EXECUTIVE OFFICER
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STATE OF CALIFORNIA
The Resources Agency
DEPARTMENT OF WATER RESOURCES
Southern District

LOS OSOS-BAYWOOD
GROUND WATER PROTECTION STUDY

District Report

October 1973

State of California | The Resources Agency

Memorandum

To : California Regional Water Quality Control Board
Central Coast Region
2238 Broad Street
San Luis Obispo, CA 93401

Attention: Mr. Kenneth R. Jones
Executive Officer

Date :

File No.:

Subject: Los Osos-Baywood Ground Water Protection Study Report

From : **Department of Water Resources**
Los Angeles, CA 90055

In accordance with Interagency Agreement No. 1-5-014 between the State Water Resources Control Board (SWRCB) and the Department of Water Resources (DWR), we submit herewith 25 copies of the above report together with a reproducible master copy.

We wish to express our appreciation for the cooperation extended to us by your Board and Staff; the San Luis Obispo County Flood Control and Water Conservation District; the San Luis Obispo County Department of Health; the University of California's Agricultural Extension Service; the San Luis Obispo County's Farm Advisor's Office; the State Department of Health; the U. S. Soil Conservation Service; the Baywood Park County Water District; the California Cities Water Company; the Sunset Terrace Mutual Water Company; Brown & Caldwell Water Resources Engineers, Inc.; the water drillers who furnished us information; and several private individuals.

Jack J. Coe
Acting District Engineer
Southern District

Attachment

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

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JACK J. COE, Acting District Engineer

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ACKNOWLEDGEMENT

We wish to express our appreciation for the cooperation extended to us by the staffs of the California Regional Water Quality Control Board, Central Coast Region; the San Luis Obispo County Flood Control and Water Conservation District and the County's Department of Public Health; the University of California's Agricultural Extension Service; the Farm Advisor's Office, San Luis Obispo County; the State Department of Health; the U. S. Soil Conservation Service; Brown and Caldwell, Water Resources Engineers, Inc.; the Baywood Park County Water District; the California Cities Water Company; the Sunset Terrace Mutual Water Company; water well drillers; and numerous individuals.

1. INTRODUCTION

Any plan for managing waste water in the Los Osos-Baywood area adjacent to Morro Bay (Figure 1) could have an important effect on the quantity and quality of the ground water, most of which is now of excellent quality. One particularly important element in any plan is that of protecting ground water from sea-water intrusion.

The Department of Water Resources (DWR) Bulletin No. 63-6, "Sea Water Intrusion: Morro Bay Area, San Luis Obispo County", February 1972, reported, "Sea water has intruded into the coastal portions of the Recent alluvial sediments in response to withdrawals of ground water at wells . . ." The effects of sea-water intrusion into the upper Pleistocene old dune sand of the Los Osos ground water basin have been observed at one isolated shallow well near the southern shoreline of Morro Bay. The Bulletin recommended a more thorough evaluation of the available ground water resources in the upper and lower Pleistocene materials of the coastal portion of Los Osos Ground Water Basin.

Because of this condition, the State Water Resources Control Board (SWRCB) contracted with DWR to obtain additional information about the effects on the ground water by percolation, including the collection and export of waste water now discharged to septic tank-leach line systems in the Los Osos-Baywood area.

The study will assist Brown and Caldwell, Water Resources Engineers, Inc. in developing water quality management plans for SWRCB.

Objective and Scope of the Investigation

The objective of the investigation was to determine the factors that affect ground water quality and quantity-quality relationships in the Basin.

In the main, the scope of the investigation was confined to data in the files of DWR and other public agencies. Thanks to the cooperation of the San Luis Obispo County Flood Control and Water Conservation District, it was possible for DWR to collect and evaluate limited, selected data in the field. The funds allocated did not permit of any field work to determine the Basin's ground water capacity and safe yield.

Specifically, the scope includes the consideration of: (1) the quantity and quality of the surface, ground, and waste water; (2) occurrence, movement, and use of surface, ground, and waste water; (3) quality effects of waste water

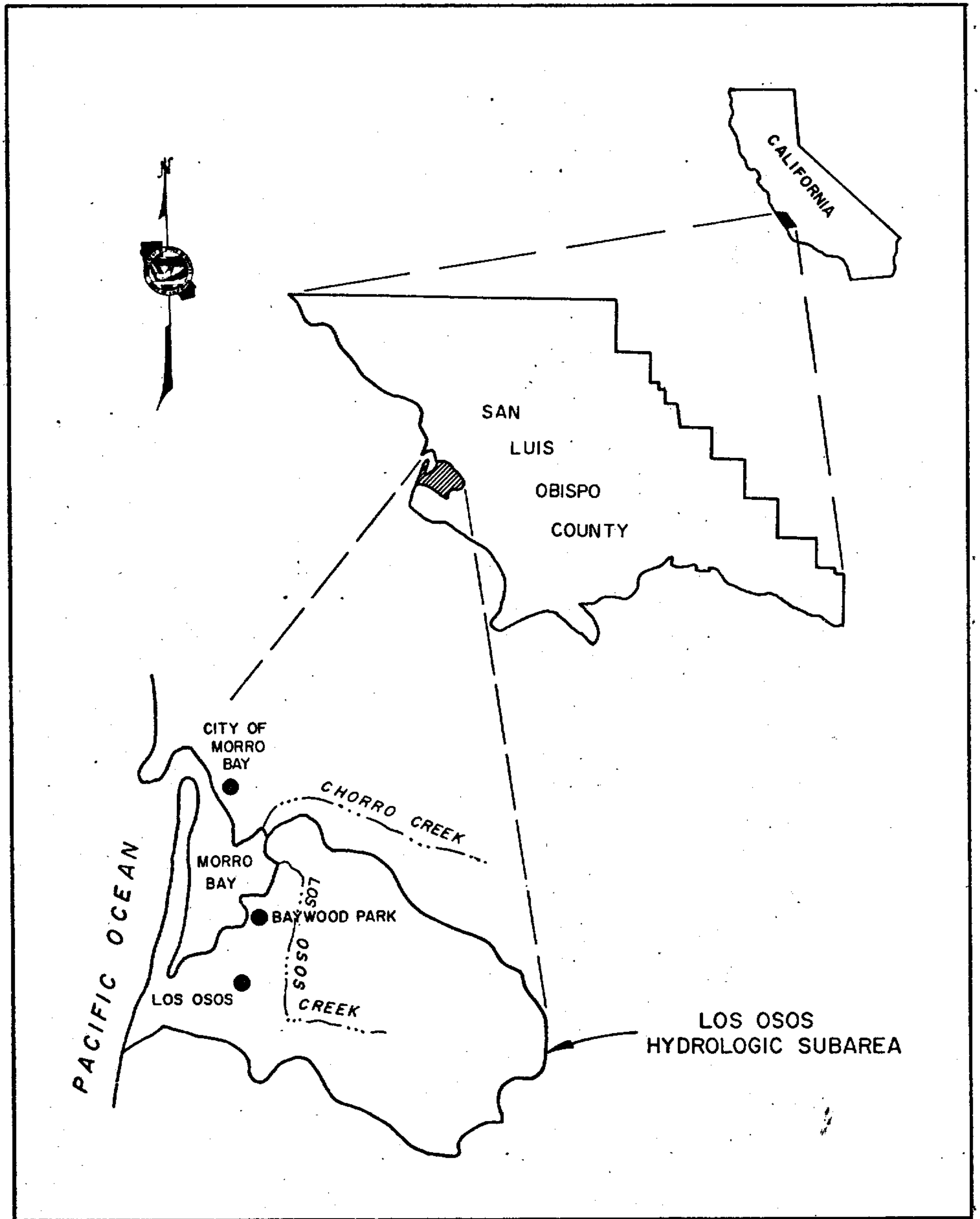

FIGURE I-LOCATION MAP

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT 1973 on ground water; (4) impact of exporting waste water on the quantity and quality of the ground water; (5) optimum disposal of waste water to protect the quantity and quality of the freshwater resources; and (6) suitable monitoring to detect changes that might impair ground water quality.

Area of the Investigation

The study area is a subdivision of the San Luis Obispo hydrologic subunit, Los Osos hydrologic subarea, in the coastal region of San Luis Obispo County (Figure 1). The subdivision is for compiling, filing, and retrieving geohydrologic data with electronic data-processing machines. The hydrologic subarea is divided into a water-bearing area identified as the Los Osos Ground Water Basin (Los Osos Basin), and a nonwater-bearing area. These two subdivisions are discussed in detail in Chapter 3.

Morro Bay and Morro Rock, the projection rising on the northwest border, are the prominent physiographic features of the area. The Bay opens into the ocean between Morro Rock on the north and a baymouth bar (Appendix A) on the south, the latter forming the western shore of the Bay.

The study area's climate consists of long, moderate summers and short, wet winters. During summer, the prevailing on-shore winds frequently roll heavy fogs into the Los Osos Valley. Air temperatures recorded at Morro Bay Fire Department from 1960 to 1968 ranged from an average high of 62°F to an average low of 51°F, with an average annual of 56°F. Killing frosts are rare.

Average seasonal precipitation ranges from 10 to 25 inches with 80 percent occurring from December through March. Storms originating in the Aleutian Islands move down the coast and bring short, heavy rains to the Santa Lucia Mountain Range, especially at their higher elevations.

2. LAND USE AND WATER USE

Land-use estimates were employed to determine the demand for and use of water in the Basin, including the volume of ground water pumped and applied to support urban and agricultural development. Estimates were also made of the volume of water lost consumptively.

Land Use

In May 1973, DWR conducted a land-use survey of the Los Osos hydrologic subarea, updating 1968 DWR land-use maps with the aid of photo interpretation of the 1972 color infrared aerial photos. The photos were made available by and interpreted with the assistance of the Geography Department of the University of California, Riverside (UCR). In addition, a field-check was conducted to verify questionable interpretations. Land-use acreage by category and subarea were determined by the cut-and-weigh process (Table 1). Areas of urban and irrigated agricultural developments are shown on Plate 1, for Subareas 1, 2, and 3 (alluvium) and Subareas 4 and 5 (tributary to the alluvium).

The study area encompasses 18,000 acres, of which slightly more than 10,000 acres are classified as tributary area, (Subareas 4 and 5) with relatively steep slopes and shallow soil. For convenience, the thin mantle of alluvium occurring in the Los Osos Creek (Clark Valley) was included in Subarea 4. Vegetation consists of brush, grass, and trees. The rolling hills in the tributary areas were planted to dry-farmed barley and oats. Residential development is insignificant and confined to farmsteads.

The alluvial area in Subareas 1, 2, and 3 amounts to 7,600 acres. There, the terrain is relatively flat, with deeper soils. Most irrigated agriculture and urban development is in the alluvial plain.

Residential development comprises 560 acres. Commercial development, including schools, amounts to 15 acres. There is no industry, but 130 acres are occupied by farmsteads, feedlots, dairies, golf course, and cemetery. Vacant lots, streets, roads, and rights-of-way accounted for 230 acres.

Over 450 acres are irrigated, with 260 fallow acres. Truck crops -- mostly lettuce, celery, flowers, strawberries, cabbage, cauliflower, and brussel sprouts -- comprise the largest acreage. Field crops, including sugar beets and safflower, occupy 140 acres, while 130 acres consist of mixed pasture (grasses and legumes), sudan grass, and irrigated native pasture. Nonirrigated agriculture occupies 2,100 acres of oats, barley, improved pasture, and garbanzo beans.

There is no large surface reservoir for storage of runoff. Some farms have small ponds used to store irrigation or stock water. All water demand is supplied by wells.

Urban Water Use

Urban water use was estimated by applying per capita unit values to the population in the five subareas. Consumptive use of precipitation on an acreage basis was estimated from the amount of precipitation falling on the urban area and consumed through evapotranspiration by vegetation.

TABLE I
LAND USE, 1972
LOS OSOS HYDROLOGIC SUBAREA
(in acres)

Category and class of land use	Subarea I	Subarea 2	Subarea 3	Subarea 4	Subarea 5	Total study area
WATER SERVICE AREA						
Urban and Suburban						
Residential	434	113	11	0	0	558
Commercial	14	0	1	0	0	15
Industrial	0	0	0	0	0	0
Unsegregated urban and suburban areas	18	11	65	25	13	132
SUBTOTALS	466	124	77	25	13	705
Included nonwater-service area	155	40	24	6	2	227
TOTAL GROSS URBAN AND SUBURBAN AREA	621	164	101	31	15	932
Irrigated Agriculture						
Alfalfa	0	0	0	0	0	0
Pasture	0	0	119	8	0	127
Citrus and subtropical	0	0	0	0	0	0
Truck crops	11	18	148	0	0	177
Field crops	0	0	132	11	0	143
Deciduous fruits and nuts	0	0	0	2	0	2
Small grains	0	0	6	0	0	6
Vineyards	0	0	0	0	0	0
SUBTOTALS	11	18	405	21	0	455
Fallow	0	0	264	0	0	264
Included nonwater-service area	1	1	23	2	0	27
TOTAL GROSS IRRIGATED AGRICULTURE	12	19	692	23	0	746
TOTAL GROSS WATER SERVICE AREA	633	183	793	54	15	1,678
NONWATER-SERVICE AREA						
Nonirrigated agriculture	19	61	1,655	189	223	2,153
Native vegetation	1,033	2,264	976	5,730	4,048	14,045
TOTAL GROSS NONWATER-SERVICE AREA	1,052	2,325	2,631	5,919	4,271	16,198
GRAND TOTAL	1,685	2,508	3,424	5,973	4,286	17,876

Because population was the basis for urban water use, it was necessary to divide the 1972 population (3,490)* according to residential and farmstead acreage in the five subareas.

Urban applied water was estimated at 179 gallons per capita per day, (gpcd) or 0.2 acre-feet per capita per year (excluding golf-course use). From this, 76 gpcd** was assumed to be sewage return flow. The balance of applied water, 103 gpcd, was attributed to outside uses for maintaining vegetation. Consumptive use (net water use) was derived from outside water applications and from the precipitation falling on the area.

Applied water and consumptive use by a golf course, cemetery, feedlots, dairies, vacant lots, streets, roads, and rights-of-way were included in the urban category.

Irrigated Agriculture Water Use

Agricultural water use, both applied and consumptive, were estimated by applying unit values of water use to land-use acreage. Irrigation efficiencies published in DWR Bulletin No. 18, "San Luis Obispo County Investigation", were used with consumptive use of applied water to derive amounts of applied water. Slight modifications were made in published unit values to reflect local climatic conditions.

Native Vegetation Water Use

Consumptive use of precipitation in areas of native vegetation was estimated by applying unit values of water use to four categories of vegetation: grass, brush, trees, and riparian vegetation. Most of the information from which the unit values were derived was based on studies conducted by the U. S. Agricultural Research Service at its former field office in Lompoc. Because of lack of data it was assumed that riparian vegetation would use water consumptively at the same rate as pan evaporation.

The effect of native vegetation use of precipitation is not shown in the summary, but is reflected in the hydrology section of the report.

Summary of Applied and Net Water Use

A summary of applied water under and agricultural uses and consumptive use of water under average low, average, and average high precipitation conditions are in Table 2 and 3, respectively.

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* July 1, 1972, estimate by the San Luis Obispo County Planning Department.

** From San Luis Obispo County Study "Report on Master Water and Sewer Plan", May 1972, by Camp, Dresser, and McKee (CDM).

TABLE 2

APPLIED WATER
UNDER SELECTED CONDITIONS OF PRECIPITATION
LOS OSOS HYDROLOGIC SUBAREA
(in acre-feet)*

Subarea	Urban			Irrigated Agriculture			Totals		
	Average low	Average	Average high	Average low	Average	Average high	Average low	Average	Average high
1	600	600	600	30	20	20	630	620	620
2	150	150	150	50	40	40	200	190	190
3	140	140	140	1,320	990	860	1,460	1,130	1,000
4	10	10	10	70	50	40	80	60	50
5	10	10	10	0	0	0	10	10	10
TOTALS	910	910	910	1,470	1,100	960	2,380	2,010	1,870

* Rounded to 10 acre-feet

TABLE 3

CONSUMPTIVE USE OF WATER UNDER SELECTED PRECIPITATION CONDITIONS LOS OSOS HYDROLOGIC SUBAREA

(in acre-feet)*

Subarea	Urban			Irrigated agriculture			Non-irrigated and undeveloped			TOTALS		
	Average low	Average	Average high	Average low	Average	Average high	Average low	Average	Average high	Average low	Average	Average high
1	250	250	250	20	10	10	1,300	1,700	1,960	1,570	1,960	2,220
2	60	60	60	40	20	20	2,280	3,280	3,700	2,380	3,360	3,780
3	70	70	70	980	560	480	2,480	3,320	3,620	3,530	3,950	4,170
4	0	0	0	50	30	20	6,630	7,960	8,290	6,680	7,990	8,310
5	0	0	0	0	0	0	4,340	4,870	4,930	4,340	4,870	4,930
TOTALS	380	380	380	1,090	620	530	17,030	21,130	22,500	18,500	22,130	23,410

* Rounded to 10 acre-feet

Total applied water under 1972 land use conditions was estimated at a little over 2,000 acre-feet per year. From this quantity, a little over 1,000 acre-feet, or 50 percent, is lost from the system through consumptive use. The remaining 50 percent is return flow to the Basin.

3. GEOLOGY

To understand the movement, quantity, and quality of ground water of the Basin, it is important to have a knowledge of both surface and subsurface geology -- the kinds of rocks and structures that affect infiltration of surface water and ground water movement. For this study, the information obtained from previous investigations and data is employed to develop this understanding, particularly data in DWR Bulletin No. 63-6, "Sea Water Intrusion: Morro Bay Area, San Luis Obispo County".

For the purposes of this investigation, geologic formations have been divided into water-bearing and nonwater-bearing groups (Figure 2).

Water-bearing Group

Water-bearing sediments consist of Pleistocene and Recent age marine and nonmarine sand, gravel, silt, and clay; they comprise the Los Osos Basin. This group is of primary concern, inasmuch as it is the main source of ground water and is subject to sea-water intrusion when ground-water withdrawals are maintained in excess of recharge. It consists of Recent dune sand and alluvium, older sand dunes, and the Paso Robles Formation. The water-bearing sediments thicken in a seaward direction.

Recent Dune Sand (Qs). This sand is very fine-to-medium-grained and wind-blown. It conformably overlies the upper Pleistocene old dune sand along the surface of the baymouth bar, which forms the western shore of Morro Bay. Recent dune sand may be as much as 25 feet thick, extending to a maximum width of about 1,000 feet. On the baymouth bar, this active sand moves between the different old dune hillocks (some as much as 100 feet high) and also progresses eastward to form tonguelike projections into the Bay.

Although insignificant in terms of ground-water production, the sand probably exhibits permeabilities in the range of from 200 to 300 gpd/ft^2. It is in hydraulic continuity with the underlying old sand dunes and the ocean.

Alluvium (Qal). Clay, silt, sand, and gravel derived chiefly from Franciscan lithologic units constitute the Recent alluvial deposits. These deposits are adjacent and parallel to the streams, and, as a rule, lie unconformably on Franciscan bedrock.

However, where Los Osos Creek bisects the old dune sand deposits, Recent materials are in unconformable contact with what are believed to be Paso Robles sediments. The Recent materials attain an estimated maximum thickness of at least 70 feet near the mouth of Los Osos Creek.

The finer-grained silt and clay in the Recent alluvium appear to be complexly discontinuous throughout their extent. However, locally there are semiconfined-to-confined ground-water conditions. Wells constructed in the sand and gravel produce from 20 gallons per minute (gpm) to 50 gpm. Based on specific capacity data, permeabilities in these alluvial sediments exceed 300 gpd/ft^2.

Old Dune Sand (Qso). Upper Pleistocene old dune sand deposits are composed of fine-to-medium-grained arkosic sand with thin clay, silt, and gravel interlayers. Individual clay beds do not extend laterally any great distance and interfinger with sand, which provides the means for vertical movement of water. The sediments are believed to have been deposited offshore and on land by wind and streams under conditions of rising and lowering sea levels and during this time some of the land was occasionally inundated by the sea. Deposition is continuing under similar conditions.

Partially terraced, the sediments overlie unconformably lower Pleistocene deposits throughout most of their areal extent in the central portion of the Basin.* Northeast of Los Osos Creek, these deposits unconformably overlie Franciscan bedrock. Along the southern edge of the ground water basin, they unconformably overlie undifferentiated Monterey and Franciscan rocks. Toward the southwestern coastal extremity of the study area, Pleistocene gravels may be buried beneath unconformable old dune sand. In a wildcat oil exploration hole, Spooner No. 1 (30S/10E-24Fa), gravel is found at elevations higher than 160 feet above sea level. (See Appendix B, indentification systems used in this report.)

At 30S/11E-23C1 old dune sand was penetrated to a depth of 60 feet from ground surface, with the bottom at 15 feet above sea level. From 60 feet to a depth of 631 feet, principally continental silt and clay deposits were penetrated. These silts and clays contain an abundance of reworked diatoms and radiolarians, which suggest that they may be Pliocene sediments. Sediments containing reworked diatoms and radiolarians have not been looked for elsewhere in the study area except in the DWR test wells.

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* Previous investigators have referred to these truncated deposits as "marine terrace deposits"; however, in this report they are termed "old dune sand".

At drill site MBO-5 (30S/10E-12J1), old dune sand is about 70 feet thick. It probably underlies most of Morro Bay and is partially exposed on the barrier bar.

The thickness of these sediments in Los Osos Valley varies widely due to the undulating topography. Generally, thicknesses of as much as 150 feet (at wells 30S/11E-8M1 and -8H1) have been penetrated. The sediments thin to a feather-edge as they contact the consolidated lithologic units that form the Irish Hills. South of the Bay, sand dunes have been deposited against the Irish Hills from sea level to a height of more than 800 feet.

In the Baywood Park-Los Osos area, upper Pleistocene sand is the most important source of ground water for municipal, domestic, and irrigation uses.

Because this old dune sand contains only discontinuous silt and clay lenses, no apparent semiperched water zones are formed. Also, the dunes readily absorb precipitation and probably transmit ground water to the underlying lower Pleistocene deposits.

Transmission of ground water through the old dune sand has produced an area of springs along the southeastern shore of Morro Bay at the northwestern corner of Section 18, Township 30 South, Range 11 East (Figure 2). In 1970, it was reported that at the northeast corner of Section 11, Township 30 South, Range 10 East, there was a surface depression, formed within old dune sand, from which spring water also flowed. The velocity of ground water movement through the sands is estimated to range in the order of 3 to 6 feet per day or about 1,100 to 2,200 feet per year. Local semiconfining fine-grained layers probably create above-sea-level-pressure heads. Yields of wells penetrating old dune sand range from 10 to about 500 gpm.

Estimates based on specific capacity indicate that this sand exhibits moderate permeabilities, ranging from 200 to 400 gpd/ft^2.

Paso Robles Formation (Qpr). The oldest water-bearing zone, or aquifer unit, is in the portion of the lower Pleistocene equivalent in age to the Paso Robles Formation in other areas.

At drill site MBO-5, near the synclinal axis of Los Osos Valley, Paso Robles deposits were initially encountered at about 100 feet below ground surface, or approximately 95 feet below sea level. There the Paso Robles interval continues to about 390 feet below ground surface, where Franciscan bedrock was encountered (Figure 3).

