Appendix A

REVIEW OF GROUNDWATER CONDITIONS IN THE NORTHERN SANTA MARIA BASIN
and
SCENARIOS FOR THE EVALUATION OF IMPACTS OF DEVELOPMENT ON THE WATER RESOURCES OF NIPOMO MESA

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I. INTRODUCTION

A. Purpose of this Study

The proposed update of the South County Area of the County's General Plan proposes a substantial reduction in allowable density for planned development based primarily on limitations of water supply and a postulated overdraft of the area described in *Ground Water in the Arroyo Grande Area* prepared by the Department of Water Resources for the County of San Luis Obispo in 1979. In addition, the County Planning Department has updated the withdrawals section of the water balance for the area which increases the postulated overdraft. However, any revision of a water balance should consider all the factors involved in the preparation of that balance, and this study includes information on factors in that water balance not recently revised.

The primary purpose of this review is to compile all of the information relevant to an informed decision regarding water availability in the Nipomo area. This information includes the geology of the water-bearing rocks of the area, and evaluations of the relative balance between recharge and extractions of fresh water. This information is, of necessity, technical, and this document is intended primarily as back-up for the less technical discussions of this subject in the EIR of which this is an appendix.

B. Content of This Report

This compilation of technical data includes information bearing on the geology of the groundwater basin (Section II) and changes in its hydrology over time (Section III) based primarily on information contained in reports prepared primarily by government agencies but also including some information from other sources. Section IV is a discussion of the implications of this information as they relate to land use issues on Nipomo Mesa.

C. Availability of Information

Information relating to the groundwater resources of the northern Santa Maria Basin can be divided into three groups: 1) investigations published by the U.S. Geological Survey; 2) studies conducted by the State Department of Water Resources for the two counties and studies conducted by the counties themselves; and 3), studies conducted by individuals or groups usually prompted by the need to evaluate water availability for a particular land use decision. The major reports containing significant information on the water resources of the Santa Maria Basin are grouped as follows:

U.S. Geological Survey:

1. *Geology and Ground-Water Resources of the Santa Maria Valley Area, California:* U.S. Geological Survey Water-Supply Paper 1000, prepared by G. F. Worts, Jr. and published in 1951. This is the basic reference for the geology of the basin, and while it is somewhat out-of-date, it also contains significant information on water levels.

2. *Utilization of Ground Water in the Santa Maria Valley Area, California:* U.S. Geological Survey Water-Supply Paper 1819-A, prepared by G. A. Miller & R. E. Evenson and published in 1966. This report updates the study of Worts primarily in areas of recharge and extraction.

San Luis Obispo County:

3. *San Luis Obispo County Investigation:* State Water Resources Board Bulletin 118 prepared by the State Department of Water Resources for the County in 1958. This report covers the entire county, and information for the Santa Maria Basin is limited.

4. *Ground Water in the Arroyo Grande Area:* prepared by the Department of Water Resources for the County of San Luis Obispo, June, 1979. This report is the primary basis for evaluating water resources in the Nipomo area.

Santa Barbara County:

5. *Adequacy of the Santa Maria Groundwater Basin:* prepared by the Santa Barbara County Water Agency, November 1977.

Other Reports:

6. *Water, Wastewater and Drainage Studies, Nipomo Mesa Planning Study:* prepared by Charles Lawrence of Lawrance, Fisk & McFarland, Inc., for RRM Design Group and Nipomo Mesa Technical Study Sponsors, August 24, 1987. This study was sponsored by landowners on the Mesa to supplement the report by the Department of Water Resources in the County's consideration of land use in the area.

7. *Ground Water Availability for the Proposed Black Lake Golf Course Development Project:* prepared by James M. Montgomery, Consulting Engineers, for Plaza Builders, Inc., June 1982. This study was prepared primarily by Charles Lawrence, and the information contained in it has been largely updated and revised in the report above.

II. GEOLOGY OF THE SANTA MARIA BASIN

A. Studies of the Basin

Geological investigations of the Santa Maria Groundwater Basin are limited primarily to the initial, major study by the U.S. Geological Survey (Worts) published in 1951 and the update by Miller and Evenson in 1966. The San Luis Obispo County Investigation by DWR includes geological cross sections that are a significant addition to the geology of the basin. The local study of the Arroyo Grande area by DWR in 1979 relied primarily on geological mapping by Hall, and did not attempt to further revise previously published subsurface geological relationships.

The applicability of these studies to the Nipomo area is hampered by the USGS delineation of the basin as ending at the crest of the mesa, and by the DWR studies ending at the San Luis Obispo County line. One purpose of this compilation is to bring together in one document the geology presented in these separate studies.

B. Structural Framework of the Basin

The general geology of the Santa Maria Basin is illustrated on Figure A-1. This map, prepared by Miller and Evenson in 1966, is the simplest map available of the complex units of the basin, and it has been used to depict the general geology of the basin in most of the recent documents (e.g., San Miguel Project EIS/EIR). It shows the distribution of the non-water bearing, consolidated rocks (**TKJu** on map) that flank the basin, the older sediments of the Orcutt Uplands (**QTs**), the recent alluvium of the valley bottom (**Qal**), the river channel deposits (**Qrc**), and the dune sands (**Qs**). Unfortunately, the USGS defined the basin as ending on Nipomo Mesa, and the area of critical concern in this compilation is incomplete. Also, the authors' "lumping" of the coastal dune sands with the dune sands on the mesa is a major error as developed in detail below.

A more complete geologic map has been prepared for this investigation by combining the geologic map of Worts (1951, Plate 1) and the geologic map included in the DWR (1979) report as Figure 4 at the San Luis Obispo County line, the southerly limit of the DWR study. This composite geologic map (Figure A-2) has been annotated to emphasize the major geological units of the basin, its structural axis, and the locations of the two geological cross sections of Worts (Figure A-3) that are pertinent to this study. Points to note on these illustrations include:

- The axis of the basin is located near its south flank. The older water bearing units (Careaga Sand, Paso Robles and Orcutt Formations) dip gently to the southwest on the northeastern flank of the basin, and are upturned more steeply on the southwest flank.

- The older water bearing rocks, particularly the Paso Robles Formation, are thickest (2,500-3,000') at the basin axis and thin toward the flanks. At the southerly edge of the Nipomo Mesa (right end of Section D-D'), the water bearing section has thinned to approximately 800 feet.

- The recent alluvium of the valley, from which much of the agricultural water is pumped, is limited to the area north of the Orcutt Upland and south of Nipomo Mesa. This unit is approximately 200 feet thick beneath the Santa Maria Valley alluvial plain.

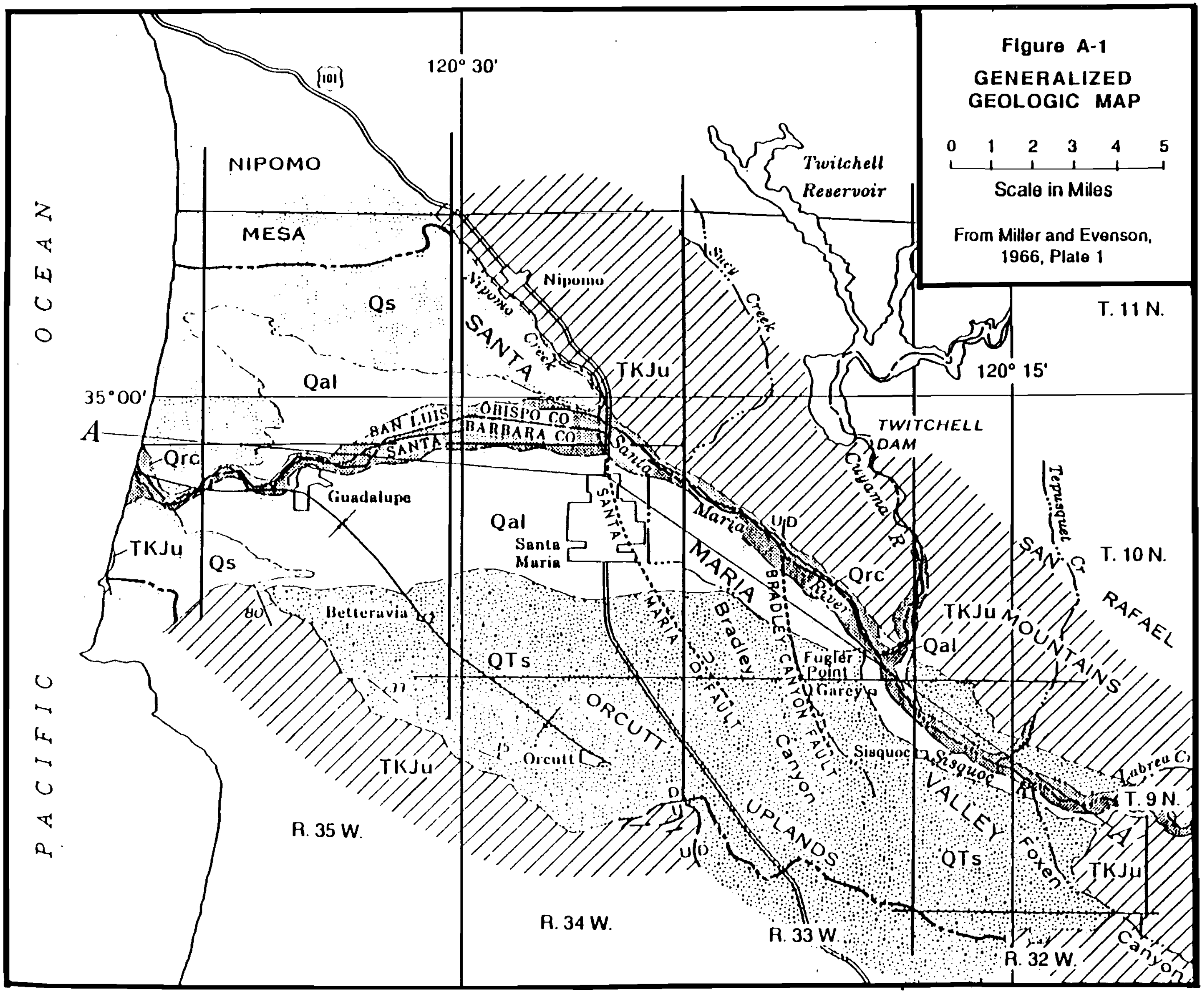


Figure A-1
GENERALIZED GEOLOGIC MAP

From Miller and Evenson, 1966, Plate 1

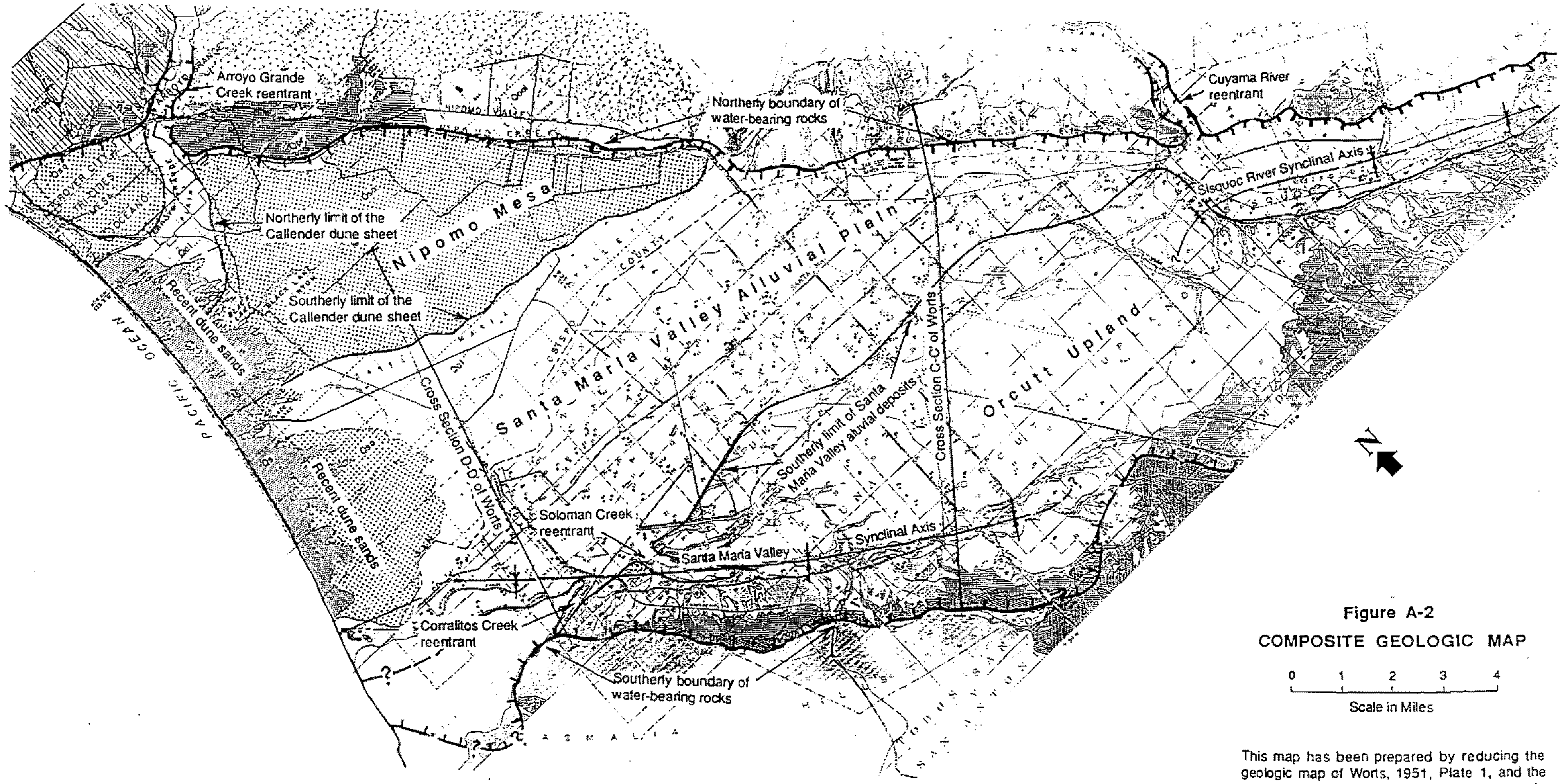


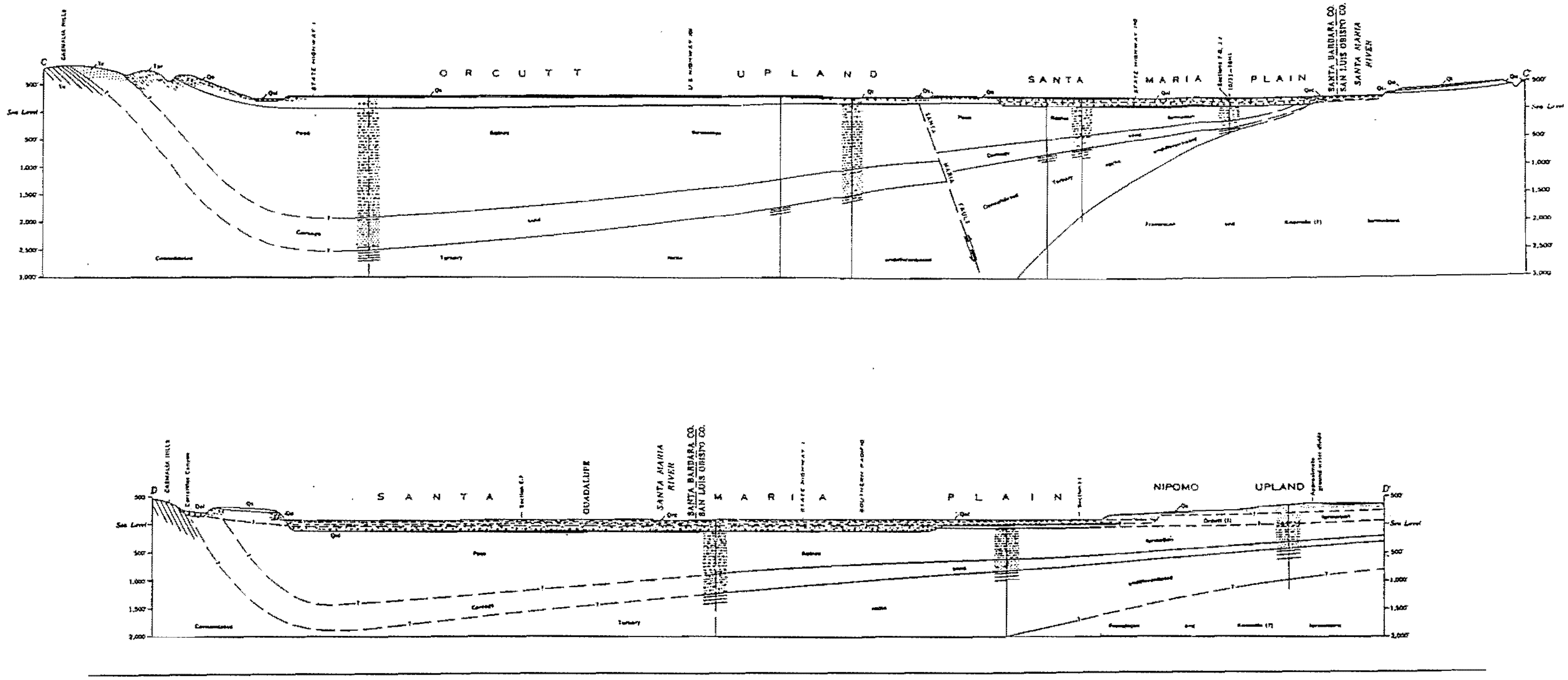
Figure A-2

COMPOSITE GEOLOGIC MAP

0 1 2 3 4

Scale in Miles

This map has been prepared by reducing the geologic map of Worts, 1951, Plate 1, and the geologic map of DWR, 1979, Figure 4, to a scale of 1"=2 mi. and combining them at the Santa Barbara/San Luis Obispo County line, the southern limit of the DWR map. Major structural features, stratigraphic units, and lines of cross section discussed in the text of this report are enhansed for ease of identification.



GEOLOGIC STRUCTURE SECTIONS OF THE SANTA MARIA VALLEY AREA, SANTA BARBARA COUNTY, CALIFORNIA

from Worts, 1951

The locations of the cross sections are shown on Figure A-2

STRUCTURE CROSS SECTIONS OF THE SANTA MARIA VALLEY

- Water bearing rocks shown as underlying Nipomo Mesa (see Figure A-4 for clarity) include a thin Careaga at the base, Paso Robles, Orcutt (?), and a thin cap of dune sand. Also, the dune sand is shown as overlapping the Orcutt and lying directly on the upper alluvium of the valley. This relationship is in error, but it is corrected in the DWR County Investigation of 1955.

C. Physiographic Units

1. Regional Relationships

The sequence of physiographic features of the Santa Maria Groundwater Basin, particularly the development of Nipomo Mesa, is important in the interpretation of subsurface information relating to the distribution of water-bearing units. An understanding of the sequence of periods of erosion and deposition and the placement of major water-bearing units in this sequence is essential to the interpretation of well data.

The sequence of the younger physiographic units of the basin from younger to older is summarized as follows:

River Channel Deposits (Qrc of Miller and Evenson, 1966, and Qrc of Worts, 1951). These deposits are limited to the channel of the Santa Maria River, and they are reworked, transported, and otherwise modified by significant flow in the Santa Maria River. This may be yearly depending on rainfall.

Recent Sand Dunes (Qs of Miller and Evenson, 1966, Qs of Worts, 1951, and Qs + Qso, in part, of DWR, 1979). This unit includes active dunes and stabilized dunes (Qs and Qso of DWR) along the coastal lowlands, but it does not include much older dunes on Nipomo Mesa and the Grover City/Tri Cities Mesa assigned as Qso by DWR on the geologic map. This distinction is discussed in greater detail below.

Older Sand Dunes (inland units designated Qs and QTs by Miller and Evenson, 1966, Qs by Worts, 1951, and Qso by DWR on Nipomo Mesa). These sand dunes are substantially older than the recent sand dunes listed above.

The "keys" to resolution of the conflicts in assignment of units noted above are the physical development of the southerly and northwesterly flanks of Nipomo Mesa. The steep southerly flank of the Mesa upstream from Highway 101 is obviously the result of erosion by the Santa Maria River. However, the steep bluffs continue westerly from Highway 101 even though the river departs from the bluffs and flows southwesterly toward Guadalupe. The most likely explanation is that the Santa Maria River previously flowed along the base of these bluffs to a mouth located near Oso Flaco Lakes. A similar explanation for the cutting of the northwest flank of the Mesa by Arroyo Grande Creek is likely. This is the interpretation on cross sections included in the County Investigation by DWR in 1955 (Figure A-5), but it is not clear from the illustrations included in the 1979 report.

The alignment of the old dunes on the mesa and the interdunal depressions are shown on Figure A-6. This illustration was prepared for the Mesa Property Owners' Association General Plan Amendment EIR, and does not cover the entire mesa. However, it serves to illustrate the trend of dune features and the larger interdunal depressions that can be identified based on 20-foot contours.

