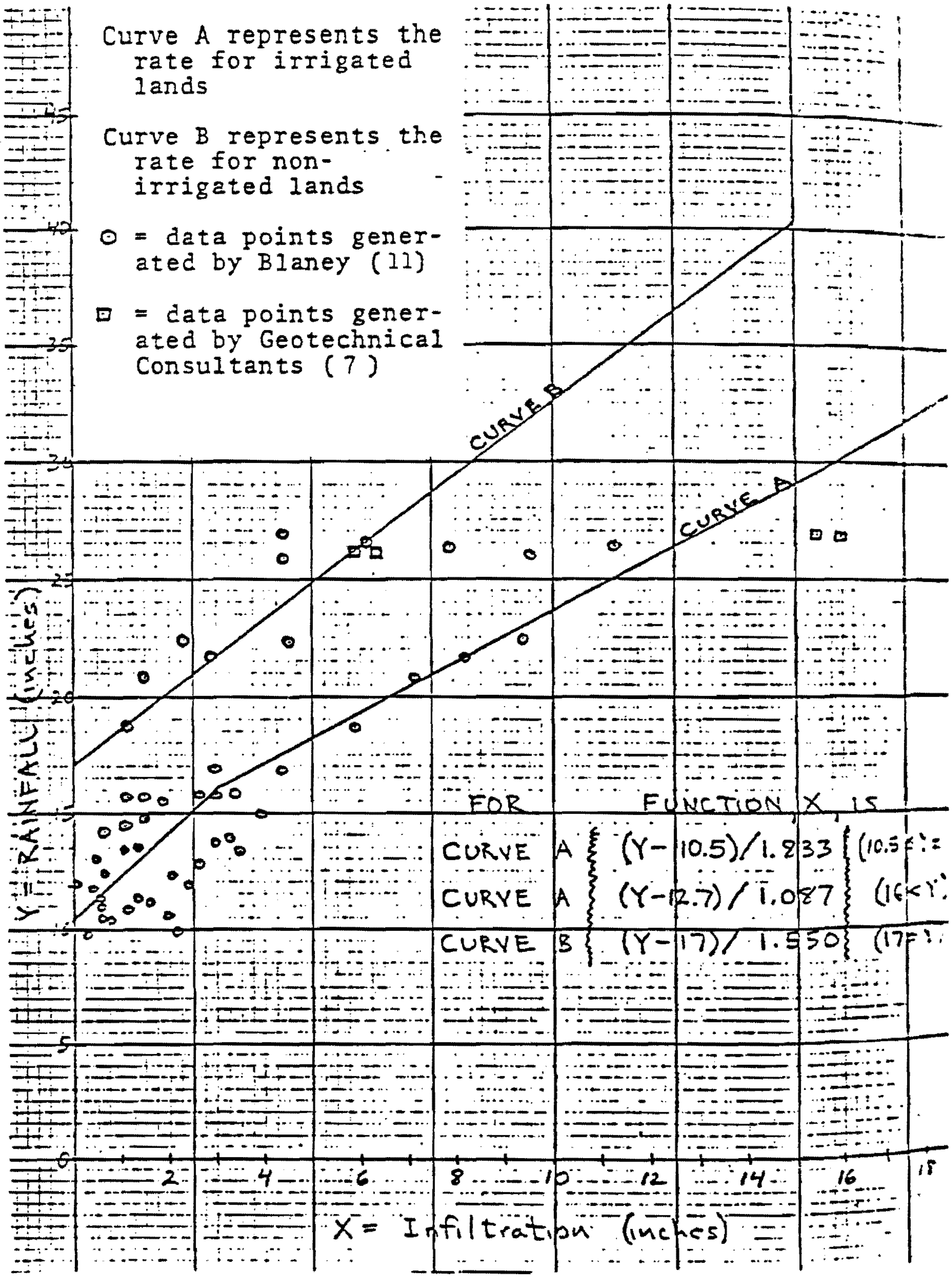
Figure C-1

RAINFALL INFILTRATION CURVES

FOR SANTA BARBARA COUNTY



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a gradational boundary condition exists. Based on the judgment of the Water Agency staff as to the relative permeability of the confining layers within a particular groundwater basin, a value of the effective area of permeability which would transmit deep percolation of rainfall within the confined area was made. Such values range from 50 percent in the Santa Maria Valley to 25 percent in the South Coast basins.

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STATE OF CALIFORNIA—RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF WATER RESOURCES
P. O. Box 6598
LOS ANGELES
90055
(213) 620-4107

JAN 14 1981

Mr. Charles H. Lawrance
James M. Montgomery, Consulting Engineers, Inc.
250 North Madison Avenue
Pasadena, CA 91101

Dear Mr. Lawrance:

This is in response to your letter of December 23, 1981, requesting a breakdown of the estimate of subsurface outflow for Nipomo Mesa as given in the Southern District's report "Ground Water in the Arroyo Grande Area".

As Harry Iwanaga explained to you on the telephone, he has reevaluated the data from the area. Following is a breakdown of the range of outflow values: subsurface outflow to Arroyo Grande Plain, 225 to 300 acre-feet; outflow to the ocean, 225 to 350 acre-feet; and outflow to Santa Maria Valley, 2300 to 2800 acre-feet. This gives a rounded total subsurface outflow for Nipomo Mesa of 2800 to 3500 acre-feet.

I hope this information will be helpful to you.

Sincerely,

Jack J. Coe, Chief
Southern District

RECEIVED
JAN 15 1982
JAMES M. MONTGOMERY
CONSULTING ENGINEERS, INC.
WASTE ENGINEERING
PASADENA, CA.

save water

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APPENDIX C

WATER USE FACTORS AND PROJECTIONS OF WATER DEMAND

1. Population Projections
2. Irrigated Acreage Projections
3. Water Use Factors
4. Historic Ground Water Pumpage
5. Projected Ground Water Demand
6. Black Lake Project Water Demand

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APPENDIX C

C-1 Population Projections

a. SLOCO LUE, Table B, p. 15 shows populations in 1,000, viz:

Area	7/79	7/80	7/85	7/90	7/95	7/00
Nipomo	5.296	5.487	6.232	6.881	7.527	8.233
So.Co. Rural	4.070	4.190	4.750	5.240	5.740	6.280 (South County)
SLOCO Total	143.9	148.9	168.2	184.9	201.2	219.1

b. Population Rates (JMM) (in percentage)

Item	7/79	7/80	7/85	7/90	7/95	7/00
LUE Nipomo ÷ SLOCO Total	3.68	3.69	3.71	3.72	3.74	3.76
LUE Rural ÷ SLOCO Total	2.83	2.81	2.82	2.83	2.85	2.87
BLSP ÷ LUE Nipomo	—	—	465/ 62.3 =7.5	1270/ 68.8 =18.5	1270/ 75.3 =16.9	1270/ 82.3 =15.4

The ratios indicate that both Nipomo (area) and Rural (South County) are projected by LUE to grow at about the same rate as SLOCO generally.

c. Population Increases in Nipomo or portion thereof (in 1,000)

	1980-85	1985-90	1990-95	1995-2000
LUE Nipomo Area	0.745	0.649	0.646	0.706
BLSP	0.465	0.805	0	0

Total Nos:

for LUE (Nipomo Area - much bigger than Nipomo Mesa) - 2.746 (1980-00)

for BLSP - 1.270 (1980-00)

The population increase data indicate that the Black Lake Specific Plan (BLSP) will apparently involve a somewhat greater growth than anticipated for the "Mesa" (W. of US 101) under the Land Use Element (LUE).

d. Based on projections for Nipomo CSD (E. of US 101) and Calif. Cities W. Co. (Mesa) From page C-10, it appears that water production increases were:

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Purveyor	1974-75 to 1975-76	1978-79 to 1979-80	1970-71 to 1979-80
Cal. Cities W. Co.	375.1-310.2=64.9 AFY 20.9% (1 yr)	439.4-388.4=51.0 AFY 13.1% (1 yr)	439.4-185.5=253.9 AFY
		Arithmetic, not compounded	15.2%/yr (9 yrs)
N.C.S.D.	448.9-355.4=93.5 26.3% (1 yr)	544.8-539.8=15.0 2.8% (1 yr)	554.8-250.7 304.1 (9 yrs)
		Arithmetic not compounded	13.5%/yr

Note: For 1974-75 to 1979-80 1975 to 1980

(Water) Cal. Cities W. Co. (439.4-310.2)/310.2=0.417÷5 years=8.3%/yr
(Water) N.C.S.D. (554.8-355.4)/355.4=0.561÷5 years=11.2%/yr

DWR's AG-NM Pop'n

(Sheet C-2) (30.9-29.6)/29.6=0.0439÷5 years = 0.88%/yr
(includes Arroyo Grande - Not confined to Nipomo Mesa at all)

LUE Nipomo Pop'n 1979-80

(5.487-5.296)/5.296=3.6%/yr

From the foregoing, it appears that water production of both NCSD and Cal. Cities W. Co. has been rising much faster than implied by LUE pop'n projections and DWR's more general pop'n. projections (larger area). This probably reflects climatic variations to some extent.