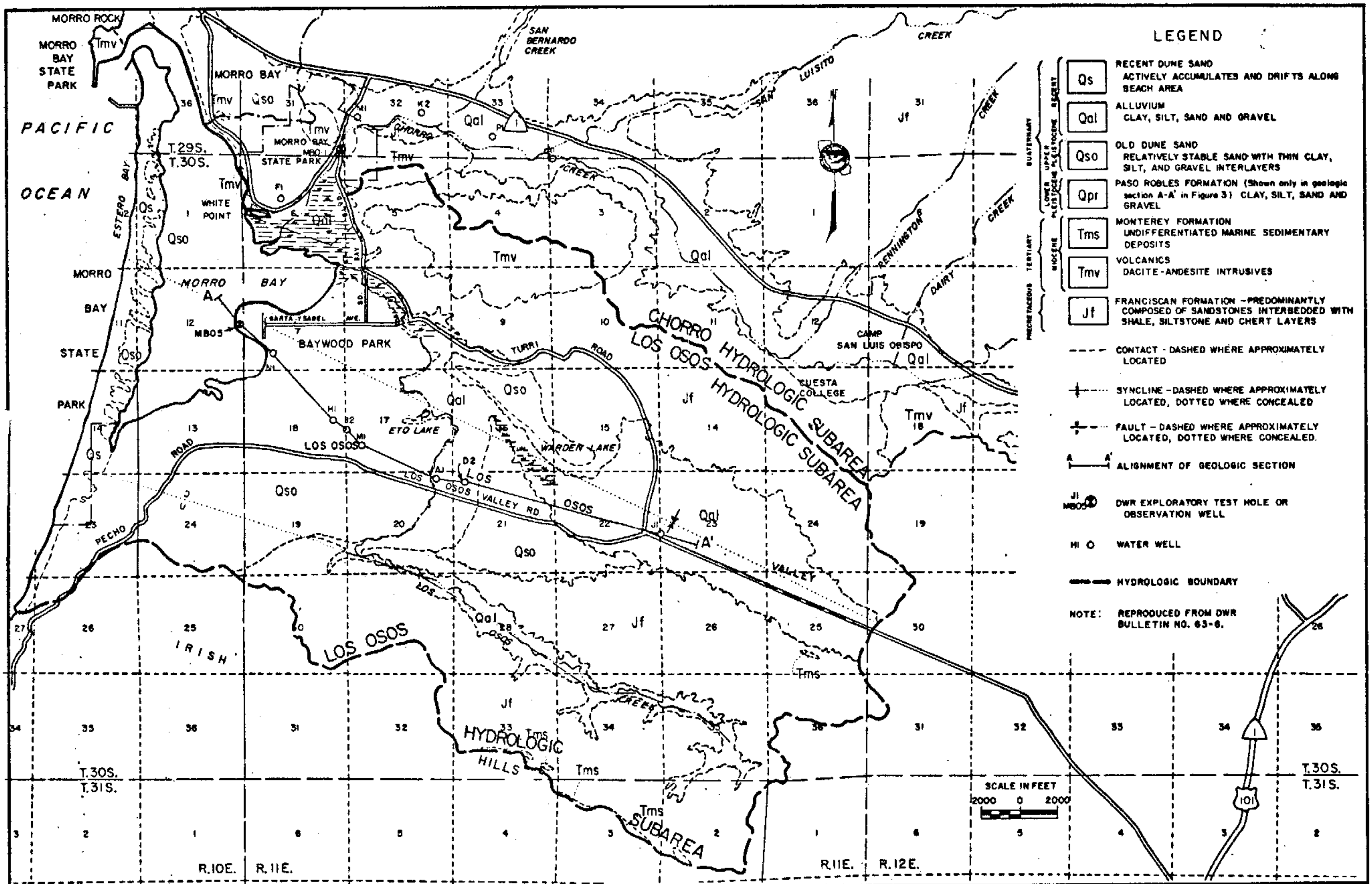

Figure 2—AREAL GEOLOGY

DEPARTMENT OF WATER RESOURCES, 1973

The upper 60 feet of the Paso Robles Formation consist of silt and clay that separate the sand and gravel from the overlying upper Pleistocene old dune sand deposits.

The upper hydraulically confining member probably is a separator to preserve the freshwater zones that extend from Los Osos Valley to beneath Morro Bay and still farther offshore. Because the sediments forming the Paso Robles Formation have been flushed by fresh water since their deposition, they are probably in hydraulic continuity with the ocean. DWR Bulletin No. 63-6 reports that:

"On the U. S. Coast and Geodetic Survey bathymetric map of 1967, the sea floor topography offshore from Morro Bay is shown as smooth and slopes gently seaward for at least 10 miles. Because of an apparent absence of nearshore submarine canyons, drainage from the study area during the lowering of sea level at the end of the Wisconsin Glacial Stage may have been insufficient to bisect the seaward extensions of the Paso Robles sediment. Therefore, the subsea extent of these sediments provides an excellent potential for substantial amounts of fresh water in storage if the upper Pleistocene hydrogeologic data obtained at MBO-5 prevails west of Morro Bay.

"On the basis of the relatively smooth ocean-bottom bathymetry west of Morro Bay, the Paso Robles sediments are thought to extend offshore for at least 10 miles, where elevations are 400 to 450 feet below sea level. A series of offshore geologic studies* by the U. S. Geological Survey (USGS) indicated that the deepest part of the offshore basin (Quaternary sediments) trends northwest-southeast and projects landward to Los Osos Valley. However, the quality of the records makes a determination of the thickness impossible.

"(The onshore hydrogeologic regimen of the Recent alluvium suggests that the offshore extension of these sediments is very limited and that these materials are probably not capable of storing significant volumes of fresh water.)".

Few wells have been perforated in the Paso Robles aquifer. Except for Well MBO-5, none produces solely from this formation because all are perforated in the younger overlying aquifer sediments also, or convey water via a gravel pack.

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* As part of the offshore geologic studies conducted by the Office of Marine Geology of the USGS, four offshore geophysical profiles were run in the area west of Morro Bay in June 1968. A deep-penetration, high-energy sparker system was used to obtain data on bedrock and the depth to basement. Because a high-energy seismic system was used, only an approximation of the areal distribution and thickness of Quaternary sediments was derived.

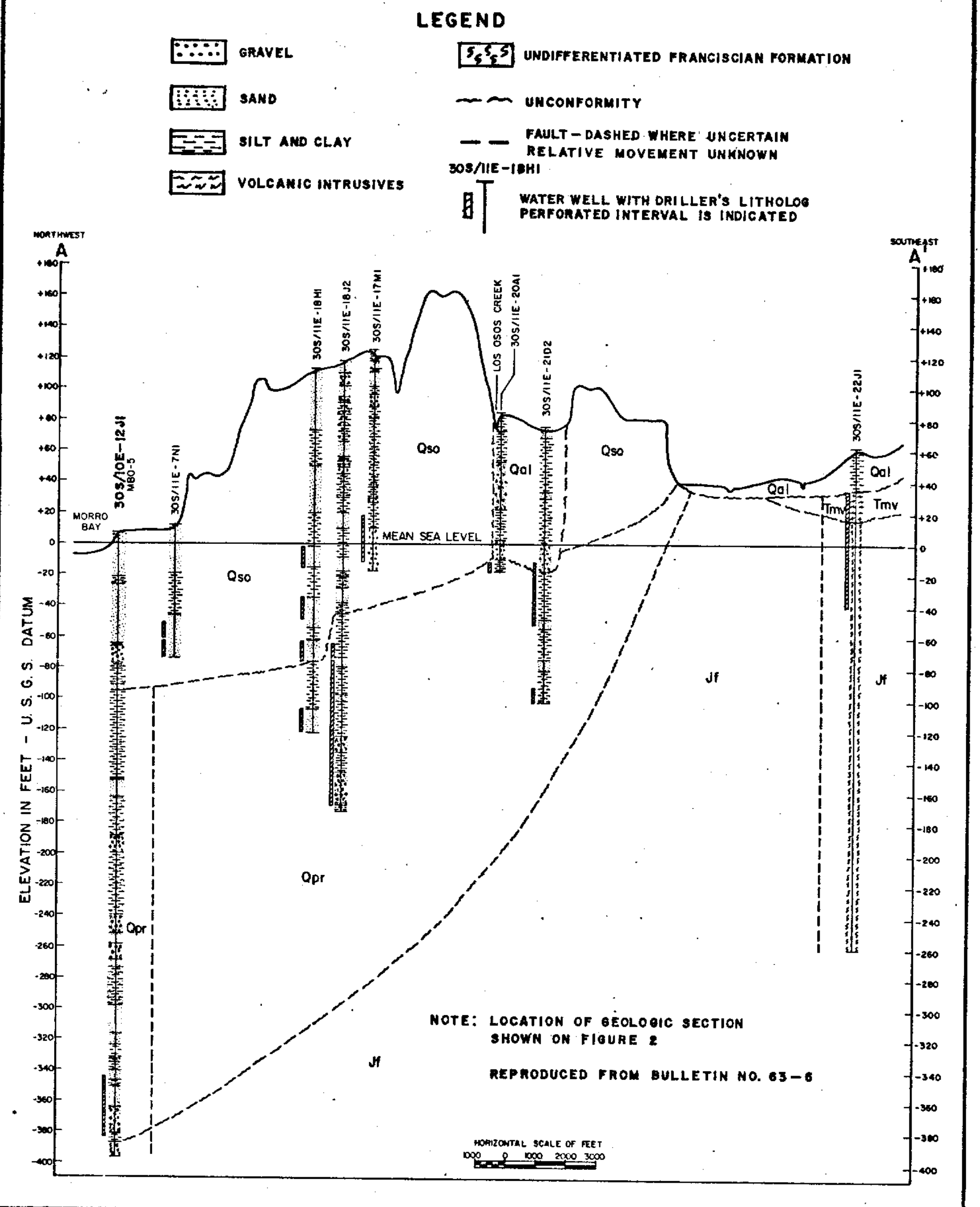

Figure 3 – GEOLOGIC SECTION A-A'

Tests have not been conducted to determine the physical characteristics of the Paso Robles Formation (coefficients of permeability, transmissibility, and storage). However, according to the MBO-5 lithologic and electric logs, the coarse materials probably exhibit high permeabilities -- in excess of 500 gallons per day per square foot (gpd/ft^2).

Nonwater-bearing Group

The nonwater-bearing group includes marine sediments of Miocene age, nonmarine sediments of Jurassic age, and volcanic rocks of Miocene age. Rocks classified as nonwater-bearing usually yield negligible quantities of water to wells.

Monterey Formation (Tms). Undifferentiated marine sedimentary deposits of Miocene age, usually referred to in this report as constituting the Monterey Formation, unconformably overlie the Franciscan Formation along the southern flank of Los Osos Valley in the Irish Hills. The shales (which grade into siltstones) predominate in this area. For this study, all other Miocene deposits in the Irish Hills also have been considered as part of this Formation.

Because they are impermeable, these materials are capable of transmitting water only through joints, fractures, and bedding planes, which provide limited avenues for movement of water.

Franciscan Formation (Jf). The earliest geologic phase in the study area is represented by the Franciscan Formation, which is predominantly composed of greenish-gray gray-wackes (sandstones). The Formation is thought to be more than 15,000 feet thick, but its lower boundary remains unknown. It forms the major part of the Santa Lucia Range and the eastern part of the San Luis Range.

It is the bedrock, or basement complex, that underlies the entire study area. A log of a well drilled in Section 18, T30S, R11E, indicates serpentine (Franciscan Formation) was penetrated at a depth of 215 feet. Logs of deeper nearby wells do not show evidence of serpentine. However, the serpentine logged may represent a bedrock high or peak rising from the floor of the ground water basin. If this represents an isolated occurrence, the reduction in storage capacity over the estimated 95,000 acre-feet is negligible and may be no more than 75 acre-feet.

Because this formation is relatively impermeable, no water wells have been found that produce ground water directly from the Franciscan. However, through a system of joints, fractures, and weathered portions, this formation is capable of transmitting water derived from precipitation, which supplies perennial springs and partially supplies the flows of the intermittent streams. It also supplies subsurface water to the more permeable alluvial deposits on top of it and exposed along the sides of valley-fill areas.

Volcanic Intrusives. A series of dacite-andesite plugs have intruded the Franciscan Formation, the best known of which is Morro Rock. Southeastward from it, the remainder of the volcanic plugs trend linearly, suggesting that the intrusions occurred along a zone of structural weakness.

The intrusives are considered nonwater-bearing because they are essentially impermeable and would be capable of transmitting water only along joints and fractures.

Geologic Structure

Even though extensive deformational activity undoubtedly occurred along the coast before Miocene time, surface evidence for those structural events is scarce.

Folds. In the study area, the most prominent fold is the northwest-southeast-trending synclinal depression that delimits the Los Osos Ground Water Basin. This syncline is the principal surface feature that separates the San Luis Range from the Santa Lucia Range in the study area.

Local deformation of the Franciscan lithologic units has undoubtedly also occurred as a result of volcanic intrusion during Miocene time. However, because of extensive soil cover and few outcrops, folding attitudes along the andesite-dacite plug alignment are not easily distinguishable and are therefore difficult to ascertain.

Faults. Generally, surficial fault features are sparse in the study area and available subsurface hydrogeologic information does not suggest the presence of barriers to ground-water flow.

During the intense deformation that occurred in late Miocene time the Los Osos Valley syncline may have been faulted along its axis. This may have caused a corresponding subparallel zone-of-weakness fracture that became suitable for the emplacement of intrusives now represented by the series of volcanic cones.

The fault, which is covered by alluvial sediments in Los Osos Valley, probably extends offshore from Morro Bay. A second fault trends along the longitudinal extent of Clark Valley, paralleling the Los Osos Creek streambed and probably extends beneath the old dune sand marine terraces northwest of the western end of Clark Valley. Possibly the fault continues seaward along an alignment between DWR's exploratory hole

MBO-5 and the southern shore of Morro Bay. Near MBO-5, upward vertical displacement seems to have occurred south of the fault.

4. HYDROLOGY

The sole source of water is precipitation and runoff originating in the watersheds. They replenish the ground water, which is pumped and used.

Precipitation

Since July 1966, precipitation data have been collected by the Baywood Park County Water District.

DWR correlated these data with four neighboring precipitation stations in order to extend the Baywood Park County Water District records back to the 1955-56 season, July 1 to June 30 (Table 4). The data indicate that the lowest precipitation during the period studied occurred as recently as the 1971-72 season and the highest during the 1957-58 season. Average seasonal precipitation for the 17-year period is 15.5 inches at the Baywood Park County Water District Station.

Annual rainfall on the valley floor averaged about 15.5 inches from 1955-56 through 1971-72. In the tributary areas, precipitation increases with elevation; but an analysis of an isohyetal map indicates that annual rainfall at the higher elevations averages about 20 inches.

Figure 4 is reproduced from an isohyetal map of San Luis Obispo County prepared by SLOCFC&WCD. It depicts the mean seasonal precipitation over the entire Basin from 1935-36 through 1966-67.

Average rainfall volumes (rounded to 100 acre-feet) for the period of record were determined from existing precipitation data for the average low, average, and average high precipitation conditions (Table 5). The average low and high were determined by averaging the departures from average precipitation. The low is based on 10.9 inches in the alluvium and 14.0 inches on tributary areas; the average on 15.5 inches and 20 inches; the high on 22.0 inches and 28.4 inches. From the table it can be seen that rainfall under "average" conditions can amount to about 27,000 acre-feet a year on the study area. Only a small portion of this amount percolates deeply. Most of it is lost through evapotranspiration and the remainder becomes surface runoff to the Bay.

TABLE 4

SEASONAL PRECIPITATION
BAYWOOD PARK COUNTY WATER DISTRICT STATION
LOS OSOS BASIN

Season	Precipitation in inches
1955-56	17.86
1956-57	11.07
1957-58	31.29
1958-59	9.46
1959-60	13.9
1960-61	9.64
1961-62	19.19
1962-63	17.55
1963-64	10.74
1964-65	15.79
1965-66	11.2
1966-67	23.06
1967-68	10.77
1968-69	29.43
1969-70	9.41
1970-71	14.27
1971-72	8.15

TABLE 5
SEASONAL PRECIPITATION
LOS OSOS HYDROLOGIC SUBAREA
(in acre-feet)*

Subarea	Average low	Average	Average high
1	1,500	2,200	3,100
2	2,300	3,300	4,600
3	3,100	4,400	6,300
4	6,900	9,900	14,100
5	5,000	7,200	10,200
TOTALS	18,800	27,000	38,300

* Round to 100 acre-feet

Surface Water

The study area is drained principally by Los Osos Creek. From its headwaters in Clark Valley, it flows to the northwest 4 miles to Los Osos Valley where a 1/4-to-1/2-mile-wide alluvial flat has been formed. In the upper part of the flat, Los Osos Creek has cut its bank to a depth of as much as 16 feet. Thereafter, it trends northward for 2 miles, along the eastern edge of the old dune sand deposits, draining into a tidal estuary to the eastern end of Morro Bay. Eto Lake, a small impoundment of a minor tributary to Los Osos Creek, is in this vicinity.

An unnamed tributary which flows intermittently in its upper reaches rises 6 miles in from Morro Bay, drains the central portion of Los Osos Valley, and flows northwest. Halfway down its length, it supplies most of the water that flows into Warden Lake, a marshlike depression. From there, it flows another 2 miles and merges with Los Osos Creek just before the latter empties into Morro Bay.

Under low, average, and high precipitation conditions (Table 5), volumes of surface runoff (rounded to 100 acre-feet) were estimated at 1,500, 5,800 and 15,700, acre-feet, respectively. The volumes account for the water lost by consumptive use of precipitation and surface runoff.

Surface runoff to the Bay occurring under low, average, and high rainfall conditions amounts to about 700, 2,700, and 7,300 acre-feet annually. The value of surface water runoff to the Bay is the difference between estimates of volumes of deep percolation and the total volume of surface water runoff occurring from precipitation. The data in Plate 2 show the relative volumes of surface runoff inflow-outflow of each subarea.

There are no surface-water-gaging stations in the study area. In January 1973, SLOCFC&WCD installed a standard crest gage in Los Osos Creek, at Los Osos Valley Road, but it was destroyed soon after, on January 18, 1973, by heavy runoff. At that time, the flow was estimated at a gage height of over 6 feet*. On June 6, 1973, runoff was measured at four locations along Los Osos Creek (Figure 4 and Table 6).

Surface flow at 30S/11E-28F (in the lower Clark Valley) is perennial along this reach of Los Osos Creek, whereas upstream flow may not occur during some periods of the year.

Higher flows at 30S/11E-20G (south of Los Osos Valley Road) are due to seepage along Los Osos Creek and tributary surface flow. Irrigation return adds to the flow also.

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* Oral communication, Glenn A. Britton, SLOCFC&WCD, June 11, 1973.

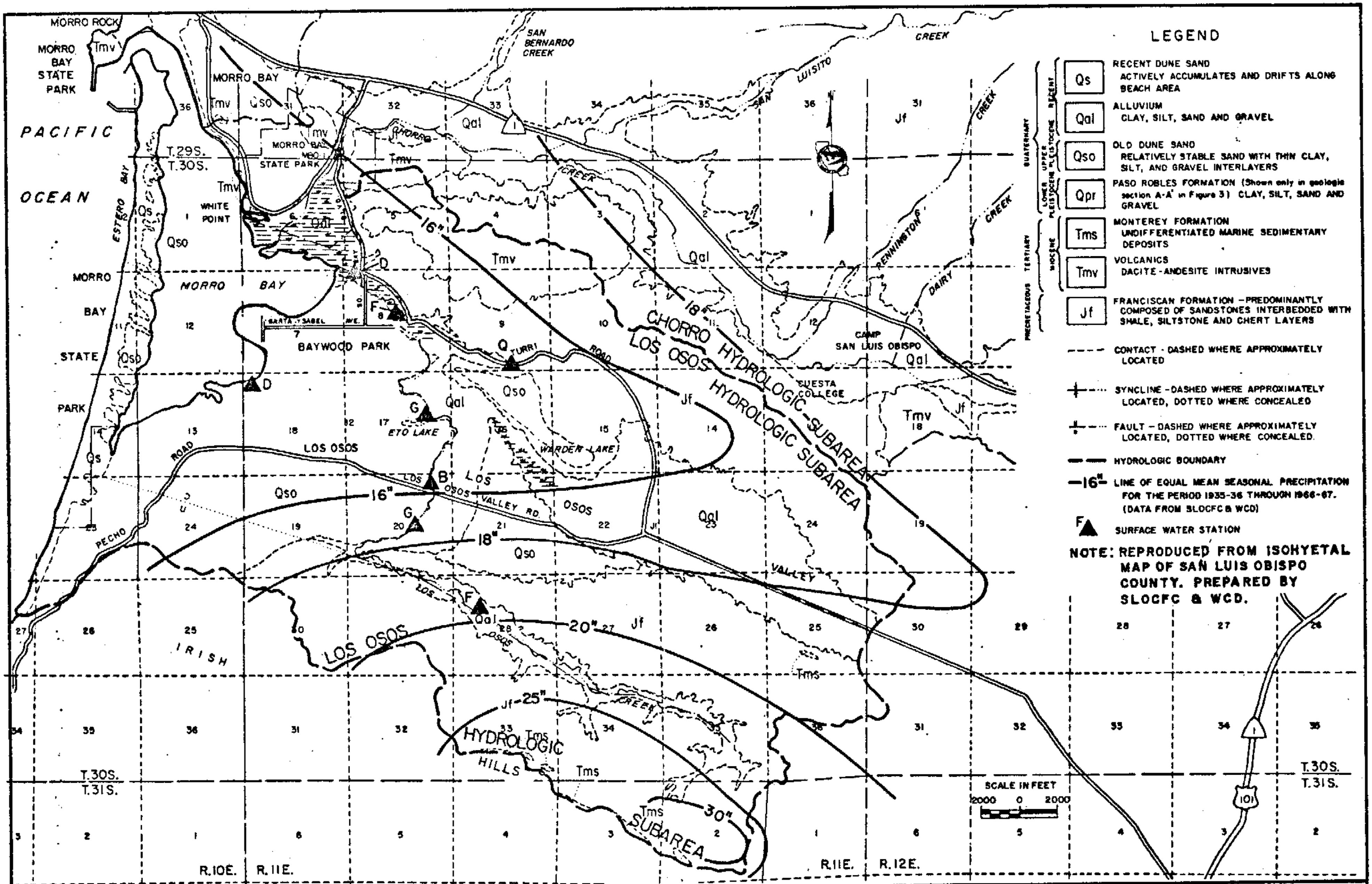

Figure 4—ISOHYETS AND SURFACE WATER STATIONS

DEPARTMENT OF WATER RESOURCES, 1973

In the area of 30S/11E-8F (near Santa Ysabel Avenue, extended), numerous branching flows occur in the wide, soft, muddy channel of Los Osos Creek, impeding measurements of flow. An estimate of total flow below tributary drainages into Los Osos Creek is 1.7 cubic feet per second (cfs), about 0.7 cfs is due to contributions by tributary flow.

Flow measured at 30S/11E-8D (at highway bridge) has been estimated at 3.4 cfs. A portion of it results from side flow or seepage from the higher elevated portions of the sediments in the channel after saturation with sea water during high tide.

Data indicated that there has been a gain in surface water flow of 1.5 cfs at 30S/11E-20G, a loss of 1.4 cfs at 30S/11E-8F (seepage also contributes to flow above 30S/11E-8F), and a gain of 1.7 cfs, which is partially sea water, at 30S/11E-8D.

Eto and Warden Lakes are the only known natural bodies of fresh water in the area. Eto Lake is partially sustained by seepage from irrigated agriculture, and surface outflow from it is to Los Osos Creek. Warden Lake is a natural depression in a nameless tributary of Los Osos Creek.

Volumes of deep percolation of runoff are not based on measurements, but represent the relative magnitudes that might be expected for soils in the Basin. Volumes of deep percolation shown on Plate 2 also include deep percolation of applied water, and have been rounded off to 100 acre-feet. The following relates to deep percolation of runoff under average precipitation conditions: In Subareas 1 and 2, about 85 percent of the water percolates deeply into the old dune sand which has a high infiltration capacity, the remaining 15 percent becoming surface runoff to the Bay and Los Osos Creek.

In Subarea 3, the alluvium consists of finer-grained sediments with low infiltration capacity. However, major deep percolation of surface runoff occurs in drainage channels. About 45 percent percolates deeply, the remaining 55 percent flowing to drainage tributary to Los Osos Creek and then to the Bay. Deep percolation in Los Osos Creek is estimated at 50 percent of the surface flow.

Subarea 4 is underlain by bedrock covered with a thin soil mantle, and it is here that precipitation rates are the highest. About 20 percent percolates deeply. However, much of it emerges as surface flow to Los Osos Creek via springs and seepage along the valley floor. As a result, alluvium along the valley floor is mostly saturated because of continuous flow in Clark Valley.

TABLE 6

RUNOFF IN LOS OSOS CREEK, LOS OSOS BASIN
JUNE 6, 1973

Location	Flow in cfs*
30S/11E-28F (Lower Clark Valley)	0.8
30S/11E-20G (0.4 miles south of Los Osos Valley Road)	2.4
30S/11E-8F (Santa Ysabel Avenue, extended)	1.7
30S/11E-8D (at Highway Bridge)	3.4

* At time of measurement

Subarea 5 is underlain by bedrock with a thin soil mantle where about 20 percent of the runoff percolates deeply, much of which moves into the Basin, 50 and 30 percent of the surface flow from 1,900 acres in the northwest portion of the subarea flows to the Bay and to Subarea 3, respectively. Flow from the remainder of Subarea 5 is to upper Los Osos Valley, Subarea 3. This results in an additional 45 percent of the volume of surface inflow to deep percolation, the remainder flowing to the Bay.

Surface water is lost by evapotranspiration, by outflow to Morro Bay, and by deep percolation.

Ground Water

Ground water is found in the Basin's Recent and Pleistocene sediments -- the Recent alluvium, Pleistocene old dune sand, and lower Pleistocene Paso Robles Formation. These sediments comprise the principal source for domestic, municipal, and agricultural uses.