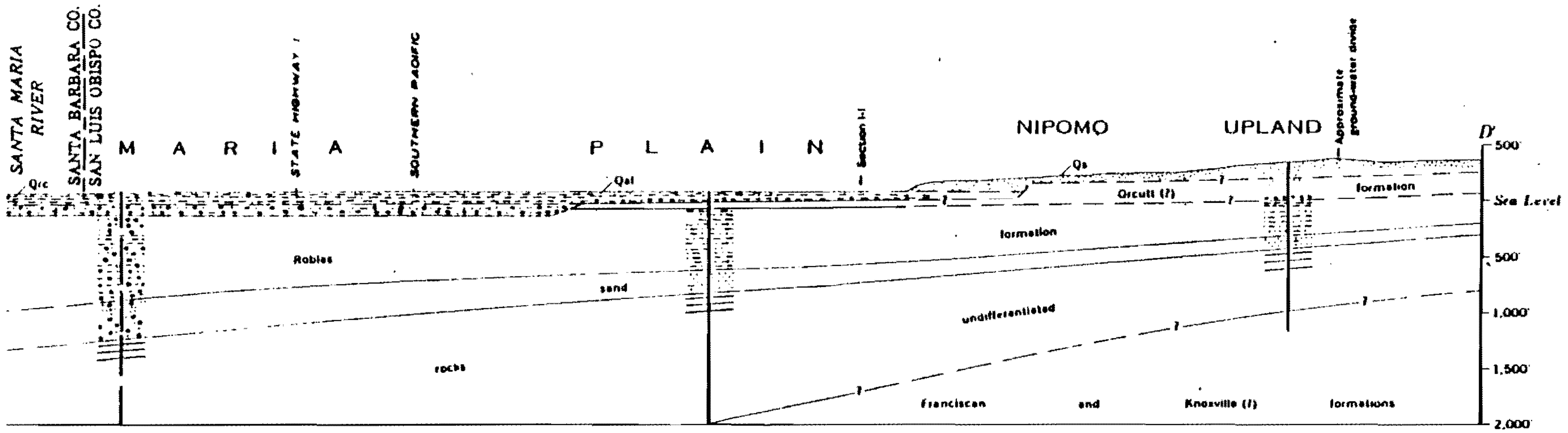
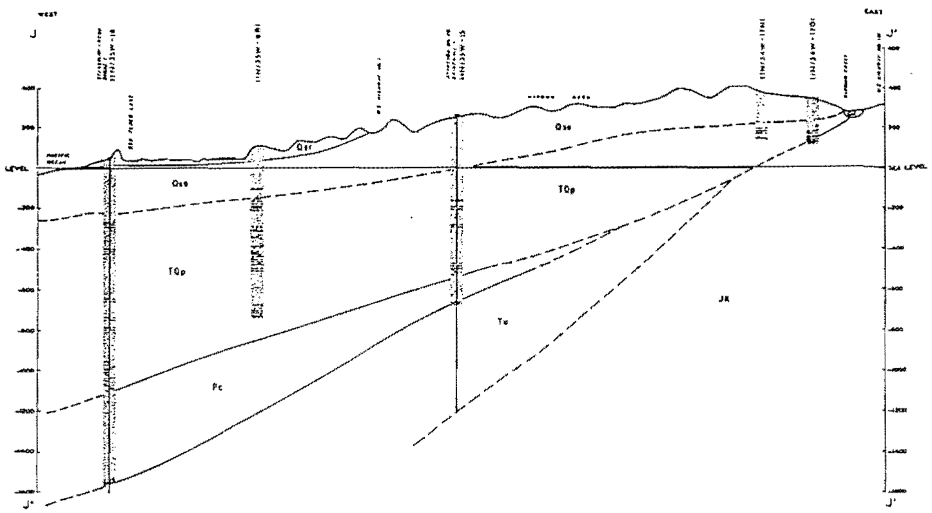
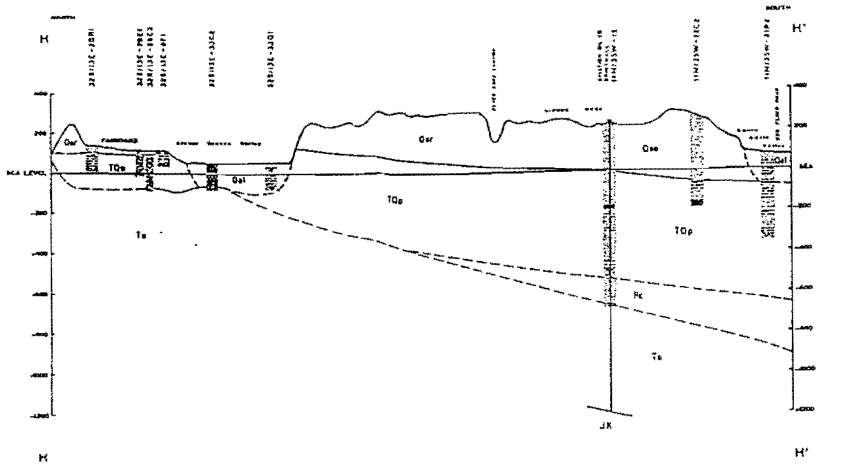


Figure A-4

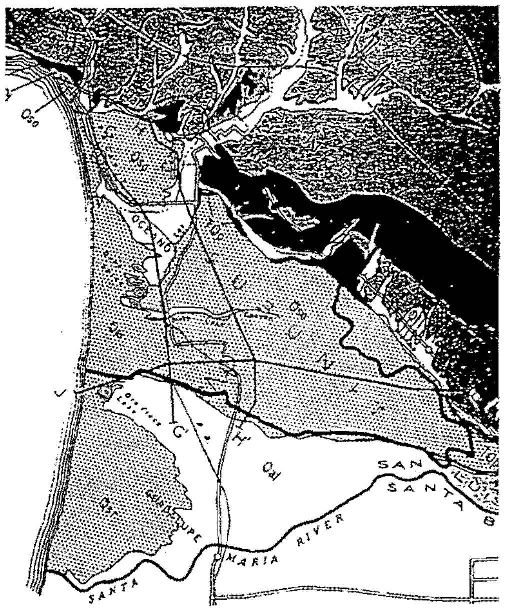
NORTHERLY END OF CROSS SECTION D-D'

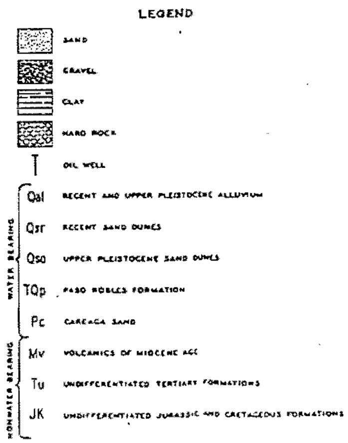
(Vertical scale is twice horizontal scale)





LOCATION MAP





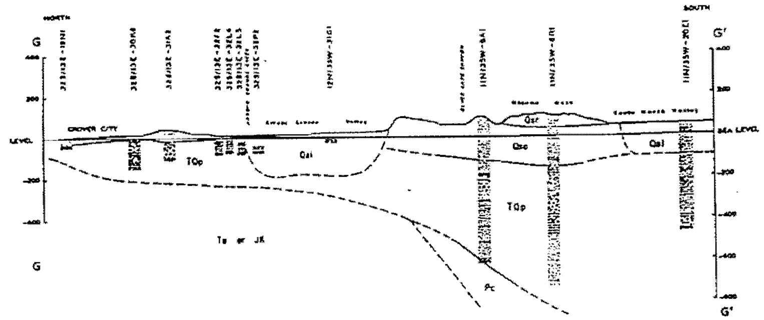
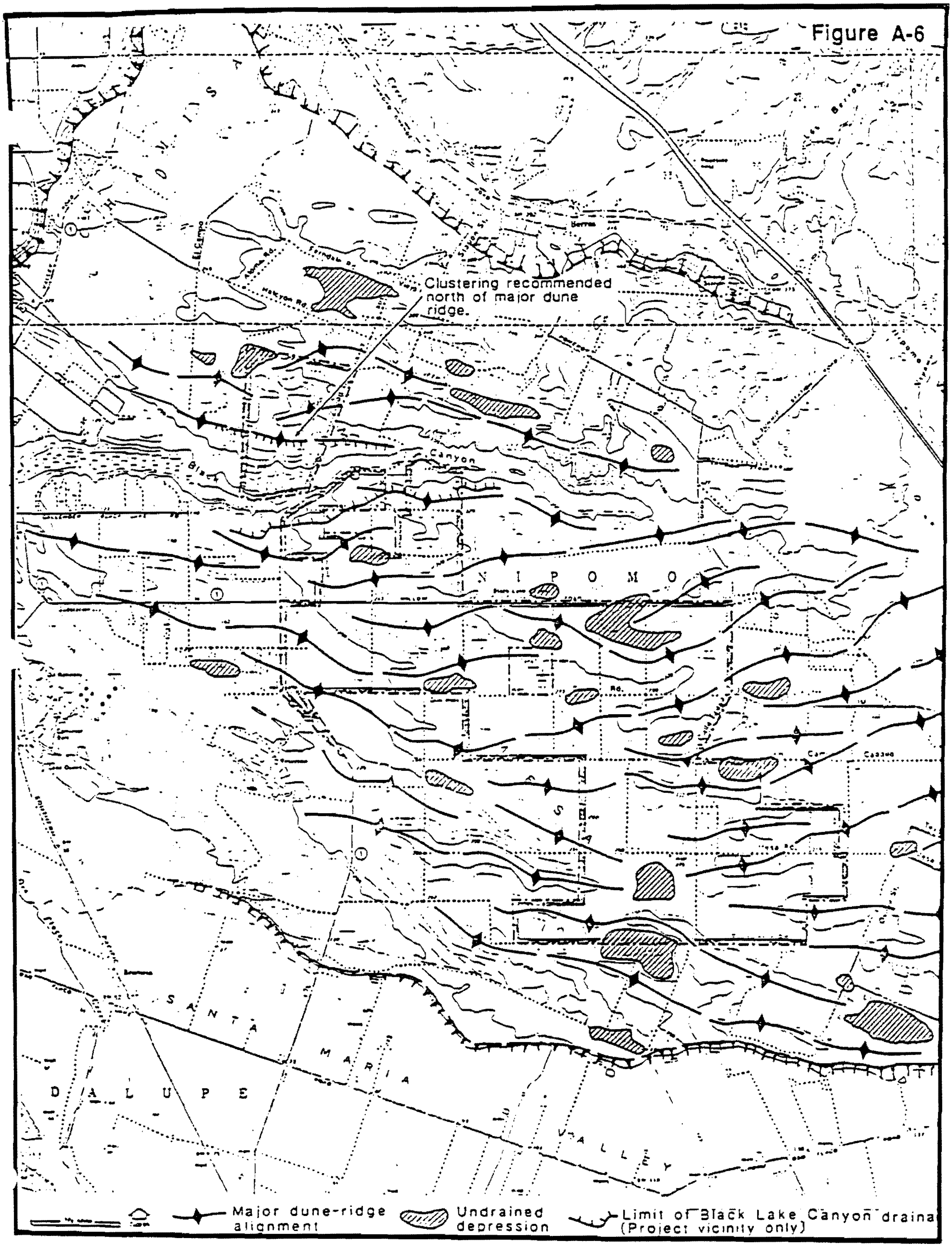


Figure A-5

CROSS SECTIONS FROM SAN LUIS OBISPO COUNTY INVESTIGATION

(Department of Water Resources, 1958)

(Vertical scale is approximately 13 times horizontal scale)



(From Nipomo Mesa Property Owner's Association EIR)

The consequences of this interpretation are that the sand dunes on Nipomo Mesa are at least 40,000 years old (pre-latest Ice Age), and are more likely equivalent to the Cayucos terrace (oxygen isotope Stage 5e) approximately 120,000 years old. On the other hand, the dunes at the coastline (DWR units Qs for active and Qso for stabilized dunes) are, probably no older than approximately 5,000 years, the time when sea level stabilized at about its present level.

2. Black Lake Canyon

Black Lake Canyon is a unique feature in that it has almost no drainage area. Figure A-7, prepared originally for the Bjerre General Plan Amendment EIR, shows the limit of the area draining to this canyon, and its relationship to the older dunes on the mesa (OS on map) and the younger dunes along the coast (YS). The canyon is about four miles long and approximately one-quarter mile wide. Its drainage area extends back from it rim to the top of the nearest dune, which provides for a drainage area about one-half mile wide. Cooper (1967), in his classic study of the coastal dunes of California, attributed the canyon to a tributary of Arroyo Grande Creek. However, given its very small drainage area and the high permeability of the sand soils, it is virtually impossible that it could have been cut by surface runoff.

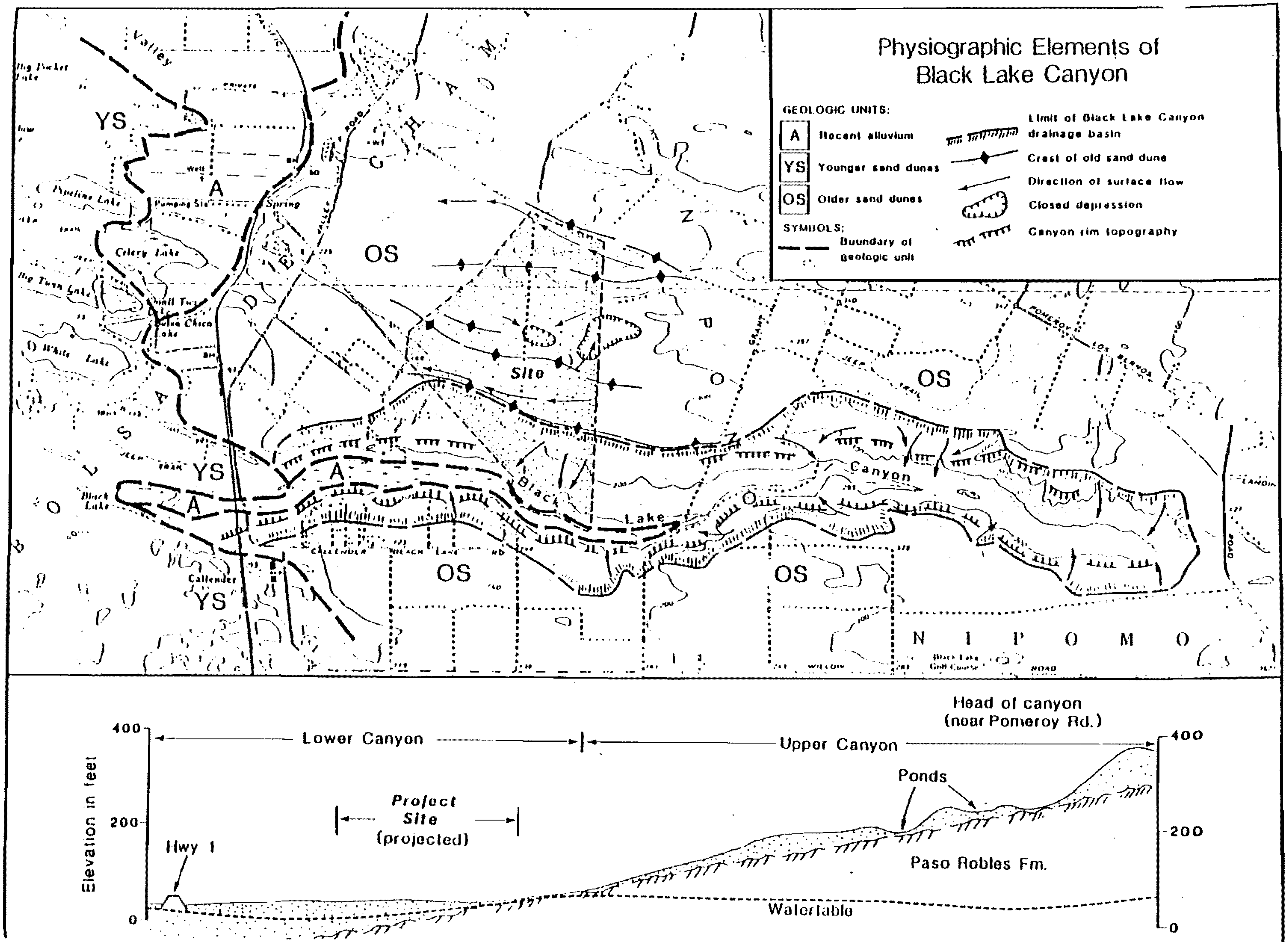
An unusual feature of the canyon is the presence of several small ponds near the upper end and a larger area of ponded water near Highway 1 (cross section on Figure A-7). The ponds at the upper end of the canyon are clearly perched water, as they are 150 feet above static groundwater levels in the area. The surface water in the lower end of the canyon is probably also perched, although this is less clear. The materials in the walls of the canyon have been examined at a number of localities by this author, and no pebbles, clayey or silty rock fragments, or other materials suggesting an origin other than wind-blown sand have been found. The dunes on the mesa are, therefore, presumed to extend downward to elevations approximately equivalent to the bottom of the canyon. Figure 7 of the DWR report has been modified to show these relationships, and is included here as Figure A-8. This interpretation appears to be consistent with the text of the DWR report (pages 15 and 17), but the cross sections and the geologic map do not separate these units.

The perching mechanism is presumed to be clayey layers in the Paso Robles Formation underlying the sands in the bottom of the canyon as this is consistent with the elevation of clay and silty clay layers in the Paso Robles Formation as shown on Figure A-8. The mechanism of cutting the canyon is interpreted to be sapping by a large spring or springs during the last Ice Age when rates of precipitation were probably higher.

D. Summary of Significant Geologic Relationships

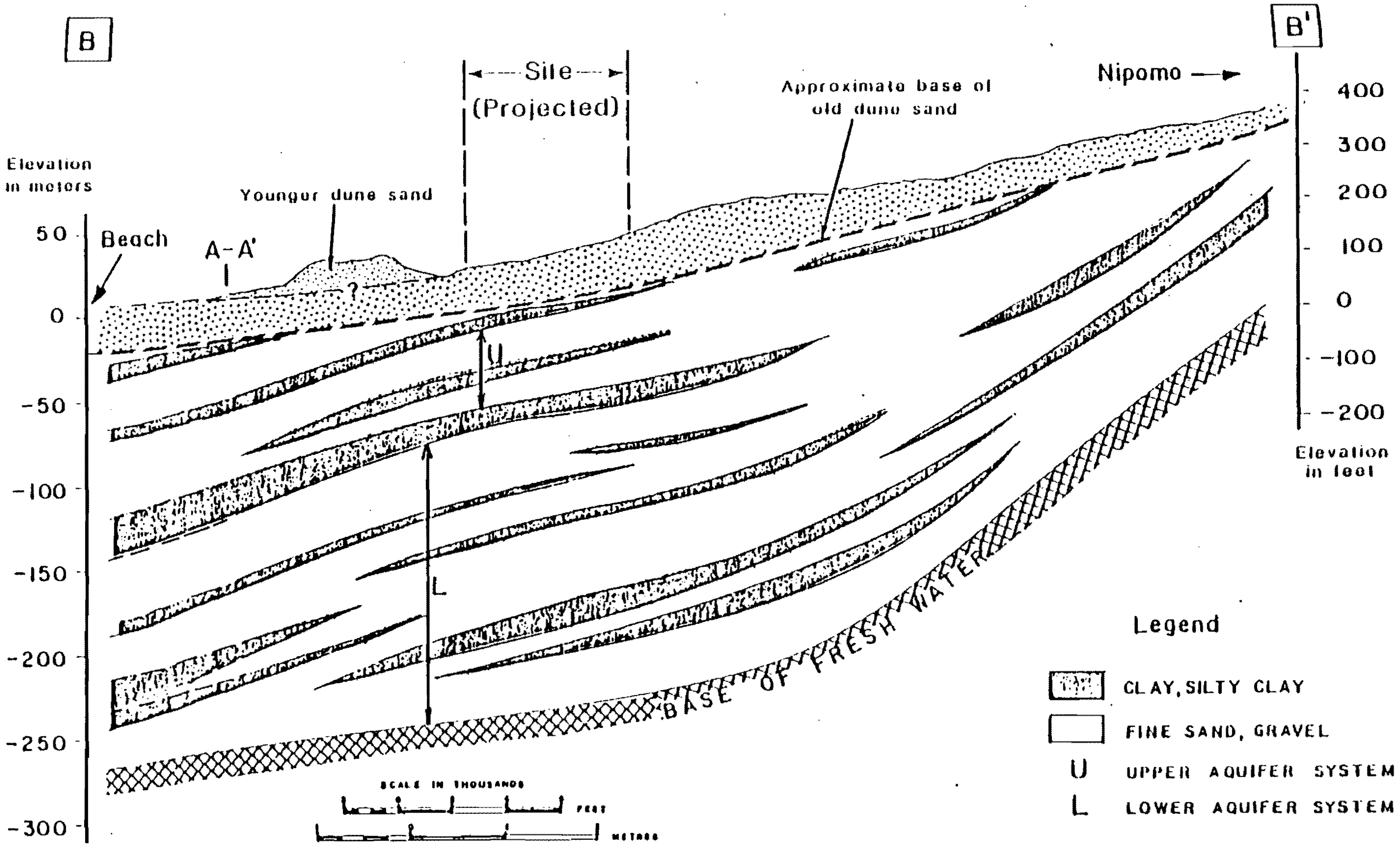
The geologic relationships discussed above that are important to an understanding of groundwater conditions in the Nipomo Mesa area are illustrated on Figure A-9. Cross section A-A' is aligned across the central portion of Nipomo Mesa and the westerly end of the Santa Maria Basin (Figure A-10). Cross section B-B' is aligned to show conditions beneath the mesa in relationship to the ocean to the west. Both cross sections are also aligned approximately parallel to groundwater flow for use in the next section of this report.

Relationships to note include:



(From Bjerre General Plan Amendment EIR)

Figure A-7



A-13

Figure A-8 GENERALIZED CROSS SECTION B - B'

Location of cross section shown on Figure A-12

Department of Water Resources, Southern District, 1979.