Nipomo CSD has reported water consumption (deliveries, not production) as separate figures supplied to SLOCO, along with average service connections for each fiscal year, viz:

FY	AFY Cons.	Avg. Serv. Conn*	AFY/S.C.**
1968-69	156.16	337	0.464
1969-70	189.1	361	0.524
1970-71	213.4	384	0.556
1971-72	246.7	424	0.582
1972-73	258.0	493	0.523
1973-74	273.4	543	0.503
1974-75	302.5	603	0.502
1975-76	382.0	697	0.548
1976-77	400.9	780	0.514
1977-78	439.6	875	0.502
1978-79	459.4	926	0.496
1979-80	472.1	957	0.493

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*Apparently, NCSD uses a factor of 14.9% of production for unaccounted for water. Increase in "customers" in past 11 years in (957-337)/337 = 1.84 ÷ 11 years = 16.7%/yr (arithmetic)
620 s.c./11 years = 56.4 s.c./yr over period. (Note: according to Robert Gregg, So. Cal. W. Co., Chief Engr, the Calif. Cities W. Co. (Vista) System in Nipomo Mesa are only adding about 10 customers/yr.)

**Average AFY/service connection for period 0.5+. This is generally typical for a mix of residences and businesses, even with some industry.

It is of interest to consider the 1980± consumption for public systems, etc. in Nipomo Mesa, viz:

System	Production AFY	Equiv. Pop'n @ 0.2 AFYc
Calif Cities	450±	2,250
NCSD	570±	2,850
Misc.	80± (assume)	400

Total Equiv. Pop = 5,500 5,487 (LUE, p.15)

e. It is also noted that SLOCO's LUE states (p. 29) "Therefore, a workable resource management policy must be based on the realization that prior to an actual critical countywide resource shortage, the question is not whether population growth should be accomodated, but where that growth should be guided." The significance of this statement is believed to include:

- It was made within the context of "How Resources and Growth are related and the importance of the county's identifying resource capacities well in advance and resolving issues of population distribution and location, rather than growth versus no-growth. It is for the Resource Management System (RMS) to anticipate which resources may face shortages and how the shortages may be overcome.

- The LUE's Chapter 3 "Information Base" had discussed population "holding capacities" (constrained both by LUE policies and resources availabilities) as well as water resources availability. The RMS discussion (p. 30) notes that "potable, plentiful water resources often are not conveniently located for ready distribution to urban areas. If the county is to grow beyond the present level, supplemental water resources (including new facilities for distribution of existing remote sources) will be needed. The LUE had established a certain preliminary growth rate for South County (page C-1, also LUE, p.15) and it may be inferred that the growth within Nipomo Mesa could as well involve areas West of the U.S. 101 freeway as East of the freeway.

- Much of the town of Nipomo (East of the freeway) represents an established urban center (although its growth is understood to be somewhat constrained due both, to water concerns, and to individual sewage disposal system difficulties and lack of public sewerage

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facilities.) NCSD, the public district which largely serves the town of Nipomo, is currently appropriating most of its water supply from unconsolidated, water-bearing deposits West of the freeway.

- o California Cities Water Company draws its water supply from Nipomo Mesa Ground Water Sub-basin and serves water to customers located overlying the unconsolidated deposits West of the freeway. This area is also considered by some as being part of "Nipomo".

- o Depending upon future developments, the urban areas west of the freeway might exercise increasing overlying rights to the local sub-basin water, but this is too complex to be projected.

C-2 Irrigated Acreage Projections

The only available data on acreage are from DWR and SLOCO Engineering Department. The information used to determine the DWR estimates below were reviewed by JMM and resulted in significantly higher acreage estimates. The historic and projected acreage figures are estimated as follows:

Year	DWR District Report[a] June 1979 Irrigated Agriculture Acres	JMM Approximation[b] Semi Ag. Acres	Other Irrig. Acres	Total Acres
1972		150	836	986
1977	800	150	1104	1254
1980	1200			
1981		150	1225	1375
1990	1600			
2000	1900			

[a] Irrig. acres if from Table 4, p. 10. Irrig. demand is from Table 5, p. 10. Applied irrigation is from Table 11, p. 48.

[b] JMM values shown should be rounded off; they are shown prior to rounding merely for bookkeeping purposes. The 1977 acreages were approximated from the DWR Central Coastal Land Use Survey 1977-78 maps for Nipomo, Calif. and Oceano, Calif. for which the photo interpretation was made and field checked in 1977. Acreages for 1972 and 1981 were approximated as a function of change from the 1977 conditions, based upon discussions with the San Luis Obispo County Farm Advisors, especially Mr. Jack Foott.

The SLOCO Land Use Element has designated 1400 acres for agricultural reserve purposes for the year 2000. The agricultural reserve will be likely be under irrigation. The rural area may also in part have some acreage in irrigation. The rural acreage in irrigation for current and future conditions is not designated in the L.U.E. JMM has therefore projected that roughly 5 percent or roughly 400 acres of rural and rural residential zoning will be under irrigation for year 2000. The semi-agriculture (golf course and cemetery irrigation) should be

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roughly 200 acres based on the development of the proposed Black Lake Project. Based on these estimates, the total irrigated acreage for year 2000 would be about 2000 acres.

C-3 Water Use Factors

a. Land Use Zoning

Review of the map "South County-Land Use Categories" (including "Errata")* shows the following approximate breakdown of acreages (JMM):

Category	Acres	
Agriculture	1,400	
Rural Lands	3,900	
Recreation	3,900	
Residential Rural	4,700	
Residential Suburban	--	
Residential Single Family	--	
Residential Multiple Family	--	
Office & Professional	--	
Commercial Retail	--	
Commercial Service	--	
Industrial	1,800	
Public Facilities	--	
Open Space	--	
Urban Reserve (Area)	3,100	(Nothing East of U.S. 101)
Village Reserve (Area)	900	
Subtotal	19,700	
Allowance for Roads	1,400	
Total	21,100	

Corresponds to DWR's area for Nipomo Mesa Sub-basin.

* Amendments adopted by SLOCO Board of Supervisors 4/27/81

The existing Land Use Zones may be grouped according to general water use as irrigated acreage, population intensive, and other. The Black Lake Project water uses have been estimated previously and the value of the water use factors used in these estimates are evaluated.

Irrigated Acreage	Population Intensive
Agriculture	Urban Reserve
Rural	Village Reserve
Recreation	Recreation
Residential Rural	Residential Rural
	Rural
	Agriculture

Other
Industrial

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b. Water Use Factors for Irrigated Acreage

The unit applied factor for irrigated acreage is based on the crop and coastal climatic and sandy soil conditions. This information was obtained from the DWR's Mr. David Inouye.

Irrigation of:	Unit Applied Water, ft/yr or AFY/ac
Semi-agriculture	3.6
Pasture	3.6
Lemons/Oranges	2.2
Misc. Semi-tropical (probably including kiwis)	2.2
Avocado	2.2
Field Crops (varies)	1.0-2.3
Truck (varies)	2.0-2.7

The semi-agriculture unit applied water is for recreation irrigation. The truck crop unit applied water of 2.7 AFY/ac is used for agricultural zoning. The rural and residential rural categories are estimated to have an unit applied water factor of 2.2 AFY.

c. Water Use Factors for Population Intensive Zoning

The urban reserve category is the most population intensive with the remaining categories village reserve, residential rural, recreation, rural, and agricultural reserve in order of decreasing intensity. The per capita water use in various areas and per capita water use trends as determined by the DWR and local water purveyors are described below:

(1) DWR Southern District Report "Southern District Urban Per Capita Water Use Study, 1971-77," November 1978 cites a few urban per capita values noted for this period, viz:

San Luis Obispo	165 gpcd	(0.185 AFYc)
Arroyo Grande	143 gpcd	(0.161 AFYc)
Santa Maria	195 gpcd	(0.219 AFYc)

(2) DWR Southern District Report "Southern District Urban Per Capita Water Use Study, 1960-1970," May 1972 cites:

San Luis Obispo	166 gpcd	(0.187 AFYc)
Arroyo Grande	143 gpcd	(0.161 AFYc)
Santa Maria	182 gpcd	(0.204 AFYc)

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(3) DWR Southern District Report "Ground Water in the Arroyo Grande Area," June 1979 cites:

Item	1970	1980	1990	2000
Nipomo Pop. (Table 2, p.5)	3,642	4,930	6,060	7,180
Nipomo Domestic & Urban Water Demand, AF (Table 3, p. 9)	550	750	920	1,090
Nipomo per capita use AFYc (JMM calculation)	0.150	0.152	0.152	0.152

No future effects of urban water conservation were assumed by DWR.