Ground Water Replenishment. Major ground water replenishment is by deep percolation of runoff in drainage channels, chiefly Los Osos Creek, and, to a lesser extent, deep percolation of precipitation, which occurs over the entire study area. Percolation of precipitation into joints, fractures, and other openings in bedrock or hard rock contributes to springs and the Basin by side flow at lower elevations. Such water mixes with surface and ground water flow. This occurs most visibly in Clark Valley, where surface flow occurs during most of the summer when there is little or no rainfall.

Annual replenishment from surface runoff to the study area under low, average, and high precipitation conditions is estimated at 800, 3,100 and 8,400 acre-feet respectively.

Under long-term high precipitation volumes, volume of deep percolation would be on a decreasing trend because of the increasing saturated volume of the Basin, and surface water flow volume would have an increasing trend.

The Recent alluvium is comprised of semiconfining-to-confining members in the floodplain, and replenishment is through side flow of deep percolation of precipitation and infiltration of surface water in drainage channels. In Subarea 3, annual replenishment from surface runoff under low, average, and high precipitation volumes is estimated at 500, 1,900, and 4,600 acre-feet, respectively.

In some areas of Recent alluvium incised by Los Osos Creek, clay beds directly underlying the Creek impede deep percolation of surface water. One such area is northerly of Los Osos Valley Road. The depth of the bed of Los Osos Creek is about 16 feet, whereas depth to water in SWN 30S/11E-20B2 (not in use) on the west bank was 24 feet in June 1973 (Figure 5). When -20B1 was drilled in 1967 water was first encountered at a depth of 20 feet; after completion of the well, depth to water was 58 feet, and in May 1973 it was 49.6 feet. In another well, 30S/11E-20A1 (north of -20B1), water was first encountered at a depth of 30 feet. The well, constructed with a gravel pack, had a depth to water of 15 feet after completion.

Data from -20A1 and -20B1 indicate an unsaturated zone underlying Los Osos Creek in this area and since 1967 levels have been rising. Both wells pump water from the Paso Robles Formation.

The old dune sand is replenished by deep percolation of precipitation, side flow from deep percolation along the lower elevations of the Irish Hills, and infiltration of surface water flows, principally from Los Osos Creek. Because of the relatively high infiltration capacity of the sand, surface water runoff is negligible. However, during periods of flow, the water in a drainage channel incised in the old sand dunes discharges into Eto Lake.

Annual replenishment from surface runoff and subsurface inflow to Subareas 1 and 2 under low, average, and high rainfall volumes is estimated at 500, 1,700, and 5,000 acre-feet, respectively. The values include 50 percent of the deep percolation from surface water flow from Clark Valley and about 90 percent of subsurface flow from Subarea 3. Contributions from deep percolation in Subareas 4 and 5 could add an additional amount estimated to be 40 percent of the volume of deep percolation. Under average conditions replenishment to Subareas 1 and 2 should exceed estimated subsurface outflow.

The Paso Robles Formation is replenished in areas where it is in hydraulic continuity with Recent alluvium, old dune sand, and along the Basin margins at depths where it intercepts seepage from bedrock.

Domestic water after use is returned to the ground water basin via disposal to septic tanks and leach fields. Estimated volume of water returned to Subareas 1 and 2 by these means was 280 acre-feet in 1972. About 300 acre-feet of the water delivered to consumers in Subareas 1 and 2 was consumptively lost.

In some wells, the volume of waste water returned to the Basin is reflected by rising ground water elevations, particularly Well No. 30S/11E-18Q1 (not in use), and, to a lesser degree, Well No. 30S/11E-7Q1, where extractions amount to about 70 acre-feet annually.

Water used for irrigated agriculture varies in volume, depending on the volume of precipitation. For low, average, and high precipitation, the volume of irrigation water returned to the Basin is about 400, 500, and 400 acre-feet a year, respectively. Most of the irrigated agriculture is in Subarea 3.

Movement and Discharge of Ground Water. Water that has infiltrated the subsurface materials moves from areas of higher hydraulic head to those of lower head. Under nonpumping conditions, ground water moves down the hydraulic gradient toward the lowest elevations of the aquifer systems.

Subsurface flow is to the west and north except where it is affected by heavy pumping (Figure 5). The lines of equal ground water elevation (ground water contours) in the Recent alluvial areas under natural conditions would represent piezometric or pressure surfaces. In those alluvial areas, the aquifer systems are overlain and confined by relatively less permeable sediments (silt and clay), which cause water levels to rise in wells to elevations above the top of the aquifers. Ground water contours shown in the old dune sands represent the water-table surface. Such water-table elevations represent nonpressure conditions because the old dune sand is not confined by overlying silt and clay. However, an exception to this is 30S/11E-7N1, where, after completion of the well, ground water rose 4 feet.

Ground water in the Paso Robles Formation is under pressure -- at least, at the lower coastal end of the Valley. Many wells penetrate the Paso Robles formation, but only one, 30S/10E-21J1, yields water under pressure solely from this zone. Under natural conditions, flow from this 2-inch-diameter well is estimated at 300 acre-feet a year. The other wells also yield water from the Recent alluvium or the old dune sand, via perforations in the well casing and or gravel packed around the well casing.

Fluctuations in water-table elevations at selected wells in the Los Osos Ground Water Basin are depicted in Figure 6. Only infrequent measurements are available for wells in Recent alluvium.

Since the 1950's, water-table elevations obtained near Baywood-Los Osos have ranged from 1 foot to about 73 feet above sea level. The highest levels are those for well 30S/11E-18Q1, which has not been in use since the late 1960's. Conversely, the lowest water-table elevations obtained during pumpage occurred in 1971 at the Baywood Park-Los Osos community supply well 30S/11E-18K1. The lowest elevation, about 100 feet below sea level, took place during the summer of 1971. This well, which has a depth of 254 feet, penetrates Paso Robles sediments.

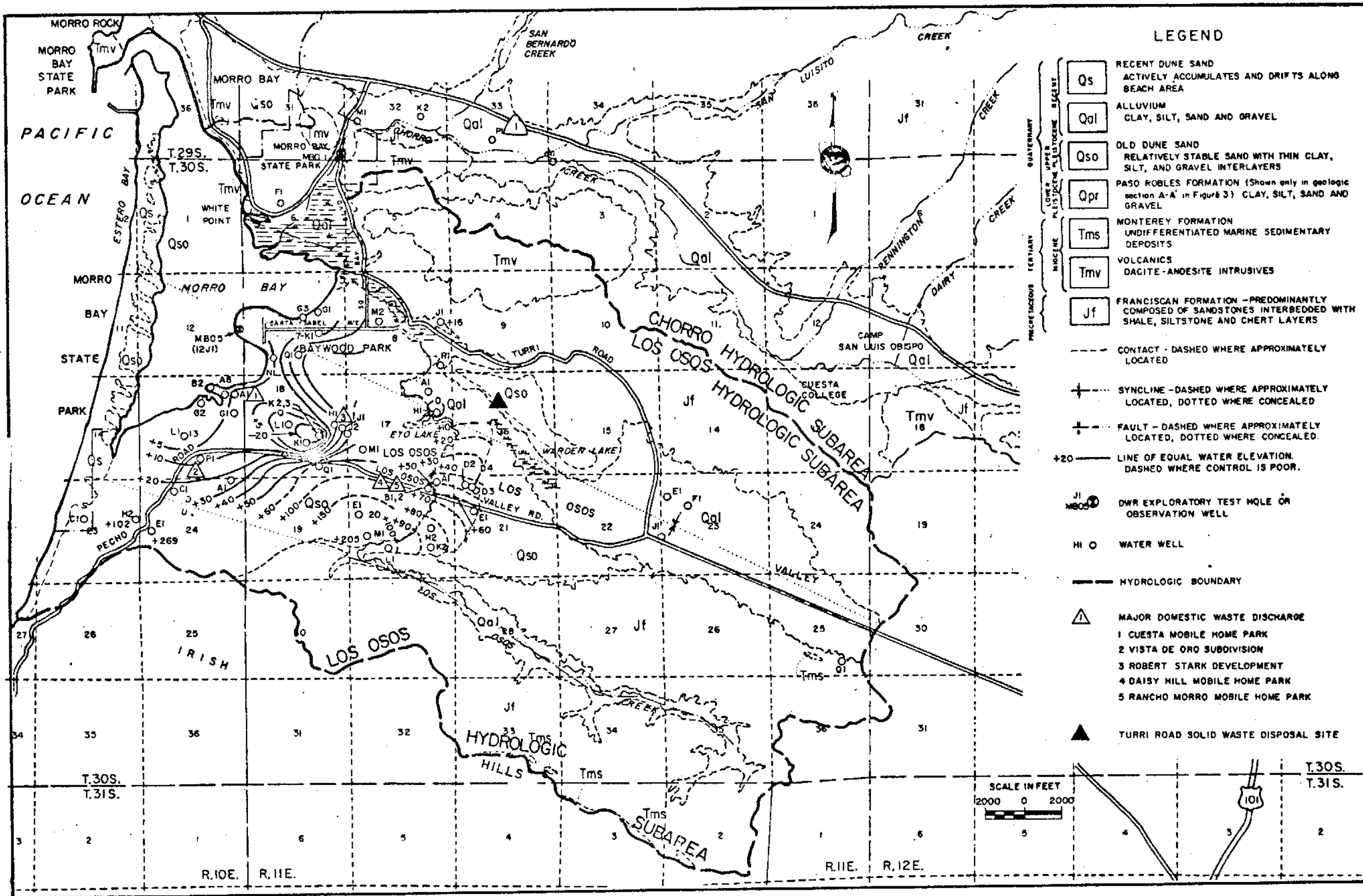

Figure 5-LOCATIONS OF WELLS, WASTE DISCHARGERS, AND GROUND WATER ELEVATIONS AS OF MAY AND JUNE 1973

DEPARTMENT OF WATER RESOURCES, 1973

In general, water-table levels are higher during the spring and lower during the fall. Except for localized water table depressions caused by pumpage, overall subsurface flow is toward Morro Bay.

Within the Recent alluvium, the piezometric surface elevation control is negligible, as can be seen in Figure 6 for levels for 30S/11E-20K2 recorded in the mid-1950's.

Under prolonged pumping, when the water is drawn below a confining zone, water is considered unconfined until such time as pressure in the confining zone recovers. In SWN 30S/11E-17A1, heavy pumping dewatered a shallow water-bearing zone; after pumping stopped, water could be heard cascading into the well casing. The water level in this was 26.5 feet below sea level when measured. The actual drawdown is not known, since the pump had been shut down sometime before.

Static peizometric surface elevations of about 20 feet below sea level have occurred at Well No. 30S/11E-17H1, where drawdown elevations were as low as about 24 feet below sea level in the fall of 1967. A static elevation of more than 10 feet above sea level was obtained in the spring of 1968.

Excess ground water under Los Osos Creek discharges into Morro Bay. A portion of the water-table surface in the old dune sand of Los Osos Valley is represented by springs (northwestern corner of Section 18, Township 30 South, Range 11 East). These springs form a bog within a eucalyptus grove along the southern shore of the Bay. Here, water from the sand probably also flows beneath Morro Bay, where the water-table surface intersects the bottom of the Bay.

Ground water flowing out of the old dune sand discharges into two connecting ponds. The upstream pond is 300 by 40 feet, the downstream pond, 100 by 40 feet. The flow measured at the outlet of the lower pond was 135 gpm.

Ground water flow also was noted at the baymouth bar in 1970, as indicated by a spring in a topographic depression at the northeast corner of Section 11, Township 30 South, Range 10 East.

Ground water in the old dune sand and the Paso Robles Formation is being redistributed indirectly by human activity. The increase use of municipal water has resulted in the nonuse of many domestic wells. In areas where pumping has been reduced, ground water elevations have been rising through discharge of municipal water after use via septic tanks and leach fields. In a few areas, water levels in domestic wells are drawn down below the depth of the wells, resulting in their nonuse.

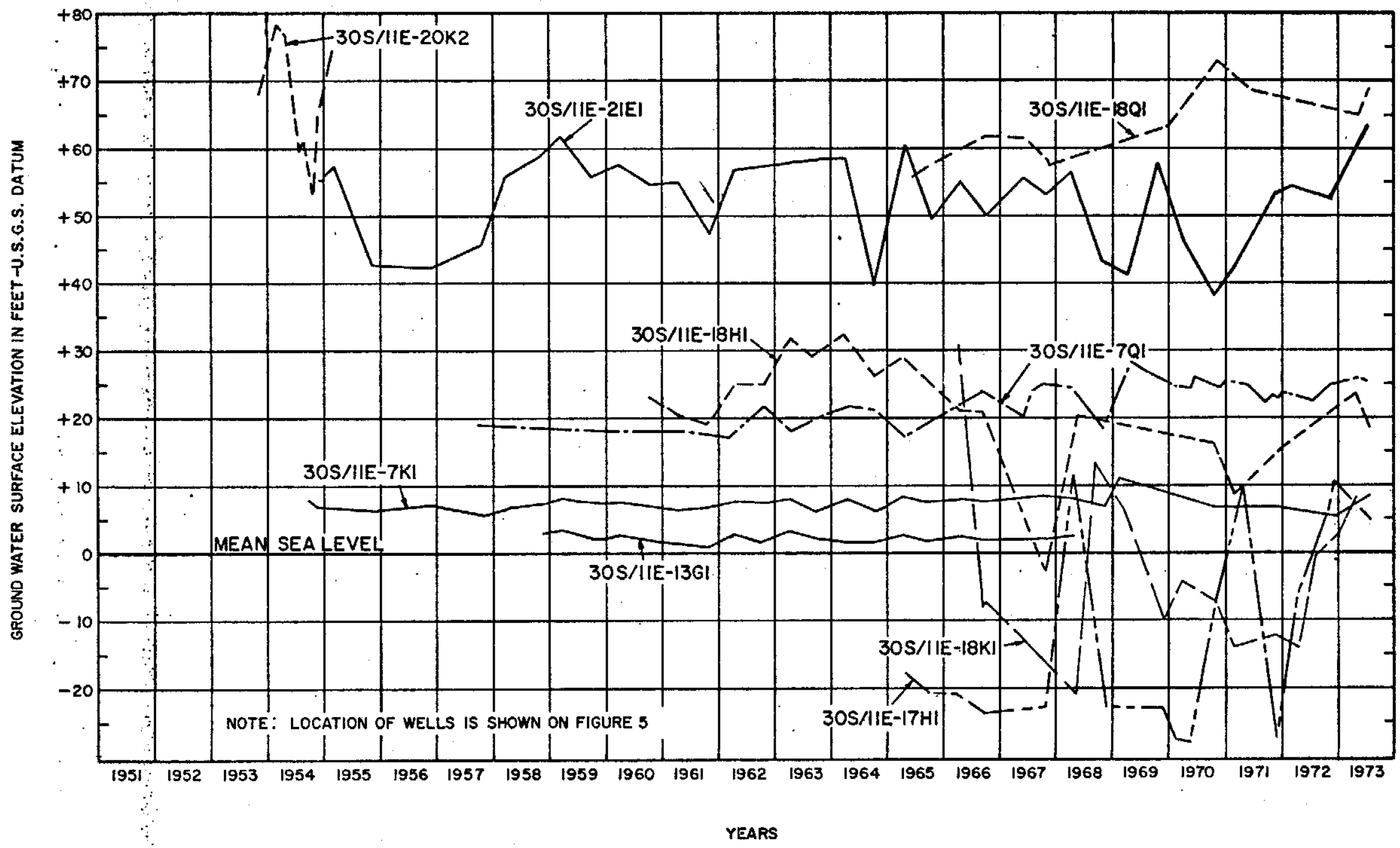

Figure 6 - WATER LEVEL TRENDS-LOS OSOS GROUND WATER BASIN

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1973

Some wells on the higher slopes penetrate shallow thicknesses of old dune sand and extend deeper into older nonwater-bearing formations. To maintain flow in wells, water pumped from them is no more than a few gpm.

Agricultural use of land on the old dune sand is increasing, and ground water for irrigation partially comes from the old dune sands, but mostly it comes from the lower Pleistocene Paso Robles Formation. This is particularly true of the municipal, irrigation, and domestic wells constructed during the last five years.

Figure 7 is a graphical presentation showing the volume of municipal ground water production from the Los Osos-Baywood area of the Basin for the periods shown. Beginning in 1970, the graph depicts a sharp rise in ground water production for the three water companies serving the Los Osos-Baywood area.

From 1955-56 to 1971-72, ground water production has increased from less than 100 to about 800 acre-feet per year. At the present rate, ground water production will exceed 1,500 acre-feet annually within the next 10 years. For the same period, service connections have increased from about 250 to 2,000 (Table 7). Moreover, in Subareas 1 and 2, individual domestic water users extracted an estimated additional 5 to 10 acre-feet per year. For irrigated agriculture it was about 65 acre-feet (Table 3). Total extractions for municipal, irrigation, and domestic uses for 1972 amounted to about 875 acre-feet per year.

Total volume of ground water extractions for the Basin is about 2,000 acre-feet.

Under natural conditions ground water is lost from the Basin by subsurface outflow. Springs form along the coastal margins, where ground water elevations are above sea level. They occur in the northwest corner of Section 18, T30S, R11E and, as of June 1973, flow at an estimated 135 gpm (220 acre-feet per year). This flow is reduced by evapotranspiration and infiltration before discharging to Morro Bay. Flow rates fluctuate with changes in ground water elevations. Based on limited data, it has been estimated that ground water outflow from the Basin is from 3,000 to 7,500 acre-feet per year, during longtime average and high rainfall.

Imported Water

San Luis Obispo County has contracted for 25,000 acre-feet per year from the State Water Project to meet the growing deficiency in the entire County. Initial delivery is scheduled for 1980.

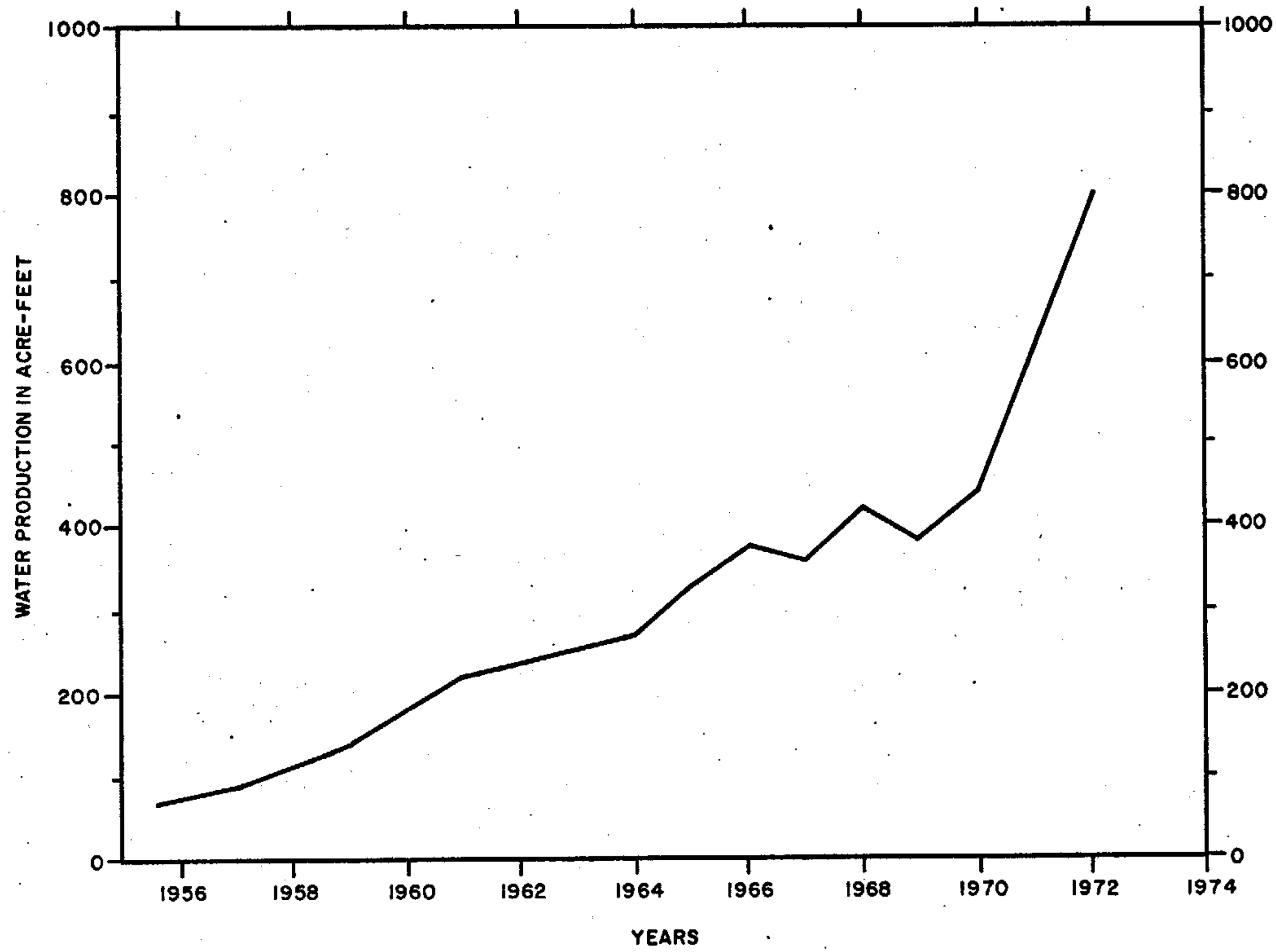

Figure 7-ESTIMATED MUNICIPAL WATER PRODUCTION IN ACRE-FEET, LOS OSOS-BAYWOOD AREA

DEPARTMENT OF WATER RESOURCES, 1973

TABLE 7

ESTIMATED SERVICE CONNECTIONS

SUBAREAS 1 and 2

LOS OSOS BASIN

Season	Cumulative number of service connections
1955-56	250
-57	300
-58	360
-59	430
-60	500
-61	580
-62	680
-63	780
-64	840
-65	920
-66	930
-67	1,000
-68	1,050
-69	1,120
-70	1,230
-71	1,520
-72	1,970

Requests have been made for a portion of the imported water for use in the Los Osos-Baywood part of the Basin.

Water from the State Water Project and the existing Nacimiento Reservoir are the two major significant water supply sources to meet the growing water deficiency. However, to get water to the user the conveyance and regulatory facilities must be planned and developed.

A number of alternatives and a recommended water supply system were prepared for the County of San Luis Obispo by CDM, Inc., Environmental Engineers, in their "Report on Waste Water and Sewerage Plan", May 1972.

The County is using the recommended plan as a general guide in its negotiations for development and implementation. The recommended plan includes staging its water supply facilities, including conveyance of water from Nacimiento Reservoir to Whale Rock Reservoir, for regulation and distribution and use in the Morro Bay Area.

Water Balance

A water balance of volumes of naturally occurring water and applied ground water to the surface of the Basin is shown for the low, average, and high values of precipitation (Table 8 and Plate 2).

Under average precipitation conditions, the amount of deep percolation is much larger than the amount of applied water (extraction) for the entire Basin (Table 8). However, the amount of deep percolation is about equal to the amount of applied water (extractions) in the areas of immediate concern Subareas 1 and 2 (Plate 2).

The source of data and the values for deep percolation of surface water runoff and runoff to the Bay were explained in the foregoing pages.

In addition, ground water elevations (Figure 5) point to a below-sea-level ground water depression. The dewatered storage space amounts to over 100 acre-feet from 5 feet above sea level to the summer depressed ground water elevations. This indicates that in recent years, amounts of extractions and ground water movement out of the Basin were larger than the amount of deep percolation.

Data developed for this study suggest that the annual safe yield of the Basin may be much greater than the 800 to 1,000 acre-feet estimated by previous investigators.

5. WATER QUALITY

Evaluations of the suitability of surface and ground water for beneficial domestic and agricultural uses were on the basis of the concentrations of the major mineral constituents in the water sampled. The water quality criteria for domestic and irrigation water that were used in the evaluations are presented in Appendix B.

The quality of water in the study area is the result of: (a) the kind and quantities of chemicals in the precipitation and airborne ocean spray; (b) the chemical pickup from the lithologic units through which water percolates; (c) the dissolved chemicals in domestic and animal waste; (d) the chemicals in the irrigation return; (e) the chemical pickup from evaporite deposits; and (f) the location of sea-water intrusion.

Ground water

Well water is the main source of supply for all municipal, domestic, and agricultural uses. Almost all the water supply is pumped from the old dune sand in Subareas 1 and 2 and from the alluvium in Subarea 3. Subareas 4 and 5 consist of essentially nonwater-bearing formations and yield little water to wells. Mineral analyses of ground water sampled from wells are shown in Appendix D.

Subareas 1 and 2. Ground water in the old dune sand in Subareas 1 and 2 is predominantly sodium chloride (Na Cl) in character acquired from chemicals inherent to the deposits and from salt blown onto the land along with ocean spray and then percolated to the ground water along with rain. Total dissolved solids (TDS) concentrations range from 100 to 900 mg/l, but are usually less than 200 mg/l. Nitrates (NO_3) are generally less than 20 mg/l, but have been as high as 90 mg/l. Samples with higher TDS and NO_3 concentrations were from wells near the bay shore in Section 13, T30S, R10E. In 1966, a TDS concentration of 925 mg/l (and a Cl concentration of 395 mg/l) was reported in Well No. 30S/10E-13B2 and in 1970 a NO_3 concentration of 92 mg/l was reported in Well No. -13G2.