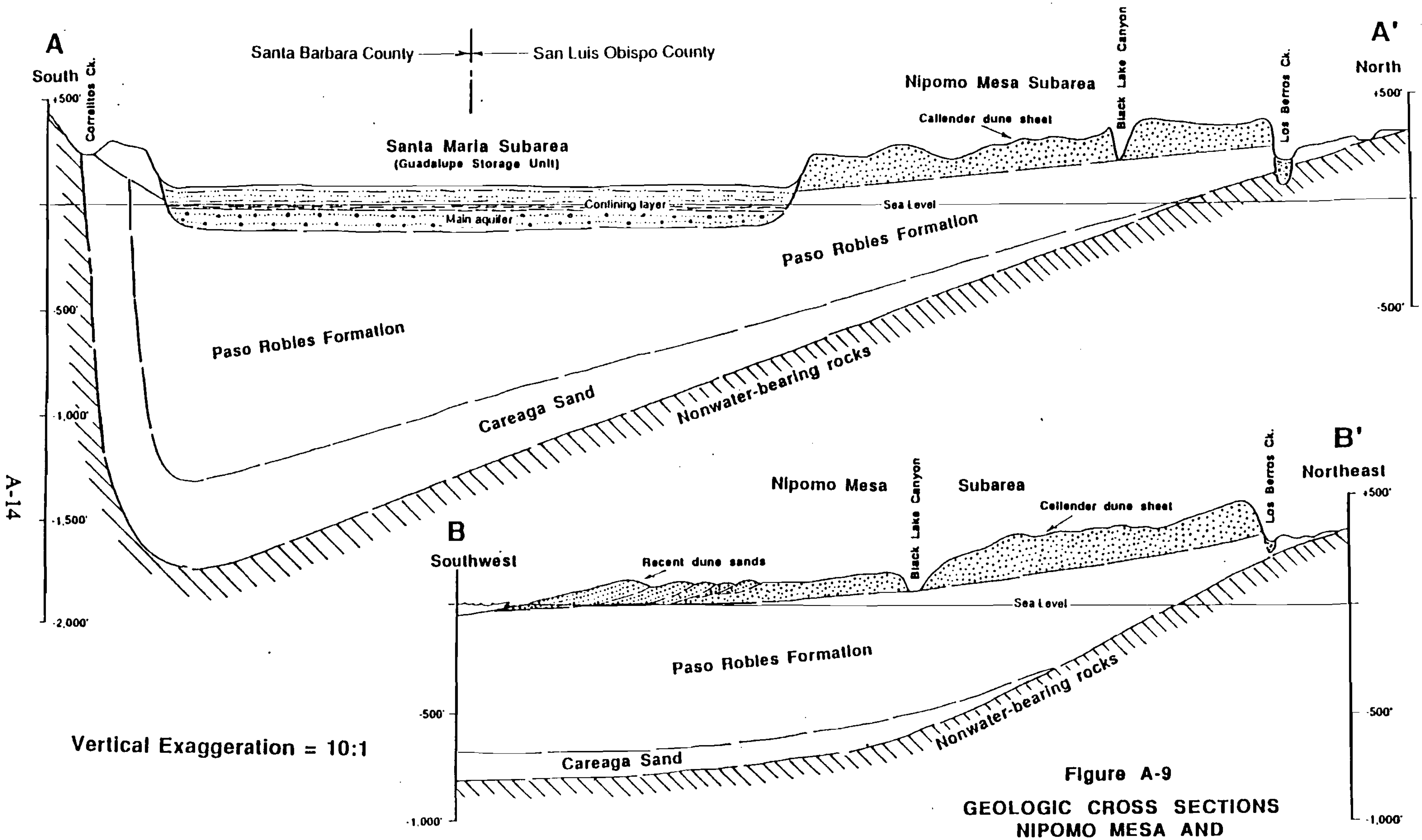


Figure A-9

GEOLOGIC CROSS SECTIONS
NIPOMO MESA AND
ADJACENT PARTS OF THE
SANTA MARIA GROUNDWATER BASIN

(See Figure A-10 for locations of sections)

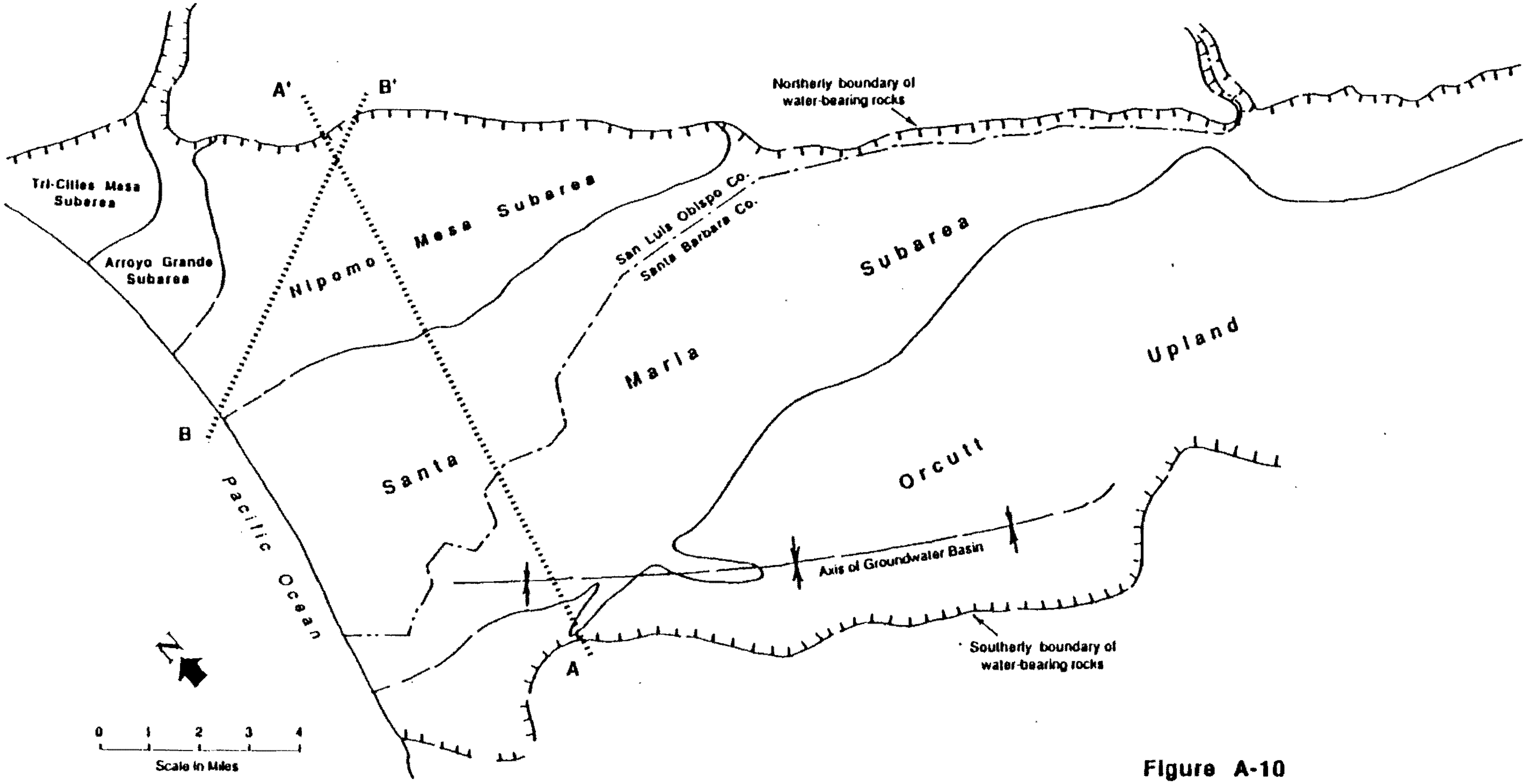


Figure A-10

LOCATION MAP FOR CROSS SECTIONS SHOWN ON FIGURE A-9

Nipomo Mesa Recharge Capability:

1. Nipomo Mesa is underlain by old dune sands that are generally in the range of approximately 100 feet thick. These sands are very porous and permeable. They have the capability to infiltrate and hold large quantities of rainfall until it can percolate into the less permeable Paso Robles Formation below.

2. The surface of the mesa is old dune-sand topography that consists of aligned dune ridges and inter-dunal depressions that trap and contain any runoff from adjacent slopes. This topography is at least 40,000 years old, and is more likely 120,000 years old. The presence of this topography documents the capability of the dune sands to infiltrate essentially all the rain that falls on the mesa, even under much wetter climates that have occurred in past Ice Ages.

3. Black Lake Canyon cannot have been cut by surface runoff, and it is probably the result of sapping by a large spring or springs that developed at the base of the dune sands. Ponds in the canyon are the result of perching on clay layers in the Paso Robles Formation which immediately underlie the sands exposed in the bottom of the canyon. This relationship defines the thickness of the dune sands near the canyon.

4. The Paso Robles Formation, the primary aquifer beneath the mesa, is exposed on the northerly flank of the mesa near Los Berros Creek, but not on the southerly flank near the Santa Maria River and a tributary of Oso Flaco Creek. These relationships, and those in Black Lake Canyon, define the configuration of the base of the dune sands beneath the mesa.

Groundwater Basin Definition:

5. The water-bearing rocks beneath Nipomo Mesa are part of the northeasterly flank of the Santa Maria Groundwater Basin. There is, therefore, no geological basis for an "Arroyo Grande Groundwater Basin" or a "Nipomo Mesa sub-basin", and the use of these terms should be avoided.

6. Nipomo Mesa differs from adjacent areas only in that it is underlain by a thick sand section and topography that promote high rates of recharge.

These geological relationships are an important part of the analysis of the potential effects of development on the mesa on the groundwater resource as discussed in Section III of this report.

III. HYDROLOGY OF THE NORTHERN SANTA MARIA GROUNDWATER BASIN

A. Definition of the Basin and Subunits

1. Definition of the Basin

The configuration of the groundwater basin as a physical basin is defined by the effective base of fresh water. Maps showing the base of fresh water for the basin south of Nipomo Mesa from Miller and Evenson (1966) and for San Luis Obispo County from DWR (1979) are included as Figures A-11 and A-12. These maps show that the bottom of the hydrologic basin is located near its southwesterly edge between Orcutt and Betteravia, and is approximately 2,000 feet below sea level. The northeasterly flank forms most of the area of the basin which extends to approximately the Santa Maria River, Nipomo, and Arroyo Grande. The inclination of the northeast flank averages approximately 5.4% (3.1°) while the southwest flank is steeper at approximately 23% (13°).

The portion of the basin within San Luis Obispo is the northwesterly part of the northeast flank of the Santa Maria Basin. It is not a groundwater basin in itself, nor is it a subbasin. It includes two subareas defined by DWR, and one subunit as discussed below.

2. Subdivisions of the Department of Water Resources

The most recent report by DWR (1979, p. 23, par. 2) divides the portion of the basin in San Luis Obispo County into "three storage areas on the basis of different inflow-outflow patterns and topographical differences. These three areas are ... the Arroyo Grande Plain-Tri-Cities Mesa, Nipomo Mesa, and the Santa Maria Valley." (emphasis added) Later in the water quality section (p.33), the report notes: "For convenience of data retrieval, compilation, and discussion, the study area is divided into three areas in conformance with the Department's system for aerial designation of hydrologic units. These are: Arroyo Grande hydrologic subarea, Nipomo Mesa hydrologic subarea, and Santa Maria hydrologic subunit within San Luis Obispo County (Figure" A-13). (emphasis added).

The above is included in this discussion to emphasize that the DWR report does not identify the Arroyo Grande study area as a groundwater basin, and that the subdivisions of the study area are defined as subareas or a subunit. The term "sub-basin" is not used in the text of this report.

3. Subdivisions of the U.S. Geological Survey

The USGS (Miller and Evenson, 1966) has subdivided the basin into storage units (Figure A-14) based on physical relationships and also along arbitrary boundaries. In addition to the subareas defined above, the USGS has subdivided the Santa Maria subunit of DWR into the Santa Maria storage unit and the Guadalupe storage unit. The Guadalupe storage unit is that portion of the Santa Maria River alluvium that is overlain by a confining unit. The Fugler Point storage unit and the Sisquoc storage unit are arbitrary subdivisions of the alluvial basin upstream from the Santa Maria storage unit.

The Orcutt Uplands is the area south and southwest of the area underlain by significant alluvium. It is subdivided into the Betteravia, Orcutt and Bradley Canyon storage units along arbitrary boundaries.