(4) DWR "Water Action Plan for the San Luis Obispo-Santa Barbara Counties Area, May 1981 cites:

- o The intensive DWR retrofit campaign in Santa Barbara County in the Spring of 1980 involved some 112,000 households and is indicated to have saved over 800 AFY. (p. 15). This would correspond to about 0.072 AFY/household or perhaps 1.5 to 1.6% of current (JMM calculation).

- o The anticipated reduction in urban water demands (pp. 15-18) is:

	San Luis Obispo County			Santa Barbara County		
Item	1980	1990	2000	1980	1990	2000
Projected percent below unmodified urban demand						
With current supply	1.7	10	17	1.8	8	15
With supplemental supply	1.7	10	17	1.8	9	17

- o "The statewide goal for reducing per capita demand by 2000 is 15 percent below that expected without conservation and is predicted upon the implementation of reasonable and practical measures." (p. 15)

- o "Additional potential reduction in demand can be achieved through voluntary efforts. The voluntary efforts include retrofit of existing toilets and showers, pressure reduction, and leak repair. Exterior uses account for more than 40 percent of residential demand so there are potential savings from more efficient watering of existing landscaping and more use of low water-using plants in new landscaping. Recycling and other actions in the industrial sector will also reduce demand." (p. 15)

- o DWR used a declining unit urban use water demand in their projections as indicated in the following data:

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Item	1975	1980	1990	2000
		(in thousands)		
Total Applied Demand, AF				
Arroyo Grande - Nipomo Mesa	18.2	19.0	20.3	21.5
Santa Maria Valley (SLOCO)	32.3	44.1	44.9	45.8
Subtotal	50.5	63.1	65.2	67.3
Agricultural Applied Water Demand				
Arroyo Grande - Nipomo Mesa	12.9	13.5	14.4	15.0
Santa Maria Valley (SLOCO)	31.3	43.1	43.9	44.7
Subtotal (from p. 23)	44.2	56.6	58.3	59.7
Difference Equals Applied Urban Demand	6.3	6.5	6.9	7.6
Projected Population				
Arroyo Grande - Nipomo Mesa	29.6	30.9	36.7	43.7
Santa Maria Valley (SLOCO)	6.5	6.8	7.2	8.3
Subtotal (from p. 14)	36.1	37.7	43.9	52.0
Urban Water Use AFYc (JMM)	0.175	0.172	0.157	0.146
Urban Water Use gpcd (JMM)	156	153	140	130

The area embraced by the preceeding tabulation is somewhat larger than that considered by the DWR 6/79 Ground Water Report for the Arroyo Grande Area. The urban population was not considered to be affected by the presence or absence of future supplemental supply. Increase in total applied water demand accompanying future supplemental supply was due solely to increased agricultural irrigation.

d. Industrial

The primary water user for industrial purposes is the Oso Flaco Refinery which was not willing to provide any information on extractions from their wells. The water however, is totally consumed through evaporation or ocean outfall. There is also a minor amount of other industrial users which extract relatively small amounts of ground water. An estimate of 650 AFY was made by DWR (1979). This is projected to increase at the same rate as the population while no change in industrial water use is anticipated.

e. Black Lake Project Water Use Factors

(1) Ervin Engineering "Black Lake Golf Course Development, Nipomo Mesa, Preliminary Report on Sewage Treatment Facilities," June, 1981

- o p. 1: 600 DU's @ avg. occupancy of 2.5 and 1000 gpcd (wastewater) 50-room hotel, avg. occupancy of 2 persons and 50 gpcd (wastewater)

(2) Perliter & Ingalsbe, Cons. Engrs. letter of 12/3/80 to Mr. Don Engen

- o 500 single-family houses have avg. potable water consumption of 350,000 gpd (p. 1)
- o Country club and commercial - 70,000 gpd avg. (p.1) potable water

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- o 100 unit motel - 30,000 gpd avg. (p. 1) potable water
- o 27-hole golf course - 500,000 gpd avg. (p. 1) irrigation

Unit use for single-family dwellings:

350,000 gpd = 390 AFY 0.78 AFY/DU

If 3 pers/capita	0.26	AFYc	(unusually high)	(JMM)
2.5	0.31	AFYc	(unusually high)	(JMM)
3.5	0.22	AFYc	(unusually high)	(JMM)
4.0	0.20	AFYc	(more typical)	(JMM)

Unit use for Country Club & Commercial —

Unit Use for 100-unit motel

30,000 gpd 200 pers/day avg. occup.? 150 gpcd (High?) (JMM)

Unit use for 27-hole golf course

560,000 gpd irrig. 626 AFY

Assuming 160 acres, 626/160 = 3.9 ft/yr (seems OK, JMM)

(3) John F. Mann, Jr. "Water Feasibility Report, Black Lake Country Club," July 5, 1976.

pp. 7-8	Add 18 hole golf course	101.5 ac
	Add parks	9.0 ac
	Add green acres	70.6 ac
	Subtotal irrig.	181.1 ac

Consumptive use of grass 3.33 ft/yr (p. 8-9) 603 AFY

Domestic: (p. 7)

375 dwelling units 1,144 pers 3/DU (JMM)

100 gpcd (p. 8) = 0.114 mgd 128 AFY (generous, JMM)

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4. Historic Ground Water Pumpage

a. M&I EXTRACTIONS, AFY

Year	SLOCO Engr'g. Dept. Data[a]			DWR Dist. Report June 1979[b]			Toups[c]	Tentative[d]
	Cal. Cities W. Co.	Nipomo C.S.D.	Unorganized Nip. Mesa	Domestic & Urban	Urban Supply	Industrial Cooling Wtr.	Ind'l. Cool.	Total M&I JMM
1960-61	5.5	—	62.4					600?
1961-62	50.5	—	57.3					
1962-63	68.0	—	65.3					
1963-64	94.0	—	69.9					
1964-65	131.7	—						
1965-66	151.9	—						
1966-67	156.6	59.4						1,000±
1967-68	171.2	173.0						
1968-69	173.5	183.5						
1969-70	182.9	222.2		550				
1970-71	185.5	250.7						
1971-72	239.6	289.9						
1972-73	235.1	303.1					1,000	1,550?
1973-74	280.9	321.3						
1974-75	310.2	355.4						
1975-76	375.1	448.9					1,000	
1976-77	352.0	471.1			300	650		
1977-78	382.1	516.6						
1978-79	388.4	539.8						
1979-80	439.4	554.8		750				2,000?

[a] Obtained on July 27, 1981 by JMM from SLOCO Engineering Department files.

[b] Domestic and urban is from Table 3, p. 9 (for calendar years). Urban supply and industrial cooling water are from Table 11, p. 48, understood to be based on 1977 land use conditions.

[c] Toups Corporation report (1976) cites Union Oil Company's Oso Flaco Refinery as using 1,000 AFY.

[d] USGS Water-Resources Investigations 76-128 notes (p. 10) that the Union Oil Co. refinery was built in 1955, and disposal has always been by outfall. Water production during the 1960-80 period indicated is based upon approximations with available data.

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b. Estimates of Agricultural Extractions, AFY
For Nipomo Mesa

	DWR Dist. Report June 1979[a]			JMM Approximation (before rounding)[b]					
	Irrigated	Irrigation	Applied	Semi-Agricult.		Other Irrig.		Total Irrigation	
Year	Ag.Acres	Dem., AFY	Irr. AFY	Acres	AFY	Acres	AFY	Acres	AFY
1960									
1965									
1970									
1972				150	540	836	2,167	986	2,707
1977	800	2,000	2,000	150	540	1,104	2,970	1,254	3,510
1980	1,200	2,800	—						
1981				150	540	1,225	3,374	1,375	3,914
1990	1,600	3,400							
2000	1,900	4,100							

[a]Irrigated acres are from Table 4, p. 10. Irrigated demand is from Table 5, p. 10. Applied irrigation is from Table 11, p. 48.