Chemical concentrations of the water from the same well often fluctuate from one analysis to the next. This fluctuation which is especially evident in water samples from shallow wells, is attributed largely to the differences in the volume of recharge from precipitation. During the wet years more water with low TDS is available to dilute the water in the upper portion of the old dune sand.

The deeper wells extend into the old dune sand and the Paso Robles Formation and yield water with a magnesium-sodium

TABLE 8

SURFACE WATER BALANCE
UNDER SELECTED CONDITIONS OF PRECIPITATION
LOS OSOS HYDROLOGIC SUBAREA
(in acre-feet annually) 1/

Item	Average low		Average		Average high	
	Inflow	Outflow	Inflow	Outflow	Inflow	Outflow
Precipitation	18,800		27,000		38,300	
Applied Water 2/	2,400		2,000		1,900	
Consumptive use 3/		18,500		22,200		23,500
Deep percolation 3/ 4/		2,000		4,100		9,400
Outflow		700		2,700		7,300
TOTALS	21,200	21,200	29,000	29,000	40,200	40,200

1/ Rounded to 100 acre-feet
2/ Ground water pumpage
3/ Includes applied water
4/ Includes 300 acre-feet of sewage

bicarbonate-chloride (Mg-Na HCO_3-Cl) character and TDS concentrations from 100 to 400 mg/l. NO_3 concentrations are lower than in wells pumping only from the old dune sand. The Paso Robles contributes Mg HCO_3 water with little or no NO_3. The NO_3 in the deeper wells is contributed from the overlying old dune sand through gravel packs and wells in which the casings are perforated in both formations.

Openings provided by sand interfingering with clay beds also provide the means for movement of NO_3 into the deeper wells. The water is suitable for domestic use and is Class 1 for irrigation.

Subarea 3. Alluvium in Subarea 3 is found mainly in the upper Los Osos Valley and Los Osos Creek floodplain.

In the upper Los Osos Valley there are water quality data for four widely spaced Wells Nos. 30S/11E-22L1, -23E1, 23F1, and 25Q1. They are Mg HCO_3 or Mg Cl in character, with TDS concentrations ranging from 357 mg/l in Well No. -25Q1 to 884 mg/l in Well No. 22L1. Water from -22L1 and -23E1 is marginal for domestic use, due to high Cl and TDS concentrations, and Class 2 for irrigation, due to its high electrical conductance (EC). NO_3 concentrations in the four wells range from 2 to 19 mg/l.

A change in the quality of water in Well No. 30S/11E-23F1 suggests there may be some degradation of the ground water in the upper Valley. From 1965 to 1970, NO_3 in this well increased from 3.0 to 19.0 mg/l, Cl from 34 to 251 mg/l, and Na from 15 to 104 mg/l. Water with quality similar to that in Well No. -23F1 before the change in quality occurred, is found in Well No. 30S/11E-25Q1, this gives some support to the possibility that some of the water in the upper Valley may be degraded. Well No. 30S/11E-25Q1 is higher on the drainage pattern and believed to penetrate bedrock.

The Los Osos Creek floodplain can be subdivided into an upper and lower floodplain by the quality of the water from its wells. In the upper floodplain, data are available from Wells Nos. 30S/11E-20L1, -21D4, and -21E1. Wells Nos. -20L1 and -21D4 have water of Mg HCO_3 character, while Well No. -21E1 has water of Mg-Na HCO_3 character. The TDS concentrations ranged from 517 to 870 mg/l. The concentrations of Cl in Well No. 21E1 and that of NO_3 in Well No. 21D4 exceed the USPHS Drinking Water Standards' recommended limits. In other respects, the water is marginal for domestic use, due to high TDS concentrations and in Class 2 for irrigation, due to its high EC. In the lower floodplain, data are available from Wells Nos. 30S/11E-8R1, -17A2, -17B1, and -17H1. The water is magnesium-calcium bicarbonate (Mg-Ca HCO_3) in character, with TDS concentrations that ranged from 291 to 586 in 1970. Historically, the concentration of TDS in Well No. -8R1 have been as high as 1,070 mg/l. Except for Well

No. -8R1, well water in the lower floodplain is suitable for domestic use and is Class 1 for irrigation. Well No. -8R1 is marginal for domestic use, due to a high TDS concentration, and is Class 2 for irrigation, due to its high EC.

Near the outlet to Morro Bay, water from Well No. 30S/11E-8J1 has a history of poor quality since 1957, attributable to dissolution of evaporites in the sediments and the leaching of livestock wastes. The records show that there has been an improvement in its quality since the earliest analysis. On March 6, 1957, its TDS concentration was 2,314 mg/l; Mg, 211 mg/l; NO_3, 148 mg/l and Cl, 1,090 mg/l. A June 4, 1973 sample showed a TDS concentration of 1,746 mg/l; Mg, 133 mg/l; NO_3, 37.8 mg/l; and Cl, 750 mg/l. The largest decrease in concentrations, percentagewise, was in NO_3. Although there have been large decreases in concentrations of TDS and individual constituents, there has been little change in the character from Mg Na Cl to Na Mg Cl. The recent changes in chemical concentrations are believed due to greater ground water replenishment; the water level in Well No. -8J1 was within 2 feet of the ground surface in June 1973. Water in nearby Well No. 30S/11E-9P1, which is in the upper part of a small tributary to Los Osos Creek, has also been affected by the presence of evaporties in the sediments. On March 27, 1970, a sample showed a TDS concentration of 2,460 mg/l; NO_3, 19 mg/l; and Cl, 1,110 mg/l.

Surface Water

The quality of the ground water described in the previous section is influenced by the quantity and the quality of the inflow percolating from surface runoff, domestic waste water, irrigation return, and possibly dairy waste. The quality and quantity of the percolating water is estimated below:

Surface Runoff. Data on surface runoff quality are sparse (Appendix E). For this study, DWR collected a few samples in the field at selected stations (Figure 4).

Samples from Los Osos Creek are Mg HCO_3 in character, which is typical of water from the Franciscan Formation. TDS concentrations ranged from 368 mg/l, upstream, at Station 30S/11E-28F, to 421 mg/l, downstream, at Station 30S/11E-8F. NO_3 concentrations were less than 1 mg/l, with the highest at Station 30S/11E-28F. The farthest downstream sample had no measurable NO_3, due perhaps to consumptive use by aquatic plants and algae in the Creek. The water meets USPHS Drinking Water Standards and is Class 1 for irrigation.

Los Osos Creek, sampled at Station 30S/11E-8D, has a Na Cl character, with a TDS concentration of 5,167 mg/l. The high TDS concentration showed the influence of tide water from the Morro Bay estuary. The water is unsuitable for domestic or irrigation use due to high EC and high concentrations of TDS and Cl. The NO_3 concentration was 5.4 mg/l.

The sample from the small tributary to the lower reach of Los Osos Creek at Station 30S/11E-9Q had a Na Cl character and a TDS concentration of 1,145 mg/l. It is Class 3 for irrigation, based on 350 mg/l Cl, and is unsuitable for domestic use. Its poor quality is attributed to a low flow of 5 gpm at the time of sampling, the presence of evaporites in the local sediments, rubbish in the bed of the drainage channel, and concentrations of minerals due to evapotranspiration.

A sample from Eto Lake, near its outlet to Los Osos Creek, had a Na-Mg HCO_3 character and a TDS concentration of 152 mg/l. It was suitable for domestic use and was Class 1 for irrigation. This sample provided only a general index to the Lake's quality. Additional data are necessary to define its quality and impact on the area's water.

The quality of the surface water from the upper Los Osos Valley (Subarea 3) is not known. On the basis of the quality of water from wells in the upper Valley and from the underlying rock types, TDS concentrations probably range from 300 to 800 mg/l and total hardness from 200 to 400 mg/l, depending on volume of flows. The flow is to the lower Los Osos floodplain and contributes to the local ground water in the lower reach of Los Osos Creek. The high TDS concentration in Well No. -8R1 may be due partly to the flow from the Upper Valley.

Domestic Waste. The volume of domestic waste discharged to the septic tank-leach field systems was estimated at 300 acre-feet in 1972. Of that amount, over 90 percent, or 280 acre-feet, was discharged in Subareas 1 and 2.

Data on the quality of the effluent that would percolate are lacking.

For this report, a study by the University of California at Los Angeles (UCLA) on the mineralization from domestic use furnished guidelines on the quality of percolating waste water in the Basin. According to the study, the average pickup of selected minerals was: TDS, 200 mg/l and total nitrogen (N), 30 mg/l. The minerals added to the Los Osos Basin in 1972 would approximate 80 tons of TDS and 10 tons of total N. The impairment of ground water quality from sewage was shown by increased NO_3, TDS, and also hardness.

The NO_3 in ground water results from the nitrification of ammonia in the zone of aeration as waste water percolates. The ammonia becomes oxidized to nitric acid, which then reacts with Ca and Mg in the sediments producing the soluble Ca and Mg nitrate. Due to the addition of Ca and Mg nitrate to the water an increase in hardness and TDS results. However, the effects of waste may not be apparent on a short-term basis, due to the influence of the complex chemical environment of the ground.

In Subareas 1 and 2, NO_3 concentration in the ground water has been increasing, although in some wells it has been decreasing. The greatest increase has been in Subarea 1, where the population is largest, the highest concentrations being in Section 13, T30S, R10E and in Section 18, T30S, R11E (Table 9).

Trends in the concentration of NO_3 in selected wells in Subareas 1 and 2 are shown in Figure 8.

Five developments discharging large volumes of domestic waste water in Subareas 1 and 2 are listed below:

Name of Discharger	Design flow in gpd
Vista de Oro Subdivision Baywood Park	21,000
Robert Stark Development Baywood Park	5,000
Cuesta Mobile Home Park San Luis Obispo	22,000
Daisy Hill Mobile Home Park San Luis Obispo	42,600
Rancho Morro Mobile Home Park San Luis Obispo	26,400

Effects from these large volume dischargers have not been defined, but their location should be noted and their presence taken into account in future water management or surveillance programs (Figure 5).

Because the volume of domestic waste discharges is small in Subarea 3, its effect on ground water quality is not significant. However, wells may be affected locally. Well No. 30S/11E-21D4 had a NO_3 concentration of 60 mg/l in June 1973. This well is next to a residence and the

TABLE 9

HIGH NITRATE CONCENTRATIONS IN SELECTED WELLS
LOS OSOS-BAYWOOD AREA
LOS OSOS BASIN

Well No.	Year sampled	Nitrate, in mg/l
30S/10E-13A1	1965	45
-13A6	1961	53
-13B1	1961	20
-13B2	1962	80
-13G2	1970	92
-13L2	1972	47
30S/11E-18H1	1970	29
-18J1	1961	17
-18K1	1970	19
-18A1	1963	35

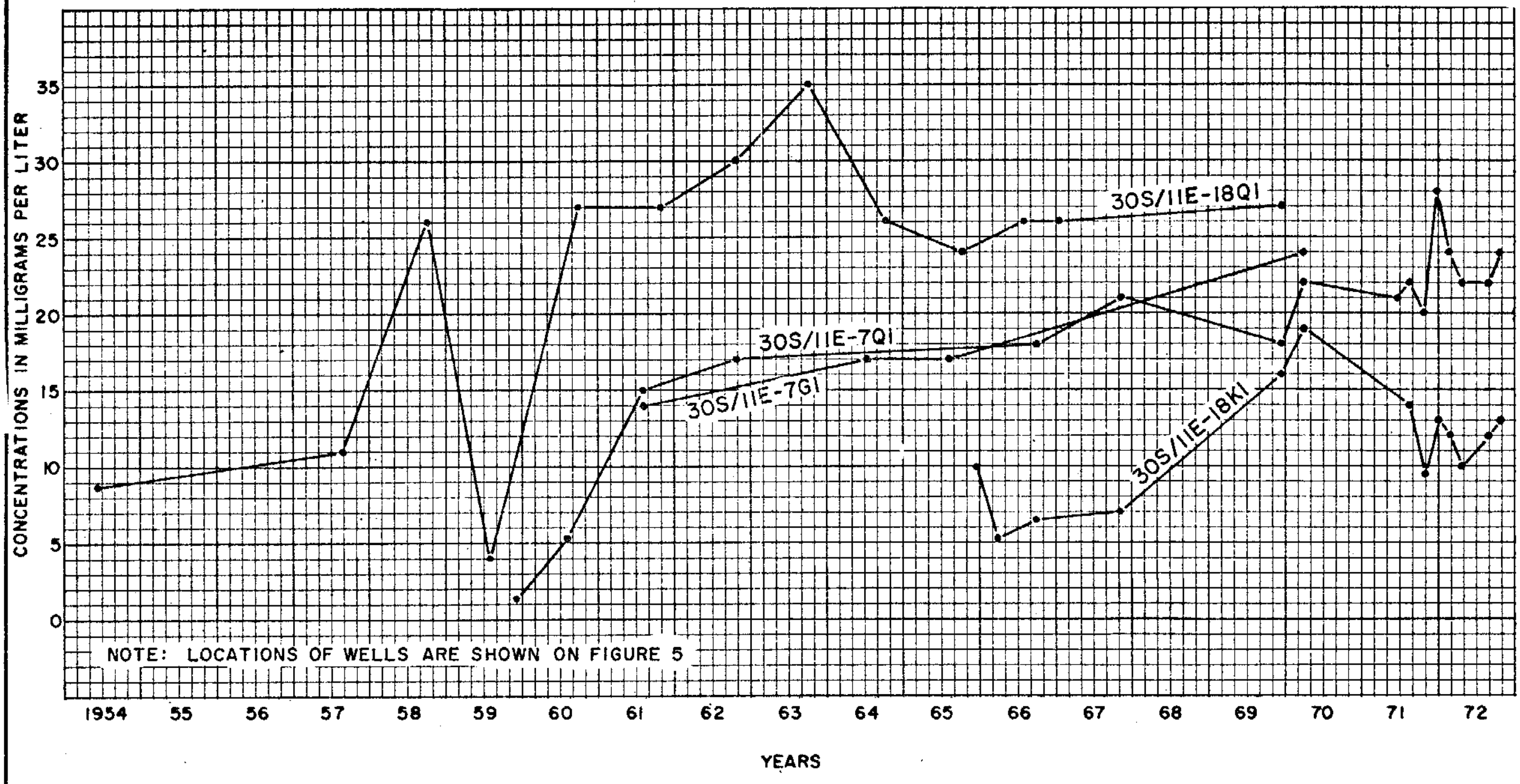

Figure 8–TRENDS IN NITRATE CONCENTRATIONS

DEPARTMENT OF WATER RESOURCES, SOUTHERN DISTRICT, 1973 high concentration of NO_3 may be due to sewage effluent from its leach field entering the well casing before substantial dilution occurred. The source of NO_3 concentrations in Subarea 3 is more likely fertilizers or animal waste, rather than domestic waste.

Irrigation Return. About 700 acres of farmland are irrigated, over 90 percent of which are in Subarea 3, mostly in the Los Osos Creek floodplain.

Table 10 shows the approximate amount of TDS and NO_3 nitrogen added to the ground water basin by deep percolation of irrigation return in the five subareas during years of average precipitation.

Precipitation on farmland adds little to the volume of irrigation return. Of the average of 1.3 acre-feet per year contributed from this source, 1.1 acre-feet is consumptively used, leaving a negligible 0.2 acre-feet for deep percolation.

Determining the effects of irrigation return on the Basin's ground water is difficult and inconclusive. NO_3 concentrations, which are used as indicators of degradation from fertilizers, are low except in Well No. -21D4, which had 60 mg/l NO_3 on June 4, 1973. Most of the irrigation water is applied in Subarea 3 in the Los Osos Creek floodplain and water levels indicate that the direction of ground water flow in the floodplain is towards the northwest. However, the ground water flow direction may be changed by short term pumping depressions.

Dairy Waste. In Subarea 3, the Highland Dairy, with about 100 cows, in the NW 1/4, Section 23, T30S, R11E, and the Dutch Maid Dairy, with about 200 cows, in the SE 1/4, Section 25, T30S, R11E, are the source of significant waste.

Studies at the University of California at Riverside have indicated that dairy cows contribute 80 pounds of waste per day, of which 12 pounds are dry matter. Each cow produces 2.2 tons of dry matter per year containing 140 pounds nitrogen, 45 pounds phosphates, and 177 pounds potassium oxide. Thus, Highland and Dutch Maid Dairies between them produce each year a total of 21 tons of nitrogen, 7 tons of phosphates, and 25 tons of potassium oxide. In addition, each cow requires approximately 35 gallons of water for twice daily washing before milking; this amounts to 25 acre-feet per year for both dairies. These dairy wastes may be degrading the quality of the ground water.

Effects of Changes in Domestic Waste Disposal

Although many plans could be devised for disposing domestic wastes generally they can be reduced to three:

1. Continue present method of domestic wastes disposal.

TABLE 10

CONCENTRATION OF TDS AND NITRATE N

LOS OSOS HYDROLOGIC SUBAREA

Subarea	Acres of irrigated crops	Deep percolation in acre-feet	Total TDS added @ 0.2 tons per acre-foot per year	Nitrate N added @ 0.03 tons per acre-foot per year
1	12	10	2.	.3
2	19	17	3.	.5
3	692	424	85.	12.7
4	23	21	4.	.6
5	0			
TOTALS	746	475	94	14.1

2. Dispose of adequately treated wastes at a different location within Subareas 1 and/or 2 of the Los Osos Basin.

3. Export them for treatment and disposal outside of the Basin.

Each of these may produce different effects on the quality and levels of the ground water in the Basin, especially in Subareas 1 and 2,where domestic waste discharges aid in maintaining a seaward ground-water gradient.

In the three plans,the use and conservation of surface water runoff would have a beneficial effect on the quantity and quality of the ground water.

In Plan 1, the threat of sea-water intrusion would be minimized because the percolation of domestic waste dischargers would aid in maintaining ground water levels in Subarea 1. However, ground water quality will continue to deteriorate, especially NO_3 concentrations, which will continue to increase.

If ground water extraction continues and/or increases in the center of Subarea 1, the threat of sea-water intrusion will continue, due to the large pumping trough. In Plan 1, there will be a need to disperse the location and amounts of extraction from wells to minimize the threat of sea-water intrusion and the volume of underflow toward the ocean that is lost to the Basin unless some way can be found to recover it. It will also be necessary to blend the pumped ground water from this area with water of better quality extracted from other parts of the Basin. That will occur when and if the NO_3 exceeds USPHS Drinking Water Standards.

Plan 2 would heighten the threat of sea-water intrusion if a suitable location cannot be found next to or near Morro Bay that would permit rapid recharge of the ground water basin. This Plan will eliminate percolation from the leaching fields in the locations vital to minimizing the effects of sea-water intrusion.

If domestic waste is disposed of without removing NO_3, Plan 2 would simply be changing the disposal site of the NO_3-laden waste water, which therefore would still cause an increase of the NO_3 concentration of the ground water. However, if the disposal site is in Subarea 2, there would be greater opportunity to dilute the waste water. If sites can be found next to Morro Bay that would permit rapid recharge of the ground water, the opportunity for the NO_3 to flow to the ocean would be greater and less NO_3 would be recycled to the basin. If ground water extractions increase, the threat of sea-water intrusion will continue to increase.

In Plan 3, the effect of increasing sea-water intrusion would be similar to that in Plan 2, only more so, though the NO_3 problem would not continue as in the past. However, as in Plans 1 and 2, the impact on the Basin with respect to the danger of sea-water intrusion would increase with the increasing volume of extraction.

A result of conservation and/or direct use of surface water runoff would be a reduction in the freshwater outflow of Los Osos Creek to the Bay and marsh, which would affect the ecology. Because Morro Bay and the adjacent marsh are an important ecological and geographical feature in the coastal landscape, an impact study of the reduced flow should be considered in developing a water conservation program that would protect the environment.

Monitoring Program

The nature and location of monitoring depends on the plan selected and implemented. There is a need to monitor ground water elevations and quality to check such current potential quality problems as sea-water intrusion and waste disposal. Networks that could accomplish this and be compatible with the various plans should be selected after a field inspection has been conducted to determine the location and adequacy of existing wells.

However, during the interim period collection of water samples and water levels from municipal wells should be continued to determine changes in water quality and elevations.

6. KEY FINDINGS AND CONCLUSIONS

Changes in the disposal of domestic wastes could cause significant effects on the quantity and quality of the Los Osos Basin's water resources.

The key findings and conclusions of the study as they relate to changes that may occur are:

1. Urban growth has been rapid in recent years. Most of growth and its associated urban wastes have occurred in Subareas 1 and 2 (Plate 1). In 1972, the urban-suburban area covered 930 acres and irrigated agriculture, which has been developing and is mainly in Subarea 3, covered 750 acres.

2. The only source of municipal water is well water. In 1972, about 800 acre-feet were pumped for urban-suburban use and about 1,100 acre-feet for irrigated agricultural use.

3. Little water is used in Subareas 4 and 5, which are tributary to Subareas 1, 2, and 3. Except for a small alluviated section of Clark Valley, the area is essentially nonwater-bearing and is mostly covered with native vegetation.

4. Precipitation is an important natural source of water for the Basin. It amounts to an annual average of 20 inches in the tributary area (Subareas 4 and 5) and about 15 inches in the water-bearing areas (Subareas 1, 2, and 3). Total average annual volume of precipitation is about 27,000 acre-feet.

5. All the surface water from Subarea 4 and much from Subarea 5 flows into Los Osos Creek and Morro Bay. Annual flow to the Bay is estimated at 700 acre-feet if volume of precipitation is low, 2,700 acre-feet if it is average, and 7,300 acre-feet if it is high.

6. Alluvium in the upper Basin beginning about 1 mile east of Valley Park Cemetery is shallow -- from 20 to 30 feet deep -- and contains little usable ground water storage capability that can be depended upon for long-term carry-over storage. There is no significant surface water carry-over storage in the area.

7. The ground-water-bearing materials in the lower Basin (Subareas 1 and 2) contain most of the ground-water-storage capability of the whole Basin. The water-bearing materials thicken in a westward direction and are about 400 feet thick at Morro Bay.

8. Current water quality conditions in Subareas 3, 4, and 5, have had only a limited effect on Subareas 1 and 2. The old dune sand next to the alluvium in Los Osos Creek has low-to-moderate permeability. Consequently, much of the surface flows, especially flood flows, in the Creek discharge water to Morro Bay and are lost to the Basin.

9. About 800 acre-feet of ground water is pumped to meet the rapidly rising urban needs of the Los Osos-Baywood area. As a result, a pumping trough has developed below sea level in Subarea 1, thereby increasing the threat of sea-water intrusion.

10. Of the average annual amount extracted and applied, about 300 acre-feet returns from the area's septic tank-leach field systems to the ground-water Basin in the form of domestic waste water effluent. Percolation of domestic waste water minimizes the threat of sea-water intrusion because it aids in maintaining the ground water level in the vital area next to the Bay.

11. Percolation of domestic waste water effluent has degraded ground-water quality. The increase in NO_3 concentrations in parts of the area is a reliable indicator of the extent of degradation. The highest reported concentration was over 90 mg/l in Well No. 30S/10E-13G2 near Cuesta-by-the-Sea.

12. A potential source of supplemental water to the Basin is from the Recommended Water Supply System, contained in the "Report on Master Water and Sewerage Plan", May 1972, Camp, Dresser, and McKee. It includes the water in the Nacimiento Reservoir and the State Water Project as major sources, with Whale Rock Reservoir serving as a regulating reservoir.

The County is now using the Recommended Water Supply System as a guide in its negotiations with local agencies.

These key findings and conclusions underline the urgent need for complete management of the Los Osos Basin's water resources: its water supply; conservation; use; and treatment and disposal of waste water. Important elements of such a management plan should include, but not be limited to:

1. Conservation (including artificial recharge) and direct use of the flow in Los Osos Creek, now being wasted to Morro Bay, to supplement the ground-water supply in Subareas 1 and 2 in a comprehensive, coordinated manner.

2. Maintenance of watershed cover to enhance infiltration and conservation of runoff for subsequent underground storage of good quality water.

3. Dispersion of the extraction wells in the Subareas 1 and 2 on a comprehensive, coordinated basis to control ground water levels. The amounts and locations of extraction should be regulated to lessen the threat of sea-water intrusion and lessen subsurface and spring outflow from the Basin to the Bay.

4. Development of a plan for blending poor quality water with good quality ground water, imported water, or surface water or a combination of the three waters before delivery so as to minimize the public health problems caused by high NO_3 concentrations in water from some wells.