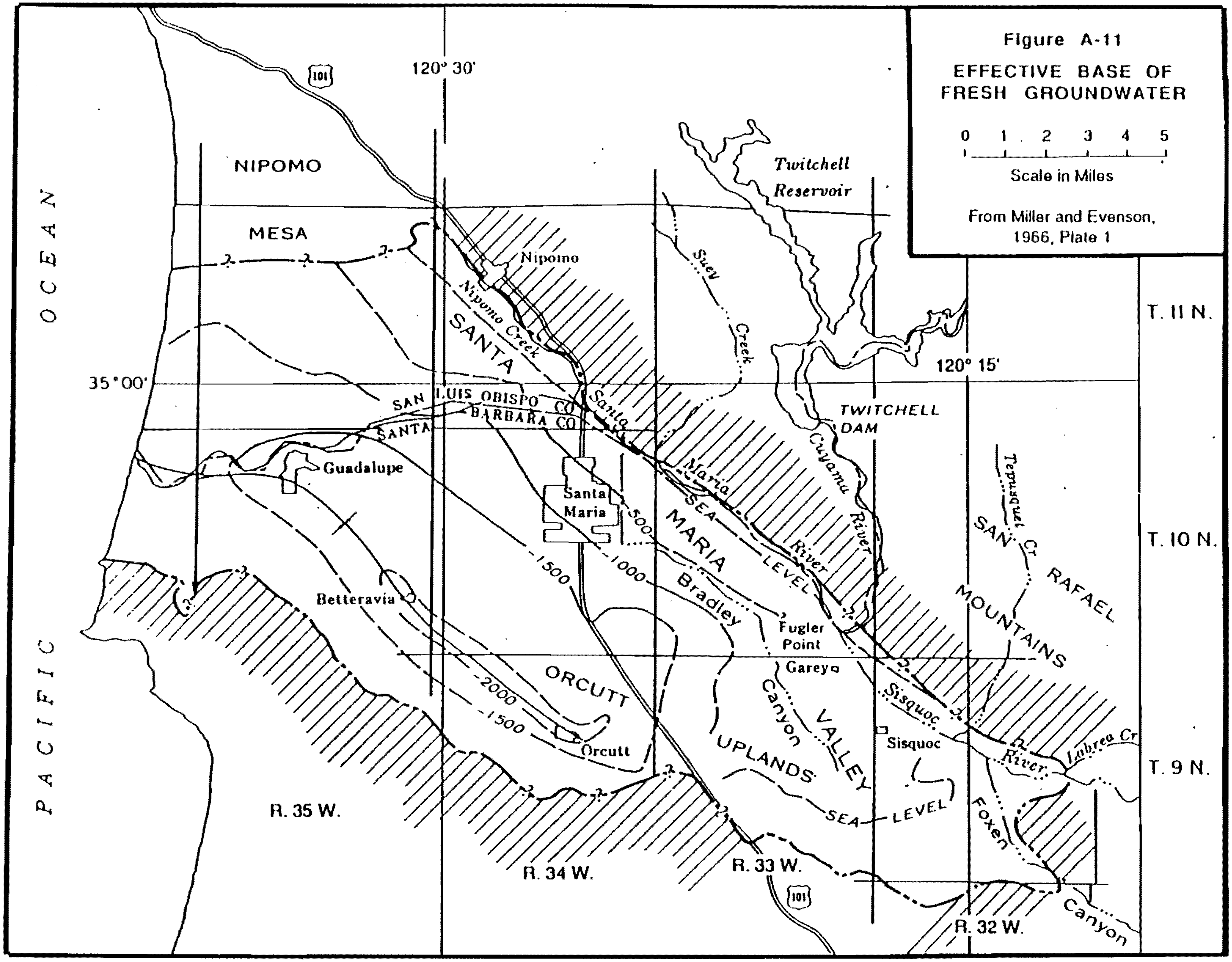


Figure A-11
EFFECTIVE BASE OF FRESH GROUNDWATER

From Miller and Evenson, 1966, Plate 1

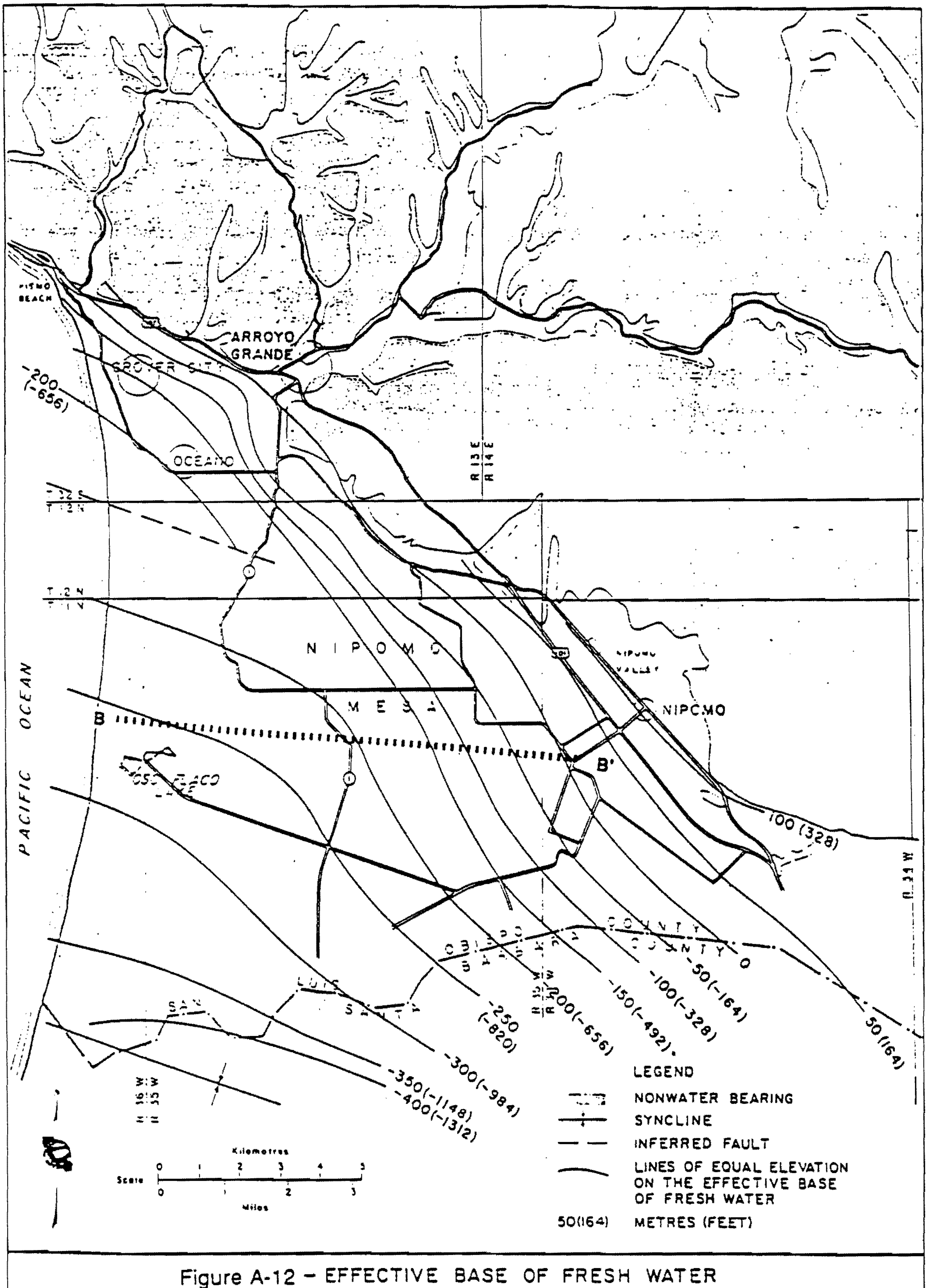


Figure A-12 – EFFECTIVE BASE OF FRESH WATER

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1979

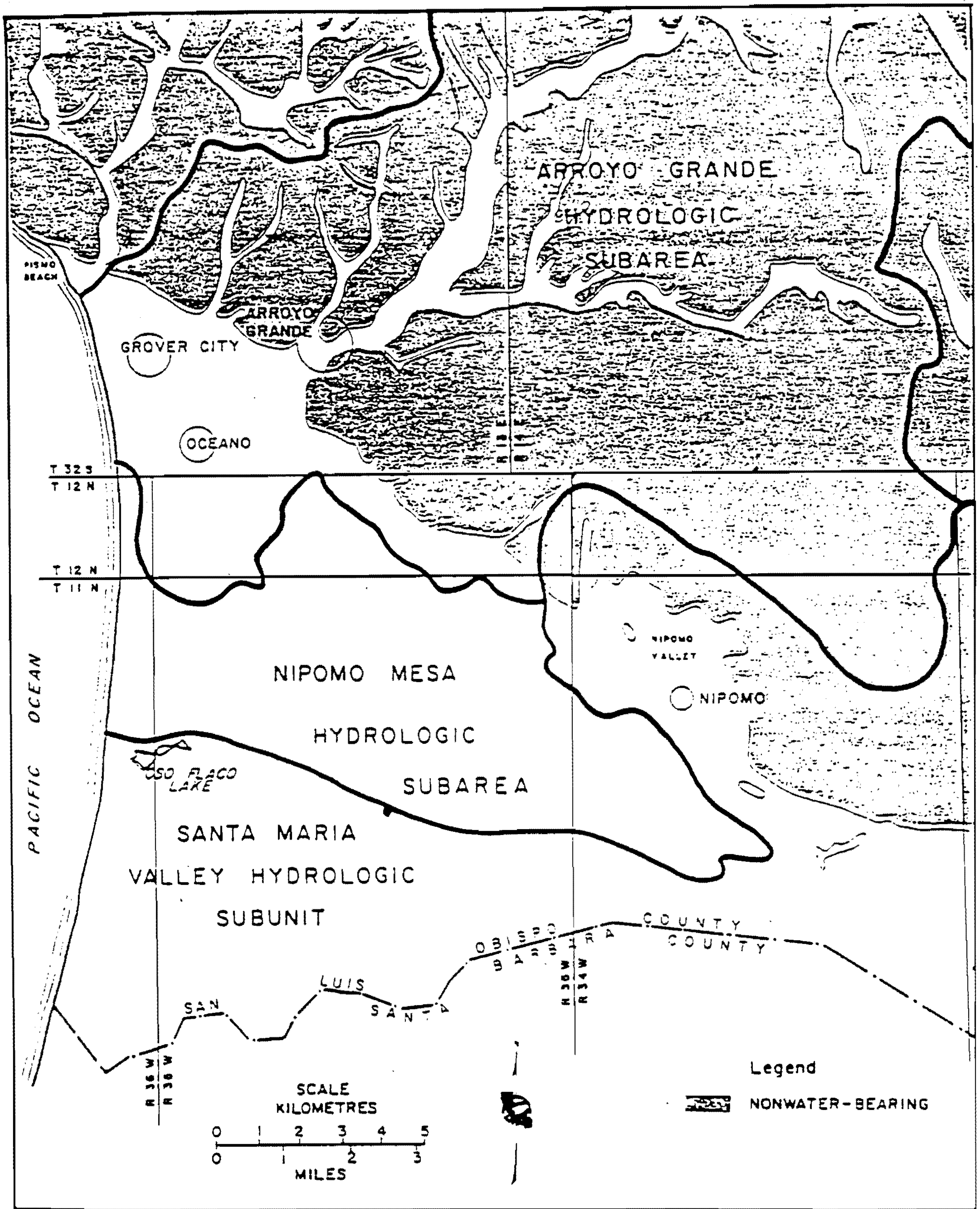


Figure A-13 - HYDROLOGIC AREA BOUNDARIES

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1979

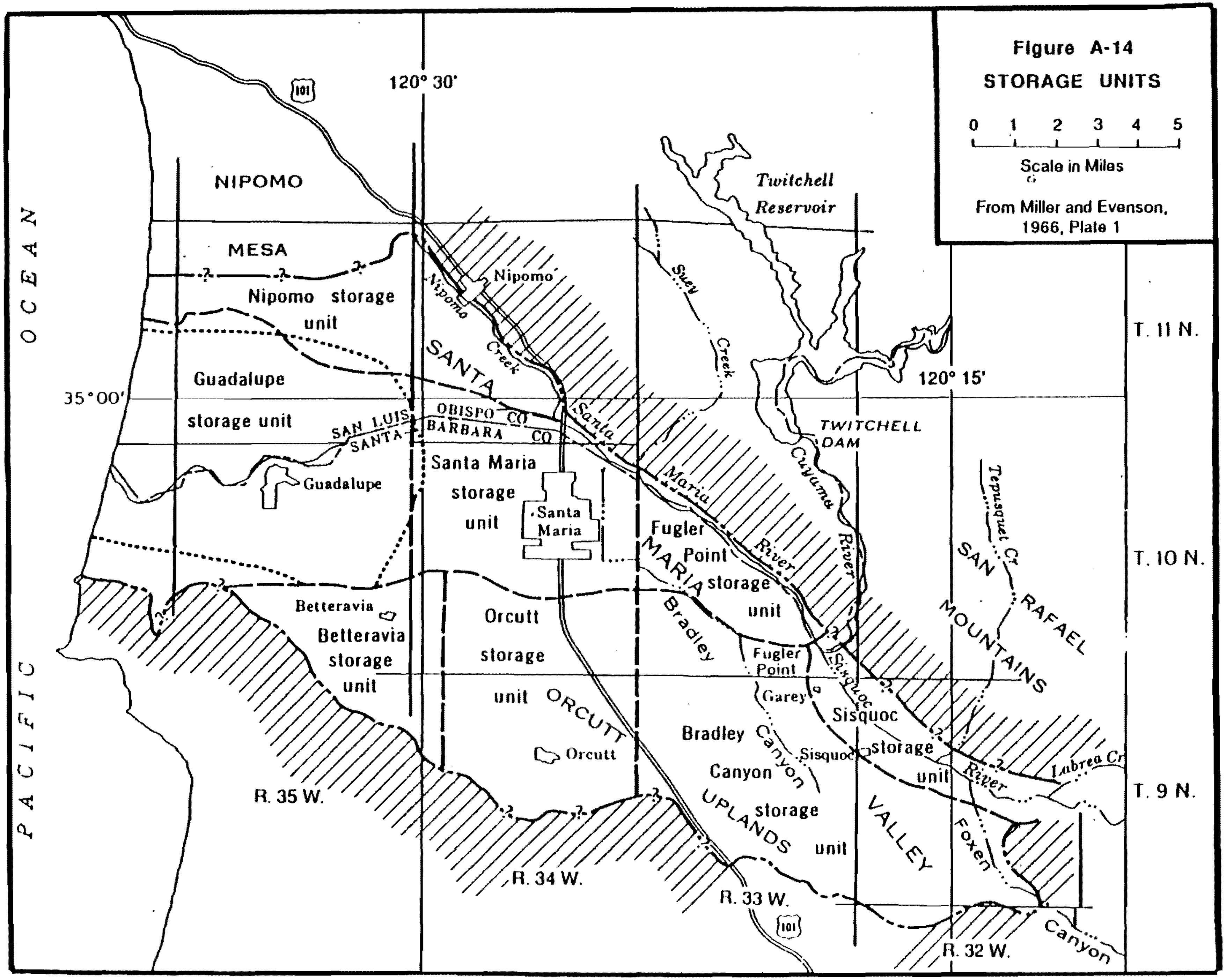


Figure A-14
STORAGE UNITS
0 1 2 3 4 5
Scale in Miles
From Miller and Evenson, 1966, Plate 1
120° 30'
120° 15'
35°00'
NIPOMO
MESA
Nipomo storage unit
Guadalupe storage unit
Santa Maria storage unit
Orcutt storage unit
Betteravia storage unit
Fugler Point storage unit
Bradley Canyon storage unit
Sisquoc storage unit
PACIFIC
OCEAN
SAN LUIS OBISPO CO
SANTA BARBARA CO
SANTA MARIA VALLEY
ORCUTT UPLANDS
SAN RAFAEL MOUNTAINS
Twitchell Reservoir
TWITCHELL DAM
Nipomo
Nipomo Creek
Santa Maria River
Cuyama River
Suey Creek
Tepusquel Cr
Sisquoc River
Labrea Cr
Bradley Canyon
Foxen Canyon
Santa Maria
Guadalupe
Betteravia
Orcutt
Garey
Sisquoc
Fugler Point
101
T. 11 N.
T. 10 N.
T. 9 N.
R. 35 W.
R. 34 W.
R. 33 W.
R. 32 W.

4. Terminology of This Report

The terminology of this report utilizes the terminology of DWR as to subareas having boundaries based on physical characteristics, and the terminology of the USGS for storage units having arbitrary boundaries within subareas. These subdivisions of the Santa Maria Basin are summarized in Table A-1 below.

Table A-1

BASIN SUBDIVISIONS USED IN THIS REPORT

Subareas	Storage Units	Definition
Santa Maria	Santa Maria Fugler Point Sisquoc	Underlain by unconfined alluvium of the Santa Maria and Sisquoc Rivers.
	Guadalupe	Underlain by confined alluvium of the Santa Maria River.
Orcutt Upland	Betteravia Orcutt Bradley Canyon	Underlain by Orcutt, Paso Robles and Careaga Formations.
Nipomo Mesa	Not subdivided	Underlain by old wind-blown sands and Paso Robles Formation.
Arroyo Grande	Not subdivided	Underlain by alluvium of Arroyo Grande Creek.
Tri-Cities Mesa	Not subdivided	Underlain by thin section of Paso Robles Fm.

The separation of the Arroyo Grande subarea from the Tri-Cities Mesa subarea has not been proposed by DWR, and may not be warranted based on their small areal extent. However, they are divided herein to maintain consistency, and because they are in the area of primary concern of this review.

B. Changes in Groundwater in Storage in the Santa Maria Basin

1. Methods of Analysis and Assumptions

Changes in groundwater in storage in any groundwater basin are normally evaluated in two ways: 1) a water balance that compares inflow, consisting of recharge from streams and rainfall and return waters from irrigation and urban uses, against outflow, consisting of pumpage for agricultural and urban uses and outflow to the sea to prevent seawater intrusion; and 2), a direct analysis of change in storage based on changes in groundwater levels and assumed values of average specific yield (i.e., the effective porosity of the units within which the water-level changes occur).

Both of these approaches to the evaluation of the status of a groundwater basin involve significant assumptions, and it is normal practice to analyze conditions based on both methods. The most significant assumption in the water balance computation is the normally the value assigned to recharge from rainfall and/or infiltration from streamflow. The remaining values in the balance are normally subject to fairly accurate analysis. The primary assumption in the computation of changes in storage is the assignment of an average specific yield to the section within which the change in groundwater levels occur.

Published analyses of the status of the Santa Maria Groundwater Basin based on both approaches are included below and are compared as to their implications, over time, as to the status of the groundwater basin. In general, it is the impression of this reviewer, that a water balance is "speculative" in that it involves numerous assumptions, a number of which may be subject to a substantial range of variation.

On the other hand, the change in storage method goes directly to the condition. That is, groundwater levels are either moving up or down, and the only major assumption is the average specific yield which determines the magnitude of the change. Additional comments are included after discussion of the two types of analyses as provided from all available sources below.

2. U.S. Geological Survey Estimates

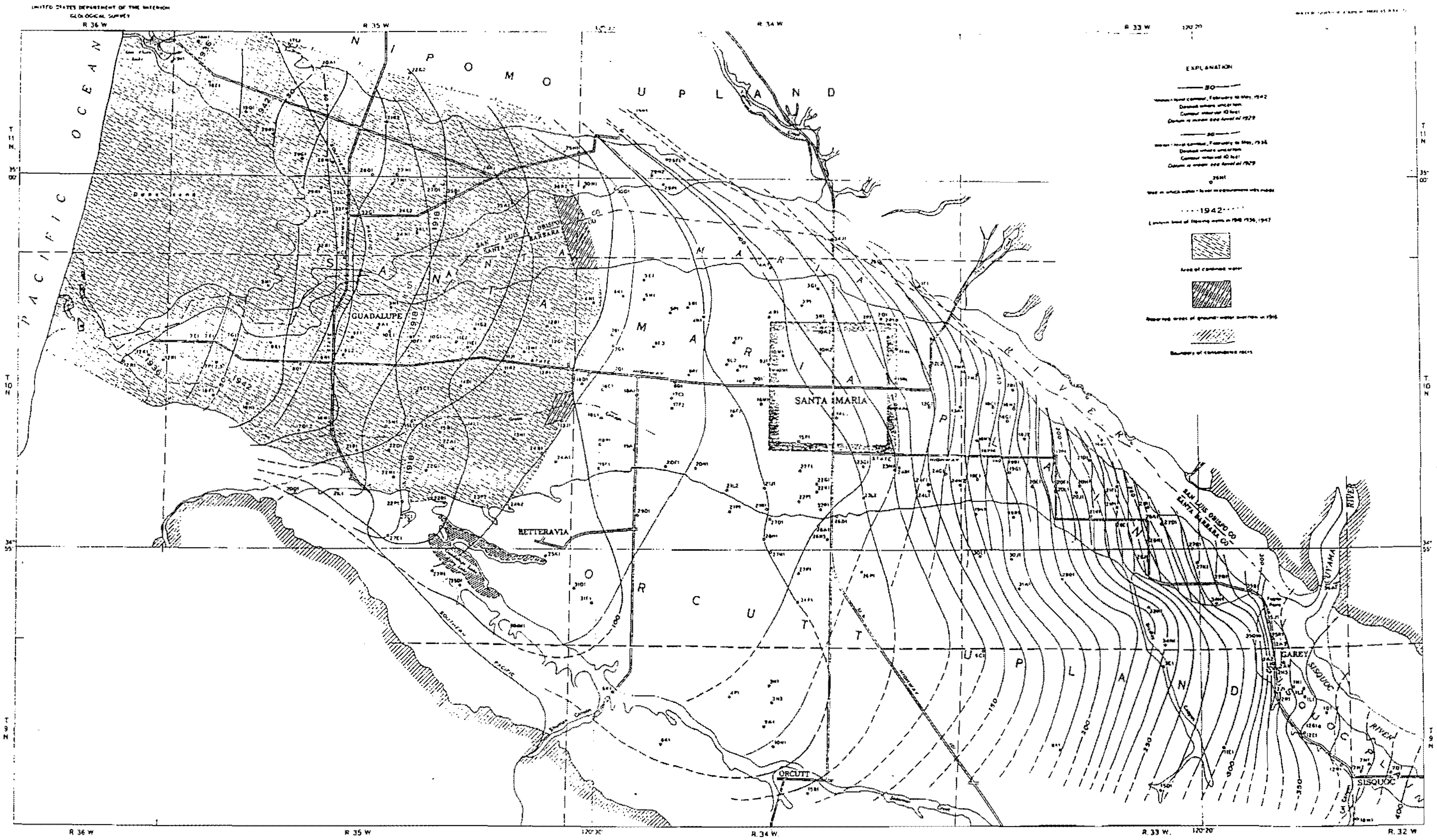
Water-level contours for the main alluvial aquifer of the Guadalupe and Santa Maria storage units for the years 1939 and 1942 and the limits of the confining layer at the westerly end of the basin are shown on Figure A-15. Water-level profiles for the years 1907, 1918, 1936 and 1944 are shown on Figure A-16, and estimates of changes in groundwater in storage for the basin (as defined by the USGS) are summarized in Table A-2.

Miller and Evenson (1966) revised the water balance of Worts as shown in Table A-3, and refined the estimates of changes in groundwater in storage by utilizing the subdivisions of the basin as discussed above. Water-level contours for 1959 are shown on Figure A-17, and the refinements to estimates of groundwater in storage are shown on Table A-3.

3. Santa Barbara County Water Agency Estimates

Update of the change in storage in the Santa Maria Basin prepared by the Santa Barbara County Water Agency (1977, p. 9) and their revised water balance (p. 33) are shown in Table A-4. Water–level contours for 1959 are shown on Figure A-18

The County of Santa Barbara currently (Guzman, 1987) estimates a gross overdraft (i.e., for pumpage and not adjusted for return waters) of 21,000 AFY and total pumpage of 131,000 AFY of which 84% is for agricultural use. These values indicate the current estimate of average annual supply is approximately 110,000 AFY.

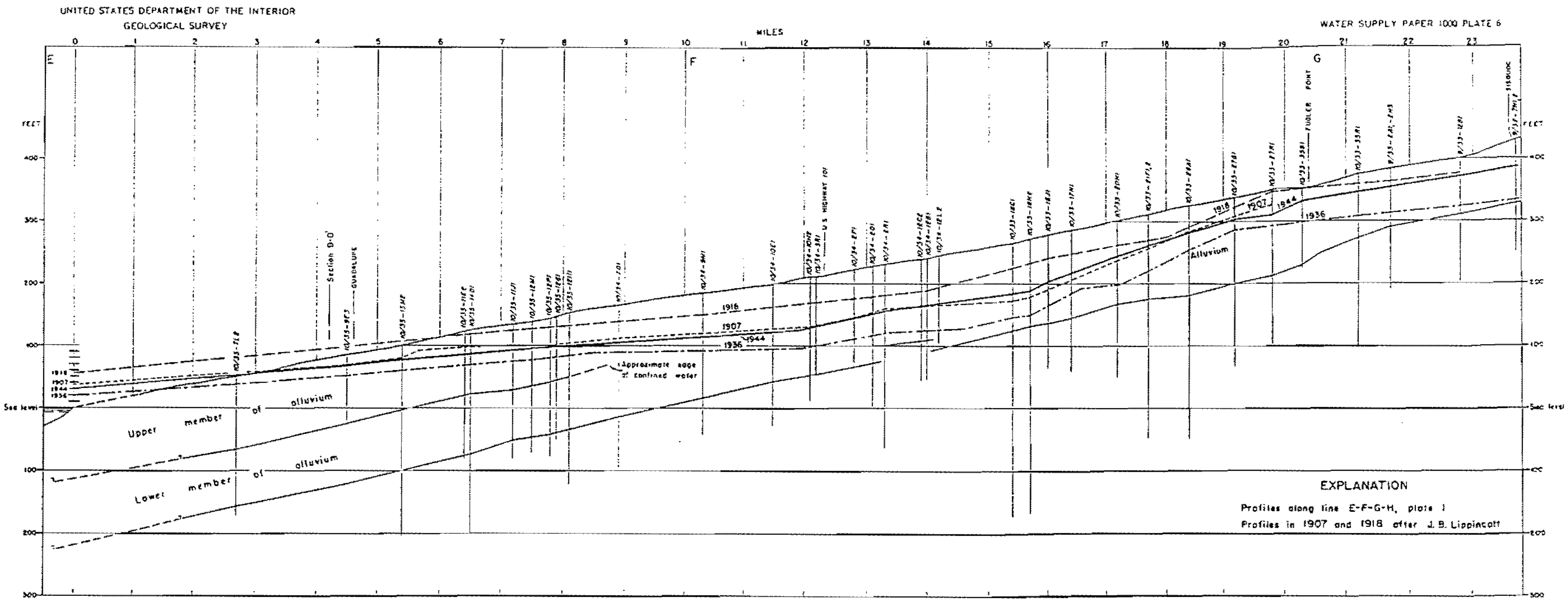


MAP OF THE SANTA MARIA VALLEY AREA SHOWING WATER-LEVEL CONTOURS FOR THE MAIN BODY IN 1939 AND 1942; THE AREA OF CONFINED WATER; THE EASTERN LIMIT OF FLOWING WELLS, AND REPORTED AREAS OF GROUND-WATER OVERFLOW

Figure A-15

WATER-LEVEL CONTOURS SANTA MARIA BASIN, 1939 & 1942

(from Worts, 1951)



WATER-LEVEL PROFILES FOR THE MAIN WATER BODY IN 1907, 1918, 1936, AND 1944

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Figure A-16

WATER-LEVEL PROFILES
SANTA MARIA BASIN, 1907, 1918,1936 & 1944

(from Worts, 1951)

(Profiles are along the Santa Maria River)

#6

Table A-2

CHANGES IN GROUNDWATER IN STORAGE ESTIMATED BY WORTS IN 1951

Change in Storage

	Period		
	1929-36	1936-45	1929-45
By use of Specific Yield Method:			
Average net rise (+) or decline (-) of water levels (ft.):			
Sisquoc plain [1]	-16	+30	+14
Santa Maria plain [2]	-20	+25	+5
Orcutt, Nipomo and minor uplands	-12	+10	-2
Net increase (+) or decrease (-) in storage (acre-feet):			
Sisquoc plain [1]	-76,000	+143,000	+67,000
Santa Maria plain [2]	-29,000	+37,000	+8,000
Orcutt, Nipomo and minor uplands	-95,000	+80,000	-15,000
Totals:	-200,000	+260,000	+60,000

Water Balance

	1929-36	1936-45	1929-45
Total recharge (acre-feet)	235,000	886,500	1,121,500
Total discharge (acre-feet)	394,000	622,200	1,016,200
Net change in storage (acre-feet)	-159,000	+264,300	+105,300
Difference in methods (acre-feet)	41,000	4,300	45,000

Notes:

1 Sisquoc plain includes the terrace to the north and part of the Santa Maria plain 0 to 10 miles west of Fugler Point.

2 Part of Santa Maria plain 10 to 13 miles west of Fugler Point.

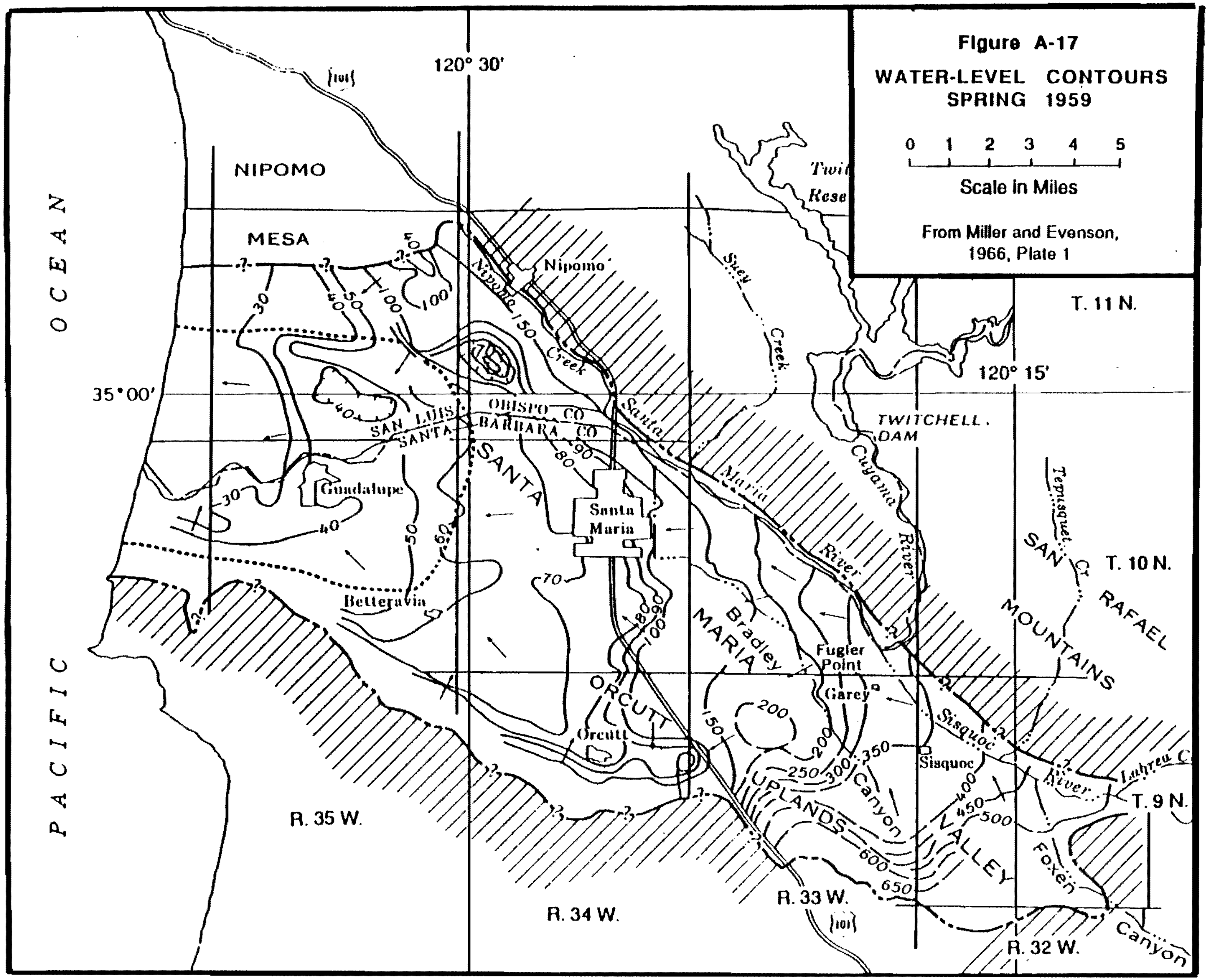

Figure A-17

WATER-LEVEL CONTOURS SPRING 1959

0 1 2 3 4 5

Scale in Miles

From Miller and Evenson, 1966, Plate 1

Table A-3

CHANGES IN GROUNDWATER IN STORAGE
ESTIMATED BY MILLER AND EVENSON, 1966

Change in Storage

Storage Unit	Surface area (feet)	Average saturated thickness of full reservoir below 1918 levels (feet)	Specific yield (percent)	Number of well logs	Estimated groundwater in storage (acre-feet) 1918	1950	1959
Guadalupe	25,000	70	13	161	235,000	171,000	145,000
Nipomo	10,500	160	15	10	250,000	160,000	140,000
Betteravia	6,100	120	12	26	82,000	65,000	47,000
Santa Maria	17,400	160	20, 15	161	540,000	292,000	265,000
Fugler Point	5,500	260	20, 13	61	230,000	153,000	170,000
Orcutt	16,200	180	15	93	460,000	277,000	290,000
Bradley Canyon	22,000	340	14	41	1,020,000	992,000	900,000
Sisquoc	4,280	380	21, 14	37	255,000	252,000	250,000
Totals:	107,000				3,070,000	2,360,000	2,210,000
				Change in storage:	-710,000		-150,000
				Average annual change in storage:	-21,000		-17,000 (4)