[b]JMM values should be rounded off; they are shown prior to rounding merely for bookkeeping purposes. The 1977 acreages were approximated from the DWR Central Coastal Land Use Survey 1977-78 maps for Nipomo, California and Oceano, California, for which the photo interpretation was made in 9/77 and the field check also in 1977. Acreages for 1972 and 1981 were approximated as a function of change from the 1977 conditions, based upon discussions with the San Luis County Farm Advisors, especially Mr. Jack Foott.

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c. Combined M&I plus Irrigation Extractions for Nipomo Mesa. Values are by JMM in AFY and are approximated.

Year	Total Extractions, AFY
1955	200
1960	1,600
1965	2,500
1970	3,500
1975	4,600
1980	5,700

d. Total extractions since Nipomo Mesa initial development, AF, approx. (J. F. Mann, Jr. indicates 1952-55 pumpage = 200 AFY

1950-55	1,000 AF
1955-60	5,000
1960-65	10,000
1965-70	15,000
1970-75	20,000
1975-80	26,000
1981	5,000

Total from the first development 82,000
82,000/28± yr = 2,900 AFY avg.

C-5 Ground Water Demand Projections

The three water use categories used in projecting water demand are irrigated acreage, population, and other. The DWR, SLOCO Engineering Department, SLOCO Planning Department, and local water purveyors have estimated projected growth in these categories to varying degrees. The water demand for the Black Lake Project is estimated using the various water use factors previously described. The water demands are projected for the year 2000.

(a) Year 2000

(1) DWR's year 2000 projection (w/o supplemental water) was:

Irrigation	4,100 AFY	Nipomo Mesa (p. 10)
Domestic/Urban	1,350	Nipomo (p. 9)
Ind'l Cooling	650	Assumed by JMM, after p. 48
Total	6,100 AFY	

The population projection was 7,180 for Nipomo (DWR, p. 5)

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(2) Year 2000 Water Use (JMM Estimate)

Population	Water Use Factor		
Rural (0.20)(6280) (Rural, Res., Rural, Rec. Village, Agriculture)	(132 gpcd)	186	AFY
Nipomo (Community)(8233)	(132 gpcd)	1217	AFY
		1403	AFY
Irrigated Acreage			
Agriculture 1400 acres	(2.7 ft/yr)	3780	AFY
Semi-Agriculture 195 acres	(3.6 ft/yr)	700	AFY
Rural, 5% = 195 acres	(2.2 ft/yr)	430	AFY
Res. Rural, 5% = 235 acres	(2.2 ft/yr)	520	AFY
Total Irrigated Acreage Water Use		5430	AFY
Year 2000 Water Use (Ag. & Dom.) (Rounded)		6830	AFY
Industrial			
(650) (1.5 growth rate) (Rounded)		980	AFY
Total: Domestic, Irrigated Ag., Industrial		7,810	AFY
Less Return Flow			
Domestic 30%		421	AFY
Applied Water 20% Return Flow		1086	AFY
Total Return Flow		1507	AFY

6. Black Lake Project Water Demand

a. Consumptive Use Aspects

(1) All wastewater will be recovered and used for golf course irrigation. Due to the greater demand for irr. water than can be supplied by the effluent, the storage requirements for effluent (daily regulatory and wet weather) will be quite minimal and should involve only negligible evaporation losses. In effect, the effluent will be base load and wells peaking supply, primarily on a seasonal basis.

At year 5 (1988), projected population is 1,318 residents
Tentatively assume inside water is 85 gpcd
Residential wastewater flow is 112,000+ gpd
Allow also for 200 seat restaurant
Assume avg. 2400 meals/day
Assume 4 gal/meal
Restaurant wastewater flow is 9,000 gpd
Incidental visitors to golf course(s)

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Allow 300 persons @ 5 gpcd or 1,500 gpd
Other - 1500 gpd
Total Wastewater Flow 124,000 gpd by 1988

(2) Outside water use in residential areas and commercial areas (other than the public golf course) will be limited in order to minimize losses.

(a) For incidental uses, e.g. car-washing, allow 5 gpcd
(b) For irrigation (landscape), possibilities are:

1. Traditional lawns and shrubs
2. Minimal water use per Sunset Magazine October 1976 issue, "Good looking - unthirsty," pp. 78-85; "Instead of a big, thirsty lawn," pp. 86-87

(3) For existing golf course, 120 ac x 3.33'/yr = 400 AFY (existing)
(4) For new 9-hole course, 45 ac x 3.33'/yr = 150 AFY
(Designers will be "challenged" to minimize the cons. use req'ts.)
(5) Grading - drainage design of the development should deliberately concentrate the urban runoff strategically in favorable percolation areas, thereby actually increasing the deep penetration of rainfall and other natural recharge modestly.

(6) Evaluation of landscape irrigation:

o Traditional lawns and shrubs - Assume 3'/yr
o Sunset Magazine type vegetation - Assume 0.3'/yr
o Assume areas for lawns/shrubs or Sunset Mag. type are about 2 x floor plan for each D.U.

(7) If 1988 total bldg. floor plan is 20 ac, then @ 2 x floor plan landscaped area (over and above golf course) is - 40 acres.

If we use traditional irrigation, cons. use might be:

40 ac. x 3+ ft/yr = 122 AFY

If we use Sunset Magazine vegetation, absolute minimum water use might be:

40 ac. x 0.3 ft/yr = 12 AFY

If the vegetation planted replaces native vegetation, there might be some tradeoff.

If well watered vegetation is installed, there could be enhancement of deep penetration by rainfall naturally.

(8) Net <u>increase in consumptive use</u> of native water due to 1988 level Black Lake Project is approximately:

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- o New 9-hole golf course - 150 AFY
- o New landscape irrigation elsewhere - 67 AFY (Say midway between extremes)
- o Miscellaneous outside use - 7 AFY
- o Inside use (wastewater) - None

Total Increase (under assumptions made) - 224 AFY

b. Note: An additional 24 AFY will be required pumpage for the proposed project for leaching of soil salts underlying the golf course.

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APPENDIX D

GROUND WATER QUALITY ASPECTS

This appendix presents certain supporting information pertaining to the water quality aspects of the ground water in Nipomo Mesa Sub-Basin relevant to the proposed Black Lake Project.

CURRENT WATER QUALITY

Ground water sampling has been conducted in the past primarily by the State of California, Department of Water Resources (DWR) and to a more limited extent, by the State of California, Department of Health. The latter's work has been confined to public water supply water wells in systems having 200 or more service connections. The San Luis Obispo County Health Department samples public water wells, from time to time, in systems with fewer than 200 service connections. There are occasional samples taken for private farm or other wells as well. Analyses are conducted by State certified laboratories, and most of the results have been compiled by DWR. A general updating and compilation of results were conducted by JMM in order to obtain an historic and current perspective of water quality relevant to the proposed Black Lake Project.

Table D-1 presents an array of representative ground water quality constituents in Nipomo Mesa and vicinity. Data are derived from a November 1973 DWR compilation, but the water quality objectives for the Central Coastal Regional Water Quality Control Board are taken from that Board's Water Quality Control (Basin) Plan. It can be seen that Nipomo Mesa's ground water quality is generally superior to that of neighboring (lower) Santa Maria Valley to the south and bordering Arroyo Grande Sub-Basin to the north. JMM believes that this phenomenon is attributable partially to the nature of the sand dunes formations found through much of the Mesa, with their somewhat limited salt leaching potential, as well as the fact that the land development on the Mesa is relatively new, so there has been only limited recycling of water via domestic and irrigation use.

Table D-2 lists the mineral quality of ground water in wells near the proposed Black Lake Project in Nipomo Mesa, together with dates of sampling. Of those listed, the Bevington Well (11N35W10J1) of Nipomo Community Services District (NCSD) and the Omya Well (11N35W11J2) of NCSD are among the closest to the Black Lake Project in addition to Wells 11N35W10M and 11N35W11C. The water quality cited easily conforms to the objectives of the RWQCB.