5. Determination of optimum disposal of domestic waste water effluent.

6. After selection of the management plan, establishment of a plan to monitor the quantity and quality of ground and surface water. This would also provide data on such current and potential water quality problems as sea-water intrusion and the effects of waste water disposal.

APPENDIX A

DEFINITIONS

Alluvium - Stream-deposited sedimentary materials, usually of Recent geologic age.

Anion - A negative ion.

Aquifer - A geologic formation, or zone, that transmits water in sufficient quantity to supply a well or spring. In the Los Osos-Baywood area it is chiefly composed of beds of sand.

Baymouth bar - A bar extending partially or entirely across the mouth of a bay.

Cation - A positive ion.

Chemical character of water - A classification based on the predominant anion and cation constituents, expressed in equivalent parts per million. Identified by the name of the ions which constitute one-half or more of the total ions for that water.

Confined ground water - A body of water which is immediately overlain by material sufficiently impermeable to sever free hydraulic connection with the water above it and moving under gradient or pressure caused by the difference in head between the intake, or forebay area, and the discharge area.

Degradation - An impairment of the quality of water due to causes other than disposal of sewage and industrial waste.

Drawdown - The lowering of the water table, or piezometric surface, by pumping ground water from a well.

Electric log - The record obtained by lowering electrodes in a bore hole and measuring, as the electrodes are withdrawn, continuous changes in electrical resistivity and spontaneous potential (SP) of geologic formations. Changes in resistivity and SP result principally from differences in lithology and ground water salinity.

Electrical Conductance (EC) - The reciprocal of the resistance measured between opposite faces of a centimeter cube of an aqueous solution at a temperature of 25° Centigrade.

Equivalents per million (epm) - Chemically equivalent weights of solute contained in one million parts by weight of solution. Parts per million (ppm) divided by the combining weight of an ion.

Evaporite - A sediment deposited from an aqueous solution as a result of extensive or total evaporation of the solvent.

Fault - A fracture or fracture zone along which the two sides have been displaced in relation to one another. The displacement may range from a few inches to many miles.

Fresh water - Water containing less than 1,500 parts per million total dissolved solids.

Ground water - Subsurface water in the zone of saturation and moving under control of the water table or piezometric gradient.

Ground water basin - An area underlain by one or more permeable formations containing and capable of furnishing a substantial water supply.

Ground water storage - That stage of the hydrologic cycle during which water occurs below ground surface in the zone of saturation.

Hydraulic continuity - The connection that must exist in order to have appreciable ground water flow through sufficiently permeable materials.

Hydraulic gradient (Head) - Under unconfined ground water conditions, the slope of the profile of the water table. Under confined ground water conditions, the slope of the profile of the piezometric surface.

Hydrology - The applied science concerned with water, its occurrence, distribution, use, and circulation through the unending hydrologic cycle, which consists of precipitation, runoff, infiltration, storage, use, disposal, evaporation, and reprecipitation. It is concerned both with the physical and chemical reaction of water with the rest of the earth and with its relation to the life of the earth.

Impairment - A change in the quality of water which makes it less suitable for beneficial use.

Impermeable - Having a texture that does not permit water to move through it perceptibly under the head differences ordinarily found in subsurface water.

Infiltration - The flow or movement of water through the soil surface into the ground.

Lithologic log (litholog) - The log of a well or bore hole obtained by examination and classification of drill cuttings from the subsurface materials that have been traversed.

Milligrams per liter (mg/l) - One milligram of dissolved substance per liter of solution at a temperature of 20°C. At moderate concentrations, mg/l is for practical purposes the same as parts per million (ppm).

Parts per million (ppm) - One part by weight of solute in one million parts solution at a temperature of 20°C.

Percolation - The movement, or flow, of water through the interstices of porous media.

Permeability - The capacity of a porous media for transmitting a fluid. The degree of permeability depends upon the size and shape of the pores, the size and shape of their interconnections, and the extent of the interconnections.

Permeability, Field coefficient of - The amount of water moving through a unit area of aquifer per unit time under unit hydraulic gradient at the natural temperature. It is usually expressed in gallons per day per square foot (gpd/ft^2).

Piezometer - A small-diameter observation well used to monitor the positive pressure exerted by a water table, or pressure aquifer, or to obtain ground water samples for chemical analysis.

Piezometric surface - The surface to which confined ground water will rise in wells under prevailing aquifer head.

Pollution - Defined in Section 13005 of the California Water Code as "an impairment of the quality of the waters of the State by sewage or other waste to a degree which does not create an actual hazard to the public health but which does adversely and unreasonably affect such waters for domestic, industrial, agricultural, navigational, recreational or other beneficial use, or which does adversely and unreasonably affect the ocean waters and bays of the State devoted to public recreation."

Pressure head - The hydrostatic pressure of water at a given point in a ground water body. It is usually expressed as the height (in feet) of the column of water that can be supported by the pressure.

Saturation, Zone of - The zone below the water table in which all interstices are filled with ground water.

Sea water - Ocean water containing approximately 36,000 ppm total dissolved solids.

Sea-water intrusion - The invasion of sea water into fresh water aquifers under a landward or downward hydraulic gradient.

Sewage - Defined in Section 13005 of the California Water Code as "Any and all waste substance, liquid or solid, associated with human habitation, or which contains or may be contaminated with human or animal excreta or excrement, offal, or any feculent."

Syncline - A concave fold where strata dip toward a common axis.

Total Dissolved Solids (TDS) - The dry residue from the dissolved matter in an aliquot of a water sample remaining after evaporation of the sample at a definite temperature.

Total Hardness (TH) - Principally caused by the presence of magnesium and calcium ions which form insoluble compounds with soap commonly expressed as the sum of these cations in mg/l as calcium carbonate ($CaCO_3$).

Unconfined aquifer - An aquifer containing a water table which is at atmospheric pressure and above which water can, in most cases, percolate freely to the zone of saturation.

Unconfined ground water - Ground water whose upper surface forms a water table at atmospheric pressure and in which hydraulic pressure is equal to the depth from that water table to the point in question. It moves under gravity according to the slope of the water table.

Unconformity - A surface of erosion, or sometimes nondeposition, that separates younger strata from older rocks.

Water Table - The surface of ground water at atmospheric pressure in an unconfined aquifer. It forms the upper limit of the zone of saturation.

Well - A shaft, or hole, sunk into the earth to obtain oil, gas, water, etc., or to inject fluids into the earth.

APPENDIX B

IDENTIFICATION SYSTEMS AND CRITERIA USED IN REPORT

This appendix contains explanations of the sampling point identification system, areal designation system, and water quality criteria used in the preparation of this study and report.

SAMPLING POINT IDENTIFICATION SYSTEM

For convenience in recording the wells, springs, and surface waters from which samples have been taken in this investigation, the following system has been used:

Water Wells

Wells from which samples of water or measurements of depth to ground water have been obtained are assigned state well numbers. For these, wells are referenced by use of the United States Public Land Survey System. The well number consists of the township, range, and section numbers, a letter to indicate the 40-acre lot in which the well is located, and a number to identify the particular well in the 40-acre lot.

Sections are subdivided into 40-acre lots, as shown in Figure 1. For example, well 30S/11E-13N3 denotes the third well to be assigned a number in Lot N of Section 13 of Township 30 South, Range 11 East.

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Figure 1

Section lines have not generally been surveyed into areas included in the Spanish and Mexican land grants. So that the state well number system may be used in these areas, section lines have been projected across the ranchos on the standard United States Geological Survey quadrangle sheets. The projections of section lines used for well numbering in the Southern District are delineated on quadrangle sheets in the Los Angeles office of the Department of Water Resources. It is suggested that interested agencies and individuals desiring to project section lines for well numbering trace the projections from the Department's maps, so as to avoid conflicts and confusion in assigning well numbers.

The reader will occasionally notice a well which does not plot in the location indicated by its number. This occurs in instances where an erroneous number has been assigned and used for a relatively long time; generally, the erroneous number has been referred to in numerous reports. To avoid further confusion, the number has been continued in use.

Springs

Springs are assigned state well numbers on the same basis as are water wells, but the letter S is inserted immediately after the lot identification. For example, 30S/10E-18DS1 is the first spring assigned a number in Lot D of Section 18 of Township 30 South, Range 10 East.

Surface Waters

The system used for identifying surface water sampling points is similar to that used for wells and springs for this study. For instance a sampling point may be designated 30S/11E-8F. For the exact location the reader must refer to Figure 4 of the report.

AREAL DESIGNATION SYSTEM

A brief discussion and explanation of the areal designation system is presented in this appendix together with a short discussion of the relationship of a ground water basin to the system. For a comprehensive discussion of the areal designation system and a complete listing of the code numbers, the reader is referred to "Names and Areal Code Numbers of Hydrologic Areas in the Southern District", California Department of Water Resources, April 1964.

Drainage Province

The drainage province is a geographic area, generally equivalent in area and configuration to the water quality control board regions, as defined in Chapter 4, Division 7, of the California Water Code, except that all province boundaries are drainage divides.

Hydrologic Unit

A hydrologic unit is, in general, thc total watershed area, including both water-bearing and nonwater-bearing formations, of a major stream system, such as the Santa Ynez River Valley.

Hydrologic Subunit

A hydrologic subunit is a major subdivision of a hydrologic unit and also includes water-bearing and nonwater-bearing formations. The subunit is best typified as a major tributary of a stream, a major valley, or a plain along a stream containing one or more ground water basins and having closely related geologic, hydrologic, and topographic characteristics.

Ground Water Basin

The ground water basin is defined as the area underlain by one or more permeable formations capable of furnishing a substantial water supply. It usually constitutes only a small portion of a hydrologic subarea because the nonwater-bearing hills and mountains of the surface drainage basin are excluded from the ground water basin. The boundaries of the ground water basin are generally determined by the extent of water-bearing materials, whereas the boundaries used in the areal designation system are based on drainage or watershed considerations.

Many sets of guidelines by which the suitability of water may be judged have been suggested by authorities to codify the requirements for water quality for beneficial use. Included in these attempts at classification are several terms, some of which may appear strange or confusing to the reader; among them are standards, criteria, and objectives. This section attempts to define the jargon of the discipline as used in this report and to explain at least one of the many systems employed.

Definition of Terms

Before any discussion of water quality classification can be presented, it is necessary to explain several terms. These are:

Standards. Standards are those values established by some regulatory agency as obligatory limits on water quality. Perhaps the best-known of these are the United States Public Health Service Drinking Water Standards. Equally important to any discussion of water quality criteria in California are those standards established by the California Department of Public Health. The two sets of standards differ only slightly.

Criteria. As opposed to standards, criteria are guidelines for judging water for a particular use. They are more general than standards and are by no means obligatory. Criteria must be cited with reference to the use for which a particular water source is intended, as they can vary from place to place and with a given situation. The discussion here is only intended as a brief summary; for a more definitive work, the reader is referred to the excellent treatise by Dr. J. E. McKee and H. W. Wolfe, entitled "Water Quality Criteria", to mention only one of many books on the subject.

Objectives. Objectives refer to the level of water quality desired. They are used most often with respect to ground water in one basin or to surface water in a given stream, lake, bay, or area of the ocean. Generally, objectives are goals for water quality that are thought to be reasonable to maintain in a natural body of water, particularly one which receives some discharge of manmade waste. It might be noted that use of the term objectives usually implies that the objectives have been established by some regulatory agency. It should also be stressed that, for effective water quality control, objectives should only be established after due deliberation and study, and they should be reexamined periodically. Objectives are dynamic and should be modified according to changes in environment.

Specific Uses

With the general terminology defined, the specific requirements for various uses can now be examined.

Domestic Use. Water used for drinking and culinary purposes should be clear, colorless, odorless, pleasant-tasting, and free from toxic salts. It should not contain excessive amounts of dissolved minerals and must be free from pathogenic organisms. In addition to these physical and bacteriological requirements, certain qualifications are generally placed on chemical quality, either as requirements by a regulatory agency or for comparative grading of different waters.

The 1962 Drinking Water Standards of the United States Public Health Service are legally applicable only to drinking water and water supply systems used by interstate carriers and others subject to Federal quarantine regulations. However, they have been adopted by the entire water works profession as minimum standards for control and are widely quoted.

The standards themselves, as promulgated, include discussions of bacteriological, physical, radiological, and chemical aspects. Only the chemical aspects will be discussed here. Table 1 presents the standards; the recommended values are those which should not be exceeded in a water supply if other more suitable supplies are or can be made available. The mandatory values are those which, if exceeded, constitute grounds for rejection of the supply.

The standards for fluoride are related to the annual average of maximum daily air temperatures (based on a minimum five-year record) and are presented in Table 2 . The average concentration should not exceed the appropriate upper limit in the table. The presence of fluoride in average concentrations greater than twice the optimum values in Table constitutes grounds for rejection of the supply. The standards further state that where fluoridation is practiced, the average fluoride concentration shall be kept within the upper and lower control limits in Table 2 .

In California, the State Board of Public Health issues water supply permits in accordance with its "Interim Policy on Mineral Quality of Drinking Water", as adopted September 4, 1959, and in accordance with "Policy Statement and Resolutions by the State Board of Public Health with Respect to Fluoride

TABLE 1

UNITED STATES PUBLIC HEALTH SERVICE
DRINKING WATER STANDARDS, 1962

Substance	Recommended limits of concentrations, in mg/l	Mandatory limits of concentrations, in mg/l
Metheylene blue active substance (MBAS) as ABS	0.5	--
Arsenic (As)	0.01	0.05
Barium (Ba)	--	1.0
Cadmium (Cd)	--	0.01
Carbon chloroform extract (CCE)	0.2	--
Chloride (Cl)	250	--
Chromium (hexavalent) (Cr^{+6})	--	0.05
Copper (Cu)	1.0	--
Cyanide (CN)	0.01	0.2
Fluoride (F)	**	**
Iron (Fe)	0.3	--
Lead (Pb)	--	0.05
Manganese (Mn)	0.05	--
Nitrate (NO_3)*	45	--
Phenols	0.001	--
Selenium (Se)	--	0.01
Silver (Ag)	--	0.05
Sulfate (SO_4)	250	--
Total dissolved solids (TDS)	500	--
Zinc (Zn)	5	--

*In areas in which the nitrate content of water is known to be in excess of the listed concentration, the public should be warned of the potential dangers of using the water for infant feeding.
**See Table 2.

TABLE 2

UNITED STATES PUBLIC HEALTH SERVICE
DRINKING WATER STANDARDS, 1962 -- FLUORIDE

Annual average of maximum daily air temperatures, in degrees Fahrenheit	Recommended control limits -- fluoride concentrations, in mg/l		
	Lower	Optimum	Upper
50.0 - 53.7	0.9	1.2	1.7
53.8 - 58.3	0.8	1.1	1.5
58.4 - 63.8	0.8	1.0	1.3
63.9 - 70.6	0.7	0.9	1.2
70.7 - 79.2	0.7	0.8	1.0
79.3 - 90.5	0.6	0.7	0.8

Ion Concentrations in Public Water Supplies", as approved August 22, 1958. The interim policy on mineral quality is presented as follows:

1. Water supply permits may be issued for drinking and culinary purposes only when the Public Health Service Drinking Water Standards of 1946* and the State Board of Public Health policy on fluorides are fully met.

2. In view of the wide variation in opinion in this field, the uncertainty as to the long-time health effects, the uncertainty of public attitude concerning various mineral levels, and the obvious need for further study, temporary permits may be issued for drinking water supplies failing to meet the Drinking Water Standards if the mineral constituents do not exceed those listed under the heading "Temporary Permit" in Table 3 .

TABLE 3

UPPER LIMITS OF TOTAL SOLIDS AND SELECTED MINERALS IN DRINKING WATER AS DELIVERED TO THE CONSUMER

	Permit	Temporary Permit
Total Solids	500 (1,000)**	1,500 milligrams per liter
Sulphates	250 (500)**	600 " " "
Chlorides	250 (500)**	600 " " "
Magnesium	125 (125)	150 " " "

*This interim policy relates to potable water and is not intended to apply to a secondary mineralized water supply intended for domestic uses other than drinking and culinary purposes.

**Numbers in parentheses are maximum permissible, to be used only where no other more suitable waters are available in sufficient quantity for use in the system.

3. <u>Exception</u>: No temporary permit for drinking water supplies in which the mineral constituents exceed those listed under the heading "Temporary Permit" as set forth in #2 above may be issued unless the Board determines after public hearing:

   (a) The water to be supplied will not endanger the lives or health of human beings; and

* Author's Note: It is assumed in the absence of any later standards, that the 1962 edition of the Drinking Water Standards now applies.

(b) No other solution to meet the local situation is practicable and feasible; and

(c) The applicant is making diligent effort to develop, and has reasonable prospect of developing a supply of water which will warrant a regular permit within an acceptable period of time.

The burden of presenting evidence to fulfill the requirements as set forth in (a), (b), and (c) above is upon the applicant.

With respect to fluoride concentration, the State Board of Public Health has defined the maximum safe amounts of fluoride ion in relation to mean annual temperature as shown in Table 4

TABLE 4

CALIFORNIA STATE BOARD OF PUBLIC HEALTH,
MAXIMUM FLUORIDE ION CONCENTRATIONS

Mean annual temperature, in degrees Fahrenheit*	Mean monthly fluoride concentration, in milligrams per liter
50	1.5
60	1.0
70 - above	0.7

*For temperature values between those shown in the table, the fluoride ion concentrations may be obtained by interpolation.

The State Board of Public Health's policy on fluoride ion further states that:

1. The concentration of the fluoride ion in public water systems, whether added or naturally occurring, should not exceed the fluoride ion concentrations stated in the above table.

2. In the development of new public water systems used for drinking and culinary purposes the above fluoride ion concentrations shall not be exceeded.

3. In existing public water systems used for drinking and culinary purposes in which the above fluoride ion concentrations are exceeded, the fluoride ion concentration shall be reduced to a safe level by the use of methods acceptable to the State Department of Public Health. Exception: In cases where the Department determines

after investigation that it is not practicable and feasible to reduce the fluoride ion concentration in the entire supply to a safe level, special methods, acceptable to the State Department of Public Health, shall be provided by the applicant to furnish water of suitable fluoride ion concentration to all children 10 years of age or under.

Agricultural Use. The major criteria for judging the suitability of water for irrigation are chloride concentration, specific electrical conductance (presented as EC x 10^6 at 25° C), boron concentration, and percent sodium.

Chlorides are present in nearly all waters. They are not necessary to plant growth, and in high concentrations cause subnormal growing rates and burning of leaves.

Electrical conductance indicates the total dissolved solids, and furnishes an approximate indication of the overall mineral quality of the water. For most waters, the total dissolved solids, measured in milligrams per liter (mg/l) may be approximated by multiplying the electrical conductance by 0.7. As the amount of dissolved salts in irrigation water increases, the crop yields are reduced until at high concentrations (the value depending on the plant, type of soil, climatological condition, and amount of water applied) plants cannot survive.

Boron is never found in the free state but occurs as borates or boric acid. This element is essential in minor amounts for the growth of many but not all plants. It is, however, extremely toxic to most plants in higher concentrations. Limits of tolerance for most irrigated crops vary from 0.5 to 2.0 mg/l. Citrus crops, particularly lemons, are sensitive to boron in concentrations exceeding 0.5 mg/l.

The percent sodium, as reported in analyses, is 100 times the proportion of the sodium cation to the sum of all cations, all expressed in milliequivalents per liter (meq/l). Water containing a high percent sodium has an adverse effect upon the physical structure of soils that contain clay by dispersing the soil colloids. This, in turn, retards the movement of water and the leaching of salts, and makes the soils difficult to work. The effect of potassium in water is similar to that of sodium.

Because of the diverse climatological conditions, crops, soils, and irrigation practices in California, criteria which may be set up to establish the suitability of water for irrigation must necessarily be of a general nature, and judgment must be used in applying these criteria to individual cases.

Based on studies by Dr. L. D. Doneen, Professor of Water Science and Engineering at the University of California at Davis, three classes of irrigation water have been established:

Class 1 Excellent to Good. Regarded as safe and suitable for most plants under any condition of soil or climate.

Class 2 Good to Injurious. Regarded as possibly harmful for certain crops under certain conditions of soil or climate, particularly in the higher range of this class.

Class 3 Injurious to Unsatisfactory. Regarded as problably harmful to most crops and unsatisfactory for all but the most tolerant.

Limiting values for concentrations of chloride, boron, specific electrical conductance, and percent sodium for these three classes of irrigation water have been established and are shown in Table 5.

TABLE 5

CRITERIA FOR IRRIGATION WATERS

Factors	Class 1 - Excellent to good	Class 2 - Good to injurious	Class 3 - Injurious to unsatisfactory
Specific electrical conductance, $ECx10^6$ at 25° C	Less than 1,000	1,000 - 3,000	More than 3,000
Boron, mg/l	Less than 0.5	0.5 - 2.0	More than 2.0
Chloride, mg/l	Less than 175	175 - 350	More than 350
Percent sodium	Less than 60	60 - 75	More than 75

Table 6 and 7 were extracted from U. S. Department of Agriculture Technical Bulletin 962, "The Quality of Water for Irrigation Use, 1948", by L.V. Wilcox, and are presented to show the relative tolerance of crop plants to irrigation of crop plants to salt.

TABLE 6

PERMISSIBLE LIMITS OF BORON FOR SEVERAL CLASSES OF IRRIGATION WATER

In milligrams per liter

Classes of water	Crop groups		
	Sensitive	Semitolerant	Tolerant
Excellent	< 0.33	< 0.67	< 1.00
Good	0.33 to 0.67	0.67 to 1.33	1.00 to 2.00
Permissible	0.67 to 1.00	1.33 to 2.00	2.00 to 3.00
Doubtful	1.00 to 1.25	2.00 to 2.50	3.00 to 3.75
Unsuitable	> 1.25	> 2.50	> 3.75

TABLE 7

RELATIVE TOLERANCE OF CROP PLANTS TO BORON

(In each group the plants first named are considered as being more sensitive and the last named more tolerant).

Sensitive to boron	Semitolerant to boron	Tolerant to boron
Lemon	Lima bean	Carrot
Grapefruit	Sweet potato	Lettuce
Avocado	Bell pepper	Cabbage
Orange	Tomato	Turnip
Thornless blackberry	Pumpkin	Onion
Apricot	Zinnia	Broadbean
Peach	Oat	Gladiolus
Cherry	Milo	Alfalfa
Persimmon	Corn	Garden beet
Kadota fig	Wheat	Mangel
Grape (Sultanina and Malaga)	Barley	Sugar beet
Apple	Olive	Palm (Phoenix carariensis)
Pear	Ragged robin rose	Date palm (P. dactylifera)
Plum	Field pea	Asparagus
American elm	Radish	Tamarix, or athel (Tamarix aphylla and T. gallica)
Navy bean	Sweet pea	
Jerusalem-artichoke	Pima cotton	
Persian (English walnut)	Acala cotton	
Black walnut	Potato	
Pecan	Sunflower (native)	

TABLE 8

RELATIVE TOLERANCE OF CROP PLANTS TO SALT*

Low salt tolerance	Medium salt tolerance	High salt tolerance
Pear	Pomegranate	Date palm
Apple	Fig	Salt grass
Orange	Olive	Bermuda grass
Grapefruit	Sweet corn	Rescue grass
Prune	Potato (White Rose)	Western wheatgrass
Plum	Carrot	Barley
Almond	Onion	Sugar beet
Apricot	Sudan grass	Rape
Peach	Alfalfa (California common)	Cotton
Strawberry	Rye	
Lemon	Wheat	
Avocado	Oats	
Field bean	Orchardgrass	
Radish	Rice	
Celery	Meadow fescue	
Meadow foxtail	Sorghum (grain)	
Red clover	Corn (field)	
	Flax	
	Sunflower	
	Castorbean	

*Based on Agriculture Handbook No. 60, U. S. Department of Agriculture. February 1954.

Industrial Water Use. Criteria of quality of water for industrial purposes are exceedingly difficult to ascertain. Industrial usage of water is so varied that a single set of criteria for chemical, physical, and bacterial requirements would be meaningless.

Total Hardness

For purposes of classification, in the Southern District of the Department of Water Resources, the following definitions of relative hardness are used: Waters containing 100 mg/l or less of total hardness (as $CaCO_3$) are considered "soft", those containing 101 to 200 mg/l are considered "moderately hard", and those with more than 200 mg/l are considered "very hard".