Water Balance

		Period 1919-59	1951-59
Average annual recharge (acre-feet)			
Seepage loss from streams		39,000	41,000
Infiltration of rain		8,200	11,000
	Total:	47,000	52,000 (1)
Average annual discharge (acre-feet)		1918-58	1950-58
Underflow to ocean		11,000	8,000
Net pumpage:			
Irrigation		53,000	87,000
Other uses		6,000	8,900
	Total:	70,000	104,000 (2)
Equation balance (acre-feet)		1918-59	1950-59
Recharge minus discharge (1-2)		-23,000	-52,000 (3)
Average annual discrepancy in hydraulic equation (3-4)		2,000	35,000

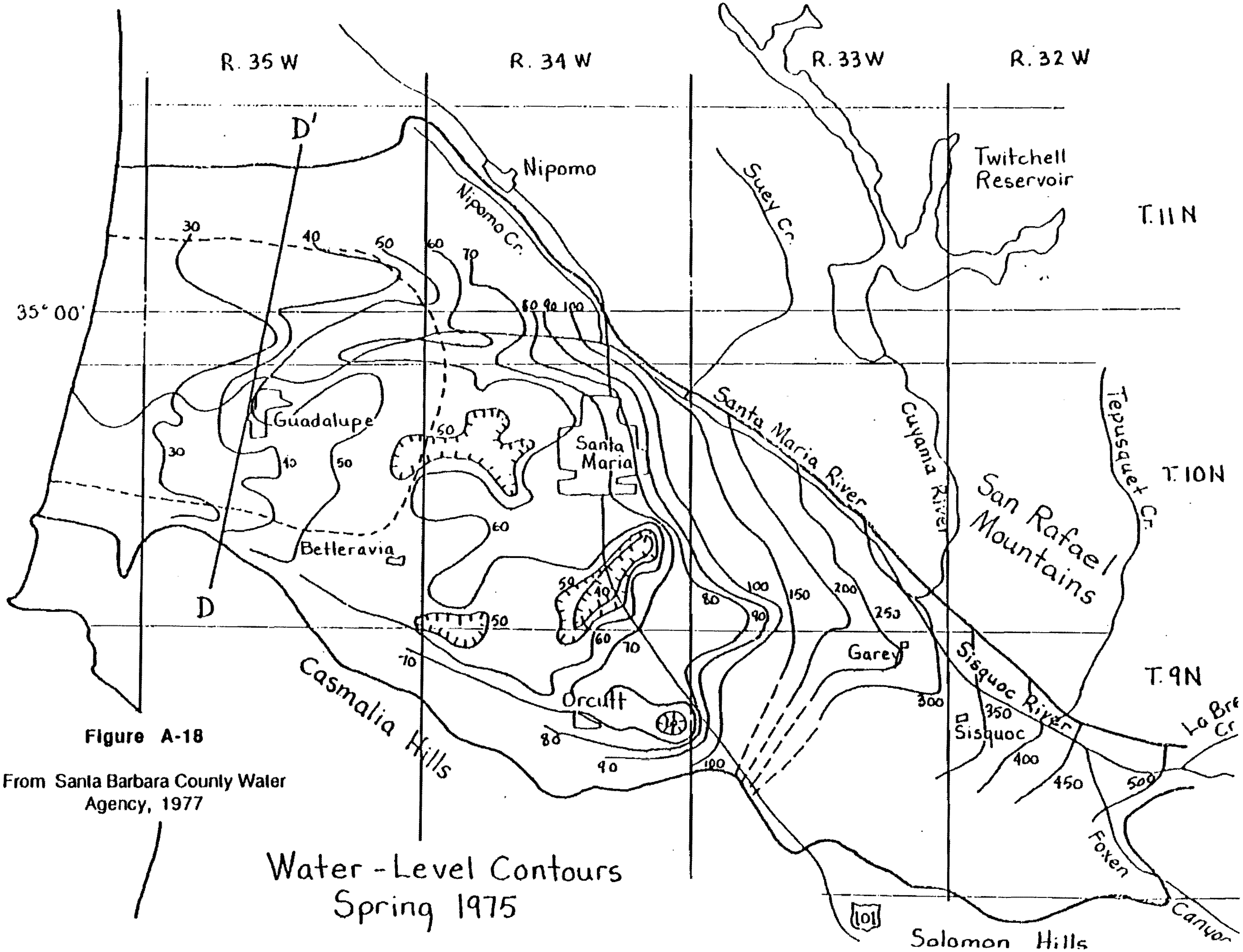

Figure A-18

From Santa Barbara County Water Agency, 1977

Table A-4

CHANGES IN GROUNDWATER IN STORAGE ESTIMATED BY THE SANTA BARBARA COUNTY WATER AGENCY 1977

Change in Storage

Storage Unit	Surface area (feet)	Estimated groundwater in storage (acre-feet) 1959	1975
Guadalupe	25,000	145,000	145,000
Nipomo	10,500	140,000	140,000
Betteravia	6,100	47,000	43,000
Santa Maria	17,400	265,000	223,000
Fugler Point	5,500	170,000	170,000
Orcutt	16,200	290,000	238,000
Bradley Canyon	22,000	900,000	855,000
Sisquoc	4,280	250,000	240,000
Totals:	107,000	2,210,000	2,054,000

Dewatered Storage (Acre-Feet)

	1950-159	1959-75	1918-75
Net	150,000	160,000	1,020,000
Average Annual	17,000	10,000	18,000

Water Balance

	1935-72	1959-75	1975	2000
Average Annual Supply (AF):				
Stream seepage:				
Gaged	55,500	60,750	68,100	68,100
Ungaged	1,500	1,300	1,500	1,500
Subsurface Inflow	1,500	1,300	1,500	1,500
Rainfall Infiltration	8,700	4,800	10,700	11,000
Totals:	67,200	68,150	81,800	82,100
Average Annual Disposal (AF):				
Subsurface Outflow	9,000	7,000	6,000	4,000
Net Pumpage:				
Municipal and Industrial	8,000	9,300	13,250	17,500
Agriculture	61,200	61,700	82,700	90,000
Totals:	78,200	78,000	101,950	111,500
Supply minus Disposal	-11,000	-9,850	-20,150	-29,000
Average Annual Change in Storage	-6,700	-10,000		

C. Groundwater in Storage in San Luis Obispo County Subareas

1. Department of Water Resources Estimate

Estimates of groundwater in storage in subareas in the San Luis Obispo County portion of the Santa Maria Basin developed by the Department of Water Resources (1979, p. 30) are summarized in Table A-5 below, and water level contours are shown on Figure A-19.

Table A-5

GROUNDWATER IN STORAGE IN SUBAREAS OF THE SANTA MARIA BASIN IN SAN LUIS OBISPO COUNTY ESTIMATED BY THE DEPARTMENT OF WATER RESOURCES, 1979

Change in Storage

Subarea	Area (Acres)	Average Specific Yield (%)	Storage Above Sea Level (AF) 1965	1967	1970	1975
Arroyo Grande and Tri-Cities Mesa	7,200	11.25	2,700	—	8,400	8,500
Nipomo Mesa	21,000	14.00	—	194,000	—	172,000
Santa Maria (San Luis Obispo Co.)	18,000	15.00	---	48,400	---	45,600

Water Balance

	Subarea: Arroyo Grande & Tri-Cities Mesa	Nipomo Mesa	Santa Maria Valley (SLO)
Category of Inflow (AFY):			
Deep percolation of precipitation	2,400	3,300	8,000
Subsurface seepage	720	500	19,500
Infiltration in Arroyo Grande Creek	2,000-3,000	---	—
Irrigation and urban return water	2,200	1,000	9,000
Totals:	7,320-8,320	4,800	36,500
Category of Outflow (AFY):			
Applied irrigation	5,300	2,000	29,000
Urban supply	600	300	—
Industry cooling water	—	650	---
Subsurface outflow	200	3,300	8,000
Totals:	6,100	6,250	37,000
Inflow minus Outflow	1,220-2,220	-1,450	-500
Average annual Change in Storage (from tabulation above)	580	-2,750	-350

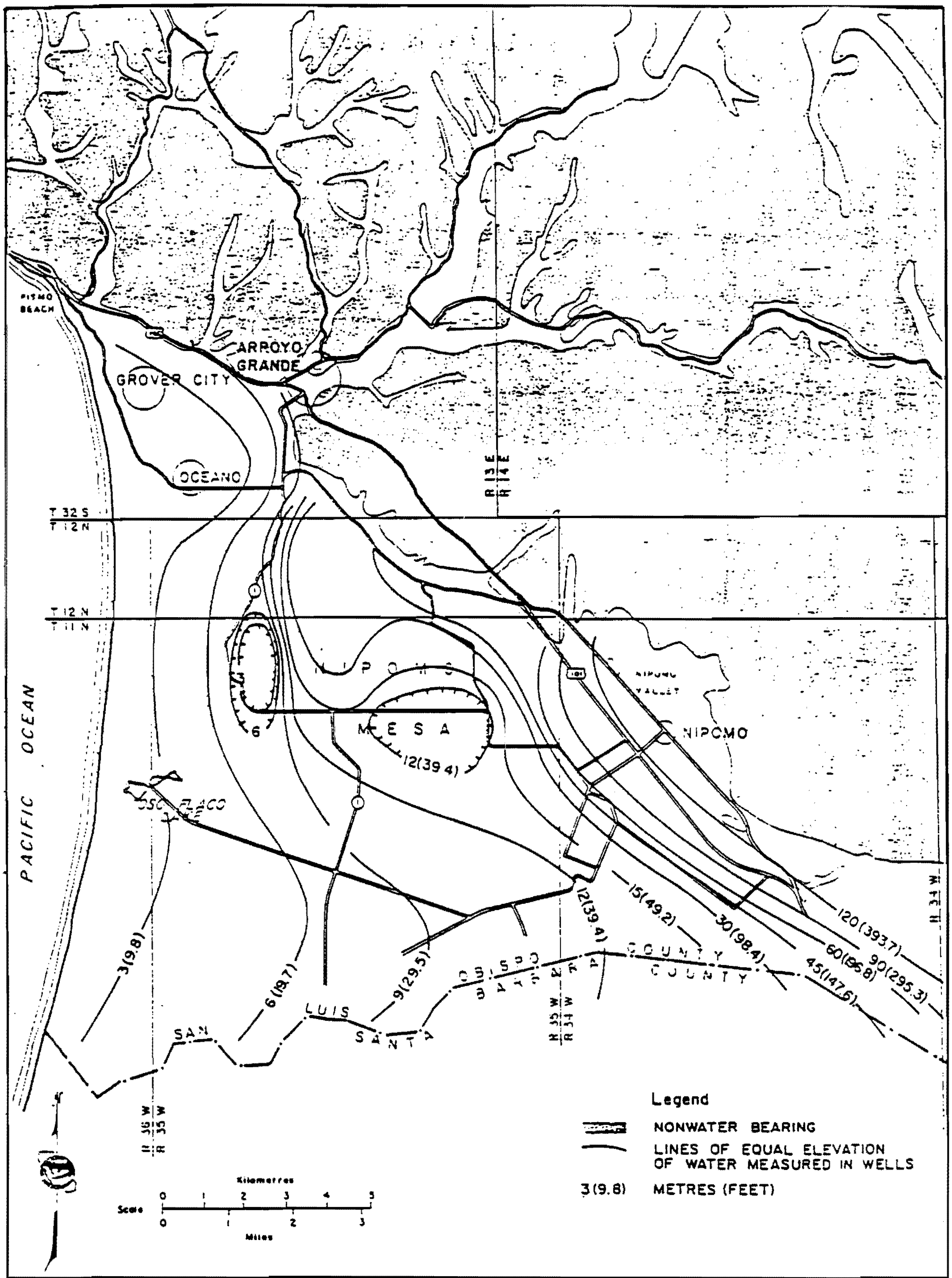

Figure A-19 - WATER LEVELS, FALL 1975

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1979

2. Lawrence, Fisk and McFarland Estimates

Lawrence, Fisk and McFarland (LFM) in their recent review of water resources of the Nipomo Mesa (1987) have estimated change in storage (Appendix A) and revised the water balance (p. II-20) for this subarea as shown in Table A-6 below.

Table A-6

CHANGES IN GROUNDWATER IN STORAGE FOR THE NIPOMO MESA SUBAREA OF THE SANTA MARIA BASIN
(Lawrence, Fisk and McFarland, 1987)

Change in Storage, 1975-1985

Map Reference (Figure A-20)	Average Change (ft.)	Area (acres)	Specific Yield (%)	Net Change (AFY)
1	2.8	1,570	14	+640
2	-2.1	660	14	-195
3	+6.1	710	14	+610
4	+29	650	14	+2,650
5	+11.9	1,660	14	+2,780
6	26.4	650	14	+2,400
7	-9.3	900	14	-1,170
8	2.0	2,150	14	+620
9	-5.7	3,140	14	-2,500
10	-0.4	1,950	14	-110
11	-7.7	1,180	14	-1,270
12	-8.3	1,520	14	-1,760
13	-37.2	550	14	-2,870
14	-6.4	120	14	-110
15	+7.2	1,250	14	+1,180
16	+2.4	1,350	14	+450
Totals:		19,990		+1,185

Water Balance, 1987 Conditions

Category of Inflow (AFY):		
Deep percolation of precipitation		3,510
Subsurface seepage		500
Irrigation and urban water return		1,160
Allowances for pipeline leakage		150
	Total:	5,320
Category of Outflow (AFY):		
Applied irrigation (agr. and Black Lake golf course)		2,430
Major water purveyor pumpage		1,600
Small public water systems pumpage		270
Private well pumpage		850
UNOCAL Refinery		1,320
Subsurface outflow to ocean		260
Subsurface outflow to adjacent sub-basins		2,790
	Total:	9,520
Balance (Deficit)		(4,200)

LAWRANCE, FISK & McFARLAND, INC.
314 East Carrillo, Suite 1
SANTA BARBARA, CALIFORNIA 93101
(805) 564-2441

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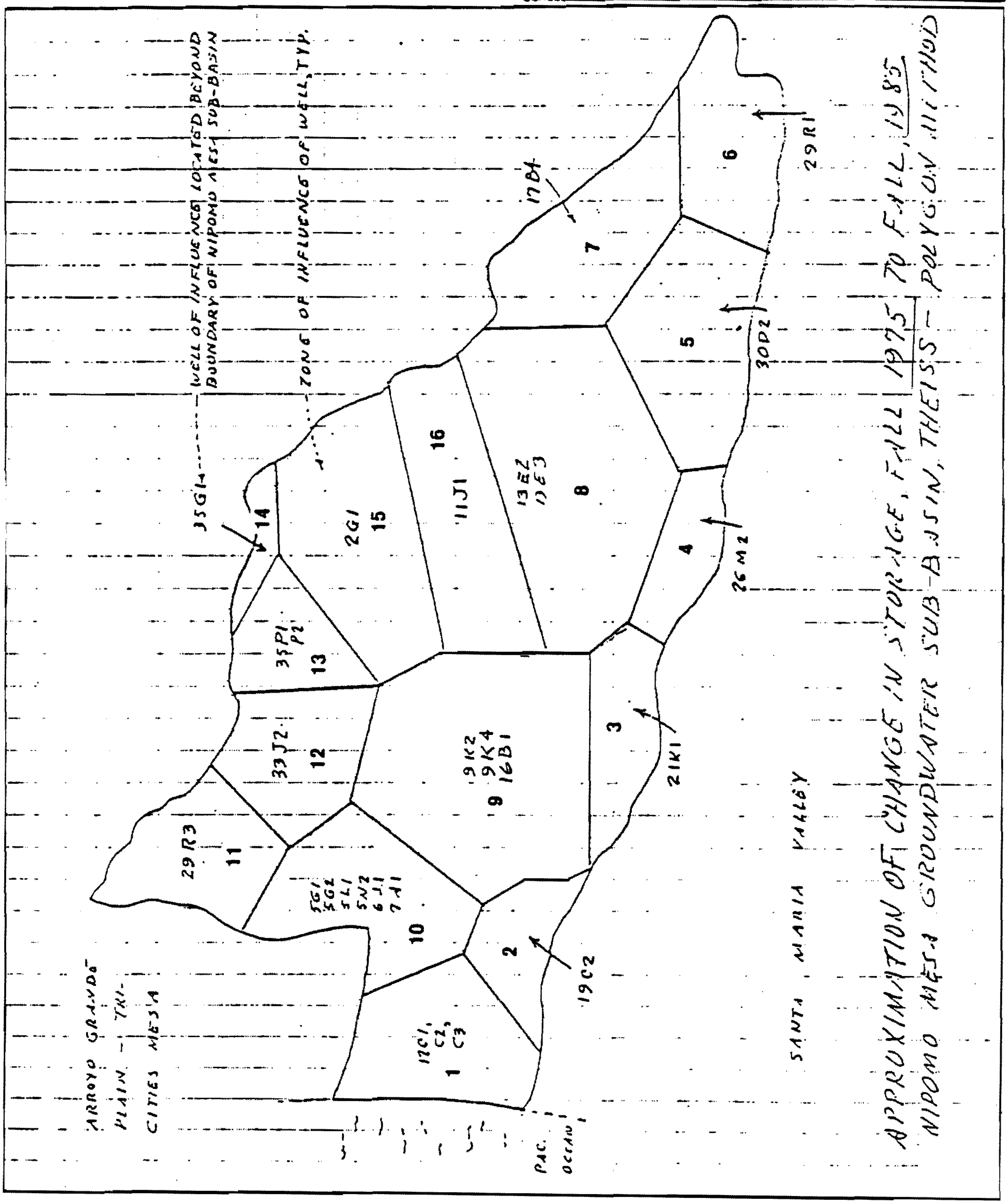


3. County Estimate

The County Planning Department has developed the water balance shown below by updating the 1979 estimate of the Department of Water Resources utilizing primarily data prepared by LFM and recommended by the County Engineering Department. This water balance is included in the hearing draft of the proposed update of the South County General Plan as Appendix C.

Table A-7

HYDROLOGIC EQUATION FOR THE NIPOMO MESA SUB-UNIT OF THE ARROYO GRANDE GROUNDWATER BASIN

San Luis Obispo County Planning Department
1987 Conditions

INFLOW (AFY)		
Deep percolation of precipitation		3,300
Subsurface seepage		500
Irrigation return		960
domestic return (60% of domestic pumpage)		1,330
	Total:	6,090
OUTFLOW (AFY)		
Agricultural pumpage		3,310
Domestic pumpage		2,220
Industrial pumpage (UNOCAL cooling water)		1,310
Outflow to Arroyo Grande Valley		300
Outflow to Santa Maria Valley		2,800
Outflow to the ocean		350
	Total:	10,290
DIFFERENCE BETWEEN THE INFLOW AND OUTFLOW		
	OUTFLOW	10,290
	INFLOW	6,090
	OVERDRAFT	4,200

In the table above, the terminology of the authors is retained. However, we should note that we disagree with the term "Arroyo Grande Groundwater Basin", and the assumption that a deficit in a water balance necessarily indicates an overdraft condition.

D. Summary of Changes in Groundwater in Storage

Estimates of changes in storage (above sea level) for the total Santa Maria Groundwater Basin (USGS definition) and subunits and storage units in the northern part of the basin for the period 1918 to 1975 are plotted on Figure A-21. It should be emphasized that these are average trends between the years noted, and that the plots do not necessarily represent steady rates of decline.

The basin as a whole has declined 33% from approximately 3 million acre-feet of groundwater in storage above sea level to approximately 2 million acre-feet in the 57-year period. During this same period, the Nipomo storage unit declined 44% from 250,000 acre-feet to 140,000 acre feet. The Santa Maria storage unit declined 59% during this period, while the decline in the Guadalupe storage unit was similar to that in the Nipomo storage unit. The average rates of decline in the basin and in these three storage units have been less since approximately 1959 than in the period before.