There is some variation in the mineral content of the well water cited. In discussing water quality for a well believed by JMM to be Well 11N35W11G1 (results not included in the compilation), Dr. John F. Mann, Jr. notes that the Total Dissolved Solids (TDS) of 420 mg/l indicated that this well was drawing from deeper levels in the Pasa Robles formation where the recharge path was

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TABLE D-1

REPRESENTATIVE GROUND WATER QUALITY CONSTITUENTS IN NIPOMO MESA AND VICINITY[a]

Quality Parameter	Units	Nipomo Mesa Typical[b] Wells	Nipomo Mesa RWQCB[c] Objectives	Santa Maria Valley Typical[b] Wells	Santa Maria Valley RWQCB[c] Objectives	Arroyo Grande Typical[b] Wells	Arroyo Grande RWQCB[c] Objectives
		10.C2	--	12.AO	--	10.C1	--
pH	Units	7.4	--	7.8	--	7.6	--
EC	umhos/cm	544	--	1338	--	1107	--
Ca	mg/l	41	--	133	--	99	--
Mg	mg/l	18	--	63	--	53	--
Na	mg/l	48	50	88	100	66	50
K	mg/l	2	--	5	--	3	--
CO_3	mg/l	0.2	--	1.1	--	0.9	--
HCO_3	mg/l	115	--	246	--	284	--
SO_4	mg/l	95	200	437	500	200	200
Cl	mg/l	57	100	76	80	89	100
NO_3	mg/l	10.2	45	18.8	45	49.8	45
F	mg/l	0.2	--	0.5	--	0.3	--
B	mg/l	0.08	0.2	0.21	0.2	0.11	0.2
SiO_2	mg/l	--	--	--	--	--	--
TDS	mg/l	373	800	1036	1000	781	800
TH	mg/l	180	--	585	--	463	--

[a] Quality data are from Department of Water Resources, Southern District Report "Summary of Groundwater Quality in the South Central Coast Drainage Province," November 1973.

[b] Designation by DWR of typical wells is hydro unit/subunit/subarea.

[c] Central Coastal Regional Water Quality Control Board ground water objectives for Arroyo Grande also includes Nipomo Mesa, for Santa Maria Valley refers to Coastal Santa Maria Valley. RWQCB objectives for NO_3 (nitrate) are actually stated for nitrogen alone but have been converted to NO_3 by JMM for this tabulation.

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TABLE D-2

MINERAL QUALITY OF GROUND WATER IN WELLS NEAR BLACK LAKE PROJECT[a]
Wells are in T11N, R35W, SB B&M

Quality Parameter	Units	9P (10/26/71)	9G (10/13/65)	9K5 (4/12/79)	10M (6/18/64)	10J1 (10/12/73)	10R (11/8/74)	10R2 (11/8/74)	11C (10/21/77)	11J (10/12/73)	11J1 (11/5/79)	11J2 (7/6/78)
EC	umhos/cm	290	626	--	280	233	232	350	850	233	244	
TDS	mg/l	171	381	610	180	188	153	232	469	188	174	490
Alk	mg/l	38										
TH	mg/l	54	204	390	39	39	22	78	257	39	42	280
Ca	mg/l	11	42	86	9	11	4.8	15	57	11	10	56
Mg	mg/l	6.4	24	26	4	2.8	2.6	9.7	28	2.8	4.0	33
Na	mg/l	35	45	43	36	30	32	34	74	30	31	83
K	mg/l	2.1	2	2.8	2	1.2	2.0	2.0	2.4	1.2	1.3	3.3
HCO_3	mg/l	46	139	125	52	37	22	51	228	37	37	150
SO_4	mg/l	11	107	265	2	3.7	5.8	36	72	37	6.0	121
Cl	mg/l	50	56	39	51	49	45	46	108	49	48	98
NO_3	mg/l	12.0	4.0	9	6.5	9.3	8.8	17.0	3.0	9.3	6.6	13
F	mg/l	0.0	0.2	0.2	0.1	0.2	0.3	0.3	0.2	0.2	0.4	0.3
B	mg/l	0.00	0.00	--	0.00	0.00	0.00	0.00	0.03	0.00	0.0	--
SiO_2	mg/l	--	--	--	--	--	--	--	--	--	--	--
pH	units	7.2	7.8	8.0	7.3	6.5	7.2	7.5	8.3	6.5	7.3	8.3

[a] Data obtained are primarily from various reports by Southern District, State of California, Department of Water Resources, 1969-79.

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longer and the water somewhat more mineralized than that drawn from most wells in the vicinity (whose TDS is usually less than 200 mg/l). Dr. Mann's discussion was contained in his July 5, 1976 report "Water Feasibility Report, Black Lake Country Club."

PROBABLE QUALITY OF BLACK LAKE PROJECT GROUND WATER

Based upon the foregoing and the apparent concern that the Black Lake Project emphasize use of low TDS supply water (RWQCB concern, p. 9 of JMM Progress Report of 9/19/81), the typical supply water for the Black Lake Project is assumed to have the following range of quality in mg/l:

Constituent	Avg	Range
TDS	300	180 - 420
TH	125	80 - 250
Ca	25	15 - 50
Mg	15	10 - 30
Na	40	30 - 80
K	2	1 - 3
HCO_3	90	50 - 150
SO_4	60	40 - 100
Cl	50	50 - 80
NO_3	10	8 - 15

It would, of course, be hoped that a combination of good yield and favorable supply source might provide quality on the lower end of the range assumed above.

EFFECTS OF DOMESTIC USE UPON WATER QUALITY

The use of domestic water for normal purposes (washing, bathing, toilet flushing, food preparation, etc.) has the obvious effects of contributing various organic pollutants and microorganisms to the water together with certain mineral salts. The resulting sewage is normally treated at municipal treatment plants having at least secondary level treatment, including disinfection. This removes the great bulk of the organic pollutants and microorganisms and usually renders the effluent suitable for certain reuse, such as for golf course irrigation. The following discussion confines itself to mineral quality aspects of wastewater treatment plant effluent, most particularly TDS, nitrogen, and phosphorus. These are quality constituents that increase with each successive use of the water and are not normally reduced by the wastewater treatment plant.

MINERAL SALTS PICKUP BY MUNICIPAL WATER USE

In this context, municipal water use includes normal domestic, commercial, and public (but not industrial) uses of water. Various studies have been made in the past as to the amount of mineral pickup to be anticipated as a municipal water supply is converted to municipal wastewater. A commonly discussed value as

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regards TDS pickup is about 300 mg/l but this makes certain assumptions as to the use or nonuse of ion exchange water softeners, per capita water consumption, industrial contributions, and the like. Table D-3 illustrates these matters by comparing the potable supply and wastewater effluent quality for four communities in the South Coast of Santa Barbara County, summarized recently by a consultant report. It should be noted that the Santa Barbara and Carpinteria areas both have industrial water use. All four areas have at least some commercial and public use, and probably all areas also have at least some home water softening with locally regenerated units. Also, there is some likelihood of salt ground water infiltration into the Santa Barbara system.

Table D-4 displays the apparent mineral pickup in municipal water use, potable to secondary effluent, as inferred from Table D-3 for the South Coast communities and as listed for general conditions by two authorities. It is implied that the lower values shown for the four South Coast of Santa Barbara County communities are probably at about the upper limit of the national average. Although some water mineralization (from discharge of bodily wastes and cleaning residues) is inevitable in any conversion of potable water supply to sewage, the less mineralized supply waters tend to experience somewhat less mineralization than the more mineralized ones. This is apparently a condition largely related to the reduced need for local softening, usually cation exchange softeners regenerated by salt.

Assuming an intermediate value for the future water supply for the Black Lake Project as previously listed, and in consideration of the intention of both the developer and RWQCB to prohibit the use of locally-regenerated water softeners in the Project, a projection of mineral pickup of as low as 200 mg/l TDS and up to a maximum of about 260 mg/l TDS is made for the Project's wastewater. This includes allowance for a per capita wastewater flow averaging about 85 gallons per day.

Similarly, projections are made for sodium and chloride pickup of approximately 55 and 50 mg/l, respectively for the Black Lake Project wastewater. These are somewhat less than the "normal" values, the consideration being the prohibition of on-site softener regeneration. Elimination of on-site softening of itself, aside from on-site regeneration, could aid in minimizing the mineral pickup. This is because in conventional home or commercial softening, two sodium ions (molecular weight 46) are exchanged for a single calcium ion (atomic weight 40) or a single magnesium ion (atomic weight 24.3).