APPENDIX C
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APPENDIX D

MINERAL ANALYSES OF GROUND WATER

DATE TIME	SAMPLER LAB	TEMP	FIELD LABORATORY PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR	REM
					MINERAL CONSTITUENTS IN				MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE					MILLIGRAMS PER LITER					
	T		CENTRAL COASTAL DRAINAGE PROVINCE																
	T-10		SAN LUIS OBISPO HYDRO UNIT																
	T-10.B		SAN LUIS OBISPO HYDRO SUBUNIT																
	T-10.B3		LOS OSOS HYDRO SUBAREA																
	30S/10E-12J01 M																		
11/16/71	5050				51	65	103	5.5	0	429	170	70	.4	.28	.3	706	394		E
1230			8.0	1007	2.54	5.35	4.48	.14	.00	7.03	3.54	1.97	.01		--	676	43	2.3	C
					20	43	36	1		56	28	16							
	30S/10E-13A01 M																		
08/03/61					9.0	6.0	32	1.0	0	33	5.0	46	27.0	.05	.1	190	47		E
	5788		6.6	265	.45	.49	1.39	.03	.00	.54	.10	1.30	.44		21.0	163	20	2.0	
					19	21	59	1		23	4	55	18						
07/12/62					11	10	33	3.0	0	43	11	51	34.0	.05	.2	202	69		
	5788		7.0	350	.55	.82	1.44	.08	.00	.70	.23	1.44	.55		24.0	198	34	1.7	
					19	28	50	3		24	8	49	19						
07/08/64					21	11	43	1.0	0	47	4.0	79	41.0	.02	.1	266	98		E
	5788		7.5	370	1.05	.90	1.87	.03	.00	.77	.08	2.23	.66		--	223	59	1.9	
					27	23	49	1		21	2	60	18						
08/03/65					14	11	36	1.0	0	44	8.0	58	45.0	.00	.1	240	80		
	5050		7.8	369	.70	.90	1.57	.03	.00	.72	.17	1.64	.73		--	195	44	1.7	
					22	28	49	1		22	5	50	22						
	30S/10E-13A02 M																		
08/03/61					25	8.0	41	1.0	0	58	22	75	21.0	.06	.0	276*	96		
	5788		7.3	434	1.25	.66	1.78	.03	.00	.95	.46	2.12	.34		19.0	241	48	1.8	
					34	18	48	1		25	12	55	9						
07/08/64					23	12	51	1.0	0	46	19	98	21.0	.05	.1	272	107		
	5788		7.2	420	1.15	.99	2.22	.03	.00	.75	.40	2.76	.34		--	248	70	2.1	
					26	23	51	1		18	9	65	8						
08/03/65					28	16	57	1.0	0	34	23	140	21.0	.02	.1	340	136		
	5050		7.1	612	1.40	1.32	2.48	.03	.00	.56	.48	3.95	.34		--	303	108	2.1	
					27	25	47	1		11	9	74	6						
	30S/10E-13A03 M																		
08/03/61					--	--	--	--	0	44	--	60	--	--	--		75		
	5788		6.5	318					.00	.72		1.69			--				
	30S/10E-13A04 M																		
08/03/61					--	--	--	--	0	62	--	50	--	--	--		85		
	5788		6.9	357					.00	1.02		1.41			--				
	30S/10E-13A05 M																		
08/03/61					--	--	--	--	0	42	--	58	--	--	--		85		
	5788		6.7	361					.00	.69		1.64			--				
	30S/10E-13A06 M																		
08/03/61					13	17	50	1.0	0	74	9.0	66	53.0	.02	.1	310*	103		
	5788		6.7	479	.65	1.40	2.18	.03	.00	1.21	.19	1.86	.85		20.0	265	42	2.2	
					15	33	51	1		29	5	45	21						
07/03/64					10	9.0	41	1.0	0	50	5.0	46	42.0	.02	.1	202	62		
	5788		7.8	300	.50	.74	1.78	.03	.00	.82	.10	1.30	.68		--	179	21	2.3	
					16	24	58	1		28	3	45	23						S
08/04/65					11	4.0	21	1.0	0	61	3.0	27	2.0	.02	.1	160	44		E
	5050		7.5	186	.55	.33	.91	.03	.00	1.00	.06	.76	.03		--	99	0	1.4	T
					30	18	50	2		54	3	41	2						
	30S/10E-13B01 M																		
08/03/61					10	13	33	1.0	0	69	1.0	54	20.0	.04	.1	236*	79		
	5788		7.0	350	.50	1.07	1.44	.03	.00	1.13	.02	1.52	.32		21.0	187	22	1.6	T
					16	35	47	1		38	1	51	11						
	30S/10E-13B02 M																		
08/03/61					36	14	50	2.0	0	50	8.0	123	34.0	.07	.1	296*	148		
	5788		6.5	491	1.80	1.15	2.18	.05	.00	.82	.17	3.47	.55		19.0	311	107	1.8	
					35	22	42	1		16	3	69	11						
07/12/62					17	17	51	3.0	0	43	20	79	70.0	.05	.1	326	113		
	5788		6.9	515	.85	1.40	2.22	.08	.00	.70	.42	2.23	1.13		22.0	300	78	2.1	
					19	31	49	2		16	9	50	25						
10/30/62		65 F			16	20	50	2.0	0	39	20	89	80.0	.05	.1	300	122		
1620	5050	18 C	7.3	549	.80	1.64	2.18	.05	.00	.64	.42	2.51	1.29		29.0	325	90	2.0	
					17	35	47	1		13	9	52	27						
07/05/63					29	32	55	2.0	0	61	7.0	151	62.0	.05	.1	438	204		
850	5050		7.2	715	1.45	2.63	2.39	.05	.00	1.00	.15	4.26	1.00		20.0	388	154	1.7	
					22	40	37	1		16	2	66	16						
07/08/64					18	1.0	22	1.0	0	59	2.0	27	5.0	.02	.1	118	49		
	5788		7.7	180	.90	.08	.96	.03	.00	.97	.04	.76	.08		--	105	1	1.4	
					46	4	49	2		52	2	41	4						S
08/03/65					12	4.0	21	1.0	0	52	6.0	30	5.0	.02	.1	92	47		
	5050		7.2	196	.60	.33	.91	.03	.00	.85	.12	.85	.08		--	105	4	1.3	
					32	18	49	2		45	6	45	4						
07/19/66		61 F			59	74	75	3.0	0	23	22	395	23.0	.02	.1	925	452		
1200	5050	16 C	7.2	1405	2.94	6.09	3.26	.08	.00	.38	.46	11.14	.37		--	662	433	1.5	T
					24	49	26	1		3	4	90	3						
09/28/66		65 F			--	--	--	--	0	23	--	437	25.0	--	--				
	5050	18 C	6.9						.00	.38		12.32	.40		--				
										3		94	3						
09/28/66		65 F			--	--	--	--	0	23	--	437	25.0	--	--				
1400	5050	18 C	6.9	1660					.00	.38		12.32	.40		--				
										3		94	3						

MINERAL ANALYSES OF GROUND WATER

T CENTRAL COASTAL DRAINAGE PROVINCE
T-10 SAN LUIS OBISPO HYDRO UNIT
T-10.B SAN LUIS OBISPO HYDRO SUBUNIT
T-10.B3 LOS OSOS HYDRO SUBAREA

CONTINUED

DATE TIME	SAMPLER LAB	TEMP		FIELD LABORATORY PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR	REM
						MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE									MILLIGRAMS PER LITER					
30S/10E-13B02 M																				
05/26/67		56	F			18	20	36	1.0	0	28	16	97	35.0	.02	.0	307	127		
1010	5050	13	C	7.2	401	.90	1.64	1.57	.03	.00	.46	.33	2.74	.56		--	237	104	1.4	T
						22	40	38	1		11	8	67	14						
11/02/67		58	F			10	5.0	23	1.0	0	41	6.0	33	2.0	.02	.0	101	46		
1315	5050	14	C	7.8	187	.50	.41	1.00	.03	.00	.67	.12	.93	.03		--	100	12	1.5	
						26	21	52	2		38	7	53	2						S
30S/10E-13G02 M																				
08/03/61						15	11	50	1.0	0	63	18	84	4.0	.06	.0	260*	83		
	5788			6.8	424	.75	.90	2.18	.03	.00	1.03	.37	2.37	.06		14.0	228	31	2.4	
						19	23	56	1		27	10	62	2						
07/12/62						12	12	48	1.0	0	80	6.0	70	18.0	.05	.2	266	80		
	5788			7.2	420	.60	.99	2.09	.03	.00	1.31	.12	1.97	.29		18.0	224	14	2.3	
						16	27	56	1		36	3	53	8						
10/30/62						11	13	48	1.0	0	83	8.0	72	14.0	.16	.1	190	81		
1600	5050			7.1	415	.55	1.07	2.09	.03	.00	1.36	.17	2.03	.23		21.0	229	13	2.3	T
						15	29	56	1		36	4	54	6						
03/25/70	5050	64	F			12	9.0	68	1.0	0	63	31	43	92.0	.04	.2	290	67		
1555	5050	18	C	7.1	482	.60	.74	2.96	.03	.00	1.03	.65	1.21	1.48		--	287	16	3.6	
						14	17	68	1		24	15	28	34						
30S/10E-13L01 M																				
06/20/60	5117					--	--	--	--	--	--	--	36	--	--	--				
													1.02			--				
08/09/60						--	--	--	--	0	37	--	39	--	--	--		45		
	5788			7.3	200					.00	.61		1.10			--				
09/13/60	5117					--	--	--	--	--	--	--	36	--	--	--				
													1.02			--				
08/03/61						22	5.0	24	1.0	0	86	2.0	40	.0	.03	.1	176*	76		
	5788			6.7	270	1.10	.41	1.04	.03	.00	1.41	.04	1.13	.00		23.0	159	5	1.2	
						43	16	40	1		55	2	44							
07/12/62						11	5.0	24	1.0	0	46	.0	38	6.0	.03	.2	148	48		
	5788			7.5	220	.55	.41	1.04	.03	.00	.75	.00	1.07	.10		27.0	135	11	1.5	
						27	20	51	1		39		56	5						S
10/30/62						16	4.0	26	1.0	2.0	59	.0	38	7.0	.04	.2	136	57		
1540	5788			8.4	220	.80	.33	1.13	.03	.07	.97	.00	1.07	.11		21.0	144	5	1.5	
						35	14	49	1	3	44		48	5						
07/05/63						9.0	5.0	21	1.0	0	40	1.0	34	7.4	.03	.1	124	43		
731	5050			7.9	204	.45	.41	.91	.03	.00	.66	.02	.96	.12		32.0	130	10	1.4	
						25	23	51	2		38	1	55	7						
08/04/65		66	F			4.0	6.0	25	1.0	0	41	3.0	36	6.0	.02	.1	160	35		E
	5050	19	C	7.6	199	.20	.49	1.09	.03	.00	.67	.06	1.02	.10		--	101	1	1.8	T
						11	27	60	2		36	3	55	5						
07/19/66		62	F			7.0	6.0	24	1.0	0	40	5.0	37	7.0	.02	.1	113	42		
1100	5050	17	C	7.6	202	.35	.49	1.04	.03	.00	.66	.10	1.04	.11		--	107	9	1.6	
						18	26	54	2		35	5	54	6						
09/28/66		70	F			--	--	--	--	0	43	--	30	5.4	--	--				
1430	5050	21	C	6.8	203					.00	.70		.85	.09		--				
											43		52	5						
05/26/67		65	F			9.0	3.0	22	1.0	0	45	4.0	34	7.0	.02	.2	169	35		E
1000	5050	18	C	8.0	196	.45	.25	.96	.03	.00	.74	.08	.96	.11		--	102	0	1.6	T
						27	15	57	2		39	4	51	6						S
11/02/67		64	F			6.0	6.0	23	1.0	0	36	20	35	6.0	.00	.0	141	40		E
1330	5050	18	C	7.1	198	.30	.49	1.00	.03	.00	.59	.42	.99	.10		--	115	10	1.6	
						16	27	55	2		28	20	47	5						S
03/21/70	5050	63	F			7.0	5.0	22	1.0	0	37	4.0	32	10.0	.00	.2	107	38		
1000	5050	17	C	7.8	194	.35	.41	.96	.03	.00	.61	.08	.90	.16		--	99	8	1.6	
						20	23	55	2		35	5	51	9						
30S/10E-13L02 M																				
06/28/71	5117					--	--	--	--	--	--	--	29	5.8	--	--				
1120	5091												.82	.09		--				
08/17/71	5117					--	--	--	--	--	--	--	30	3.9	--	--				
1345	5091												.85	.06		--				
09/29/71	5117					--	--	--	--	--	--	--	31	6.0	--	--				
1100	5091												.87	.10		--				
10/28/71	5117					--	--	--	--	--	--	--	--	--	--	--				
1415	5091															--				
01/27/72	5117					--	--	--	--	--	--	--	30	2.6	--	--				
1130	5091												.85	.04		--				
02/23/72	5117					--	--	--	--	--	--	--	30	4.8	--	--				
1115	5091												.85	.08		--				

MINERAL ANALYSES OF GROUND WATER

CENTRAL COASTAL DRAINAGE PROVINCE (T)
SAN LUIS OBISPO HYDRO UNIT (T-10)
SAN LUIS OBISPO HYDRO SUBUNIT (T-10.B)
LOS OSOS HYDRO SUBAREA (T-10.B3)

Column heads: MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE; B, F, SIO2, TDS, SUM, TH, NCH in MILLIGRAMS PER LITER.

DATE TIME	SAMPLER LAB	TEMP	FIELD LABORATORY PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR	REM
30S/10E-13L02 M												CONTINUED							
03/13/72	5117		7.6		8.0	5.0	19	1.0	0	37	.8	30	3.7	--	.2	130*	40		
1050	5091				.40	.41	.83	.03	.00	.61	.02	.85	.06		--	86	10	1.3	T
					24	25	50	2		40	1	55	4						S
03/29/72	5117				--	--	--	--	--	--	--	31	5.9	--	--				
1445	5091											.87	.10		--				
04/26/72	5117				--	--	--	--	--	--	--	32	4.1	--	--				
1515	5091											.90	.07		--				
05/30/72	5117				--	--	--	--	--	--	--	31	4.4	--	--				
1400	5091											.87	.07		--				
07/31/72	5117				--	--	--	--	--	--	--	32	4.8	--	--				
1100	5091											.90	.08		--				
08/31/72	5117				--	--	--	--	--	--	--	32	5.2	--	--				
	5091											.90	.08		--				
10/26/72	5117				--	--	--	--	--	--	--	31	47.0	--	--				
1115	5091											.87	.76		--				
30S/10E-13P01 M																			
10/02/54					10	6.0	27	1.0	0	44	7.0	34	21.7	.00	.1	171*	50		E
	5786		7.2	244	.50	.49	1.17	.03	.00	.72	.15	.96	.35		--	128	14	1.7	T
					23	22	53	1		33	7	44	16						
07/19/61					6.0	6.0	25	1.0	0	43	2.0	35	16.0	.04	.2	133	40		
	5050		7.3	213	.30	.49	1.09	.03	.00	.70	.04	.99	.26		27.0	139	5	1.7	
					16	26	57	2		35	2	50	13						
30S/10E-23H01 M																			
08/03/61					12	15	43	1.0	0	90	19	61	3.6	.06	.2	260*	92		
	5788		7.1	372	.60	1.23	1.87	.03	.00	1.48	.40	1.72	.06		21.0	220	18	2.0	
					16	33	50	1		40	11	47	2						
07/08/64		69 F			10	2.0	22	3.0	0	33	2.0	41	7.0	.02	.1	134	33		E
	5788	21 C	7.0	180	.50	.16	.96	.08	.00	.54	.04	1.16	.11		--	103	6	1.7	T
					29	9	56	5		29	2	63	6						S
08/05/65					10	11	39	1.0	0	66	16	56	12.0	.02	.1	190	70		
	5050		7.6	344	.50	.90	1.70	.03	.00	1.08	.33	1.58	.19		--	177	16	2.0	
					16	29	54	1		34	10	50	6						
03/25/70	5050	64 F			13	87	11	1.0	29	378	12	28	5.0	.00	.1	451	390		
1520	5050	18 C	8.3	696	.65	7.15	.48	.03	.97	6.20	.25	.79	.08		--	372	32	0.2	
					8	86	6		12	75	3	10	1						
30S/10E-24A01 M																			
01/09/63	5117		7.2		5.8	2.4	20	.6	0	26	.0	27	2.1	--	.0		25		
1300	5091				.29	.20	.87	.02	.00	.43	.00	.76	.03		--	71	3	1.8	
					21	14	63	1		35		62	2						S
04/04/63	5117		7.2		--	--	--	--	--	--	--	--	--	--	.0		32		
1000	5091														--				
02/09/66	5117				--	--	--	--	--	--	--	--	--	--	--	120*			
1645	5091														--				
03/26/70	5050	64 F			5.0	4.0	20	.0	0	29	4.0	29	11.0	.00	.1	103	29		
1445	5050	18 C	7.0	167	.25	.33	.87	.00	.00	.48	.08	.82	.18		--	87	5	1.6	
					17	23	60			31	5	53	12						S
06/28/71	5117				--	--	--	--	--	--	--	27	9.0	--	--				
1055	5091											.76	.15		--				
08/17/71	5117				--	--	--	--	--	--	--	28	9.0	--	--				
1400	5091											.79	.15		--				
09/29/71	5117				--	--	--	--	--	--	--	29	8.9	--	--				
1050	5091											.82	.14		--				
10/28/71	5117				--	--	--	--	--	--	--	30	8.6	--	--				
1405	5091											.85	.14		--				
12/30/71	5117				--	--	--	--	--	--	--	34	9.9	--	--				
1020	5091											.96	.16		--				
01/27/72	5117				--	--	--	--	--	--	--	28	9.1	--	--				
1115	5091											.79	.15		--				
02/23/72	5117				--	--	--	--	--	--	--	32	7.4	--	--				
1100	5091											.90	.12		--				
03/29/72	5117				--	--	--	--	--	--	--	28	7.6	--	--				
1430	5091											.79	.12		--				

APPENDIX D

MINERAL ANALYSES OF GROUND WATER

T — CENTRAL COASTAL DRAINAGE PROVINCE
T-10 — SAN LUIS OBISPO HYDRO UNIT
T-10.B — SAN LUIS OBISPO HYDRO SUBUNIT
T-10.B3 — LOS OSOS HYDRO SUBAREA

CONTINUED

DATE TIME	SAMPLER LAB	WELL	TEMP		FIELD LABORATORY PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR	REM
		30S/10E-24A01 M																			
04/26/72	5117						--	--	--	--	--	--	--	28	8.8	--	--				
1500	5091													.79	.14		--				
05/30/72	5117						--	--	--	--	--	--	--	28	8.0	--	--				
1430	5091													.79	.13		--				
07/31/72	5117						--	--	--	--	--	--	--	31	6.7	--	--				
1045	5091													.87	.11		--				
08/31/72	5117						--	--	--	--	--	--	--	33	7.7	--	--				
	5091													.93	.12		--				
10/26/72	5117						--	--	--	--	--	--	--	29	8.4	--	--				
1100	5091													.82	.14		--				
		30S/11E-07G01 M																			
08/03/61							13	7.0	18	1.0	0	52	8.0	30	14.0	.07	.1	168*	62		E
	5780				7.2	212	.65	.58	.78	.03	.00	.85	.17	.85	.23		24.0	141	19	1.0	
							32	28	38	1		40	8	40	11						
07/08/64							11	7.0	20	1.0	0	37	5.0	34	17.0	.02	.1	144	57		E
	5780				7.3	190	.55	.58	.87	.03	.00	.61	.10	.96	.27		--	113	26	1.2	T
							27	29	43	1		31	5	49	14						
08/03/65							9.0	7.0	19	1.0	0	47	6.0	27	17.0	.00	.1	130	52		
	5050				7.7	212	.45	.58	.83	.03	.00	.77	.12	.76	.27		--	109	13	1.2	
							24	31	44	2		40	6	40	14						
03/25/70	5050		65	F			9.0	9.0	19	1.0	0	41	7.0	30	24.0	.00	.1	123	60		
1700	5050		18	C	7.3	223	.45	.74	.83	.03	.00	.67	.15	.85	.39		--	119	26	1.1	
							22	36	40	1		33	7	41	19						
		30S/11E-07G02 M																			
08/03/61							16	9.0	23	1.0	0	44	10	39	33.0	.05	.2	192*	77		E
	5780				6.5	270	.80	.74	1.00	.03	.00	.72	.21	1.10	.53		24.0	177	41	1.1	
							31	29	39	1		28	8	43	21						
		30S/11E-07G03 M																			
08/03/61							9.0	7.0	19	1.0	0	47	1.0	31	13.0	.05	.2	148*	52		E
	5780				7.2	195	.45	.58	.83	.03	.00	.77	.02	.87	.21		24.0	128	13	1.2	
							24	31	44	2		41	1	47	11						
07/12/62							8.0	6.0	20	1.0	0	43	4.0	30	8.0	.00	.1	112	45		
	5780				7.4	200	.40	.49	.87	.03	.00	.70	.08	.85	.13		18.0	116	10	1.3	
							22	27	49	2		40	5	48	7						
07/08/64							12	5.0	20	1.0	0	43	4.0	28	13.0	.02	.1	132	51		E
	5780				7.9	180	.60	.41	.87	.03	.00	.70	.08	.79	.21		--	104	16	1.2	T
							31	21	46	2		39	4	44	12						S
08/03/65							8.0	6.0	18	1.0	0	41	5.0	26	13.0	.00	.1	120	45		
	5050				7.9	187	.40	.49	.78	.03	.00	.67	.10	.73	.21		--	97	11	1.2	
							24	29	46	2		39	6	43	12						
07/19/66			67	F			8.0	7.0	19	1.0	0	45	3.0	31	12.0	.00	.1	118	49		
1230	5050		19	C	6.9	194	.40	.58	.83	.03	.00	.74	.06	.87	.19		--	103	12	1.2	
							22	32	45	2		40	3	47	10						
09/28/66			72	F			--	--	--	--	0	40	--	25	14.0	--	--				
1400	5050		22	C	7.7	198					.00	.66		.71	.23		--				
												41		44	14						
01/03/67			72	F			--	--	--	--	0	40	--	25	14.0	--	--				
	5050		22	C	7.7	198					.00	.66		.71	.23		--				
												41		44	14						
05/26/67			62	F			7.0	6.0	17	1.0	0	40	4.0	27	11.0	.00	.1	78	42		
1030	5050		17	C	7.7	190	.35	.49	.74	.03	.00	.66	.08	.76	.18		--	93	9	1.1	
							22	30	46	2		39	5	45	11						
11/02/67			65	F			8.0	4.0	17	1.0	0	21	4.0	34	8.0	.00	.0	111	36		
1500	5050		18	C	7.5	171	.40	.33	.74	.03	.00	.34	.08	.96	.13		--	86	20	1.2	T
							27	22	49	2		23	5	64	9						
		30S/11E-07J01 M																			
03/05/57			60	F			8.0	6.0	19	1.0	0	38	5.0	30	13.0	.00	.4	122	45		
1245	5009		16	C	7.1	200	.40	.49	.83	.03	.00	.62	.10	.85	.21		20.0	121	14	1.2	
							23	28	47	2		35	6	48	12						
		30S/11E-07N01 M																			
10/02/54							17	11	24	1.0	0	96	4.0	41	4.3	.00	.0	201*	88		
	5786				7.4	298	.85	.90	1.04	.03	.00	1.57	.08	1.16	.07		--	150	9	1.1	T
							30	32	37	1		55	3	40	2						
08/30/57							9.0	7.0	18	.0	0	43	6.0	28	13.0	.04	.2	130	52		
	5050				7.1	195	.45	.58	.78	.00	.00	.70	.12	.79	.21		--	102	17	1.1	T
							25	32	43			38	7	43	12						
09/30/58							23	8.0	24	2.0	0	111	2.0	36	.0	.00	.2	204	91		E
	5787				8.2	290	1.15	.66	1.04	.05	.00	1.82	.04	1.02	.00		25.0	175	0	1.1	
							40	23	36	2		63	1	35							
07/28/59							24	7.0	18	1.0	4.0	81	1.0	35	2.0	.00	.1	197	89		
	5787				8.6	316	1.20	.58	.78	.03	.13	1.33	.02	.99	.03		25.0	157	16	0.8	T
							46	22	30	1	5	53	1	40	1						
08/03/61			67	F			14	10	23	1.0	0	86	5.0	38	2.3	.05	.1	178*	76		
	5780		19	C	7.0	282	.70	.82	1.00	.03	.00	1.41	.10	1.07	.04		24.0	160	4	1.1	
							27	32	39	1		54	4	41	2						

Column headings as printed: DATE / TIME; SAMPLER / LAB; TEMP; FIELD / LABORATORY / PH / EC; MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE: CA, MG, NA, K, CO3, HCO3, SO4, CL, NO3; MILLIGRAMS PER LITER: B, F / SIO2, TDS / SUM, TH / NCH; SAR; REM