The estimates of changes in groundwater in storage in the Nipomo Mesa subunit and the Santa Maria Valley subarea by DWR between 1967 and 1975 are also shown. These changes differ from those of the Santa Barbara County Water Agency in that DWR shows Nipomo Mesa as declining while the Water Agency shows it as unchanged. Also, DWR shows the San Luis Obispo portion of the Santa Maria Valley as steady while the Water Agency shows the Santa Maria storage unit in decline.

The LFM estimate of the change in groundwater in storage in the Nipomo Mesa subarea is shown as a slight increase over the DWR estimate for 1975.

The information shown on Figure A-21 should be taken as providing general trends in the reductions of groundwater in storage in the basin as a whole and its subdivisions. This trend is generaly one of a "leveling off" of reductions in storage. The reasons for this are not clear. The implementation of Twitchell Reservoir as a groundwater recharge project may have been a significant influence.

E. Recent Conditions

Figure A-22 shows groundwater levels in the Santa Maria Basin for 1975, the most recent available mapping. This map has been generated by combining the DWR map for fall, 1975 (Figure A-19) with the Santa Barbara County Water Agency map for spring, 1975, and smoothing the contours to eliminate the complexities of local pumping depressions. This process introduces local errors, generally in the range of 5-10 feet. However, the contours are considered reasonably accurate in depicting regional relationships which is the purpose of this map.

Figure A-23 shows groundwater levels on the cross sections of Figure A-9. Groundwater in storage above sea level is emphasized because it represents the degree to which a lowering of levels can be tolerated without introducing a condition of potential seawater intrusion (i.e., an overdraft). It should be noted that groundwater levels in the Nipomo Mesa subarea are much higher than those in adjacent Santa Maria subarea at equivalent distances from the ocean.

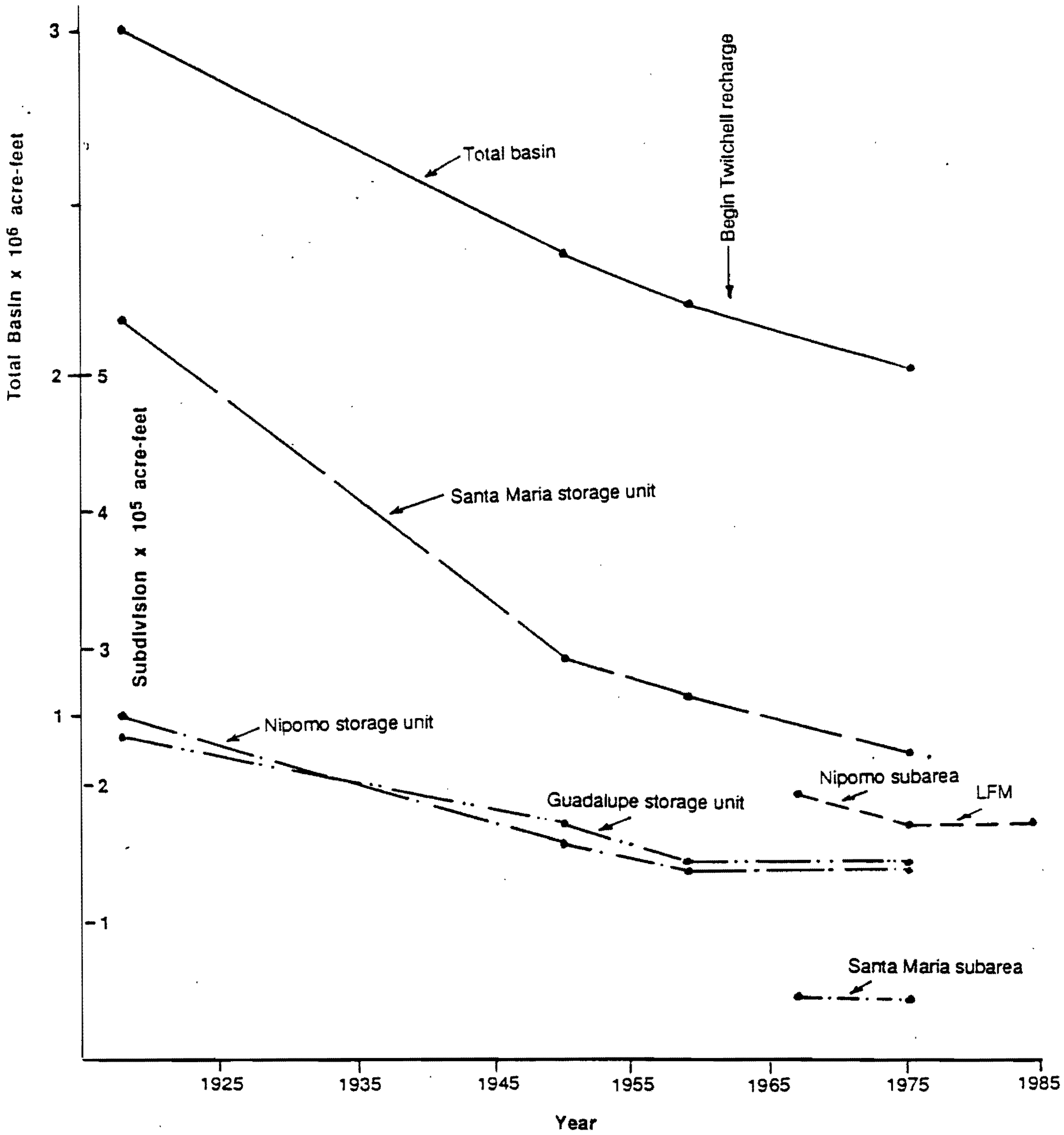
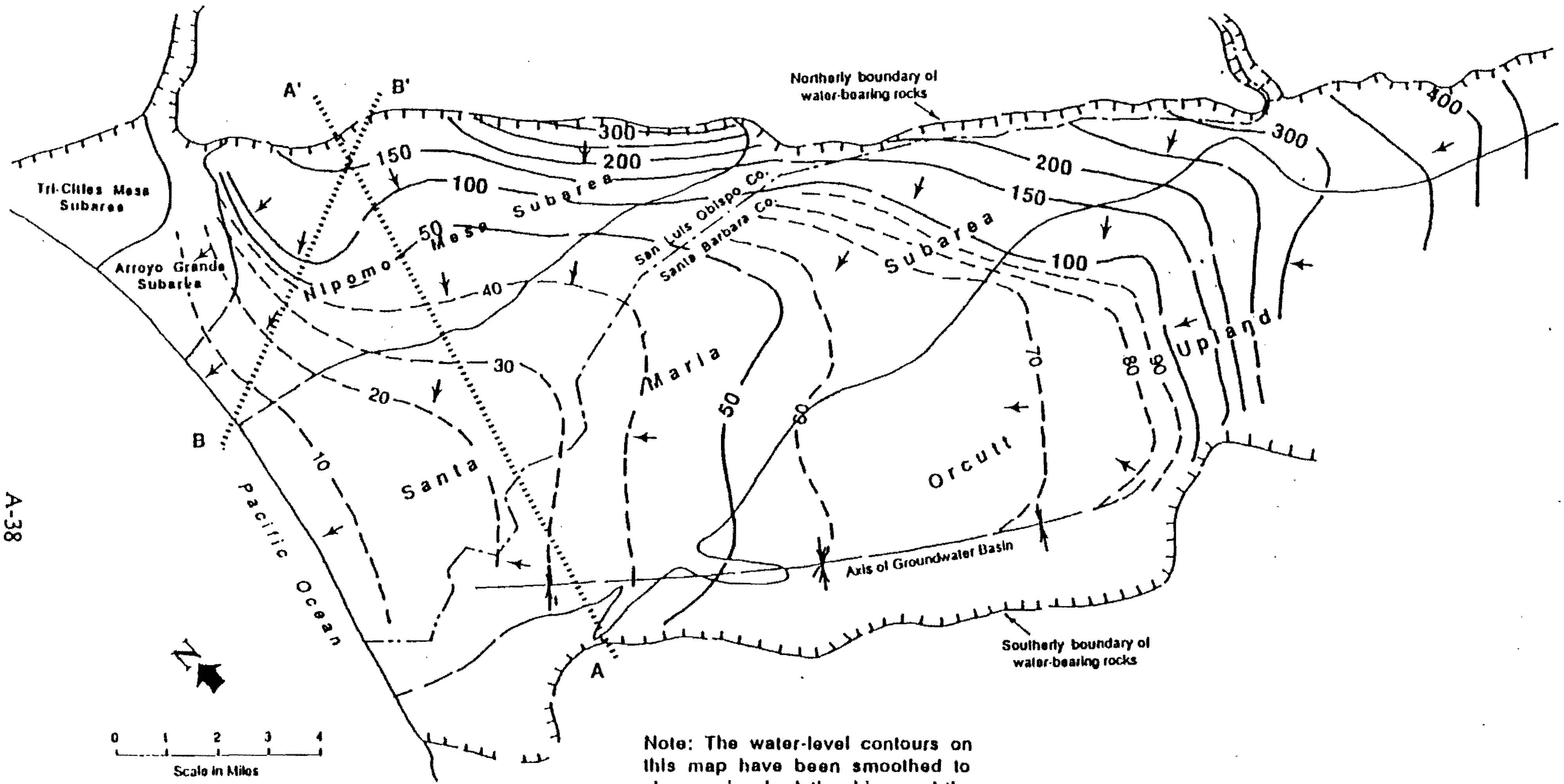


Figure A-21

CHANGES IN GROUNDWATER IN STORAGE ABOVE SEA LEVEL FOR THE SANTA MARIA BASIN AND ITS SUBDIVISIONS



Note: The water-level contours on this map have been smoothed to show regional relationships, and the effects of local pumping depressions are not shown.

Figure A-22

GROUNDWATER LEVELS IN THE SANTA MARIA BASIN, 1975

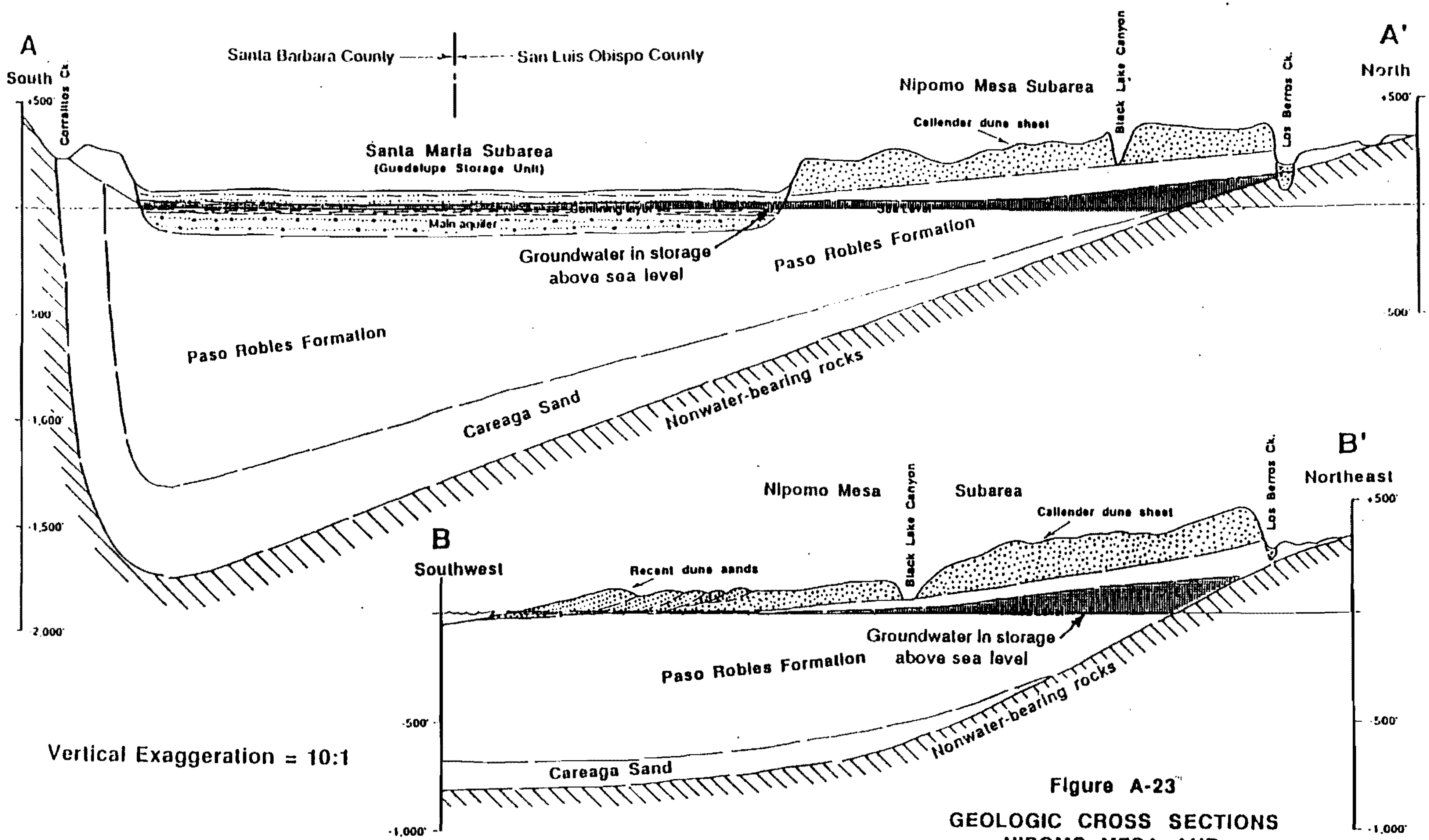


Figure A-23

GEOLOGIC CROSS SECTIONS NIPOMO MESA AND ADJACENT PARTS OF THE SANTA MARIA GROUNDWATER BASIN SHOWING GROUNDWATER LEVELS

1975

(See Figure A-22 for locations of sections)

IV. DISCUSSION OF ISSUES

A. Terminology

The term, "Arroyo Grande Groundwater Basin", appears from time to time in documents prepared by the County and some cities in the County. The Department of Water Resources did not use this term in their study of the area, and it has apparently been coined by others. Based on geologic and hydrologic relationships developed in previous sections of this report, the water-bearing rocks in the Arroyo Grande area are part of the northeast flank of the Santa Maria Groundwater Basin, rather than being a separate basin.

While proper terminology is not the most important issue addressed herein, we believe that use of this term may convey to the decision-maker that the water-bearing rocks in the San Luis Obispo County portion of the Santa Maria Groundwater Basin can be treated separately from the basin as a whole. This may erroneously affect consideration of more important issues, and we believe that use of this term should be discontinued.

The term, "Nipomo Mesa Subbasin" appears occasionally in reports on the Arroyo Grande or Nipomo areas. This term also was not used by DWR as discussed previously in this report. Its use has the same problems as "Arroyo Grande Groundwater Basin", but the implications are not as strong. We suggest that use of this term also be discontinued.

B. Overdraft in the Nipomo Mesa Subunit

1. Definitions

The term "overdraft" can be defined in various ways, but, in simple terms, it is withdrawal of groundwater in excess of safe yield or perennial yield. Safe yield or perennial yield, in turn, have numerous definitions, most of which can be reduced to: "The amount of ground water one can withdraw without getting into trouble" (Lohman, 1972, p. 62). "Trouble" may mean any undesirable effect such as running out of water, inducing encroachment of salt water, or depleting the flow of a nearby stream. Avoiding or finding solutions to such "troubles" is a highly complex problem. Lohman (1972) suggests:

> "The modern approach is for the hydrologist to acquire sufficient detail concerning the combined ground- and surface-water system so aquifer response can be predicted by electsic-analog or mathematical models. Then management, such as state or local water-conservation agencies, within the framework of prevailing laws or regulations, may test the response of the system to various assumed stresses and thereby select the most desirable or equitable distribution of available water. Thus the role of the hydrologist is to gather and present the facts; the water manager determines who shall have how much water and from what source."

This report is intended to summarize the hydrologic information that is available for the Nipomo Mesa subarea for use by the "manager" in determining "who shall have how much water and from what source."

2. Changes in Groundwater in Storage

a) Natural Outflow

The use of the term "overdraft" in the Area Plan is apparently based on the determination that outflow exceeds inflow in the water balance, and that the Nipomo Mesa subarea ("Arroyo Grande Groundwater Basin") is in a state of overdraft. As noted above, "overdraft" is a "trouble term", and a decline in groundwater levels does not necessarily mean that a condition of overdraft exists, or that it will result from existing levels of extraction.

It is important to note that coastal groundwater basins are dynamic systems in which groundwater levels within a basin are the result of a balance between inflow (recharge) and outflow to the ocean or to adjacent portions of the basin. Prior to man's use of this resource, the Nipomo Mesa subarea was in a state of balance in which inflow equaled outflow and groundwater levels were at maximum levels. Man's first use of this resource probably reduced groundwater levels to some extent, and further reductions in both water levels and outflow probably resulted from increased use.

The present status of the balance between natural inflow and outflow as included in the Planning Department's water balance is that recharge (deep percolation of precipitation and subsurface seepage) totals 3,800 acre-feet/year while outflow to the sea to preclude saltwater intrusion, and outflow to adjacent subareas, totals 3,450 acre-feet/year. This change represents a decline from maximum, natural recharge conditions of only 10%.

b) Changes in Storage

DWR (1979, p. 32) estimates an average reduction in groundwater in storage between 1967 and 1975 of 2,750 AFY, but notes that there were interim fluctuations "according to the amount of rainfall". LFM (1987) estimates an increase in groundwater in storage from 1975 to 1985 of 1,185 AF (Table A-6 of this report) or an average increase of 118 AFY. However, LFM also estimates an average deficit of 4,200 AFY based on their water balance (Table A-6 of this report), and (p. II-22), and the apparent increase in storage is attributed to a "series of above-average rainfall years".

c) Rainfall Patterns

Monthly rainfall for the City of Santa Maria for the period 1886-1985 (water years) as kept by the Santa Barbara County Flood Control District (SBCFCD) is included here as Table A-8, and the cumulative departure from average annual rainfall prepared by SBCFCD is reproduced as Figure A-20. On this plot, "wet periods" are those during which the curve is generally trending upward, and "dry periods" are those during which the curve is trending downward. Rainfall conditions for periods beginning in 1919 are as follows:

Period	Rainfall Condition
1919-1935	Dry
1935-1945	Wet
1945-1977	Dry
1977-1985	Slightly wet