FERTILIZER ASPECTS OF TREATMENT PLANT EFFLUENT

Two of the minerals registering accretions in potable water use in municipal systems have potential fertilizer values: nitrogen (N) and phosphorus (P). Nitrogen pickup is primarily from organic wastes and is not necessarily related to the mineral content of the tapwater. The same is true of phosphorus pickup. Rather, these are primarily the results of per capita contributions. For example, in the Los Angeles River Basin (4B) Water Quality Control Plan, prepared for the State Water resources Control Board and adopted by the Regional Water Quality Control Board, the wastewater nitrogen and phosphorus were:

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TABLE D-3

COMPARISON OF POTABLE SUPPLY AND WASTEWATER EFFLUENT QUALITY[a]

Quality Parameter	Units	Santa Barbara[b] Potable	Santa Barbara[b] Effluent	Montecito Potable	Montecito Effluent	Summerland Potable	Summerland Effluent	Carpinteria Potable	Carpinteria Effluent
EC	umhos/cm	0.9	1.73	1.0	1.39	0.9	1.69	1.0	1.60
TDS	mg/l	578	1,370	620	1,064	564	1,318	680	1,120
Alkalinity	mg/l	--	231	--	226	--	291	--	339
Total Hard.	mg/l	396	471	376	365	375	561	383	438
Ca	mg/l	90	124	93	82	78	142	87	111
Mg	mg/l	43	39	40	33	44	52	39	33
Na	mg/l	53	228	62	158	49	162	62	157
NH_3-N	mg/l	--	0.2	--	2	==	13	--	15
NO_3-N	mg/l	$\ll 1$	7	$\ll 1$	5	$\ll 1$	3	0.97	3
Cl	mg/l	19	331	78	245	18	190	58	255
SO_4	mg/l	297	282	236	192	302	558	221	243
Total PO_4	mg/l	<1	15.3	<1	18.4	<1	18.4	<1	21.5
B	mg/l	0.28	0.5	0.27	0.7	0.3	0.6	0.29	0.6
BOD_5	mg/l	--	15	--	17	--	31	--	21
Total SS	mg/l	--	18	--	7	--	44	--	15
pH value	pH	7.4	7.0	7.5	7.4	7.2	7.6	7.5	7.8
SAR Units	SAR	1.0	4.6	1.3	3.7	1.1	2.9	1.4	3.4
K	mg/l	3	--	3	--	3	--	3	--
HCO_3	mg/l	--	--	178	--	146	--	226	--
F	mg/l	<1	--	<1	--	<1	--	<1	--

[a] The potable analytic data are from Table 3-4 and the effluent (treated wastewater) are from Table 4-3 of the Santa Barbara Regional Water Reclamation Study Facilities Plan, (CH_2MHill, December 1980.)

[b] In the past, there has been some evidence of salt groundwater infiltration in the Santa Barbara system, tending to increase the sodium (Na), chloride (Cl), and Total Dissolved Solids (TDS).

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TABLE D-4

APPARENT MINERAL PICKUP IN MUNICIPAL WATER USE

POTABLE TO SECONDARY EFFLUENT

Quality Parameter	Units	Santa Barbara	Montecito	Summerland	Carpinteria	Ref (1)	Ref (2)
TDS	mg/l	792	644	754	440	320	150-400
Alk ($CaCO_3$)	mg/l	—	80	171	154	85	100-150
TH	mg/l	75	(11)	186	55	70	---
Ca	mg/l	34	(11)	64	24	15	15-40
Mg	mg/l	(4)	(7)	8	(6)	7	15-40
Na	mg/l	175	96	113	95	70	40-70
NH_3-N	mg/l	0.2	2	13	15	16	---
NO_3-N	mg/l	7^-	5^-	3^-	2	2	5-9
Cl	mg/l	312	167	172	197	75	20-50
SO_4	mg/l	(15)	(44)	256	22	30	15-30
Total PO_4	mg/l	$15^{\pm}$	18^{-+}	$18^{\pm}$	21^{-+}	8	20-40
B	mg/l	0.2	0.4	0.3	0.3	—	0.1-0.4
SAR units	SAR	3.6	2.4	1.8	2.0	—	---
SiO_3	—	—	—	—	—	15	2-10
HCO_3	—	—				100	50-100
(BOD)	mg/l					25	---
(Organics)	mg/l					52	---
NO_2-N	mg/l					0.3	---

[a] For Santa Barbara, Montecito, Summerland, and Carpinteria, data are derived from Table D-3. Santa Barbara's TDS, Na, and Cl pickup may be abnormal for most communities and due to salt ground water infiltration in a limited area. Ref. (1) is Weinberger, L. W., Stephan, D. G., and Middleton, F. M., "Solving our Water Problems - Water Renovation and Reuse," Ann. New York Acad. Sci, 136:131-154. Ref. (2) is Tchobanoglous, G. and Eliassen, R., "The Indirect Cycle of Water Reuse," Water Wastes Engineering, Vol. 6, No. 2, 1969. The data cited are for domestic sewage. The NO_3-N increment might be somewhat different in a secondary effluent.

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Constituent	lb/capita/day	Equivalent Concentration mg/l
Total nitrogen	0.043	50
Total phosphorus	0.008	10

The foregoing concentrations were for wastewater in the Hyperion tributary area, where the per capita flow was projected at about 109 gpcd. For systems with more concentrated wastes and/or with higher contributions of organic wastes, such as from certain industries, the concentrations for nitrogen and phosphorus would be higher. However, a portion of these (raw) contributions would be removed in the sewage treatment process. For example, both nitrogen and phosphorus are reduced in passage through activated sludge aeration tanks. However, there is always some N and P content in the effluent unless certain tertiary treatment is undertaken. Thus, for instance, the 4B Basin Plan projected effluent quality, including N and P, for a number of inland wastewater reclamation plants with the Hyperion tributary area as well as for the Hyperion Treatment Plant itself.

Assumed Fertilizer Content in Black Lake Treatment Plant Effluent

Table D-5 summarizes fertilizer aspects of certain wastewater treatment plant effluents, including that of the proposed Black Lake Project plant. Comparative data for a number of other secondary plant effluents in Southern California are listed, these aiding in developing the assumed quality for the Black Lake plant effluent.

It is understood that secondary treatment will be provided for the wastewater, this being a minimum requirement for reclamation and reuse for golf course irrigation in conformance with the State Health Department's Wastewater Reclamation Criteria (California Administrative Code Title 22, Divison 4 "Environmental Health.")

Takeup of Fertilizer Components During Irrigation

The Basin 4B Plan (Volume II, page II-16-239) cites the maximum allowable unit (per acre) application to agricultural lands as 500 lb N/yr with double cropping removal of N annually. The corresponding allowable unit P_2O_5 application was 700 lb/yr, this being equivalent to about 306 lb P/yr. These criteria, developed by University of California scientists, were within the context of wastewater treatment plant digested sludges being applied to agricultural lands for fertilization and soil conditioning purposes. It is important that the applications not be made in excess of the capacities of the crops to take up the nutrients, else there is a possibility of leaching of nitrate into the underlying ground water.

The Project Report on the Green Acres Project by James M. Montgomery, Consulting Engineers, Inc. and PRC Toups, for Orange County Water District, September 1981 projects a tertiary effluent quality (Table D-5) in the proposed landscape irrigation project. The report projects that 30 percent of the N will be lost to volatilization by ammonia evaporation and nitrification/denitrification processes occurring in the soil. There will be other losses involving leaching of

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TABLE D-5

FERTILIZER ASPECTS OF WASTEWATER TREATMENT PLANT EFFLUENTS

	Concentration, Mg/l					
Treatment Plant Effluent	Total N	Total P	NH_3-N	Organic-N	PO_4-P	NO_3-N
Burbank WRP (1990-2000)[a]	10.2	5.4	--	--	--	--
LA - Glendale WRP (1980)[a]	12.0	5.2	--	--	--	--
Sepulveda WRP (1980)[a]	12.0	4.6	--	--	--	--
Hyperion TP (1980-2000)[a]	30	3.0	--	--	--	--
OCSD Plant No. 1 (1/76-6/77)[b]	--	--	39	5.9	5.5	--
Green Acres Project, Projected[c]	--	--	30	1.5	0.07	1.0
Santa Barbara, City[d]	>7.2	5	0.2	--	5	7
Montecito SD[d]	>7	6	2	--	6	5
Summerland SD[d]	>16	6	13	--	6	3
Carpinteria[d]	>18	7	15	--	7	3
Assumed, Black Lake Project[e]						
Average	30	7	22	6	6	2+
Range	20-60	6-15	--	--	--	--

[a] From Los Angeles River Basin (4B) Plan.

[b] From Orange County Water District Reports, representing secondary effluent from Orange Coutny Sanitation Districts Plant No. 1. (Same as influent to OCSD's Water Factory 21).

[c] From the JMM PRC Toups Green Acres Project Report for Orange County Water District, September 1981. This will be a tertiary (filtered) effluent.

[d] From Tables D-3 and D-4.

[e] By JMM, based upon consideration of preceding data. Values listed are approximate.