APPENDIX D

MINERAL ANALYSES OF GROUND WATER

DATE TIME	SAMPLER LAB	TEMP	FIELD LABORATORY PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR	REM
					MINERAL CONSTITUENTS IN				MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE					MILLIGRAMS PER LITER					
	T	CENTRAL COASTAL DRAINAGE PROVINCE																	
	T-10	SAN LUIS OBISPO HYDRO UNIT																	
	T-10.8	SAN LUIS OBISPO HYDRO SUBUNIT																	
	T-10.83	LOS OSOS HYDRO SUBAREA																	
	30S/11E-07N01 M											CONTINUED							
12/10/61					12	9.0	23	1.0	0	81	3.0	32	3.9	.00	.1	147	67		
	5050		7.6	267	.60	.74	1.00	.03	.00	1.33	.06	.90	.06		32.0	156	1	1.2	
					25	31	42	1		57	3	38	3						
10/31/62					19	8.0	22	1.0	0	92	3.0	32	2.0	.06	.2	198	81		
	5788		7.9	290	.95	.66	.96	.03	.00	1.51	.06	.90	.03		21.0	153	5	1.1	T
					37	25	37	1		60	2	36	1						
10/07/63					12	10	22	1.0	0	83	.0	35	3.0	.02	.2	150	71		
1300	5050		7.4	276	.60	.82	.96	.03	.00	1.36	.00	.99	.05		34.0	150	3	1.1	
					25	34	40	1		57		41	2						
10/07/64		64 F			12	11	20	1.0	0	83	4.0	33	3.0	.00	.0	138	75		
	5050	18 C	7.8	251	.60	.90	.87	.03	.00	1.36	.08	.93	.05		--	125	7	1.0	
					25	38	36	1		56	3	38	2						
02/10/66	5117				--	--	--	--	--	--	--	--	--	--	--	160*			
1440	5091														--				
10/02/66					21	3.0	21	1.0	0	74	7.0	32	2.0	.00	--	128	65		
	5050		7.6	242	1.05	.25	.91	.03	.00	1.21	.15	.90	.05		--	124	5	1.1	
					47	11	41	1		52	6	39	2						
11/02/67		62 F			12	9.0	22	1.0	0	74	5.0	35	3.0	.00	.0	151	67		
	5050	17 C	7.5	242	.60	.74	.96	.03	.00	1.21	.10	.99	.05		--	123	7	1.2	
					26	32	41	1		51	4	42	2						
12/10/69	5117				15	8.0	19	.0	0	75	5.0	31	2.0	.00	.1	110	70		
	5050		7.9	251	.75	.66	.83	.00	.00	1.23	.10	.87	.03		--	117	9	1.0	
					33	29	37			55	4	39	1						
11/08/70	5117	63 F			9.0	11	20	.0	0	76	5.0	32	2.0	.02	.2	144	68		
1415	5050	17 C	7.6	252	.45	.90	.87	.00	.00	1.25	.10	.90	.03		--	116	5	1.1	
					20	41	39			55	4	39	1						
08/17/71	5117				14	9.8	20	2.2	0	65	5.6	36	1.1	--	.1	175*	75		
1430	5091				.70	.81	.87	.06	.00	1.07	.12	1.02	.02		--	121	22	1.0	T
					29	33	36	2		48	5	46	1						S
03/17/72	5117		7.0		12	9.0	--	.8	0	70	6.0	35	1.0	.07	.1		50		
	5091			200	.60	.74		.02	.00	1.15	.12	.99	.02		--		10		
										50	5	43	1						
	30S/11E-07Q01 M																		
12/30/59					8.0	7.0	19	1.0	0	37	4.0	30	1.3	.02	.0	109	49		
	5050		7.4	189	.40	.58	.83	.03	.00	.61	.08	.85	.02		26.0	115	19	1.2	
					22	32	45	2		39	5	54	1						S
02/03/60	5117				--	--	--	--	--	--	--	27	--	--	--				
												.76			--				
08/02/60					9.0	8.0	43	1.0	0	34	74	31	5.3	.04	.0	154*	56		
	5788		7.7	260	.45	.66	1.87	.03	.00	.56	1.54	.87	.09		21.0	209	28	2.5	T
					15	22	62	1		18	50	28	3						
08/09/60					--	--	--	--	0	37	--	35	--	--	--		45		
	5788		7.7	200					.00	.61		.99			--				
08/18/60					--	--	--	--	0	38	--	31	--	--	--		42		
	5788		7.5	205					.00	.62		.87			--				
08/24/60					--	--	--	--	0	34	--	31	--	--	--		60		
	5788		7.3	205					.00	.56		.87			--				
09/20/60					--	--	--	--	0	37	--	31	--	--	--		47		
	5788		7.2	215					.00	.61		.87			--				
08/03/61					8.0	10	21	1.0	0	43	9.0	35	15.0	.04	.1	176*	61		E
	5788		6.8	220	.40	.82	.91	.03	.00	.70	.19	.99	.24		19.0	139	26	1.2	T
					19	38	42	1		33	9	47	11						
08/22/62	5117		7.5		7.8	6.2	21	1.1	0	28	7.5	31	--	--	.0	170*	45		
1330	5091				.39	.51	.91	.03	.00	.46	.16	.87			--	88	22	1.4	T
					21	28	49	2		31	11	58							
10/30/62		62 F			8.0	7.0	20	1.0	0	37	5.0	29	17.0	.00	.1	108	49		
1640	5050	17 C	7.8	211	.40	.58	.87	.03	.00	.61	.10	.82	.27		31.0	136	19	1.2	T
					21	31	46	2		34	6	46	15						
02/10/66	5117				--	--	--	--	--	--	--	--	--	--	--	145*			
1330	5091														--				
09/20/66		64 F			9.0	6.0	20	1.0	0	31	5.0	30	18.0	.00	--	140	47		
1100	5050	18 C	7.3	213	.45	.49	.87	.03	.00	.51	.10	.85	.29		--	104	22	1.3	T
					24	27	47	2		29	6	49	17						S
11/02/67		60 F			9.0	7.0	21	1.0	0	34	8.0	34	21.0	.00	.0	166	51		E
	5050	16 C	7.3	214	.45	.58	.91	.03	.00	.56	.17	.96	.34		--	118	24	1.3	T
					23	29	46	2		28	8	47	17						
12/10/69	5117	62 F			7.0	6.0	18	.0	0	26	6.0	29	18.0	.00	.1	124	42		
	5050	17 C	7.2	191	.35	.49	.78	.00	.00	.43	.12	.82	.29		--	97	21	1.2	T
					22	30	48			26	7	49	17						
03/26/70	5050	62 F			8.0	7.0	20	1.0	0	31	7.0	32	22.0	.00	.1	123	49		
0840	5050	17 C	7.3	205	.40	.58	.87	.03	.00	.51	.15	.90	.35		--	112	24	1.2	
					21	31	46	2		27	8	47	18						

MINERAL ANALYSES OF GROUND WATER

DATE TIME	SAMPLER LAB	TEMP		FIELD LABORATORY PH	EC	MINERAL CONSTITUENTS IN CA	MG	NA	K	CO3	MILLIGRAMS PER LITER MILLIEQUIVALENTS PER LITER PERCENT REACTANCE VALUE HCO3	SO4	CL	NO3	MILLIGRAMS PER LITER B	F SIO2	TDS SUM	TH NCH	SAR	REM
	T			CENTRAL COASTAL DRAINAGE PROVINCE																
	T-10			SAN LUIS OBISPO HYDRO UNIT																
	T-10.B			SAN LUIS OBISPO HYDRO SUBUNIT																
	T-10.B3			LOS OSOS HYDRO SUBAREA																
	30S/11E-07Q01 M												CONTINUED							
05/14/71	5117	60	F			8.0	7.0	22	1.0	0	33	8.0	31	24.0	.01	.0	154	49		
1415	5050	16	C	7.1	223	.40	.58	.96	.03	.00	.54	.17	.87	.39		--	117	22	1.4	T
						20	29	49	2		27	9	44	20						
06/24/71	5117					--	--	--	--	--	--	--	31	21.0	--	--				
1040	5091												.87	.34		--				
08/17/71	5117					--	--	--	--	--	--	--	33	22.0	--	--				
1420	5091												.93	.35		--				
09/29/71	5117					--	--	--	--	--	--	--	33	22.0	--	--				
1020	5091												.93	.35		--				
10/28/71	5117					--	--	--	--	--	--	--	33	20.0	--	--				
1335	5091												.93	.32		--				
12/30/71	5117					--	--	--	--	--	--	--	30	28.0	--	--				
0950	5091												.85	.45		--				
01/27/72	5117					--	--	--	--	--	--	--	32	22.0	--	--				
1030	5091												.90	.35		--				
02/23/72	5117					--	--	--	--	--	--	--	32	24.0	--	--				
1015	5091												.90	.39		--				
03/17/72	5117			6.8		9.0	6.6	18	.8	0	30	8.0	35	7.0	.09	.1		50		
	5091				200	.45	.54	.78	.02	.00	.49	.17	.99	.11		--	99	25	1.1	
						25	30	44	1		28	10	56	6						
03/29/72	5117					--	--	--	--	--	--	--	33	23.0	--	--				
1345	5091												.93	.37		--				
04/26/72	5117					--	--	--	--	--	--	--	32	22.0	--	--				
1445	5091												.90	.35		--				
05/30/72	5117					--	--	--	--	--	--	--	33	2.3	--	--				
1345	5091												.93	.04		--				
07/31/72	5117					--	--	--	--	--	--	--	33	21.0	--	--				
1030	5091												.93	.34		--				
08/31/72	5117					--	--	--	--	--	--	--	32	2.2	--	--				
	5091												.90	.04		--				
10/26/72	5117					--	--	--	--	--	--	--	31	24.0	--	--				
1045	5091												.87	.39		--				
	30S/11E-08J01	M																		
03/06/57	5117	62	F			173	211	367	2.0	0	416	109	1090	148	.35	1.0		1300		
		17	C	8.0	3860	8.63	17.35	15.96	.05	.00	6.82	2.27	30.74	2.39		9.0	2314	959	4.4	
						21	41	38			16	5	73	6						
09/16/60		62	F			160	185	355	1.0	0	450	103	945	136	.55	1.5	2444*	1160		
	5788	17	C	7.4	3690	7.98	15.21	15.44	.03	.00	7.38	2.14	26.65	2.19		11.0	2118	791	4.5	
						21	39	40			19	6	69	6						
10/30/61						148	187	345	2.0	0	427	99	929	167	.33	.6	2342	1139		
	5050			7.2	3570	7.39	15.38	15.01	.05	.00	7.00	2.06	26.20	2.69		25.0	2112	789	4.4	
						20	41	40			18	5	69	7						
10/22/62		62	F			112	140	335	1.0	0	305	79	833	65.0	.44	.8	1938	856		
	5788	17	C	8.1	2900	5.59	11.51	14.57	.03	.00	5.00	1.64	23.49	1.05		7.0	1722	605	5.0	
						18	36	46			16	5	75	3						
09/23/63		65	F			80	150	335	1.0	19	227	88	815	104	.42	1.1	1885	817		
1330	5050	18	C	8.2	3096	3.99	12.34	14.57	.03	.63	3.72	1.83	22.98	1.68		18.0	1722	599	5.1	
						13	40	47		2	12	6	75	5						
10/07/64		65	F			112	158	318	1.0	0	362	94	820	113	.40	1.1	1849	930		
	5050	18	C	8.1	3172	5.59	12.99	13.83	.03	.00	5.93	1.96	23.12	1.82		--	1794	633	4.5	
						17	40	43			18	6	70	6						
10/04/65		63	F			131	149	330	2.0	0	411	97	818	86.0	.36	.7	2020	940		
	5050	17	C	7.9	3311	6.54	12.25	14.36	.05	.00	6.74	2.02	23.07	1.39		--	1815	603	4.7	
						20	37	43			20	6	69	4						
09/28/66		75	F			--	--	--	--	0	366	--	730	60.0	--	--				
1330	5050	24	C	8.3	3240					.00	6.00		20.59	.97		--				
											22		75	4						
11/02/67		63	F			120	140	317	2.0	0	391	95	790	73.0	.44	1.2	2126	876		E
	5050	17	C	7.8	3030	5.99	11.51	13.79	.05	.00	6.41	1.98	22.28	1.18		--	1730	555	4.7	
						19	37	44			20	6	70	4						
12/11/69	5117	63	F			101	130	274	6.0	0	406	99	658	60.0	.42	1.3	1588	787		
1000	5050	17	C	8.1	2792	5.04	10.69	11.92	.15	.00	6.65	2.06	18.56	.97		--	1528	454	4.3	
						18	38	43	1		24	7	66	3						
06/04/73	5050					104	133	306	.6	0	383	75	750	37.8	.32	.9	1746	806		
	5050			7.9	2842	5.19	10.94	13.31	.02	.00	6.28	1.56	21.15	.61		--	1595	493	4.7	
						18	37	45			21	5	71	2						

MINERAL ANALYSES OF GROUND WATER

DATE TIME	SAMPLER LAB	TEMP	FIELD LABORATORY	PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR	REM
						MINERAL CONSTITUENTS IN	MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE								MILLIGRAMS PER LITER					
	T	CENTRAL COASTAL DRAINAGE PROVINCE																		
	T-10	SAN LUIS OBISPO HYDRO UNIT																		
	T-10.B	SAN LUIS OBISPO HYDRO SUBUNIT																		
	T-10.B3	LOS OSOS HYDRO SUBAREA																		
	30S/11E-08M02 M																			
03/27/70	5050	65	F			12	8.0	21	1.0	0	45	9.0	35	21.0	.00	.0	145	63		
1110	5050	18	C	7.5	242	.60	.66	.91	.03	.00	.74	.19	.99	.34		--	129	26	1.2	
						27	30	41	1		33	8	44	15						
05/14/71	5117	61.0	F			8.0	11	22	1.0	0	33	9.0	43	17.0	.01	.0	182	65		
1445	5050	16.1	C	7.2	269	.40	.90	.96	.03	.00	.54	.19	1.21	.27		--	127	38	1.2	T
						17	39	42	1		24	9	55	12						
	30S/11E-08R01 M																			
08/03/61						97	83	69	3.0	0	736	2.0	100	2.7	.15	.1	824*	584		
	5788			7.6	1270	4.84	6.83	3.00	.08	.00	12.06	.04	2.82	.04		35.0	754	0	1.2	
						33	46	20	1		81		19							
07/12/62						80	111	74	5.0	0	793	18	117	.0	.16	.1	1070	657		E
	5788			8.0	1380	3.99	9.13	3.22	.13	.00	13.00	.37	3.30	.00		18.0	813	6	1.3	TC
						24	55	20	1		78	2	20							
10/30/62		68	F			71	105	74	3.0	0	793	4.0	92	3.0	.12	.2	810	609		
1520	5788	20	C	7.7	1260	3.54	8.64	3.22	.08	.00	13.00	.08	2.59	.05		19.0	761	0	1.3	C
						23	56	21	1		83	1	16							
07/05/63						79	99	75	3.0	12	677	2.0	92	4.3	.13	.1	698	604		C
950	5050			8.4	1160	3.94	8.14	3.26	.08	.40	11.10	.04	2.59	.07		28.0	727	29	1.3	S
						26	53	21	1	3	78		18							
07/19/66		69	F			92	89	68	3.0	23	690	4.0	98	4.0	.10	.2	694	596		
1300	5050	21	C	8.4	1263	4.59	7.32	2.96	.08	.77	11.31	.08	2.76	.06		--	720	0	1.2	
						31	.49	20	1	5	76	1	18							
09/28/66		72	F			--	--	--	--	0	721	--	88	3.9	--	--				
1330	5050	22	C	8.1	1330					.00	11.82		2.48	.06		--				
											82		17							
05/26/67		74	F			63	85	81	6.0	0	639	15	98	3.5	.12	.2	647	507		
1100	5050	23	C	8.1	1138	3.14	6.99	3.52	.15	.00	10.47	.31	2.76	.06		--	666	0	1.6	C
						23	51	26	1		77	2	20							
11/02/67		68	F			44	79	72	3.0	0	531	4.0	101	3.0	.11	.2	586	435		
	5050	20	C	8.2	1051	2.20	6.50	3.13	.08	.00	8.70	.08	2.85	.05		--	567	0	1.5	
						18	55	26	1		74	1	24							
	30S/11E-09P01 M																			
03/27/70	5050	64	F			143	208	345	.0	0	361	88	1110	19.0	.16	.7	2460	1213		
1200	5050	18	C	7.3	3906	7.14	17.11	15.01	.00	.00	5.92	1.83	31.30	.31		--	2091	917	4.3	
						18	44	38			15	5	80	1						
	30S/11E-17A02 M																			
03/21/70	5050	62	F			41	37	33	1.0	0	262	22	57	4.0	.02	.2	352	255		
1515	5050	17	C	7.8	614	2.05	3.04	1.44	.03	.00	4.29	.46	1.61	.06		--	324	40	0.9	
						31	46	22			67	7	25	1						
	30S/11E-17B01 M																			
08/03/61		67	F			23	19	28	1.0	0	138	13	43	6.6	.05	.1	290*	136		
	5788	19	C	7.5	416	1.15	1.56	1.22	.03	.00	2.26	.27	1.21	.11		26.0	228	23	1.0	T
						29	39	31	1		59	7	31	3						
	30S/11E-17H01 M																			
06/16/55		63	F			38	33	34	3.0	0	265	20	51	3.3	.05	.0	332*	231		
	5050	17	C	7.5	563	1.90	2.71	1.48	.08	.00	4.34	.42	1.44	.05		--	313	14	1.0	
						31	44	24	1		69	7	23	1						
09/28/66		65	F			--	--	--	--	11	210	--	40	13.0	--	--				
1500	5050	18	C	8.6	575					.37	3.44		1.13	.21		--				
03/27/70	5050	62	F			45	43	34	2.0	0	304	29	56	.0	.04	.1	403	289		
1010	5050	17	C	7.4	677	2.25	3.54	1.48	.05	.00	4.98	.60	1.58	.00		--	359	41	0.9	
						31	48	20	1		70	8	22							
	30S/11E-17M02 M																			
06/06/73	5050					16	15	24	.8	0	118	10	31	10.2	.00	.1	209	102		
	5050			7.6	332	.80	1.23	1.04	.02	.00	1.93	.21	.87	.16		--	165	5	1.0	T
						26	40	34	1		61	7	27	5						
	30S/11E-18D01S M																			
03/26/70	5050	67	F			10	6.0	25	1.0	0	35	7.0	37	25.0	.00	.1	137	50		
1200	5050	19	C	6.9	234	.50	.49	1.09	.03	.00	.57	.15	1.04	.40		--	128	21	1.5	
						24	23	52	1		26	7	48	19						
06/04/73	5050					7.6	6.1	23	.5	0	35	4.3	34	18.6	.00	.1	142	44		
	5050			6.8	237	.38	.50	1.00	.01	.00	.57	.09	.96	.30		--	111	16	1.5	T
						20	26	53	1		30	5	50	16						
	30S/11E-18H01 M																			
12/30/59						8.0	6.0	22	1.0	0	34	3.0	32	2.0	.02	.0	125	45		
	5050			7.3	207	.40	.49	.96	.03	.00	.56	.06	.90	.03		28.0	119	17	1.4	
						21	26	51	2		36	4	58	2						S
08/02/60						8.0	8.0	23	1.0	0	40	7.0	33	18.0	.00	.0	170	53		E
1455	5050			7.8	225	.40	.66	1.00	.03	.00	.66	.15	.93	.29		31.0	149	20	1.4	
						19	32	48	1		33	7	46	14						
08/09/60						--	--	--	--	0	41	--	34	--	--	--		53		
	5788			7.0	225					.00	.67		.96			--				N
08/18/60						--	--	--	--	0	42	--	32	--	--	--		61		
	5788			7.0	230					.00	.69		.90			--				
08/24/60						--	--	--	--	0	44	--	33	--	--	--		75		
	5788			7.6	240					.00	.72		.93			--				

MINERAL ANALYSES OF GROUND WATER

T CENTRAL COASTAL DRAINAGE PROVINCE
T-10 SAN LUIS OBISPO HYDRO UNIT
T-10.B SAN LUIS OBISPO HYDRO SUBUNIT
T-10.B3 LOS OSOS HYDRO SUBAREA

CONTINUED

DATE TIME	SAMPLER LAB	TEMP	FIELD LABORATORY PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR	REM
	30S/11E-18H01 M																		
09/20/60					--	--	--	--	0	40	--	33	--	--	--		69		
	5788		7.0	240					.00	.66		.93			--				
07/19/61					10	6.0	19	1.0	0	37	5.0	34	20.0	.06	.0	129	50		
	5050		7.0	210	.50	.49	.83	.03	.00	.61	.10	.96	.32		27.0	140	19	1.2	
					27	26	45	2		31	5	48	16						S
10/30/62					9.0	9.0	25	1.0	0	37	9.0	33	30.0	.02	.1	150	60		
1655	5050		7.4	253	.45	.74	1.09	.03	.00	.61	.19	.93	.48		28.0	162	29	1.4	
					19	32	47	1		28	9	42	22						
02/10/66	5117				--	--	--	--	--	--	--	--	--	--	--	180*			
1340	5091														--				
09/28/66					9.0	6.0	21	1.0	0	40	3.0	29	13.0	.00	--	153	47		E
1100	5050		7.6	211	.45	.49	.91	.03	.00	.66	.06	.82	.21		--	102	14	1.3	T
					24	26	48	2		38	3	47	12						S
11/02/67		62 F			9.0	7.0	17	1.0	0	45	5.0	33	8.0	.00	.0	176	51		E
	5050	17 C	7.8	220	.45	.58	.74	.03	.00	.74	.10	.93	.13		--	102	15	1.0	T
					25	32	41	2		39	5	49	7						S
12/10/69	5117				10	6.0	20	.0	0	49	5.0	30	14.0	.00	.1	86	50		
	5050		8.3	219	.50	.49	.87	.00	.00	.80	.10	.85	.23		--	109	10	1.2	T
					27	26	47			40	5	43	12						S
03/26/70	5050	64 F			10	8.0	24	1.0	0	35	14	33	29.0	.00	.0	149	58		
1000	5050	18 C	7.1	247	.50	.66	1.04	.03	.00	.57	.29	.93	.47		--	136	30	1.4	
					22	30	47	1		25	13	41	21						
06/24/71	5117				--	--	--	--	--	--	--	29	5.5	--	--				
1050	5091											.82	.09		--				
03/17/72	5117		6.8		9.0	4.5	23	.7	0	70	6.0	35	2.0	.19	.1		110		
	5091			190	.45	.37	1.03	.02	.00	1.15	.12	.99	.03		--	115	0	1.6	
					24	20	55	1		50	5	43	1						S
	30S/11E-18J01 M																		
07/19/61		67 F			15	15	21	1.0	0	92	12	35	17.0	.04	.1	177	99		
	5050	19 C	7.4	303	.75	1.23	.91	.03	.00	1.51	.25	.99	.27		28.0	189	24	0.9	
					26	42	31	1		50	8	33	9						
	30S/11E-18J02 M																		
07/19/61					23	21	28	1.0	0	183	1.0	35	4.3	.07	.0	205	144		
	5050		7.7	384	1.15	1.73	1.22	.03	.00	3.00	.02	.99	.07		29.0	232	0	1.0	
					28	42	30	1		74		24	2						
	30S/11E-18J03 M																		
07/19/61		68 F			9.0	7.0	17	1.0	0	52	2.0	28	9.9	.03	.1	125	52		
	5050	20 C	7.2	200	.45	.58	.74	.03	.00	.85	.04	.79	.16		28.0	127	9	1.0	
					25	32	41	2		46	2	43	9						
	30S/11E-18K01 M																		
12/09/65					17	5.0	21	1.0	0	37	17	35	10.0	.03	.3	156	63		E
1000	5874		7.5	220	.85	.41	.91	.03	.00	.61	.35	.99	.16		--	124	33	1.2	T
					39	19	41	1		29	17	47	8						
02/10/66	5117				--	--	--	--	--	--	--	--	--	--	--	120*			
1350	5091														--				
03/23/66	5117		7.3		.0	.0	31	.8	0	32	2.7	36	5.3	--	.1	150*	25		
0915	5091				.00	.00	1.35	.02	.00	.52	.06	1.02	.09		--	92	0	0.0	T
							99	1		31	4	60	5						S
09/28/66		63 F			7.0	5.0	17	1.0	0	42	1.0	24	6.6	.00	--	129	38		E
1045	5050	17 C	7.7	175	.35	.41	.74	.03	.00	.69	.02	.68	.11		--	82	4	1.2	T
					23	27	48	2		46	1	45	7						
11/02/67		62 F			8.0	4.0	18	1.0	0	41	3.0	26	7.0	.00	.2	113	36		
	5050	17 C	7.4	170	.40	.33	.78	.03	.00	.67	.06	.73	.11		--	87	3	1.3	T
					26	21	51	2		43	4	46	7						
12/10/69	5117				6.0	5.0	19	.0	0	26	4.0	28	16.0	.00	.1	111	36		
	5050		7.3	177	.30	.41	.83	.00	.00	.43	.08	.79	.26		--	91	14	1.4	
					19	27	54			28	5	51	17						
03/26/70	5050	64 F			6.0	5.0	20	.0	0	33	5.0	26	19.0	.00	.0	108	36		
1015	5050	18 C	7.1	173	.30	.41	.87	.00	.00	.54	.10	.73	.31		--	97	9	1.5	
					19	26	55			32	6	43	18						S
08/17/71	5117				--	--	--	--	--	--	--	27	14.0	--	--				
	5091											.76	.23		--				
09/29/71	5117				--	--	--	--	--	--	--	26	13.0	--	--				
1035	5091											.73	.21		--				
10/28/71	5117				--	--	--	--	--	--	--	26	9.5	--	--				
1340	5091											.73	.15		--				
12/30/71	5117				--	--	--	--	--	--	--	29	13.0	--	--				
1005	5091											.82	.21		--				
01/27/72	5117				--	--	--	--	--	--	--	25	12.5	--	--				
1045	5091											.71	.20		--				

Column heading note: MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE; B, F, SIO2, TDS, SUM, TH, NCH in MILLIGRAMS PER LITER.