Table A-8

RAINFALL AT SANTA MARIA

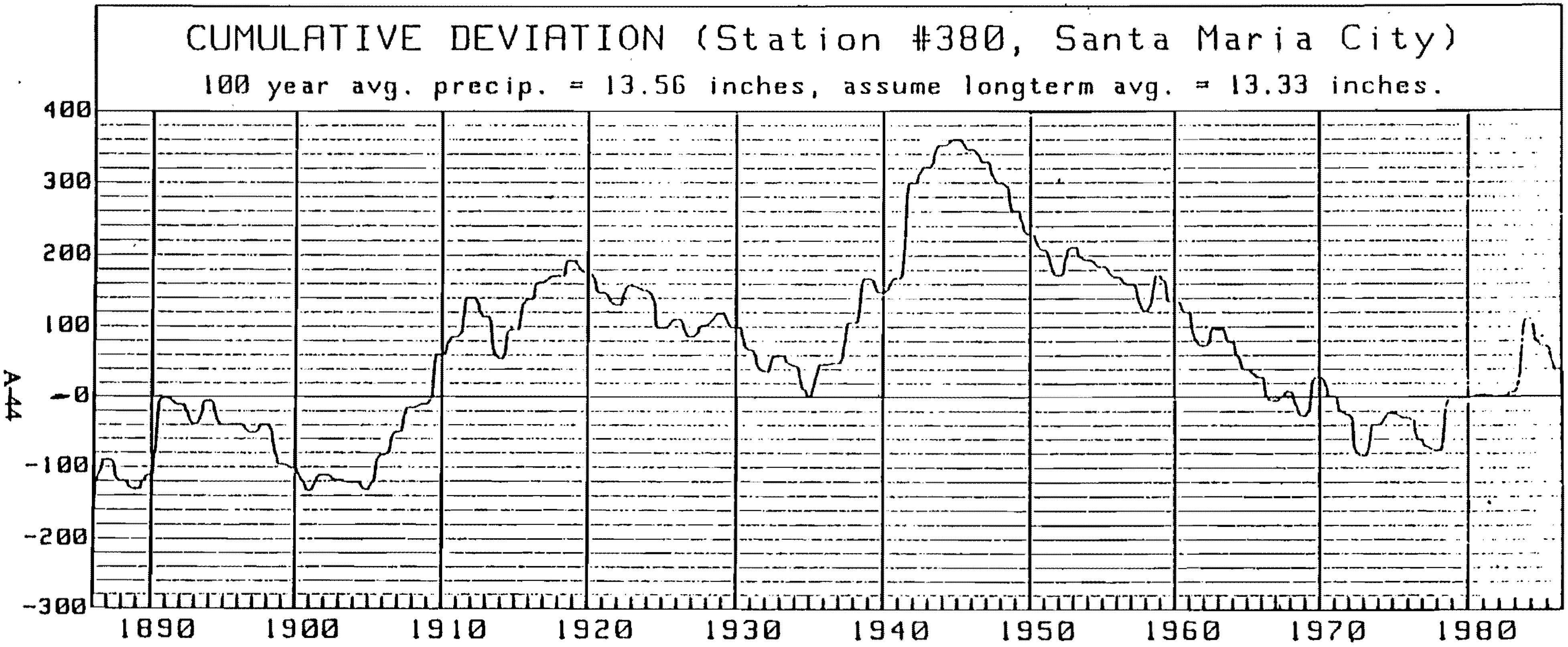
SANTA MARIA RAINFALL (Station #380. Santa Maria City)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1885-86	0.00	8.80	1.60	1.83	.97	2.55	3.37	0.00	0.00	0.00	0.00	0.00	19.12
1886-87	.06	.59	.72	.50	5.95	.25	1.07	.22	0.00	0.00	0.00	.30	9.66
1887-88	.40	1.09	2.69	4.62	.43	1.98	.12	.14	0.00	0.00	0.00	0.00	11.47
1888-89	0.00	2.59	5.86	.42	1.35	4.20	.97	.60	.05	0.00	0.00	0.00	16.04
1889-90	7.53	1.80	6.71	7.02	3.64	.88	.10	.13	0.00	.06	0.00	.55	28.42
1890-91	.70	.70	3.40	.63	3.57	.71	1.58	.20	0.00	0.00	0.00	.03	11.52
1891-92	0.00	.33	2.77	.56	2.18	2.36	.45	1.15	0.00	0.00	0.00	0.00	9.80
1892-93	.35	1.95	2.52	2.08	3.10	6.84	.80	.05	0.00	0.00	0.00	0.00	17.69
1893-94	.65	.22	2.95	1.16	1.78	.62	.25	.73	.16	.06	0.00	1.05	9.63
1894-95	.68	.07	3.86	4.43	1.22	1.25	.53	.51	0.00	0.00	0.00	.01	12.56
1895-96	.65	1.26	.60	4.60	0.00	2.59	1.77	.03	0.00	.11	.03	.02	11.66
1896-97	.60	1.82	2.34	3.55	4.00	2.52	.14	.01	0.00	.03	0.00	.10	15.11
1897-98	.67	.03	.55	1.44	1.06	.65	.02	1.14	0.00	0.00	0.00	.96	6.52
1898-99	.30	.05	.64	3.49	.46	4.88	.99	.75	0.00	0.00	0.00	0.00	11.56
1899-00	1.86	1.21	.89	.87	.05	1.41	.97	1.97	0.00	0.00	0.00	0.00	9.23
1900-01	.65	5.40	.35	4.51	3.17	.25	1.82	.13	0.00	0.00	0.00	.12	16.40
1901-02	1.60	.56	.01	1.73	4.03	2.37	1.70	.20	0.00	0.00	0.00	0.00	12.20
1902-03	1.02	2.59	.79	1.80	1.91	3.97	.71	0.00	0.00	0.00	0.00	0.00	12.79
1903-04	0.00	.19	.16	.55	5.39	3.06	1.73	.10	0.00	0.00	.86	2.55	14.59
1904-05	1.25	.03	1.55	1.65	5.83	4.46	.69	1.58	0.00	.02	0.00	.07	17.33
1905-06	.15	1.37	.31	2.64	3.40	6.94	.55	2.39	.02	0.00	.01	.01	17.79
1906-07	0.00	.63	4.35	7.78	1.02	3.95	.23	0.00	.04	0.00	0.00	.06	18.06
1907-08	3.57	0.00	1.80	3.98	3.76	.35	.26	.18	0.00	0.00	0.00	1.03	14.97
1908-09	.52	.97	.61	10.31	4.98	4.39	0.00	0.00	0.00	0.00	0.00	0.00	21.78
1909-10	.75	2.14	5.89	3.47	.50	3.82	.01	0.00	0.00	0.00	0.00	.65	17.23
1910-11	.72	.15	.45	6.42	3.80	6.68	1.82	0.00	0.00	0.00	0.00	0.00	20.04
1911-12	0.00	0.00	1.77	1.34	.10	4.13	.69	1.60	0.00	0.00	0.00	0.00	9.63
1912-13	0.00	.40	.20	2.20	1.27	.63	.42	0.00	.34	0.00	0.00	0.00	5.46
1913-14	1.00	2.45	2.95	9.36	2.20	.90	0.00	0.00	0.00	0.00	0.00	0.00	18.86
1914-15	0.00	0.00	5.40	4.05	6.31	.54	1.11	1.52	0.00	0.00	0.00	0.00	18.93
1915-16	0.00	.60	3.31	8.95	2.12	1.49	.19	0.00	0.00	0.00	0.00	2.51	19.17
1916-17	1.92	.52	4.15	2.53	2.01	.50	.11	.23	0.00	0.00	0.00	0.00	11.97
1917-18	.09	0.00	.31	.53	9.39	5.87	0.00	0.00	0.00	0.00	0.00	0.00	16.19
1918-19	.63	3.55	1.46	.68	2.36	1.57	0.00	.74	0.00	0.00	0.00	.41	11.40
1919-20	0.00	.15	1.88	.24	1.78	4.02	1.12	0.00	0.00	0.00	0.00	0.00	9.19
1920-21	.73	.94	1.24	3.13	1.65	1.57	.32	1.45	.01	0.00	0.00	.44	11.48
1921-22	.05	.13	5.32	4.90	2.97	2.50	.22	.35	0.00	0.00	0.00	0.00	16.44
1922-23	.32	1.34	3.59	1.91	1.06	.18	3.97	.05	.01	.01	0.00	.22	12.66
1923-24	.30	0.00	.62	.64	.46	3.01	1.00	.01	0.00	0.00	.03	.04	6.11
1924-25	.76	.78	1.85	2.56	1.67	3.28	2.34	1.71	.05	.02	.01	.01	15.04
1925-26	.16	.12	1.81	1.72	2.99	.41	2.69	.11	.01	.02	.01	.04	10.08
1926-27	.55	3.37	.91	1.88	5.21	2.10	1.26	.06	.20	.02	.01	.02	15.59
1927-28	3.08	.81	3.80	.22	2.51	3.99	.19	.71	0.00	0.00	.01	.02	15.34
1928-29	.04	2.31	2.16	2.29	1.22	1.61	.94	0.00	.16	0.00	0.00	.01	10.73
1929-30	.02	0.00	.15	3.42	1.18	2.70	.94	.68	.08	0.00	0.00	.16	9.33
1930-31	.02	1.55	0.00	4.16	1.13	.28	.42	.94	.06	.01	.31	.09	8.97
1931-32	.04	2.46	6.56	4.25	2.14	.31	.31	.26	.04	.02	.02	.07	16.48
1932-33	.09	.09	1.31	6.08	.30	.94	.18	.38	1.96	0.00	0.00	.02	11.35
1933-34	.32	.03	2.91	1.11	1.52	.20	0.00	.26	1.30	.01	.01	.01	7.68
1934-35	3.14	2.19	1.78	4.16	1.64	3.11	3.09	0.00	0.00	.01	.26	.17	19.55
1935-36	.50	2.02	1.71	1.31	5.32	1.23	1.06	.13	.03	.02	.01	.14	13.49
1936-37	1.83	0.00	5.69	3.59	4.83	4.65	.22	0.00	0.00	.01	0.00	0.00	20.82
1937-38	.16	.26	2.88	4.72	7.39	4.09	2.01	.04	.02	0.00	.02	.59	22.18
1938-39	.18	.23	1.53	3.25	2.18	2.39	.22	.03	0.00	0.00	0.00	1.50	11.51
1939-40	.46	1.03	1.30	5.41	2.67	1.98	1.74	0.00	0.00	0.00	0.00	.02	14.61
1940-41	.73	.12	5.25	5.04	6.93	8.72	3.86	.07	0.00	.09	.03	.01	30.75
1941-42	1.04	.32	7.50	1.35	1.30	2.04	2.82	.08	0.00	0.00	.02	.02	16.49
1942-43	.82	.24	2.94	7.23	1.27	3.04	1.06	.02	0.00	0.00	0.00	0.00	17.22
1943-44	1.05	.47	3.09	1.32	4.69	1.26	2.46	.11	.01	0.00	0.00	0.00	14.46

Table A-8 (cont.)

RAINFALL AT SANTA MARIA

1944-45	.12	2.26	1.90	.61	2.87	3.27	.11	.04	.11	0.00	.02	0.00	11.31
1945-46	.53	.88	3.11	.50	1.63	4.13	.20	.10	0.00	0.00	0.00	0.00	11.08
1946-47	.24	3.71	1.98	.35	1.10	1.27	.28	.30	.13	0.00	0.00	.06	9.42
1947-48	.58	.04	.29	.06	1.29	3.21	1.89	.81	.03	0.00	0.00	0.00	8.20
1948-49	.08	.01	2.92	1.37	1.29	2.54	.06	.82	0.00	0.00	0.00	0.00	9.09
1949-50	.03	.71	2.78	2.54	1.50	1.37	.73	.15	0.00	.62	0.00	.04	10.47
1950-51	.85	1.50	.88	2.01	1.10	.87	1.36	.01	0.00	0.00	.01	.07	8.66
1951-52	.57	1.17	4.05	5.69	.69	5.30	.42	0.00	.68	0.00	0.00	0.00	18.57
1952-53	.02	2.97	4.73	1.45	0.00	.27	1.23	.12	.07	0.00	0.00	.01	10.87
1953-54	.01	2.34	.29	3.48	1.44	4.20	.33	0.00	.02	.01	0.00	0.00	12.12
1954-55	0.00	.97	2.08	3.95	1.35	.40	1.98	.60	.01	0.00	0.00	0.00	11.34
1955-56	0.00	1.60	4.50	2.84	.64	0.00	1.89	.54	0.00	0.00	0.00	0.00	12.01
1956-57	.61	0.00	.74	2.17	1.95	.79	1.00	.98	.22	0.00	0.00	0.00	8.46
1957-58	1.70	.55	1.78	2.41	4.70	4.25	4.27	.18	0.00	0.00	0.00	1.43	21.27
1958-59	0.00	.30	.13	1.75	4.57	0.00	.23	0.00	0.00	0.00	0.00	0.00	6.98
1959-60	0.00	0.00	.65	3.55	4.13	.85	2.15	0.00	0.00	0.00	0.00	0.00	11.33
1960-61	1.75	2.50	.80	.80	.10	.68	.23	.21	0.00	.02	0.00	.02	7.11
1961-62	0.00	1.63	1.50	2.13	10.08	1.02	.04	.03	.02	0.00	0.00	0.00	16.45
1962-63	.36	0.00	.21	.54	3.75	3.15	2.29	.53	.01	0.00	0.00	.46	11.30
1963-64	1.49	1.92	.19	1.00	0.00	1.70	1.13	.31	.07	0.00	0.00	0.00	7.81
1964-65	1.64	2.41	1.63	.84	.51	1.59	2.87	0.00	0.00	.10	.12	0.00	11.71
1965-66	0.00	4.34	2.37	.95	.80	.26	.03	0.00	.14	0.00	0.00	.22	9.11
1966-67	0.00	2.10	2.88	2.90	.39	2.57	3.68	.21	.26	0.00	0.00	.36	15.35
1967-68	0.00	2.78	1.35	.63	.91	2.03	.51	.04	0.00	0.00	0.00	0.00	8.25
1968-69	1.95	1.05	1.58	7.47	6.92	.45	1.36	0.00	0.00	0.00	0.00	.06	20.84
1969-70	.33	.98	.53	2.65	.42	4.64	.04	0.00	0.00	0.00	0.00	0.00	9.59
1970-71	0.00	3.45	3.46	.77	.09	.25	1.02	.74	0.00	0.00	0.00	.04	9.82
1971-72	.38	.64	3.37	.19	.45	0.00	.26	.16	0.00	0.00	0.00	0.00	5.45
1972-73	.53	3.56	1.73	4.92	5.44	3.20	0.00	.05	0.00	0.00	0.00	.16	19.59
1973-74	.64	2.50	2.36	3.90	.15	4.78	.88	0.00	0.00	0.00	0.00	0.00	15.21
1974-75	1.87	.13	4.05	.04	3.22	2.39	.75	0.00	0.00	0.00	0.00	0.00	12.45
1975-76	.72	.15	.06	0.00	4.47	.61	1.25	0.00	.02	.02	1.20	3.47	11.97
1976-77	1.37	.32	.55	2.48	.02	1.59	.05	2.09	0.00	0.00	0.00	.04	8.51
1977-78	0.00	.13	3.94	4.94	7.30	4.62	1.98	0.00	0.00	0.00	0.00	1.55	24.46
1978-79	0.00	1.10	1.29	4.02	3.04	2.65	.16	.07	0.00	0.00	0.00	.18	12.51
1979-80	.45	.21	.98	4.19	5.08	2.14	.46	.28	0.00	0.00	0.00	0.00	13.79
1980-81	0.00	0.00	1.19	3.57	3.79	3.77	.49	0.00	0.00	0.00	0.00	0.00	12.81
1981-82	.90	1.26	.85	2.90	1.27	5.04	1.76	0.00	.23	0.00	.07	.59	14.87
1982-83	1.27	3.67	1.21	5.52	5.43	3.82	2.24	.02	0.00	0.00	.27	1.41	24.86
1983-84	.35	2.10	2.63	.02	.37	.48	.57	0.00	0.00	0.00	0.00	0.00	6.52
1984-85	.60	1.93	3.63	.98	.85	1.38	.04	0.00	0.00	0.00	0.00	0.00	9.41
Average	.67	1.25	2.19	2.81	2.54	2.37	1.02	.33	.07	.01	.03	.24	13.53



DEVIATION FROM MEAN IN %; TIME SCALE = SEP-AUG WATER YEARS.

Figure A-24

The period of the DWR estimate of change in storage, 1967-1975, was slightly dry (average of 2.5% below average annual rainfall), and the period of the LFM estimate, 1975-1985, was slightly wet (average of 6% above average annual rainfall). However, these departures from average are relatively minor in comparison to those that occurred in the first half of the century when cumulative departure from normal rainfall in Santa Maria was as high as +360%.

The rainfall record for Nipomo (SLO-38) is shorter (1921-1988), but the station is closer to the area of interest. For the period of record, the average annual rainfall is 16.16 inches. For the period July 1967 to July 1975 (the DWR period of analysis), the average annual rainfall was 17.27 inches, or about 7% above average. For the period July 1975 to July 1985 (the LFM period of analysis), the average annual rainfall was 19.07 inches, or about 18% above average.

d) Changes in Water Levels

Interpretation of the changes in groundwater in storage as discussed above depends on the degree to which these changes are affected by variations in rainfall. To further clarify this aspect of the evaluation of these analyses, we have reviewed well hydrographs prepared by LFM included in Appendix A of their report, well hydrographs included in the Bjerre EIR (p. V-109), and hydrographs included in the DWR report. These hydrographs suggest that:

1. The two-year drought of 1976-77 resulted in a significant lowering of groundwater levels in most wells.
2. The wet year of 1980 resulted in a rebound of water levels to near average conditions.
3. The very wet year of 1983 did not result in water levels significantly higher than those for average to moderately wet years.
4. Annual variations in most years are generally in the range of 3-5 feet.

These relationships suggest that, while a series of very dry years will result in pronounced lowerings of groundwater levels, substantial increases in groundwater levels due to very high rainfall cannot occur unless the water levels in the basin have been drawn down during previous dry years. This suggests that there is a "cap" on weter-level recovery in very wet years, the most likely explanation of which is that the subarea is so close to naturally full that very wet years are not effective unless space for recharge has been provided by previous dry years.

These rainfall relationships suggest that the period of the LFM estimate of change in groundwater in storage was not so unusual as to discard it in favor of a water balance in which the factor for recharge of rainfall is questionable.

3. Overdraft as Applied to the Nipomo Mesa Subarea

The County Planning Department (Land Use Element, Circulation Element, South County Planning Area, Hearing Draft, p. 5-4) and the Planning Department and the County Engineering Department (Land Use Element, Circulation Element, South County Planning

Area, Hearing Draft, Appendix C) describe the Nipomo Mesa "Sub-unit" as being in a state of overdraft based on the water balance for this area. The LFM and DWR reports also indicate a deficit in the water balance. The average decline in water levels beneath the mesa that should be expected with the deficits postulated are as follows assuming 14% specific yield and an area of 21,000 acres:

Source	Year(s)	Deficit (AFY)	Average Decline (ft./yr.)	10-year Decline (ft.)
County water balance	1987	4,200	1.43	14.3
LFM water balance	1987	4,200	1.43	14.3
DWR water balance	1975	1,450	0.49	4.9
DWR change in storage	1967-1975	2,750	0.94	9.4

Declines in water levels of the magnitudes listed above were not observed by LFM in their estimation of change of groundwater in storage for the period 1975 to 1985, and they are not apparent in hydrographs included in their report or those that we have prepared in our work on the mesa. We, therefore, question those factors in the water balances that are subject to estimation, in that the resulting deficits do not appear to have resulted in water -level declines of the magnitude required for these deficits to be accurate. The recharge from infiltration of precipitation, a factor that is common to all the water balances listed above, is discussed in the next section of this report.

In addition, we question the procedure of designating a subarea of a groundwater basin as being in overdraft, particularly when (based on the County's water balance) that subarea is discharging 90% of its recharge to adjacent subareas or to the sea. The determination of a state of overdraft involves two basic evaluations: 1) that there is a significant state of decline of water levels; and 2), that the state of this decline, or the continuation of the decline, may result in an adverse condition such as sea-water intrusion, inadequacy of the resource to support existing development, etc.

Based on information discussed above, the groundwater levels beneath Nipomo Mesa would appear to be at levels that are near-naturally full, and very wet years such as 1983 have not resulted in significant increases in groundwater in storage. Therefore, there is not now information indicating that there is a significant and continuing state of decline in groundwater levels beneath the mesa.

In addition, there is no indication that a continuing decline in water levels, even if present, would likely lead to an adverse condition such as described above. Groundwater levels beneath the westerly part of the mesa are at about 100 feet above sea level approximately 3 miles from the coast, whereas equivalent levels in the Santa Maria Valley to the south are approximately 16 miles inland. If there is a potential for an adverse condition, it is that the mesa may not be able to continue to "export" water at a rate sufficient to overcome the deficits in adjoining subareas, particularly the the Santa Maria Valley to the south.

C. Recharge of the Nipomo Mesa Subunit

1. Derivation of Assumptions

The volume of groundwater that may safely be extracted from a basin or a subarea of a basin without significant adverse effects is approximately equivalent to the average annual recharge of that basin or subarea. Average annual recharge of the Nipomo Mesa Subunit is assigned a value of 3,300 AFY for deep percolation of precipitation and 500 AFY for subsurface seepage in the water balance presented by DWR (1979, Table 11, p. 48).

We previously expressed concern related to the value assigned for deep percolation of rainfall for the Nipomo Mesa subunit in a letter to Mr. Clint Milne, Deputy County Engineer (October 9, 1987), in which we compared derivations of this value for the various subareas as follows:

	Subarea/Subunit		
Parameter	Nipomo Mesa	Arroyo Grande	Santa Maria*
Basin area (DWR Table 7), acres	21,100	7,200	18,000
Deep perc. of precip. (Tab. 11), AF	3,300	2,400	8,000
Deep perc. of precip., feet	0.156	0.333	0.444
Deep perc. of precip., inches	1.88	4.00	5.33
Average rainfall (DWR Fig. 3), inches	15±	16±	14±
Deep perc. of precip. as % of rainfall	12.5	25.0	38.1

* San Luis Obispo County portion only

2. Local Conditions

Based on the above, it would appear that DWR assumed approximately 40% recharge of rainfall in the Santa Maria subarea, 25% recharge in the Arroyo Grande subarea, and 12.5% in the Nipomo Mesa subarea. Based on our experience in these areas, the relative relationships would appear to be inconsistent with actual conditions.

a) Nipomo Mesa Conditions

We have previously been involved in the preparation of EIRs for the Black Lake Golf Course Development, the Bjerre General Plan Amendment, and the EIR for the Nipomo Mesa Property Owner's Association. During the course of the preparation of these EIRs, we have had the opportunity to check erosional relationships between interdunal depressions on the mesa based on the thesis that if runoff from the mesa were significant, then there should be indications of erosion of channels between interdunal depressions.

To date, in our on-site investigations of projects on the mesa, we have found no instances of significant runoff (i.e., erosional channels) between interdunal depressions. The dune topography of the mesa is at least 40,000 years old, and is more likely about 120,000 years old. As such, it provides the "ultimate test" of potential runoff under the total range of rainfall conditions extending back for thousands of years, and involving the absolute maximum range of runoff conditions that may be postulated for the foreseeable future.

As a result, we have concluded that, under the maximum possible range of conditions (40,000 to 120,000 years), all precipitation falling on Nipomo Mesa infiltrates to the groundwater basin, evaporates, or is extracted by vegetation. This condition is acknowledged by DWR (1979, p. 17, par. 1), but it does not appear to be considered in the estimate of deep percolation of precipitation discussed above.

b) Normal Assumptions

Estimates of infiltration of precipitation are normally (e.g., Santa Barbara County Water Agency, 1977, p. 21) based on the following assumptions:

- Rainfall must exceed 11 inches/year on irrigated land for deep percolation of rainfall to be effective.
- Rainfall must exceed 17 inches/year on areas of native vegetation for deep percolation of rainfall to be effective.
- There is a maximum of approximately 30 inches/year above which additional rainfall is not effective in contributing to recharge.

These "normal assumptions" evolve from an investigation of rainfall penetration conducted in Ventura County in 1934 by the California Division of Water Resources, and they have been commonly relied upon, absent information to the contrary, since that time. We have not "back-calculated" the assumptions of DWR to determine if these assumptions are the basis for their assignments of recharge from rainfall on Nipomo Mesa. However, the very low per-acre recharge on the mesa is consistent with it having large areas of native vegetation and eucalyptus groves, and the much higher recharge in the Santa Maria Valley and the Arroyo Grande Plain would fit these assumptions in that they are largely irrigated land.

We do not disagree with the results of the 1934 investigations in Ventura County. However, we do disagree with their application to Nipomo Mesa, if that is the case. More specifically:

- The soils are old sand dunes, generally 100 feet or more in thickness, and with very rapid infiltration. Therefore, percolating rainfall will move rapidly to a level below the root zone of native vegetation and the extensive eucalyptus groves. This infiltration will be stored in the sand dune unit until it can infiltrate into the underlying Paso Robles Formation.
- There is no runoff from the mesa, as acknowledged in the DWR report, and all rainfall infiltrates locally or accumulates in the many interdunal depressions. Therefore, the usual "cap" on infiltration of rainfall of 30 inches/year is not applicable. All rainfall on the mesa will infiltrate to the groundwater basin unless it evaporates or is used by vegetation.