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the irrigation water past the root zone. Each acre-foot of reclaimed wastewater similar to that expected from OCSD's Water Factory 21 will contain 64 lb N and 0.2 lb P. Based upon irrigation application rates used in the Green Acres project area, losses due to ammonia volatilization, and an assumed commercial fertilizer (16-6-8 NPK) cost of about $0.14/lb, the benefit of using wastewater in the project area is estimated to be as much as $53/AF. Potential applications included among others:

Golf Course	AFY	Acres	ft/yr
Mile Square	370	140	2.64
Santa Ana	235	100	2.35
Mesa Verde	400	145	2.76
Costa Mesa	475	200	2.38

In a comprehensive study of wastewater reclamation possibilities, including market surveys, for park and golf course irrigation within Orange County, a range of application rates was evident among the several communities investigated. The application rates depended upon climatic conditions and the nature of the soil, a sandy soil usually requiring greater unit irrigation rates than, for example, a soil with substantial clay and/or silt content. Data of interest in the final report by James M. Montgomery, Consulting Engineers, Inc. ("Engineering analysis of Reuse Projects within Orange County, Volume III, Orange & Los Angeles Counties, Water Reuse Study," May 1980) included the following:

Community	Golf Course and Park Acreage	Potential Total AFY	Applied Irrigation Water Unit Rate (ft/yr)
Brea	350	959	2.74
La Habra	54	70	1.30
Fullerton	700	1,718	2.45
Placentia	219	802	3.66
Yorba Linda	130	330	2.54
Anaheim	862	2,567	2.98
Orange	2,707	7,447	2.75
Buena Park	395	1,154	2.92
La Palma	25	70	2.80
Cypress	215	579	2.69
Los Alamitos	200	500	2.50
Santa Ana	228	553	2.43
Seal Beach	116	272	2.34
Newport Beach	1,714	4,493	2.62

The foregoing gives an indication of potential wastewater treatment plant effluent application rates to golf courses, such as the Black Lake Golf Course via the Black Lake Project. It is of interest to estimate the probable disposition of

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nutrients in the effluent, especially nitrogen with particular regard to the underlying ground water.

Approximate Disposition of Applied Nutrients

The nutrients in reclaimed effluent of concern vis-a-vis the underlying ground water are nitrogen (N) and phosphorus (P). As indicated previously, the application rates for effluent to golf course turf would be such that there would be no significant possibility of the phosphorus not being taken up completely in the root system. For example, with an assumed total phosphorus concentration in the Black Lake plant effluent of 7 mg/l (nearly 0.01 ton/AF) and a maximum conceivable golf course application rate equivalent to 638 AFY/165 ac. equals 3.9 ft/yr (Figure 4-1), the maximum application of P would be about 80 lb/ac/yr. This would, of course, assume a case of no dilution of effluent with well water (not actually planned.) This is only about one-fourth of the upper limit cited previously in connection with the 4B Basin Plan. Actually, the effluent would be diluted with well water on a ratio of about 3.6 parts of well water to one part effluent, so the margin of safety, if such were actually needed for P, is even greater.

On the other hand, N does have some significance in ground water, because the Drinking Water Standards still place an upper limit on N as 10 mg/l (corresponding to 45 mg/l NO_3) out of concerns of potential methemoglobinemia in infants. Furthermore, the nitrogen concentrations assumed for the effluent are significantly greater than those for P, being about 0.04 ton/AF as compared to 0.01 ton/AF, and the allowable application rates to croplands are only 0.25 ton/acre/yr for the N as compared with 0.35 ton/acre/yr for the P.

The comtemplated application rate of N to the golf course turf is calculated approximately as follows:

Irrigation rate x Proportion of Effluent x N Concentration, or

3.9 AF/ac/yr x (1/4.6) x 0.04 Ton/AF = 0.034 T/ac/yr or 68 lb/ac/yr

This is comfortably below the upper limit of 500 lb/ac/yr used in the Basin 4B Plan and should allow for considerably greater concentrations of N in the effluent or less dilution by well water or both, should this occur. It is expected that the primary grassed areas of the golf course will be mowed periodically, thereby removing nutrients from the surface on a generally continuous basis. With specific respect to frequently mowed grasses, Herman Bouwer ("Groundwater Hydrology," McGraw-Hill, 1978, p. 415) cites an upper limit of N uptake as 500 kg/ha/yr or season. This value corresponds to 445 lb/ac/yr or 89 percent of the agricultural application limit for the Basin 4B Plan. The 68 lb/ac/yr cited above for the Black Lake application rate is comfortably within this turf limit as well.

Bouwer notes that up to 25 percent of the applied N will be removed by denitrification. He mentions that if an agricultural crop were to take up to 100 kg/ha and if denitrification losses were 20 kg/ha, then 60 cm of effluent at 20 mg/l N content could be applied during the growing season without fear of

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nitrate contamination of underlying ground water. This means that 120 kg/ha (107 lb/ac) could be applied viz:

$$0.6 \text{ m} \times 10{,}000 \text{ m}^2 \times 20 \text{ mg/l N} = 120 \text{ kg N/ha}$$
$$\text{Denitrification} = 20 \text{ kg N/ha}$$
$$\text{Crop Uptake} = 100 \text{ kg N/ha}$$

Bouwer also notes that P uptake ranges from 10-70 kg/ha/yr but that P not removed by crop roots will largely be adsorbed or otherwise immobilized in moist soils, except in sand with a low pH value.

The U.S. Environmental Protection Agency Process Design Manual for Land Treatment of Municipal Waste Water (October 1977) cites the phenomenon of organic nitrogen in a soil being converted to nitrate that eventually reaches ground water (page A-22). This EPA Manual also notes that if total N input does not greatly exceed crop requirements for N, removals of 35 to 60 percent can be expected as a result of crop uptake (page A-23). The Manual discusses storage of N in the soil by the mechanisms of fixation of ammonium by clay minerals and organic matter, retention of ammonium as an exchangeable cation, and incorporation into soil organic matter, this last being the most important mechanisms (pages A-17 to A-21). It was mentioned that at Bakersfield, California, an effluent-irrigated cropped area experienced a buildup of 7,400 lb N/ac to a depth of 5 ft as a result of 36 years of such irrigation (Page A-21).

Nitrogen Impacts with Black Lake Golf Course Irrigation

For the purposes of estimating probable N impacts from recycling of Black Lake Treatment Plant effluent for golf course irrigation, two basic cases are considered:

- Case I - Assumes 30 mg/l total N in the effluent and the flow is uniformly diluted with well water at 3.6 parts well water to one part effluent and used over the entire 165 acres of irrigated golf course.

- Case II - Assumes 40 mg/l total N in the effluent, dilution of the flow with only 2.0 parts of well water to one part effluent and used only over 107 acres of irrigated golf course.

In each case, the effluent is taken as 138 AFY and the unit applied water irrigation rate as 3.9 ft/yr, after Figure 4-1. Table D-6 presents an approximation of probable nitrogen impacts of effluent irrigation of Black Lake Golf Course under Cases I and II described above. The assumptions used are believed reasonable; the resulting percolate concentrations are indicated to be significant but should become greatly reduced upon dilution with the main groundwater body and the general recharge. They may not represent much of an actual increase to total nitrogen in the ground water basin when recognition is given to savings in artificial fertilizer applications to be expected as a result of the effluent reuse in golf course irrigation. If the new golf course's soil mantle is not very thick, there might be a good possibility of considerable long range buildup of nitrogen, as well as phosphorus. The nitrogen would eventually reach some equilibrium, and nitrates could also be released from the soil and percolate downward. The

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TABLE D-6

PROBABLE NITROGEN IMPACTS OF EFFLUENT IRRIGATION OF BLACK LAKE GOLF COURSE[a]

Item	Case I	Case II
Assumed total N concentration in effluent, mg/l	30	40
Assumed dilution ratio, well water : effluent	3.6:1	2:1
Annual effluent quantity, acre-feet	138	138
Annual application, total N, lb	11,250	15,000
Annual quantity of blending well water, acre-feet	500	276
Annual irrigation application of total blend, acre-feet	638	415
Unit application of irrigation water, ft/yr	3.9	3.9
Golf course area irrigated, acres	165	107
Disposition of applied N, lb/yr		
Surface volatilization at assumed 25% of applied	2,810	3,750
Available for plant-root uptake	8,440	11,250
Assumed plant-root uptake at 50%	4,220	5,630
Available for soil organic matter accumulation	4,220	5,620
Soil organic matter accumulation, assumed 20%	840	1,120
Deep percolation of remainder	3,380	4,500
Assumed percolation from effluent irrigated area, ft/yr[b]	0.89	0.89
Assumed percolation from effluent irrigated area, acre-feet/yr	147	95
Theoretical N concentration in percolate, T/AF	0.0115	0.0237
Theoretical N concentration in percolate, mg/l	8.5	17
Theoretical annual N increment in total basin recharge attributable to effluent irrigation of golf course, mg/l[c]	0.27	0.36

[a] Refer to Figure 4-1 for basic irrigation schematic, applicable to Case I directly.