MINERAL ANALYSES OF GROUND WATER

DATE TIME	SAMPLER LAB	TEMP	FIELD LABORATORY PH	EC	MINERAL CONSTITUENTS IN MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE: CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	MILLIGRAMS PER LITER: B	F / SIO2	TDS / SUM	TH / NCH	SAR	REM
	T	CENTRAL COASTAL DRAINAGE PROVINCE																	
	T-10	SAN LUIS OBISPO HYDRO UNIT																	
	T-10.8	SAN LUIS OBISPO HYDRO SUBUNIT																	
	T-10.83	LOS OSOS HYDRO SUBAREA																	
	30S/11E-18K01 M											CONTINUED							
02/23/72	5117				--	--	--	--	--	--	--	26	12.0	--	--				
1030	5091											.73	.19		--				
03/17/72	5117		6.6		5.4	6.5	21	.6	0	20	4.0	25	8.0	.30	.1		100		
	5091			150	.27	.53	.95	.02	.00	.33	.08	.71	.13		--	81	24	1.5	
					15	30	54	1		26	6	57	10						S
03/29/72	5117				--	--	--	--	--	--	--	25	12.0	--	--				
1400	5091											.71	.19		--				
04/26/72	5117				--	--	--	--	--	--	--	25	10.0	--	--				
1415	5091											.71	.16		--				
05/30/72	5117				--	--	--	--	--	--	--	23	10.0	--	--				
1330	5091											.65	.16		--				
07/31/72	5117				--	--	--	--	--	--	--	35	8.6	--	--				
1000	5091											.99	.14		--				
08/31/72	5117				--	--	--	--	--	--	--	25	12.0	--	--				
	5091											.71	.19		--				
10/26/72	5117				--	--	--	--	--	--	--	25	13.0	--	--				
1015	5091											.71	.21		--				
	30S/11E-18K03 M																		
05/12/69	5117		8.3		13	6.0	36	--	--	64	6.0	46	9.0	.10	.2	180	57		
	5091			288	.65	.49	1.57			1.05	.12	1.30	.15		--			2.1	
					24	18	58			40	5	50	6						
	30S/11E-18K99* M																		
06/28/71	5117				--	--	--	--	--	--	--	26	5.2	--	--				
1030	5091											.73	.08		--				
08/17/71	5117				--	--	--	--	--	--	--	28	2.4	--	--				
1410	5091											.79	.04		--				
09/29/71	5117				--	--	--	--	--	--	--	30	5.3	--	--				
1041	5091											.85	.09		--				
10/28/71	5117				--	--	--	--	--	--	--	28	3.0	--	--				
1350	5091											.79	.05		--				
12/30/71	5117				--	--	--	--	--	--	--	30	5.3	--	--				
1010	5091											.85	.09		--				
01/27/72	5117				--	--	--	--	--	--	--	29	5.1	--	--				
1100	5091											.82	.08		--				
02/23/72	5117				--	--	--	--	--	--	--	30	5.2	--	--				
1045	5091											.85	.08		--				
03/29/72	5117				--	--	--	--	--	--	--	31	4.2	--	--				
1415	5091											.87	.07		--				
04/26/72	5117				--	--	--	--	--	--	--	30	4.1	--	--				
1430	5091											.85	.07		--				
05/30/72	5117				--	--	--	--	--	--	--	29	5.4	--	--				
1415	5091											.82	.09		--				
07/31/72	5117				--	--	--	--	--	--	--	31	5.8	--	--				
1015	5091											.87	.09		--				
08/31/72	5117				--	--	--	--	--	--	--	30	5.6	--	--				
	5091											.85	.09		--				
10/26/72	5117				--	--	--	--	--	--	--	30	6.3	--	--				
1030	5091											.85	.10		--				
	30S/11E-18Q01 M																		
06/11/54		63 F			6.0	8.0	23	1.0	0	45	.0	39	8.7	.10	.0	125*	48		
	5786	17 C	7.1	210	.30	.66	1.00	.03	.00	.74	.00	1.10	.14		--	108	11	1.4	
					15	33	50	2		37		56	7						
08/30/57					7.0	7.0	23	.0	0	40	5.0	37	11.0	.04	.0	141	47		
	5050		7.2	213	.35	.58	1.00	.00	.00	.66	.10	1.04	.18		--	110	14	1.5	T
					18	30	52			33	5	53	9						
09/30/58					4.0	14	30	1.0	0	49	5.0	47	26.0	.00	.0	189	68		
	5787		6.7	290	.20	1.15	1.31	.03	.00	.80	.10	1.33	.42		26.0	177	28	1.6	
					T	43	49	1		30	4	50	16						

* Water from two wells.

MINERAL ANALYSES OF GROUND WATER

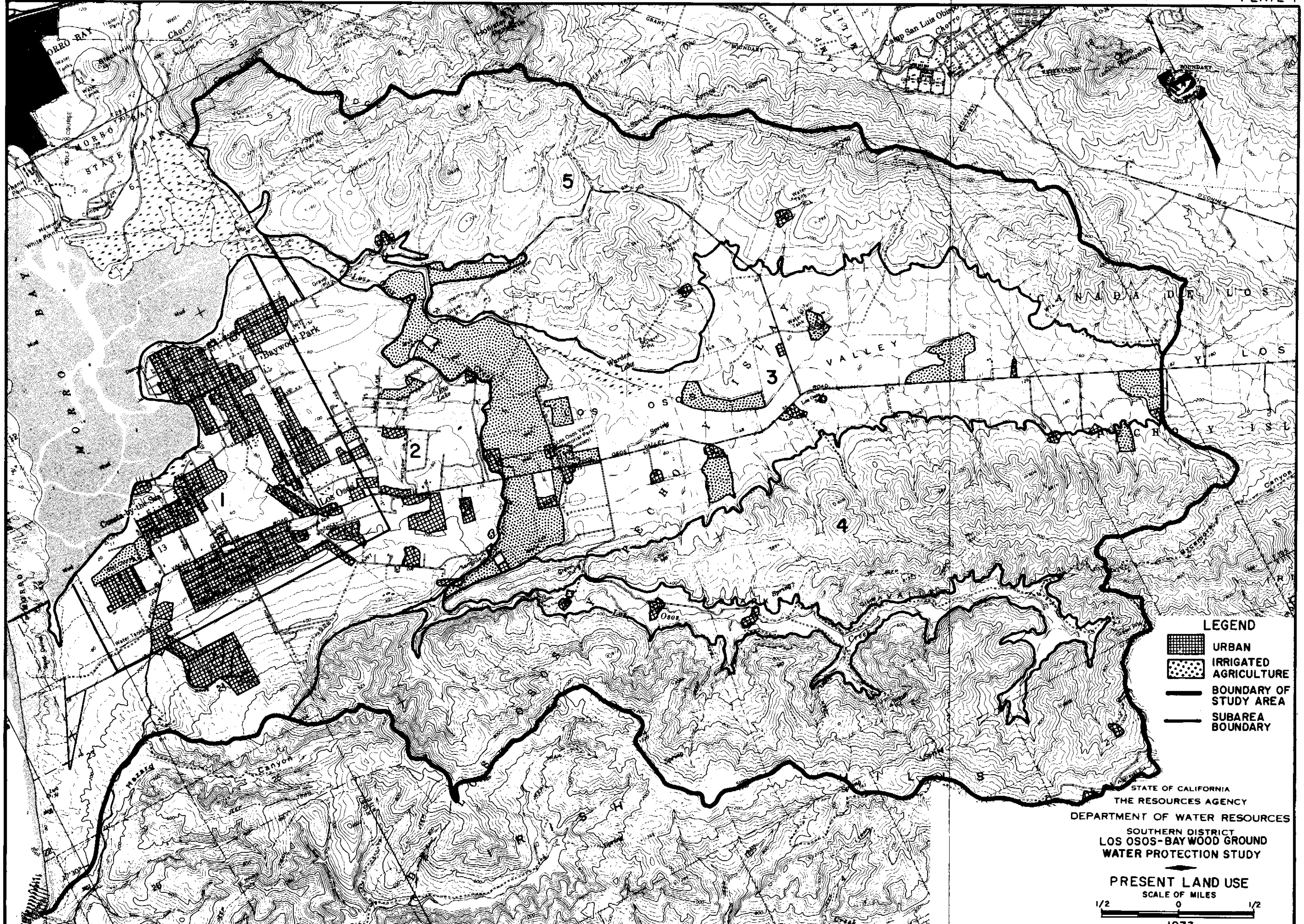
DATE TIME	SAMPLER LAB	TEMP		FIELD LABORATORY PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR	REM
						MINERAL CONSTITUENTS IN	MILLIGRAMS PER LITER MILLIEQUIVALENTS PER LITER PERCENT REACTANCE VALUE								MILLIGRAMS PER LITER					
	T	CENTRAL COASTAL DRAINAGE PROVINCE																		
	T-10	SAN LUIS OBISPO HYDRO UNIT																		
	T-10.8	SAN LUIS OBISPO HYDRO SUBUNIT																		
	T-10.83	LOS OSOS HYDRO SUBAREA											CONTINUED							
	30S/11E-18Q01 M																			
07/28/59						9.0	7.0	25	1.0	0	43	3.0	46	4.0	.00	.1	165	52		
	5787			7.0	274	.45	.58	1.09	.03	.00	.70	.06	1.30	.06		29.0	145	17	1.5	C
						21	27	51	1		33	3	61	3						
09/29/60		64	F			11	9.0	29	1.0	0	37	3.0	50	27.0	.03	.1	159	65		
	5050	18	C	6.8	292	.55	.74	1.26	.03	.00	.61	.06	1.41	.44		23.0	171	34	1.6	
						21	29	49	1		24	2	56	17						
10/31/61		58	F			12	12	23	1.0	0	49	2.0	46	27.0	.04	.1	180	80		E
	5050	14	C	7.3	231	.60	.99	1.00	.03	.00	.80	.04	1.30	.44		22.0	169	40	1.1	
						23	38	38	1		31	2	50	17						
10/22/62		63	F			7.0	9.0	31	1.0	0	39	7.0	42	30.0	.04	.1	131	55		
	5050	17	C	7.3	290	.35	.74	1.35	.03	.00	.64	.15	1.18	.48		26.0	172	23	1.8	T
						14	30	55	1		26	6	48	20						
09/23/63		73	F			9.0	9.0	35	1.0	0	41	5.0	43	35.0	.02	.1	154	60		
1430	5050	23	C	7.0	300	.45	.74	1.52	.03	.00	.67	.10	1.21	.56		26.0	183	26	2.0	
						16	27	55	1		26	4	48	22						S
10/07/64		68	F			10	8.0	29	1.0	0	35	12	44	26.0	.00	.0	158	58		
	5050	20	C	7.5	280	.50	.66	1.26	.03	.00	.57	.25	1.24	.42		--	147	30	1.7	
						20	27	51	1		23	10	50	17						
10/04/65		58	F			15	7.0	35	2.0	0	56	13	50	24.0	.25	.2	180	67		
1000	5874	14	C	7.8	300	.75	.58	1.52	.05	.00	.92	.27	1.41	.39		--	174	21	1.9	N
						26	20	52	2		31	9	47	13						
09/28/66		64	F			--	--	--	--	0	34	--	34	26.0	--	--				
	5050	18	C	7.7	257					.00	.56		.96	.42		--				
											29		49	22						
09/28/66		64	F			--	--	--	--	0	34	--	34	26.0	--	--				
1000	5050	18	C	7.7	257					.00	.56		.96	.42		--				
											29		49	22						
01/03/67		64	F			--	--	--	--	0	34	--	34	26.0	--	--				
	5050	18	C	7.7	257					.00	.56		.96	.42		--				
											29		49	22						
11/02/67		64	F			10	9.0	31	.0	0	36	10	48	.0	.04	.0	185	62		
1245	5050	18	C	7.9	277	.50	.74	1.35	.00	.00	.59	.21	1.35	.00		--	126	33	1.7	T S
						19	29	52			27	10	63							
12/11/69	5117	62	F			7.0	8.0	26	1.0	0	30	6.0	43	27.0	.00	.0	145	50		
1100	5050	17	C	7.8	262	.35	.65	1.13	.03	.00	.49	.12	1.21	.44		--	133	26	1.6	
						16	30	52	1		22	5	54	19						
	30S/11E-18Q02 M																			
12/15/62	5117			7.3		7.6	6.8	21	.7	0	36	6.6	30	--	--	.1		47		
1730	5091					.38	.56	.91	.02	.00	.59	.14	.85			--	90	18	1.3	
						20	30	49	1		37	9	54							
01/09/63	5117			7.5		7.0	5.0	23	.4	--	32	.0	34	4.3	--	.1		38		
1300	5091					.35	.41	1.00	.01		.52	.00	.96	.07		--			1.6	
						20	23	56	1		34		.62	5						
02/09/66	5117					--	--	--	--	--	--	--	--	--	--	--	125*			
1625	5091															--				
	30S/11E-18R01 M																			
08/05/65						7.0	6.0	21	.0	0	31	5.0	39	3.0	.00	.1	131	42		
	5050			7.0	198	.35	.49	.91	.00	.00	.51	.10	1.10	.05		--	96	17	1.4	T
						20	28	52			29	6	63	3						
	30S/11E-20B01 M																			
04/18/72	5117	63	F			41	46	39	1.9	0	344	34	47	.5	.09	.3	372	292		
	5050	17	C	8.0	669	2.05	3.78	1.70	.05	.00	5.64	.71	1.33	.01		--	379	10	1.0	
						27	50	22	1		73	9	17							
	30S/11E-20D01 M																			
03/26/70	5050	63	F			5.0	5.0	20	1.0	0	28	4.0	33	6.0	.00	.0	112	33		
1650	5050	17	C	6.8	175	.25	.41	.87	.03	.00	.46	.08	.93	.10		--	88	10	1.5	T
						16	26	56	2		29	5	59	6						
	30S/11E-20L01 M																			
03/26/70	5050	64	F			56	57	37	2.0	0	382	50	57	4.0	.08	.3	517	374		
1750	5050	18	C	7.6	815	2.79	4.69	1.61	.05	.00	6.26	1.04	1.61	.06		--	451	61	0.8	
						31	51	18	1		70	12	18	1						
	30S/11E-21D04 M																			
06/06/73	5050					101	108	63	.6	0	620	129	103	60.6	.09	.3	882	696		
1000	5050			8.0	1441	5.04	8.88	2.74	.02	.00	10.16	2.69	2.90	.98		--	870	188	1.0	
						30	53	16			61	16	17	6						
	30S/11E-21E01 M																			
03/27/70	5050	63	F			72	89	97	2.0	0	311	36	326	2.0	.05	.2	870	546		
915	5050	17	C	7.4	1526	3.59	7.32	4.22	.05	.00	5.10	.75	9.19	.03		--	777	291	1.8	
						24	48	28			34	5	61							
	30S/11E-22L01 M																			
06/11/54		64	F			36	83	94	5.0	0	380	32	211	5.0	.25	.3	884*	432		
	5786	18	C	8.2	1380	1.80	6.83	4.09	.13	.00	6.23	.67	5.95	.08		--	653	120	2.8	T
						14	53	32	1		48	5	46	1						

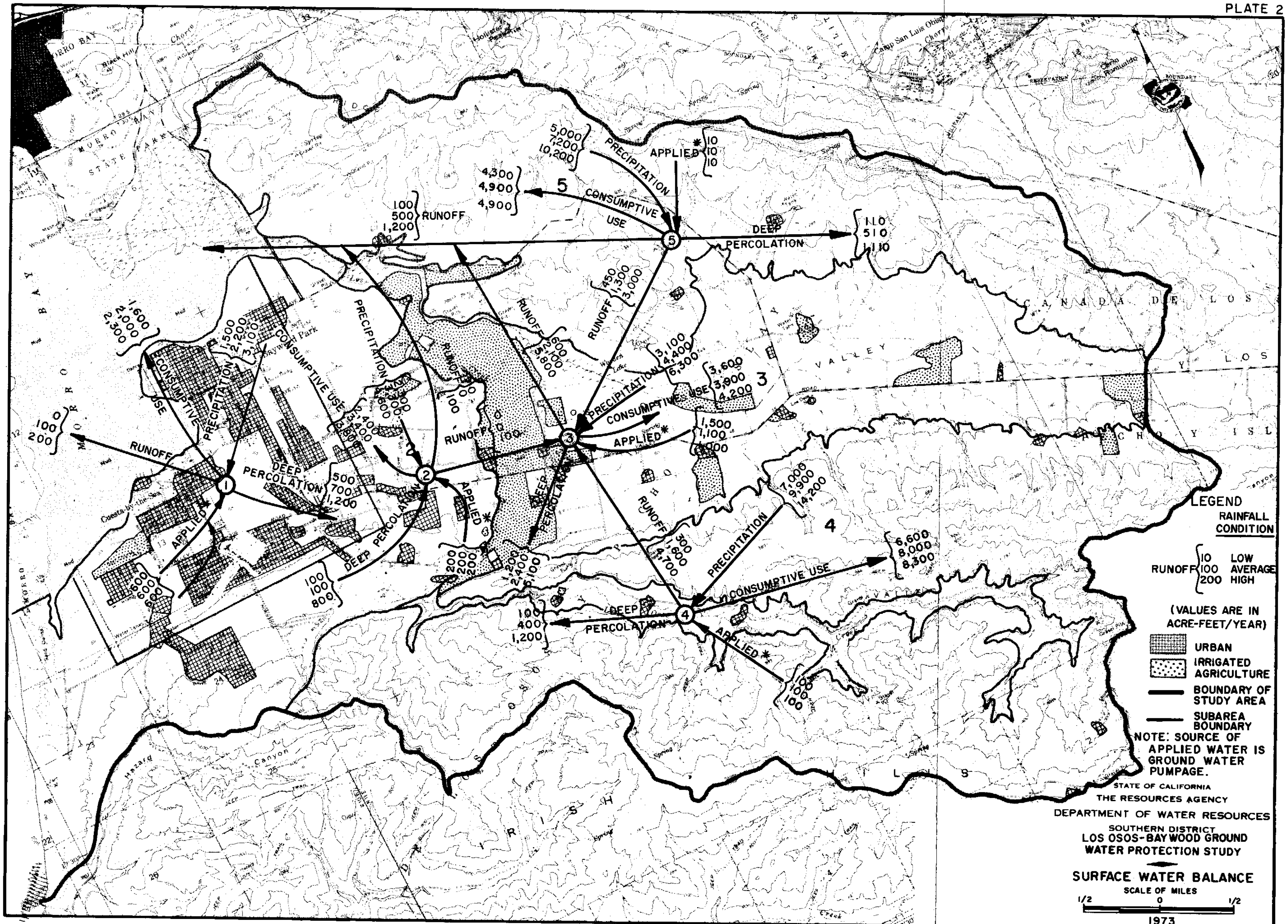
MINERAL ANALYSES OF GROUND WATER

DATE TIME	SAMPLER LAB	TEMP		FIELD LABORATORY PH	EC	CA	MG	NA	K	CO3	HCO3	SO4	CL	NO3	B	F SIO2	TDS SUM	TH NCH	SAR	REM
						MINERAL CONSTITUENTS IN					MILLIGRAMS PER LITER / MILLIEQUIVALENTS PER LITER / PERCENT REACTANCE VALUE				MILLIGRAMS PER LITER					
	T			CENTRAL COASTAL DRAINAGE PROVINCE																
	T-10			SAN LUIS OBISPO HYDRO UNIT																
	T-10.B			SAN LUIS OBISPO HYDRO SUBUNIT																
	T-10.B3			LOS OSOS HYDRO SUBAREA																
	30S/11E-23E01 M																			
03/05/57		63	F			42	77	114	1.0	0	363	27	244	16.0	.00	.8	721	422		
1400	5009	17	C	8.0	1360	2.10	6.33	4.96	.03	.00	5.95	.56	6.88	.26		22.0	721	124	2.4	
						16	47	37			44	4	50	2						
	30S/11E-23F01 M																			
12/09/65						11	49	15	1.0	0	246	7.0	34	3.0	.01	.2	312	229		
	5874			7.8	530	.55	4.03	.65	.03	.00	4.03	.15	.96	.05		--	241	28	0.4	T
						10	77	12	1		78	3	18	1						
03/27/70	5050	64	F			59	85	103	.0	0	395	35	251	19.0	.11	.5	756	497		
1230	5050	18	C	7.9	1452	2.94	6.99	4.48	.00	.00	6.47	.73	7.08	.31		--	746	173	2.0	
						20	49	31			44	5	49	2						
	30S/11E-25Q01 M																			
06/13/68						43	33	40	1.0	0	325	10	36	1.8	.22	.0	357	243		
	5050			7.4	626	2.15	2.71	1.74	.03	.00	5.33	.21	1.02	.03		--	325	0	1.1	
						32	41	26			81	3	15							
	30S/12E-30F01S M																			
12/06/65						45	13	22	1.0	0	179	11	39	18.0	.00	.3	300	166		
	5874			7.7	470	2.25	1.07	.96	.03	.00	2.93	.23	1.10	.29		--	237	20	0.7	T
						52	25	22	1		64	5	24	6						S

APPENDIX E
MINERAL ANALYSES OF SURFACE WATER

Station No.	Date sampled	EC	PH	Mineral constituents in milligrams per liter												
				Ca	Mg	Na	K	CO_3	HCO3	SO_4	Cl	NO_3	F	B	TDS	TH
							Los Osos Creek									
30S/11E-8D	6-4-73	8,500	8.1	101	207	1,430	47	0	43	357	2,500	5.4	0.5	0.66	5,167	1,103
30S/11E-8F	6-6-73	740	8.3	52	47	37	1	0	36	38	52	0.0	0.2	0.06	422	323
30S/11E-20B	3-30-54	344	8.0	28	22	16	3	0	178	24	20	2.5	0.2	0.35	182	160
	2-7-58	576	8.2	30	49	22	2	0	296	30	35	2.1	0.0	0.15	395	277
	1-6-65	201	7.0	11	14	9	4	0	104	13	8	2.0	0.2	0.04	130	85
30S/11E-20G	6-5-73	721	8.4	50	49	31	1	5	350	42	43	0.2	0.2	0.07	414	327
30S/11E-28F	6-6-73	652	8.2	41	49	24	1	-	347	31	31	0.8	0.2	0.04	368	304
							Tributary to Los Osos Creek									
30S/11E-9Q	6-6-73	1,971	8.1	86	94	180	1	0	555	37	350	3.2	0.4	0.1	1,145	601
							Eto Lake									
30S/11E-17G	6-4-73	416	7.3	22	17	35	3.5	0	152	5	52	0.6	0.1	0.09	254	125


LEGEND
URBAN
IRRIGATED AGRICULTURE
BOUNDARY OF STUDY AREA
SUBAREA BOUNDARY
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT
LOS OSOS-BAYWOOD GROUND WATER PROTECTION STUDY
PRESENT LAND USE
SCALE OF MILES
1/2 0 1/2
1973
MORRO BAY
Baywood Park
Los Osos
LOS OSOS VALLEY
1
2
3
4
5


LEGEND
RAINFALL CONDITION
RUNOFF 10 LOW
100 AVERAGE
200 HIGH
(VALUES ARE IN ACRE-FEET/YEAR)
URBAN
IRRIGATED AGRICULTURE
BOUNDARY OF STUDY AREA
SUBAREA BOUNDARY
NOTE: SOURCE OF APPLIED WATER IS GROUND WATER PUMPAGE.
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SOUTHERN DISTRICT
LOS OSOS-BAYWOOD GROUND WATER PROTECTION STUDY
SURFACE WATER BALANCE
SCALE OF MILES
1/2 0 1/2
1973
PRECIPITATION
CONSUMPTIVE USE
APPLIED
RUNOFF
DEEP PERCOLATION
MORRO BAY
LOS OSOS VALLEY
CANADA DE LOS OSOS
IRISH HILLS