Based on these considerations, it would appear that the value for infiltration of rainfall in the water balance for the Nipomo Mesa subarea should be substantially increased. Available data are not adequate to derive a revised value directly, and consideration of a change is deferred to the comparisons of values in the balance as discussed below.

3. Suggested Revisions to the Nipomo Mesa Subarea Water Balance

While it is not the intent of this document to propose a precise revision of the existing water balance for the Nipomo Mesa subarea, some response to the questions raised above would appear to be required. Significant points to note include:

1. The present status of the balance between natural inflow and outflow as

included in the County's water balance is that recharge (deep percolation of precipitation and subsurface seepage) totals 3,800 AFY while outflow to the sea to preclude saltwater intrusion, and outflow to adjacent subareas, totals 3,450 AFY. This change represents a decline from maximum, natural recharge conditions of only 10%.

2. In addition, this relationship provides that only about 350 AFY is available for consumptive use, beyond which a decline in water levels would be expected. Agricultural uses alone are assigned a consumptive use of 2,390 AFY in the budget, and domestic uses are assigned a consumptive use of 890 AFY. Thus, even if all urban uses were removed from the mesa, including the use by Unocal, there would still be a deficit of 2,040 AFY as a result of agricultural use alone.

3. The estimated deficit in the budget of 4,200 AFY requires an average annual decline of water levels beneath the mesa of approximately 1.5 feet per year. Changes of this magnitude do not appear to be reflected in measured well levels, and LFM estimates a small increase in groundwater in storage during the period 1975-1985.

4. Review of available hydrographs indicate that very dry periods such as 1976-77 are reflected in major drawdowns of water levels in pumped areas. Where such dry periods are followed by a wet year (1978), wells substantially recover to normal levels. However, if there is not a major drawdown, then very wet years such as 1983 have very little effect on well levels. These effects sugget that the Nipomo Mesa subarea is near full, and is "spilling" excess recharge in very wet years.

Based on these considerations, it would appear that the value for infiltration of rainfall should be increased substantially. An increase of 4,200 AFY to a value of 7,500 AFY would appear to be justified by the change in storage estimate of LFM. This estimate spans a moderately wet period due primarily to the very wet years of 1978 and 1983. The increased rainfall in 1978 was very effective in recharging the groundwater basin, but the even greater rainfall of 1983 was relatively ineffective as discussed above.

While the suggested increase of 4,200 AFY is a very major increase, the resulting percentage of infiltration of rainfall is only 28.4%. This is slightly higher than that applied by DWR to the Arroyo Grande subarea, but significantly below the 38% applied to the Santa Maria Valley subunit by DWR.

D. Maintenance of Outflow from the Nipomo Mesa Subunit

1. Physical and Historical Relationships

The revisions to the water balance suggested above include maintenance of the existing outflow to adjacent subareas of 2,800 AFY to the Santa Maria Valley and 300 AFY to the Arroyo Grande subarea as included in the water balance prepared by the County (Table A-7). This condition will continue as long as groundwater remains at or near present levels. However, should these levels decline, outflow would also decline until a new balance is reached. Such a decline is not likely to result in an overdraft (i.e, an adverse condition such as seawater intrusion) provided outflow to the sea is maintained. However, outflow to adjacent agricultural areas would be reduced.

The Nipomo Mesa subarea has, in the past, functioned as an area of significant recharge to more intensively irrigated areas to the north on the Arroyo Grande plain and to the south in the Santa Maria Valley. This relationship has developed because the porous sand soils of the mesa provide rapid infiltration of rainfall, and its topography functions as natural recharge basins that contain and infiltrate almost all the rain that falls on the mesa. The adjacent agricultural areas cannot match this recharge capability even though tilled fields have an above-average capability for infiltration.

In addition, the mesa has relatively infertile soils, and pumping for agricultural uses on the mesa has, historically, been significantly less than nearby areas with more fertile soils. As a result, the mesa has evolved as the recharge area for adjacent, more fertile agricultural areas to the north and south, and outflow to adjacent subareas has become a significant part of its water balance.

2. Potential for Reduction in Outflow

In our previous investigations of water availability for development on Nipomo Mesa, the potential for reductions in outflow to adjacent agricultural areas has been a major issue. Potential effects on the adjacent Santa Maria Valley (i.e., Guadalupe and Santa Maria storage units) would be small in comparison to their overall storage and present rates of overdraft. These storage units have a total of 368,000 AFY in storage above sea level and an annual defecit of 42,000 AFY. The present outflow of 2,800 AFY to these adjacent subareas is 0.76% of available storage and 6.7% of the annual defecit of these subareas. While outflow from beneath Nipomo Mesa is relatively small in comparison, the Santa Maria Groundwater Basin is in overdraft based on agricultural use alone, and reductions in the outflow will only increase this problem.

Effects on the Arroyo Grande plain are conjectural. Water from Lopez Reservoir has replaced much of the urban demand on local groundwater resources, and levels have risen in recent years. However, urban development has expanded rapidly in the area, and demands on groundwater may again exceed recharge.

In the following section, changes in recharge resulting from various types and densities of urbanization on Nipomo Mesa are analyzed in detail. This analysis indicates that urbanization involving relatively large areas of impervious surfaces (high-density residential, commercial and most industrial) will increase the rate of recharge, and that medium and low density residential can be held near "no change" with modest restraints on landscaping. With this revised analysis, involving primarily the increased recharge of urban runoff, the issue of potentially reduced outflow to agricultural users in adjacent areas is avoided.

E. Impact Scenarios

1. Urban Impact Scenarios

The impact of various types of urban development on the mesa are evaluated below in terms of the net change in groundwater availability on a per-acre basis. This approach allows evaluation of the impact of various types of urban development while avoiding differences of opinion on the status of the groundwater resource. It also leads to the development of consumptive use factors that can be applied directly to the consideration of alternatives.

Values used in developing these scenarios are as follows:

Inside Water Demand: A reasonable average value is 75 gallons/day/person. At 3.07 persons per dwelling unit, the unit demand would be 84,041 gallons/year or 0.2579 acre-feet/year.

Inside Consumptive Use: For septic tank disposal (95% return water), consumptive use would be 0.0129 acre-feet/year. For community disposal (90% return water), consumptive use would be 0.0258 acre-feet/year.

Demand for Landscape Irrigation: Demand for irrigation of landscaping will vary depending on the size of the lots involved. In two recent studies in the Vandenberg Village area of Santa Barbara County (this area has sand soils similar to those on Nipomo Mesa), average water demand over a 5-year period for 30,000 sq. ft. lots and 8,000 sq. ft. lots was reported by the Park Water Company as 1.1 acre-feet/year and 0.58 acre-feet/year, respectively. If the average inside demand estimated above is subtracted from total demand, the demand for irrigation of landscaping is estimated to range from 0.3221 acre-feet/year for 8,000 sq. ft. lots to 0.8421 acre-feet/year for 30,000 sq. ft. lots.

Consumptive Use of Landscape Irrigation: Assuming a 40% return water factor for the sand soils on the mesa (consistent with values used in Los Osos), the consumptive use of landscape irrigation is estimated to range from 0.1933 acre-feet/year for 8,000 sq. ft. lots to 0.5053 acre-feet/year for 30,000 sq. ft. lots.

Runoff from Impervious Surfaces: Assuming approximately 10% loss to evaporation, runoff from impervious surfaces for an average year with 15 inches of rain, would be approximately 1.125 acre-feet/year per acre of impervious surface.

Recharge of Rainfall on Landscaping: During the wet season of the year, a part of the rainfall on landscaped areas will also recharge the underlying groundwater basin. The percentage of recharge of these waters is assumed to be the same as that during the dry season. This is probably a conservative value in that most introduced species are dormant during the wet season, and uptake of rainfall is probably less than the 60% assumed for this category.

a. Natural Conditions

The net change in recharge of the groundwater basin under natural conditions depends on the amount of rainfall used by natural vegetation, and the large eucalyptus groves that were planted many years ago and that may be considered as part of the natural landscape. Precise values on the use of water by this vegetation are not available. However, it is commonly assumed that natural vegetation develops to a level at which it uses essentially all rainfall in average years, and that significant recharge occurs only in years that are wetter than average. Water use by eucalyptus is also unknown. However, the canopy of these large trees is more bulky than that of the native oaks and dune scrub, and the water use by eucalyptus is probably at least as great as the natural vegetation.

The Department of Water Resources (1979) estimates deep percolation of rainfall on the mesa at 1.88 inches/year (12.5% of average rainfall). If this value is correct, then the average annual net change in groundwater availability for natural conditions is 0.1567 acre-feet/acre.

b. Low Density, Single-Family Residential

This scenario assumes development at approximately 2 units/acre, i.e., 18,000± sq. ft. lots with the remainder in streets. With this scenario, all natural vegetation would be removed and replaced with residences, streets, driveways, landscaping and some areas left barren. Impervious surfaces are estimated as follows on a per acre basis:

Type		Area (sq. ft.)
House and garage (two)		6,000
Driveways (two)		1,600
Other impervious areas		800
Streets (120 x 42±)		5,000
	Total	13,400

A water balance for one acre of low density, single-family residential development on Nipomo Mesa is estimated in Table A-9 in a simplified form in which extractions are expressed as consumptive use, and return of applied waters are omitted from the equation.

Table A-9

WATER BALANCE FOR LOW DENSITY, SINGLE-FAMILY DEVELOPMENT ON NIPOMO MESA

Category	Basis	Change (acre-feet/year)
Recharge Of:		
Runoff from impervious areas	(13,400 sq. ft. x 1.125 acre-ft./acre)	0.3461
Rainfall onto pervious areas	(30,160 sq. ft. x 15 in. x 40%)	0.3462
	Total Recharge:	0.6923
Consumptive Use Of:		
Inside water (2 residences)	(0.0258 acre-ft. x 2)	0.0516
Landscape irrigation	(interpolated from data above for 2 residences)	0.6986
	Total Consumptive Use:	0.7502
	Net Change in Consumptive Use of Water (per acre of development):	0.0579

In the tabulation above, it should be noted that consumptive use of water directly by residents is very small (less than 7% of consumptive use) in comparison to consumptive use by landscaping. The latter can be considered a worst-case condition in that the data used for estimating landscape use is from an area in which landscaping is much more extensive than that in existing developments on the mesa. If assumptions as to the use of water by landscaping were to be reduced by only 8%, then residential development at 2 units/acre would have a slightly beneficial impact on the availability of water resources.

c. Medium Density, Single-Family Residential

This scenario assumes development at approximately 4 units/acre, i.e., 8,000± sq. ft. lots with the remainder in streets and ROW. With this scenario, all natural vegetation would be removed and replaced with residences, streets, driveways, landscaping and some areas left barren. Impervious surfaces are estimated as follows on a per acre basis:

Type		Area (sq. ft.)
House and garage (four)		10,000
Driveways (four)		2,800
Other impervious areas		1,200
Streets (130 x 42±)		5,500
	Total	19,500

A water balance for one acre of medium density, single-family residential development on Nipomo Mesa is estimated in Table A-10 in a simplified form in which extractions are expressed as consumptive use, and return of applied waters are omitted from the equation.

Table A-10

WATER BALANCE FOR MEDIUM DENSITY, SINGLE-FAMILY DEVELOPMENT ON NIPOMO MESA

Category	Basis	Change (acre-feet/year)
Recharge Of:		
Runoff from impervious areas	(19,500 sq. ft. x 1.125 acre-ft./acre)	0.5036
Rainfall onto pervious areas	(24,060 sq. ft. x 15 in. x 40%)	0.2762
	Total Recharge:	0.7798
Consumptive Use Of:		
Inside water (4 residences)	(0.0258 acre-ft. x 4)	0.1032
Landscape irrigation	(0.1933 acre-ft. x 4)	0.7732
	Total Consumptive Use:	0.8764
Net Change in Consumptive Use of Water (per acre of development):		0.0966

As with the low density scenario, consumptive use of water directly by residents is very small (about 12% of consumptive use) in comparison to consumptive use by landscaping. The latter can be considered a worst-case condition in that the data used for estimating landscape use is from an area in which landscaping is much more extensive than that in existing developments on the mesa. If assumptions as to the use of water by landscaping were to be reduced by only 11%, then residential development at 4 units/acre would have a slightly beneficial impact on the availability of water resources.

d. High Density, Multi-Family Residential

This scenario assumes development at approximately 10 units/acre in which approximately 20% of the land area would be landscaped and the remainder would be converted to impervious surfaces.

A water balance for one acre of high density, multi-family residential development on Nipomo Mesa is estimated in Table A-11 in a simplified form in which extractions are expressed as consumptive use, and return of applied waters are omitted from the equation.

Table A-11

WATER BALANCE FOR HIGH DENSITY, MULTI-FAMILY DEVELOPMENT ON NIPOMO MESA

Category	Basis	Change (acre-feet/year)
Recharge Of:		
Runoff from impervious areas	(34,848 sq. ft. x 1.125 acre-ft./acre)	0.9000
Rainfall onto pervious areas	(8,712 sq. ft. x 15 in. x 40%)	0.1000
	Total Recharge:	1.0000
Consumptive Use Of:		
Inside water (10 residences)	(0.0258 acre-ft. x10)	0.2580
Landscape irrigation	(8,712 sq. ft. x 2 acre-ft./acre)	0.4000
	Total Consumptive Use:	0.6580
Net Change in Consumptive Use of Water (per acre of development):		- 0.3420

A significant beneficial impact on groundwater availability can be achieved with high density development because the higher consumptive use by vegetation is minimized, consumptive use directly by people is small, and runoff from impervious surfaces which can be directly recharged is high.

e. Commercial/Industrial Uses

This scenario assumes that existing vegetation would be removed and replaced primarily by impervious surfaces or barren ground. This is the case with most industrial uses on the mesa, and uses with a high demand for water for use in industrial processes (e.g., the Unocal Refinery) are specifically excluded. Such uses should be reviewed individually for their demand on water resources.

A water balance for one acre of typical industrial development on Nipomo Mesa is estimated in Table A-12 in a simplified form in which extractions are expressed as consumptive use, and return of applied waters are omitted from the equation. Landscaping is assumed at 10% of the area of use, although most existing industrial developments have no landscaping. The 10% rate is used as worst-case in that increased residential development in the area may result in requirements for a more sensitive approach in the treatment of industrial and commercial uses.

A significant beneficial impact on groundwater availability can be achieved with industrial development because the higher consumptive use by landscaping is minimized, consumptive use directly by people is small, and runoff from impervious surfaces which can be directly recharged is high.

Table A-12

WATER BALANCE FOR TYPICAL INDUSTRIAL DEVELOPMENT ON NIPOMO MESA

Category	Basis	Change (acre-feet/year)
Recharge Of:		
Runoff from impervious areas	(39,204 sq. ft. x 1.125 acre-ft./acre)	1.0125
Rainfall onto pervious areas	(4,356 sq. ft. x 15 in. x 40%)	0.0500
	Total Recharge:	1.0625
Consumptive Use Of:		
Inside water	Equivalent of 1 residence on septic tank	0.0129
Landscape irrigation	(4,356 sq. ft. x 2 acre-ft./acre)	0.2000
	Total Consumptive Use:	0.2129
Net Change in Consumptive Use of Water (per acre of development):		- 0.8496

f. Conversion of Agricultural Uses

While agricultural uses on the mesa are relatively limited in comparison to those in the adjacent Santa Maria and Arroyo Grande Valleys, future urban uses on the mesa could result in the conversion of some agricultural uses. Agriultural uses normally involve consumptive use of water resources in the range of 1.0-3.0 acre-feet per acre even with water-saving procedures such as drip irrigation.

In the urban scenarios developed above, the consumptive use of groundwater is estimated as being significantly below 1.0 acre-feet per acre, and the conversion of agricultural uses would generally have a positive impact on water resources.

The impact of conversion of prime agricultural lands to urban uses is addressed later in this report.

2. Rural Impact Scenarios

a. Residential Use

The potential impacts on water resources of development at Residential Suburban and Residential Rural densities are difficult to address quantitatively as the potential variations are complex. However, the elimination of natural vegetation or eucalyptus for the construction of a residence and a moderate open area around the residence will, generally, result in a small beneficial impact on water resources. This is due to the very low consumptive use of the inside residential water demand with disposal by septic systems (0.026 acre-feet/year) as opposed to the higher consumptive use of the vegetation removed to construct the residence (about 1.0 acre-foot/acre cleared). At these rates, it is only necessary to clear about 1,200 square feet to offset the inside consumptive use. However, if landscaping is extensive, then there may be a slight increase in consumptive use (approximately equivalent to the low density, single-family residential example given above).

Rural development that now exists on the mesa tends to have limited landscaping. If future development were to occur in a similar way, then the impact of the basic use (i.e., the residence) on water resources would be slightly beneficial. However, development with more extensive landscaping cannot be precluded.

b. Secondary Uses

Evaluating secondary uses, primarily hobby farming, on these larger lots is the primary problem in estimating impacts on water resources. Consumptive use of water by various crops is estimated from Table 5 (year 2,000) of the San Luis Obispo Master Water Plan Update as follows:

Crop	Applied Water (ft)	Irrigation Efficiency	Consumptive Use
Vegetable (truck)	1.4	70%	0.98
Field	1.7	75%	1.28
Citrus & subtropical	1.9	80%	1.52
Deciduous	2.3	75%	1.72
Pasture (irrig.)	2.9	70%	2.03

While the use of large quantities of water cannot be totally precluded, it is unlikely that extensive row crops would be planted because these are very labor-intensive. More likely scenarios at these densities include a small to moderate orchard and a small vegetable garden. In Residential Suburban areas, the entire lot may be used. In Residential Rural areas, a large part of the lot may be left in natural vegetation or eucalyptus to provide for privacy.

Based on the consumptive use values given above, and assuming a credit for elimination of use by natural vegetation or eucalyptus of approximately 1 acre-foot/acre, the net increase could range from approximately 0 to about 1 acre-foot/acre. An average increase in the consumptive use of water resources of approximately 0.5 acre-foot per acre of hobby farming would appear to be reasonable.

3. Summary of Impact Scenarios

a. Urban Development

The impact scenarios developed above indicate that medium- to low-density residential development can be accommodated on the mesa with essentially no significant impact on water resources. High density multi-family and most industrial developments will have a beneficial impact on water resources due to the elimination of use by existing natural vegetation and the very low consumption of water by these land uses.

These conditions are compared in Table A-13 to typical urban conditions such as the City of San Luis Obispo in which wastewater is disposed of by discharge to San Luis Obispo Creek and to the sea, and runoff from impervious surfaces is also lost.

Table A-13

COMPARISON OF NET CHANGE IN CONSUMPTIVE USE OF WATER RESOURCES WITH DEVELOPMENT ON NIPOMO MESA AND WITH DEVELOPMENT OF A TYPICAL URBAN AREA

(Acre-Feet per Year per Acre of the Use)

Development Condition	Nipomo Mesa	Net Change in a Typical Urban Area		
		Consumption	Lost Runoff	Total
High density (10 du/ac)	-0.34	2.60	0.90	3.50
Medium density (4 du/ac)	0.10	2.32	0.50	2.82
Low density (2 du/ac)	0.06	1.68	0.35	2.03
Residential Suburban	-0.1 to 0.5	1.20	0.17	1.37
Industrial/Commercial	-0.85	2.0±	1.01	3.0±

Note: Negative values indicate net reduction in consumptive use of water resources.

It should be emphasized that the values in the table above are approximate, and they are intended only to illustrate the major reduction in net loss of water resources that can be accomplished with recharge of wastewater and runoff from urban impervious surfaces.

b. Implementation of Assumed Recharge

The Nipomo Mesa development scenarios assume that provision will be made in any development proposal to collect and recharge all excess runoff from developed areas. This is a likely assumption in that most of the mesa consists of closed depressions within which accumulated runoff cannot be accommodated in any other way. However, the setting aside of areas to be used for recharge may further reduce development density with little or no increase in consumptive use.

Also, higher density development may involve local sewage treatment systems such as at the Black Lake golf course development. In the past, the design of such systems has emphasized "disposal". Should development increase on the mesa, local treatment systems should be designed to emphasize reclamation.

c. Rural Development

Evaluation of the consumptive use of water resources resulting from development on large lots is much less precise than for higher density development because of potentially high consumption by secondary uses such as "hobby farming". However, the basic residential use, with modest landscaping, would have an insignificant to slightly beneficial impact on water resources.

d. Agricultural Conversion

Conversion of agricultural uses on the mesa to urban uses would generally have a positive impact on water resources. Soils on the mesa are generally assigned Grade 3 (non-prime) by the Soil Conservation Service, and such conversions would not result in the loss of prime agricultural lands.

F. Conditions Off the Mesa

The scenarios developed above are valid only for that part of Nipomo Mesa that overlies the Santa Maria Groundwater Basin, and areas to the northeast of Highway 101would be subject to standard procedures in estimating consumptive use of water with no "credit" for recharge of urban runoff. One exception to this is that the Nipomo Community Services District has completed the first phase of its wastewater treatment plant, and it is now returning wastewater to the groundwater basin from its infiltration ponds west of Highway 101. The District pumps most of its water from beneath the mesa, and return waters have been limited in the past to areas west of Highway 1. However, as additional areas to the east of Highway 101 are sewered, reclamation of wastewater by the District will increase.

G. Groundwater Quality

In any groundwater management system involving the recharge of wastewater, effects on water quality may be a significant issue. Each time groundwater is re-used, the dissolved solids in the water tend to increase. Characteristics of concern include the total dissolved solids, chloride and nitrate.

The Regional Water Quality Control Board generally considers development at a density of one acre or more as not posing a significant water quality problem. Since the proposed project would reduce allowable densities, and requested alternatives are primarily at a density of 1 dwelling unit/acre (Residential Suburban), potential effects of the project and the alternatives on groundwater quality are presumed to be insignificant. However, the effects on groundwater quality of increasing development on the mesa should be monitored. Should adverse salt build-ups be detected, it may be necessary to add salt removal mechanisms at local treatment plants.

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