[b] Assumed at 0.31 ft/yr rainfall percolation and 0.58 ft/yr returns from applied water, average values.

[c] Assumes total annual recharge is 4,540 AFY basic (p. 3-7) plus 49 AFY enhanced recharge by the Project. This does not take credit for possible reduction in artificial fertilizers for the golf course. The theoretical increment is probably small in comparison with agricultural operations.

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total applications indicated are probably modest compared with agricultural fertilizer use. Also, local effects from septic tank leach fields and leaching cesspools are probably more pronounced than for the golf course, although the golf course does generally have a significantly greater area of influence than do individual on-site sewage disposal systems.

Actual Nitrogen Impacts Recently Noticed Nearby

Reference is made to the U. S. Geological Survey Water Resources Investigation 76-128 "Evaluation of Ground-Water Quality in the Santa Maria Valley, California," by Jerry L. Hughes, July, 1977. Some of the points of relevance include:

- In comparison to the solutes from irrigation return, natural recharge, and rains, discharge of wastewater from municipal and industrial wastewater-treatment facilities contributes less than 10 percent. The quality of treated wastewater is often lower in select chemical constituents than the receiving water (Abstract).

- Point source discharges in Santa Maria Valley include two oil companies, one sugar refinery, and four municipal wastewater-treatment facilities (Santa Maria, Santa Maria Airport, Laguna Sanitation District, and Guadalupe). Municipal treatment plant effluent is discharged to streams and to evaporation-percolation ponds or is sold to nearby farmers for application on feed crops. Regardless of the method, part of the wastewater percolates to and influences the quality of ground water in the area of discharge. Most of the solutes in these wastewaters were, however, in the ground water pumped for the cities and industries represented.

- Figure 17 (pp. 56-57) "Distribution of Nitrogen in Ground Water, Santa Maria Valley, California," indicates contours of total nitrogen, mg/l in 9-10/75 with intervals of 5 and 10 mg/l:

  - Santa Maria's disposal area shows a contour of up to 10 mg/l
  - Laguna Sanitation District shows a contour of 5 mg/l
  - Santa Maria Airport shows less than 5 mg/l
  - Guadalupe shows less than 5 mg/l

  These reflect local circumstances.

- As an example of local effects:

  - Recharge of wastewater containing less than 10 mg/l N from the Santa Maria facility to groundwater with N concentrations greater than 10 mg/l has improved the quality of groundwater with respect to this constituent (p. 60). On the other had, the increase in chloride concentration in the area of Santa Maria's wastewater discharge is partly a result of the higher Cl concentration in water from city wells in the Orcutt area and

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partly from a NaCl contribution associated with regenerating water softeners used by some of the city residents (p. 62).

- Within the recharge mound produced by the Guadalupe treatment plant discharge all constituents except N show an area of degradation related to this point source. (p. 62).

- The effect of wastewater discharge from the Laguna and airport facilities on ground water seems to be minimal. (p. 62).

o The foregoing is presented to illustrate the complexities of ground water quality effects and the great importance of local conditions. The results in Santa Maria Valley cannot necessarily be extrapolated to Nipomo Mesa area (the northeastern portion of Santa Maria Valley.

SALT BALANCE

The use of ground water for beneficial purposes almost invariably and inevitably is accompanied by some tendency for the ground water to increase (at least gradually) in mineral content. Irrigation uses (both agricultural and landscape) evapotranspirate much of the applied water but leave the salt content, much of which may then tend to return to the ground water by natural or artificial flushing. Agriculture (and landscape) activities involve applications of fertilizers and possibly herbicides and insecticides (in smaller measure). Industrial and municipal (including domestic) use of water provides accretions of salts as normal contributions.

JMM performed a brief, basin-wide investigation of salt balance for Nipomo Mesa Ground Water Sub-Basin in order to explore the probable effects of the proposed Black Lake Project upon total salts for year 2000 conditions. In making this calculation, the following assumptions were made:

o Precipitation would be expected to contain about 20 mg/l TDS, this value being considered appropriate for a coastal area and so used in Santa Barbara County Water Agency's December 15, 1977 Report "Adequacy of the Groundwater Basins of Santa Barbara County."

o Agricultural fertilizers would produce a salt accretion of approximately 0.23 ton/acre/yr, this value having been used in the Basin 4B Plan and in the SBCWA Adequacy of the Ground Water Basins Report.

o Irrigated agricultural lands were assumed thus:

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Zoning Category	Actual Irrigated Acreage
Irrigated agriculture	1,400
Rural lands	140
Recreation	480
Residential rural	350
Total	2,370
Round Off	2,400

- o Industrial salt contributions would be negligible, this due to an ocean outfall export for cooling tower blowdown, etc. at Union Oil Company Refinery. Additional industrial development resulting in theoretical salt contributions was not anticipated.

- o Year 2000 Nipomo area population would be 10,000 persons, with the town of Nipomo representing about 8,200 and rural areas 1,800.

- o Population east of Highway 101 would be 4,100, west of 101 would be 5,900.

- o Exported pumpage would supply the population served by Nipomo Community Services District located east of Highway 101. The pumpage would generally be from NCSD's Omya, Bevington, and Eureka Wells.

- o There would be no NCSD municipal sewage disposal west of highway 101. Any individual or municipal disposal east of 101 would not contribute salts to the Nipomo Mesa Sub-basin.

- o The only subsurface outflow would be to the ocean.

- o Salt contributions from stream seepage were sufficiently small to be safely ignored.

Table D-7 presents the estimated Year 2000 Salt Balance for Nipomo Mesa Ground Water Sub-Basin. Under the assumptions made, it appears that the total accretion of salt will be about 800 tons/yr, corresponding to about 0.005 T/AF/yr (nearly 4 mg/l) when compared with the amount of fresh water reported in storage above sea level in 1975. The buildup rate would be greater if the volume in storage had been decreased, as would be expected.

The significance of the calculation of Table D-7 is that some salt buildup is inevitable, and the rate indicated for the Nipomo Ground Water Sub-basin does not appear excessive in comparison with many other coastal basins. The portion attributable to the proposed Black Lake Project is calculated approximately as follows:

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	T/yr TDS
New Black Lake Golf Course 45 acres @ 0.23 T/ac/yr	11*
New Population, including visitors, via wastewater treatment plant 138 AFY @ 260 mg/l TDS pickup (0.35 T/AF)	49
Total due to Project	60
Percent of Total Contributions 60/1510 = 4%	

*The figure shown does not actually discount the N and P not needed, due to effluent irrigation. This would reduce the percentage slightly.

It is noted that any increased population and agriculture or "semi-agriculture" developments will involve increased salt contributions. The proposed Black Lake Project may offer regulatory authorities a somewhat better chance of minimizing such impact than in the case of an equivalent area comprised of many individual private parcels developing without subdivision control.

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TABLE D-7

ESTIMATED YEAR 2000 SALT BALANCE FOR NIPOMO NESA GROUND WATER SUB-BASIN[a]

Item	Water, AFY[b]		Salt, Tons/year[c]	
Additions				
Precipitation	21,100 acres x 14.7/12 =	25,800	25,800 x 20/736 =	700
Agricultural Fertilizers[d]		--	2,400 acres x 0.23 T/ac =	550
Industrial Contributions		--	Negligible	--
Municipal and Domestic Wastewater	5,900 persons at 0.11 AFYc =	650	650 x 0.4 T/AF =	260
Total		--		1,510
Removals				
Subsurface Outflow	To ocean only =	260	260 x 0.4 T/AF =	104
Domestic Water Export	4,100 persons at 0.13 AFYc =	530	530 x 0.4 T/AF =	210
Industrial	Assumed value =	1,000	1,000 x 0.4 T/AF =	400
Total				714
Accretion[d]			Difference	796
			Round Off	800

[a] Values are approximate only. See assumptions in text.

[b] An overall area per capita wastewater production value is 0.11 AFY (slightly below 100 gpcd). A slightly higher value is used for overall area per capita water demand (0.13 AFY).

[c] One ton/AF is equivalent to 736 mg/l concentration. Groundwater extracted generally is assumed to average 0.4 T/AF TDS (nearly 300 mg/l). This same value is applicable to subsurface outflow.

[d] Includes semi-agricultural uses, such as Black Lake Golf Course and cemeteries. The annual accretion of 800 T/yr TDS, if applied (for purposes of comparison) to the volume in storage above sea level in 1975 (172,000 AF) would correspond to about 0.005 T/AF/yr.

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